NPS/007/020 – Technical Specification for Enterprise Active Network Management Schemes

1. Purpose

The purpose of this document is to detail the requirements for enterprise active network management (EANM) system(s) capable of constraining output from and / or import to customers' installations connected to the Northern Powergrid (NPg) distribution system to mitigate distribution and / or transmission system constraints and / or operate the NPg distribution system efficiently.

This document supersedes the following documents, all copies of which should be withdrawn from circulation.

Document Reference	Document Title	Version	Published Date
NPS/007/020	Technical specification for the Active Network Management Schemes	2.0	March 2024

2. Scope

This document outlines requirements for a system (or systems) covering the following features:

- Application software and firmware suitable for operating on NPg supplied hardware platforms, including multi-site enterprise grade virtualised servers.
- Application software forming a resilient, fault-tolerant, and extensible capability enabling the implementation of Active Network Management within the NPg electricity distribution system.
- Inherent integration capabilities to an existing Distribution Management System (DMS), and future systems including an Advanced Distribution Management System (ADMS) and a Distributed Energy Management System (DERMS).

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

2.1 Table of Contents

3. Technical requirements

3.1 Enterprise ANM System Architecture

This section describes the capability required from the ANM system's architectural framework. The ANM system shall support the following:

3.1.1 Enterprise architecture	The simultaneous deployment of multiple discrete ANM zones / applications within a single extensible core enterprise software platform.
3.1.2 Interfaces for integration	Industry standard application interfaces (ICCP, DNP3, SOAP, REST, etc.) to enable integration with third party systems.
3.1.3 System model / modelling	Importation/extraction of network structural and scheduled data using an industry standard CIM (Common Information Model) format. agreed with NPg. Be capable of supporting an industry standard power system mode to enable real-time load flow studies to be carried out using real-time / close to real-time data from the ANM system.
3.1.4 DMS Integration	Integration with the current DMS (Distribution Management System), currently Power on Advantage, by means of an appropriate industry standard interface to: 1) Provide information to the DMS system including, but not limited to: • ANM system health statuses. • Control instructions / set point values issued to Managed Customers. • Alerts re. non-compliance of Managed Customers. • Alerts re. de-energisation of non-compliant Managed Customers. • Managed Customer's Managed Equipment that is de-energised. • Managed Customer's metering circuit breaker status. • Managed Customers' Managed Equipment circuit breaker status. • Information from Monitoring Points located at distribution system constraint points that requiring management / being managed by the ANM system. • Monitoring Point analogues • Equipment at ANM Monitoring Points in/out of service. • That required for constraint reporting for internal, customer and regulatory reporting. 2) Accept control commands, analogue and status data from the DMS system, including but not limited to: • Distribution system related SCADA data. • Distribution system circuit breaker and switch statuses. • Those required when operating in SCADA control mode. • Trip reset signal generated via the DMS. 3) Share analogue and status values between the ANM and DMS systems including:

	• Enabling analogue and status values acquired directly from ANM to be made available to / displayed by the DMS system. • Analogue and status values in the DMS system to be made available to individual ANM applications.
3.1.5 Customer management controller connectivity and monitoring device connectivity	Being capable of interfacing directly with a Local ANM Controller that is deployed to control a customer's import from and / or export to the distribution system and Monitoring Points that are monitoring power system parameters on the distribution system via an appropriate protocol (IP bearers will be provided by NPg utilising LTE cellular and/or dedicated circuits)
3.1.6 Historian integration	Being capable of exporting historical operational data to historian applications such as Plant Information (PI) at a specified frequency for historian data recording purposes. Such data transfer may be directly a historian application or indirectly via DMS.

Please indicate if the following is available as part of the standard offer or is available as an option:

3.1.7 Measurements / status information from an external source	Being able to: • accept measurements / status information from distribution system equipment via an external system, such as iHost. • accept measurements / status information from an NGESO system to enable the ANM system to manage constraints at a Grid Supply Point (GSP).
3.1.8 Open software standards / interoperability	Being capable of supporting plug-ins and microservices from other products or service providers (e.g., plugins for forecasting).

3.2 Enterprise ANM System Hardware Environment(s)

The ANM system shall be suitable to be operated on hardware provided by NPg. Two sets of hardware will be installed in separate locations within the NPg geographic area and the ANM system should operate in a seamless instant failover mode in the event of failure of one of those sets of hardware. A third set of hardware, potentially installed at a third location, will be installed to act as a witness server.

In addition to the hardware above, there will be:

- Monitoring Point hardware installed at strategic locations on the distribution system; and
- Local ANM Controllers, which are controllers installed on the distribution system at Managed Customer's sites. These receive and pass on instructions received from the Central ANM Controller. They monitor the Managed Customer's responses to control instructions / set-point values and react appropriately to any deviation from an acceptable Managed Customer's response. A Local ANM Controller is likely to include the functionality of a Monitoring Point.

The ANM system shall be capable of the following: -

3.2.1 Central ANM system capability	Operating in a fully redundant multi-site configuration and achieving "Hot/Hot" or "instant failover" capable redundancy with the ability to support the "hot swappable" replacement of components for maintenance purposes without interrupting continuity of the ANM service.

3.2.2	Back up	Supporting backup to offline media (e.g., tape library) for disaster recovery purposes without interruption to the ANM service.
3.2.3	Server hardware	Operating on hardware provided by NPg which is either: • Virtualised VMware based servers on at least two locations with a third server available for a witness server; or • Used by the existing DMS system
3.2.4	Grid Edge Processing	Where required for responsiveness and/or local resilience, providing and supporting any additional logic suitable for execution on remote RTU devices using IEC-61131 compliant coding. (An example of such functionality might include local intervention to issue a lower setpoint in the event of communication failure with the Central ANM Controller).

3.3 Distribution System Observation and Control Requirements

The ANM system shall be able to monitor and control power flows and voltages simultaneously at multiple locations on the distribution system to ensure that it always functions within its operating parameters. The ANM system shall be capable of the following:

3.3.1	Distribution system power flows	The ANM system shall use real-time measured distribution system power flows and voltage at specific distribution system measurement points to establish Managed Customer control instructions / set points and subsequently send such control instructions / set points to relevant Managed Customers. The ANM system shall use real-time measured distribution system power flows and voltage at specific measurement points to establish control instructions for NPg assets and subsequently send control instructions to relevant NPg assets. Suitable Local ANM Controller and Monitoring Point hardware will be provided by NPg at all relevant measurement locations and Managed Customer sites.
3.3.2	Management against distribution system limits	Creating control instructions / set points that can be issued to Managed Customers to manage power flows and voltage at specific Monitoring Points and other points (for example where a Monitoring Point cannot be deployed, and a proxy Monitoring Point is required) in the distribution system against pre-determined, pre-determined seasonal or dynamic system limits. These limits, and the ability to vary them, should be as follows: • Pre-determined distribution system limits: The ANM system shall be capable of issuing control instructions / set points to Managed Customers to ensure that the pre-determined limits are

	• not exceeded. The ANM system shall provide authorised users with the ability to modify the pre-determined limits. • Seasonal distribution system limits: The ANM system shall be capable of issuing control instructions / set points to Managed Customers to ensure that the pre-determined seasonal limits for different asset types (including, but not limited to, overhead lines, underground cables, and transformers) are not exceeded. The ANM system shall provide authorised users with the ability to modify the pre-determined seasonal limits. • Dynamic network limits: The ANM system shall include functionality to automatically modify the system limits based upon receipt of a signal from an authorised NPg system that established asset ratings in close to real time. (e.g., a dynamic overhead line ratings system). • Creating control instructions / set points that can be issued to NPg assets to manage power flows and voltage at specific measurement points and other network points against pre-determined, pre-determined seasonal or dynamic system limits, as above.
3.3.3 Directional power flow	Taking account of the direction of real and reactive power flow at Monitoring Points when establishing control instruction / set points.
3.3.4 Management of import-driven and export-driven constraints	Managing both import-driven and export-driven constraints.
3.3.5 Management of voltage constraints	Managing voltage constraint including high voltage, low voltage, and voltage step change.
3.3.6 Monitoring Point status	Allowing measurement equipment at Monitoring Points to be set to be either 'In Service' or 'Out of Service' by the Central ANM Controller. • 'In Service' Monitoring Point: the ANM system shall manage the Managed Customer associated with the Monitoring Point according to the ANM Local Controller associated with that Managed Customer. • 'Out of Service' Monitoring Point: the ANM system shall establish and issue a fail-safe control instruction / set point to the Managed Customer associated with the Monitoring Point.
3.3.7 Operating regime	Having a minimum of two operating profiles including, but not limited to, those listed below, which define how the Local ANM Controllers are controlled: • Operating regime 1: ('Standard Operation'): the ANM system's Central controller shall be able to set a Local ANM Controller to be 'In Service'. In this operating regime, the ANM system, via the Local ANM Controller, shall send control instructions / set points to the Managed Customer and manage the implementation of those instructions by the customer such that the distribution system operates within pre-determined limits at the pre- determined Monitoring Points. • Operating regime 2 ('Out of Service'): the ANM system's coordinating controller shall be able to set a Local ANM Controller to be 'Out of Service'.

