International Recommendations for Ice-Fall / Ice-Throw Risk Assessments

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Two cantons – two requirements

Motivation and Project Objective

Large deviations in:

- Stipulation of mitigation measures / regulatory requirements
- Requirements of authorities regarding assessments
- Methodologies / results of individual consultants

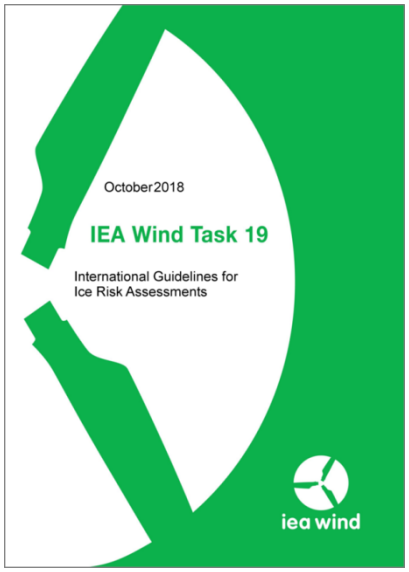
Project Objective:

- International guidelines/recommendations for the elaboration of ice-throw / ice-fall risk assessments
- Awareness of authorities and wind energy community about crucial parameters → Paving the way to more transparency
- Identification of core recommendations (‘must haves’)

Project Organisation

8 international Partners (with different background)

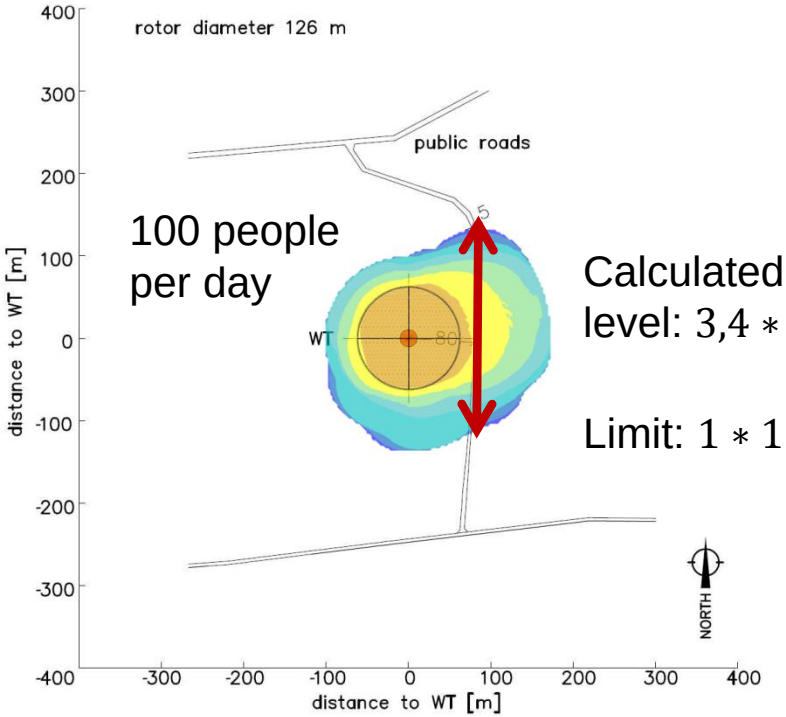
- 4x Consultants
- 2x Certification bodies
- 1x WF developer & operator
- 1x Turbine Manufacturer



International Recommendations

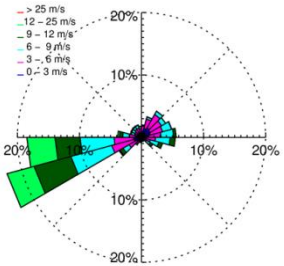
- Published in October 2018
- Under the umbrella of IEA Wind Task 19

Prevalent approach of ice-fall risk assessments



Calculated Risk level: $3{,}4 * 10^{-5}$

Limit: $1 * 10^{-6}$



Wind Data

Icing Data

BUT: Assumptions and uncertainties!

