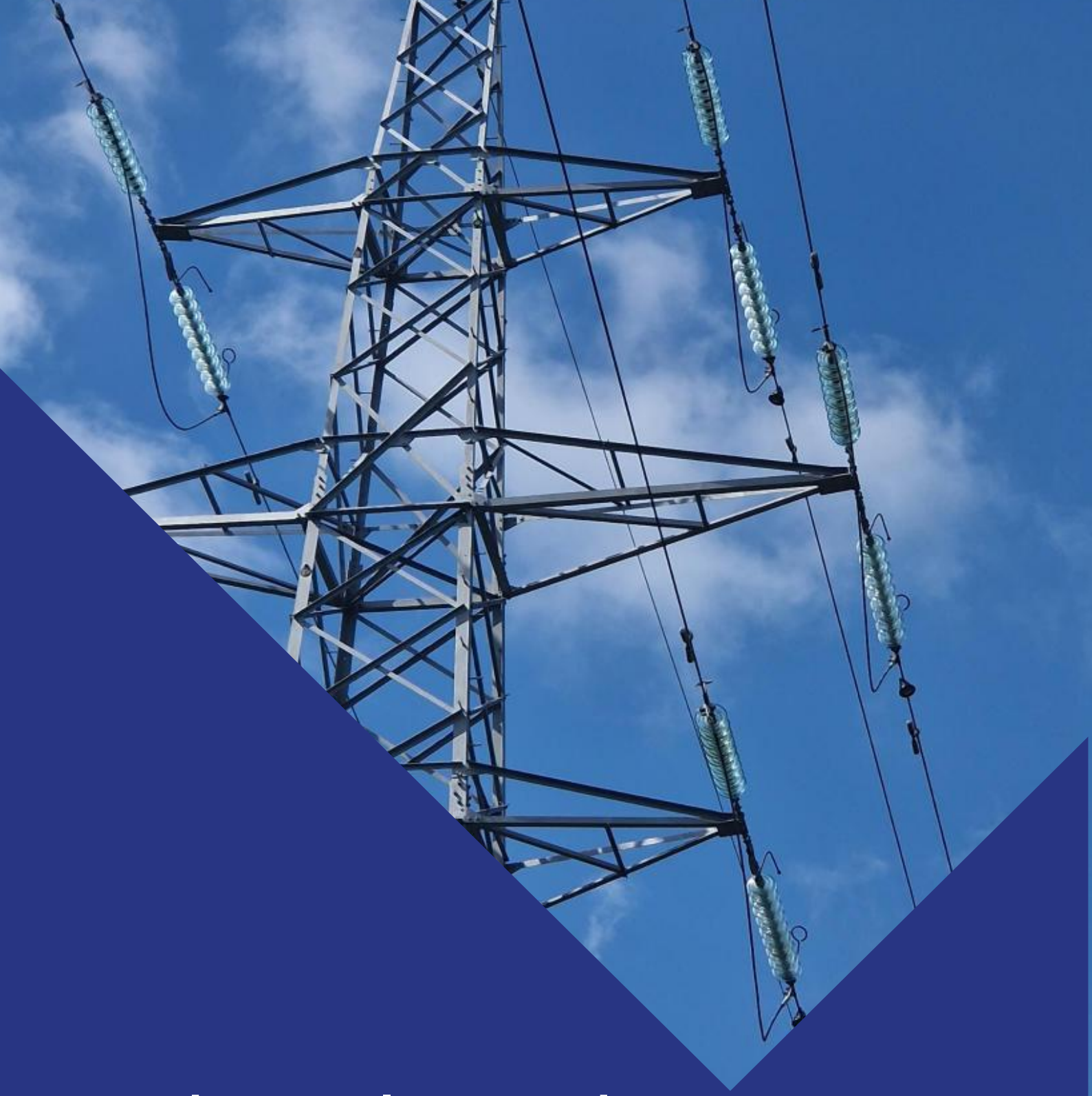

# Running Cool NIA Project

## Work Package 4.2 – Retrofit OHL Temperature Monitoring Equipment Engineering Specification

**July 2023**

Electricity Distribution

nationalgrid

# Contents

| Issue | Date | Author | Approver | Comment |
|---|---|---|---|---|
| 1.0 | 29/05/2023 | S Casallas | S Jupe | Initial draft for comment |
| 2.0 | 13/07/2023 | S Jupe | S Jupe | Absorbing initial feedback from NGED to remove FPI functionality references |
| 3.0 | 25/07/2023 | S Jupe | S Jupe | Removal of current detection functionality from specification |
| 4.0 | 17/08/23 | S Casallas | S Jupe | Addition of 11kV/6.6 kV table in section 3 |

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## Glossary

| | |
|---|---|
| ANM | Active Network Management |
| APN | Access Point Name |
| BIL | Basic Insulation Level (Lightning Impulse Withstand) |
| DNP3 | Distributed Network Protocol |
| FAT | Factory Acceptance Testing |
| GSM | Global System for Mobile Communication |
| IP Rating | Ingress Protection Rating |
| NGED | National Grid Electricity Distribution |
| OHL | Overhead Line |
| OTA | Over-The-Air |
| RTC | Real Time Clock |
| SCADA | Supervisory Control and Data Acquisition |
| STPFR | Short-Term Post-Fault Rating |
| TRL | Technology Readiness Level |

# 1. Scope

1.1. This document provides the specification for equipment which can be retrofitted to overhead line (OHL) systems in order to monitor conductor temperature.