		In this operating regime, the Local ANM Controller shall issue a control instruction / set point to the Managed Customer to implement a pre-determined import and / or export limit.
3.3.8	Management of Managed Customers – constraint handling	Minimising the constraints imposed on Managed Customers by implementing control instructions / set points to achieve the following objectives: 1. No customers shall be constrained if there is no issue at the relevant Monitoring Point(s). 2. At any point in time, unused access capacity of one Managed Customer should be made available to other Managed Customers in accordance with the Principles of Access. 3. Where there is a need to implement constraints, the ANM system shall issue control instructions / set points to one or more Managed Customers according to the Principles of Access. This would manage the export or import of Managed Customers as appropriate. Where a Managed Customer fails to respond to a control instruction / set point instructing them to reduce their import / export in the pre-determined timescale, the Local ANM Controller shall issue a non-compliance set point (e.g., zero) to the Managed Customer. Where a Managed Customer fails to respond to a non-compliance set point in the pre-determined timescale, the Local ANM Controller shall trip either i) the Managed Customer's Managed Equipment circuit breaker, or ii) the NPg metering circuit breaker(s) supplying the Managed Customer's installation in accordance with the Connection Agreement. Where a Managed Customer Managed Equipment is required to trip, but fails to respond in a pre-determined timescale, the Local ANM Controller shall trip the NPg metering circuit breaker(s) supplying the Managed Customer's installation. Where a Managed Customer's Managed Equipment circuit breaker has been tripped, the ANM system shall have the capability to receive a reset signal generated by the NPg Control Engineer via the DMS. On receipt of this signal the Managed Customer will be able to close the circuit breaker controlling the Managed Equipment (assuming that the NPg metering circuit breaker(s) supplying the Managed Customer's installation is closed) thus allowing the ANM system to issue a control instruction / set point such that the Managed Customer can recommence import or export.
3.3.9	Configurable upper and lower thresholds	Allowing the configuration of bespoke upper and lower limit, triggering user-defined actions once measurement parameter at a Monitoring Point (such as power flow or voltage) cross the limit.
3.3.10	Management of non-compliance	Monitoring and responding to a Managed Customer non-compliance with a control instruction / set point in accordance with the procedure set out in 3.3.8.
3.3.11	Management of de-energised Managed Customers	Monitoring of Managed Customer's de-energised Managed Equipment (e.g. for maintenance, in response to a Loss of Mains protection signal, or as a result of non-compliance with a control instruction /set point in accordance with 3.3.8) such that the ANM system does not attempt to issue a control instruction / set point to that customer.

3.3.12 Re-energisation of Managed Customers	Re-energisation of a Managed Customer's equipment to the distribution system following a Smart Trip or Global Trip issued by the ANM system via the Local ANM Controller. This is when the Managed Customer's Managed Equipment has been de-energised in accordance with the requirements of 3.4.8 and following further calculations and /or remedial actions when the ANM system determines the risk has passed. The Local ANM Controller shall not re-energise a Managed Customer before a reset through SCADA when: • Tripping of the NPg metering circuit breaker(s) supplying the Managed Customer's installation has been the method of de-energisation due to non-compliance escalation. • The customer was de-energised by any other non ANM related means.
3.3.13 Time stamping	Having a self-contained facility to synchronise with all Local ANM Controllers and Monitoring Point hardware. A facility shall be provided to derive a definitive time, e.g., a GPS clock, and shall also provide the facility to accept a definitive time from an external source e.g., master station protocol. All control instructions / set points, analogue data, status indications, alerts and any other messages shall be time-stamped to the nearest tenth of a second. The time stamping regime shall co-ordinate with that in DMS i.e. the Local ANM Controller time stamp shall be in GMT, and the User interface timestamps shall be in local time (i.e., GMT or BST according to the time of year, such changes to be automatic within the ANM system). The part of the ANM system where any conversion takes place and the timestamping arrangements at the interface with DMS shall be agreed with NPg.
3.3.14 Operational Code OC6	The ANM system shall integrate with a DMS initiated Grid Code Operational Code 6 (OC6) Demand Control instruction (which may be for voltage control and / or demand disconnection) such that the effect of the OC6 instruction is not undermined. The objective of OC6 is to permit a reduction in demand in the event of an incident affecting the national electricity transmission system. The arrangements to achieve this shall be discussed and agreed with NPg. Where such functionality doesn't from part of the functionality of a bidder's / vendor's system, the bidder / vendor shall commit to developing such functionality as part of the ANM system development.
3.3.15 Local Joint Restoration Co-ordination	The ANM system facilitate the operation of a Local Joint Restoration Plan, e.g. by providing the control engineer with the facilities to control or disable the operation of the ANM system in the event of a total shutdown of the transmission system.

3.4 Control of Managed Customers

The ANM system shall be able to manage import-based Managed Customers, export-based Managed Customers and Managed Customers, such as those with electricity storage, that both import and export. The power import/export from these Managed Customers shall be managed to ensure that the distribution system operate within its limits at all times. The ANM system shall be capable of the following:

3.4.1	ANM algorithm standardisation	Having its functionality provided by a set of standard algorithms that can be applied to manage any part of the distribution system without the development of proprietary solutions for application to different parts of the distribution system. This must be demonstrated from reference projects. The ANM algorithm shall be configurable (i.e., rules governing the operation of the algorithm should be capable of being amended by authorised users) such that future requirements of the ANM system can be implemented easily.
3.4.2	Types of technology and types of Managed Customer	Having the ability to seamlessly integrate, control and minimise the constraints of Managed Customers irrespective the technology type and size of their Managed Equipment (including electricity storage system) and host multiple Local ANM controllers at different points on the distribution system i.e., manage multiple distribution system constraints and multiple ANM Managed Customers at multiple locations.
3.4.3	Set point	Supporting, for each Managed Customer (or Managed Equipment), a single export set point for export, a single import set point for import and both export and import set-point for bi-directional devices such as electricity storage systems. The ANM system must determine which participating Managed Customers are relevant to solving any distribution system constraint and calculate the required set point response.
3.4.4	Operating mode	Supporting the operation of Managed Customers in two different modes of operation: • ANM control, and • SCADA control (i.e., telecontrol via DMS). In this control mode a Control Engineer shall be able to provide a control instruction / set point to one or more Managed Customers. In this case the ANM system shall continue to manage the remaining Managed Customers according to the Principles of Access.
3.4.5	ANM control actions	Performing three types of control actions: • Managing active and or reactive power import / export of Managed Customers and /or Managed Equipment via control instructions / set-point. • De-energising Managed Customers and / or Managed Equipment from the distribution system. • Re-energising Managed Customers and / or Managed Equipment to the distribution system.
3.4.6	Principles of Access	Aggregating and controlling a group(s) of Managed Customers based upon agreed Principles of Access (PoA) within an ANM constraint management zone. • Priority The Local ANM Controller shall issue control instructions / set points to Managed Customers in a pre- defined priority order using, for example, a principle such as 'Last-In First-Out' (LIFO). • Effectiveness Principle of Access The Local ANM Controller shall issue control instructions / set points to Managed Customers in a way that defines a priority order based on the effectiveness of individual Managed Customers to manage a distribution system issue at a Monitoring Point.

