AWS Tender Specifications:AWS\_Sensors

# Air Temperature

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 1 | T.SP.1 | Sensor/Hardware Performance | Measurement Range | The measurement range shall be -80 °C to +60 °C. | Demonstration | Essential (Regional Input) |
| 4 | T.SP.2 | Sensor/Hardware Performance | Sensor Performance Constant | The instrument time constant under controlled conditions shall be 20 s or better over the entire operational range. For field measurements in non-actively aspired radiation screens this may not be achievable. | Inspection | Essential |
| 6 | T.SP.3 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 21 | T.SP.4 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 22 | T.SP.5 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 25 | T.SP.6 | Sensor/Hardware Performance | Sources of Error | The Tendered equipment shall demonstrate that the following common sources of error have been adequately compensated for:- a) Self heating of the thermometer element b) Inadequate compensation for lead resistance c) Inadequte Compensation for non-linearites in the sensor or processing instrument d) sudden changes in switch contact resistance. | Inspection | Essential |
| 44 | T.SP.7 | Sensor/Hardware Performance | Allowed Technologies | The air temperature measurement shall use either resistance thermometer or thermocouple technology. | Inspection | Essential |
| 400 | T.SP.8 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be 0.2 ºC or better. | Inspection | Essential (Regional Input) |
| 1068 | T.SP.9 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1072 | T.SP.10 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 10 | T.SS.1 | Sensor Siting | Installation Height | The sensor/instrument for Ta measurements shall be mounted inside the radiation screen at a height between 1.25 and 2.0 m above ground level. | Inspection | Essential |
| 11 | T.SS.2 | Sensor Siting | Installation in Screen | The sensor/instrument for Air Temperature measurements shall be mounted in a radiation/thermometer screen. The screen (and other contained/attached sensors) shall not affect the measurements more than 0.5 ºC under any condition. | Inspection | Essential (Regional Input) |
| 12 | T.SS.3 | Sensor Siting | Actively or Passively Aspirated Screen | If ice rime accretion is expected to significantly reduce the air circulation in the instrument screen in which the RH Measurement is made, then artificial/forced ventilation may be used.  The Tenderer shall demonstrate that the RH measurements are not influenced by wet deposition and then evaporation during precipitation, drizzle or fog. The Tenderer shall also demonstrate that screen provides sufficent protection from pollution that the sensor is not affected. | Inspection | Essential (Regional Input) |
| 13 | T.SS.4 | Sensor Siting | Airflow in an Aspirated Screen | If an aspirated screen is used the airflow across the sensors shall be 3m/s and shall not be outside the range of 2.5-10m/s under normal conditions. | Inspection | Essential (Regional Input) |
| 14 | T.SS.5 | Sensor Siting | Monitoring Actively Aspirated Screen | If an aspirated screen is used, sufficient monitoring parameters should be provided to monitor the health and status of the ventilation device. | Inspection | Very Important |
| 24 | T.SS.6 | Sensor Siting | Shade Angle | The temperature sensor should be sited so as to not be in shadow from other instruments or obstructions outside the enclosure. To maintain less than 1°C additional uncertainty, the temperature sensor/screen should not be in shadow when the sun is above 7 degrees above the horizon | Inspection | Very Important (Regional Input) |
| 380 | T.SS.7 | Sensor Siting | Installation in Screen [Grass Minimum Temperature] | If the sensor is for measuring grass minimum temperature, the sensor shall be mounted in a horizontal position in a special small radiation/thermometer screen with sufficient dishes/louvres to shield the sensor from external solar radiation. The presence of the screen shall not affect the measurements in any way. | Inspection | Essential (Regional Input) |
| 381 | T.SS.8 | Sensor Siting | Non-Aspirated Screen [Grass Minimum Temperature] | If the sensor is for measurement of Grass Minimum Temperature, the radiation screen shall be passive, active ventilation shall not be applied. | Inspection | Essential (Regional Input) |
| 382 | T.SS.9 | Sensor Siting | Installation Height [Grass Minimum Temperature] | If the sensor is installed for the measurement of Grass Minimum Temperature, the sensor/instrument shall be mounted inside the radiation shield on suitable supports 25 to 50 mm above the ground and in contact with the tips of the grass.  When the ground is covered with snow, the sensor shall be supported immediately above the surface of the snow, as near to it as possible without actually touching it. | Inspection | Essential (Regional Input) |
| 2 | T.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Air Temperature shall be presented in/by the instrument/system in degrees Celsius (°C). | Demonstration | Essential (Regional Input) |
| 3 | T.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported temperature shall be 0.1 °C (or better). | Demonstration | Essential (Regional Input) |
| 5 | T.MR.3 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous air temperature should be sampled at least 4 times over the interval of the sensor time constant. For example, if the sensor time constant is 20 seconds, then there should be a sample at least every 5 seconds | Inspection | Very Important |
| 20 | T.MR.4 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 7 | T.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | Averages of all valid samples of Air Temperature shall be produced over 1 minute intervals. The 1 minute average shall be used as the instantaneous value for air temperature. | Demonstration | Essential |
| 8 | T.OS.2 | Observation Statistics/Algorithms | Observation Extremes | The maximum and minimum temperature one minute (average) temperature values measured over a 24 hour period shall be determined[=daily maximum/minmum]. The time of occurrence shall also be stored | Inspection | Essential |
| 9 | T.OS.3 | Observation Statistics/Algorithms | Minimum Data | At least 66% of the air temperature samples in one minute should be available to enable the computation of the instantaneous air temperature value. If insufficient data, the data should be marked as invalid/missing | Inspection | Very Important (Regional Input) |
| 34 | T.OS.4 | Observation Statistics/Algorithms | Rate of Change Check | After each signal measurement, the current instantanous value should be compared to the preceding one. If the difference between two samples is more than 2C, the current sample is identified as suspect and is not used for the computation of an average. | Inspection | Very Important (Regional Input) |
| 36 | T.OS.5 | Observation Statistics/Algorithms | Jump Check | If the difference between consecutive one minute averages is more than 3C, then the data should be flagged as suspect for further investigation. If the difference is more than 10C, then the data should be flagged as erroneous for further investigation. | Inspection | Very Important (Regional Input) |
| 37 | T.OS.6 | Observation Statistics/Algorithms | Stuck Sensor | If over a 60 minute interval the value one minute values of air temperature have not changed by 0.1C, then the data should be flagged as suspect for further investigation. | Inspection | Very Important (Regional Input) |
| 1012 | T.OS.7 | Observation Statistics/Algorithms | NMHS Calculated Parameters | Additional Air Temperature Statistics may be requested by the NMHS, to meet local or RA requirements. These may be inserted here. | Demonstration | Essential (Regional Input) |
| 15 | T.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 16 | T.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |
| 55 | T.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Pressure

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 27 | P.SP.1 | Sensor/Hardware Performance | Measurement Range | The measurement range shall be 500 – 1080 hPa (for both station pressure and mean sea level pressure).  [[The NMHS may adapt this range in response to expected pressure range for the installation region]] | Inspection | Essential (Regional Input) |
| 29 | P.SP.2 | Sensor/Hardware Performance | Sensor Performance Constant | The instrument time constant under controlled conditions shall be 2 s | Inspection | Essential |
| 31 | P.SP.3 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 40 | P.SP.4 | Sensor/Hardware Performance | Sensor Uncertainty | Maximum difference: 0.3hPa/year [Normal Use] No more than 0.3hPa/30C temperature change Hysteresis less than 0.3 after change of 50hPa and back again | Inspection | Essential (Regional Input) |
| 42 | P.SP.5 | Sensor/Hardware Performance | Static Head | To achieve the required uncertainty of the pressure measurements, a static head, should be used. If used, the static head should be located in an open environment, not affected by the proximity of buildings. The Supplier should provide documentation specifying any additional uncertainty introduced by the use of their static head. | Inspection | Very Important |
| 53 | P.SP.6 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 54 | P.SP.7 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 502 | P.SP.8 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring P shall be based on an electronic barometer. However, any sensor type compliant with the requirements in this section shall be considered. | Inspection | Essential (Regional Input) |
| 508 | P.SP.9 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be 0.15 hPa or better.   For the tendency it shall be equal or better than 0.2 hPa | Inspection | Essential (Regional Input) |
| 524 | P.SP.10 | Sensor/Hardware Performance | Temperature Correction in Calibration | If the instrument is applying a correction for the ambient air temperature (measured internally or with a separate thermometer), the temperature compensation function should be fully taken into account in the calibration procedure. | Inspection | Very Important |
| 1062 | P.SP.11 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1080 | P.SP.12 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 41 | P.SS.1 | Sensor Siting | General Installation Features | The instrument shall be mounted in a location taking into the following conditions: • shielded from direct sunshine at all times • kept at a constant temperature [or within a specified temperature range] • installed in a draught free location • vibration free mounting. And strong magnetic fields | Inspection | Essential |
| 43 | P.SS.2 | Sensor Siting | Installation Height | The sensor/instrument for P measurements may be installed at a height between 1.2 and 2.0 m above ground level. | Inspection | Essential (Regional Input) |
| 28 | P.MR.1 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported measurement and tendency shall be 0.1 hPa. | Demonstration | Essential (Regional Input) |
| 30 | P.MR.2 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous pressure should be sampled at least 4 times over the interval of the sensor time constant. For example, if the sensor time constant is 2 seconds, then there should be a sample at least every 0.5s. | Inspection | Very Important |
| 52 | P.MR.3 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 56 | P.MR.4 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Pressure shall be presented in/by the instrument/system in hectopascals hPa. | Demonstration | Essential (Regional Input) |
| 32 | P.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | Averages of all valid samples of Pressue shall be produced over 1 minute intervals. The 1 minute average shall be used as the instantaneous value for pressure | Demonstration | Essential (Regional Input) |
| 33 | P.OS.2 | Observation Statistics/Algorithms | Minimum Data | At least 66% of the pressure samples in one minute should be available to enable the computation of the instantaneous air temperature value. If insufficient data, the data should be marked as invalid/missing | Inspection | Very Important (Regional Input) |
| 35 | P.OS.3 | Observation Statistics/Algorithms | Rate of Change Check | After each signal measurement, the current instantanous value should be compared to the preceding one. If the difference between two samples is more than 0.3hPA, the current sample is identified as suspect and is not used for the computation of an average. | Inspection | Very Important (Regional Input) |
| 38 | P.OS.4 | Observation Statistics/Algorithms | Stuck Sensor | If over a 60 minute interval the value one minute values of pressure have not changed by 0.1hPa, then the data should be flagged as suspect for further investigation. | Inspection | Very Important (Regional Input) |
| 39 | P.OS.5 | Observation Statistics/Algorithms | Jump Check | If the difference between consequetive one minute averages is more than 0.5hPa, then the data should be flagged as suspect for further investigation. If the difference is more than 2hPa, then the data should be flagged as erroneous for further investigation. | Inspection | Very Important (Regional Input) |
| 514 | P.OS.6 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 949 | P.OS.7 | Observation Statistics/Algorithms | Derived Parameters | The pressure tendency should be determined using the difference between the current pressure measurement, and the pressure values over the previous 3 hours | Inspection | Desirable (Regional Input) |
| 1015 | P.OS.8 | Observation Statistics/Algorithms | Derived Parameters 2 | The NMHS may request that QFE and QNH be calculated by the sensor, as well as statistics (maximum, minimum, standard deviation) to meet local or RA requirements. These should be outlined here. | Inspection | Very Important (Regional Input) |
| 1123 | P.OS.9 | Observation Statistics/Algorithms | Derived Parameters 3 | A Mean Sea Level should be determined, and WGS-84/EGM96 be applied to dtermine the altitude with respect to Mean Sea Level | Inspection | Very Important |
| 45 | P.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 47 | P.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |
| 1017 | P.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Wind Direction

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 71 | WD.SP.1 | Sensor/Hardware Performance | Sensor Performance Constant | The Sensor Damping Ratio shall be > 0.3 | Inspection | Essential |
| 105 | WD.SP.2 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 107 | WD.SP.3 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 157 | WD.SP.4 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 650 | WD.SP.5 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring WD shall be an electrical recording wind direction instrument. The most common instruments in use are vanes, combined propeller anemometers/vane and ultrasonic instruments for measuring both wind speed and wind direction. However, any sensor type compliant with the requirements in this section shall be considered.  [[NMHS may edit if they have a preference for a particular sensor type]] | Inspection | Essential (Regional Input) |
| 657 | WD.SP.6 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be 5°. | Inspection | Essential (Regional Input) |
| 973 | WD.SP.7 | Sensor/Hardware Performance | Sampling Frequency | If the sensor is to be used to report wind gust, then wind speed should be sampled at 1Hz or greater. 4Hz is preferred. | Inspection | Very Important |
| 1070 | WD.SP.8 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1074 | WD.SP.9 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 76 | WD.SS.1 | Sensor Siting | Installation Height | The Wind Direction Sensor shall be sited at a standard height of 10m above open terrain [roughness length <=0.03m]. Open terrain is defined as any area where the distance between the anemometer and the obstructions is at least 10 times the height of the obstruction. | Inspection | Essential (Regional Input) |
| 90 | WD.SS.2 | Sensor Siting | Sensor location in Mast | The WD sensor is preferably installed on top of the mast. If this is not possible, the sensor shall be installed on a cross arm with a length of at least three mast or tower widths, attached to the mast at 10 m height.  The Wind Direction sensor shall be installed so as to not impact the Wind Speed measeruement. | Inspection | Essential (Regional Input) |
| 952 | WD.SS.3 | Sensor Siting | Distance to Obstacles 1 | The wind sensor shall be sited so that any obstacle taller than 4m shall be at a distance equal to 10 times its height. For example, if an obstacle is 6m tall, it shall be no closer than 60m to the wind sensor | Inspection | Essential (Regional Input) |
| 955 | WD.SS.4 | Sensor Siting | Distance to Obstacles 2 | The wind sensor shall be sited so that any obstacle taller than 8m shall be at a distance of more than 15 times its width. For example, there is a tower that is 9m tall and 10m wide, then the wind sensor shall be sited more than 150m away | Inspection | Essential (Regional Input) |
| 1124 | WD.SS.5 | Sensor Siting | Installation | The Wind Direction Sensor shall mounted so that WD=0 complies to true North. | Inspection | Essential (Regional Input) |
| 59 | WD.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Wind Direction shall be presented in/by the instrument/system in degrees clockwise from true north. | Inspection | Essential (Regional Input) |
| 63 | WD.MR.2 | Measurement/Functional Requirements | Measurement Range | The maximum measurement range shall be 0-360 degrees.  [[Additional local conditions may apply. If supporting the METAR/SPECI bulletins, North would be designated as 360degrees, 0degrees indicating no wind]] | Inspection | Essential (Regional Input) |
| 66 | WD.MR.3 | Measurement/Functional Requirements | Reporting Resolution | The Reporting Resolution for Wind Direction shall be 1 degree | Inspection | Essential (Regional Input) |
| 103 | WD.MR.4 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 651 | WD.MR.5 | Measurement/Functional Requirements | WD Orientation | Wind direction is defined as and shall be reported as the direction from which the wind blows, and it is measured clockwise from geographical north, namely, true north (referred to the World Geodetic System 1984 (WGS-84) and its Earth Geodetic Model 1996 (EGM96)). | Demonstration | Essential (Regional Input) |
| 654 | WD.MR.6 | Measurement/Functional Requirements | Practical Range | The maximum measurement range shall be 0 – 360°. If two successive samples differ by more than 180°, the difference is decreased by adding or subtracting 360° from the second sample to obtain a wind direction between 0 – 360°. | Demonstration | Essential (Regional Input) |
| 665 | WD.MR.7 | Measurement/Functional Requirements | Installation in Mast | The sensor/instrument for WD measurements shall be installed in a mast. The mast shall be stable and installed vertically. | Inspection | Essential (Regional Input) |
| 78 | WD.OS.1 | Observation Statistics/Algorithms | Vector Averaging | Vector averaging should be used for the average values of wind speed and direction. | Inspection | Very Important |
| 83 | WD.OS.2 | Observation Statistics/Algorithms | Minimum Data | At least 75% of the wind direction samples should be available to enable the computation of both the 2 minute and 10 minute averages. If insufficient data, the 2/10 minute average should be marked as invalid/missing | Demonstration | Very Important (Regional Input) |
| 87 | WD.OS.3 | Observation Statistics/Algorithms | Stuck Sensor | If the average values of wind direction do not vary by more than 10 degrees over a 60 minute interval, the data should be flagged as suspect for further investigation | Inspection | Very Important (Regional Input) |
| 93 | WD.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 95 | WD.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |
| 109 | WD.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Wind Speed

