Heat Network Technical Assurance Scheme – Technical Specification – Substation

Overview

HNTAS-TS-SS-P0

Version History

Revision	Notes	Date
V0.4	Draft issue alongside consultation	10/04/25

Disclaimer

The following technical document has been prepared for issue ahead of the Heat Networks Technical Standards consultation and is published in a draft format. This document is intended to provide background context to the structure, style and contents of HNTAS draft Code documents, as they currently exist. The information in this document has been developed to facilitate understanding of the scheme.

DESNZ is not currently seeking views on specific individual technical requirements in the draft Code documents due to their large number and technical complexity.

Draft Code documents, including Technical Specifications and Assessment Procedures, have been reviewed and consulted on through a series of technical workshops with participation from a range of experts from across the heat network industry. We are seeking views on individual requirements through further, facilitated workshops with sector technical experts and through our pilot programme. The content of this document is therefore still in development and is subject to change. Requirements should not be considered as fixed at this stage.

You can sign up to receive updates and provide views on future detailed draft technical documents as they are published by contacting: heatnetworks@energysecurity.gov.uk.

Please be advised that this document references other HNTAS draft Code documents which have not yet been published. These referenced documents will be published at a later date. References to the Heat Networks Code of Practice (CP1) 2020 found within this document will also be subject to change following the publication of updated standards.

Contents

Foreword

This technical specification forms part of the UK Government's Heat Network Technical Assurance Scheme (HNTAS, the Scheme) delivered by the Department of Energy Security and Net Zero, in partnership with the Scottish Government and Ofgem. The Department of Energy Security and Net Zero appointed FairHeat as technical author for this document.

The Scheme has been designed and developed in consultation with a range of experts across the heat network industry, culminating in a series of technical specifications and Assessment Procedures to facilitate the validation and verification of performance outcomes of elements within a heat network.

This document provides an overview of the series of technical specifications for the Substation element.

This document sits within a series of technical specifications and supplementary specifications for the Substation as outlined in Table 1 and Table 2 below.

This Technical Specification – Substation: Overview is current and valid as of [XX/XX/XX].

For further information on the Heat Network Technical Assurance Scheme please refer to Heat Network Technical Assurance Scheme – Scheme Rules – New Build Heat Networks: Assessment Regime (HNTAS-SR-NB-AS).

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Normative document structure

Technical Specifications

Document type	Element	Part/phase					
		Overview	Phase 1: Feasibility	Phase 2: Design	Phase 3: Construction	Phase 4: Operation (initial)	Phase 5: Operation (ongoing)
		P0	P1	P2	P3	P4	P5
Technical Specifications (TS)	Energy Centre (EC)	HNTAS-TS-EC-P0	HNTAS-TS-EC-P1	HNTAS-TS-EC-P2	HNTAS-TS-EC-P3	HNTAS-TS-EC-P4	HNTAS-TS-EC-P5
	District Distribution Network (DD)	HNTAS-TS-DD-P0	HNTAS-TS-DD-P1	HNTAS-TS-DD-P2	HNTAS-TS-DD-P3	HNTAS-TS-DD-P4	HNTAS-TS-DD-P5
	Substation (SS)	HNTAS-TS-SS-P0	HNTAS-TS-SS-P1	HNTAS-TS-SS-P2	HNTAS-TS-SS-P3	HNTAS-TS-SS-P4	HNTAS-TS-SS-P5
	Communal Distribution Network (CD)	HNTAS-TS-CD-P0	HNTAS-TS-CD-P1	HNTAS-TS-CD-P2	HNTAS-TS-CD-P3	HNTAS-TS-CD-P4	HNTAS-TS-CD-P5
	Consumer Connection (CC)	HNTAS-TS-CC-P0	HNTAS-TS-CC-P1	HNTAS-TS-CC-P2	HNTAS-TS-CC-P3	HNTAS-TS-CC-P4	HNTAS-TS-CC-P5
	Consumer Heat System (CH)	HNTAS-TS-CH-P0	HNTAS-TS-CH-P1	HNTAS-TS-CH-P2	HNTAS-TS-CH-P3		