	• Shared Principle of Access or Pro Rata The Central Controller shall apply constraints across all the Managed Customers associated with the Monitoring Point in a shared pro rata manner reflecting the real time import / export from the Managed Customer(s). • Dynamic Principle of Access or dynamic priority stack. The ANM controller shall allow dynamic principles of access, where the Managed Customer priority order can be adapted. (This is of relevance in cases such as where Access-SCR curtailment compensation is relevant, and where repositioning of a Managed Customer in the priority stack may be required as part of flexibility service dispatch.)
3.4.7 Distribution system measurement	Detecting distribution power flow and /or voltage at each Monitoring Point. The ANM system shall be capable of monitoring multiple Monitoring Points.
3.4.8 Distribution system measurement- based control	The ANM system shall measures network parameters (e.g. current and / or voltage) at each Monitoring Point and implement the following escalating actions to reduce the measured value at a Monitoring Point when the measured value breaches a configurable threshold. • Trim (ANM Stage 1). • Smart Trip (ANM Stage 2). • Global Trip (ANM Stage 3). The stages are described as a), b) and c) below. Once the measured value drops below a threshold (release threshold) that violates no network condition, the ANM releases the Managed Customer in accordance with d). a) Trim (ANM stage 1) When the measured value exceeds the Trim Threshold, the ANM system shall start a (configurable) Trim Observation Timer; when the Trim Observation Timer expires and the measured value is above the Trim Threshold, the ANM constraint management algorithm calculates the required change in the Managed Customer's import / export and issues a control instruction / set point to the Managed Customer(s) in accordance with the merit order, to bring the measured value below the Trim Threshold. b) Smart Trip (ANM stage 2) The Smart Trip Threshold is for a violation higher than the Trim Threshold, therefore is a Stage 2 escalation. When the measured value exceeds the Smart Trip Threshold, the ANM system shall start a (configurable) Smart Trip Observation Timer; when the Smart Trip Observation Timer expires and if the measured value is above the Smart Trip Threshold, the ANM system issues trip instructions to trip instructions to trip the circuit breaker controlling the Managed Customers Managed Equipment in accordance with the Principle of Access (e.g. in accordance with a LIFO stack), to bring the measured value below the Trim Threshold, constraint management algorithm repeats the stage if the measured value is above the Smart Trip Threshold. When the measured value falls below the Smart Trip Threshold and above the Trim Threshold the ANM implements Stage 1 as above.

		c) Global trip (ANM stage 3) The Global Trip Threshold is for violations higher than the Smart Trip Threshold, therefore is a Stage 3 escalation. When the measured value exceeds the Global Trip Threshold, the ANM system shall start a configurable Global Trip Observation Timer. When the Global Trip Observation Timer expires and if the measured value is above the Global Trip Threshold, the ANM system issues trip instructions to trip the circuit breakers controlling all the Managed Customers Managed Equipment associated with the Monitoring Point concurrently. d) Release Operation The Release Threshold is lower than the Trim Threshold therefore no escalation is required and the restrictions on the Managed Customers are eased. If the measured value is below the Release Threshold, the ANM system shall facilitate the re-energisation of de-energised managed plant in accordance with 3.3.12 before calculating new control instructions / set points to be issued the relevant Managed Customer. Each Managed Customer should have a maximum ramp rate associated with the control instructions / set points where required to avoid any voltage step change violations.
3.4.9	Escalating actions due to non-compliance	Managing Managed Customer(s) non-compliance with control instructions / set points through a staged approach of escalating action designed to avoid tripping the metering circuit breaker of the Managed Customer's site unless absolutely necessary: • Escalating actions non-compliance (stage 1) If the Managed Customer import / export exceeds a configurable level over a configurable period, the Local ANM Controller shall issue a non-compliance set point (e.g., zero) to the Managed Customer. • Escalating actions non-compliance (stage 2) If the Managed Customer does not respond appropriately to the new non-compliance set-point issued in response to a stage 1 escalation within a configurable period, the Local ANM Controller shall trip either i) the Managed Customer's Managed Equipment circuit breaker, or ii) the NPg metering circuit breaker(s) supplying the Managed Customer's installation. in accordance with the Connection Agreement. Where a Managed Customer Managed Equipment circuit breaker is required to trip, but fails to respond in a pre-determined timescale, the Local ANM Controller shall trip the NPg metering circuit breaker(s) supplying the Managed Customer's installation.
3.4.10	Safe operation of the distribution system	Ensuring the distribution system is operating within pre-defined thresholds by monitoring the power flows and voltage in real-time at Monitoring Points and calculating the control instructions / set points of multiple Managed Customers.

3.4.11 Set point	Calculating control instructions / set points to be issued to Managed Customers by considering factors such as whether Managed equipment is energized, MW ramp rates, and the Principle of Access (e.g., LIFO stack) where required. The ANM system algorithm shall constrain all available Managed Customers in accordance with the agreed Principles of Access and provide control instructions / set points to the Managed Customer(s) in real time, to ensure that the distribution system operates within the limits / thresholds configured within the ANM system. The control instructions / set points generated shall adhere to the MW ramp rates defined for each Managed Customer to prevent voltage step changes violations. The control instructions / set-points shall be updated in real time, such that if a Managed Customer is not utilising their full set-point, this is reallocated to other Managed Customer(s) in the priority stack.
3.4.12 ANM System start up	Issuing, on initial ANM system start-up, zero set-points (or minimum set-points) to Managed Customers and then releasing import / export capacity in a controlled manner by issuing control instructions / set points so as to minimise the impact on the distribution system and other customers.

3.5 Constraint Management Algorithm/Application

The ANM system shall be capable of the following:

3.5.1	Constraint management application	The constraint management application shall include features which allow the following capability: • Real-time detection of distribution system operational topology changes and automatic update the topology in the ANM system to reflect this. • Monitoring of distribution system status and management of distribution system constraints in real time to calculate required control instruction(s) / set-point(s) to be issued to Managed Customers to ensure that the distribution system operates within the thresholds configured within the ANM system. • Management of thermal and voltage constraints using active power (MW) and reactive power (MVAr) via the control of Managed Customers in real-time and the allocation of distribution system capacity to the Managed Customers within the ANM constraint management zone based on the agreed Principles of Access. • The use of dynamic distribution system assets ratings for constrained locations that will automatically adjust the asset ratings at constrained locations to take account of, for example, pre and post event limits, dynamic overhead line rating systems, and seasonal changes etc. • The use of on-line ANM system configuration changes and system upgrades without interrupting the ANM service.
3.5.2	Measurement of distribution system power flow	The AMN system shall be able to measure power flows on the distribution system at each Measurement Point to establish the required control instructions / set points and manage in real-time the active and / or reactive power imported by / exported from a group of Managed Customers to ensure that the distribution system operates within the limits / thresholds configured within the ANM system.
3.5.3	Management of multiple Managed Customers	An ANM constraint management zone managed by the ANM system shall be able to manage any combination of up to 50 Managed Customers and up to 50 Monitoring Points on the distribution system, where any of these Managed Customers may affect any of the Monitoring Points on the distribution system. Any constraint Monitoring Points on the distribution system may be affected by multiple Managed Customers. This many-to-many mapping may change in real time as the topology of the distribution system change e.g. via Control Engineer switching.

3.5.4	Management of multiple constraints in different distribution system operational topologies	The ANM system shall be able to manage any combination of distribution system constraints, and operate effectively when the distribution system is either intact or in outage conditions, and manage several distribution system outages concurrently that may affect Monitoring Point, whether in series or in parallel (for example, there may be an outage on a 132/66kV transformer at a bulk supply point and also on one leg of a 66kV ring supplied by that bulk supply point; or there may be outages each affecting two 66kV transformer-feeders from a bulk supply point supplying different 66/11kV substations).
3.5.5	Adapt to changes in system conditions and apply different distribution system asset ratings	The ANM system shall be able to adapt to a change in distribution system conditions that require application of different asset ratings as result of a planned or unplanned outages (e.g. loss of a circuit or a transformer). In either case, the ANM algorithm must be able to adapt accordingly (where different distribution system asset ratings may apply depending on the nature of the outage) such that it can continue operating and Managed Customers are not adversely affected.
3.5.6	Detection of distribution system outage	The ANM system shall be able to interpret system abnormal running conditions through: • Distribution system circuit breaker and switch statuses provided from DMS. • A power flow (or lack of) derived from a Monitoring Point, where appropriate.
3.5.7	Inputs and outputs	The ANM system shall accept the following inputs from Local ANM Controllers and Monitoring Point hardware compliant with this specification via an appropriate communications protocol (such as DNP3.0): • Either amps or MW/MVAr (to be determined by NPg, which may differ between Managed Customer sites within the same scheme); and • Amps for all monitored power flows (Monitoring Points). • Voltage where appropriate. • Real time thermal ratings in either amps or MW/MVAr (to be determined by NPg) for use in the calculation of control instructions / set points.
3.5.8	Observe a Principle of Access	The ANM system shall ensure that the control instruction / set points i.e., maximum permitted import / export, issued to Managed Customers reflects the Principles of Access configurable by the user, where: • Multiple Managed Customer sites may have the same priority according to the Principle of Access, and so shall be constrained to the same extent. • Individual Managed Customer sites may have tranches of import and/ or export capacity with different priority according to the Principle of Access, and so shall be constrained to different extent. • Constraints shall be imposed / released strictly in accordance with the Principle of Access.

	The Managed Customer site with the lowest priority according to the Principle of Access shall be constrained maximumly before a constraint is applied to the next Managed Customer's site priority according to the Principle of Access and any escalation actions shall be initiated where required.
3.5.9 Dead band	The ANM system shall provide a user-configurable means of avoiding high numbers of low magnitude set-point changes, to control oscillations (e.g. a generator is curtailed then released in a constant cycle) such as the application of dead bands, hysteresis or smoothing.