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 70 | WS.SP.1 | Sensor/Hardware Performance | Sensor Performance Constant | For a mechanical wind speed sensor, the distance constant shall be in the range 2-5m. [A distant constant is not required for an ultrasonic sensor] | Inspection | Essential |
| 73 | WS.SP.2 | Sensor/Hardware Performance | Sampling Frequency | If the sensor is to be used to report wind gust, then wind speed should be sampled at 1Hz or greater. 4Hz is preferred. | Inspection | Very Important |
| 104 | WS.SP.3 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 106 | WS.SP.4 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 158 | WS.SP.5 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 613 | WS.SP.6 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring Wind Speed shall be based on an electrical anemometer. The most common instruments in use are cup anemometers, propeller anemometers and ultrasonic anemometers. However, any sensor type compliant with the requirements in this section shall be considered. | Inspection | Essential (Regional Input) |
| 619 | WS.SP.7 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be  • 0.5 m/s for WS 5 m/s. | Inspection | Essential (Regional Input) |
| 1071 | WS.SP.8 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1075 | WS.SP.9 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 88 | WS.SS.1 | Sensor Siting | Sensor location in Mast | The WS sensor is preferably installed on top of the mast. If this is not possible, the sensor shall be installed on a cross arm with a length of at least three mast or tower widths, attached to the mast at 10 m height. | Inspection | Essential (Regional Input) |
| 953 | WS.SS.2 | Sensor Siting | Distance to Obstacles 1 | The wind sensor shall be sited so that any obstacle taller than 4m shall be at a distance equal to 10 times its height. For example, if an obstacle is 6m tall, it shall be no closer than 60m to the wind sensor | Inspection | Essential (Regional Input) |
| 954 | WS.SS.3 | Sensor Siting | Distance to Obstacles 2 | The wind sensor shall be sited so that any obstacle taller than 8m shall be at a distance of more than 15 times its width. For example, there is a tower that is 9m tall and 10m wide, then the wind sensor shall be sited more than 150m away | Inspection | Essential (Regional Input) |
| 60 | WS.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Wind Speed and Wind Gust shall be presented in/by the instrument/system in metres per second (m/s). | Demonstration | Essential (Regional Input) |
| 64 | WS.MR.2 | Measurement/Functional Requirements | Measurement Range | The maximum measurement range shall be 0-75m/s. In regions of extremely high winds, an extended range of 0-100m/s may be requested.  Wind Gust, may reach 150m/s | Inspection | Essential (Regional Input) |
| 65 | WS.MR.3 | Measurement/Functional Requirements | Reporting Resolution | The Reporting Resolution for Wind Speed shall be 0.5m/s  The Reporting Resolution for Wind Gust (if measured) shall be 0.1m/s | Demonstration | Essential (Regional Input) |
| 102 | WS.MR.4 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 72 | WS.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | Averages of all valid wind speed samples over 10 minute intervals shall be produced. This 10 minute average shall be used as the instantaneous value for wind speed. A standard deviation of wind speed shall also be calculated. If the wind sensor is in support of an aerodrome, then an additional 2 minute average shall be calculated. | Inspection | Essential (Regional Input) |
| 74 | WS.OS.2 | Observation Statistics/Algorithms | Calculated Parameters 2 | If an observation of wind gust is required, then this shall be the running mean of all valid wind speed samples in a 3 second period. | Inspection | Essential (Regional Input) |
| 75 | WS.OS.3 | Observation Statistics/Algorithms | Installation Height | The Wind Speed sensor shall be sited at a standard height of 10m above open terrain. Open terrain is defined as any area where the distance between the anemometer and the obstructions is at least 10 times the height of the obstruction.  [[A roughness index of 0.03m or less may also be used as a definition for Open Terrain]] | Inspection | Essential (Regional Input) |
| 77 | WS.OS.4 | Observation Statistics/Algorithms | Vector Averaging | Vector averaging should be used for the average values of wind speed and direction. | Inspection | Very Important |
| 82 | WS.OS.5 | Observation Statistics/Algorithms | Minimum Data | At least 75% of the wind speed samples should be available to enable the computation of both the 2 minute and 10 minute averages. If insufficient data, the 2/10 minute average should be marked as invalid/missing | Demonstration | Very Important (Regional Input) |
| 84 | WS.OS.6 | Observation Statistics/Algorithms | Rate of Change Check | If the difference between a wind speed sample and the preceding one is more than 20m/s, then the data should be flagged as suspect for further investigation and not used for the calculation of the average. | Inspection | Very Important (Regional Input) |
| 85 | WS.OS.7 | Observation Statistics/Algorithms | Jump Check | if the difference between consecutive 2 minute wind speed averages is more than 10m/s the the data should be flagged as suspect for further investigation. If the difference is more than 20m/s it should be flagged as erroneous for further investigation. | Inspection | Very Important (Regional Input) |
| 86 | WS.OS.8 | Observation Statistics/Algorithms | Stuck Sensor | If the average values of wind speed do not vary by more than 0.5m/s over a 60 minute interval, the data should be flagged as suspect for further investigation | Inspection | Very Important (Regional Input) |
| 1016 | WS.OS.9 | Observation Statistics/Algorithms | Installation Height | The Wind Speed sensor shall be sited at a standard height of 10m above open terrain. Open terrain is defined as any area where the distance between the anemometer and the obstructions is at least 10 times the height of the obstruction. | Inspection | Essential (Regional Input) |
| 92 | WS.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 94 | WS.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |
| 108 | WS.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Precipitation Amount

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 110 | PA.SP.1 | Sensor/Hardware Performance | Collecting Gauge Orifice Area | In case the sensor/instrument for measuring Precipitation is based on collection of precipitation, the area of the collector orifice shall be at least 200 cm2 and no larger than 500 cm2. The area of the orifice shall be known to the nearest 0.5 %, and the construction shall be such that this area remains constant while the gauge is in normal use.  The construction shall be such as to minimize wetting areas. The container shall also have a narrow entract and be sufficiently protected from radiation to minimize the loss of water by evaporation. | Inspection | Essential (Regional Input) |
| 120 | PA.SP.2 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 121 | PA.SP.3 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 159 | PA.SP.4 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 531 | PA.SP.5 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring Precipitation shall be based on an electronic recording instrument. Any sensor type compliant with the requirements in this section shall be considered. | Inspection | Essential (Regional Input) |
| 538 | PA.SP.6 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be the larger of 5% or 0.1 mm | Inspection | Essential (Regional Input) |
| 541 | PA.SP.7 | Sensor/Hardware Performance | Heating | If appropriate for local conditions, the precipitation sensor should be equipped with rim heating and funnelheating (tipping bucket). The heating should be controlled by a thermostat and it should be switched on below an ambient temperature of 5 ºC. The heating should avoid snow and ice building up at the rim, and it should melt solid precipitation falling into the funnel. The heating should keep the rim and funnel above 0 ºC, but the heating should be as little as possible to avoid evaporation of the precipitation. For other types of instruments heating should be offered as required for the local conditions. | Inspection | Very Important (Regional Input) |
| 545 | PA.SP.8 | Sensor/Hardware Performance | General Installation Features | The instrument shall be mounted in a location optimized for taking precipitation measurements: • Minimal wind disturbances by nearby structures • Non-splashing ground surface around the gauge installation location | Inspection | Essential (Regional Input) |
| 558 | PA.SP.9 | Sensor/Hardware Performance | Excitation and Power Supply | If the sensor requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. Where possible, extra-low and low power equipment should be used, both to increase electrical and enable the use of solar power. | Inspection | Very Important (Regional Input) |
| 1063 | PA.SP.10 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1079 | PA.SP.11 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals.  For Precipitation Measurements, wetting and evaporation loss factors may be provided. | Response | Essential (Regional Input) |
| 112 | PA.SS.1 | Sensor Siting | Installation Height | The collecting orifice of the precipitation gauge shall be installed at [[local precipitation guage height]].  The WMO makes no recommendation on installation height, but the CIMO Guide notes heights level with local ground surface [0m] and then 0.5-1.5m are commonly used. | Inspection | Essential (Regional Input) |
| 113 | PA.SS.2 | Sensor Siting | Wind Screen | In case a precipitation gauge is offered, to achieve the highest accuracy of the precipitation measurements, a wind screen may be installed around the precipitation gauge to minimize errors due to wind. The top of the wind screen should be at the same height as the orifice of the precipitation gauge. For other types of instruments this requirement may not apply. | Inspection | Very Important |
| 950 | PA.SS.3 | Sensor Siting | Distance to Obstacles 1 | The precipitation sensor shall be sited such that obstacles are at a distance of at least twice the height of the object above the sensor. That is, if the sensor is 2m taller than than the rainguage top, it shall be at least 4m away. | Inspection | Essential (Regional Input) |
| 951 | PA.SS.4 | Sensor Siting | Distance to Obstacles 2 | The precipitation sensor shall be sited such that any obstacle does not occupy more than 10 degrees of arc around the sensor | Inspection | Essential (Regional Input) |
| 58 | PA.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Precipitation Amount shall be presented in/by the instrument/system in millimetres. | Demonstration | Essential (Regional Input) |
| 62 | PA.MR.2 | Measurement/Functional Requirements | Measurement Range | The maximum measurement range shall be 0-500mm/day. This may be increased to meet local conditions | Inspection | Essential (Regional Input) |
| 67 | PA.MR.3 | Measurement/Functional Requirements | Reporting Resolution | The Reporting Resolution for Precipitation Amount shall be 0.1mm. | Demonstration | Essential (Regional Input) |
| 119 | PA.MR.4 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 111 | PA.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | The individual measurements are providing the instantaneous readings. The system shall calculate/make available • amounts over 1 minute, 10 minutes, hours, 24 hours. | Demonstration | Essential (Regional Input) |
| 544 | PA.OS.2 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 114 | PA.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 115 | PA.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |

# Relative Humidity

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 69 | U.SP.1 | Sensor/Hardware Performance | Sensor Performance Constant | The instrument time constant under controlled conditions shall be 40 s or better over the entire operational range. If used for Dewpoint Temperature measurement, then the sensor time constant shall be 20s.For field measurements in non-actively aspired radiation screens this may not be achievable. | Inspection | Essential |
| 154 | U.SP.2 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 155 | U.SP.3 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 160 | U.SP.4 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 475 | U.SP.5 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring RH should be based on an electrical capacitance measurement probes.   Sensors for measuring Dew Point directly are usually based on dewpoint mirror.  However, any sensor type compliant with the requirements in this section should be considered by Customer. | Inspection | Very Important (Regional Input) |
| 481 | U.SP.6 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor measurement uncertainty shall be better than +/- 3 %RH.  If the sensor reports directly a Dew Point Temperature, the sensor uncertainty shall be 0.25C | Inspection | Essential (Regional Input) |
| 501 | U.SP.7 | Sensor/Hardware Performance | Excitation and Power Supply | If the sensor requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. Where possible, extra-low and low power equipment should be used, both to increase electrical and enable the use of solar power. | Inspection | Very Important (Regional Input) |
| 1069 | U.SP.8 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1073 | U.SP.9 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 144 | U.SS.1 | Sensor Siting | Installation in Screen | The sensor/instrument for RH measurements shall be mounted in a radiation/thermometer screen. The presence of the screen shall not affect the measurements in any way. | Inspection | Essential (Regional Input) |
| 145 | U.SS.2 | Sensor Siting | Actively or Passively Aspirated Screen | If ice rime accretion is expected to significantly reduce the air circulation in the instrument screen in which the RH Measurement is made, then artificial/forced ventilation may be used.  The Tenderer shall demonstrate that the RH measurements are not influenced by wet deposition and then evaporation during precipitation, drizzle or fog. The Tenderer shall also demonstrate that screen provides sufficent protection from pollution that the sensor is not affected. | Inspection | Essential (Regional Input) |
| 146 | U.SS.3 | Sensor Siting | Monitoring Actively Aspirated Screens | If an aspirated screen is used, sufficient monitoring parameters should be provided to enable the health and status of the ventilation device to be checked. | Inspection | Very Important |
| 147 | U.SS.4 | Sensor Siting | Installation Height | The sensor/instrument for RH measurements shall be mounted inside the radiation screen at a height between 1.25 and 2.0 m above ground level | Inspection | Essential (Regional Input) |
| 57 | U.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, U shall be presented in/by the instrument/system in %RH. | Demonstration | Essential (Regional Input) |
| 61 | U.MR.2 | Measurement/Functional Requirements | Measurement Range | The maximum measurement range shall be 0-100%RH.  If presented as Dew Point Temperature, the maximum temperature range shall be -80C to 35C | Inspection | Essential (Regional Input) |
| 68 | U.MR.3 | Measurement/Functional Requirements | Reporting Resolution | The Reporting Resolution for Relative Humidity shall be 1%RH (or better). If reported as Dew Point Temperature, the reporting resolution shall be 0.1C | Demonstration | Essential (Regional Input) |
| 138 | U.MR.4 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous humidity should be sampled at least 4 times over the interval of the sensor time constant | Inspection | Very Important |
| 153 | U.MR.5 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 139 | U.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | Averages of all valid samples of Relative Humidity shall be produced over 1 minute intervals. The 1 minute average shall be used as the instantaneous value for relative humidity | Demonstration | Essential (Regional Input) |
| 140 | U.OS.2 | Observation Statistics/Algorithms | Minimum Data | At least 66% of the relative humidity samples in one minute should be available to enable the computation of the instantaneous relative humidity value. If insufficient valid data, the instantaneous humidity value should be marked as invalid/missing. | Inspection | Very Important (Regional Input) |
| 141 | U.OS.3 | Observation Statistics/Algorithms | Rate of Change Check | After each signal measurement, the current instantanous value should be compared to the preceding one. If the difference between two samples is more than 5%RH, the current sample is identified as suspect and is not used for the computation of an average. | Inspection | Very Important (Regional Input) |
| 142 | U.OS.4 | Observation Statistics/Algorithms | Jump Check | if the difference between consecutive one minute averages if more than 10%RH, then the data should be flagged as suspect for further investigation. If the difference is more than 15% RH, the the data should be flagged as erroneous for further investigation. | Inspection | Very Important (Regional Input) |
| 143 | U.OS.5 | Observation Statistics/Algorithms | Stuck Sensor | if over a 60 minute interval the value of the one minute values of RH have not changed by 1%RH and RH < 95%, then the data should be flagged as suspect for further investigation. | Inspection | Very Important (Regional Input) |
| 462 | U.OS.6 | Observation Statistics/Algorithms | Td calculations from Ta and RH | If Td is calculated from RH and Ta, the 1 and 10 minute averages of Td should be calculated from the instantaneous RH and Ta measurements, after which the averages for Td can be calculated. It is not allowed to calculate averages for Td from averages of Ta and RH. | Demonstration | Very Important |
| 487 | U.OS.7 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 947 | U.OS.8 | Observation Statistics/Algorithms | Derived Parameters | If relative humidity is measured, then a Dew Point Temperature should also be calculated, using the formula from Annex 4.B CIMO Guide | Inspection | Very Important (Regional Input) |
| 1014 | U.OS.9 | Observation Statistics/Algorithms | NMHS Calculated Parameters | Additional Relative Humidity Statistics may be requested by the NMHS, to meet local or RA requirements. These may be inserted here. | Demonstration | Essential (Regional Input) |
| 148 | U.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 149 | U.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |
| 156 | U.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# General

