NPS/007/021 – Technical Specification for Secondary Distribution Substation Monitoring Systems

1. Purpose

The purpose of this document is to detail the technical requirements for monitoring systems for use in secondary distribution substations and/or similar operational situations.

Northern Powergrid's primary requirement is the collection and regular transmission of network data from distribution transformers and LV feeders with transmission back to existing back office systems.

Suppliers may additionally provide options where equipment might additionally be deployed for recording data such as pressure, fluid levels or environmental conditions, and/or provide limited control for non-operational equipment such as dehumidifiers etc.

This document supersedes the following documents, all copies of which should be destroyed.

Reference	Version	Date	Title
NPS/007/021	1.0	Apr 2018	Technical Specification for Secondary Distribution Substation Monitoring Systems

2. Scope

This document applies to telemetry systems suitable for monitoring voltage, current and other calculated parameters such as power flow, power factor, harmonic distortion etc collected at secondary distribution substation sites and similar installations.

This specification covers the following main components:

- A central unit containing measurement inputs, communication equipment, processor and power supply;
- Voltage collection clamps and/or connectors;
- A temperature probe; and
- Current sensing elements such as split core current transformers or Rogowski coils

Installations are generally anticipated to require all the above components however where suitable current transformers and/or voltage connections are available connections to existing devices may be requested.

Mandatory and optional requirements are outlined. Optional features are not considered core functionality.

Where the supplied equipment is required to co-exist with existing and/or planned secondary distribution substation automation systems, such integration is expected to be limited to operation as a slave unit, sharing of communication links and/or installation in shared equipment cubicles.

A block diagram outlining the core system components is included in Appendix 1.

2.1. Table of Contents

3. Technical Requirements

3.1. Summary

Northern Powergrid seeks a monitoring solution, or solutions, suitable for installation inside and/or adjacent to PENDA* devices installed at secondary distribution substations.

Northern Powergrid will consider offers of different monitoring equipment models where these are necessary to achieve optimal installation depending on factors including, but not limited to:

- Indoor / Outdoor location
- Whether feeder data associated with a PENDA-I or PENDA-O unit is to be monitored
- The number of feeders connected to the target PENDA
- Whether the PENDA contains existing Current Transformers or requires retrofit Current Sensors
- Whether the PENDA contains phase voltage connections or requires retrofit busbar clamps.

The monitoring equipment shall be externally simple and robust comprising a single enclosure containing all components other than sensors (e.g. Current Transformers, Rogowski coils, voltage taps, temperature probes), external antenna(s) (where fitted) and associated cabling. A block diagram outlining the core system components is included in Appendix 1.

The apparatus supplied shall be capable of collecting measurements from the electrical distribution network, performing specified calculations (e.g. deriving power and harmonic content) and communicating these to central systems including the currently installed Nortech iHost system.

The equipment will initially be installed in a stand-alone mode utilising its own communication however at a point in future, installations may be reconfigured to connect to a shared communication or become a slave off another on site system.

Where additional features may be desirable in limited situations but not considered core functionality suppliers are requested to indicate if these are available as an option. This includes features such as binary inputs and the ability to be installed on an electricity Pole.

* See section 5 Definitions for a definition of the term PENDA.

3.2. General Requirements

3.2.1. Environmental Conditions

All parts of the equipment shall continue operate under the following environmental conditions:

Ref	Requirement/Characteristic
3.2.1.1	Be protected against ingress to BS EN 60529 IP32 or better.
3.2.1.2	Be protected against impact to BS EN 62262 IK08 or better.
3.2.1.3	Ambient Temperature in the range -25°C to +55°C.
3.2.1.4	Relative humidity between 0 – 90% non-condensing.
3.2.1.5	In accordance with the Climatic conditions outlined in BS EN 60870-2-2.

Equipment designed for outdoor installation shall continue to operate under the following additional conditions:

Ref	Requirement/Characteristic
3.2.1.6	Be protected against ingress to BS EN 60529 IP44D or better.
3.2.1.7	Be demonstrated to be stable against UV light in accordance with BS ISO 4582.
3.2.1.8	Be immune to polluted coastal locations as evidenced by tests to ISO 9227, 7253, 4628, 10289.

Equipment designed for mounting outdoors on electricity poles above 3.65m shall continue to operate under the following additional conditions:

Ref	Requirement/Characteristic
3.2.1.9	Be protected against ingress to BS EN 60529 IP45 or better.

The following requirement may be requested as a preference for unusually harsh install conditions:

Ref	Requirement/Characteristic
3.2.1.10	Additional environmental protection to BS EN 61439-1 7.2 Special service conditions (pollution, animals etc).

3.2.2. Equipment Location

Equipment shall be installable/operable in the following locations:

Ref	Requirement/Characteristic
3.2.2.1	Within an indoor a secondary distribution substation and/or similar operational building.
3.2.2.2	Within an outdoor secondary distribution substation compound, attached to the PENDA-O unit or possibly other suitable structures.
3.2.2.3	Within a PENDA-O or similar cabinet generally (but not always) part of an outdoor secondary distribution substation. Note: These can be particularly space constrained locations.

Please indicate if the following is available as an option:

Ref	Requirement/Characteristic
3.2.2.4	Suitable for attachment to outdoor electricity distribution poles at a height of 3.65m or above.

3.2.3. Equipment Construction

The equipment shall be constructed as follows:

Ref	Requirement/Characteristic
3.2.3.1	With a warranted design lifespan of at least 5 years and a guaranteed repair / replacement period extending to at least 10 years.
3.2.3.2	With lifespan limiting factors and/or components identified together with any mitigations. (An example might be the need to replace a real time clock battery after a specified time to guarantee accurate time stamps immediately after reboot.)
3.2.3.3	To enable safe installation without interrupting supplies to customers.
3.2.3.4	With all components housed in a single enclosure except for sensors, voltage sensing connectors, external antennas and wiring thereto.
3.2.3.5	Using either separate modules or single composite circuity within the enclosure.
3.2.3.6	Using a DIN rail topology where multiple separate modules are employed within the enclosure.
3.2.3.7	With all wiring between modules, within the enclosure and connections to external components labelled and identified on an accompanying schematic diagram.
3.2.3.8	Without any use of forced ventilation.
3.2.3.9	Such that maintenance and testing of associated and/or adjacent electrical distribution equipment is not impeded.
3.2.3.10	Such that routine physical maintenance is not required.
3.2.3.11	With Mean Time Between Failure in years provided for all major components.
3.2.3.12	With markings identifying compatible installation environment. (e.g. restricted to indoor use)

3.2.3.13	So as to maintain at all times, including but not limited to conditions where access covers are removed, a minimum BS EN 60529 IP20 protection for any exposed conductive component carrying greater than 50VAC.
3.2.3.14	Fully operable while connected via Northern Powergrid private data networks with no requirement to directly access servers on external data networks.

3.2.4. Manuals

Documentation shall be supplied as follows:

Ref	Requirement/Characteristic
3.2.4.1	Manual covering Installation / commissioning.
3.2.4.2	Manual covering configuration, including details of all available configuration options.
3.2.4.3	Manual covering operation.
3.2.4.4	Manual covering programming (where relevant).
3.2.4.5	On CD and/or downloadable.
3.2.4.6	Licensed for storage in Northern Powergrid documentation retrieval systems.

3.2.5. Enclosure

Tender replies shall include maximum external dimensions for the following parameters:

- height (h);
- width (w); and
- depth (d).

The enclosure shall meet the following requirements:

Ref	Requirement/Characteristic
3.2.5.1	Contain all system components with the exception of sensors, voltage sensing connectors, external antennas and associated wiring.
3.2.5.2	Have ventilation and/or temperature control arrangements compatible with the environment.
3.2.5.3	Have durable labels permanently fixed to the outside with text and/or graphics as agreed with Northern Powergrid.
3.2.5.4	Contain a diagram detailing the location and function of modules within the enclosure.
3.2.5.5	Contain a permanently fixed diagram detailing location, function and, where applicable, rating of connections, jumpers, switches and protective devices (fuses and. /or circuit breakers).
3.2.5.6	Clearly indicate the presence of any heater and its rating.
3.2.5.7	Have an Antenna feed through for connection of the external antenna providing TNC, N-Type or SMA connection to the external antenna.
3.2.5.8	Have a completely removable access door or cover to assist access in restricted situations.