- Mathematical model
- Data basis for the location
- Risk Assessment

Size and weight distributions

	Dimensions	Mass	Numbers
50 %	3x4x8cm	86g	250
35 %	5x8x10cm	240g	175
10 %	5x10x50cm	1,5kg	50
5 %	3x20x100cm	5,4kg	25

	Dimensions	Mass	Numbers
77 %	3x5x10cm	90g	385
14 %	3x9x10cm	243g	69
9 %	10x13x20cm	1,6kg	44
0,4 %	16x19x20cm	5,5kg	2

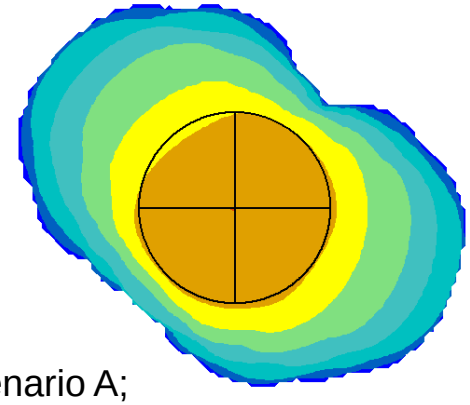


Fig.: Scenario A;
Dmax = 154m

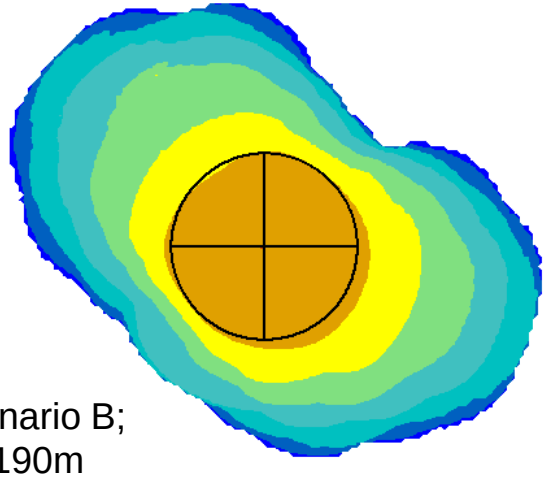


Fig.: Scenario B;
Dmax = 190m

Mathematical Model

(i.e. statistical trajectory model)

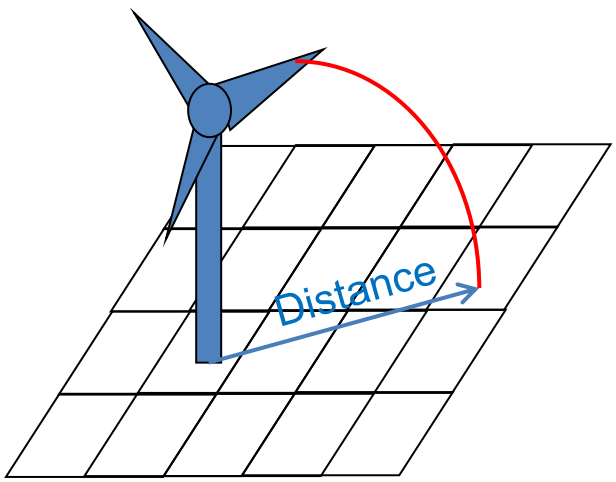
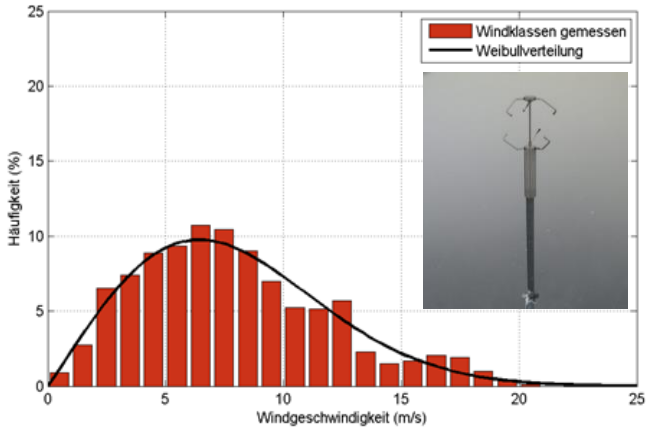


Fig.: Calculation of Trajectories

- Turbine parameters:
  - H_N, D_R, operational mode (e.g. idling)
- Topography in case of complex terrain
  - DTM or via post-processing
- Physical parameters:
  - Air density, vertical wind profile, radial distribution of ice on the blade, parameters of relevant ice fragments
- Integration into a statistical model
  - Blade position, break-off points…

