Appendix 2 – Summary of Key Requirements of Rain Gauge for Market Consultation

Pertaining to	: **Market consultation (Request for Information) regarding Precipitation gauges and 3rd line support**
Reference no.	: **TN 432441**
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Disclaimer

The requirements listed below are in draft form and will undergo further refinement between October and December 2023. Further, this list of requirements is not exhaustive and potential bidders should be aware that additional requirements may be included in the final document.

1. Functional Requirements

1.1 General Requirements

1.1.1 The purpose of this tender is to procure catchment style precipitation gauges to replace the current gauge used at KNMI stations with automatic precipitation measurements.

1.1.2 The precipitation gauge must be a commercially available off-the shelf product.

1.1.3 The precipitation gauge must be a catchment style gauge, however, the measuring principle (i.e., weighing gauge, tipping-bucket, self-emptying weighing gauge, etc.) can vary.

1.1.4 The precipitation gauge shall be capable of measuring and reporting precipitation intensity.

1.1.5 The precipitation gauge must be capable of measuring both liquid and solid precipitation.

1.2 Metrology Requirements

1.2.1 The response sensitivity must correspond to a precipitation height of at least 0.01 mm.

1.2.2 The collection area of the precipitation sensor must be at least 200cm² ±0.5% over the entire operating temperature range.

1.2.3 If a device with a collection container is used, the collection container must be able to hold at least 800 mm of precipitation (equivalent to a volume of 5 l). Note: Not required for devices without a collection container.

1.2.4 For the determination of precipitation type, a temperature measurement must be carried out on the sensor in the measuring range: -15˚C to +50˚C. The measurement uncertainty should be a maximum of ±5˚C.

1.3 Precipitation Intensity Requirements

1.3.1 Range of intensity measurements should be between 0.02 – 400 mm/h for 1-minute average values.

1.3.2 Resolution of intensity values should be 0.1 mm/h at a minimum. Note: Higher values are preferred since the gauge will be used to report **precipitation duration**.

1.3.3 The required measurement uncertainty for intensity under constant flow (laboratory conditions) should be 5% for intensities > 2 mm/h and 10% for intensities > 10 mm/h.

1.3.4 The achievable measurement uncertainty for intensity in the field should be 5 mm/h, and 5% for intensities above 100 mm/h.

2. Maintainability Requirements

2.1 Precipitation Gauge Calibration Requirements

2.1.1 The tenderer shall include a calibration procedure that ensures the precipitation parameter(s) can be verified, adjusted and calibrated by KNMI staff in the KNMI calibration lab. This calibration procedure must be clearly documented.

2.1.2 The calibration shall be traceable to a standard reference.

2.1.3 There must be an adjustment procedure that can be carried out at KNMI.

2.1.4 Describe the adjustment procedure that can be carried out at KNMI in a comprehensive and understandable way.

2.1.5 Definition Calibration interval: The time after which the sensor must be repaired or calibrated and adjusted to meet the required metrological requirements over this period of time. In this case, the sensor is operated under the required environmental and operating conditions and the maintenance prescribed by the contractor is fulfilled. The calibration interval must be greater than or equal to 12 months.

3. Technical Requirements

3.1 General Requirements

3.1.1 A unique ID/serial number of the precipitation gauge, as well as the firmware version shall be available in the data message or is accessible through specific commands.

3.1.2 Commands shall be available to retrieve, change and store the parameter and configuration settings of the precipitation gauge.

3.1.3 The parameters/settings configured and stored in the precipitation gauge shall be retained after a re-start or shutdown due to power failure.

3.1.4 The time between switching on the precipitation gauge (power on) and the first output of a data message containing valid observational data shall be 1 minute or less.

3.1.5 The measured quantities reported by the Precipitation Gauge shall contain the values generated during the most recent measurement. Note: measurement window should be configurable.

3.2 Communication Requirements

3.2.1 The precipitation gauge shall be equipped with one serial interface for all data communications. Note: Any standard RS422/485/232 protocol is acceptable. USB is not acceptable. Modbus is a possibility as well.

3.2.2 Handshake shall not be required for communication with the Precipitation Gauge, neither in hardware nor in software.

3.2.3 The Precipitation Gauge shall support at least one of the listed options for the following transmission characteristic: speed: 1200, 2400, 4800, 9600 or 19200 bits per second. Note: 9600 and above is preferred.

3.2.4 The precipitation gauge shall support operation in polling mode.

3.3 Sensor Output Requirements

3.3.1 The format of the precipitation gauge response to any command shall be specified. This specification shall include the length of any response.

3.3.2 The precipitation gauge response shall contain a data integrity check, for example a checksum.

3.3.3 The precipitation gauge response shall be enclosed by unique predefined delimiters, for example STX (start of text) and ETX (end of text).