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 966 | G.SP.1 | Sensor/Hardware Performance | Environment: EMC | EMC susceptibility is according to EC-regulations, but special care must be taken to withstand static electric shocks, as well as the use of handheld radio and telephone equipment in the vicinity of the systems. | Inspection | Essential (Regional Input) |
| 967 | G.SP.2 | Sensor/Hardware Performance | Availability of System Components | The availability of the single hardware components is as follows:  Component Availability  Instruments 99.98%, based on a MTBF of 12 months and a MTTR of 1 hour. | Inspection | Important |
| 126 | G.MR.1 | Measurement/Functional Requirements | Initiate information request at start-up | When a system component or system part starts up, it will initiate information request from all other system components or system parts that are supposed to supply data/information to it. At least the most actual information is requested. Historical information can also be requested from the AWS Network Controller, up to 7 days old, and the period over which historical data is requested, is configurable | Demonstration | Very Important |
| 128 | G.MR.2 | Measurement/Functional Requirements | Information transmission at start-up | When a system component or system part starts up, it will send information to all other system components or system parts that are dependent on (data from) the starting system component or system part. The starting system component or system part should at least inform the other dependent system component or system part that it is available again | Demonstration | Very Important |
| 130 | G.MR.3 | Measurement/Functional Requirements | Error messages must be unambiguous | An error message must unambiguously explain the cause and condition of the error. | Demonstration | Essential |
| 131 | G.MR.4 | Measurement/Functional Requirements | Effectiveness of system parameter changes | Changed configuration parameters should come into effect immediately unless explicitly stated otherwise. The system component or system part should notify the user when the parameter change comes into effect. When parameters are changed by other means than from the AWS Network Controller (for example by direct access to equipment), the AWS Network Controller should also be notified. [[NMHS may insert additional consultation/authorisation process]] | Demonstration | Very Important |
| 133 | G.MR.5 | Measurement/Functional Requirements | Identical software | The software for the same type (AWS, MIPS, etc.) of system should be identical. Differences in the individual systems should be established by means of configuration parameters. | Demonstration | Very Important |
| 134 | G.MR.6 | Measurement/Functional Requirements | Data storage when communication has been lost | When a system component or system part sends data to another system component or system part while a communication error occurred, the data should be stored/buffered by the sending system component or system part. When storage is full, the oldest data should be overwritten first. After recovery of the communication, the system component or system part should send the stored data again, the newest data should be sent first. The period for which data should be stored is configurable but should be at least 365 days. | Demonstration | Very Important (Regional Input) |
| 135 | G.MR.7 | Measurement/Functional Requirements | Data retrieval when communication has been lost | When a system component or system part has tried to retrieve data from another system component or system part while a communication error occurred, the retrieving system component or system part should retrieve the missing data when communication has restored again. The newest data is retrieved first. The period for which missing data should be retrieved, is configurable. The AWS Network Controller should be notified of the communication error.  [[The Customer may request additional redundancy/checksum/error checking]] | Demonstration | Very Important |
| 136 | G.MR.8 | Measurement/Functional Requirements | Data retrieval when data was not yet available | When a system component or system part tried to retrieve data from another system while the data was not yet available, the system component or system part should try to retrieve all missing data the next occurrence of data retrieval, if time allows. The newest data should be retrieved first. The AWS Network Controller should be notified of the communication error. | Demonstration | Very Important |
| 137 | G.MR.9 | Measurement/Functional Requirements | Maintenance on ‘Hot Standby’ systems | It may be possible to do maintenance on software and hardware on ‘hot standby’ systems, without disrupting the operational status of the system. | Demonstration | Important |
| 165 | G.MR.10 | Measurement/Functional Requirements | Configuration of access to data | It should be possible to arrange access and access levels to all types of data by configuration by a data/system manager  The following access levels will be distinguished:-  • Access to data from within a process (e.g. batch environment) • Interactive access to data using a search and request facility • Unrestricted access to the data by an authorised data/system manager [[NMHS to determine of this allows modification of Observation/Raw Data]]  The data/system manager should have: • The possibility to define the specific users groups • The possibility to arrange a specific access level for each user group | Demonstration | Very Important |
| 183 | G.MR.11 | Measurement/Functional Requirements | Logging of exceptions | When deviations from normal operation (sensor, communication, software problems) are detected, the AWS or Sensor shall analyse the exception, time stamp it, and store them in log file. At least time, sensor location, sensor type, instrument ID, percentage of missed samples and status’ are logged. The AWS/Sensor start-ups/shutdowns and AWS/Sensor-exceptions shall be logged as well.  The AWS/Sensor shall only log status changes. For example, if a sensor changes status from ‘normal operation’ to ‘instrument malfunction’, it will be logged once, and if it shall return to ‘normal operation’ again, this shall also be logged only once. When an AWS/sensor performs a start-up or reset, all status’ shall be logged once. | Demonstration | Essential |
| 184 | G.MR.12 | Measurement/Functional Requirements | Other (meta)data | The AWS or sensor should contain all required other (meta)data that is required to process the “raw” observation data into meteorological parameters. Such (meta) data may include (but not limited to) station lat/long, station altitude above MSL, calibration factors of the instruments, installation heights of instruments, etc. It should be possible to change this (meta)data from a remote site with minimal interruption of the AWS/sensor main tasks. | Demonstration | Very Important (Regional Input) |
| 219 | G.MR.13 | Measurement/Functional Requirements | Determine (sub-)system status | The status of each (sub-)system is determined based on status information from the (sub-)systems. | Demonstration | Very Important |
| 123 | G.OS.1 | Observation Statistics/Algorithms | System time | The system clocks of the various components within the systems should be synchronised. The normal/standard time-base for the total system time should be UTC. Primary time synchronisation should be achieved by connection to a network time server, or by connecting a GPS/GNSS receiver   The possibility to set the clock manually (e.g. for testing purposes) should also be included.   The time of the equipment should not differ by more than 1 s from UTC and have a resolution of 1s or better. | Demonstration | Very Important |
| 81 | G.PSI.1 | Power/Site Infrastructure | Electrical Safety | All installed equipment should comply with applicable local requirements for electrical safety. In the absence of local requirements, IEC 60950-1 may be used. | Inspection | Very Important (Regional Input) |
| 249 | G.PSI.2 | Power/Site Infrastructure | Electrical regulations | The equipment and installation shall conform to the latest editions or regulations of local authorities. The most common international standards are (latest versions shall be applicable): • CE marking • FCC Declaration of Conformity • ISO 9001 : quality management systems and quality assurance  In addition, local standards and regulations apply, the supplier to define which ones are valid for the installation region (latest versions): • Safety regulations for low voltage installations, including supplements and alterations • Lighting conductor installations • Telecommunication colours of cores of cables for use inside buildings and for mounting wires • Telecommunication regulations for wireless (data)communication, use of available frequencies • Factories built low voltage switch gear and control cabinets • Safety transformers • Electrical symbols   The supplier shall be responsible for the correct application of local standards (latest editions) and regulations necessary to achieve conformity with local legislation.   In the absence of local requirements, IEC 60950-1 may be used. | Inspection | Essential (Regional Input) |
| 250 | G.PSI.3 | Power/Site Infrastructure | Mains power | The supplier shall confirm the mains power that is used in the installation region. All equipment that is supplied in this project that uses mains power, shall work with the local mains power without the use of (external) power converters. The correct power cables shall be supplied with all equipment. | Inspection | Essential (Regional Input) |
| 284 | G.PSI.4 | Power/Site Infrastructure | Lightning Protection | If a wind mast or another high structures is supplied and installed in the field, it shall be equipped with a lightning protection system. This includes a lightning conductor at a height of two meters above the top of the mast (or high structure).   For Europe the lightning protection system shall comply with IEC 62305 (EN 62305) standard ‘protection of structures against lightning’. For other installation, other regulations may apply, the supplier shall be responsible for correct application of the regulations. | Demonstration | Essential (Regional Input) |
| 304 | G.PSI.5 | Power/Site Infrastructure | Electrical power supply | All equipment shall operate at a mains supply voltage applicable to the installation region: xxx VAC ± yy%, aa Hz ± bb%.[[Customer to insert local/regional values]] | Inspection | Essential (Regional Input) |
| 80 | G.R.1 | Regulatory/Standards | Electromagnetic Compatibility | Installed equipment should have suitable electromagnetic compatibility for operation in the installed environment. In the absence of a local standard, IEC 61326:1997 + A1:1998 + A2:2000 + A3:2003 can be used used. | Inspection | Very Important (Regional Input) |
| 359 | G.R.2 | Regulatory/Standards | Regulations | The equipment and installation shall conform to the latest editions or regulations of local authorities and the customer.  The supplier shall be responsible for the correct application of valid European/US/applicable standards (latest editions) necessary to achieve conformity with the local legislation on machinery safety.  For electrical and control systems particularly, all relevant components, apparatuses, panels, boards, systems and installations, which are part of the scope of work, have to comply with the applicable standards. The work of the supplier will be in conformity with the applicable standards. | Inspection | Essential (Regional Input) |
| 960 | G.R.3 | Regulatory/Standards | Workmanship Rules | Cabinets are assembled by the supplier. High-qualified workmanship and extreme care should be applied when assembling the equipment. At least the following aspects should reflect this:  • All process specification steps should be rigorously followed.  • All quality assurance specifications should be rigorously followed. • High quality soldering with a good reflow, it should be free of excessive solder, pits and cracks, and is not subjected to mechanical stress. • All cabling should be properly guided and bundled, and attached every 30 cm (no loose cables, no free hanging cables). Unnecessary extra cable loops should be avoided. Cables have always to be installed as close as possible to grounded surfaces. All cable connections in cabinets should be terminated on connector plugs with metal enclosures. The cabling inside cabinets should be routed in an orderly manner in fixed traces, and tied up. The presence of loose cabling over lengths of more than 30 cm is not permitted. • Bolts should be properly torqued and sealed. • All parts should be properly attached by screws, adhesive or brazing (no loose parts).  • Painting and coatings should be applied smoothly and with constant thickness, without the presence of drops and non-treated areas. • All equipment should be adequately cleaned and free of dust and dirt. Cabinets, enclosures and housings should be free of scratches and dents. | Inspection | Very Important (Regional Input) |
| 1086 | G.R.4 | Regulatory/Standards | ISO 9001 | All Tenderers, and their subcontractors were appropriate, should have ISO9001 certification. Documentary evidence of this certification should be included with the Tender documents. | Response | Very Important |
| 290 | G.HSE.1 | HSE | Equipment can be physically disconnected from any power supply | When equipment is switched OFF, e.g., by means of a physical ON/OFF switch, the total equipment can be physically disconnected from the power supply. If not so, provisions will be supplied enabling a physical disconnection. | Demonstration | Very Important |
| 291 | G.HSE.2 | HSE | Minimising risk of injury and damage | The system shall be designed in such a way as to prevent or minimise the risk of personal injury or system damage. | Inspection | Essential |

# Cabling & Wiring

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 251 | CW.PSI.1 | Power/Site Infrastructure | Maximum amount of cables in ducts | New cable ducts should not contain more cables than 75% of their maximum capacity - existing cable ducts should not contain more cables than 100% of their maximum capacity after completion of the works. | Inspection | Very Important |
| 252 | CW.PSI.2 | Power/Site Infrastructure | Cables shall comply to local standards, regulations and norms | All cables that are used in the systems delivered by the supplier, shall comply to local standards, regulations and norms. It is the responsibility of the supplier to find out what local standards, regulations and norms are applicable and that all cables are compliant with these regulations. | Inspection | Essential (Regional Input) |
| 253 | CW.PSI.3 | Power/Site Infrastructure | Cables shall support one voltage or power supply | Only a single voltage or power supply shall be supported by a cable. It is not allowed to have two different voltages or power supply from two different circuit breakers in one cable. | Inspection | Essential |
| 254 | CW.PSI.4 | Power/Site Infrastructure | Cables shall be of uninterrupted length | Cables between two terminations should be of one uninterrupted length. | Inspection | Very Important |
| 255 | CW.PSI.5 | Power/Site Infrastructure | Wiring in trunking systems is not allowed | Wiring in trunking is not allowed. | Inspection | Very Important |
| 256 | CW.PSI.6 | Power/Site Infrastructure | Clamps are not allowed for single-core cables | Clamps are not allowed for single-core cables. Where clamps are used, these should be of the claw type fixed on slotted a channel and suitable for horizontal or vertical mounting. | Inspection | Very Important |
| 257 | CW.PSI.7 | Power/Site Infrastructure | Cable saddles shall be of isolating material | Cable saddles should be of isolating material. | Inspection | Very Important (Regional Input) |
| 258 | CW.PSI.8 | Power/Site Infrastructure | Adhesive saddles are not allowed | The use of adhesive saddles is not allowed. | Inspection | Important |
| 259 | CW.PSI.9 | Power/Site Infrastructure | Single-core cables shall be separated from other circuits | Circuits employing single-core cables should be kept well separated from other circuits, and non-magnetic clamps should be used. | Inspection | Very Important |
| 260 | CW.PSI.10 | Power/Site Infrastructure | Sufficient cable supports | Cable supports or clamps shall be spaced at adequate intervals to eliminate excessive sag or mechanical tension of the cables. | Inspection | Essential (Regional Input) |
| 261 | CW.PSI.11 | Power/Site Infrastructure | Junction and terminal boxes with glands | Where a cable enters a junction box or terminal box the correct size and type of the entry gland should be used. | Inspection | Very Important |
| 262 | CW.PSI.12 | Power/Site Infrastructure | Protection for entry glands of cables | Provisions may be made to protect cables against being pulled out of an entry gland. | Inspection | Important |
| 263 | CW.PSI.13 | Power/Site Infrastructure | Cable cores should be terminated according to applicable regulations | Cable cores should be properly terminated, as directed by applicable regulations, by means of lugs, except where an alternative arrangement is-applied in the design of the equipment. | Inspection | Very Important (Regional Input) |
| 264 | CW.PSI.14 | Power/Site Infrastructure | Conduits should be only used for cable protection | Conduits should only be for cable protection. | Inspection | Very Important |
| 265 | CW.PSI.15 | Power/Site Infrastructure | Conduits shall not be used for wiring | Conduits should not be used for wiring. | Inspection | Very Important (Regional Input) |
| 266 | CW.PSI.16 | Power/Site Infrastructure | Conduits shall be of synthetic material | It is preferred to use conduits of a stroke-proof synthetic material, e.g. Hostalit. No elbows and tees may be used. The conduits may be open-ended. | Inspection | Important (Regional Input) |
| 267 | CW.PSI.17 | Power/Site Infrastructure | Local control panels shall be made of metal die-casting aluminium | Local control panels should be made of die-cast aluminium. | Inspection | Very Important (Regional Input) |
| 268 | CW.PSI.18 | Power/Site Infrastructure | Junction boxes of aluminium shall be stroke-proof and drip-water-proof | Junction boxes of aluminium material should be vandal proof, dust resistant and drip-water-proof and be provided with glands. Junction boxes should have protection IP 55 (or better). | Inspection | Very Important |
| 269 | CW.PSI.19 | Power/Site Infrastructure | Conduits shall be free of burrs and sharp projections | Conduits should be free from burrs and sharp projections and should be of sufficient capacity. | Inspection | Very Important |
| 270 | CW.PSI.20 | Power/Site Infrastructure | Bends, tees, blank ends shall be standard-made units | Bends, tees, blank ends etc., shall be standard-made units. Efficient means of bonding lengths of trunking and accessories together shall be provided to ensure that trunkings are mechanically and electrically continuous throughout. | Inspection | Essential (Regional Input) |
| 271 | CW.PSI.21 | Power/Site Infrastructure | Screws, nuts, and washer material | All screws, nuts, washers in the electrical installation shall be of stainless steel or galvanised steel. | Inspection | Essential (Regional Input) |
| 272 | CW.PSI.22 | Power/Site Infrastructure | Cable runs shall be approved by the Customer | Cable runs to the main power supply panel should be approved by the customer. The supplier should indicate his preferred cable routing. Where possible existing cable runs should be used. | Inspection | Very Important (Regional Input) |
| 273 | CW.PSI.23 | Power/Site Infrastructure | Cable cores shall be protected | Cables that are less than 2,500 mm above floor level, down drops to switches, etc., and all other cables liable to mechanical damage should be protected. | Inspection | Very Important |
| 274 | CW.PSI.24 | Power/Site Infrastructure | Cable trunking shall be mounted according to manufacturer specification | To mount the cable trunking original mounting, fittings as specified by manufacturer should be used. | Inspection | Very Important |
| 275 | CW.PSI.25 | Power/Site Infrastructure | Exposed cable runs shall be of a matching colour | Exposed cable runs should be of a matching colour matching with the rest of the installation environment. | Inspection | Very Important |
| 276 | CW.PSI.26 | Power/Site Infrastructure | Perforated cable trunking is not allowed for vertical runs of cables | Vertical cable runs should not be made of perforated cable trunks. | Inspection | Very Important |
| 277 | CW.PSI.27 | Power/Site Infrastructure | Cable trunking shall consist of sections | Cable trunking should consist of sections, generally not less than 2 metres long, complete with coupling plates, manufactured from sheet steel, protected against corrosion through galvanisation. | Inspection | Very Important (Regional Input) |
| 278 | CW.PSI.28 | Power/Site Infrastructure | Cables shall be separated in trunking compartments | As far as practical, the separation of cabling in trunking compartments and conduits should be as follows: • 400 and 230 V circuits • control circuits • data and communication cabling • low tension and electronic circuits. | Inspection | Very Important |
| 279 | CW.PSI.29 | Power/Site Infrastructure | All wires shall be labelled | All wiring shall be identified at both ends by fixed markers giving wire number as shown on supplier’s drawings. All cables shall bear identification in the form of numbered markers, they shall, where applicable, be marked with . Markers shall be black text on yellow background. | Inspection | Essential (Regional Input) |
| 280 | CW.PSI.30 | Power/Site Infrastructure | All cables shall be labelled | All cables should be identified at both ends with non-corrodible cable markers giving the amount and the cross-section of the conductors and the coding of the panels that are connected at both sides. Near each cable run branch the cables should be labelled. The cable-markers must be approved by the customer. | Inspection | Very Important (Regional Input) |
| 281 | CW.PSI.31 | Power/Site Infrastructure | All panels shall be labelled | Labels should be provided for every panel to describe the duty of or identify every instrument, relay, push button, indicator lamps, or items of equipment mounted internally. The labels should be clear, concise and unambiguous and must be approved by the customer before manufacture. Each label should be permanently secured to the panel surface immediately adjacent to the item to which it refers. Internally and externally fitted labels should be finished white with black engraved letters and numbers. | Inspection | Very Important (Regional Input) |
| 282 | CW.PSI.32 | Power/Site Infrastructure | Grounding shall comply with applicable regulations | Grounding shall be according the latest version of applicable regulations. The metal frames and casings of the cable runs and the remote control stations shall be bonded together and earthed to the earth bars. The grounding shall not be connected to the building earth, but to the installation grounding system as provided by the customer. Armoured cables shall only be earthed at the power feeding side. | Inspection | Essential (Regional Input) |
| 283 | CW.PSI.33 | Power/Site Infrastructure | Each enclosure shall include grounding facilities | Each enclosure includes a copper earth bar, running along the full length of the panel with provision for connecting to the central grounding system and connected to the earth bar of the cable compartments. | Inspection | Very Important |
| 1116 | CW.PSI.34 | Power/Site Infrastructure | Cable Protection of for local conditions | The NMHS may specify additional cabling requirements to reflect local climatic/soil conditions or regulations - for example on cabling depth, or protection from humidity or vermin | Inspection | Essential (Regional Input) |
| 1117 | CW.PSI.35 | Power/Site Infrastructure | Site Drawings | Where the Tenderer provides AWS/Smart Sensor Site design, clear drawings showing the location of cables shall be provided to the Customer for each site. | Inspection | Essential (Regional Input) |
| 305 | CW.HSE.1 | HSE | All equipment shall meet a specified installation protection factor | Degree of protection between panels and between cable compartments and cabinets should be IP 30. When doors are opened protection should be IP 20. Degree of protection between cable compartment and main bus-bar compartment should be IP 40 after extension. For cabinets and equipment not installed in cabinets, protection should be IP 55. For the AWS cabinet, see AWS\_029. | Inspection | Very Important (Regional Input) |