Enclosures to be mounted at ground level in an outdoor situation shall meet the following additional requirements:

Ref	Requirement/Characteristic
3.2.5.9	Be certified intruder resistant to UK Building Research Establishments Loss Prevention Standard BRE-LPS 1175 SR1. (Alternative solutions offered by the manufacturer, including reference to Standards, shall be included in the tender reply).
3.2.5.10	Provide secure cable entry enclosing all connectors and cable terminations.
3.2.5.11	Be accessible via a hinged front door incorporating padlock facility able to accept Northern Powergrid padlocks as follows: • body of up to 63mm2;

	• 10mm diameter shackle; • clear inside width of 35mm; and • shackle inside length between 25mm and 45mm. The hole provided for the shackle shall not be less than 11mm diameter.
3.2.5.12	Incorporate an access detection switch/sensor linked to the processor.

Please indicate if the following options are available:

Ref	Requirement/Characteristic
3.2.5.13	Fixing points suitable for fixing to wooden poles using either M12 or M16 galvanized coach screws.
3.2.5.14	Space within the enclosure for additional modules where slave devices are supported (see processor and connectivity sections).

3.2.6. Processor

The system shall include a processor or equivalent which is capable of undertaking the following tasks/operations:

Ref	Requirement/Characteristic
3.2.6.1	Collect measurements from inputs at intervals referenced to the system time. i.e. on the hour, 10minutes past the hour 20 minutes past the hour etc for a 10 minute collection cycle.
3.2.6.2	Store at least 28 Days of un-transmitted, processed data based on a 10 minute reporting period for all Integral Sensor Inputs and Computed Values.
3.2.6.3	Analyse/Summarise data prior to transmission to central office system.
3.2.6.4	Support flexible configuration of Cellular, serial and Ethernet ports to support different protocols (see preferences section for additional protocols):
3.2.6.5	Support IP Based communication.
3.2.6.6	Support TLS encryption compliant with BS EN 62351-3 for IP based communication.
3.2.6.7	Implement DNP3 communication compliant to at least IEEE 1815 DNP3 Level 2 2012.
3.2.6.8	Communicate with central systems using DNP3 slave over IP.
3.2.6.9	Communicate with central systems using DNP3 slave over serial.
3.2.6.10	For waveform captures only, transmit data to a central system using a published transfer protocol over an IP Based communication bearer .
3.2.6.11	Have a configurable IP and Port of the recipient system for transfers identified in 3.2.6.10, which may be separate from the DNP3 target.
3.2.6.12	The format of data uploaded in 3.2.6.10 above must be freely available unencumbered by any confidentiality requirement.
3.2.6.13	Incorporate a watchdog timer capable of restarting an unresponsive system.
3.2.6.14	Synchronise system time to DNP3 timestamps received from central systems.
3.2.6.15	Secure local connections against unauthorised access.
3.2.6.16	Secure remotely accessible ports against unauthorised access.
3.2.6.17	Maintain a 28 day system log detailing as a minimum: • Start-up; • Shutdown; • restoration of power; and • error conditions.
3.2.6.18	Provide selected system status values in a form suitable for mapping to DNP3 binaries. (this is to enable e.g. error conditions to be notified as unsolicited transmissions.
3.2.6.19	Store data in non-volatile solid state memory or disk with no use of mechanical media.
3.2.6.20	Be immune to corruption caused by power failures and/or brownouts.
3.2.6.21	Ensure any additional communication required for functions such as, but not limited to, managing settings and/or firmware updates are IP based with documentation sufficient to enable integration with Northern Powergrid systems.

3.2.6.22	Be immune to internal corruption during extended periods when communication to central systems is interrupted.

Please indicate if any of the following options are available:

Ref	Requirement/Characteristic
3.2.6.23	Receive data/measurement from external RTU/IED devices using. Modbus and/or DNP3.
3.2.6.24	Receive data/measurement from external wireless devices and/or sensors.
3.2.6.25	Communicate with local devices using DNP3 master over IP.
3.2.6.26	Communicate with local devices using DNP3 master over serial.
3.2.6.27	Communicate with local devices using MODBUS-RTU master (serial).
3.2.6.28	Synchronise system time from alternative sources where DNP3 is unavailable.
3.2.6.29	Support execution of user supplied programs and/or algorithms. Note: vendors must indicate what languages and programming standards are supported.
3.2.6.30	Support full device encryption.
3.2.6.31	Support secure storage of encryption keys typically using secure element hardware.
3.2.6.32	Support enforcement of signed firmware.

3.2.7. Real Time Clock

The system shall include a real time clock to provide an initial time reference to the processor and enable low power "sleep" periods for ultra-low power applications.

The real time clock shall meet the following requirements:

Ref	Requirement/Characteristic
3.2.7.1	Provide the system time with initial time when booting.
3.2.7.2	Maintain synchronism with the system time once the processor establishes an accurate sync to an external source (DNP3).
3.2.7.3	Continue to operate for 28 days in the absence of an external power source.
3.2.7.4	Maintain drift of less than 2 Seconds per day in the absence of updates from the processor.
3.2.7.5	Where primary cells are utilised to maintain the real time clock during power outages the primary cell lifespan shall be greater than 10 years.

Please indicate if your system supports the following options:

Ref	Requirement/Characteristic
3.2.7.6	Real Time Clock Initiates Heartbeat transmissions in low power units.
3.2.7.7	Real Time Clock can bring rest of system out of low power sleep mode.

3.2.8. Physical / Wireless Connection (excluding integral measurement inputs)

Physical and/or wireless connections are required to transmit data back to central systems and optionally facilitate communication with additional nearby devices.

The following inputs shall be provided as a minimum:

Ref	Requirement/Characteristic
3.2.8.1	A Cellular Modem having the following characteristics: • configurable to use a private APN endpoint ; • compatible with all UK public Cellular networks ; • compliant with 2G, 3G and 4G/LTE (CAT-1) standards ; • Capable of accepting GSMA SIM Specification compliant EUICC SIM cards ; • Capable of remote re-provisioning GSMA SIM Specification compliant EUICC SIM cards onto alternative cellular providers in the event of a change of contracted provider (it is understood this will require the presence of Sim Toolkit and/or other software to support this process) ; and • Capable of accepting SIM cards and/or EUICC profiles supplied under Northern Powergrid contracts and fitted/tested by the vendor prior to equipment delivery.
3.2.8.2	An external Cellular antenna option to assist in marginal coverage areas including where the unit is installed in a building and/or metal cabinet. Please indicate the maximum feeder length available to an external antenna.
3.2.8.3	A vandal resistant external Cellular antenna to assist in areas of marginal coverage.
3.2.8.4	RJ45 Ethernet (minimum 10BaseT).
3.2.8.5	RS232 serial connection (configurable to support DNP3master/slave and/or MODBUS-RTU (master/slave) if available).
3.2.8.6	Hardware flow control signals available on RS232 connections sensitive to the maintained level not just transition.
3.2.8.7	Diagnostic/Programming interface connection.
3.2.8.8	Mitigate against mutual interference of the cellular connection when two units are co-located (e.g. to monitor a PENDA having a large number of ways).

Please indicate if any if the following options are available:

Ref	Requirement/Characteristic
3.2.8.9	RS485 serial connection(configurable to support DNP3master/slave and/or MODBUS-RTU master/slave).
3.2.8.10	RS485 isolated to 1.5KV RMS / 2.1KV DC between input and all other circuits.
3.2.8.11	Wi-Fi.
3.2.8.12	Digital inputs (please indicate quantity level).
3.2.8.13	Digital Counter Inputs (please indicate quantity and counter size e.g. 4 I/P 16 Bit).
3.2.8.14	Digital outputs (please indicate quantity).
3.2.8.15	Digital I/O isolated to 1.5KV RMS / 2.1KV DC between input/output and all other circuits.
3.2.8.16	LPWAN (typically LORA).
3.2.8.17	Low Power RF – typically IEE 802.15.4 for connection to wireless sensors.
3.2.8.18	Environmental bus connectivity (typically 1 Wire for temperature / humidity transducers).
3.2.8.19	Internal expansion bus technologies such as SPI and/or I2C (typically for addition of low power RF modules).
3.2.8.20	Cellular connectivity using LTE CAT-M1.

3.2.9. Local Status Indication/Display

The system shall clearly indicate its operational state to staff in the vicinity as follows:

Ref	Requirement/Characteristic
3.2.9.1	Indicate the operational status to installation or maintenance staff in vicinity by means of LEDs and/or Text display. N.B Text display shall mean either a physical feature of the equipment or a suitably authorised and configured mobile device.
3.2.9.2	Employ indication method compatible with install location (e.g. an integral text display is not suitable for equipment mounted at high on a pole).
3.2.9.3	Provide visual indication of Power Present.
3.2.9.4	Provide visual indication of System OK.
3.2.9.5	Provide visual indication of System Requiring Attention.
3.2.9.6	Provide visual indication of Active Communication.