Table 1: Technical Specification structure

Supplementary specifications

Document type	Element		Reference
Acceptance Testing specification (AT)	Energy Centre	EC	HNTAS-AT-EC
	District Distribution Network	DD	HNTAS-AT-DD
	Substation	SS	HNTAS-AT-SS
	Communal Distribution Network	CD	HNTAS-AT-CD
	Consumer Systems - Consumer Connection and Consumer Heat System	CS	HNTAS-AT-CS

Table 2: Supplementary specifications structure

Introduction

HNTAS is a performance-based assurance scheme, which contains impartial assessment and independent certification, to ensure that heat network performance outcomes are achieved, and maintained.

An impartial assessment is to be made with regards to claims made by a Responsible Party as to whether Technical Standards have been fulfilled, and Key Performance Indicators (KPIs) will be achieved (validation) or have been achieved (verification), for identifiable elements of a heat network.

The Technical Standards to be fulfilled are contained within technical specifications.

The Technical Standards consist of the following technical obligations:

- The Technical Requirements to be met
- The Performance Monitoring Requirements to be met
- The Key Failures to be avoided at each stage
- The Evidence Requirements to be provided, to demonstrate conformity with the Technical Standards and avoidance of Key Failures

The Technical Standards also contain the KPIs for each element, to be achieved and maintained in operation. The fundamental principle of the Scheme is to ensure throughout all the HNTAS Stages, that the KPIs will be achieved (design, installation) or have been achieved (commissioning, operation), to ensure performance outcomes.

There are separate technical specifications for each heat network element, at each phase of a heat network development and operation.

This document specifically provides an overview of the series of technical specifications for the Substation element. It contains the following:

- A description of the scope of the Substation
- An outline of the structure of the series of technical specification and of each individual technical specification document
- A description of the KPIs specific to the Substation, including the minimum monitoring points required to calculate KPIs

More information on HNTAS assessment can be found within Heat Network Technical Assurance Scheme – Scheme Rules – New Build Heat Networks: Assessment Regime (HNTAS-SR-NB-AS).

1. Scope

This document specifies Technical Standards for a Substation.

It is applicable to a Substation, which is defined as a connection between distribution networks, which contains an exchange of thermal energy, or a connection between a distribution network and Consumer Heat System where at least one of the following characteristics are applicable:

- Instantaneous hot water system with a maximum output greater than 70 kW (with a minimum domestic hot water temperature of 50°C)
- Space heating output greater than 20 kW
- Potable stored hot water systems (indirect cylinders) with a stored water volume greater than 300 l, and a minimum storage temperature of 60 °C

A Substation typically contains the following (but is not limited to) plate heat exchangers, pumps, pressurisation and expansion equipment, water quality equipment, strainers, heat meters and control valves.

Where there is a connection between distribution networks which contains heat generation equipment (for example, top-up boiler) in addition to the above, this would not be defined as a Substation. This arrangement would be subject to Technical Requirements under the Energy Centre element.