# AWS Network Management

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 127 | ANM.MR.1 | Measurement/Functional Requirements | Initiate information request on request of system operator | The system operator can give a command to initiate information request to system components or system parts supplying information to other system components or system parts. | Demonstration | Important |
| 132 | ANM.MR.2 | Measurement/Functional Requirements | System parameter change registration | All changes to system parameters shall be logged by the Measuring System and the AWS Network Controller | Demonstration | Essential |
| 211 | ANM.MR.3 | Measurement/Functional Requirements | MIPS shall show progress of data acquisition | The ANM may have a feature to show (to the system operator and technicians) the progress of the data acquisition from all AWS’. The following items may be shown:  • The station accessed  • The status of the connection  • The number of attempts to set up a connection before the connection was been made  • The connection time  • The number of retries on the data acquisition  • The progress in % received data.  • The performance status of the data communication | Demonstration | Important |
| 227 | ANM.MR.4 | Measurement/Functional Requirements | Presentation of system status of remote systems | A graphical display should show the operational status of all system components:  AWS • Status of AWS • Status of all connected sensors • Status of all housekeeping information [for example power, door open, clock] • Status of data communication connection | Demonstration | Very Important (Regional Input) |
| 230 | ANM.MR.5 | Measurement/Functional Requirements | Map display 1: overview | The ANM should have screens with map overviews of all stations in the observation network. If all stations can be shown on one map, only one screen is required, if the number of stations is so large that one map is not sufficient, additional screens should be added.  For every station the station ID (WMO code) should be shown as text next to the station.   The stations should be colour coded, where the colours have the following meaning. The status of the instruments is related to the AWS internal meteorological parameter validation (AWS\_006), and in case an instrument does not output any data at all.  Colour |Instruments| Housekeeping information| AWS| Data communication   Green |OK| OK| OK| OK  Green blinking |One or more housekeeping parameters report problems| Yellow |One or more instruments report problems| OK |OK| OK  Yellow blinking |One or more instruments report problems| One or more housekeeping parameters report problems| OK| Ok  Orange |AWS is reporting problems |OK  Orange blinking|One or more instruments report problems |Unknown| AWS is reporting problems |OK  Red |One or more instruments report problems |One or more housekeeping parameters report problems| AWS is reporting problems| OK  Red blinking |Unknown| Unknown |Unknown| No data communication possible. | Demonstration | Very Important (Regional Input) |
| 231 | ANM.MR.6 | Measurement/Functional Requirements | Map display 2: station information | On the map display its should be possible to click on any station, which will zoom in on the station, showing additional information in a graphical manner:  • WMO station ID, WMO name [and “normal” name, if required]  • graphical presentation using colour coding (icon, button), of all meteorological parameters assessed at a station, measured or derived/calculated (for example dewpoint temperature)  if the parameter is OK the icon/button will be green, if the data is not qualified OK, it should be yellow, if the data is unavailable, the it should be red.  • at least one but up to the latest 10 numerical values of all parameters assessed at a station, measured or calculated (for example dewpoint temperature)  • graphical presentation using coloured buttons, of all housekeeping parameters assessed at a station, measured or calculated  - if the parameter is OK the button will be green,  if the data is not qualified OK, the button should be yellow,  if the data is unavailable, the button should be red.  • at least one but up to the latest 10 numerical values of all housekeeping parameters assessed at a station, measured or calculated  This display should be automatically updated every time new data from the AWS’ is received in the MIPS. | Demonstration | Very Important (Regional Input) |

# Measurement Data Archive

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 164 | MDA.MR.1 | Measurement/Functional Requirements | Management of configuration parameters for data archiving | It should be possible to configure the process of archiving by configuration parameters. An example of such a parameter is: • Default storage period | Demonstration | Very Important (Regional Input) |
| 167 | MDA.MR.2 | Measurement/Functional Requirements | Manual access to data | The data/system manager shall have the possibility to intervene in the running processes related to stored data. Such actions shall mainly focus on correction of inconsistencies. The required functions for this manual type of management are, for example.: • Removal of data from the different data sets and/or databases • To set the parameters for the management of archive issues for each database. Such change to overrule the default setting of the storage periods will be temporarily and in case of specific weather circumstances (e.g. in cases of calamities) • To carry out consistency controls | Demonstration | Essential (Regional Input) |
| 185 | MDA.MR.3 | Measurement/Functional Requirements | The Measurement Data Storage shall request data from AWS’ | The AWS/Sensor should have the capability to have the Measurement Data Storage system retrieve (pull) data from the AWS/Sensor on request. The Measurement Data Storage should contact the AWS/Sensor via the selected data communication method and request data by specifying the meteorological parameters, a start and end time and a start and end date. However, if due to whatever reason the Measurement Data Storage is missing data for a certain period of time, the period of retrieval should be configurable by the Measurement Data Storage up to a maximum of [[NMHS to set limit]] | Demonstration | Very Important (Regional Input) |
| 186 | MDA.MR.4 | Measurement/Functional Requirements | The Measurement Data Storage shall request log data from AWS/Sensor | The AWS/Sensor should have the capability to have the MDS retrieve log data, on request. The MDS should connect to the AWS/Sensor and request the log data specified by a start and end time and a start and end date. The log data should be stored on the MDS and be available for technicians and administrators. | Demonstration | Very Important (Regional Input) |
| 203 | MDA.MR.5 | Measurement/Functional Requirements | MIPS shall have a data acquisition module | The MIPS shall have a module [Measurement Data Storage] that acquires data from the supplying systems, the AWS stations. Acquisition shall be done via the chosen data communication system, the configuration of which is done in the MDS. The MDS shall be able to buffer acquired data for at least one hour. | Demonstration | Essential (Regional Input) |
| 204 | MDA.MR.6 | Measurement/Functional Requirements | Simultaneous acquisition of data | The MDA (which may be part of a combined MIPS or separate) should be able to acquire data simultaneously from various AWS. There is a time window for creating and disseminating of reports, and all required AWS data should be acquired in time for this report generation. | Demonstration | Very Important (Regional Input) |
| 205 | MDA.MR.7 | Measurement/Functional Requirements | Acquisition of data from AWS stations | The Measurement Data Archive (MDA) may acquire and store data from AWS/smart sensor stations. Acquisition may take place by specifying a start and end time and a start and end date, and the parameters/data that may be acquired. For the regular acquisition, this may be arranged through configurations for each station. The MDA may acquire data from all AWS-stations every [[NMHS to define frequency, for example every 10 minutes]]. The newest data may be collected first.  [[The NMHS should also define whether the MDA pulls/requests data from the AWS, or whether the AWS pushes the data]] | Demonstration | Important |
| 207 | MDA.MR.8 | Measurement/Functional Requirements | MIPS data storage requirements | The Measurement Data Archive (MDA) can store meteorological data in files or databases in various manners. The data that is acquired by MDA may not be identical to the data that will be stored.  At least the following data should be stored for a period of at least 7 days:  • All 1-minute moving averages from the AWS’ from the observations taken once every minute.  • All 10-minute averages from the AWS’ from the observations taken once every minute, including the 10 minute minimum, the 10 minute maximum, standard deviation, # of good measurements used for the averages.  • All reports.  • Log files from the AWS’ and the MDA itself.  Storage capacity should only be limited by available disk space, which should be dimensioned adequately. The MDA operations should not be affected when the above-described quantities are exceeded.  There are no specific requirements on how the data will be stored. However, for many reasons it would be convenient if data is stored in a relational database, which provides many of the data management tools as standard features. Storage in files is possible, bur many of the required tools will have to be provided separately.  Disk space should be dimensioned so that at most 50% of the capacity is used during normal operation. Storage structure should be defined in detail by the supplier. | Demonstration | Very Important (Regional Input) |
| 216 | MDA.MR.9 | Measurement/Functional Requirements | Changing the system time | A system administrator should have the possibility to set/change the system time.   [[The Customer may add additional security requirements to avoid errors or malicious use]] | Demonstration | Very Important (Regional Input) |
| 232 | MDA.MR.10 | Measurement/Functional Requirements | Map display 3: diagnostics and actions | It may be possible to right-click on the meteorological parameters from MIPSM\_013, which will provide access to the following information or actions (through sub menus or text boxes/windows):  • detailed information on the data quality, including but not limited to station/parameter description, status (fatal fault, data unavailable, range error, rate of change error, source of a problem (bad power supply, broken data cable, etc.) • a parameter can be forced to a particular value, a numerical value or to an error state. This action will be logged and can only be executed by a technician or meteorological system parameter • at least the latest alarm but also up to the latest 10 alarms related to the parameters • if the system can assess the reason for an alarm, it may provide a short description of this reason. | Demonstration | Important |
| 233 | MDA.MR.11 | Measurement/Functional Requirements | Request AWS data for technical diagnostics | The MDA can requests an AWS for the real time data from a selected meteorological parameter . There are two ways to request AWS: • Real time AWS data   The MDA requests the latest real time AWS data. When data becomes available in the AWS, the AWS sends it directly to the MDA. This data communication should not interrupt or interfere with the regular data communication between MDA and AWS.  • Historic AWS data  The MDA requests historic AWS data. In the request, the start and end date/time are specified and the parameters from which data are desired. The AWS sends the MDA the requested data. If the data are not available, the AWS should notify the MDA of this. The header of the data displayed should show the selected AWS and parameter(s). The received AWS data should be displayed from the latest to older data as (ASCII) text. It should be possible to scroll back and forward in the data. | Demonstration | Very Important |
| 206 | MDA.OS.1 | Observation Statistics/Algorithms | Processing module | The MIPS/MDA may have facilities to perform computations on acquired ‘raw’ data, which will lead to the production of so-called ‘derived quantities’. The calculations can be simple (e.g., calculation of measured air pressure to mean sea level pressure), or more complex (e.g. deriving cloud cover from the combination of time averaged lidar measurements in combination with satellite data and some additional algorithms).   For the computations, at least the following arithmetic functions must be available: adding, subtracting, multiplying, power, square root, exponent, logarithm, sine, cosine.   It may be possible to implement new calculations by the user, through configuration or by an embedded programming tool. Adding additional or new algorithms may not require coding on the main program.  Algorithms from this module may be invoked not only to convert ‘raw’ data to those stored, but also if data from has to be converted to quantities suitable for insertion in reports. | Demonstration | Important |

# National Message Generation

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 124 | NMG.MR.1 | Measurement/Functional Requirements | SYNOP/METAR/SPECI Requirements | The system is capable of handling (coding, decoding, automatic generation, manual generation) all nationally and internationally defined SYNOP and METAR/SPECI reports defined in Manual on the Codes.  [[Customer may add additional requirements, for example BUFR, CLIMAT]] | Demonstration | Essential (Regional Input) |
| 209 | NMG.MR.2 | Measurement/Functional Requirements | Removal of old meteorological reports | The NMG should automatically remove old meteorological reports, the number of days after which the reports are removed is configurable by the NMHS. | Demonstration | Very Important (Regional Input) |
| 662 | NMG.OS.1 | Observation Statistics/Algorithms | WD for SYNOP | In the SYNOP wind direction should be reported • in degrees to the nearest 10°, using a 01 ... 36 code (for example, code 2 means that the wind direction is between 15 and 25°),  • WD in the SYNOP is based on a 10 minute average. | Inspection | Very Important |
| 663 | NMG.OS.2 | Observation Statistics/Algorithms | WD in BUFR | If BUFR generation is included, the wind direction should be reported • in degrees with at least 1° resolution,  • WD in BUFR code is based on a 10 minute average. | Inspection | Very Important |

# GUI

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 200 | GUI.MR.1 | Measurement/Functional Requirements | MIPS components shall have a Graphic User Interface (GUI) | All aspects of the MIPS should have a graphical user interface. It should work with windows to show information in a structured and configurable manner. MIPS displays can be shown in web browsers or in dedicated client applications.anner. MIPS displays can be shown in web browsers or in dedicated client applications.  [[In the above, Windows=a region on a display, not neccessarily the Microsoft Operating System of the same name]] | Demonstration | Very Important (Regional Input) |
| 201 | GUI.MR.2 | Measurement/Functional Requirements | Resolution | The physical resolution of graphical presentations should be such that all information on the screens is clear and readable at a distance of 1 m from the screen. If the windows are scaled to their smallest dimensions, it should still be possible to see and read all the information on a standard size terminal. | Demonstration | Very Important (Regional Input) |
| 202 | GUI.MR.3 | Measurement/Functional Requirements | MIPS displays | If display for any aspect of the MIPS are part of the delivery, they shall be at least [[NMHS to insert size, for example 21 inch]] | Demonstration | Essential (Regional Input) |
| 236 | GUI.MR.4 | Measurement/Functional Requirements | The displays shall have a graphical user interface (GUI) | All aspects of the MIPS should have a graphical user interface. It should work with windows to show information in a structured and configurable manner. MIPS displays can be shown in web browsers or in dedicated client applications.anner. MIPS displays can be shown in web browsers or in dedicated client applications.  [[In the above, Windows=a region on a display, not neccessarily the Microsoft Operating System of the same name]] | Inspection | Very Important (Regional Input) |
| 238 | GUI.MR.5 | Measurement/Functional Requirements | Size and number of displays | Any size of display should be supported, but in general the size should at least be 21”. | Inspection | Very Important |
| 240 | GUI.MR.6 | Measurement/Functional Requirements | Data to display via Ethernet, LAN/WAN or WIFI | The displays should communicate with the relevant part of the MIPS via Ethernet, LAN/WAN or Wifi. | Demonstration | Very Important |
| 242 | GUI.MR.7 | Measurement/Functional Requirements | Scaling of graphical presentations | The size (width, height) of a graph may scale with the window size, i.e. if the horizontal dimension of the window becomes twice as large, so may the vertical dimension of the graph. The minimum size of the window is defined by the readability of the text on the screen. | Inspection | Important |
| 243 | GUI.MR.8 | Measurement/Functional Requirements | Physical units of displayed data | For some meteorological quantities it shall be possible to choose the physical units to be used in the graphs. For example, wind speed can be displayed in m/s or knots, pressure in hPa, mmHg, temperature in ºC and ºF. [[The default shall be to SI units unless designated by the Customer]] | Inspection | Essential (Regional Input) |
| 244 | GUI.MR.9 | Measurement/Functional Requirements | Up-dating graphs in minimised windows | The graphs in minimised windows should be updated continuously in the same manner as they would be if the window was ‘open’. | Inspection | Very Important |
| 245 | GUI.MR.10 | Measurement/Functional Requirements | Trend graphs, time series | It should be possible to display meteorological and housekeeping data in trend graphs, i.e. measurements as function of time. The following items can be selected for a graph: • The data to be used. For each graph the data to display can be selected. The available data is selectable from a list in a pop-up menu. In each graph a maximum of four elements can be displayed, i.e., at most 4 curves per graph. Each element should have has its own scale along the vertical (y-) axis. If 4 curves are displayed, two y-axes are displayed on the left side of the graph and two on the right side. • Line type • Colour of the curve. • Time scale  The time scale is defined by either:  • Historic data: start and end time/date. In this case the horizontal axis starts at the start time and ends at the end time.  • Start time/date and a period of time. The period of time can be 1, 3, 6, 12 or 24 hours.  • The end time as the latest measurement and the period before, which can be 1, 3, 6, 12 or 24 hours.  It should be possible to zoom in or out in a simple manner. The legends for the displayed data should be shown in the graph. A cross-hair cursor can be moved over the graph, showing the time and the measured values on the display. It should be possible for users to apply the above mentioned tools to configure their own graph set-ups (and also save these configurations). | Inspection | Very Important |
| 246 | GUI.MR.11 | Measurement/Functional Requirements | Other display elements | It shall be possible to display data in:  • Text boxes, numerical values and text, updated automatically as new data becomes available in the MIPS • Wind roses for wind direction and variation in wind direction. The arrow form the direction the wind is blowing from, points towards the center of the wind rose. Variation can be shown as a circle section around the outside/inside of the wind rose. Main tick at every 30ºminor ticks every 10º. | Inspection | Essential (Regional Input) |
| 247 | GUI.MR.12 | Measurement/Functional Requirements | Colours | It may be possible to freely select the colour for each element on the screen, as well as for text. | Inspection | Important |
| 248 | GUI.MR.13 | Measurement/Functional Requirements | Text size | Text size may be scaled automatically with the dimensions of the text boxes on the screens. A separate tool to scale text size is not required. | Inspection | Important |
| 361 | GUI.MR.14 | Measurement/Functional Requirements | Dimensions of the display system | The dimensions of a display system (if part of the project delivery) should not exceed the size of a standard PC (desktop or tower). | Inspection | Very Important (Regional Input) |