Please indicate if any of the following options are available:

Ref	Requirement/Characteristic
3.2.9.7	Provide additional status Indication via a Local Console port (may be a physical or optical connection).
3.2.9.8	Access additional status information by means of a local keypad.
3.2.9.9	Ability to inhibit illuminated indicators e.g. where their presence could increase chances of trespass and/or vandalism.

3.2.10. DNP3 Configuration

It must be possible to flexibly map monitored data, processed values and binary ports (where fitted) to DNP3 indices ready for collection by scan or unsolicited upload to central systems. To achieve this the following DNP3 related functionality is required:

Ref	Requirement/Characteristic
3.2.10.1	Support DNP3 configuration to IEEE 1815 DNP3 level 2 2012.
3.2.10.2	Support for data value conversion between float and integer values including pre scaling of float values by 10^n.
3.2.10.3	Support for data precision change (e.g. 64 bit float to 32 bit float).
3.2.10.4	Support mapping of all integral and slave inputs to DNP3 indexes.
3.2.10.5	Support setting deadband thresholds for analogue values.

3.2.10.6	Support setting absolute thresholds for analogue values.
3.2.10.7	Any unsolicited events are timestamped when the event occurred.
3.2.10.8	Data sent in DNP3 format shall be demonstrated to be compatible with Nortech iHost.
3.2.10.9	Transmit a unique monitoring unit serial number as a DNP3 string.
3.2.10.10	Transmit the Cellular SIM serial number as a DNP3 string (where cellular modem fitted).
3.2.10.11	Transmit the wireless network status (typically signal strength/modulation type) as DNP3 values.
3.2.10.12	Transmit the unit status as DNP3 values (Typically normal operating or error conditions).
3.2.10.13	Inhibit transmission of unmapped and/or unwanted inputs.

Please indicate if the following option is available:

Ref	Requirement/Characteristic
3.2.10.14	Ability to retrieve the current DNP3 mapping from the processing unit in the form of a human readable XML file either by DNP3 or other suitable read only transfer mechanism.

3.2.11. Configuration and Commissioning

The following shall be provided to facilitate configuration and commissioning:

Ref	Requirement/Characteristic
3.2.11.1	Facility to apply standard configurations avoiding repetitive input when multiple devices are being configured.
3.2.11.2	Ability to undertake configuration tasks using a standard laptop PC.
3.2.11.3	Any software necessary to configure the system shall be provided at no extra cost and freely loadable on all PCs used to support the system and operable without dongles or other restrictive license control mechanisms.
3.2.11.4	Initial configuration by upload of a human readable configuration file or single firmware file.
3.2.11.5	Current configuration available from the unit in the form of a downloadable, human readable file.
3.2.11.6	Confirmation is provided when a configuration is valid and correctly loaded into the target device.
3.2.11.7	Capability to receiving configuration / firmware remotely on IP addressable devices.
3.2.11.8	Facility to confirm correct operation prior to leaving site, this particularly relates to verifying successful data transfer over the cellular network.

Please indicate if the following option is available:

Ref	Requirement/Characteristic
3.2.11.9	Capture of GPS position (e.g. from a phone app) at commissioning time to confirm install location.
3.2.11.10	Capture of Substation Name and Feeder Way Names electronically at install time to avoid reduce transcription errors (NB this could include suitable tagged photographs including unit serial number).

3.2.12. Power Supply

The system shall support the following power supply features:

Ref	Requirement/Characteristic
3.2.12.1	Default system supply obtained from the voltage sense input(s).
3.2.12.2	Operate from a supply voltage ranging between 200V and 264V.
3.2.12.3	Withstand 2 times minimal voltage for 10mS.
3.2.12.4	Backup is required for the real time clock only.
3.2.12.5	Any batteries included (e.g. for the Real Time Clock) must have a demonstrable life greater than 10 years taking account of temperature extremes anticipated in service.

3.2.12.6	A means to report the current health of any batteries included in the system.

3.2.13. Integral Sensor Inputs and Computed Values

The minimum monitoring requirements are reflected in this section Vendors should indicate where products exceed these requirements.

The system shall support data acquisition and processing as follows:

Ref	Requirement/Characteristic
3.2.13.1	Be adaptable to cater for differing numbers of LV feeders Supplier must specify how this is achieved e.g. • Utilising units with different fixed numbers of inputs ; • Additional expansion units ; and • Operating standard units in parallel or master slave.
3.2.13.2	Have at least 16Bit digitisation capability.
3.2.13.3	Maintain digitisation accuracy better than +-0.05% of full scale.
3.2.13.4	Have inputs protected against damage from voltage and current transients caused by routine faults on the electrical network.
3.2.13.5	Support current sense inputs compatible with 1V, 0.33V, 1A and 5A signals.
3.2.13.6	Be configurable on an input by input basis to match connected current transformer and/or Rogowski coil ratios.
3.2.13.7	Ensure Power measurements are signed (both Real and Reactive).
3.2.13.8	Sample current and voltage waveforms according to BS EN 61000-4-30.
3.2.13.9	Sensor input ports must either: • use plugs and sockets demonstrated to be available from mainstream electrical/electronic factors; or • provide a flying lead option which may be terminated with plugs sockets of Northern Powergrid's choosing.

The system shall perform specific data acquisition and processing as follows:

Ref	Requirement/Characteristic
	Physical Measurement / Sample
3.2.13.10	Measure Phase to Neutral Voltage for each PENDA busbar.
3.2.13.11	Measure the Current on all phase and Neutral conductors of every incoming and outgoing PENDA circuit.
3.2.13.12	Have input capacity to physically acquire phase and neutral currents from a minimum of six circuits without requiring expansion and/or additional processor units.
3.2.13.13	Be configurable to obtain transformer current from sensors applied to the transformer circuit or by summation of outgoing feeder sensors on a per install basis. (the default should be summation of outgoing feeders).
3.2.13.14	Measure Transformer Tank Temperature (probe attached to outside of tank).
	Calculated and/or Derived Values
3.2.13.15	Continually calculate all average, values for discrete successive periods configurable to 10 or 30 minute.
3.2.13.16	Support setting of 10 / 30 minute periods separately for the following: • Busbar voltages ; • Transformer Temperature ; and • Per PENDA incoming / outgoing circuit. e.g. a possible configuration might be • Busbar voltages calculated on 10 min time period ; • Transformer temperature calculated on 30 min time period ; • Incoming (Transformer) PENDA circuit calculated on 10 min time period ; • 1 PENDA circuit calculated on 10 min time period ; and • Remaining PENDA circuits calculated on a 30 min time period.
3.2.13.17	Calculate average PENDA busbar AC RMS voltages.
3.2.13.18	Calculate average phase and neutral AC RMS currents for every incoming and outgoing PENDA circuit.
3.2.13.19	Calculate average Real Power (Watts) and direction for each phase on every incoming and outgoing PENDA circuit.
3.2.13.20	Calculate average Reactive Power (VAr) and direction for each phase on every incoming and outgoing PENDA circuit.
3.2.13.21	Calculate average Voltage Total Harmonic Distortion up to 10th Harmonic on PENDA busbars.
3.2.13.22	Calculate average Current Total Harmonic Distortion up to 10th Harmonic on each phase of every PENDA circuit.
	Event Trigger and Waveform Capture
3.2.13.23	Capture Voltage and Current waveforms in response to defined triggers as follows: • Record at least 7 cycles / per capture trigger ; • Record all phase voltages and currents and neutral current on the affected way ; • Sample rate at least 8KHz (16KHz preferred) ; • Sample resolution to provide an A/D resolution of at least 1A over the full current range ; and • The 7 cycle capture period must be configurable at commence at any point from 7 cycles before the trigger time to the trigger time.
3.2.13.24	Trigger captures based on any combination of: • Exceed an absolute threshold Current ; • Exceed an absolute threshold dI/dT ; and • Exceed a voltage delta between successive waveform cycles. All triggers to be configurable and settable by the user.

3.2.13.25	Capture current excursions in the range 0 to 15,000 amperes (0-15KA rms).
3.2.13.26	Include the following metadata with each capture date: • The way number the capture relates to; and • A date/time stamp of the initiating trigger to the nearest second as defined by the system time.
3.2.13.27	Notify of all trigger events via DNP3.
3.2.13.28	Be configurable to up-load waveform capture data to central systems on receipt of a request signal from a central system or upload on completion of capture.