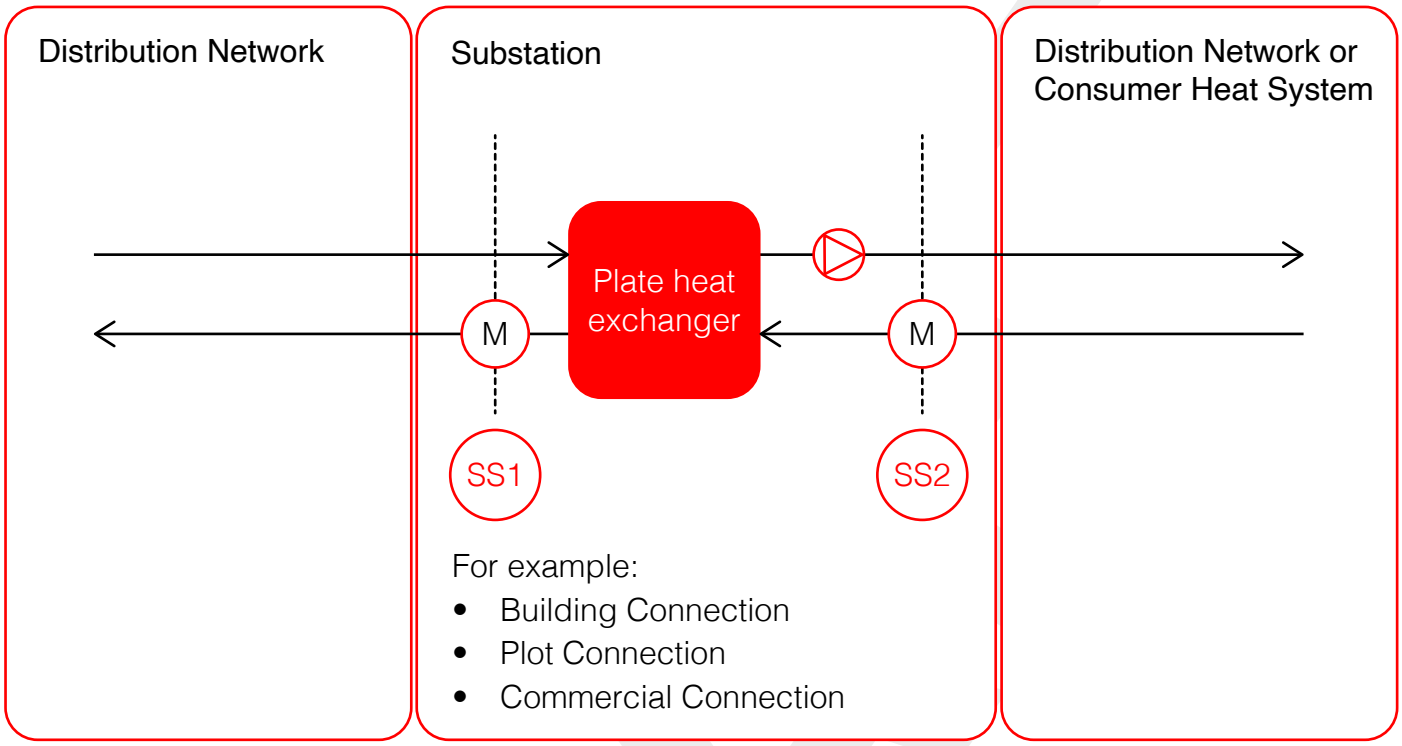
Where there is a connection between distribution networks which only contains ancillary equipment, such as valves and heat meters, and does not contain either pumps or plate heat exchangers and equipment required for a new hydraulically separated circuit (for example, water quality equipment andpressurisation equipment), this would not be defined as a Substation. This arrangement would be subject to Technical Requirements under the Communal Distribution Network element.

The Substation boundary for the purposes of measuring performance, via Key Performance Indicators, is determined by the intake and offtake monitoring point location (SS1 and SS2) as indicated in Figure 1.

The physical boundary of the Substation, for where the Technical Requirements apply, may not be the same as the performance boundary defined above. The physical boundary may be determined by physical barriers (such as walls) or contractual relationships. It is expected that the physical boundary and performance boundary are similar.

For clarity, all other heat network elements are not in the scope of this technical specification.