3.6 User Interface Requirements

The ANM system shall provide a graphical user interface (GUI) with the following requirements:

3.6.1 ANM dashboard	The capability to act as an ANM software web interface that allows the user to: • View a live diagram which presents real-time operational data. • Extract all data from the system log, assisted by some basic reporting tool. • Change all user configurable settings on the system where appropriate. • Monitor the performance of the application, database, operating on the system.
3.6.2 User management	The capability to allow the ANM system to control access to the GUI via user accounts with different access rights (viewer, controller, and administrator), including the following: • Viewer: a user with viewer access shall have access to ANM displays but shall be unable to execute any control actions (i.e., read only). • Controller: a user with controller access shall have access to view and operate the ANM controller. • Administrator: a user with administrator access shall have access to change ANM controller configuration values and edit user accounts.

3.6.3	User Interface for Control Engineer	The capability to allow the ANM system to be able to interact with the DMS/ADMS to provide ANM visibility in the DMS/ADMS user interface to Control Engineers. The user interface for control engineers shall allow authorised users to view, and potentially edit, the following information: • ANM dashboard (within DMS/ADMS). • Web view ANM dashboard. • ANM controller operating modes. • Monitoring Point service statuses. • Managed Customer control instruction / set point issued by control engineers when operating in SCADA control mode. • Managed Customer power output, circuit breaker status and communication status (read only). • Monitoring Point current / power flows and direction and communication status (read only). • Monitoring Point thresholds. • Active constraints and associated control actions • Escalation actions due to non-compliance. • The ANM interface with DMS/ADMS should provide an alarm system for any equipment failure and communication failures indicating the type and location of the fault.
3.6.4	Interface for Viewing Historic Data	The capability for the ANM controller to utilise a GUI that allows authorised users to view historic data relating to the ANM system's operations.

3.7 Cybersecurity

The ANM system shall be designed in accordance with industry good practice, considering the recommendations of the Centre for the Protection of National Infrastructure's ICS Systems Security Good Practice Guide as a framework to the design of security, NIST 800-82 ICS Security Guideline, Information technology – Security techniques – Information security management systems, ISO/IEC 27001 and its family of standards , IEC62443, and Northern Powergrid's Code of Practice for IS Security (ITS/100/001).

Cybersecurity security requirements are laid out by Northern Powergrid's parent Berkshire Hathaway Energy, and compliance with these requirements will be verified through a security requirements questionnaire issued separately as part of any procurement process. The details will be those specified on the date the questionnaire is issued and can be expected to include requirements such as maintaining security controls in accordance with the requirements of ISO/IEC 27001, maintaining specified levels of encryption and authentication.

The following shall be provided as a minimum:

3.7.1	Protection against cyber attacks	Compliance with all applicable sections of the Berkshire Hathaway Energy security requirements questionnaire.

3.8 Application User Security

To manage application user security the ANM system shall:

3.8.1	Application user security	• Support the recording of all user actions in a secure audit log. • Restrict system access to authorised users only. • Warn on invalid inputs. • Lock user accounts on multiple failed logins. Provide access to users via role-based access rights. • Support the principle of 'least privilege'.

3.9 Fail Safe Requirements.

The ANM system shall be capable of carrying out a health check and ensure fail safe operation for loss of communications and / or non-topical measurements. The ANM system shall be capable of the following:

3.9.1	ANM system health check	Carrying out a full internal health check periodically or on an ad hoc basis, both locally and remotely, and provide necessary alarms highlighting the location of any failures (if any encountered) and the type of equipment involved.
3.9.2	Heartbeat	Issuing a positive indication of its effective operation (for example, by sending and verifying receipt of a control instruction / set-point for every controlled site, regardless of whether that control instruction / set-point has changed) to each Local ANM Controller on a user-configurable cycle. If any Local ANM Controller does not receive such a control instruction / set point for a separately user configurable
		period, then that Local ANM Controller shall issue a user-configurable fail-safe control instruction / set-point (including, but not necessarily confined to, zero) to its associated local site(s).
3.9.3	Fail-safe to several types of failure	Defaulting to a fail-safe mode in the event of any failure scenarios by identifying and managing failures including: • Component failures (e.g., in the Central ANM Controller, in a Local ANM Controller, Monitoring Point or in transducers etc.). • Communication failures. • Measurement failures, non-topical and stale data (where applicable).
3.9.4	Communication failures or failures to respond	Managing communications by implementing a fail-safe response for failures or failures to respond for each of these interfaces, as follows: • ANM – DMS/ADMS. • Central ANM Controller – Local ANM Controller. • Local ANM Controller – Managed Customer's measurements. • Local ANM Controller – Managed Customer's Managed Equipment control system. • Local ANM Controller – Managed Customer's Managed Equipment circuit breaker.

3.9.5	Fail-safe in the event of stale or non-topical data	Checking the frequency of data changes and, in the event of stale data, implementing a fail-safe response. The system shall maintain normal operation for all circuits and sites unaffected by stale analogues. The ANM system shall utilise the user-configurable upper and lower thresholds for each Monitoring Point. Any measured values outside this range shall be treated as non-topical, and the system shall respond by implementing a fail-safe response
3.9.6	Critical constraint measurement goes non-topical	Having the capability for the Central ANM Controller to issue a fail-safe control instruction / set point to all Managed Customer sites relevant to a Monitoring Point (in the current network configuration) if the real time measured data at the constraint Measurement Point is stale or non-topical.
3.9.7	Managed Customer site's import / export becomes non-topical	Acting as follows: If any Managed Customer site's import / export becomes non-topical, the Local ANM Controller shall; • Issue a fail-safe limit to the Managed Customer's; and • Assume that such Managed Customer's Managed Equipment can no longer be controlled. The Central ANM Controller shall; • Skip to the next Managed Customer In accordance with the Principle of Access where constraints are required.
3.9.8	Restoration of communications.	Acting as follows: Upon restoration of communications links, the Central ANM Controller shall resynchronise the relevant data links and return the Managed Customer to ANM control without user intervention.

3.10 ANM Testing

This section describes NPg's requirements regarding the testing of the ANM system and the provision of the capability to simulate real distribution system operation and feed it into an off-line representative copy of the core enterprise ANM system for testing purposes. The following shall be provided as a minimum:

3.10.1 ANM algorithm	Standard algorithms shall be capable of being tested by NPg, and their functionality must be demonstrated in different distribution system configurations.
3.10.2 ANM testing mode	The Central ANM Controller shall operate under different simulated distribution system running arrangements, with different real and reactive power flows conditions and different generation/ demand levels, which are impossible to simulate on a live distribution system, the vendor must provide a network simulator with the capability to simulate real distribution system operation and feed it into an off-line representative copy of the ANM system for testing purposes.
3.10.3 Network simulator	The network simulator shall support the ability to: • Vary the distribution system running arrangements such that circuit breakers/switches can be operated during the testing of the ANM system and the operation of the ANM system can be observed and monitored. • Change generation and demand on the network during the testing of the system such that the operation of the ANM system in such circumstances can be observed and monitored.

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

3.10.4 Emulator	The vendor shall provide a system emulator that can accept historical data from our DMS/ADMS (in an agreed format) that can then be replayed through the ANM system for testing purposes. This should test the data path from the DMS/ADMS via the (A)DMS-ANM communications link through to the ANM applications.

3.11 ANM System Reporting

The ANM system shall be capable of logging distribution system conditions and generating required curtailment reports for regulatory requirements (such as those laid down in the Access Significant Code Review (Access SCR)) and curtailment analyses to meet DSO requirements. The ANM system shall be capable of the following:

3.11.1 Reporting functionality	Providing information for curtailable connections on a periodic basis (e.g., monthly reports), detailing the volume of distribution system curtailment / constraint experienced by each Managed Customer. A sample report detailing the required reporting information is given in Appendix 2. These reports should be compliant with Access SCR requirements.
3.11.2 Logging Managed Customer curtailment against the Curtailment Limit	Measuring the level of curtailment that is experienced by a Managed Customer and compare it to their curtailment limit in the case of a Curtailable Connection or in the case of a Flexible Connection any other constraint level.
3.11.3 Curtailment trigger logging	Logging the source of curtailment / constraint noting for example, the distinction between curtailment / constraint that is triggered by distribution constraints, transmission constraints, fail-safe actions, or manual operator control actions.

3.11.4 Constraint identifier	Identifying the asset (i.e., power transformer, overhead line, underground cable) that is causing a network constraint on each occasion when the ANM system actively managed a Monitoring Point.