Please indicate if the following is available as an option:

Ref	Requirement/Characteristic
3.2.13.29	Capability to continuously set calculation time periods beyond the 10 / 30 minutes specified above.

3.2.13.1. Voltage Sensing Connections

Suitable connectors shall be supplied for the dual purpose of sensing phase voltages and sourcing power for the monitoring unit as per the following

Ref	Requirement/Characteristic
3.2.13.1.1	Clamps, fully shrouded on non-mating surfaces, having integral fusing, suitable for connection to live PENDA busbars.
3.2.13.1.2	Shrouded 4mm male connections suitable for live connection to generator synchronisation outputs available on recent PENDA installations. Note - Generator synchronisation outputs comprise binding posts similar to RS Stock No 645-8691 which will not accept shrouds on standard 4mm (shrouded) plugs and instead require a wide skirt or other suitable means to avoid accidental contact with the bare 4mm pin when disconnected. Generator sync connectors are usually protected with 6A HRC fuses. On occasions 16A fuses may be used e.g. when a sync terminal connection is shared with a 13A outlet.
3.2.13.1.3	Protected with HRC fuse rated to at least Type F 50KA.
3.2.13.1.4	Safety compliant with BS EN61010.
3.2.13.1.5	Installation Overvoltage Rated to CAT IV 600V.

Please indicate if the following is available as an option or separate product

Ref	Requirement/Characteristic
3.2.13.1.6	A fully shrouded voltage clamp solution similar to 3.2.13.1.1 which can be applied with an insulated tool in restricted spaces such as between fuseways in older transformer mounted cabinets.
3.2.13.1.7	A fully shrouded insulation piercing connector suitable for obtaining voltage sense connections from an outgoing distribution feeder. Note that the solution must be able to be applied safely in the confined space below a fuse panel.

3.2.13.2. Current Sensors

Unless connection to existing CTs is specified, suitable current sensors such as Split core Current Transformers or Rogowski Coils shall be supplied as per the following

Ref	Requirement/Characteristic
3.2.13.2.1	Accuracy to class 1 CT equivalent or Better assuming an optimal install situation.
3.2.13.2.2	Suitable for installation on PENDA unit feeders without interrupting supplies to customers.
3.2.13.2.3	Where connection to existing CTs is required a suitable connection system shall be supplied.
3.2.13.2.4	Installation Overvoltage Rated to CAT IV 600V.
3.2.13.2.5	Safety compliant with BS EN61010.

3.2.13.2.6	Suitable for monitoring loads in the range 0 - 2000A rms.
3.2.13.2.7	Suitable for capturing transient disturbances in the range 0 – 15000A rms.

3.2.13.3. Temperature Sensor

Temperature Sensors shall be supplied as per the following:

Ref	Requirement/Characteristic
3.2.13.3.1	Suitable for installation on the outside of a distribution transformer tank / casing.
3.2.13.3.2	Accurate to +- 0.5C in the range 0 to 70 degrees C.
3.2.13.3.3	Resolution of 0.1C.
3.2.13.3.4	With a range of lead lengths and/or extensions to cater for runs to transformers located away from the PENDA and/or where an indirect route is necessary to avoid trip hazards etc.

Please indicate if the following is available as an option or separate product:

Ref	Requirement/Characteristic
3.2.13.3.5	Wireless connected Temperature Sensor with the following characteristics: • Battery powered with minimum 10 year battery life ; • Replaceable battery ; • Encrypted wireless link back to monitor ; and • Wireless function limited to serial line replacement which is demonstrably separate from all network stacks within the monitor limiting any credible attack surface to the transmitted temperature readings. (it is envisaged a receiver unit for such a device might comprise a separate unit connected to an existing analogue or 1wire input, additionally it is accepted that battery life constraints might limit the frequency of reading).
3.2.13.3.6	Any other Innovative method(s) of sensing transformer temperature where a hardwired sensor is impractical for example an infra-red thermometer (pyrometer) mounted adjacent to the monitor “looking” at a transformer over a distance of circa 3 metres.

3.2.14. Support

The supplier shall indicate which of the following support services are available:

Ref	Requirement/Characteristic
3.2.14.1	On Site Support/ Repair services.
3.2.14.2	Return to Base repair service.
3.2.14.3	Remote support covering assistance with day to day installation / operation and patching issues.
3.2.14.4	The existence of a helpdesk ticket system for logging issues.
3.2.14.5	Development services for adding / altering hardcoded functionality.

3.2.15. Compliance with Applicable Standards

In addition to specific standards mentioned elsewhere in this document, relevant parts of the following shall be complied with:

Ref	Requirement/Characteristic
3.2.15.1	Conform to Electromagnetic Compatibility Directive 2014/30/EU.
3.2.15.2	Conform to Low Voltage Directive 2014/35/EU.
3.2.15.3	Conform to Radio Equipment Directive 2014/53/EU.
	Electricity Equipment Construction Standards
3.2.15.4	Compliant with BS EN 61439-1 Low-voltage switchgear and control gear assemblies. General rules.

3.2.15.5	Compliant with BS EN 61439-5 Low-voltage switchgear and control gear assemblies. Assemblies for power distribution in public networks.
	Safety Standards
3.2.15.6	Compliant with BS EN 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements.
3.2.15.7	Compliant with BS EN 61010-2-030 Safety requirements for electrical equipment for measurement, control, and laboratory use. Particular requirements for testing and measuring circuits.
	Electromagnetic Compatibility Standards
3.2.15.8	Compliant with BE EN 61000-6-2 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
3.2.15.9	Compliant with BS EN 61000-6-4 Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.
	Radio Frequency Disturbance Standards
3.2.15.10	Compliant with BS EN 55011 Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement.
	GSMA M2M Specifications
3.2.15.11	Conform to relevant provisions of Active GSMA M2M Specifications for SIM Remote Provisioning available from GSMA (currently detailed at https://www.gsma/com/esim-m2m-specifications).

4. References

4.1. External Documentation

Reference	Title
2014/30/EU	Electromagnetic Compatibility Directive 2014/30/EU.
2014/35/EU	Low Voltage Directive 2014/35/EU.
2014/53/EU	Radio Equipment Directive 2014/53/EU.
BE EN 61000-6-2	Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
BRE-LPS 1175 SR1	Building Research Establishments Loss Prevention Standard - Intruder resistance.
BS 2782-5:Method 552A:1999, ISO 4582:1998	Methods of testing plastics. Optical and colour properties, weathering. Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or laboratory light sources.
BS EN 55011	Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement.
BS EN 60529	Degrees of protection provided by enclosures (IP code).
BS EN 60870-2-2	Telecontrol equipment and systems. Operating conditions. Environmental conditions (climatic, mechanical and other non-electrical influences).
BS EN 61000-4-30	Electromagnetic compatibility (EMC). Testing and measurement techniques. Power quality measurement methods.
BS EN 61000-6-4	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.
BS EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements.
BS EN 61010-2-030	Safety requirements for electrical equipment for measurement, control, and laboratory use. Particular requirements for testing and measuring circuits.
BS EN 61439-1	Low-voltage switchgear and control gear assemblies. General rules.
BS EN 61439-1 7.2	Low-voltage switchgear and controlgear assemblies. General rules. Section 7.2 Adverse Environments
BS EN 61439-5	Low-voltage switchgear and control gear assemblies. Assemblies for power distribution in public networks.
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).
BS EN 62351-3	Power systems management and associated information exchange. Data and communications security. Communication network and system security. Profiles including TCP/IP.
BS EN ISO 10289	Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates. Rating of test specimens and manufactured articles subjected to corrosion tests.
BS EN ISO 4628	Paints and varnishes. Evaluation of degradation of coatings. Designation of quantity and size of defects, and of intensity of uniform changes in appearance.
BS EN ISO 7253	Paints and varnishes. Determination of resistance to neutral salt spray (fog).
BS EN ISO 9227	Corrosion tests in artificial atmospheres. Salt spray tests.
IEEE 1815-2012	IEEE Standard for Electric Power Systems Communications-Distributed Network Protocol (DNP3).

4.2. Internal Documentation

Reference	Title
IMP/001/017 Appendix 1F	Standard for Application of System Monitoring.