Figure 1: Illustrative drawing of Substation boundary



1.1 Equipment in scope of element

The following equipment is within scope of the Substation element:

- Heat exchange equipment (plate heat exchangers)
- Hot water equipment (calorifiers)
- Pressurisation and expansion equipment (pressurisation unit, expansion vessel)
- Water quality equipment
  - Air and dirt separators
  - Vacuum degassers
  - Dosing pots
  - Side stream filtration units
  - Online water quality monitoring equipment
  - Corrosion prevention equipment (such as coupons)
  - Strainers
  - Water softeners

- Pumps
  - Network distribution pumps
- Pipework
- Pipework expansion provision
- Insulation
- Control and field equipment (valves and actuators, sensors, switches)
- Ancillary equipment
  - Valves, test points, drain points, air vents, orifice plates
- Building Management System (BMS) panel
- Metering and Monitoring Systems
  - Monitoring points (meters and sensors)
  - Automatic and remote monitoring systems

1.2 Example typologies

There are many different typologies of a Substation. Within the Evidence Requirements sections of this technical specification, common typologies are referred to, to demonstrate differences in the expected evidence to be provided.

A description of each example typology is outlined in Table 3.

ID	Example typology	Description
A	Commercial Customer Connection	A Substation which is a connection between a distribution network and a commercial Consumer Heat System. For example, a Commercial Building Connection serving one commercial user, as seen in Figure 2.
B	Communal Distribution Network Connection	A Substation which is a connection between a District Distribution Network and Communal Distribution Network. For example, a multi-residential Building Connection, as seem in Figure 3.
C	Communal Distribution Network pressure break	A Substation, which is a connection between one Communal Distribution Network serving another Communal Distribution Network, for the purposes of a pressure break. This scenario is likely to occur where there is a necessity to reduce operating pressures of a network by splitting one Communal Distribution Network into two hydraulically separated circuits (resulting in two Communal Distribution Networks). An example of this is a Substation part way up a high-rise building, as seen in Figure 4.
D	District Distribution Network pressure break	A Substation, which is a connection between one District Distribution Network serving another District Distribution Network. This scenario is likely to occur where there is a necessity to boost pressures of a District Distribution Network. An example of this is a pumping station, as seen in Figure 5.

Table 3: Descriptions of example typologies used within the Substation technical specification

