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Winter maintenance equipment — Road weather information systems

Part 3: Requirements on measured values of stationary equipment

National foreword

This British Standard is the UK implementation of EN 15518-3:2023. It supersedes BS EN 15518-3:2011, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/513, Construction equipment and plant and site safety.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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information systems - Part 3: Requirements on measured
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European foreword

This document (EN 15518-3:2023) has been prepared by Technical Committee CEN/TC 337 "Road operation equipment and products", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2024, and conflicting national standards shall be withdrawn at the latest by May 2024.

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This document supersedes EN 15518-3:2011.

EN 15518-3:2023 includes the following significant technical changes with respect to EN 15518-3:2011:

- added definition and requirements for:
 - freezing temperature;
 - ice;
 - hoar frost;
 - ice film thickness;
 - snow layer thickness;
- differentiation between embedded and remote (non-invasive) road sensors and specific requirements for:
 - road surface temperature;
 - road surface condition;
 - water film thickness;
 - ice film thickness (only for remote sensors);
 - snow layer thickness (only for remote sensors);
- adaptation of the definition and differentiation between active and passive measurement methods in the requirements for freezing temperature;
- added requirements for:
 - amount of de-icing agent;
 - amount of precipitation;
- adaption of requirements for:
 - road body temperature;

- air temperature;
- relative humidity;
- precipitation intensity;
- removed requirements for snow height (on and next to the road).

EN 15518, *Winter maintenance equipment — Road weather information systems*, is currently composed with the following parts:

- *Part 1: Global definitions and components;*
- *Part 2: Road weather — Recommended observation and forecast;*
- *Part 3: Requirements on measured values of stationary equipment;*
- *Part 4 (CEN/TS): Test methods for stationary equipment.*

A list of all parts in a series can be found on the CEN website: <https://www.cenelec.eu/>.

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Introduction

Road Weather Information Systems (RWIS) are complex structures used for road maintenance decision support, which feature as a rule the following components: meteorological sensors and instruments, road condition sensors (embedded or remote), transmission technology, computer systems for processing, representation and storing of information, road weather forecasts and alarms, in relation to traffic control and traffic information systems and more.

A stationary road weather station performs the acquisition of road and meteorological information at a fixed location.

This document lays down the requirements for the recommended sensor components of a road weather station of a Road Weather Information System (RWIS). In the description of requirements, a distinction is made between the sensor components forming a basis road weather station for winter use and the recommended complementary optional sensor components.

Parameters which are not in the standard but offered on the market could be useful but are left out of this minimum standard due to the fact that there are currently no professional methods available to verify these parameters.

The aim is to ensure extensive combination and interchangeability within the systems.

With a set terminology for the components and the meteorological expressions an attempt is made to counteract a diversity of terms and designations for identical phenomena.

1 Scope

This document specifies the terminology and performance requirements for all sensor components of stationary equipment within a Road Weather Information System (RWIS).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 15144, *Winter maintenance equipment — Terminology — Terms for winter maintenance*

CEN/TS 15518-4, *Winter maintenance equipment — Road weather information systems — Part 4: Test methods for stationary equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15144 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

NOTE The following definitions have been established specifically for the RWIS domain.

3.1 Road parameters

3.1.1

pavement surface temperature

<remote measurements> effective radiation temperature of a pavement surface and the contaminant layer; <embedded measurements> conductive temperature on the pavement surface

3.1.2

road body temperature

temperature of the road in a specific depth in the construction layers

3.1.3

amount of de-icing agent

mass of de-icing agent on a road surface per square metre

3.1.4

freezing temperature

temperature at which a liquid begins to freeze on a road surface

Note 1 to entry: The requirement specifications for freeze temperature in this document are valid under well-known and reproducible laboratory environment conditions. The real environment condition on a road under traffic result in high variations due to the highly variable distribution of water film and de-icing agent concentration over the pavement surface and a lot of other influences like traffic, solar radiation, surface slope, etc.

3.1.5

road surface condition

qualification of the status of road surface affected by road weather phenomenon

3.1.6

water film thickness

mean thickness of the film of water present on a flat surface, measured on a specific measurement area observed by a sensor

Note 1 to entry: If a sensor provides also ice film and snow layer thickness, then this parameter means the liquid portion. If a sensor doesn't provide ice film and snow layer thickness, then water film thickness means all kind of water content (water equivalent).

3.1.7

ice

water on a surface freeze from a liquid state to solid state, if surface temperature drops down below *freezing temperature* (3.1.4) or if liquid precipitate falls on a surface whose temperature is below freezing and immediately freezes into solid state

3.1.8

hoar frost

ice crystals deposit formed from contact of airborne moisture with a surface whose temperature is below freezing

Note 1 to entry: Hoar frost differs from ice in that the frost crystals grow independently and, therefore, have a more granular texture. Currently known surface sensor technologies are not able to detect Hoar Frost directly. The condition can only be classified by the measuring station with the help of atmospheric sensors.