4.3. Amendments from Previous Version

Reference	Description
3.2.2.4	Flood clause mitigation removed / renumber.
3.2.3.1	Warranty / support period updated as per previous scope of works.
3.2.3.14	Added (highlight not dependent on external network routing).
General	GPRS changed to Cellular (clarity).
General	Processor clock changed to system time (clarity).
3.2.6.10/11/12/21/22	added (guidance on format of communication that cannot be carried over DNP3).
3.2.8.1	updated to include remote SIM provision.
3.2.8.8	Added (mitigate observed difficulty when units co-located).
3.2.8.20	Added LTE CAT-M1 into options.
3.2.9.1	Elaborated that Text display may be encompassed by a separate device.
3.2.9.2	Elaborated display must be compatible with type of installation.
3.2.9.9	Added inhibit of status display where this would compromise security.
3.2.11.8	added requirement to verify data transfer at commissioning.
3.2.11.9/10	added options that would mitigate issues at the commissioning stage.
3.2.12.2	added acceptable supply voltage range.
3.2.13.2	updated at least 16bit digitisation.
3.2.13.9	Added fly lead option for designs which may have proprietary connectors.
3.2.13.11	updated (include neutral monitoring for pre fault capture).
3.2.13.12	Specified minimum number of feeders in line with current supplier practice.
3.2.13.13	Explicitly stated that values for PENDA input may be obtained by summation of outgoing way values.
3.2.13.23/4/5/6/7/8/	added clauses to support waveform capture.
3.2.13.21/22	previous neutral measuring options removed.
3.2.13.1.1	updated to include integral fuses (standard install).
3.2.13.1.2	updated to clarify nature of shrouding on generator sync terminal connection.
3.2.13.1.6/7	Added (options for alternative voltage connections).
3.2.13.2.1	

3.2.13.2.6/7 3.2.13.3.4 3.2.13.3.5/6 3.2.15.11 6.2	Updated to remove unreasonable expectation regarding rogowski coils that are not concentrically mounted. Added to clarify current coil ranges under normal and fault conditions. Added requirement for varying temp sensor lead lengths. Added option request for wireless temperature sensors. Added (GSMA Standards for remote provision of M2M SIMS). Review period harmonised with normal practice for standards section.

5. Definitions

Term	Definition
PENDA	Public Electricity Network Distribution Assembly This term is defined in BS EN 61439 and supersedes former informal descriptions such as “LV Fuse Board”, “LV Board”, ”LV Cabinet”, “Feeder Pillar”. PENDAs share the following characteristics: • used for the distribution of electrical energy in three phase systems for which the rated voltage does not exceed 1 000 V AC.; • stationary; and • suitable for use only by skilled persons. Two variants are used PENDA-I Suitable for installation indoors only in places where only skilled persons have access. PENDA-O Suitable for installation indoors or outdoors including situations that are accessible to ordinary persons.
PENDA-I	See PENDA above.
PENDA-O	See PENDA above.

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	14/07/2022

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years?	Non Standard Review Period & Reason	
No	5 years	Update will be dictated by contract renewal date or any significant changes in the specification or documents referenced
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Malcolm Grisdale	Operational Technology Architect	14/07/2022

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

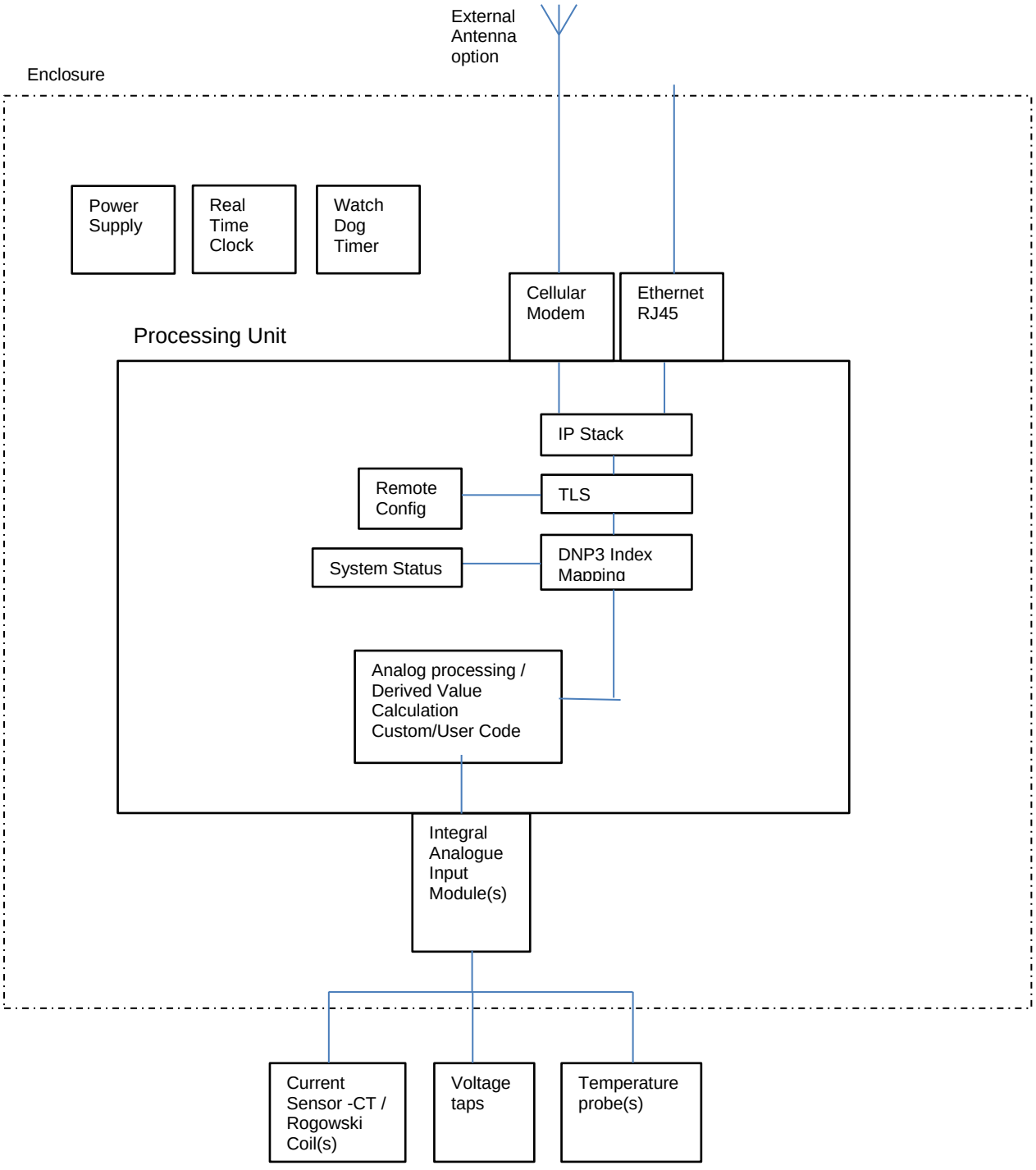
		Date
Alan MacDonald	Policy & Standards Engineer	10/06/2022
Jim Paine	Technical Policy Manager	27/06/2022

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Mark Callum	Head of Smart Grid Implementation	24/06/2022

Appendix 1 – Outline of Core System Components



Appendix 2 – SELF CERTIFICATION CONFORMANCE DECLARATION

Secondary Distribution Substation Monitoring Systems shall comply with the latest issues of the relevant national and international standards.
Additionally this technical specification amplifies and/or clarifies requirements relating to these Standards.

This self-declaration sheet identifies the clauses of the aforementioned specification and standards relevant to Secondary Distribution Substation Monitoring Systems for use on Northern Powergrid's distribution network. The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration
codes.

Conformance declaration codes
N/A = Clause is not applicable/ appropriate to the product
Cs1 = The product **conforms fully** with the requirements of this clause
Cs2 = The product **conforms partially** with the requirements of this clause
Cs3 = The product **does not conform** to the requirements of this clause
Cs4 = The product **does not currently conform** to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

Instructions for Completion

- **When Cs1 code is entered:**
  - **I. State the reference of test reports, etc. that support this declaration AND**
  - **II. A summary of the compliance.**
- **When any other code is entered: state the reference of the test report(s), etc. that support this declaration AND a summary of the reason for non-conformance.**
- **Prefix each remark with the relevant 'BS EN' 'IEC' or 'ENATS' where appropriate to indicate which specification the comment is made against.**

Manufacturer:

Product Reference:

Related ASSEMBLY type(s):

Name and position/role (block capitals):

Signature & Date:

NOTE: A separate self-declaration shall be completed for each item or variant submitted, OR the products can be grouped together and a group declaration made for each group IF every self-declaration states clearly the range of products to which it applies.