3.12 Event and Data Logging

The ANM system should be capable of logging different events and generating alarms to different users as required and keeping a log of the alarms for a configurable period. The ANM system shall be capable of the following:

3.12.1 Event conditions	Generating an event log under failure conditions including: • Failure of customer's equipment at a Managed Customer's site. • Failure to retrieve information from a Managed Customer. • Failure to retrieve information from a Monitoring Point. • Failure of connection from the DMS/ADMS to the Central ANM Controller. • Failure of communications from the Central ANM Controller to a Local ANM Controller. • Failure of communications from the Central ANM Controller to a Monitoring Point. • Monitoring Point failure. • Local ANM Controller failure. • Managed Customer non-compliance to control instructions, including events associated with escalation. • Managed Equipment CB trip. • Managed Customer's Managed Equipment out of service.
3.12.2 Data historian	Saving all system data (i.e., received data, calculated values, control instructions / set points) and actions in a local data historian in a timestamped manner. This data shall be stored for at least three years and be accessible to authorised users.
3.12.3 Event interface	Sending all event conditions and alarms to relevant support systems, ANM management consoles, and other parties as nominated by NPg.
3.12.4 CIM integration	Demonstrating a roadmap for the delivery of Common Information Model based integration between NPg's power system design tools (i.e., DigSILENT's PowerFactory) and ANM, to better support distribution system model management by the ANM system.

3.13 Non-functional Requirements

The following are not the core functional requirements of the ANM system but must be met to make the system robust and resilient.

3.13.1 Scalability	The ANM Central controller shall be scalable, allowing streamlined addition of Monitoring Points and Managed Customers (up to hundreds of each) without significant reconfiguration of control logic or impact on performance.

3.13.2Resilience	The ANM system shall support a capability that allows a hot-standby Central ANM Controller to be seamlessly promoted to becoming the main controller without disruption to ANM operation
3.13.3 Maximum latency	The ANM system shall issue instructions to relevant Managed Customers within one second of the receipt at the Central ANM Controller of the relevant data.
3.13.4 Disaster recovery	The ANM system shall be capable of supporting fail-over to a disaster recovery system.
3.13.5 Backups	The ANM system shall be capable of supporting regular backups of the ANM system's full technical configuration such that the full ANM system can be fully rebuilt within 24 hours of suitable hardware being made available.
3.13.6 Database backups.	The ANM system shall be capable of supporting the deployment of a database replication product that, in the event of a database failure, limits data loss to only the period between the database failure and the time of the last incremental backup.

3.14 Future Requirements – DSO Functionality

The ANM environment shall be capable of further development to provide DSO functionality. These requirements are not needed as an immediate capability, but the vender should be able to fulfil them in future as required.

Please indicate if the following are available as standard or as an option:

3.14.1 ANM Platform	The ANM system shall be able to be integrated with other DERMS functionalities and capable of combining grid, commercial and market optimisation platforms with real-time control to provide MW dispatch services as per the ESO and NPg's new flexibility market mechanisms.
3.14.2 Integration with DERMS for flexibility services coordination	The ANM system shall be capable of being integrated into a DERMS platform and supporting the direct dispatch of flexibility services. ANM schemes should not conflict with delivery or coordination of ESO flexibility services. The ANM system shall be capable of optimizing the coordination of ANM schemes with balancing services, i.e., flexibility services.

3.14.3 Forecasting	The ANM system shall be capable of being integrated into a DERMS platform, of supporting forecasting, of supporting flexibility services dispatch, and be configurable to work across the following time horizons: • Intraday, • Day-ahead, • Week ahead, • One month ahead, and • Six months ahead. Forecasting shall take account of available intelligence such as seasonal factors and meteorological data. The system shall be capable of updating its system forecast based on trends in the Managed Customer's import or export, where second-by-second or minute-by-minute data is available.
3.14.4 Aggregator services	The ANM system shall support a standard interface to aggregators for the future provision of aggregation services.
3.14.5 Primacy	The ANM shall be capable of following applicable industry rules, standards and/or license conditions relating to the management of conflicts between any relevant or applicable ESO/DSO services e.g., primacy rules.

3.15 Other Future Requirements/Miscellaneous

The ANM system should also be able to fulfil several miscellaneous requirements. Please indicate if the following are available as standard or as an option:

3.15.1 Control of active devices	The ANM system shall be able to control active NPg distribution system devices including: • On-load tap changers of distribution transformers • Voltage regulators • Capacitor banks
3.15.2 CLASS System	The ANM system shall support the integration of Customer Load Active System Services (CLASS) and the control of distribution transformer tap changers.
3.15.3 Constraint management fault level	The ANM system shall be able to calculate fault levels in real-time. The system shall be able to trip generators in real-time, before fault level issues occur, to maintain fault levels at an appropriate level. The facilities to achieve this shall be discussed and agreed with NPg. In the case of a fault level trip, the ANM system shall re-calculate Managed Customer's set points setpoints in real-time to ensure generation export is maintained, or loss of generation is minimal.
3.15.4 Distribution Restoration Zone Plan co-ordination	The ANM system facilitate the operation of a Distribution Restoration Zone Plan, e.g. by providing the control engineer with the facilities to control or disable the operation of the ANM system in the event of a total shutdown of the transmission system.

3.15.5	Co-ordination with a Distribution Restoration Zone Control System (DRZCS)	The ANM system shall be able to co-ordinate with a DRZCS where a Managed Customer has a Restoration Contract as defined in the Distribution Code.

4. References

The products described within this specification shall comply with all current versions of the relevant International Standards, British Standard Specifications, and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply.

4.1 External Documentation

Reference	Title
	Centre for the Protection of National Infrastructure's ICS Systems Security Good Practice Guides
BS EN 61508	Functional safety of electrical / electronic / programmable electronic safety related systems
BS OHSAS 18001:2007 ISO 45001:2016	Health and Safety. Management Systems
IEC 60870-5-101	Transmission Protocols – Companion standard for Basic Telecontrol Tasks
IEC 60870-5-102	Companion standard for the transmission of integrated totals in electric power systems
IEC 60870-5-103	Transmission Protocols, Companion standard for the informative interface of protection equipment
IEC 60870-5-104	Transmission Protocols, Network access for IEC 60870-5-101 using standard transport. profiles
IEC 60947	Low voltage switchgear and control gear
IEC 61131-3 ed.2	Programmable Controllers Part3: Programming Languages
IEC 61850	Standard for the design of electrical substation automation.
IEEE Std 1815 (DNP 3)	IEEE Standard for Electric Power Systems Communications – Distributed Network Protocol (DNP3)
ISO 14001:2015	Environmental Management Systems
ISO 9001:2015	Quality Management Systems
ISO/IEC 27000:2014	Information technology – Security techniques – Information security management systems
NIST 800-82	National Institute of Standards and Technology, Special Publication 800-82, Guide to Industrial Control Systems (ICS) Security

4.2 Internal Documentation

Reference	Title
ITS/100/001	Code of Practice for IS Security.
NPS/005/002	Technical Specification for Remote Terminal Units (RTUs) for use at Primary Substations
NSP/009/002	Technical Specification for the Provision of Active Network Management and Associated

	Services

4.3 Amendments from Previous Version

Reference	Description
Whole Document	Whole document review

5. Definitions

Definition	Term
Active Network Management (ANM)	A system that manages power flows and voltages on an electricity distribution system by issuing control instructions / set-point in to Managed Customers to alter their import/export with a view to maintaining power flows and r voltages within pre-determined limits that do not exceed asset capabilities.
Central ANM Controller	ANM system hardware hosting the ANM system functionality that is not provided by the Local ANM Controller.
Constraint	A limitation on the electricity distribution system to deliver power beyond a certain level, whether related to an asset rating or regulatory requirement. Currently limited to thermal, forward / reverse real and reactive power flow and voltage constraints.
Customer	A person who is already connected to or is seeking a connection to NPg's distribution system.
DNP	Distributed network protocol.
GSM	Global System for Mobile Communications.
HV	High voltage, (> 1000V A.C.).
Local ANM controller	The controller local to the import / export site that passes on instructions received from the coordinating controller. It monitors local site response to target set-points and reacts appropriately. to any deviation from an acceptable local site response.
Managed Customer	A customer whose import / export asset is controlled by the ANM system for the purposes of load. management.
Merit order	The order in which participating customers are to be constrained
Monitoring Point	ANM system hardware located at a point on the distribution system to measure distribution system parameters at constrained points or provide proxy measurements of a constrained point.
Principle of Access (PoA)	The rules that define the customer's rights to access distribution system capacity, and the terms under which the customer's rights may be curtailed to alleviate network constraint. These are agreed upon prior to ANM scheme deployment. The algorithm is pre-programmed in line with these rules.
Set point	A MW / MVAr value issued by the ANM system that is not to be exceeded by a participating. customer.
Witness server	An additional server that makes automatic failover possible, by cooperating with the mirror server to decide if contact with the principal server is lost.

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 authorisation.

		Date
Deb Dovinson	Governance Administrator	01/07/2024

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 authorisation.

Standard CDS review of 3 years	Non-standard review period & reason	
Yes	Period:	Reason:
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Rose Wabuti	Smart Grid Development Engineer	03/07/2024

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 authorisation.

