

## ADOLF THIES GmbH & Co. KG

### Factory Standard Icing 012002 – Requirements for Heating Systems

This factory standard describes the requirements for the heating of measurement systems. These systems remain functional, with the utmost probability within their specifications, even under extreme meteorological icing conditions

The thresholds of the parameters temperature and wind speed have been derived from measuring data of longstanding observations at extreme locations in consideration of their probability of occurrence.

In order to define the requirements for an icing-proof measurement system, the following assumptions, derived from the observed data, have been made.

1. The probability of the occurrence of high wind speeds drops with falling air temperature.
2. The probability of the occurrence of an icing situation with respective liquid-water-content (LWC) drops with falling air temperature.
3. The icing of surfaces occurs only, when the temperature of the surfaces, which shall be kept ice-free, falls below 0°.
4. The icing is a cumulative process, the residence time is assumed to be infinite.
5. The liquid water content (LWC) of the air effects a mitigation of the requirements for the heating, because the released crystallization energy at the phase change liquid/solid counteracts the cooling by the wind, and thus the icing.

The gaseous water content of the air is not directly involved in a possible icing.

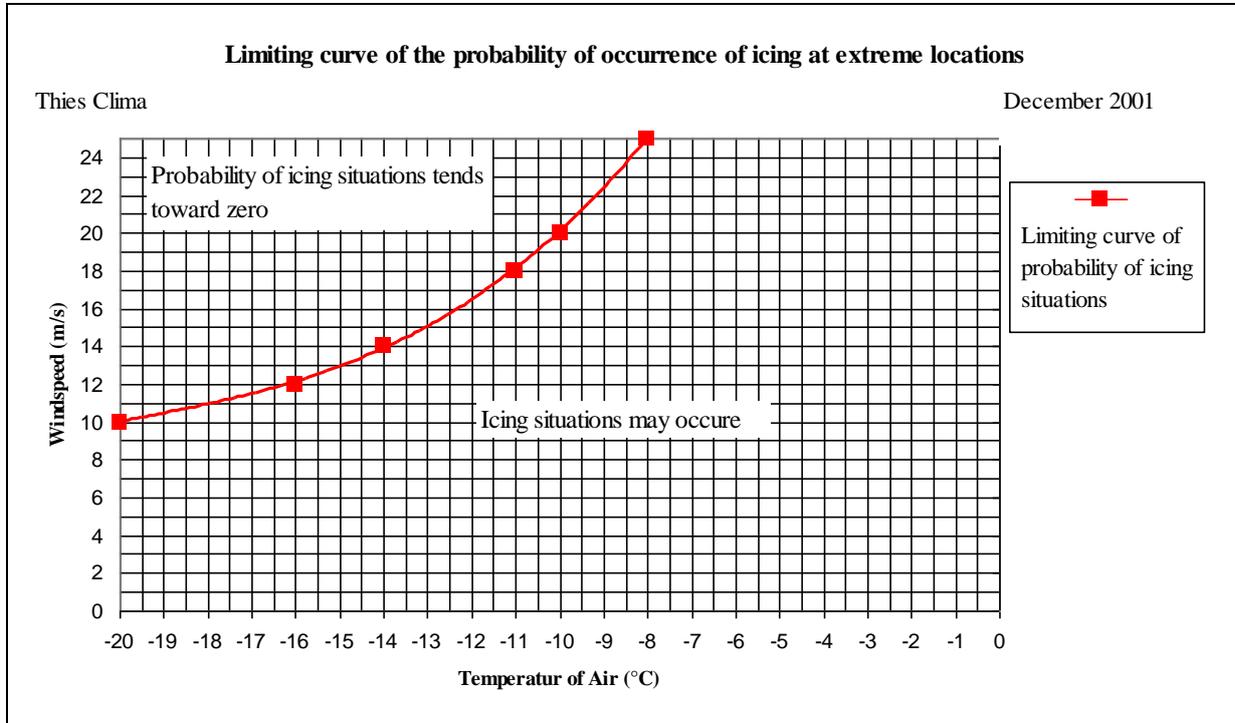
6. For testing the effectiveness of a heating system, it is sufficient to carry out a measurement in dry air as worst-case-condition.
7. Beyond the following conditions of air temperature and wind speed, icing situations are most improbable, even at locations with extremely high risk of icing:

**Conditions:**

<b>Air temperature lower than:</b>	<b>-20°C</b>	<b>-16°C</b>	<b>-14°C</b>	<b>-11°C</b>	<b>-10°C</b>	<b>-8°C</b>
<b>Wind speed higher than:</b>	<b>10 m/s</b>	<b>12 m/s</b>	<b>14 m/s</b>	<b>18 m/s</b>	<b>20 m/s</b>	<b>25 m/s</b>

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Date			
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Revision status	Rev 0 of 07.08.2002		