Clause	Requirement	Conformance Code	Remarks
	Environment		
3.2.1.1	Be protected against ingress to BS EN 60529 IP32 or better.		
3.2.1.2	Be protected against impact to BS EN 62262 IK08 or better.		
3.2.1.3	Ambient Temperature in the range -25°C to +55°C.		
3.2.1.4	Relative humidity between 0 – 90% non-condensing.		
3.2.1.5	In accordance with the Climatic conditions outlined in BS EN 60870-2-2.		
	Outdoor Environment		
3.2.1.6	Be protected against ingress to BS EN 60529 IP44D or better.		
3.2.1.7	Be demonstrated to be stable against UV light in accordance with BS ISO 4582.		
3.2.1.8	Be immune to polluted coastal locations as evidenced by tests to ISO 9227, 7253, 4628, 10289.		
	Additional when mounted on electricity Poles > 3.65m		
3.2.1.9	Be protected against ingress to BS EN 60529 IP45 or better.		
	Harsh condition Optional features		
3.2.1.10	Additional environmental protection to BS EN 61439-1 7.2 Special service conditions (pollution, animals etc).		
	Location		
3.2.2.1	Within an indoor a secondary distribution substation and/or similar operational building.		
3.2.2.2	Within an outdoor secondary distribution substation compound, attached to the PENDA-O unit or possibly other suitable structures.		
3.2.2.3	Within a PENDA-O or similar cabinet generally (but not always) part of an outdoor secondary distribution substation. Note: These can be particularly space constrained locations.		
	Optional Location features		
3.2.2.4	Suitable for attachment to outdoor electricity distribution poles at a height of 3.65m or above.		
	Construction		
3.2.3.1	With a warranted design lifespan of at least 5 years and a guaranteed repair / replacement period extending to at least 10 years.		

3.2.3.2	With lifespan limiting factors and/or components identified together with any mitigations. (An example might be the need to replace a real time clock battery after a specified time to guarantee accurate time stamps immediately after reboot.)		
3.2.3.3	To enable safe installation without interrupting supplies to customers.		
3.2.3.4	With all components housed in a single enclosure except for sensors, voltage sensing connectors, external antennas and wiring thereto.		
3.2.3.5	Using either separate modules or single composite circuity within the enclosure.		
3.2.3.6	Using a DIN rail topology where multiples separate modules are employed within the enclosure.		
3.2.3.7	With all wiring between modules, within the enclosure and connections to external components labelled and identified on an accompanying schematic diagram.		
3.2.3.8	Without any use of forced ventilation.		
3.2.3.9	Such that maintenance and testing of associated and/or adjacent electrical distribution equipment is not impeded.		
3.2.3.10	Such that routine physical maintenance is not required.		
3.2.3.11	With Mean Time Between Failure in years provided for all major components.		
3.2.3.12	With markings identifying compatible installation environment. (e.g. restricted to indoor use).		
3.2.3.13	So as to maintain at all times, including but not limited to conditions where access covers are removed, a minimum BS EN 60529 IP20 protection for any exposed conductive component carrying greater than 50VAC.		
3.2.3.14	Fully operable while connected via Northern Powergrid private data networks with no requirement to directly access servers on external data networks.		
	Manuals		
3.2.4.1	Manual covering Installation / commissioning.		
3.2.4.2	Manual covering configuration, including details of all available configuration options.		

3.2.4.3	Manual covering operation.		
3.2.4.4	Manual covering programming (where relevant).		
3.2.4.5	On CD and/or downloadable.		
3.2.4.6	Licensed for storage in Northern Powergrid documentation retrieval systems.		
	Enclosure		
3.2.5	Specify maximum external dimensions of the enclosure: Height (h); Width (w); and Depth(d).		
3.2.5.1	Contain all system components with the exception of sensors, voltage sensing connectors, external antennas and associated wiring.		
3.2.5.2	Have ventilation and/or temperature control arrangements compatible with the environment.		
3.2.5.3	Have durable labels permanently fixed to the outside with text and/or graphics as agreed with Northern Powergrid.		
3.2.5.4	Contain a diagram detailing the location and function of modules within the enclosure.		
3.2.5.5	Contain a permanently fixed diagram detailing location, function and, where applicable, rating of connections, jumpers, switches and protective devices (fuses and./or circuit breakers).		
3.2.5.6	Clearly indicate the presence of any heater and its rating.		
3.2.5.7	Have an Antenna feed through for connection of the external antenna providing TNC, N-Type or SMA connection to the external antenna.		
3.2.5.8	Have a completely removable access door or cover to assist access in restricted situations.		
	Additional requirements for enclosures mounted at ground level in outdoor situation		
3.2.5.9	Be certified intruder resistant to UK Building Research Establishments Loss Prevention Standard BRE-LPS 1175 SR1. (Alternative solutions offered by the manufacturer, including reference to Standards, shall be included in the tender reply).		
3.2.5.10	Provide secure cable entry enclosing all connectors and cable terminations.		

3.2.5.11	Be accessible via a hinged front door incorporating padlock facility able to accept Northern Powergrid padlocks as follows: • body of up to 63mm2; • 10mm diameter shackle; • clear inside width of 35mm; and • shackle inside length between 25mm and 45mm. The hole provided for the shackle shall not be less than 11mm diameter.		
3.2.5.12	Incorporate an access detection switch/sensor linked to the processor.		
	Optional enclosure features		
3.2.5.13	Fixing points suitable for fixing to wooden poles using either M12 or M16 galvanized coach screws.		
3.2.5.14	Space within the enclosure for additional modules where slave devices are supported (see processor and connectivity sections).		
	Processor Requirements		
3.2.6.1	Collect measurements from inputs at intervals referenced to the system time. i.e. on the hour, 10minutes past the hour 20 minutes past the hour etc for a 10 minute collection cycle.		
3.2.6.2	Store at least 28 Days of un-transmitted, processed data based on a 10 minute reporting period for all Integral Sensor Inputs and Computed Values.		
3.2.6.3	Analyse/Summarise data prior to transmission to central office system.		
3.2.6.4	Support flexible configuration of Cellular, serial and Ethernet ports to support different protocols (see preferences section for additional protocols).		
3.2.6.5	Support IP Based communication.		
3.2.6.6	Support TLS encryption compliant with BS EN 62351-3 for IP based communication.		
3.2.6.7	Implement DNP3 communication compliant to at least DNP3 Level 2 2012.		
3.2.6.8	Communicate with central systems using DNP3 slave over IP.		
3.2.6.9	Communicate with central systems using DNP3 slave over serial.		
3.2.6.10	For waveform captures only, transmit data to a central system using a published transfer protocol over an IP Based communication bearer.		

3.2.6.11	Have a configurable IP and Port of the recipient system for transfers identified in 3.2.6.10 which may be separate from the DNP3 target.		
3.2.6.12	The format of data uploaded in 3.2.6.10 above must be freely available unencumbered by any confidentiality requirement.		
3.2.6.13	Incorporate a watchdog timer capable of restarting an unresponsive system.		
3.2.6.14	Synchronise system time to DNP3 timestamps received from central systems.		
3.2.6.15	Secure local connections against unauthorised access.		
3.2.6.16	Secure remotely accessible ports against unauthorised access.		
3.2.6.17	Maintain a 28 day system log detailing as a minimum: • Start-up; • Shutdown; • restoration of power; and • error conditions.		
3.2.6.18	Provide selected system status values in a form suitable for mapping to DNP3 binaries. (this is to enable e.g. error conditions to be notified as unsolicited transmissions.		
3.2.6.19	Store data in non-volatile solid state memory or disk with no use of mechanical media.		
3.2.6.20	Be immune to corruption caused by power failures and/or brownouts.		
3.2.6.21	Ensure any additional communication required for functions such as, but not limited to, managing settings and/or firmware updates are IP based with documentation sufficient to enable integration with Northern Powergrid systems.		
3.2.6.22	Be immune to internal corruption during extended periods when communication to central systems is interrupted.		
	Optional Processor Features		
3.2.6.23	Receive data/measurement from external RTU/IED devices using. Modbus and/or DNP3.		
3.2.6.24	Receive data/measurement from external wireless devices and/or sensors.		
3.2.6.25	Communicate with local devices using DNP3 master over IP.		
3.2.6.26	Communicate with local devices using DNP3 master over serial.		