		Date
Alan Creighton	Senior Smartgrid Development Engineer	01/07/2024
Jeremy Meara	Operational Data and Systems Manager	02/07/2024

6.4 Authorisation

Authorisation is granted for publication of this document.

		Date
Mark Callum	Smart Grid Development Manager	01/07/2024
Paul Black	Head of System Engineering	15/07/2024

Appendix 1 – Self-certification conformance declaration

The active network management system covered by this specification shall comply with the latest issues of the relevant International, European and British Standards. This specification is intended to amplify and/or clarify the requirements of those Standards. 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 currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.
Cs4 = The product does not conform to the requirements of this clause

Instructions for completion

- When Cs1 code is entered no remark is necessary
- When any other code is entered the reason for non-conformance shall be entered
- Prefix each remark with the relevant 'BS EN' or 'ENATS' as appropriate

Manufacturer:

Product Reference:

Name: **Signature:** **Date:**

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Enterprise ANM system architecture			
Section 3.1.1	Capable of simultaneous deployment of multiple discrete ANM zones/applications within a single extensible core enterprise software platform.		
Section 3.1.2	Support of industry standard interfaces applications such SOAP and/or REST capable of enabling integration with third party systems.		
Section 3.1.3	Support importation/extraction of network structural and scheduled data using an agreed industry standard CIM (Common information Model) format. Be capable of supporting an industry standard power system mode to enable real time load flow studies to be carried out using real-time / close to real-time data from the ANM system.		
Section 3.1.4	Integration with DMS (Distribution Management System) of DNP3 and capable to integrate by means of ICCP links in future to: 1) Provide information to the DMS system including **(stated in section 3.1.4 above)** 2) Accept control commands and values from the DMS system **(stated in section 3.1.4 above)**.		
Section 3.1.5	Capable of interfacing directly with equipment controlling a Managed Customer's import and /or export from the distribution system and /or Monitoring Points monitoring power system parameters on the distribution system via DNP3/IP protocol (IP bearers will be provided by NPg utilising LTE cellular and/or dedicated circuit).		
Section 3.1.6	Capable of exporting historical and operational data to historian applications such as Plant Information (PI) at a specified frequency for historian data recording purposes: - Such data transfer maybe directly to PI or indirectly via DMS.		
	Optional features		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.1.7	Able to accept measurements from distribution system equipment via an external system, such as iHost. Able to accept measurements from an NGESO system to enable the ANM system to manage constraints at the Grid Supply Point (GSP).		
Section 3.1.8	Capable of supporting plug-ins and microservices from other products/ service providers (e.g., Plugins for Forecasting, Trading).		
ANM system hardware environment			
Section 3.2.1	The software provided should be capable of being operated in a fully redundant multi-site. configuration achieving “Hot/Hot” or “instant failover" capable redundancy with ability to support. deactivation of components for maintenance purposes without interrupting the service.		
Section 3.2.2	Supporting backup to offline media (e.g., tape library) for disaster recovery purposes without interruption to the ANM service.		
Section 3.2.3	Operable on hardware provided by NPg as stated in section 3.2.3		
Section 3.2.4	Where required for responsiveness and/or local resilience, are you able to provide and support any additional logic suitable for execution on remote RTU devices using IEC-61131 compliant coding. (An example of such functionality might include local intervention to issue a lower setpoint in the event of communication failure with the central system.		
Distribution System observation and control requirements			
Section 3.3.1	The ANM system shall use real-time measured network power flows at specific network. measurement points and send instructions to relevant Managed Customers to manage these flows.		
Section 3.3.2	The ANM system shall create control instructions / set points that can be issued to Managed. Customers to manage power flows and voltage at specific Measurement Points against pre-determined, seasonal network limits and dynamic limits as stated in section 3.3.2.		
Section 3.3.3	The ANM system shall take account of the direction of real and reactive power flow at measurement points when establishing control instruction / set points.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.3.4	The ANM system shall manage both import-driven and export-driven constraints.		
Section 3.3.5	The ANM system shall manage voltage constraints		
Section 3.3.6	The ANM system shall allow customer measurement control points to be set In Service or Out of Service as explained in 3.3.6 (Measurement Point Status).		
Section 3.3.7	The ANM system shall be able to support a minimum of two operating regimes, which define how the managed Local ANM Controllers are controlled as explained in section 3.3.7 (Operating Regime).		
Section 3.3.8	The ANM system shall minimise the constraints imposed on Managed Customers by implementing control instructions/set points in a hierarchical manner to achieve the objectives listed in section. 3.3.8 (Management of Managed Customers).		
Section 3.3.9	The ANM system shall allow the configuration of bespoke upper and lower thresholds, triggering user-defined actions once measurement parameter (such as power flow or voltage) crosses a threshold.		
Section 3.3.10	The ANM system shall monitor and respond to Managed Customer's non-compliance to an instruction by disconnecting them from the network by opening the metering breaker.		
Section 3.3.11	The ANM system shall monitor Managed Customers that are out of service (for any reason other than an ANM instruction) by not attempting to issue control instructions to the de-energised customer.		
Section 3.3.12	The ANM system shall have the functionality to re-connect Managed Customers to the electricity distribution network following a tripping control issued by the ANM system. The ANM system shall		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
	not re-connect Managed Customers who have been disconnect by any other means as detailed in Section 3.3.12 (Re-connection of Managed Customers).		
Section 3.3.13	The ANM system shall have a self-contained facility to synchronise with all Local ANM Controllers and Monitoring Point hardware. A facility should be provided to derive a definitive time as outlined in section 3.3.13 (Time stamping).		
Section 3.3.14	The ANM system shall integrate with a DMS initiated Grid Code Operational Code 6 (OC6) Demand Control instruction (which may be for voltage control and / or demand disconnection) such that the effect of the OC6 instruction is not undermined. The objective of OC6 is to permit a reduction in demand in the event of an incident affecting the national electricity transmission system. The arrangements to achieve this shall be discussed and agreed with NPg. Where such functionality doesn't from part of the functionality of a bidder's / vendor's system, the bidder / vendor shall commit to developing such functionality as part of the ANM system development.		
Section 3.3.15	The ANM system facilitate the operation of a Local Joint Restoration Plan, e.g. by providing the control engineer with the facilities to control or disable the operation of the ANM system in the event of a total shutdown of the transmission system.		
Control of Managed Customers			
Section 3.4.1	The ANM system functionality shall be provided by standard algorithms that are applied to different network areas without the development of proprietary solutions for different network areas. This must be demonstrated from reference projects. The ANM algorithm shall be configurable (able to amend rules) such that future requirement of the system can be implemented easily.		
Section 3.4.2	The ANM system shall have the ability to seamlessly integrate, control and optimise all technology types and sizes of Managed Customer (including battery storage system) and host multiple control schemes at different points on the network i.e., manage multiple network constraints for ANM customers at multiple locations.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.4.3	The ANM system shall support for each Managed Customer a single export set-point for generation, a single import set-point for controllable demands and both export and import set-point for bi-directional devices such as Battery Energy Storage Systems. The system must determine which participating Managed Customers are relevant to solving any network constraint and calculate the required setpoint response.		
Section 3.4.4	The ANM system shall support operation of remote site in two different set of modes of operation: • ANM Auto control and • ANM SCADA control (i.e., telecontrol via DMS). In this control mode a Control Engineer shall be able to provide a control instruction / set point to one or more Managed Customers. In this case the ANM system shall continue to manage the remaining Managed Customers according to the Principles of Access.		
Section 3.4.5	The ANM system shall be capable of performing three types of control actions: • Managing active and or reactive power import / export of Managed Customers via control instructions / set-point. • De-energising Managed Customers from the distribution system. • Reconnecting Managed Customers to the distribution system.		
Section 3.4.6	The ANM controller shall aggregate, and control Managed Customers based upon agreed Principles of Access (PoA) within an ANM constraint management zone example in section 3.4.6 (Principle of Access)		
Section 3.4.7	The ANM shall be able to monitor various measurement point/constraint point, measure the network loading at these constraint points and monitor and control the Managed Customers associated with each constraint point.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.4.8	The ANM system shall measures network loading at each Measurement Point and implement escalating actions to reduce the measured value at a Measurement Point when the measured value breaches a configurable threshold as described in Section 3.4.8 (Distribution system measurement-based control).		
Section 3.4.9	The local ANM controller shall manage non-compliance events through a staged approach of escalating action listed in section 3.4.9 designed to avoid tripping the generator circuit breaker unless necessary.		
Section 3.4.10	The ANM system shall ensure the network is operating within safe limits by monitoring the power flows and voltage in real-time and calculating the operating positions of multiple Managed Customers.		
Section 3.4.11	The ANM algorithm shall calculate generator set points by considering factors such as generator availability, MW ramp rates, and priority stack (LIFO) where required. The algorithm shall curtail all available ANM Managed Customers in accordance with the agreed Principles of Access and update set points in real time, considering asset thermal rating and voltage limits. The set-points generated shall adhere to the MW ramp rates defined for each generator to prevent voltage disturbances due to multiple step changes. The set-points shall be updated in real time, such that if a generator fails during a curtailment period, other Customer(s) in the priority stack is automatically dispatched.		
Section 3.4.12	On initial start-up, the ANM system shall issue zero set-points (or minimum set-points and then release import / export capacity up to its pre-determined limits in a controlled manner and in user-configurable amounts to minimise the impact on the network and other customers.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Constraint management algorithm/application			
Section 3.5.1	The constraint management application shall include features which allow the all the capability listed in section 3.5.1.		
Section 3.5.2	The AMN system shall be able to measure power flows on the distribution system at each Measurement Point to establish the required control instructions / set points and manage in real-time the active and / or reactive power imported / exported from a group of Managed Customers to ensure that the distribution system operates within the limits / thresholds configured within the ANM system.		