# IT Infrastructure

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 285 | IT.MR.1 | Measurement/Functional Requirements | Standard internal transport/network protocol | The systems should use TCP/IP as standard transport/network protocol for internal interfaces whenever possible. This enables systems to exchange data on the same hardware platform or via LAN/WAN. Exception: interfaces with instruments may not be able to use TCP/IP, but can use another protocol | Inspection | Very Important (Regional Input) |
| 307 | IT.MR.2 | Measurement/Functional Requirements | General purpose industrial computers | The system should use general purpose industrial computers as the main platform component for process control. | Inspection | Very Important (Regional Input) |
| 309 | IT.MR.3 | Measurement/Functional Requirements | General system environment | One system environment shall be used. The system shall use UNIX, Microsoft Windows, Linux, or a system of equivalent functionality as an overall general system environment. The use of other system environments than Windows, UNIX or Linux shall be motivated.   [[The Customer shall designate a time period (suggestion 5 years) for which the software will guaranteed on the offered OS.]] | Demonstration | Essential (Regional Input) |
| 310 | IT.MR.4 | Measurement/Functional Requirements | Office systems environment | The desktop systems (if part of the project) environment shall be the latest stable version of the OS, or equivalent.  [[The Customer shall designate a time period (suggestion 5 years) for which the software will guaranteed on the offered OS.]] | Demonstration | Essential (Regional Input) |
| 311 | IT.MR.5 | Measurement/Functional Requirements | Database Management System Language | All Database Management System(s) used within the system should be ANSI SQL-based. Options can be offered- industry standards should be preferable. | Demonstration | Very Important (Regional Input) |
| 324 | IT.MR.6 | Measurement/Functional Requirements | Split hardware over separate computer rooms | Redundant hardware may be split-up over separate rooms. | Inspection | Desirable |
| 325 | IT.MR.7 | Measurement/Functional Requirements | Systems will hold data on power failure | The system shall be built in a way to prevent data loss at power failures. Data shall be copied to permanent storage as soon as it is ingested by the system and not be kept in volatile memory. | Demonstration | Essential |
| 354 | IT.MR.8 | Measurement/Functional Requirements | NMHS Specified keyboard layout | Keyboards supplied with systems may have a NMHS Specified keyboard layout. Software may support the use of keyboards with a NMHS Specified keyboard layout | Inspection | Important (Regional Input) |
| 969 | IT.PSI.1 | Power/Site Infrastructure | UPS’ for AWS’ and MIPS | UPS should be supplied for all components of the MIPS to guarantee proper shutting down in case of mains power failure or brownout. In case the customer already is using a UPS at certain locations, it should be assessed if it can be re-used for the new systems. | Demonstration | Very Important (Regional Input) |

# Communications

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 174 | C.MR.1 | Measurement/Functional Requirements | Communication protocols for communication with MIPS | Communication protocols should preferably not require any user configuration other than hardware configuration. In case of serial communication configuration of standard parameters such as baud rate, parity, etc, are allowed. In case of TCP/IP, configuration of IP addresses and related parameters are allowed, as well as configuration of routers and other communication hardware. [NMHS may determine whether data is 'pushed' for AWS site to MIPS, or 'pulled'] | Demonstration | Very Important (Regional Input) |
| 314 | C.MR.2 | Measurement/Functional Requirements | Network technology | The systems should use TCP/IP over Ethernet as network technology. TCP/IP over serial lines should also be possible. | Demonstration | Very Important (Regional Input) |
| 979 | C.MR.3 | Measurement/Functional Requirements | Recovery after communication problem | Messages are stored at the AWS/Smart Sensor during a communication problem. After communication is restored the messages are sent. | Inspection | Essential (Regional Input) |
| 980 | C.MR.4 | Measurement/Functional Requirements | Error handling on protocol level | Error handling on protocol level is covered by the TCP/IP implementation. | Inspection | Very Important |
| 981 | C.MR.5 | Measurement/Functional Requirements | Physical Connection | The systems may be connected through an Ethernet network complying with IEEE 802.3 with a foiled twisted pair cable. The connector may be a RJ45. | Inspection | Important (Regional Input) |
| 317 | C.R.1 | Regulatory/Standards | Communication equipment approval | All communication equipment used for communication via the public telephone network or fixed (hired) lines, wireless telephone or radios, shall be approved by the local telecommunication authorities. If licenses are required for equipment offered, the supplier shall inform the customer for approval. | Inspection | Essential (Regional Input) |
| 362 | C.R.2 | Regulatory/Standards | Wireless communication | In case wireless communications is applied, local permit restrictions may apply related to the use of particular frequencies to be used. The supplier shall conform with the customer and local telecommunication authorities which permits are required and whether the supplier or the customer shall arrange these permits. | Demonstration | Essential (Regional Input) |

# AWS/Smart Sensors

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 199 | AS.SP.1 | Sensor/Hardware Performance | AWS cabinet | The AWS/Smart Sensor and the electronic equipment required for the AWS/Smart Sensor, should be installed in an outdoor cabinet with a protection category of IP 55, IP 56, IP 57, IP65, IP66 or IP 67 (IEC 60 529).  The material the cabinet is made of should be chosen so that the cabinet can survive at least 10 years in the environment of the installation without physical damage. The outer layer of the cabinet should be UV resistant, and not show external or internal corrosion in case it is made of metal. If powder coated or painted, the coating may have changed colour, but it should not be cracked or damaged in any other way. If glass fibre or other synthetic materials have been used, it may have changed colour, but it should not be cracked or damaged in any other way.  It should be possible to supply the cabinet in any RAL colour.  The cabinet should have at least one lock and should open/close with a key. Depending on the dimensions of the cabinet door, multiple door locks may be required.  If required due to environmental conditions, the cabinet should be double-walled and/or equipped with heating with a thermostat and a hygrostat.  At the bottom of the cabinet glands should be built in for incoming and outgoing cables.  The cabinet should be supplied with all necessary pole mounting brackets or wall mounting brackets, as required. | Inspection | Very Important (Regional Input) |
| 1059 | AS.SP.2 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1084 | AS.SP.3 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 1089 | AS.SS.1 | Sensor Siting | Operational Wind Speed Maximum | When a Tenderer is supplying a system [for example a mast and sensors, or an AWS cabinet with solar panels], they should provide details of the maximum wind speed sustainable by the combined system. This would be expected to be lower than the wind tolerances of the separate components. | Response | Important |
| 177 | AS.MR.1 | Measurement/Functional Requirements | Housekeeping data | The AWS shall be able to measure and record at least the following so-called “housekeeping” data, which can be inspected by technicians, and can be used to generate technical alarms: • cabinet door open/closed status • cabinet temperature and relative humidity • power supply voltage for all instruments • power supply voltage to all auxiliary equipment in the cabinet (network, data communication, ventilation units, heating, etc.) • heaters on/off status • ventilation units on/off statu • output voltage of back-up batteries (if present) • broken cable occurrence for data cables of all instruments.  Housekeeping parameters that indicate a status only (on/off, open/closed), shall not generate alarms. For housekeeping parameters that return a value that shall be within a particular range, for example a power supply voltage shall be between 8 and 12 VDC, it shall be possible to generate alarms for that parameter.  Housekeeping data shall be stored on the AWS for 7 days.   It shall be forwarded to the AWS Network Controller as regular observation data, and used to generate alarms for technicians if these parameters exceed the configurable threshold indicating that normal operation is interrupted or at risk of being interrupted (various alarm levels possible).  The Tenderer may also offer a local display for this information. | Demonstration | Essential (Regional Input) |
| 179 | AS.MR.2 | Measurement/Functional Requirements | AWS shall time-stamp incoming data | The AWS shall timestamp the meteorological observations, calculated parameters, and data from other sources when it is stored. The timestamp and the time of the actual observation shall not deviate more than 1 s. [[timestamp in UTC or local time to be determined by Customer]] | Demonstration | Essential (Regional Input) |
| 190 | AS.MR.3 | Measurement/Functional Requirements | AWS’ first priority is data acquisition | The first priority of an AWS is to ingest and store data from the meteorological instruments - no other processes running on AWS may disturb this function. | Demonstration | Essential |
| 191 | AS.MR.4 | Measurement/Functional Requirements | AWS storage requirements | The AWS/Smart Sensor shall be able to store the following data for a maximum of all connected instruments and other sources: • All the observations, calculated parameters, and data from other sources for [[NMHS to days specify, but at least 7 days]], • log data for [[NMHS to days specify, but at least 7 days]]. | Demonstration | Essential (Regional Input) |
| 192 | AS.MR.5 | Measurement/Functional Requirements | AWS watchdog | The AWS should have a hardware and/or software watchdog that should be triggered by an automous process.  If a time-out occurs for the watchdog, the AWS should receive a software and/or hardware-reset. | Demonstration | Very Important (Regional Input) |
| 193 | AS.MR.6 | Measurement/Functional Requirements | AWS-operations shall be monitored by a watchdog process | All processes within the AWS/Smart Sensor should be monitored by a watchdog process.  This process monitors the ingestion of data and the statuses of running processes at regular intervals. If a process is not running properly, an attempt to recover/reinitialise it must be made. If recovery fails, the system must be reset. If a software-reset fails, a hardware-reset should be applied. Anomalies and errors will be reported and stored in a log data archive. | Demonstration | Very Important (Regional Input) |
| 194 | AS.MR.7 | Measurement/Functional Requirements | Changes in an AWS-configuration may not disturb its operation | Activation of new or adapted AWS/Smart Sensor parameters and/or configuration settings, may not cause a decrease of the AWS/Smart Sensor performance for longer than 10 seconds.  The AWS/Smart Sensor configuration parameters and/or settings can be changed through the AWS Network Controller.  For changing parameters and/or configurations and activation of the new parameters, a system operator password [or another method as determined by the NMHS to ensure security] is required. | Demonstration | Very Important (Regional Input) |
| 298 | AS.MR.8 | Measurement/Functional Requirements | Environment: temperature | As a minimum, the equipment installed outdoors should be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100%] and wind speed up to 50m/s. A NMHS may modify this requirement to meet the meteorological conditions normally expected. | Inspection | Very Important (Regional Input) |
| 360 | AS.MR.9 | Measurement/Functional Requirements | Dimensions of the AWS system | The size of the AWS system (all equipment, except instruments) that has to be installed at an observation site) should be of such a dimension that it can be mounted in a standard size outdoor cabinet. | Inspection | Very Important (Regional Input) |
| 1115 | AS.OS.1 | Observation Statistics/Algorithms | Measured/Calculated Parameters | In the absence of guidance from the NMHS or WMO, the AWS/Smart Sensor shall calculate a 1 minute/instantaneous value, a 10 minute average, a max/min/standard deviation for all observations | Demonstration | Essential (Regional Input) |
| 1091 | AS.OM.1 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be initially supplied with a paper and electronic (pdf) calibration certificate that at least specifies:     • Manufacturer, brand  • Instrument type  • Serial number  • Initial calibration date  • Validity period of calibration  • Calibration range  • Traceability of calibration  • Calibration method  • Irradiance level  • Net long-wave irradiance for thermal offset correction  • Spectral distribution of irradiance  • Temperature at calibration  • Temporal variation of instrument output during calibration.  • Calibration factor/sensitivity and uncertainty  • Deviation from previous sensitivity (for recalibrations only)  • Name and signature of calibration technician that performed the calibration.  • If at recalibrations more than the sensitivity is calibrated, all old and new values for the respective parameters should be provided. | Inspection | Very Important (Regional Input) |
| 350 | AS.PSI.1 | Power/Site Infrastructure | UPS’ for AWS’ and MIPS | UPS’ should be supplied for all components of the MIPS to guarantee proper shutting down in case of mains power failure or brownout. In case the customer already is using a UPS at certain locations, it should be assessed if it can be re-used for the new systems. | Demonstration | Very Important (Regional Input) |
| 1095 | AS.PSI.2 | Power/Site Infrastructure | Solar Power Option | The Tenderer may provide details on requirements for solar powering of equipment - ideally using a low power consumption configuration.  If provided, this should include all the hardware/components required. It should also include calculations showing the number of days without sunshine the system can power the equipment. | Response | Desirable |
| 300 | AS.HSE.1 | HSE | Environment: shock and vibration level | The AWS should be able to operate in an environment with a shock and vibration level not exceeding 0.1 kB (DIN 4150/ISO 4866). | Inspection | Very Important (Regional Input) |
| 301 | AS.HSE.2 | HSE | Environment: EMC | EMC susceptibility is according to EC-regulations, but special care must be taken to withstand static electric shocks, as well as the use of handheld radio and telephone equipment in the vicinity of the systems. | Inspection | Essential (Regional Input) |

# MIPS All

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 170 | MIPS.MR.1 | Measurement/Functional Requirements | Automatic data files or database management | The data files or databases should be managed automatically by the system without human intervention. For example, the system should automatically repair damaged data files or databases, automatic correction activities should be implemented, automatic purging of data files or databases for the configured storage periods, automatic database replication (if applicable), etc. | Demonstration | Very Important |
| 212 | MIPS.MR.2 | Measurement/Functional Requirements | MIPS shall collect statistics on the acquisition processes | The MIPS shall collect statistics on all acquisition processes. The MIPS shall have facilities to display these statistics graphically (on a GUI display) as a function of time for all individual systems that supply data, but also for groups of data supplying systems (e.g., to display acquisition processes from all AWS-stations). | Demonstration | Essential (Regional Input) |
| 215 | MIPS.MR.3 | Measurement/Functional Requirements | Displaying of data in the database | The MIPS shall have GUIs to display all the data in the system, meteorological data, log files, status information, errors, reports, etc. Such displays shall contain as many screens as needed to display the data in a structured manner. These screens and displays shall be configurable by the user (system administrator). | Demonstration | Essential (Regional Input) |
| 217 | MIPS.MR.4 | Measurement/Functional Requirements | Graphical User Interface | The MIPS shall have a graphical user interface. It shall work with windows to show information in a structured and configurable manner. MIPS displays can be shown in web browsers or in dedicated client applicationsThe MIPS shall have a graphical user interface for maintenance, configuration and support tasks. It shall work with windows to show information in a structured and configurable manner. Displays can be shown in web browsers or in dedicated client applications. | Demonstration | Essential (Regional Input) |
| 234 | MIPS.MR.5 | Measurement/Functional Requirements | Management of system processes | The MIPS shall be able to access system components to perform system management (such as starting and stopping processes, file management, etc.). | Demonstration | Essential |
| 323 | MIPS.MR.6 | Measurement/Functional Requirements | Redundancy | All aspects of the MIPS should be a redundant systems. The redundant systems should have a hot standby relationship. Operation should be taken over within 1 minute. It is preferred to also have a redundant LAN. Cabling should support redundant systems (no plugs have to change to make operation of the standby system possible). | Demonstration | Very Important (Regional Input) |
| 327 | MIPS.MR.7 | Measurement/Functional Requirements | Adaptability in continuous operational environment | The system can be adapted in an operational environment, without compromising requirements regarding availability, reliability, functionality or maintainability. | Demonstration | Important |
| 348 | MIPS.MR.8 | Measurement/Functional Requirements | Software installation from central point | The system may provide facilities for the installation, for making new versions of the software operational and for making new versions of the configurations operational, from a central point, through the MIPS. | Demonstration | Important |

# Software

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 355 | S.MR.1 | Measurement/Functional Requirements | Software and system configuration supported | The software and configuration of the system must be supported by the customer’s-maintenance groups. Standards and requirements of the customer’s-maintenance groups should prevail over any standards recommended by the suppliers of the software/hardware. | Inspection | Very Important |

# Soil Temperature

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 422 | ST.SP.1 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring Soil Temperature shall be based on an electrical thermometer, usually an electrical resistance thermometer. However, any sensor type compliant with the requirements in this section shall be considered. | Inspection | Essential (Regional Input) |
| 424 | ST.SP.2 | Sensor/Hardware Performance | Measurement Range | The measurement range shall be -50 °C to +50 °C. | Inspection | Essential (Regional Input) |
| 428 | ST.SP.3 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be 0.2 ºC or better. | Inspection | Essential (Regional Input) |
| 430 | ST.SP.4 | Sensor/Hardware Performance | Sensor Performance Constant | The instrument time constant under controlled conditions shall be 20 s or better over the entire operational range. | Inspection | Essential |
| 432 | ST.SP.5 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 446 | ST.SP.6 | Sensor/Hardware Performance | Multiple outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 447 | ST.SP.7 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 977 | ST.SP.22 | Sensor/Hardware Performance | Sources of Error | The Tendered equipment shall demonstrate that the following common sources of error have been adequately compensated for:- a) Self heating of the thermometer element b) Inadequate compensation for lead resistance c) Inadequte Compensation for non-linearites in the sensor or processing instrument d) sudden changes in switch contact resistance. | Inspection | Essential |
| 1067 | ST.SP.24 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1076 | ST.SP.25 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 435 | ST.SS.1 | Sensor Siting | Siting | The electrical thermometers for Soil Temperature measurements should be inserted horizontally at the required depth into small holes with the same diameter as the instruments, drilled in an undisturbed vertical soil face, which has been exposed by trenching. | Inspection | Very Important (Regional Input) |
| 436 | ST.SS.2 | Sensor Siting | Cables | Electrical connections are to be brought out through plastic tubes via the trench, which is then refilled in such a way to restore, as far as possible, the original strata and drainage characteristics. | Inspection | Very Important (Regional Input) |
| 974 | ST.SS.3 | Sensor Siting | Installation Height | Depending on the AWS Station Type, Soil Temperature sensors shall be deployed at depths of 5cm, 10cm, 20cm and 50cm. For Agricultural Meteorological Stations, a sensor shall be installed at 100cm depth. For Principal Climatological Stations, sensors shall be installed at 100cm, 150cm and 300cm depth. | Inspection | Essential (Regional Input) |
| 978 | ST.SS.4 | Sensor Siting | Shade Angle | The soil temperature sensor should be sited so as the ground above the sensor is not in shadow from other instruments or obstructions outside the enclosure. To maintain less than 1C additional uncertainty, the temperature sensor/screen should not be in shadow when the sun is above 7 degrees above the horizon. | Inspection | Very Important (Regional Input) |
| 423 | ST.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Soil Temperature shall be presented in/by the instrument/system in degrees Celsius (°C). | Demonstration | Essential (Regional Input) |
| 426 | ST.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported temperature shall be 0.1 °C. | Demonstration | Essential (Regional Input) |
| 431 | ST.MR.3 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous soil temperature should be sampled at least 2 times over the interval of the sensor time constant. For example, if the sensor time constant is 20 seconds, then there should be a sample evey 10 seconds | Inspection | Very Important |
| 444 | ST.MR.4 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 433 | ST.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | Averages of all valid samples of Soil Temperature shall be produced over a 1 minute interval. The 1 minute average shall be used as the instantaneous value for soil temperature. | Inspection | Essential (Regional Input) |
| 434 | ST.OS.2 | Observation Statistics/Algorithms | Minimum Data | At least 66% of the soil temperature samples in one minute should be available to enable the computation of the instantaneous soil temperature value. If insufficient data is available to meet this requirement, the soil temperature should be marked as missing/invalid | Inspection | Very Important (Regional Input) |
| 975 | ST.OS.3 | Observation Statistics/Algorithms | Rate of Change Check | After each signal measurement, the current instantanous value should be compared to the preceding one. If the difference between two samples is more than 2C, the current sample is identified as suspect and is not used for the computation of an average. | Inspection | Very Important (Regional Input) |
| 976 | ST.OS.4 | Observation Statistics/Algorithms | Jump Check | If the difference between consecutive one minute averages is more than 0.5C [5/10/20cm observation], 0.3C [50cm observation] or 0.1C [100cm observation], then the data should be flagged as suspect for further investigation. If the difference is more than 1C [5/10/20cm observation], 0.5C [50cm observation] or 0.2C [100cm observation], then the data should be flagged as erroneous for further investigation. | Inspection | Very Important (Regional Input) |
| 1013 | ST.OS.5 | Observation Statistics/Algorithms | NMHS Calculated Parameters | Additional Soil Temperature Averages and additional Statistics may be requested by the NMHS, to meet local or RA requirements. These may be inserted here. | Demonstration | Very Important (Regional Input) |
| 438 | ST.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 439 | ST.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |
| 448 | ST.PSI.1 | Power/Site Infrastructure | Excitation Supply | If the sensor requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important (Regional Input) |