3.2.6.27	Communicate with local devices using MODBUS-RTU master (serial).		
3.2.6.28	Synchronise system time from alternative sources where DNP3 is unavailable.		
3.2.6.29	Support execution of user supplied programs and/or algorithms Note: vendors must indicate what languages and programming standards are supported.		
3.2.6.30	Support full device encryption.		
3.2.6.31	Support secure storage of encryption keys typically using secure element hardware.		
3.2.6.32	Support enforcement of signed firmware.		
	Real Time Clock Requirements		
3.2.7.1	Provide the system time with initial time when booting.		
3.2.7.2	Maintain synchronism with the system time once the processor establishes an accurate sync to an external source (DNP3).		
3.2.7.3	Continue to operate for 28 days in the absence of an external power source.		
3.2.7.4	Maintain drift of less than 2 Seconds per day in the absence of updates from the processor.		
3.2.7.5	Where primary cells are utilised to maintain the real time clock during power outages the primary cell lifespan shall be greater than 10 years.		
	Real Time Clock Optional features		
3.2.7.6	Real Time Clock Initiates Heartbeat transmissions in low power units.		
3.2.7.7	Real Time Clock can bring rest of system out of low power sleep mode.		
	Physical and Wireless connections		
3.2.8.1	A Cellular Modem having the following characteristics: • configurable to use a private APN endpoint ; • compatible with all UK public Cellular networks ; • compliant with 2G, 3G and 4G/LTE (CAT-1) standards ; • Capable of accepting GSMA SIM Specification compliant EUICC SIM cards ; • Capable of remote re-provisioning GSMA SIM Specification compliant EUICC SIM cards onto alternative cellular providers in the event of a change of contracted provider (it is		

	understood this will require the presence of Sim Toolkit and/or other software to support this process) ; and • Capable of accepting SIM cards and/or EUICC profiles supplied under Northern Powergrid contracts and fitted/tested by the vendor prior to equipment delivery.		
3.2.8.2	An external Cellular antenna option to assist in marginal coverage areas including where the unit is installed in a building and/or metal cabinet. Please indicate the maximum feeder length available to an external antenna.		
3.2.8.3	A vandal resistant external Cellular antenna to assist in areas of marginal coverage.		
3.2.8.4	RJ45 Ethernet (minimum 10BaseT).		
3.2.8.5	RS232 serial connection (configurable to support DNP3master/slave and/or MODBUS-RTU (master/slave) if available).		
3.2.8.6	Hardware flow control signals available on RS232 connections sensitive to the maintained level not just transition.		
3.2.8.7	Diagnostic/Programming interface connection.		
3.2.8.8	Mitigate against mutual interference of the cellular connection when two units are co-located (e.g. to monitor a PENDA having a large number of ways).		
	Physical and Wireless optional features		
3.2.8.9	RS485 serial connection(configurable to support DNP3master/slave and/or MODBUS-RTU master/slave).		
3.2.8.10	RS485 isolated to 1.5KV RMS / 2.1KV DC between input and all other circuits.		
3.2.8.11	Wi-Fi.		
3.2.8.12	Digital inputs (please indicate quantity level).		
3.2.8.13	Digital Counter Inputs (please indicate quantity and counter size e.g. 4 I/P 16 Bit).		
3.2.8.14	Digital outputs (please indicate quantity).		
3.2.8.15	Digital I/O isolated to 1.5KV RMS / 2.1KV DC between input/output and all other circuits.		
3.2.8.16	LPWAN (typically LORA).		

3.2.8.17	Low Power RF – typically IEE 802.15.4 for connection to wireless sensors.		
3.2.8.18	Environmental bus connectivity (typically 1 Wire for temperature / humidity transducers).		
3.2.8.19	Internal expansion bus technologies such as SPI and/or I2C (typically for addition of low power RF modules).		
3.2.8.20	Cellular connectivity using LTE CAT-M1.		
	Local Status Indication/Display		
3.2.9.1	Indicate the operational status to installation or maintenance staff in vicinity by means of LEDs and/or Text display. N.B Text display shall mean either a physical feature of the equipment or a suitably authorised and configured mobile device.		
3.2.9.2	Employ indication method compatible with install location (e.g. an integral text display is not suitable for equipment mounted at high on a pole).		
3.2.9.3	Provide visual indication of Power Present.		
3.2.9.4	Provide visual indication of System OK.		
3.2.9.5	Provide visual indication of System Requiring Attention.		
3.2.9.6	Provide visual indication of Active Communication.		
	Local Status Indication/Display – Optional features		
3.2.9.7	Provide additional status Indication via a Local Console port (may be a physical or optical connection).		
3.2.9.8	Access additional status information by means of a local keypad.		
3.2.9.9	Ability to inhibit illuminated indicators e.g. where their presence could increase chances of trespass and/or vandalism.		
	DNP3 Configuration		
3.2.10.1	Support DNP3 configuration to level 2 2012.		
3.2.10.2	Support for data value conversion between float and integer values including pre scaling of float values by 10^n.		
3.2.10.3	Support for data precision change (e.g. 64 bit float to 32 bit float).		
3.2.10.4	Support mapping of all integral and slave inputs to DNP3 indexes.		
3.2.10.5	Support setting deadband thresholds for analogue values.		
3.2.10.6	Support setting absolute thresholds for analogue values.		
3.2.10.7	Any unsolicited events are timestamped when the event occurred.		

3.2.10.8	Data sent in DNP3 format shall be demonstrated to be compatible with Nortech iHost.		
3.2.10.9	Transmit a unique monitoring unit serial number as a DNP3 string.		
3.2.10.10	Transmit the Cellular SIM serial number as a DNP3 string (where cellular modem fitted).		
3.2.10.11	Transmit the wireless network status (typically signal strength/modulation type) as DNP3 values.		
3.2.10.12	Transmit the unit status as DNP3 values (Typically normal operating or error conditions).		
3.2.10.13	Inhibit transmission of unmapped and/or unwanted inputs.		
	DNP3 Configuration – Optional feature		
3.2.10.14	Ability to retrieve the current DNP3 mapping from the processing unit in the form of a human readable XML file either by DNP3 or other suitable read only transfer mechanism.		
	Configuration and commissioning		
3.2.11.1	Facility to apply standard configurations avoiding repetitive input when multiple devices are being configured.		
3.2.11.2	Ability to undertake configuration tasks using a standard laptop PC.		
3.2.11.3	Any software necessary to configure the system shall be provided at no extra cost and freely loadable on all PCs used to support the system and operable without dongles or other restrictive license control mechanisms.		
3.2.11.4	Initial configuration by upload of a human readable configuration file or single firmware file.		
3.2.11.5	Current configuration available from the unit in the form of a downloadable, human readable file.		
3.2.11.6	Confirmation is provided when a configuration is valid and correctly loaded into the target device.		
3.2.11.7	Capability to receiving configuration / firmware remotely on IP addressable devices.		
3.2.11.8	Facility to confirm correct operation prior to leaving site, this particularly relates to verifying successful data transfer over the cellular network.		
	Configuration and commissioning – Optional features		

3.2.11.9	Capture of GPS position (e.g. from a phone app) at commissioning time to confirm install location.		
3.2.11.10	Capture of Substation Name and Feeder Way Names electronically at install time to avoid reduce transcription errors (NB this could include suitable tagged photographs including unit serial number).		
	Power Supply		
3.2.12.1	Default system supply obtained from the voltage sense input(s).		
3.2.12.2	Operate from a supply voltage ranging between 200V and 264V.		
3.2.12.3	Withstand 2 times minimal voltage for 10mS.		
3.2.12.4	Backup is required for the real time clock only.		
3.2.12.5	Any batteries included (e.g. for the Real Time Clock) must have a demonstrable life greater than 10 years taking account of temperature extremes anticipated in service.		
3.2.12.6	A means to report the current health of any batteries included in the system.		
	Integral Sensor Inputs and Computed Values		
3.2.13.1	Be adaptable to cater for differing numbers of LV feeders Supplier must specify how this is achieved e.g. • Utilising units with different fixed numbers of inputs ; • Additional expansion units ; and • Operating standard units in parallel or master slave.		
3.2.13.2	Have at least 16Bit digitisation capability.		
3.2.13.3	Maintain digitisation accuracy better than +-0.05% of full scale.		
3.2.13.4	Have inputs protected against damage from voltage and current transients caused by routine faults on the electrical network.		
3.2.13.5	Support current sense inputs compatible with 1V, 0.33V, 1A and 5A signals.		
3.2.13.6	Be configurable on an input by input basis to match connected current transformer and/or Rogowski coil ratios.		
3.2.13.7	Ensure Power measurements are signed (both Real and Reactive).		
3.2.13.8	Sample current and voltage waveforms according to BS EN 61000-4-30.		