Figure 2: Example typology A: commercial customer connection schematic

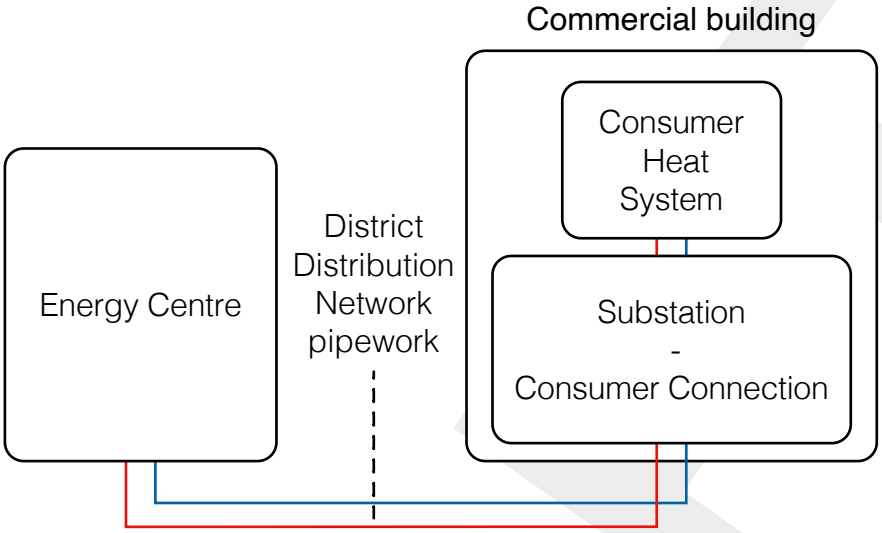


Figure 3: Example typology B: Communal Distribution Network connection schematic

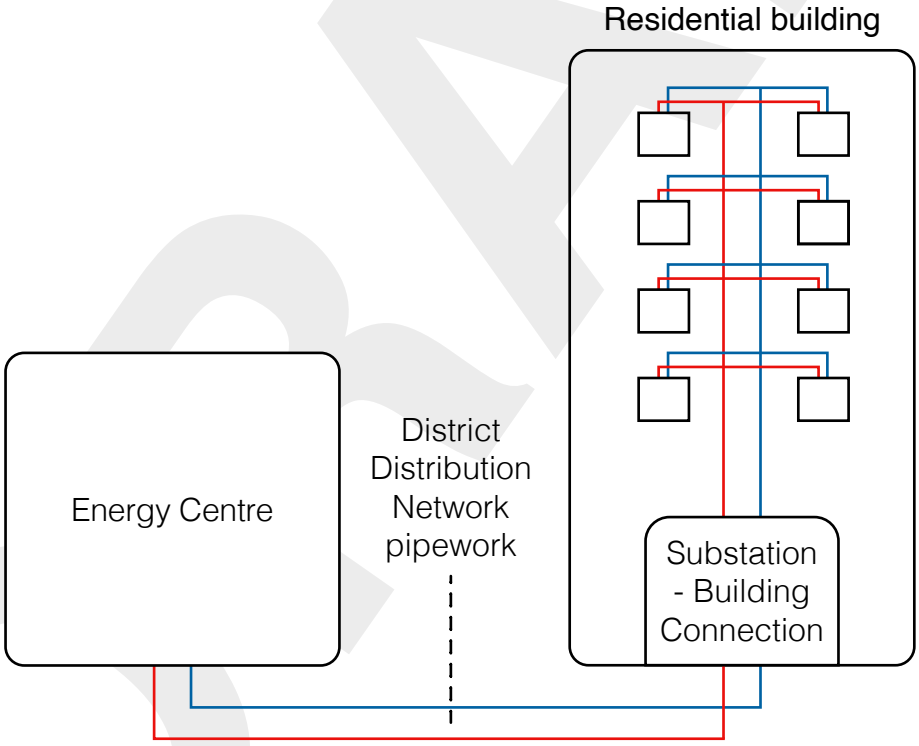


Figure 4: Example typology C: Communal Distribution Network pressure break schematic