1.2. The equipment used to monitor conductor temperature will be used to derive short-term post-fault ratings (STPFR) for OHL conductors.

1.3. The equipment used to monitor conductor temperature may be required to form part of an active operational control system, such as Active Network Management (ANM).

1.4. The metrology equipment will comprise sensors for each available phase or the phase assessed to represent the thermal pinch point in the network (for example, the lowest conductor in a vertical arrangement of three phase conductors).

1.5. The equipment must not present any health and safety risks to personnel during installation, operation, and decommissioning.

1.6. The supplier shall be able to demonstrate compliance with ISO 9001, ISO 14001, ISO 27001, and ISO 45001 standards.

# 2. General

2.1. The equipment will be used to monitor 3 wire 3 phase OHL systems from 6kV up to 132kV line-to-line (+15%). Variants of products retrofittable at different distribution voltage levels are permissible.

2.2. Due to the diversity of existing assets the equipment must the able to fit a variety of conductor types (including covered conductors).

2.3. As such the equipment must be retrofittable to common conductor types with diameters between 5mm (e.g. 16mm$^2$ Hard-drawn Copper conductor) and 29mm (e.g. 400mm$^2$ Zebra ACSR Conductor). See EE Specification 85/3[1] for full details of conductor types currently in use on overhead networks.

2.4. The maximum weight of a sensor shall be 1.5kg, unit weight shall have negligible effect on overhead conductor sag. The size of the units will be considered to ensure one-person handling.

2.5. The equipment shall be compatible with Supervisory Control and Data Acquisition (SCADA) and facilitate the reporting of unsolicited events to the remote iHost server in response to events on the network.

2.6. The equipment shall provide intelligent degradation of services in case of power supply constraints. For example, if the equipment uses an energy harvesting method and the line is de-energised then the equipment shall continue to report operational data for a minimum period of two months, gradually reducing its functionality to conserve power. This shall be contained in the equipment documentation.

2.7. Installation should be simple with minimal commissioning required. No calibration should be required for the system. The unit shall not damage the conductors during installation.

2.8. Installation of monitoring equipment on live OHLs up to and including 33kV shall be in accordance with ST: OH7A (C5). Installation on higher voltages shall be conducted under outage with the circuit deenergised and earthed.

2.9. The installation and commissioning of equipment shall not take longer than 30 minutes.

[1] www.nationalgrid.co.uk/downloads-view-reciteme/605504

2.10. The installation method shall be reversable for decommissioning of OHL monitoring equipment.

2.11. It shall be possible to mount multiple sets of sensors in close proximity to each other (e.g. on main circuit and spur at the same tower).

2.12. The equipment label shall display product name, part number, serial number, QR code, manufacturer website, certification logos. Any health and safety warnings and other labelling shall be displayed as required.

2.13. A digital record of the commissioning of the equipment shall be obtained and stored in iHost. The minimum requirements of the digital commissioning record are as follows:

- Serial number(s) of the equipment
- GPS coordinates of the unit (latitude and longitude)
- Reference to the nearest network equipment (e.g. pole number)
- Readings of temperature analogue values at point of installation
- Confirmation of satisfactory remote communications to iHost

# 3. Monitoring Equipment

3.1. The minimum Ingress Protection (IP) rating for the metrology equipment shall be IP67.

3.2. Equipment shall have a lifetime of 10 years or more given normal operating conditions.

3.3. The equipment must operate correctly from -20°C to +60°C. The device shall not behave as a sink for OHL heat radiation.

3.4. All equipment shall be uniquely identifiable and shall be in full production with a TRL of 9, and be CE marked.

3.5. The equipment shall be self-powered without the need for external power supply. Energy harvesting from the OHL is acceptable.

3.6. Power supply constraints on operational behaviour (e.g. power saving modes) shall be disclosed in the equipment documentation.

3.7. The equipment shall detect the operating temperature of the surface of the OHL conductor to within ±3°C across a full range of -20°C to 80°C (minimum). The device withstand temperature range should be -40°C to 100°C.

3.8. The equipment shall contain the embedded intelligence to know when it is unavailable. Indications and analogues are suppressed from units that are unavailable.

3.9. Equipment shall adequately withstand power surges and lightning impulses (BIL) and meet NGED's minimum requirements for monitoring equipment being deployed on OHL networks. The equipment shall not increase the risk of arcing between OHL conductors.