3.1.9

ice film thickness

mean thickness of the film (or layer) of ice (water equivalent of frozen water) present on a flat surface, measured on a specific measurement area observed by a sensor

3.1.10

snow layer thickness

approximative layer of snow (water equivalent of snow) present on flat surface, measured on a specific measurement area observed by a sensor

Note 1 to entry: Snow layer thickness gives an indication about the layer of snow, but accuracy cannot be defined nor verified.

3.2 Atmospheric parameters

3.2.1

relative humidity

RH

measure of how much water vapor is in a water-air mixture compared to the maximum amount possible

3.2.2

precipitation

falling water from the atmosphere in liquid and/or solid form which can be observed and measured on ground

3.2.3

rain

precipitation in liquid form

3.2.4

snow

water vapour in the atmosphere that has been condensed directly into ice without going through the liquid state

Note 1 to entry: The small ice crystals absorb and freeze additional water vapor from surrounding air, growing into snow crystals. The clusters of snow crystals are formulated into snowflakes.

3.2.5

amount of precipitation

thickness of the layer of water obtained by precipitation (rain or melted solid precipitation) on a horizontal surface

3.2.6

intensity of precipitation

amount of precipitations per unit of time

3.2.7

wind speed

distance which traverses the air per unit of time

Note 1 to entry: Wind speed is either instantaneous or mean wind.

3.2.8

gust of wind

sudden and transient strengthening of the wind, resulting in a brief and sudden increase in the instantaneous *wind speed* (3.2.7), compared to the value achieved by its mean wind

3.2.9

wind direction (instantaneous and mean wind)

direction from where the wind is blowing with respect to the magnetic north

3.2.10

visibility

distance defined by the meteorological optical range

3.2.11

global radiation

solar radiation received by a horizontal surface from the upper hemisphere, directed towards the ground, within a spectral range from 0,3 μm to 3 μm

3.3 General

3.3.1

protection shield

shelter built in such a manner that it protects its contents against solar radiation, precipitations and condensation and contributes at the same time to ventilation

3.3.2

sampling interval

time between two readings meant for the elaboration of a reported value

3.3.3**measurement interval**

time between two elaborated values

3.3.4**polling interval**

time between two transmissions of elaborated, reported values

3.3.5**response time**

time for a sensor to reach 90 % of its final stable reading after performing a step function of the true value

3.3.6**reporting range**

range of values of a sensor report

Note 1 to entry: The reporting range does not include accuracy requirements and is not subject to test (unlike the measuring range).

3.3.7**embedded sensor**

sensor installed in the road pavement

3.3.7.1**active measurement**

measurement of *freezing temperature* (3.1.4) by active cooling down and heating up a small measurement area, transition from liquid state to solid state, observed by an embedded sensor

3.3.7.2**passive measurement**

calculation of freezing temperature by measuring the electrochemical properties of the solution by an embedded sensor

3.3.8**remote sensor**

any kind of sensor which determines road or ground surface parameters contactless (from a certain distance)

4 Requirements

The requirements hereafter apply to sensors in road conditions. However, the accuracy requirements are meant for repeatable, reproducible and comparable, well defined environmental conditions, mostly in laboratory. Sensor set-up, calibration and special handling shall be specified by the manufacturer.

The first column of Table 1 hereafter states "B" for parameters recommended in a basic configuration, and "O" for parameters considered as optional according to specific applications.

a) Operation temperature

- 1) Sensors embedded in the pavement need to survive surface temperatures from -40 °C to $+70\text{ °C}$;
- 2) equipment placed in the air need to survive air temperatures from -40 °C to $+60\text{ °C}$.

b) Chemical resistance

All components of the road weather stations shall be resistant or protected to chemicals which roads are normally exposed.

c) Mechanical resistance

Sensors and other components embedded in the pavement shall withstand regular mechanical stress exerted by traffic which has to be commonly encountered on site, including rollovers by snow-clearing machines.

d) Electro-magnetic resistance

All components of the road weather station shall not be affected by conventional environing electro-magnetic conditions.

e) Operation conditions

The siting of road weather station with the atmospheric sensors beside the road and the expected data quality due to the environment classification in principle should follow the WMO No. 8 (Annex I.B) guidelines. However, the atmospheric data sensors for road weather station should be able to work as best as possible under circumstances which correspond to class 4 or even class 5 of the environmental classification given in WMO No. 8, Annex I.B (CIMO guide, issue 2012, Environmental conditions).

The position of the atmospheric measurements parameters for RWIS Stations should be as close to the road as possible but in accordance with the conditions and regulations of the respective road authorities.