Wind Data Basis



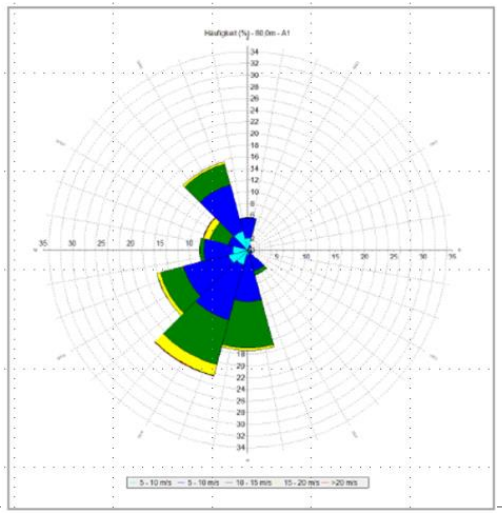


Fig. Source: Energiewerkstatt

- 10 minutes' averaging (or less)
  - Wind speed & direction
- Representative for the turbine location
  - Horizontal and vertical extrapolation
  - Long term correction
- Representative for periods when icing and melting may occur
  - Filtering shall not be done too narrow!

Icing Data Basis

Amount of ice fragments:

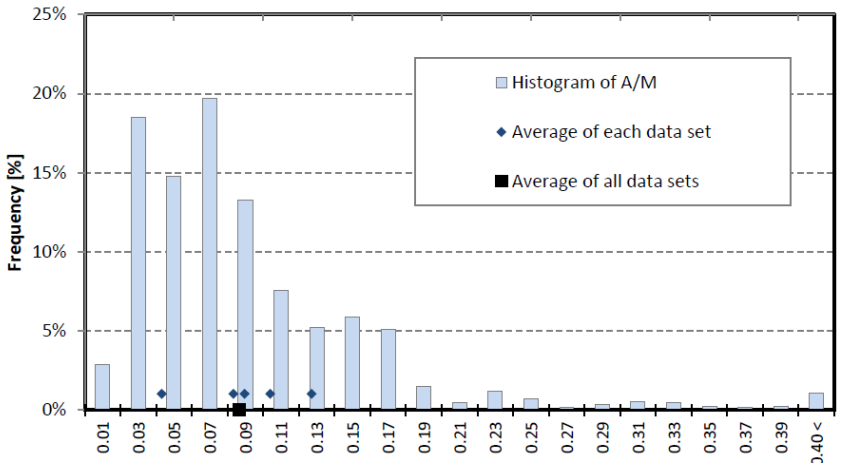
E.g. Scaling of in situ ice fall / throw observations (e.g. Gütsch, Icethrower, R.Ice…)

$$N_{site} = N_{obs} * sf_{ice} * sf_{rotor} * sf_{op}$$

Tabular indication regarding no. of fragments for five IEA icing classes

Shape of ice fragments:

E.g. Merged A/m distribution from five different collection campaigns



A/m histogram and averages for data sets

Risk Assessment

- Risk analysis:
  - Risk = “Probability of occurrence" times “Consequence“
  - Recommendations regarding Consequences and Exposure
- Risk evaluation:
  - Recommendations reg. risk acceptance criteria: “Which risk is acceptable?”
  - Distinction of individual and societal risk
  - Comparison of results of analysis and acceptance criteria to define whether additional measures are required
- Risk reducing measures
  - Efficiency / effectiveness of the individual measures

Considerations regarding uncertainties

- Two sorts of factors of influence
  - Effect on the landing positions (wind speed, aerodyn. parameters)
    - → To be estimated as realistic as possible
  - Direct effect on the calculated risk level (no. of fragments, mitigation measures…)
    - → To be selected conservatively
- Conclusion of the consortium
  - Site and project specific!
  - Biggest deviations regarding the risk: Icing data and risk assessment

Impact of operational modes

- Experiences from canton Burgenland/Austria
  - Until recently: Obligatory RBH System
- Experiences from canton Styria / Austria
  - Heating during operation
- Most significant decision: Ice fall vs. ice throw

Summary

- A first step towards more transparency
- More Objective assessments possible (e.g. in Austria)
  - Distances < “BTH+20%” accepted
  - RBH system no longer required for locations close to Vienna
- Remaining challenges
  - Considerations regarding operational modes
  - Efficiency of measures: Technical and juridical perspective
  - Authorities need to be Informed

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Photo: The Alps
Source: Energiewerkstatt

Thanks for your Attention.