Section 3.5.3	The ANM system shall be able to manage any combination of up to 50 Managed Customers and up to 50 constraints at a GSP level, where any of these Managed Customers may affect any of the constraints or affect multiple constraints. Any constraint may be affected by multiple Managed Customers, and this many-to-many mapping may change in real time as the topology of the distribution system change e.g. via Control Engineer switching.		
Section 3.5.4	The system shall be able to manage any combination of constraints in series or parallel and operate effectively for either intact or after first outage condition. Should be able to manage several acceptable first outages combinations at the same time. Example as described in Section 3.5.4.		
Section 3.5.5	The system shall be able to adapt to a change in system conditions that require application of different asset ratings as result of a planned or unplanned outages. The ANM algorithm must be able to reconfigure accordingly and apply different network asset ratings when required such that it can continue operating and connected customers are not affected. See Section 3.5.5 (Adapt to changes in system conditions and apply different distribution system asset ratings).		
Section 3.5.6	The system shall be able to interpret system abnormal running conditions through. • Distribution system circuit breaker and switch statuses from DMS • A power flow (or lack of), derived from a Monitoring Point, where appropriate.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.5.7	The ANM System shall accept the following inputs from Local ANM Controllers and Monitoring Point hardware provided to this specification via DNP3.0: • Either amps or MW/MVAr (to be determined by NPg, which may differ between which may differ between Managed Customer sites within the same scheme); and • Amps for all monitored power flows (measurement points) • Voltage where appropriate. • Real time thermal ratings in either Amps or MW/MVAr (to be determined by NPg) for use in the calculation of control instructions / set points.		
Section 3.5.8	The ANM system shall ensure that the MW / MVAr set points i.e., maximum permitted import / export, issued to sites shall reflect a merit order configurable by the user, as described in section 3.5.8 (Observe a merit order) of the main document.		
Section 3.5.9	The ANM system shall provide a user-configurable means of avoiding high numbers of low magnitude set- point changes, such as the application of dead bands, hysteresis or smoothing.		
User interface requirements			
Section 3.6.1	The ANM system shall have a software web interface that allows the user to perform functions listed in Section 3.6.1 (ANM Dashboard).		
Section 3.6.2	The ANM system shall control access to the user Interface (UI) via user accounts with different access rights (Viewer only, Controller and Administrator), including the following as described in section 3.6.2 (User Interface/User Management)		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.6.3	The ANM system must be able to interact with our DMS/ADMS to provide, ANM visibility in the DMS/ADMS user interface for the Control Engineers. The User Interface for control Engineer shall allow authorised users to view and, potentially, edit the information outlined in Section 3.6.3 (User Interface for Control engineer).		
Section 3.6.4	The ANM System shall provide a User Interface that allows authorised users to view historic data relating to the ANM operations.		
Cybersecurity			
Section 3.7.1	Be compliant with all applicable sections of the Berkshire Hathaway Energy security requirements questionnaire.		
Application user security			
Section 3.8.1	The ANM System shall provide the application user security measures that are outlined in section. 3.8.1 (Application User Security).		
Fail safe requirements.			
Section 3.9.1	The ANM system shall be capable of carrying out a full Health Check periodically or on an ad hoc basis, both locally and remotely, and provide necessary alarms highlighting the location of failure (if any encountered) and the type of equipment involved.		
Section 3.9.2	The system shall issue a positive indication of its effective operation (for example, by sending and verifying receipt of a control instruction/ set- point for every controlled site, regardless of whether that set-point has changed), as a heartbeat to each local controller on a user-configurable cycle. If any Local controller does not receive such a set point for a separately user configurable period, then that local controller shall issue a user- configurable fail-safe set-point (including, but not necessarily confined to, zero) to its associated local site(s).		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.9.3	The ANM system shall default to a fail-safe mode in the event of any failure scenarios identified in Section 3.9.3 (Fail-safe to several types of failure).		
Section 3.9.4	The ANM shall be able to manage communications failures or failures to respond for interfaces, identified in Section 3.9.4(Communication Failures or Failures to Respond).		
Section 3.9.5	Checking the frequency of data changes and, in the event of stale data**,** implement a fail-safe response. The system shall maintain normal operation for all circuits and sites unaffected by the stale analogues. The ANM system shall utilise the user-configurable upper and lower thresholds for each Monitoring Point. Any measured values outside this range shall be treated as non-topical, and the system shall respond by implementing a fail-safe mode of operation		
Section 3.9.6	If any critical constraint measurement goes non-topical, the coordinating controller shall issue a fail-safe limit to all sites that could (in the current network configuration) contribute to that constraint.		
Section 3.9.7	If any Managed Customer site's import / export goes non-topical, the ANM Local Controller and the Central controller shall act as specified in Section 3.9.7 (Managed Customer site's import / export goes non-topical):		
Section 3.9.8	Upon restoration of communications links, the ANM Controller shall resynchronise the relevant data links and return the Managed Customer to ANM control without user intervention.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
ANM testing			
Section 3. 10.1	ANM standard algorithms must be type-tested by NPg, and their functionality must be demonstrated in different network configurations.		
Section 3.10.2	The Centralised ANM Controller must operate under different simulated distribution system running arrangements, with different real and reactive power flows conditions and different generation/ demand levels, which are impossible to simulate on a live distribution system, the vendor must provide a network simulator with the capability to simulate real distribution system operation and feed it into an off-line representative copy of the ANM system for testing purposes.		
Section 3.10.3	The network simulator must support the ability to • Vary the distribution system running arrangements such that circuit breakers/switches can be operated during the testing of the ANM system and the operation of the ANM system can be observed and monitored. • Change the generation and demands on the network where these could be changed during the testing of the system such that the operation of the ANM system in such circumstances can be observed and monitored.		
	Optional features		
Section 3.10.4	The vendor must provide a system emulator that can accept historical data from our DMS/ADMS (in an agreed format) that can then be replayed through the ANM system for testing purposes. This should test the data path from the DMS/ADMS via the (A)DMS-ANM communications link through to the ANM applications.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
ANM system reporting			
Section 3.11.1	The ANM system shall provide information for curtailable connections on a periodic basis (e.g., monthly reports) detailing the volume of distribution system curtailment/constraint experienced by each Managed customer that is under ANM control. These reports should be compliant with Access Significant Code Review (SCR).		
Section 3.11.2	The ANM System shall measure the level of curtailment that is experienced by all Managed Customers and compare it to the curtailment limits.		
Section 3.11.3	The ANM System shall log the source of curtailment, noting for example, distinction between curtailment that is triggered by distribution constraints, transmission constraints, fail-safe actions, or manual operator control actions.		
Section 3.11.4	The ANM system must be able to identify the asset (i.e., power transformer, overhead line, underground cable) that is causing a network constraint on each occasion when the ANM system actively managed a Monitoring Point.		
Event and data logging			
Section 3.12.1	The ANM system shall generate an event under the failure conditions listed in Section 3.12.1 (Events)		
Section 3.12.2	The ANM system shall save all system data (i.e., received data, calculated values, control instructions / set points) and actions in a local data historian in a timestamped manner. This data historian shall be stored for up to one year and be accessible to authorised users.		
Section 3.12.3	The ANM System shall send all event conditions and alarms to relevant support systems, ANM management consoles, and other parties as nominated by NPg.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.12.4	The vendor must demonstrate a roadmap for the delivery of Common Information Model based integration between NPg's power system design tools (i.e., DIgSILENT's PowerFactory) and ANM, to better support distribution system model management by the ANM system.		
Non-functional requirements (NFR)			
Section 3.13.1	Scalability: The ANM Central Controller shall be scalable, allowing streamlined addition of Monitoring points and Managed Customers (up to hundreds of each) without significant reconfiguration of control logic or impact on performance.		
Section 3.13.2	Resilience: The ANM system shall support a capability that allows a hot-standby ANM Central controller to be seamlessly promoted to becoming the main controller without disruption to ANM operations.		
Section 3.13.3	Maximum latency: The ANM System shall issue instructions to relevant Managed Customers within one second of the receipt of the relevant data.		
Section 3.13.4	Disaster recovery: The ANM system shall be capable of supporting fail-over to a disaster recovery system.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.13.5	Backups: The ANM system shall be capable of supporting regular backups of the ANM system's full technical configuration such that the full ANM System can be fully rebuilt within 24 hours of suitable hardware being made available.		
Section 3.13.6	Database Backup: The ANM system shall be capable of supporting the deployment of a database replication/protection product that, in the event of a database failure, limits data loss to only the period between the outage and the time of the last incremental backup.		
Future requirements			
DSO functionality			
	Optional features		
Section 3.14.1	The ANM system shall be able to be integrated with other DERMS functionalities and combine the grid, commercial and market optimisation platforms with real-time control to provide MW dispatch service as per the ESO and NPg's new flex market mechanisms.		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Section 3.14.2	The ANM system shall be capable of being integrated into a DERMS platform and supporting the direct dispatch of flexibility services. ANM schemes should not conflict with delivery or coordination of ESO flexibility services. The ANM system shall be capable of optimizing the coordination of ANM schemes with balancing services, i.e., flexibility services.		
Section 3.14.3	The ANM system shall have the capability of being integrated into DERMS platform and support forecasting and dispatching flexibility services and be configurable to follow Intraday, day-ahead, week ahead, one month and six Month ahead time horizons: Forecasting shall take account of available intelligence such as seasonal factors and meteorological data. The system shall be capable of updating the system forecast based on the trends in customers output, where second-by-second or minute-by-minute data is available.		
Section 3.14.4	The ANM system should support a standard interface to aggregators for the future provision of aggregation services.		
Section 3.14.5	The ANM should follow the applicable industry rules, standards and/or license conditions relating to appropriately manage conflicts between any other applicable ANM system within range and/or ESO/DSO services e.g., Primacy Rules		