# Sunshine Duration

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 900 | SD.SP.1 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring SD shall be based on an instrument with an electrical output. Any sensor type compliant with the requirements in this section shall be considered. | Inspection | Essential (Regional Input) |
| 902 | SD.SP.2 | Sensor/Hardware Performance | Measurement Range | The maximum measurement range shall be at least 0 – 24 h. | Inspection | Essential (Regional Input) |
| 906 | SD.SP.3 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be the larger of 0.1h or 2%. | Inspection | Essential (Regional Input) |
| 907 | SD.SP.4 | Sensor/Hardware Performance | Sensor Performance Constant | The instrument response time shall be better than 20 s | Inspection | Essential |
| 910 | SD.SP.5 | Sensor/Hardware Performance | Spectral Range | The spectral range shall be at least 400 nm to 800 nm. | Inspection | Essential (Regional Input) |
| 912 | SD.SP.6 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 944 | SD.SP.7 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 945 | SD.SP.8 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 1065 | SD.SP.9 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1077 | SD.SP.10 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 915 | SD.SS.1 | Sensor Siting | Installation Platform | The Sunshine Duration recorder should be mounted on a rigid, stable stand/base plate to avoid shocks, vibrations, and movement due to wind. If a pyrheliometer is used, it should be mounted on a solar tracker that tracks the sun across the sky during the day. | Inspection | Very Important (Regional Input) |
| 916 | SD.SS.2 | Sensor Siting | Stable foundation | In case a pyrheliometer and tracker are used, the solar tracker shall be installed on a stable foundation that shall prevent movement of the pyrheliometer other than movement caused by the solar tracker. | Inspection | Essential |
| 917 | SD.SS.3 | Sensor Siting | Installation Height | The sensor/instrument shall be mounted at a height that minimizes effects/impacts of obstructions. This may be at around 1.5 m above ground level, but a rooftop or other high locations may be more suitable. | Inspection | Essential (Regional Input) |
| 918 | SD.SS.4 | Sensor Siting | Obstacle Free Installation | The Sunshine Duration recorder or pyrheliometer shall be installed with no obstacles in the line of sight between the sun and the instrument during the day when the sun is 3 degrees or more above the horizon. | Inspection | Essential (Regional Input) |
| 901 | SD.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, SD shall be presented in/by the instrument/system in (decimal) hours. | Demonstration | Essential (Regional Input) |
| 904 | SD.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported SD shall be 60 s or 1 minute. | Demonstration | Essential (Regional Input) |
| 908 | SD.MR.3 | Measurement/Functional Requirements | Stability | The stability (change per year) of the instrument should be better than 2% per year. | Inspection | Very Important (Regional Input) |
| 909 | SD.MR.4 | Measurement/Functional Requirements | Temperature Response | The temperature response of the instrument (that is, deviation due to change of ambient temperature) shall be better than 0.1%. | Inspection | Essential (Regional Input) |
| 913 | SD.MR.5 | Measurement/Functional Requirements | Calculated Parameters | The instantaneous measurements are used to calculate and make available  • SD in minutes per 10 minute interval, • SD in minutes per hour,  • SD in minutes per day.  For each calculated SD, at least 85% of the instantaneous measurements shall be used. For the SD per hour and per day, at least 90% of the instantaneous measurements shall be used. | Demonstration | Essential (Regional Input) |
| 1002 | SD.MR.6 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous measurement of Sunshine Duration should be done at least 2 times in the time interval of the sensor time constant. | Inspection | Very Important |
| 1003 | SD.MR.7 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 914 | SD.OS.1 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 936 | SD.OS.2 | Observation Statistics/Algorithms | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 937 | SD.OS.3 | Observation Statistics/Algorithms | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory. Each instruments should be initially supplied with a paper and electronic (pdf) calibration certificate that at least specifies:  • Manufacturer, brand • Instrument type • Serial number • Initial calibration date • Validity period of calibration • Calibration range • Traceability of calibration • Calibration method • Irradiance level • Net long-wave irradiance for thermal offset correction • Spectral distribution of irradiance • Temperature at calibration • Temporal variation of instrument output during calibration. • Calibration factor/sensitivity and uncertainty • Deviation from previous sensitivity (for recalibrations only) • Name and signature of calibration technician that performed the calibration. • If at recalibrations more than the sensitivity is calibrated, all old and new values for the respective parameters should be provided. | Inspection | Very Important (Regional Input) |
| 1004 | SD.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Direct Solar Radiation

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 770 | DSR.SP.1 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring Direct Solar Radiation shall be based on pyrheliometer with an electrical output. | Inspection | Essential (Regional Input) |
| 772 | DSR.SP.2 | Sensor/Hardware Performance | Measurement Range | The maximum measurement range shall be at least 0 – 2,000 W·m-2. | Inspection | Essential (Regional Input) |
| 773 | DSR.SP.3 | Sensor/Hardware Performance | Practical Range | The practical measurement range shall be at least 0 – 2,000 W·m-2. | Inspection | Essential (Regional Input) |
| 776 | DSR.SP.4 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor measurement uncertainty shall be sufficient to achive the following uncertainties [95% confidence level] in the calculated variables: 1 min totals [0.9%/0.56kJ/m^2], 1 hour totals [0.7%/21kJ/m^2] and daily totals [0.5%/200kJ/m^2] | Inspection | Essential (Regional Input) |
| 777 | DSR.SP.5 | Sensor/Hardware Performance | Sensor Performance Constant | The instrument response time shall be better than 30 s. | Inspection | Essential |
| 778 | DSR.SP.6 | Sensor/Hardware Performance | Zero Offset B | The zero offset B, the response to ? 5 K·h-1 change in T, should be better than 4 W·m-2. | Inspection | Very Important (Regional Input) |
| 779 | DSR.SP.7 | Sensor/Hardware Performance | Stability | The stability (change per year) of the instrument should be better than 0.5% of the full scale range per year. | Inspection | Very Important (Regional Input) |
| 780 | DSR.SP.8 | Sensor/Hardware Performance | Temperature Response | The temperature response, the deviation due to change of ambient temperature within an interval of 50 ºC, shall be better than 2%. | Inspection | Essential (Regional Input) |
| 781 | DSR.SP.9 | Sensor/Hardware Performance | Non-linearity | The non-linearity, the deviation in responsivity at 500 W·m-2 due to a change in irradiance from 100 to 1,100 W·m-2, shall be better than 0.5%. | Inspection | Essential (Regional Input) |
| 782 | DSR.SP.10 | Sensor/Hardware Performance | Spectral Selectivity | Spectral selectivity, the deviation of the product of spectral absorbance and spectral transmittance from the corresponding mean within the interval 300 nm to 3,000 nm, shall be better than 1%. | Inspection | Essential (Regional Input) |
| 783 | DSR.SP.11 | Sensor/Hardware Performance | Spectral Range | The spectral range (50% points) shall be at least 200 nm to 4,000 nm. | Inspection | Essential (Regional Input) |
| 784 | DSR.SP.12 | Sensor/Hardware Performance | Tilt Response | Tilt response, the deviation from the responsivity at 0° tilt (horizontal) due to change in tilt from 0º to 90º at 1,000 W·m–2 irradiance, should be better than 0.5%. | Inspection | Very Important (Regional Input) |
| 787 | DSR.SP.13 | Sensor/Hardware Performance | Field of View | The opening angle or field of view of the pyrheliometer shall be 5º. | Inspection | Essential (Regional Input) |
| 788 | DSR.SP.14 | Sensor/Hardware Performance | Slope angle | The slope angle of the pyrheliometer shall be 1º. | Inspection | Essential (Regional Input) |
| 789 | DSR.SP.15 | Sensor/Hardware Performance | User Replaceable Desiccant | If the instruments uses user replaceable desiccant, the instrument should have  • visible indication of the state of the desiccant, preferably showing a 25% level of remaining usability • in case the instrument is “smart”, an electronic output providing the state of the desiccant, preferably showing a 25% level of remaining usability • the possibility to change the desiccant in the field without disturbing the measurements, • desiccant provided in sealed bags or cartridges that are easy to exchange and that does not cause desiccant “dust” particles to be released inside the instrument. | Inspection | Very Important (Regional Input) |
| 790 | DSR.SP.16 | Sensor/Hardware Performance | Internal Desiccant | If the instrument uses internal desiccant that cannot be replaced by the user in the field, the instrument should  • have a visible indication of the state of the desiccant, preferably showing a 25% level of remaining usability • In case the instrument is “smart”, an electronic output providing the state of the desiccant, preferably showing a 25% level of remaining usability • be guaranteed to work under all humidity conditions for a period of at least 5 years without replacing the internal desiccant, • come with clear instruction when and how the internal desiccant has to be replaced. | Inspection | Very Important (Regional Input) |
| 793 | DSR.SP.17 | Sensor/Hardware Performance | Installation Platform | The pyrheliometer should be mounted on an automatic/unattended solar tracker that tracks the sun across the sky during the day.  [NMHS may specify maximum deviation of tracker from sun position, for example less than 0.1degrees.] | Inspection | Very Important (Regional Input) |
| 824 | DSR.SP.18 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 825 | DSR.SP.19 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 986 | DSR.SP.20 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 1060 | DSR.SP.21 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1083 | DSR.SP.22 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 794 | DSR.SS.1 | Sensor Siting | Stable foundation | The solar tracker shall be installed on a stable foundation that shall prevent movement of the pyrheliometer other than movement caused by the solar tracker. | Inspection | Essential (Regional Input) |
| 795 | DSR.SS.2 | Sensor Siting | Installation Height | The sensor/instrument shall be mounted at a height that minimizes effects/impacts of obstructions. This may be at around 1.5 m above ground level, but a rooftop or other high locations may be more suitable.  [NMHS may make additional specification on installation height or accessibility for maintenance] | Inspection | Essential (Regional Input) |
| 796 | DSR.SS.3 | Sensor Siting | Obstacle Free Installation | The pyrheliometer should ideally be installed with no obstacles in the line of sight between the sun and the instrument during the day. To achieve Class 1 siting, there should be no shade projected onto the sensor when the sun is at an angular height over 3 degrees. | Inspection | Very Important |
| 771 | DSR.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, DNI shall be presented in/by the instrument/system in Watt per square meter, W·m-2. | Demonstration | Essential (Regional Input) |
| 774 | DSR.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported DNI shall be 1 W·m-2. | Demonstration | Essential (Regional Input) |
| 785 | DSR.MR.3 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous measurement of direct solar radiation should be done at least 2 times in the sensor in the time interval of the sensor time constant. | Inspection | Very Important |
| 991 | DSR.MR.4 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 791 | DSR.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | The instantaneous measurements are used to calculate and make available  • 1 minute averages, • 1 minute radiant exposure, • hourly radiant exposure, • daily radiant exposure. | Demonstration | Essential (Regional Input) |
| 792 | DSR.OS.2 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 987 | DSR.OS.3 | Observation Statistics/Algorithms | Minimum Data | At least 66% of the measurement samples in one minute should be available to enable the computation of the instantaneous air temperature value. If insufficient data, the data should be marked as invalid/missing | Inspection | Very Important (Regional Input) |
| 988 | DSR.OS.4 | Observation Statistics/Algorithms | Rate of Change Check | After each signal measurement, the current instantanous value should be compared to the preceding one. If the difference between two samples is more than 800W/m^2, the current sample is identified as suspect and is not used for the computation of an average. | Inspection | Very Important (Regional Input) |
| 989 | DSR.OS.5 | Observation Statistics/Algorithms | Jump Check | If the difference between consecutive one minute averages is more than 800W/m^2, then the data should be flagged as suspect for further investigation. If the difference is more than 1000W/m^2, then the data should be flagged as erroneous for further investigation. | Inspection | Very Important (Regional Input) |
| 816 | DSR.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 817 | DSR.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.     Each instruments should be initially supplied with a paper and electronic (pdf) calibration certificate that at least specifies:     • Manufacturer, brand  • Instrument type  • Serial number  • Initial calibration date  • Validity period of calibration  • Calibration range  • Traceability of calibration  • Calibration method  • Irradiance level  • Net long-wave irradiance for thermal offset correction  • Spectral distribution of irradiance  • Temperature at calibration  • Temporal variation of instrument output during calibration.  • Calibration factor/sensitivity and uncertainty  • Deviation from previous sensitivity (for recalibrations only)  • Name and signature of calibration technician that performed the calibration.  • If at recalibrations more than the sensitivity is calibrated, all old and new values for the respective parameters should be provided. | Inspection | Very Important (Regional Input) |
| 992 | DSR.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Solar Tracker

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 798 | ST.SP.8 | Sensor/Hardware Performance | Tracking accuracy | The tracking accuracy shall be   • 0.1º or better for passive tracking, • 0.02° or better for active tracking with four quadrant (solar) sensor. | Inspection | Essential (Regional Input) |
| 799 | ST.SP.9 | Sensor/Hardware Performance | Minimum payload | The minimum payload in a balanced situation should be 20 kg, but higher when required for the particular application. | Inspection | Very Important |
| 800 | ST.SP.10 | Sensor/Hardware Performance | Minimum torque | The minimum torque should be 20 Nm while tracking, but higher when required for the particular application. | Inspection | Very Important |
| 801 | ST.SP.11 | Sensor/Hardware Performance | GPS | The tracker may be equipped with a GPS receiver. At the setup of the tracker, the GPS may provide latitude and longitude and time to the system for the most accurate tracking possible. | Inspection | Important (Regional Input) |
| 802 | ST.SP.12 | Sensor/Hardware Performance | Four quadrant sensor (sun sensor) | The tracker should optionally be equipped with a four quadrant (sun) sensor. This sensor should at regular intervals check the correct pointing of the tracker and, if necessary, automatically adjust the pointing position for the most accurate tracking possible. The adjustments initiated by this sensor should be logged and available as status information for the tracker. | Inspection | Very Important |
| 803 | ST.SP.13 | Sensor/Hardware Performance | Autonomous operation | The tracker should have an internal CPU that can completely control the tracking process, use the GPS location and time, use the sun sensor data for optimal positioning of the tracker, etc. For the standard daily monitoring operation, a connection to an external computer should not be required. The tracker should also have internal storage capabilities to store whatever is required for normal operation and the recording of log files. | Demonstration | Very Important (Regional Input) |
| 804 | ST.SP.14 | Sensor/Hardware Performance | Configuration communication | For configuration of the tracker, the tracker may have the possibility to communicate with a computer. The configuration may be operating system independent and should be possible through a web browser. The communication may be through a standard interface and protocol, such as TCP/IP (secured if through Wi-Fi) or serial. The GUI to connect to the tracker may be simple, intuitive, and contain built-in help. If additional hardware or software is required for configuring the tracker, it may be supplied with the tracker. | Demonstration | Important |
| 805 | ST.SP.15 | Sensor/Hardware Performance | Log files | The tracker should record relevant internal parameters such as (but not limited to) internal temperature, internal humidity, lat/long, pointing position, UTC of data recorded, sun sensor corrections, status information on power supply, planned and unplanned chances of pointing position, data communication problems, heating on/off, All records should be time stamped and stored in log files per day, for at least 30 days, configurable by the user. Automatic purging of log files should be possible. | Demonstration | Very Important (Regional Input) |
| 809 | ST.SP.16 | Sensor/Hardware Performance | Mounting possibilities | The tracker shall have at least the following mounting possibilities:  • mounting plates for one or more pyrheliometers, vendor independent, • a top plate for the installation of pyranometers/pyrgeometers, vendor independent. | Inspection | Essential (Regional Input) |
| 810 | ST.SP.17 | Sensor/Hardware Performance | Shading devices | The tracker shall have the possibility to mount shading devices for the pyranometers/pyrgeometers that are installed on the top plate. The geometry shall be such that the shading field of view is 5º, and the shadow is continuously casted upon the domes of the pyranometers/pyrgeometers.  The position of the shadow is controlled by the azimuth angle and solar zenith angle, as calculated by the processor in the tracker.   If the shading devices are not needed, they can be removed without affecting the tracking features for pyrheliometers.   The shading devices shall be stable, rugged, not affected by strong wind, made of UV resistant material, but as small as possible to avoid or minimize obstructing effects of the sky. | Inspection | Essential (Regional Input) |
| 811 | ST.SP.18 | Sensor/Hardware Performance | Drive mechanism | The tracker should have a mechanism to move the azimuth and zenith axes either directly, or by belt. The “direct drive” is preferred. | Inspection | Very Important (Regional Input) |
| 812 | ST.SP.19 | Sensor/Hardware Performance | External indicators | The tracker should have on the outside, easy visible for inspection, labelled indicators to show the operational status of the tracker. Such indicators may be LEDs, showing the status by different colours. Indicators should be available for at least power supply, heating power supply, heating on/of, internal temperature, tracking status, and communication status. | Inspection | Very Important (Regional Input) |
| 813 | ST.SP.20 | Sensor/Hardware Performance | Tracker data | The tracker shall be able to provide output to an external datalogger/automatic weather station. The physical output of the tracker shall “smart” such as serial or Ethernet, LAN,…... Serial interfaces are preferred.   The NMHS has a preferenc/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden | Inspection | Essential (Regional Input) |
| 814 | ST.SP.21 | Sensor/Hardware Performance | Tracker installation | The tracker should be supplied with all installation material to install it in a stable manner. Requirements for a stable foundation should be provided by the manufacturer. The tracker should be supplied with all tools and instruct ructions for the installation, including for proper levelling of the tracker. | Inspection | Very Important (Regional Input) |
| 990 | ST.SP.23 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 807 | ST.PSI.2 | Power/Site Infrastructure | Power supply and consumption tracker | The power supply for the tracker should work at least in the range: • 18 – 30 VDC and/or 100-240 VAC @ 50/60 Hz, The power consumption of the tracker should be • < 25 W for tracking operation-reduced to the required minimum when not tracking. | Inspection | Very Important (Regional Input) |
| 808 | ST.PSI.3 | Power/Site Infrastructure | Power supply and consumption heating | Heating is required to keep the electronics in the operating temperature range. Heating should be operated by a thermostat and it should work with a separate power supply. The power supply for the heating should work at least in the range: • 18 – 30 VDC and/or 100-240 VAC @ 50/60 Hz. The power consumption of the heater should be • < 150 W for maximum heating. | Inspection | Very Important |
| 815 | ST.R.1 | Regulatory/Standards | IP rating | The IP rating of the tracker may be at least IP 65. | Inspection | Desirable (Regional Input) |

