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posted: January 6, 2023 • Norway, Safety

Ice throw from wind turbines: Assessment and risk management

Author: [Bredesen, Rolv](#)

Translate: *FROM* English | *TO* English

[*excerpts*]

What is in-cloud icing?

- If temperatures are below 0°C and the structure is located inside a cloud (above cloud base height) we get in-cloud icing.
- The ice accretion rates increases with the relative windspeed and the moisture content of the cloud.
- Because the blade of a wind turbine moves fast there is an elevated hazard associated with ice throw and fall from turbines located in icing conditions.

How far can the ice be thrown?

- Maximum throw distance (screening) : $1.5 \times (\text{Diam.} + \text{Ht.}) \sim 350 \text{ m.}^*$
- Ice debris have so far not been found at this distance.
- Ice pieces have been found at 68 % of the maximum throw distance.
 - $1.4 \times$ tip height (Cattin). 1000 ice pieces with 3 % above tip height
 - $1 \times$ tip height (Lunden, 2017). 500 ice pieces total.

*Strict German/Austrian regulations

- Seifert screening formula of danger zone: (Hubheicht

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+ rotordiameter) $\times 1.5$

- In Germany/Austria it is required to have ice detection systems if there are roads or buildings within this distance.
- **Restriction on production:** turbine must stop when there is icing.
- If detection systems are reliable and sensitive, then the potential hazard is most likely associated with ice fall and not throw of smaller ice pieces.

How dangerous is the ice?

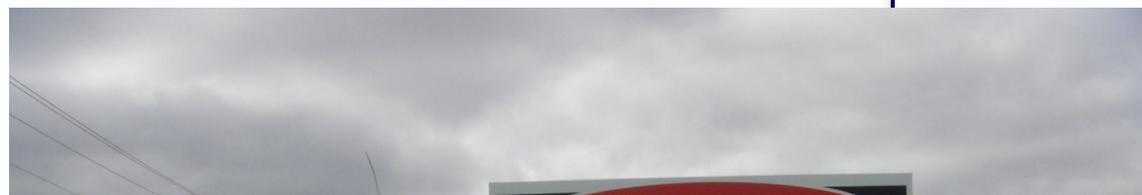
- An impact kinetic energy of more than 40 J is considered fatal.
- 40 J corresponds to a 0.2 kg ice piece with density 500 g/dm^3 falling from an elevation of 30–50 m.
- Because of the turbine height all ice pieces larger than approximately 0.2 kg are potentially fatal.

How large a risk can we accept?

Localized individual risk metric: the probability that an average unprotected person, permanently present at a specified location, is killed in a period of one year due to an accident at a hazardous installation

Acceptable risk:

- Ski tracks, hiking areas $< 10^{-4}$
- People walking along public road, industrial sites, scattered houses $< 10^{-5}$
- Houses, cafés, shops, etc. $< 10^{-6}$
- Schools, kindergartens, shopping malls, hospitals, etc. $< 10^{-7}$



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See also: R.E. Bredesen, H. Farid, M. Pedersen, D. Haaheim, S. Rissanen, G. Gruben and A. Sandve, "IceRisk: Assessment of risks associated with ice throw from wind turbine blades" (PO.339). <https://windeurope.org/summit2016/conference/allposters/PO339.pdf>, in WindEurope Summit, Hamburg, 2016.

Rolv Erlend Bredesen, *Kjeller Vindteknikk*

IEA Wind Task 19, Winterwind 2017

February 15, 2017

Download original document: "[Ice throw from wind turbines: Assessment and risk management](#)"

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