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Table 1 — Measurement requirements

	Parameters	Requirements
B	Pavement surface temperature	<p>For pavement embedded sensors:</p> <p>Measuring range: -30 °C to +60 °C; Reporting range: -30 °C to +70 °C; Resolution: 0,1 °C; The requirements only apply under stable test conditions: Accuracy: ±0,2 °C (range from -15,0 °C to +10,0 °C); ±0,8 °C (otherwise); The requirements only apply under transient test conditions: Accuracy: -1,5 °C to +0,5 °C (90 % transient); according to related test conditions in CEN/TS 15518-4</p> <hr/> <p>For remote sensors:</p> <p>Measuring range: -30 °C to +60 °C; Reporting range: -30 °C to +70 °C; Resolution: 0,1 °C; Accuracy: ±0,8 °C (range at 0 °C, isotherm laboratory condition); undefined (under different environmental conditions). according to related test condition in CEN/TS 15518-4</p>
B	Road surface condition	<p>For pavement embedded sensors:</p> <p>Dry: no humidity within the measurement area of the sensor; Not dry: from 0,015 mm water film thickness within the measurement area of the sensor.</p> <hr/> <p>For remote sensors:</p> <p>Dry: no humidity within the measurement area of the sensor; Moist: from 0,015 mm water film thickness within the measurement area of the sensor; Wet: from 0,045 mm water film thickness within the measurement area of the sensor; Ice: surface contaminated with water in solid state – whole water content frozen;</p>

Parameters	Requirements
	<p>water equivalent more than 0,015 mm;</p> <p>Snow: surface contaminated with dry, packed or wet snow (see 3.2.4). Total water equivalent more than 0,015 mm;</p> <p>Slush: surface contaminated with a mixture of snow or ice and liquid water or deicing chemical solution. Total water equivalent more than 0,015 mm;</p> <p>Hoar frost: surface contaminated with hoar frost (see 3.1.8).</p>
B	<p>Water film thickness</p> <p>The following requirements apply for pavement embedded sensors:</p> <p>Measuring range: 0,00 mm to 3,00 mm;</p> <p>Resolution: 0,01 mm;</p> <p>Accuracy: $\pm 50\%$ (range from 0,01 mm to 0,10 mm); $\pm 30\%$ (range from 0,11 mm to 3,00 mm).</p> <p>The requirements are considered for water films in liquid state. This requirement specification is valid under stable and reproducible environment conditions. It has to be considered that the real environment condition on a road under traffic, result in high variations.</p> <hr/> <p>The following requirements apply for remote sensors:</p> <p>Measuring range: 0,00 mm to 2,00 mm;</p> <p>Resolution: 0,01 mm;</p> <p>Accuracy: $\pm 50\%$ (range from 0,05 mm to 0,10 mm); $\pm 30\%$ (range from 0,11 mm to 2,00 mm).</p> <p>The reference area of remote working sensors depending on measuring distance had to be specified by the supplier as well as the maximum measuring distance and angle. The mean water film thickness is to be reported over the reference area. The requirements are considered for water films in liquid state. If a sensor did not provide ice film and snow layer thickness, then this water film is considered as all kind of water content (water equivalent). This requirement specification is valid under stable and reproducible environment conditions. It has to be considered that the real environment condition on a road under traffic, results in high variations.</p>
O	<p>Ice film thickness</p> <p>The following requirements apply for remote sensors:</p> <p>Measuring range: 0,00 mm to 2,00 mm (water equivalent);</p> <p>Resolution: 0,01 mm;</p> <p>Accuracy: $\pm 50\%$ (range from 0,05 mm to 0,10 mm); $\pm 30\%$ (range from 0,11 mm to 2,00 mm).</p> <p>The reference area of remote working sensors depending on measuring distance had to be specified by the supplier, as well as the maximum measuring distance and angle.</p>

	Parameters	Requirements
		<p>The mean ice film thickness is to be reported.</p> <p>This requirement specification is valid under stable and reproducible environment conditions. It has to be considered that the real environment condition on a road under traffic, result in high variations.</p>
0	Snow layer thickness	<p>The following requirements apply for remote sensors:</p> <p>Measuring range: 0,00 mm to 200 mm (water equivalent);</p> <p>Resolution: 0,01 mm;</p> <p>Accuracy: undefined.</p> <p>The reference area of remote working sensors depending on measuring distance had to be specified by the supplier, as well as the maximum measuring distance and angle.</p> <p>The mean snow film thickness is to be reported.</p> <p>This requirement specification is valid under stable and reproducible environment conditions. It has to be considered that the real environment condition on a road under traffic, results in high variations.</p> <p>NOTE See also definition in 3.1.10.</p>
0	Freezing temperature	<p>These requirements apply only for embedded sensors and under stable test conditions according to related test conditions in CEN/TS 15518-4:</p> <p>Active measurement:</p> <p>Measuring range: -30 °C to 0 °C;</p> <p>Resolution: 0,1 °C;</p> <p>Accuracy: ±1,0 °C (range from 0,0 °C to -15,0 °C); ±1,5 °C (otherwise).</p> <p>This requirement is independent of the de-icing agent being used.</p> <p>Passive measurement:</p> <p>Measuring range: -30 °C to 0 °C;</p> <p>Resolution: 0,1 °C;</p> <p>Accuracy: undefined.</p> <p>This requirement depends on the de-icing agent being used. The de-icing agent has to be specified.</p>
0	Amount of de-icing agent	<p>Applies for embedded active and passive sensors:</p> <p>Measuring range: 0 g/m² to 50 g/m²;</p> <p>Resolution: 1 g/m²;</p> <p>Accuracy: ±50 %.</p> <p>Maximum range depends on the de-icing agent being used. The de-icing agent has to be specified.</p>