# Global/Diffuse Sky/Reflected Radiation

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| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 681 | GDR.SP.1 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring Global, Diffuse or Reflected Radiation shall be based on pyranometer with an electrical output. Any sensor type compliant with the requirements in this section shall be considered. | Inspection | Essential (Regional Input) |
| 683 | GDR.SP.2 | Sensor/Hardware Performance | Measurement Range | The maximum measurement range shall be at least 0 – 2,000 W·m-2. | Inspection | Essential (Regional Input) |
| 688 | GDR.SP.3 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor measurement uncertainty shall be sufficient to achive the following uncertainties [95% confidence level] in the calculated variables:, 1 hour totals:3% and daily totals: 2% | Inspection | Essential (Regional Input) |
| 689 | GDR.SP.4 | Sensor/Hardware Performance | Response Time | The instrument response time shall be better than 15 s. | Inspection | Essential (Regional Input) |
| 690 | GDR.SP.5 | Sensor/Hardware Performance | Zero Offset A | The zero offset A, the response to 200 W·m-2 net thermal exposure (ventilated), should be better than 7 W·m-2 | Inspection | Very Important (Regional Input) |
| 691 | GDR.SP.6 | Sensor/Hardware Performance | Zero Offset B | The zero offset B, the response to ? 5 K·h-1 change in T, should be better than 2 W·m-2. | Inspection | Very Important (Regional Input) |
| 692 | GDR.SP.7 | Sensor/Hardware Performance | Stability | The stability (change per year) of the instrument should be better than 0.8% of the full scale range per year. | Inspection | Very Important (Regional Input) |
| 693 | GDR.SP.8 | Sensor/Hardware Performance | Directional Response | The direction response as defined in [ISO9060], shall be better than 10 W·m-2. | Inspection | Essential (Regional Input) |
| 694 | GDR.SP.9 | Sensor/Hardware Performance | Temperature Response | The temperature response, the deviation due to change of ambient temperature within an interval of 50 ºC, shall be better than 2%. | Inspection | Essential (Regional Input) |
| 695 | GDR.SP.10 | Sensor/Hardware Performance | Non-linearity | The non-linearity, the deviation in responsivity at 500 W·m-2 due to a change in irradiance from 100 to 1,000 W·m-2, shall be better than 0.5%. | Inspection | Essential (Regional Input) |
| 696 | GDR.SP.11 | Sensor/Hardware Performance | Spectral Selectivity | Spectral selectivity, the deviation of the product of spectral absorbance and spectral transmittance from the corresponding mean within the interval 300 nm to 3,000 nm, shall be better than 2%. | Inspection | Essential (Regional Input) |
| 697 | GDR.SP.12 | Sensor/Hardware Performance | Spectral Range | The spectral range (50% points) shall be at least 285 nm to 2,800 nm. | Inspection | Essential (Regional Input) |
| 698 | GDR.SP.13 | Sensor/Hardware Performance | Tilt Response | Tilt response, the deviation from the responsivity at 0° tilt (horizontal) due to change in tilt from 0º to 90º at 1,000 W·m–2 irradiance, should be better than 0.5%. | Inspection | Very Important (Regional Input) |
| 700 | GDR.SP.14 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 701 | GDR.SP.15 | Sensor/Hardware Performance | Field of View | The field of view of the pyranometer shall be 180º. | Inspection | Essential (Regional Input) |
| 702 | GDR.SP.16 | Sensor/Hardware Performance | Accuracy Bubble Level | The bubble level, or other levelling device, shall make it possible to level the pyranometer and the surface of its sensor, with an accuracy of at least 0.1º. | Inspection | Essential (Regional Input) |
| 703 | GDR.SP.17 | Sensor/Hardware Performance | User Replaceable Desiccant | If the instrument uses user replaceable desiccant, the instrument should: • have a visible indication of the state of the desiccant, preferably showing a 25% level of remaining usability • in case the instrument is “smart”, an electronic output providing the state of the desiccant, preferably showing a 25% level of remaining usability • the possibility to change the desiccant in the field without disturbing the measurements, • desiccant provided in sealed bags or cartridges that are easy to exchange and that does not cause desiccant “dust” particles to be released inside the instrument. | Inspection | Very Important (Regional Input) |
| 704 | GDR.SP.18 | Sensor/Hardware Performance | Internal Desiccant | If the instrument uses internal desiccant that cannot be replaced by the user in the field, the instrument should  • have a visible indication of the state of the desiccant, preferably showing a 25% level of remaining usability • In case the instrument is “smart”, an electronic output providing the state of the desiccant, preferably showing a 25% level of remaining usability • be guaranteed to work under all humidity conditions for a period of at least 5 years without replacing the internal desiccant, • come with clear instruction when and how the internal desiccant has to be replaced. [[For applications in coastal areas, the Customer may request additional functionality to respond to salinity]] | Inspection | Very Important (Regional Input) |
| 725 | GDR.SP.19 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 726 | GDR.SP.20 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 754 | GDR.SP.21 | Sensor/Hardware Performance | Shading Device | If used for Diffuse Sky Radiation Measurements, the dome of the pyranometer shall be shaded. The preferred option is to shade the dome with a disk/sphere with a field of view of 5º. If a shading band is used instead, the measurements have to be corrected, see CIMO Guide, Chapter 7, Annex 7.E] for details on the correction algorithms. | Inspection | Essential (Regional Input) |
| 1082 | GDR.SP.22 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 707 | GDR.SS.1 | Sensor Siting | Installation Platform | The pyranometer shall be mounted on a rigid, stable stand/base plate to avoid shocks, vibrations, heating due to sunshine and movement due to wind. If the pyranometer is installed on a solar tracker, nearby instruments shall not shade the pyranometer in any way. | Inspection | Essential (Regional Input) |
| 708 | GDR.SS.2 | Sensor Siting | Ventilation Unit | In case a ventilation unit is applied • the ventilation unit should be constructed in a way and made of a material that will not affect the pyranometer measurements in any way, • the leveling of the pyranometer should not be more difficult than without the ventilation unit, • the air flowing over the dome should be filtered and not cause additional contamination of the dome, • filter replacement should not be required for at least 3 months for any type of atmospheric conditions, • a dirty filter should not affect the operation of the ventilation unit in any way, • the ventilation unit should prevent ice and snow building up around the dome, for installations in both horizontal and tilted positions, • the cables from the pyranometer and ventilation unit should be attached in a way to avoid the building up of ice/snow at the connector, for installations in both horizontal and tilted positions, • the ventilation unit should not collect precipitation inside, for installations in both horizontal and tilted positions, • the ventilation unit should have the capability to electronically, via a datalogger, monitor their operational health. Sufficient monitoring parameters should be provided to monitor the health and status of the ventilation unit, • when heating is applied, the heating should not in any way affect the measurements-heating by thermostat is recommended, • required power (ventilation and heating) should be as low as possible, with the possibility to use a range of 12-48 VDC power supplies. | Inspection | Very Important (Regional Input) |
| 709 | GDR.SS.3 | Sensor Siting | Installation Height | The sensor/instrument shall be mounted at a height that minimizes effects/impacts of obstructions. This may be at around 1.5 m above ground level, but a rooftop or other high locations may be more suitable.  If the Sensor is primarily installed for the measuring of reflected radiation, the sensor/instrument shall be installed at a height between 1 to 2 m above ground level. During snowfall the installation height shall be adjusted to maintain an equal distance between the snow cover and the instrument. | Inspection | Essential (Regional Input) |
| 710 | GDR.SS.4 | Sensor Siting | Obstacle Free Installation | The pyranometer shall ideally be installed with no obstacles in the line of sight between the sun and the instrument during the day. To achieve Class 1 siting, there shall be no shade projected onto the sensor when the sun height is higher than 5 degress [3 degrees if latitude <= 60 degrees]. There shall be no non-shading, but reflecting obstacles with an angular height above 5 degress and a total angular width above 10 degrees. | Inspection | Essential (Regional Input) |
| 711 | GDR.SS.5 | Sensor Siting | Access to the Instruments | It should be possible for maintenance staff to access to the sensors for regular cleaning of the domes.  If the Sensor is primarily installed for the measuring of reflected radiation, then the should be possible to gain access to the instrument without distrubing the snow cover. | Inspection | Very Important |
| 714 | GDR.SS.6 | Sensor Siting | Error due to Installation Construction | If the Sensor is primarily installed for the measuring of reflected radiation, the extra error in measurements due to the construction required for the instrument installation, should not exceed 2%. | Inspection | Very Important (Regional Input) |
| 716 | GDR.SS.7 | Sensor Siting | Summer Ground Surface | If the Sensor is primarily installed for the measuring of reflected radiation, in summer-time, the ground below the instrument may be covered by short grass. | Inspection | Important |
| 682 | GDR.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Global/Diffuse Sky/Reflected Radiation shall be presented in/by the instrument/system in Watt per square meter, W·m-2. | Demonstration | Essential (Regional Input) |
| 685 | GDR.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported GHI shall be 1 W·m-2. | Demonstration | Essential (Regional Input) |
| 699 | GDR.MR.3 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous measurement of Global/Diffuse Sky Radiation should be done at least 2 times in the time interval of the sensor time constant. | Inspection | Very Important |
| 994 | GDR.MR.4 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 705 | GDR.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | The instantaneous measurements are used to calculate and make available     • 1 minute averages,  • 10 minute averages,   • hourly radiant exposure,  • daily radiant exposure,  • net shortwave radiation [Global Radiation Only]. | Demonstration | Essential (Regional Input) |
| 706 | GDR.OS.2 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 993 | GDR.OS.3 | Observation Statistics/Algorithms | Minimum Data | At least 66% of the samples in one minute should be available to enable the computation of the instantaneous air temperature value. If insufficient data, the data should be marked as invalid/missing | Inspection | Very Important (Regional Input) |
| 717 | GDR.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 718 | GDR.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory. [[The Customer may request additional calibration traceable to WRR, Davos]]  Each instruments should be initially supplied with a paper and electronic (pdf) calibration certificate that at least specifies:  • Manufacturer, brand • Instrument type • Serial number • Initial calibration date • Validity period of calibration • Calibration range • Traceability of calibration • Calibration method • Angular distribution of irradiance • Directional response of the instrument • Inclination of instrument • Irradiance level • Net long-wave irradiance for thermal offset correction • Spectral distribution of irradiance • Temperature at calibration • Temporal variation of instrument output during calibration. • Calibration factor/sensitivity and uncertainty • Deviation from previous sensitivity (for recalibrations only) • Name and signature of calibration technician that performed the calibration. • If at recalibrations more than the sensitivity is calibrated, all old and new values for the respective parameters should be provided. | Inspection | Very Important (Regional Input) |
| 995 | GDR.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Long Wave Radiation