3.3.4 The precipitation gauge response shall be fixed, i.e. all data is located at fixed positions in the data message unless the message contains tagged/labelled output. For fixed positions, the information for a specific quantity is always given between byte i and byte j or as the n^{th} element using a unique delimiter to divide the data message into elements.

3.3.5 The precipitation gauge response shall be in readable ASCII.

3.4 Status Requirements

3.4.1 The precipitation gauge shall report status information on the operational state of the precipitation gauge and clearly identify any problem, either within the regular data message or through documented diagnostic commands.

3.4.2 The Precipitation Gauge shall perform internal checks to ensure correct functioning of each module. Status information shall be reported for each module. Internal checks include but are not limited to internal temperature, status reports, any diagnostic data that is used while the gauge is collecting data.

4. Hardware Requirements

4.1 General Requirements

4.1.1 The weight and dimensions of the precipitation gauge shall be such that it can be easily transported and installed by a single person according to ARBO (or EU OSHA) guidelines. NOTE: Installation is done by KNMI.

4.1.2 Larger, independent components (such as measuring unit, load cell, etc.) should have their own serial number for traceability. Note: Not applicable for consumables, like screws, washers, “o-ring” etc.

4.2 Electrical Requirements

4.2.1 The Tenderer shall guarantee electrically safe operation of the delivered Precipitation Gauge including its components according to Dutch and EU regulations. Compliance with electric safety standard IEC 60364 standard is preferred.

4.2.2 The precipitation gauge and related parts shall comply with European standard IEC 62305 concerning lightning protection and failure of electrical installations.

4.2.3 The precipitation gauge shall be able to operate using a power supply voltage of 24 V with a maximum power consumption of the precipitation gauge, including heating, of 192 Watt or less.

4.3 Mechanical Requirements

4.3.1 The precipitation gauge shall be resistant to shock and vibration in normal operating conditions in all locations, including transport.

4.3.2 The material of the precipitation gauge and related parts shall be suitable for use in maritime and industrial environments.

4.4 Installation Requirements

4.4.1 The Precipitation Gauge must be capable of being installed within the constraints of KNMI's site set-ups. The gauge must be capable of being placed with orifice above ground within a Tretjakov -type screen or with orifice at ground level within a pit configuration. The pit is surrounded by a circular wall with a diameter of 3 m and a height of 40 cm.

4.5 Sensor Connections Requirements

4.5.1 The precipitation gauge shall be equipped with cables and connectors for use under exterior conditions according to European standards IEC 60204 and/or IEC 60364. These cables and connectors are available on the European market.

4.5.2 The Precipitation Gauge shall be provided with both the power cable and serial connection cable, and with connectors attached. Note: Both power and serial connection is allowed to be combined in one cable. The length of the cables and type of the connectors shall be specified by KNMI in consultation with Tenderer before delivery.

4.6 Operating Environment Requirements

4.6.1 The precipitation gauge shall not be damaged by environmental conditions in The Netherlands, including the Caribbean Netherlands. Damage caused by extreme weather events such as hurricanes and the debris associated with these events is exempt.

4.6.2 The precipitation gauge shall be able to operate in all environmental conditions in The Netherlands, including the Caribbean Netherlands. Specifically, it shall be able to operate according to the Requirements in the relative humidity range of 0 to 100%, the ambient temperature range of –40 to +50 °C.

5. Software Requirements

5.1 Tenderer shall inform KNMI of each new software/firmware release for the precipitation gauge during the entire Contract period. This includes updates with additional features as well as bug fixes. Information shall be provided on the contents of the update, its consequences for the operation of the precipitation gauge, and whether or not the update is critical.

5.2 Tenderer shall supply new software/firmware updates in a format that can be used by KNMI. The installation of updates or upgrades can be performed by adequately trained KNMI staff

5.3 Tenderer agrees that KNMI shall be free to choose not to install any updates or upgrades without loss of warranty or 3rd line maintenance. In the case that an update is not installed, KNMI accepts the shortcomings reported by the manufacturer which are solved in the new software/firmware version.

5.4 Tenderer shall safeguard the precipitation gauge to avoid lockup situations in which components or the whole system becomes inoperative or unresponsive.

6. Reliability Requirements

6.1 The precipitation gauge shall be designed and able to operate continuously 24 hours a day, 7 days a week.

6.2 The availability of measurements made by the sensor that meet the specifications in this document shall be 99.98% or better.

6.3 The life time of the precipitation gauge and spare parts shall be at least 10 years.

6.4 The Mean Time Between Failure (MTBF) of the precipitation gauge shall be at least 43,830 hours (=60 months), based on all environmental conditions and continuous 24/7 operation.