	Parameters	Requirements
O	Road body temperature	Measuring range: -25 °C to $+60\text{ °C}$; Resolution: $0,1\text{ °C}$; Accuracy: $\pm 0,3\text{ °C}$ (range from $-5,0\text{ °C}$ to $+5,0\text{ °C}$).
B	Air temperature	Measuring range: -40 °C to $+60\text{ °C}$; Resolution: $0,1\text{ °C}$; Accuracy: $\pm 0,2\text{ °C}$ (range from $-10,0\text{ °C}$ to $+10,0\text{ °C}$); $\pm 0,5\text{ °C}$ (otherwise).
B	Relative humidity	Measuring range: at least 30% to 100% ; Resolution: 1% ; Accuracy: $\pm 2\%$ (air temperature -20 °C to $+20\text{ °C}$).
B	Dew-point temperature	Calculated from air temperature AT and relative humidity RH: Resolution: $0,1\text{ °C}$; Accuracy: $\pm 0,5\text{ °C}$ (range: $-10\text{ °C} \leq AT \leq +10\text{ °C}$ and $85\% < RH \leq 100\%$); $\pm 1,5\text{ °C}$ (otherwise).
B	Precipitation detection time	The following precipitations have to be detected in the following time: 2 min: $\geq 1,2\text{ mm/h}$; 6 min: $\geq 0,4\text{ mm/h}$; 10 min: $\geq 0,1\text{ mm/h}$.
B	Precipitation type	Distinction between solid and liquid precipitation with 80% confidence within the above precipitation detection time.
O	Precipitation intensity	Measuring range: $0,01\text{ mm/h}$ to 200 mm/h ; Resolution: $0,01\text{ mm/h}$; Accuracy: $\pm 60\%$ (range from $0,1\text{ mm/h}$ to $0,50\text{ mm/h}$); $\pm 30\%$ (range from $0,51\text{ mm/h}$ to $5,00\text{ mm/h}$); $\pm 40\%$ (range from $5,01\text{ mm/h}$ to 100 mm/h). Undefined (for solid or mixed precipitation). The accuracy is given for liquid precipitation, when measured in a 10 min period. Solid precipitation shall be expressed in terms of the rainfall equivalent.
O	Amount of Precipitation	Measuring range: $0,01\text{ mm}$ to 200 mm ; Resolution: $0,01\text{ mm}$; Accuracy: $\pm 30\%$. The accuracy is given for liquid precipitation, when measured in a 60 min period. Accuracy: undefined (for solid or mixed precipitation). Solid precipitation shall be expressed in terms of the rainfall equivalent.

	Parameters	Requirements
O	Wind speed	Measuring range: at least from 0,0 m/s to 35,0 m/s; Resolution: 0,1 m/s; Accuracy: ± 1 m/s (range from 1,0 m/s to 10,0 m/s); ± 10 % (otherwise); Starting value: < 1 m/s. The wind speed shall be specified as an average vector over a sliding time interval of 10 min.
O	Gust of wind	Measuring range: 0 m/s to 50 m/s; Resolution: 0,1 m/s; Accuracy: ± 1 m/s (range from 1,0 m/s to 10,0 m/s); ± 10 % (otherwise); Starting value: < 1 m/s. The gust of wind is measured over 3 seconds rolling average values with at least 4 samples per second.
O	Wind direction	Measuring range: 0° to 359° ; Resolution: 1° ; Accuracy: $< \pm 10^\circ$; Starting value: < 1 m/s at an initial deflection of 90° . The wind direction shall be specified as an average vector over a sliding time interval of 10 min.
O	Visibility	Measuring range: 10 m to 500 m; Resolution: 1 m; Accuracy: ± 10 m or ± 20 %, whichever is greater.

NOTE If for an accuracy requirement a \pm percentage (%) is stated, always the percentage of the measured value is meant - unless expressly stated otherwise.

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