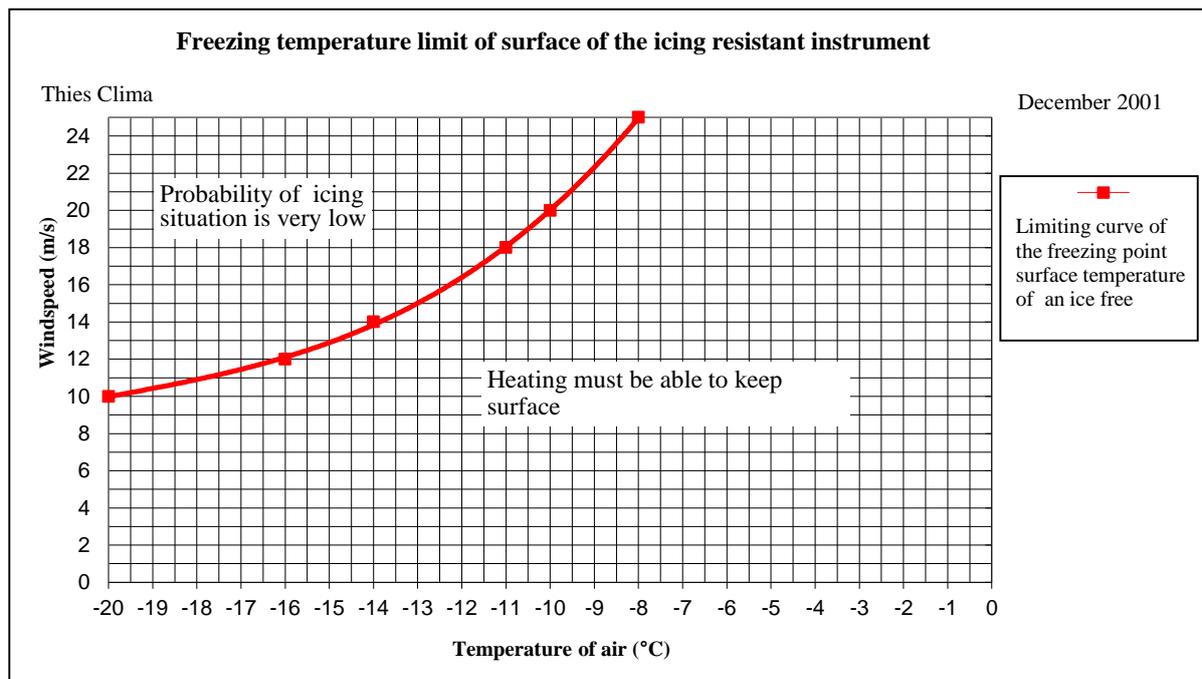
Diagram 1:



According to analysis of long-standing weather observations, the probability that icing situations occur beyond the threshold curve in the left-hand upper area of the diagram, tends towards zero. In the right-hand lower area of the diagram icing situations have been observed, where the probability drops that they occur towards the threshold curve.

The following diagram for the requirements for the heating of the uncovered surfaces of the probe for an ice-free operation has been derived from this diagram of occurrence-probability of icing-situations subject to the wind speed and air temperature.

**Diagram 2:**



### Verification of compliance with the factory standard

Instruments, being specified in accordance with the **THIES factory standard 012002**, must comply with the requirements given in the above shown diagram.

When all acquired measuring points for a surface temperature of  $\geq 0^\circ\text{C}$  are located left-hand above the threshold curve, the factory standard is fulfilled.

If some measuring points are below in the right-hand part of the diagram, icing at extreme locations cannot be ruled out.

In particular, the surfaces of the sensors, relevant for the measurement, as well as their holders, must be kept in the positive temperature range by heating under the above mentioned conditions of wind speed and air temperature.

Here, please pay attention to the following: even if the icing of parts of the instrument does not result in deterioration or failure of the measurement, it might indirectly influence the measurement or make it impossible after a longer residence time.

This might occur e.g. through ice accretions, affecting as obstacle in the flow or as shading.

#### **Recommended test setup for verification of requirements**

Installation of the device under test at operational conditions in the climatic chamber.  
Mounting of miniature temperature sensors on the sensor surfaces, which are sensible for icing.  
These sensors should have a possibly low disturbing effect to the measured results.  
Here, please take care of a good thermal coupling between surface and sensor.  
Measured values can be falsified through the heat flow of the connecting wires of the temperature sensors.  
This risk can be minimized by using thin wires.

#### **Procedure of the verification**

Supplying a pre-selectable constant wind speed to the probe parts, which are sensitive to icing.  
Reducing the air temperature while the probe heating is activated until the surface temperature falls below the 0°C-threshold.  
Enter this point of air temperature into the diagram.  
Repeat the measuring procedure with different wind speeds as parameters.

#### **Evaluation of the results**

When all acquired temperature vs wind speed measuring points are located left-hand above the threshold curve, the factory standard is fulfilled.