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| --- | --- | --- | --- | --- | --- | --- |
| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 827 | LWR.SP.1 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring Longwave Radiation shall be based on pyrgeometer with an electrical output. Any sensor type compliant with the requirements in this section shall be considered. | Inspection | Essential (Regional Input) |
| 829 | LWR.SP.2 | Sensor/Hardware Performance | Measurement Range | The maximum measurement range shall be at least -250 – +250 W·m-2. | Inspection | Essential (Regional Input) |
| 833 | LWR.SP.3 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor measurement uncertainty shall be sufficient to achive the following uncertainties [95% confidence level] in the calculated variables: daily totals: 10% | Inspection | Essential (Regional Input) |
| 834 | LWR.SP.4 | Sensor/Hardware Performance | Response Time | The instrument response time shall be better than 20 s. | Inspection | Essential (Regional Input) |
| 835 | LWR.SP.5 | Sensor/Hardware Performance | Window heating offset | The window heating offset @ 1,000 W·m-2 solar irradiance, shall be better than 5 W·m-2. | Inspection | Essential (Regional Input) |
| 836 | LWR.SP.6 | Sensor/Hardware Performance | Stability | The stability (change per year) of the instrument should be better than 2.0% of the full scale range per year. | Inspection | Very Important (Regional Input) |
| 837 | LWR.SP.7 | Sensor/Hardware Performance | Directional Response | The cosine response error at 10º. shall be better than 3%. | Inspection | Essential (Regional Input) |
| 838 | LWR.SP.8 | Sensor/Hardware Performance | Azimuth error | Azimuth error at 10º elevation, additional to cosine error, the deviation from mean, should be better than 3%. | Inspection | Very Important |
| 839 | LWR.SP.9 | Sensor/Hardware Performance | Temperature dependence | The temperature dependence of the instrument sensitivity over the range -20 ºC to 40 ºC, shall be better than 1%. | Inspection | Essential (Regional Input) |
| 840 | LWR.SP.10 | Sensor/Hardware Performance | Non-linearity | The non-linearity, the deviation in sensitivity in the range -250 – +250 W·m-2 shall be better than 0.5%. | Inspection | Essential (Regional Input) |
| 841 | LWR.SP.11 | Sensor/Hardware Performance | Spectral sensitivity | Variation in spectral sensitivity integrated over 200 nm intervals from 300 to 75,000 nm should be less than 2%. | Inspection | Very Important |
| 842 | LWR.SP.12 | Sensor/Hardware Performance | Spectral Range | The spectral range (50% points) shall be at least 4,500 nm to > 40,000 nm. | Inspection | Essential (Regional Input) |
| 845 | LWR.SP.13 | Sensor/Hardware Performance | Field of View | The field of view of the pyranometer shall be 180º. | Inspection | Essential (Regional Input) |
| 847 | LWR.SP.14 | Sensor/Hardware Performance | User Replaceable Desiccant | If the instruments uses user replaceable desiccant, the instrument should have  • visible indication of the state of the desiccant, preferably showing a 25% level of remaining usability • in case the instrument is “smart”, an electronic output providing the state of the desiccant, preferably showing a 25% level of remaining usability • the possibility to change the desiccant in the field without disturbing the measurements, • desiccant provided in sealed bags or cartridges that are easy to exchange and that does not cause desiccant “dust” particles to be released inside the instrument. • be guaranteed to work under all humidity conditions for a period of 5 years without replacing the internal desiccant. | Inspection | Very Important (Regional Input) |
| 848 | LWR.SP.15 | Sensor/Hardware Performance | Internal Desiccant | If the instruments uses internal desiccant that cannot be replaced by the user in the field, the instrument should  • have a visible indication of the state of the desiccant, preferably showing a 25% level of remaining usability • In case the instrument is “smart”, an electronic output providing the state of the desiccant, preferably showing a 25% level of remaining usability • be guaranteed to work under all humidity conditions for a period of at least 5 years without replacing the internal desiccant, • come with clear instruction when and how the internal desiccant has to be replaced. | Inspection | Very Important (Regional Input) |
| 850 | LWR.SP.16 | Sensor/Hardware Performance | Parameters needed to calculate Long Wave Radiation | All parameters that are needed to accurately calculate Long Wave Radiation, shall be provided by the instrument. The basic parameter is the output of the thermopile, and if the body (house) temperature and dome temperature are needed to accurately calculate Long Wave Radiation, the instruments shall contain these temperature sensors and output for these parameters. | Inspection | Essential (Regional Input) |
| 854 | LWR.SP.17 | Sensor/Hardware Performance | Shading Device | The dome of the pyrgeometer shall be shaded. The preferred option is to shade the dome with a disk/sphere. Nearby instruments shall not be shaded by shading devices of the Long Wave Radiation measurements in any way. | Inspection | Essential (Regional Input) |
| 855 | LWR.SP.18 | Sensor/Hardware Performance | Ventilation Unit | Pyrgeometers should be installed in a ventilation unit. Requirements:  • the ventilation unit should be constructed in a way and made of a material that will not affect the pyrgeometer measurements in any way, • the leveling of the pyrgeometer should not be more difficult than without the ventilation unit, • the air flowing over the dome should be filtered and not cause additional contamination of the dome, • filter replacement should not be required for at least 3 months for any type of atmospheric conditions, • a dirty filter should not affect the operation of the ventilation unit in any way, • the ventilation unit should prevent ice and snow building up around the dome, for installations in both horizontal and tilted positions, • the cables from the pyrgeometer and ventilation unit should be attached in a way to avoid the building up of ice/snow at the connector, for installations in both horizontal and tilted positions, • the ventilation unit should not collect precipitation inside, for installations in both horizontal and tilted positions, • the ventilation unit should have the capability to electronically, via a datalogger, monitor their operational health. Sufficient monitoring parameters should be provided to monitor the health and status of the ventilation unit, • when heating is applied, the heating should not in any way affect the measurements- heating by thermostat is recommended, • required power (ventilation and heating) should be as low as possible, with the possibility to use a range of 12-48 VDC power supplies. | Inspection | Very Important (Regional Input) |
| 867 | LWR.SP.19 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 868 | LWR.SP.20 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 997 | LWR.SP.21 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 1061 | LWR.SP.22 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1081 | LWR.SP.23 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals. | Response | Essential (Regional Input) |
| 846 | LWR.SS.1 | Sensor Siting | Accuracy Bubble Level | The bubble level, or other levelling device, shall make it possible to level the instrument with an accuracy of at least 0.1º. | Inspection | Essential (Regional Input) |
| 853 | LWR.SS.2 | Sensor Siting | Installation Platform | The pyrgeometer shall be mounted on a rigid, stable stand/base plate to avoid shocks, vibrations, and movement due to wind. | Inspection | Essential (Regional Input) |
| 856 | LWR.SS.3 | Sensor Siting | Installation Height | The sensor/instrument shall be mounted at a height that minimizes effects/impacts of obstructions. This may be at around 1.5 m above ground level, but a rooftop or other high locations may be more suitable.  If the sensor is being used for measuring upwelling Long Wave Radiation, it shall be installed at a height of approximately 2m or higher above the ground. | Inspection | Essential (Regional Input) |
| 857 | LWR.SS.4 | Sensor Siting | Obstacle Free Installation | The pyrgeometer shall be installed in a manner with the least disturbance of obstacles for the Long Wave Radiation measurements. | Inspection | Essential (Regional Input) |
| 858 | LWR.SS.5 | Sensor Siting | Access to the Instruments | It should be possible for maintenance staff to access to the sensors for regular cleaning of the domes. | Inspection | Very Important |
| 999 | LWR.SS.6 | Sensor Siting | Error due to Installation Construction | If used to measure upwelling radiation, the extra error due to the construction required for instrument isntallation, should be as small as possible but not exceed 2% | Inspection | Very Important (Regional Input) |
| 828 | LWR.MR.1 | Measurement/Functional Requirements | Units | Whatever physical quantity measured, Long Wave Radiation shall be presented in/by the instrument/system in Watt per square meter, W·m-2. | Demonstration | Essential (Regional Input) |
| 831 | LWR.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported Long Wave Radiation shall be 1 W·m-2. The resolution of hourly and daily totals shall be 1 J·m-2. | Demonstration | Essential (Regional Input) |
| 849 | LWR.MR.3 | Measurement/Functional Requirements | Algorithm to calculate Long Wave Radiation | The algorithm to calculate Long Wave Radiation from the output voltage of the thermopile, the body (house) temperature and dome temperature, shall be provided by the manufacturer. | Demonstration | Essential (Regional Input) |
| 869 | LWR.MR.4 | Measurement/Functional Requirements | Internal processing | If the instrument contains an internal CPU, it is strongly recommended to calculate all output parameters internally. However, it is still highly desirable to provide through the smart interface the Long Wave Radiation in W·m-2, J·m-2, and the body and dome temperatures in K. | Inspection | Very Important |
| 996 | LWR.MR.5 | Measurement/Functional Requirements | Sampling Frequency | The instantaneous measurement of Long Wave Radiation should be done at least 2 times in the time interval of the sensor time constant. | Inspection | Very Important |
| 1000 | LWR.MR.6 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 851 | LWR.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | The instantaneous measurements are used to calculate and make available     • 1 minute averages,  • 10 minute averages,   • hourly radiant exposure,  • daily radiant exposure,  • net longwave radiation,  • net total radiation (only if net total shortwave radiation is available). | Demonstration | Essential (Regional Input) |
| 852 | LWR.OS.2 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 998 | LWR.OS.3 | Observation Statistics/Algorithms | Minimum Data | At least 66% of the Long Wave Radiation samples in one minute should be available to enable the computation of the instantaneous air temperature value. If insufficient data, the data should be marked as invalid/missing | Inspection | Very Important (Regional Input) |
| 859 | LWR.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 860 | LWR.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be initially supplied with a paper and electronic (pdf) calibration certificate that at least specifies:  • Manufacturer, brand • Instrument type • Serial number • Initial calibration date • Validity period of calibration • Calibration range • Traceability of calibration • Calibration method • Angular distribution of irradiance • Directional response of the instrument • Inclination of instrument • Irradiance level • Net long-wave irradiance for thermal offset correction • Spectral distribution of irradiance • Temperature at calibration • Temporal variation of instrument output during calibration. • Calibration factor/sensitivity and uncertainty • Deviation from previous sensitivity (for recalibrations only) • Name and signature of calibration technician that performed the calibration. • If at recalibrations more than the sensitivity is calibrated, all old and new values for the respective parameters should be provided. | Inspection | Very Important (Regional Input) |
| 1001 | LWR.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Precipitation Intensity

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 559 | PI.SP.1 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring precipitation intensity shall be based on an electronic recording instrument. Any sensor type compliant with the requirements in this section shall be considered. The Precipitation Amount and Intensity Sensor may be the same piece of equipment. | Inspection | Essential (Regional Input) |
| 560 | PI.SP.2 | Sensor/Hardware Performance | Collecting Gauge Orifice Area | In case the sensor/instrument for measuring precipitation intensity is based on collection of precipitation, the area of the collector orifice shall be at least 200 cm2 and no larger than 500 cm2. The area of the orifice shall be known to the nearest 0.5 %, and the construction shall be such that this area remains constant while the gauge is in normal use. | Inspection | Essential (Regional Input) |
| 561 | PI.SP.3 | Sensor/Hardware Performance | Units | Precipitation intensity shall be presented in mm/hour (based on a 1 minute average). | Demonstration | Essential (Regional Input) |
| 566 | PI.SP.4 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be   • Under constant flow conditions in laboratory:  o 5% for > 2 mm/h,   o 2% for > 10 mm/h.   • In the field: o 5 mm/h, o 5% above 100 mm/h. | Inspection | Essential (Regional Input) |
| 568 | PI.SP.5 | Sensor/Hardware Performance | Sensor Time Constant | The instrument time constant under controlled conditions shall be better than 30 s. | Inspection | Essential (Regional Input) |
| 569 | PI.SP.6 | Sensor/Hardware Performance | Heating | The precipitation gauge should be equipped with rim heating and funnel heating (tipping bucket) as appropriate for the local conditions. The heating should be controlled by a thermostat and it should be switched on below an ambient temperature of 5 ºC. The heating should avoid snow and ice building up at the rim, and it should melt solid precipitation falling into the funnel. The heating should keep the rim and funnel above 0 ºC, but the heating should be as little as possible to avoid evaporation of the precipitation. For other types of instruments heating should be offered as required for the local conditions. | Inspection | Very Important (Regional Input) |
| 573 | PI.SP.7 | Sensor/Hardware Performance | General Installation Features | The instrument shall be mounted in a location optimized for taking precipitation measurements: • Minimal wind disturbances by nearby structures • Non-splashing ground surface around the gauge installation location | Inspection | Essential (Regional Input) |
| 584 | PI.SP.8 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 585 | PI.SP.9 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 1005 | PI.SP.10 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included.  [[A NMHS may modify this requirement to meet meteorological conditions normally expected. Protection against sensor icing may be required.]] | Inspection | Essential (Regional Input) |
| 1064 | PI.SP.11 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 1078 | PI.SP.12 | Sensor/Hardware Performance | Operational Sensor Uncertainty | The Tenderer shall provide documentation outlining the field/operational performance of the sensor uncertainty over time [at least a year]. This shall include sensor/calibration drift and any factors that depend on the Customers' actions [for example, maintenance/cleaning/inspection requirements]  There shall be sufficient information provided to enable a calculation of the uncertainty budget, as well as calibration/maintenance intervals.  For Precipitation Measurements, wetting and evaporation loss factors may be provided. | Response | Essential (Regional Input) |
| 574 | PI.SS.1 | Sensor Siting | Wind Screen | In case a precipitation gauge is offered, to achieve the highest accuracy of the precipitation measurements, a wind screen may be installed around the precipitation gauge to minimize errors due to wind. The top of the wind screen should be at the same height as the orifice of the precipitation gauge. For other types of instruments this requirement may not apply. | Inspection | Very Important |
| 1006 | PI.SS.2 | Sensor Siting | Installation Height | The collecting orifice of the precipitation gauge shall be installed at [[local precipitation guage height]].  The WMO makes no recommendation on installation height, but the CIMO Guide notes heights level with local ground surface [0m] and then 0.5-1.5m are commonly used. | Inspection | Essential (Regional Input) |
| 562 | PI.MR.1 | Measurement/Functional Requirements | Measurement Range | The maximum measurement range shall be: 0.02 – 2,000 mm/hour. | Inspection | Essential (Regional Input) |
| 564 | PI.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported measurement shall be: 0.1 mm/hour. | Demonstration | Essential (Regional Input) |
| 1007 | PI.MR.3 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 571 | PI.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | The individual measurements are providing the instantaneous readings. The system shall calculate/make available: • intensities over 1 minute, 10 minutes, hours, 24 hours. | Demonstration | Essential (Regional Input) |
| 572 | PI.OS.2 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 576 | PI.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 577 | PI.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |
| 1008 | PI.PSI.1 | Power/Site Infrastructure | Excitation Power | If the instrument requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. The electrical voltage required by any aspect of the system should not exceed 36 volts. [[Voltages suitable for solar power (12V) may be advantageous]] | Inspection | Very Important |

# Snowfall/Snow Cover

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| --- | --- | --- | --- | --- | --- | --- |
| ID | WMO Tag | Functionality | Requirement Heading | Requirement | Test | Importance |
| 587 | SSC.SP.1 | Sensor/Hardware Performance | Sensor Type | The sensor/instrument for measuring Snowfall/Snow Cover (amount) shall be based on an electronic recording instrument.  Any sensor type compliant with the requirements in this section shall be considered. [[Customer may insert local/Regional requirements for equipment type [altimeter or distance meter or snow gauge or water equivalent of snow]]] | Inspection | Essential (Regional Input) |
| 589 | SSC.SP.2 | Sensor/Hardware Performance | Measurement Range | The maximum measurement range shall be 0 – 25 meter. | Demonstration | Essential (Regional Input) |
| 593 | SSC.SP.3 | Sensor/Hardware Performance | Sensor Uncertainty | The sensor uncertainty shall be 1cm or better. | Inspection | Essential (Regional Input) |
| 595 | SSC.SP.4 | Sensor/Hardware Performance | Sensor Performance Constant | The instrument time constant under controlled conditions shall be better than 10 s. | Inspection | Essential |
| 596 | SSC.SP.5 | Sensor/Hardware Performance | Heating | The instrument shall be equipped with sufficient heating as appropriate for the local conditions. The heating shall be controlled by a thermostat and it shall be switched on below an ambient temperature of 1 ºC. The heating shall avoid snow and ice building up on the instrument. | Inspection | Essential (Regional Input) |
| 610 | SSC.SP.6 | Sensor/Hardware Performance | Multiple Outputs | If the instrument is equipped with both an analogue output and a smart interface, it should be possible to connect both at the same time and collect data from both outputs without any physical damage to the instrument’s electronics. | Demonstration | Very Important |
| 611 | SSC.SP.7 | Sensor/Hardware Performance | Service port | If the instrument is equipped with a (smart) service port/connection, it should be possible to connect to the service [using PC/laptop/wifi/..] while the instrument is collecting data. Through the service connection it should be possible to perform instrument maintenance, do diagnostics, configuration, to stop/start the regular data collection mode, etc.  Software tools to perform such actions should be supplied with the instruments. | Demonstration | Very Important |
| 1009 | SSC.SP.8 | Sensor/Hardware Performance | Operational Conditions | As a minimum, the equipment installed outdoors shall be capable of operating in a Temperature Range [-40C to 55C], Humidity Range [0-100% Non-condensing] and Wind Speed up to 50m/s.  Resistance to (vibration) shocks and lightning protection shall be included. A NMHS may modify this requirement to meet meteorological conditions normally expected. | Inspection | Essential (Regional Input) |
| 1011 | SSC.SP.9 | Sensor/Hardware Performance | Excitation and Power Supply | If the sensor requires an excitation voltage or a permanent power supply, this should be described fully by the Tenderer. Where possible, extra-low and low power equipment should be used, both to increase electrical and enable the use of solar power. | Inspection | Very Important (Regional Input) |
| 1066 | SSC.SP.10 | Sensor/Hardware Performance | Exposure Uncertainty | If the Tenderer provides any items that affect the exposure of the sensor, [examples include, a screen, an enclosure containing multiple sensors, a mounting post to which the sensor is affixed] then the Tenderer shall provide documentation outlining the impact of the enclosure on the sensor performance and uncertainty. | Response | Essential (Regional Input) |
| 600 | SSC.SS.1 | Sensor Siting | General Installation Features | The instrument shall be mounted in a location optimized for taking precipitation measurements: • Minimal wind disturbances by nearby structures • Measurements shall be done above a stable and controlled surface. • The measurement site shall be clear of vegetation that may disturb the measurements. | Inspection | Essential (Regional Input) |
| 601 | SSC.SS.2 | Sensor Siting | Installation Height | The sensor/instrument shall be installed at a height appropriate for the local snowfall conditions, according to the manufacturers recommendations. | Inspection | Essential (Regional Input) |
| 588 | SSC.MR.1 | Measurement/Functional Requirements | Units | Snowfall/Snow Cover measurements shall be presented in cm, with one decimal to the nearest 0.1cm. | Inspection | Essential (Regional Input) |
| 591 | SSC.MR.2 | Measurement/Functional Requirements | Reporting Resolution | The resolution of reported measurement shall be 1 cm. [[Local requirements may reduce this to 0.1cm]] | Inspection | Essential (Regional Input) |
| 1010 | SSC.MR.3 | Measurement/Functional Requirements | Output Characteristics | The physical output of the instrument should be of a standard type and format, that can be readily interfaced to equipment from other manufacturers than the Tenderer. The NMHS has a preference/requirement for [[Required Sensor Output Protocol/format]]. Outputs that require proprietary hardware/software are forbidden. | Inspection | Very Important |
| 598 | SSC.OS.1 | Observation Statistics/Algorithms | Calculated Parameters | The individual measurements are providing the instantaneous readings. The system shall calculate/make available Snowfall/Snow Cover  • at the end of 10 minute intervals,     For monitoring Snowfall/Snow Cover “real time”, the 10 minute readings are sufficient. Other readings that are useful can directly be obtained from the 10 minute readings at observations times at whole hours,3 hours, 6 hours (00, 06, 12 and 18 UTC, also for SYNOP), and 00 hours (00 UTC). The 00 UTC hour readings can be used to obtain daily Snowfall/Snow Cover. | Demonstration | Essential (Regional Input) |
| 599 | SSC.OS.2 | Observation Statistics/Algorithms | Insufficient Measurements for Averages | In case there are insufficient instantaneous measurements to calculate the averages, or measurements are unavailable for other reasons, the averages should not be stored but for example, be replaced by [[NMHS to insert code indicating instrument available, but sufficient data is not, for example //// or 9999>]]. | Demonstration | Very Important (Regional Input) |
| 602 | SSC.OM.1 | Observation/Site Metadata | Serial Number | Each instrument shall be supplied with a unique serial number. | Inspection | Essential |
| 603 | SSC.OM.2 | Observation/Site Metadata | Calibration Certificate | Each instrument should be supplied with a calibration valid for at least 90% of the calibration period as recommended by the manufacturer. The initial calibration should be done by an accredited calibration laboratory or at least be fully traceable to such an ISO17025 accredited laboratory.  Each instruments should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies: • Manufacturer • Model • Instrument type/Principle of Operation • Serial number • Hardware/Software version [if applicable] • Calibration Date • Validity period of calibration/Recommended next date of calibration  • Calibration range • Traceability of calibration (including applicable standard) • Calibration method • Calibration factor and uncertainty • Name and signature of calibration technician that performed the calibration. [\*\*] | Inspection | Very Important (Regional Input) |