Technical specification for ANM systems			
Clause/sub-clause	Requirement	Conformance code	Remarks
Other future requirements			
	Optional features		
Section 3.15.1	ANM shall be able to control active devices including: • On-load tap changers of distribution transformers • Voltage regulators • Capacitor banks		
Section 3.15.2	The ANM system shall support the integration of Customer Load Active System Services (CLASS) and the control of distribution transformer Tap Changers		
Section 3.15.3	The system shall be able to determine fault levels in a real-time. The system should be able to trip generators in real-time to maintain fault levels at an appropriate level. In the case of a fault level trip, the ANM system should re-calculate managed Customer's setpoints in real-time to ensure generation level is maintained or loss of generation is minimal.		
Section 3.15.4	The ANM system facilitate the operation of a Distribution Restoration Zone Plan, e.g. by providing the control engineer with the facilities to control or disable the operation of the ANM system in the event of a total shutdown of the transmission system.		
Section 3.15.5	The ANM system shall be able to co-ordinate with a Distribution Restoration Zone Control System (DRZCS) where a Managed Customer has a Restoration Contract as defined in the Distribution Code.		

Appendix 2: curtailable connection data specification

Requirement	Unit	Min compliance	Min NPg standard	Desirable	Comment
Customer information (held in the system)					
Managed Customer name	@	✓			Site name e.g., name of windfarm etc.
Managed Customer registered address	@	✓			Registered address of the site
Managed Customer contact details (including email)	@		✓		Contact detail to send curtailment reporting information
Import Meter Point Administration Number(s) (MPANs)	#	✓			
Export Meter Point Administration Number(s) (MPANs)	#	✓			
Unique Reference Number for the point of supply	@		✓		In case a constraint is different for different points of supply to a customer's installation
Maximum Export Capacity	kVA	✓			
Maximum Import Capacity	kVA	✓			
Non-Curtailable Export Capacity	kVA	✓			Capacity that can be given to the customer without the need for reinforcement as recorded in the Connection Agreement

Non-Curtailable Import Capacity	kVA	✓			
Curtailable Export Capacity	kVA	✓			As recorded in the Connection Agreement: "Maximum Capacity" less "Non-Curtailable Capacity", the maximum restriction that we can "instruct" a customer to Curtail by, if greater the customer is not obliged to comply
Curtailable Import Capacity	kVA	✓			
Export Curtailment Limit	Hours	✓			This is the equivalent number of hours in a 12-month period (can be a partial hour) that we can fully Curtail a customer before we need to pay that customer for doing so
Import Curtailment Limit	Hours	✓			
Energisation date	dd/mm/yyyy	✓			Energisation of the connection/commissioning of an existing customers' new demand/generation equipment
Curtailment End Date	dd/mm/yyyy (or N/A)	✓			N/A if the customer requests an enduring Curtailable Connection or does not pay applicable Reinforcement Cost
Curtailment description	@		✓		Record what the network constraint is (needs to be within the Minimum Scheme for a Curtailable Connection)

Curtailment measurement: Solution needs to issue and record for each Curtailment Instruction					This is needed to calculate the Full Export Curtailment Hours and Full Import Curtailment Hours, as applicable
Curtailment Instruction driver (Import/Export)	Binary (Import/Export)	✓			The same technical solution could be used to implement restrictions associated with both import and export at a single connection; need to know if the instruction relates to Export Curtailment Limit or Import Curtailment Limit
Curtailment Instruction issued: start date and time	dd/mm/yyyy @ hh:mm	✓			It could be that the Curtailment Instruction has a start & end date/time rather than two separate start and end instructions. Where the Curtailment Instruction is continuously variable & the end time could be related to the Curtailment Instruction refresh time (as the next unique Curtailment Instruction Value)
Curtailment Instruction issued: end date and time	dd/mm/yyyy @ hh:mm	✓			It could be that the Curtailment Instruction has a start and end date/time rather than two separate start and end instructions. Where the Curtailment Instruction is continuously variable & the end time could be related to the Curtailment Instruction refresh time (as the last sequential and same Curtailment Instruction Value)
Curtailment Instruction Value	kVA	✓			**Any solution needs to issue a Curtailment Instruction Value within a range; max being the "Curtailable Capacity"**

Curtailment Instruction Value	kW				**Any solution needs to issue a Curtailment Instruction Value within a range; max being the "Curtailable Capacity"**
Unique Identify 1	Reference	✓			MPAN number (String)
Unique Identify 2	Reference	✓			Connection ID (String)
MW Hours lost	MWH		✓		Cumulative MWH lost between a start and end dates
Curtailment hours	Hours		✓		Curtailed Hours
Curtailment Instruction Driver (Curtailable/Flexible)	Binary (CC/FC)		✓		The same technical solution could be used to implement restrictions associated with both a Curtailable Connection & Flexible Connection associated with the same customer connection.
Transmission Constrained Asset	Reference	✓			Identifying which asset had been constrained
Distribution Constrained Asset	Reference	✓			Identifying which asset had been constrained or comms fail, load flow fail etc.
De-energisation implemented: date and time	dd/mm/yyyy @ hh:mm		✓		If a customer does not respond to a Curtailment Instruction, we can De-energise that customer for the duration of the Curtailment Instruction or until the customer complies. There will need to be a discussion between the DNO Control Engineer and the customer to confirm the integrity of the installation before re-energising the connection

Re-energisation implemented: date and time	dd/mm/yyyy @ hh:mm		✓		
De-energisation warning issued: date and time	dd/mm/yyyy @ hh:mm		✓		We may consider giving the customer [x] time to respond, and follow up with a final warning before De-energising the Connection Point; needs to align with the granularity of measurement of the customers' import/export data
De-energisation final warning issued: date and time	dd/mm/yyyy @ hh:mm		✓		
Customer data:					Most solutions need to measure load flow data in real time, (used in control system to preserve the integrity of NPg assets) and also needs to record and transmit to NPg load flow management data (which need not be in real time)
Load profile granularity: Network integrity - Real time	kVA		✓		For most (but not all) the Agreed Technical Solutions close to real time data is required to manage the network integrity and shall therefore be carried on a NPg comms infrastructure
Load profile granularity: Reporting - Quarterly	kVA	✓			Lower latency and less resilient comms for the management reporting information sent to NPg system(s)
Load profile granularity: Reporting - Monthly	kVA		✓		
Load profile granularity: Reporting - Weekly	kVA		✓		
Load profile granularity: Reporting - Daily	kVA			✓	
Load profile granularity: Reporting - Real time	kVA			✓	
Exceeding Curtailment (held in the system)					

Exceeded Export Curtailment Price	£/MVAh	✓			May change biannually (historical data needed) - we need to record the price applicable at each Curtailment Instruction, and the price applicable every fourth quarter for payment purposes
Exceeded Import Curtailment Price	£/MVAh	✓			