6.5 The calibration interval of the precipitation gauge shall be at least 1 year.

7. Support and Maintenance Requirements

7.1 Support Requirements

7.1.1 A helpdesk with skilled personnel fluent in English shall be available and reachable during working hours (9:00-17:00 CET) by telephone and e-mail. The helpdesk shall reply to questions within two working days.

7.2 Maintenance Requirements

7.2.1 The design of the precipitation gauge and the setup shall be such that the cleaning and 1st line maintenance can be performed by one person.

7.2.2 The offered precipitation gauge, or compatible products meeting the same Requirements that can replace the original precipitation gauge, shall be available for the period of validity of the Contract, with a minimum of 10 years and a maximum of 16 years.

7.2.3 Precipitation gauges (or parts) that have been sent to the Tenderer for repair shall be returned after repair or replaced within 2 months (including FAT and transport). Tenderer shall specify the typical time required for a precipitation gauge repair.

7.2.4 The serviceability of the precipitation gauge shall be based on the concept of Line Replaceable Units (LRU), which means that it is designed to be repaired quickly at KNMI by replacement of modular components. Tenderer shall provide a list with recommended LRU items including recommended amounts.

7.2.5 The Precipitation Gauge shall be able to operate in the field at rural sites for at least 1 year in between 1st line maintenance instances.

7.2.6 The precipitation gauge shall be able to operate in the field at all sites including coastal and island locations for at least 1 year in between 1st line maintenance instances.

7.3 Delivery Requirements

7.3.1 Tenderer shall commit to the delivery schedule and support required during the verification tests. Note: See section 10 for details on verification tests.

8. Training

8.1 All trainings should take place in English on the basis of the documentation to be supplied.

8.2 The venue for all the training courses required below is at KNMI's headquarters in De Bilt, NL. The training courses are to include theoretical and practical parts and are aimed at approx. 10 people with engineer/technician level.

8.3 A training course is to be offered with the following topics: (1) structure of the device with its functions, (2) installation on an existing device base, (3) software, (4) hardware, (5) configuration and operation, (6) fault diagnosis and cause, (7) repair in the field, and (8) repair in the specialist workshop of KNMI.

8.4 A training course on calibration and adjustment of the sensor is to be offered with the following topics: (1) explanation of the calibration procedure and (2) explanation of the adjustment procedure

9. Documentation Requirements

9.1 Manual Requirements

9.1.1 Tenderer shall include a comprehensive and complete set of manuals and technical documentation written in Dutch or English with instructions for operation, installation, maintenance and verification of the precipitation gauge. This set shall at least include information on:

- Technical data/specifications;
- Data output description;
- Status information output description;
- Data communication options;
- Installation instructions;
- Mechanical and electronic connections;
- Electronic wiring schematic diagrams;
- Electrical specifications of digital outputs, power supply, power consumption and temperature range of the instrument;
- Measurement examples;

• Documentation on the internal algorithms and thresholds used in the precipitation gauge processing for the calculation of output quantities;

• Description of internal data quality control algorithms;

• Verification protocol;

• Description of factory acceptance test;

• Maintenance guidelines (on site and indoors);

• Safety instructions;

• Guidelines for transport;

• Troubleshooting;

• Training documentation.

9.1.2 Tender shall supply new or updated documentation when new firmware releases or upgrades of the precipitation gauge are delivered to KNMI, or when incorrect or incomplete information in the current documentation set is found.

9.1.3 All documentation files shall be formatted in Portable Document Format (PDF).

9.2 Technical Documentation Requirements

9.2.1 The algorithms used in the precipitation gauge to determine the target values must be disclosed to KNMI at the latest when the test is carried out. KNMI is committed to confidentiality.

9.2.2 Each device should be accompanied by a detailed and comprehensive protocol of the final inspection operations carried out in the factory and the results of the calibration. A sample of the protocol as well as a sample of the results of the calibration should be enclosed with the offer. The test reports and the calibration results of the precipitation gauges are transferred in digital form for archiving when the series devices are delivered.

10. Testing

10.1 The precipitation gauge will undergo a series of lab tests (i.e., step increases in flow, dynamic changes in flow, etc.) to determine if it meets the required measurement uncertainty. See 1.2.3 for required measurement uncertainty.

10.2 The precipitation gauge will placed on the test field at KNMI headquarters in De Bilt for a period of at least 6 months to ensure that it meets the achievable measurement uncertainty. See 1.2.4 for achievable measurement uncertainty. This test will also be used to ensure that the precipitation gauge can be properly installed, configured, and transmits data as expected.

10.3 The precipitation gauge will be collocated with KNMI's existing gauge at five pre-selected sites in KNMI's automated network to collect measurements for a period of 1 year. This results of this test will to determine how reliable and accurate the precipitation gauge is in comparison to KNMI's existing precipitation gauge.