**For 11kV Connected Equipment (including 6.6kV Connected Equipment)**

| | |
|---|---|
| Nominal Voltage | 11kV |
| Rated Voltage | 15kV |
| Rated 1 Minute Power Frequency Withstand Voltage | 28kV RMS |
| Rated Lightning Impulse Withstand Voltage | 75kV Peak |

**For 33kV Connected Equipment**

| | |
|---|---|
| Nominal Voltage | 33kV |
| Rated Voltage | 36kV |
| Rated 1 Minute Power Frequency Withstand Voltage | 70kV RMS |
| Rated Lightning Impulse Withstand Voltage | 170kV Peak |

**For 132kV Connected Equipment**

| | |
|---|---|
| Nominal Voltage | 132kV |
| Rated Voltage | 145kV |
| Rated 1 Minute Power Frequency Withstand Voltage | 320kV RMS |
| Rated Lightning Impulse Withstand Voltage | 650kV Peak |

3.10. If the power supply is via inductive charging, clear worked examples shall be provided of the minimum required load current for inductive charging, anticipated life and how power supply is maintained during periods when this level is not available.

Documentation shall include:

- Load required for break-even self-supporting mode of operation.
- Load required to self-power and charge battery (or super capacitor) at max rate will be advised in the product user manual.
- Status thresholds for battery low alarms.

# 4. Communications

4.1. The equipment shall be compatible with iHost which shall act as the hosting platform for event reporting, routine datalogging and periodic over-the-air (OTA) maintenance.

4.2. The equipment shall communicate over the GSM network using a 4G mobile data connection with 2G failover. If the communications network or path to iHost is unavailable the unit shall retry until communication is restored.

4.3. The equipment shall date/time stamp events. The real time clock (RTC) shall support Distribution Network Protocol 3 (DNP3) protocol and synchronise with iHost.

4.4. The equipment shall provide a local method of wireless communication (e.g. short-range wireless radio) up to 80 meters away from a commissioning device; for on-site status confirmation and diagnostics.

4.5. The equipment shall support remote communication of data from all available phases using a single SIM card. The unit shall allow for exchange of the SIM card on site without the need for a factory visit.

4.6. The equipment shall support DNP3 for integration with SCADA and iHost.

4.7. The equipment shall implement an algorithm to confirm status and remain connected to the GSM network.

4.8. Configurable host address and Access Point Name (APN) details shall be supported.

4.9. The equipment shall implement an ongoing retry algorithm should communications to iHost be interrupted or unsuccessful.

4.10. The equipment shall retain settings across a complete loss of power.

4.11. The equipment shall date/time stamp network events and store in local memory until uploaded to iHost. Logs shall remain across complete loss of power. Diagnostic events (such as reasons for communications failure) shall be recorded and reported to iHost.

4.12. The equipment shall accept remote configuration of communications parameters including host addresses and APN details.

4.13. The equipment shall accept RTC synchronisation messages from iHost.

4.14. The equipment shall log additional hardware, firmware and communications related diagnostic information and report the same to iHost in a supported format.

4.15. For clarity, NGED will provide appropriate SIM cards and data hosting via the iHost head-end system.

# 5. Data Transmission and Collection

5.1. The equipment shall sample at a frequency that does not alias the signal or introduce false readings.

5.2. Sampling of routine logging data (conductor temperature) shall be user configurable and capable of sampling and recording at 1-minute intervals.

5.3. The data shall be transmitted from the device to NGEDs central systems every ten minutes as a minimum.

5.4. Maximum, minimum, average and actual values of conductor temperature shall be provided at the end of each sample interval.

5.5. The equipment will need to collect routine logging data from the sensors and transmit periodically to the iHost server for future analysis.

# 6. User Interface

6.1. The equipment shall have following points available to drive iHost user-interface, points should be available on a per phase basis unless otherwise stated:

| **Binary Inputs** |
|---|
| N/A |
| **Analogue Inputs** |
| Conductor operating temperature |
| Backup power supply status |
| **Counter Inputs** |
| N/A |

# 7. Maintenance

7.1. The equipment shall have a maintenance interval of minimum of 5 years given normal operating conditions.

7.2. Any battery, super capacitor or other component of the power supply must be field replaceable without the need to return to factory.

7.3. The equipment shall provide a method for accepting firmware and configuration updates OTA that is compatible with iHost.

7.4. The equipment shall be capable of being upgraded OTA to unlock directional power flow and fault detection functionality (if this becomes a future requirement for NGED).

# 8. Cyber Security

8.1. The equipment shall be protected from unauthorised local connection via a user-configurable unique PIN (minimum 9 digits). Tamper detection shall prevent repeated unsuccessful attempts and provide an alarm over the SCADA system.

8.2. The unit shall meet the minimum requirements of penetration testing and be approved for use by the Cyber Security team.

# 9. Tendering Considerations

9.1. The following list of points should be considered with any tender package:

- Provision for factory acceptance testing (FAT)
- Integration to iHost
- Warranty
- Product lead times
- Product technical support
- Minimum installation time
- Quantities at different voltage levels
- Pricing table
- Cyber security penetration testing
- Additional functionality of devices available ‘out of the box’ (such as current load logging and fault passage indication capabilities)

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