3.2.13.9	Sensor input ports must either: • use plugs and sockets demonstrated to be available from mainstream electrical/electronic factors; or • provide a flying lead option which may be terminated with plugs sockets of Northern Powergrid's choosing.		
3.2.13.10	Measure Phase to Neutral Voltage for each PENDA busbar.		
3.2.13.11	Measure the Current on all phase and Neutral conductors of every incoming and outgoing PENDA circuit.		
3.2.13.12	Have input capacity to physically acquire phase and neutral currents from a minimum of six circuits without requiring expansion and/or additional processor units.		
3.2.13.13	Be configurable to obtain transformer current from sensors applied to the transformer circuit or by summation of outgoing feeder sensors on a per install basis. (the default should be summation of outgoing feeders).		
3.2.13.14	Measure Transformer Tank Temperature (probe attached to outside of tank).		
3.2.13.15	Continually calculate all average, values for discrete successive periods configurable to 10 or 30 minute.		
3.2.13.16	Support setting of 10 / 30 minute periods separately for the following: • Busbar voltages ; • Transformer Temperature ; and • Per PENDA incoming / outgoing circuit. e.g. a possible configuration might be • Busbar voltages calculated on 10 min time period ; • Transformer temperature calculated on 30 min time period ; • Incoming (Transformer) PENDA circuit calculated on 10 min time period ; • 1 PENDA circuit calculated on 10 min time period ; and • Remaining PENDA circuits calculated on a 30 min time period.		

3.2.13.17	Calculate average PENDA busbar AC RMS voltages.		
3.2.13.18	Calculate average phase and neutral AC RMS currents for every incoming and outgoing PENDA circuit.		
3.2.13.19	Calculate average Real Power (Watts) and direction for each phase on every incoming and outgoing PENDA circuit.		
3.2.13.20	Calculate average Reactive Power (VAr) and direction for each phase on every incoming and outgoing PENDA circuit.		
3.2.13.21	Calculate average Voltage Total Harmonic Distortion up to 10th Harmonic on PENDA busbars.		
3.2.13.22	Calculate average Current Total Harmonic Distortion up to 10th Harmonic on each phase of every PENDA circuit.		
3.2.13.23	Capture Voltage and Current waveforms in response to defined triggers as follows: • Record at least 7 cycles / per capture trigger ; • Record all phase voltages and currents and neutral current on the affected way ; • Sample rate at least 8KHz (16KHz preferred) ; and • Sample resolution to provide an A/D resolution of at least 1A over the full current range. The 7 cycle capture period must be configurable at commence at any point from 7 cycles before the trigger time to the trigger time.		
3.2.13.24	Trigger captures based on any combination of: • Exceed an absolute threshold Current ; • Exceed an absolute threshold dI/dT ; and • Exceed a voltage delta between successive waveform cycles. All triggers to be configurable and settable by the user.		
3.2.13.25	Capture current excursions in the range 0 to 15,000 amperes (0-15KA rms).		
3.2.13.26	Include the following metadata with each capture date: • The way number the capture relates to ; and • A date/time stamp of the initiating trigger to the nearest second as defined by the system time.		
3.2.13.27	Notify of all trigger events via DNP3.		

3.2.13.28	Be configurable to up-load waveform capture data to central systems on receipt of a request signal from a central system or upload on completion of capture.		
	Integral Sensor Inputs and Computed Values – Optional features		
3.2.13.29	Capability to continuously set calculation time periods beyond the 10 / 30 minutes specified above.		
	Voltage Sensing Connections		
3.2.13.1.1	Clamps, fully shrouded on non-mating surfaces, having integral fusing, suitable for connection to live PENDA busbars.		
3.2.13.1.2	Shrouded 4mm male connections suitable for live connection to generator synchronisation outputs available on recent PENDA installations. Note, Generator synchronisation outputs comprise binding posts similar to RS Stock No 645-8691 which will not accept shrouds on standard 4mm (shrouded) plugs and instead require a wide skirt or other suitable means to avoid accidental contact with the bare 4mm pin when disconnected. Generator sync connectors are usually protected with 6A HRC fuses. On occasions 16A fuses may be used e.g. when a sync terminal connection is shared with a 13A outlet.		
3.2.13.1.3	Protected with HRC fuse rated to at least Type F 50KA.		
3.2.13.1.4	Safety compliant with BS EN61010.		
3.2.13.1.5	Installation Overvoltage Rated to CAT IV 600V.		
	Voltage Sensing Connections – Optional features		
3.2.13.1.6	A fully shrouded voltage clamp solution similar to 3.2.13.1.1 which can be applied with an insulated tool in restricted spaces such as between fuseways in older transformer mounted cabinets.		
3.2.13.1.7	A fully shrouded insulation piercing connector suitable for obtaining voltage sense connections from an outgoing distribution feeder. Note that the solution must be able to be applied safely in the confined space below a fuse panel.		
	Current Sensors		
3.2.13.2.1	Accuracy to class 1 CT equivalent or Better for assuming an optimal install situation.		

3.2.13.2.2	Suitable for installation on PENDA unit feeders without interrupting supplies to customers.		
3.2.13.2.3	Where connection to existing CTs is required a suitable connection system shall be supplied.		
3.2.13.2.4	Installation Overvoltage Rated to CAT IV 600V.		
3.2.13.2.5	Safety compliant with BS EN61010.		
3.2.13.2.6	Suitable for monitoring loads in the range 0 - 2000A rms.		
3.2.13.2.7	Suitable for capturing transient disturbances in the range 0 – 15000A rms.		
	Temperature Sensor		
3.2.13.3.1	Suitable for installation on the outside of a distribution transformer tank / casing.		
3.2.13.3.2	Accurate to +- 0.5C in the range 0 to 70 degrees C.		
3.2.13.3.3	Resolution of 0.1C.		
3.2.13.3.4	With a range of lead lengths and/or extensions to cater for runs to transformers located away from the PENDA and/or where an indirect route is necessary to avoid trip hazards etc.		
	Temperature Sensor – Optional feature		
3.2.13.3.5	Wireless connected Temperature Sensor with the following characteristics: • Battery powered with minimum 10 year battery life ; • Replaceable battery ; • Encrypted wireless link back to monitor ; and • Wireless function limited to serial line replacement which is demonstrably separate from all network stacks within the monitor limiting any credible attack surface to the transmitted temperature readings. (it is envisaged a receiver unit for such a device might comprise a separate unit connected to an existing analogue or 1wire input, additionally it is accepted that battery life constraints might limit the frequency of reading).		

3.2.13.3.6	Any other Innovative method(s) of sensing transformer temperature where a hardwired sensor is impractical for example an infra-red thermometer (pyrometer) mounted adjacent to the monitor "looking" at a transformer over a distance of circa 3 metres.		
	Support		
3.2.14.1	On Site Support/ Repair services.		
3.2.14.2	Return to Base repair service.		
3.2.14.3	Remote support covering assistance with day to day installation / operation and patching issues.		
3.2.14.4	The existence of a helpdesk ticket system for logging issues.		
3.2.14.5	Development services for adding / altering hardcoded functionality.		
	Compliance with applicable Standards		
3.2.15.1	Conform to Electromagnetic Compatibility Directive 2014/30/EU.		
3.2.15.2	Conform to Low Voltage Directive 2014/35/EU.		
3.2.15.3	Conform to Radio Equipment Directive 2014/53/EU.		
3.2.15.4	Compliant with BS EN 61439-1 Low-voltage switchgear and control gear assemblies. General rules.		
3.2.15.5	Compliant with BS EN 61439-5 Low-voltage switchgear and control gear assemblies. Assemblies for power distribution in public networks.		
3.2.15.6	Compliant with BS EN 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements.		
3.2.15.7	Compliant with BS EN 61010-2-030 Safety requirements for electrical equipment for measurement, control, and laboratory use. Particular requirements for testing and measuring circuits.		
3.2.15.8	Compliant with BE EN 61000-6-2 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.		
3.2.15.9	Compliant with BS EN 61000-6-4 Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.		
3.2.15.10	Compliant with BS EN 55011 Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement.		

3.2.15.11	Conform to relevant provisions of Active GSMA M2M Specifications for SIM Remote Provisioning available from GSMA (currently detailed at https://www.gsma/com/esim-m2m-specifications).		