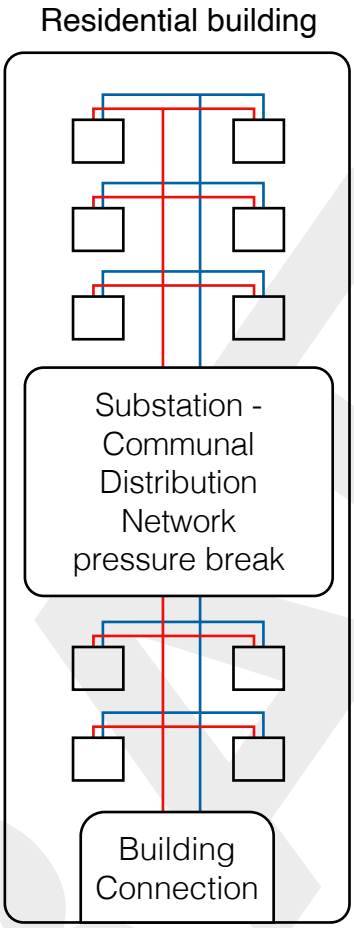
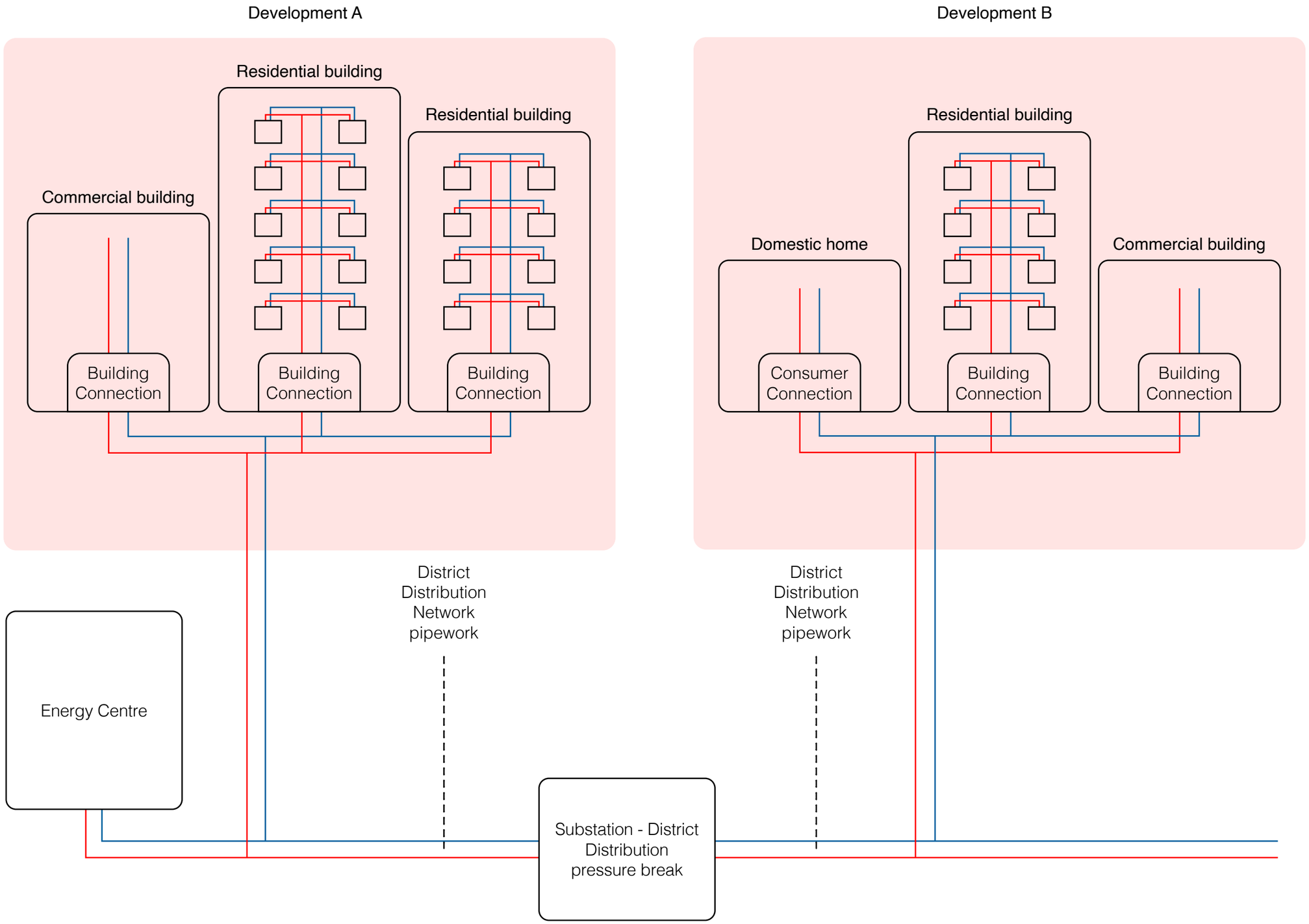


Figure 5: Example typology D: District Distribution Network pressure break schematic



2. Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

i. Heat Network Technical Assurance Scheme – Scheme Rules – New Build Heat Networks: Assessment Regime (HNTAS-SR-NB-AS) .

3. Terms and definitions

For the purposes of this document, the terms and definitions given in Heat Network Technical Assurance Scheme – Terms and Definitions (HNTAS-TD) (to be released at a later date) and the following table apply.

Term	Definition
Construction Phase	The third phase of a heat network development. This phase covers the construction of a heat network. This phase contains Construction Design (Stage 4), Installation (Stage 5) and Commissioning (Stage 6) Stages.
Evidence Requirements	Lists of evidence items, with descriptions and requirements, expected to be provided to demonstrate conformity with the Technical Requirements, Performance Monitoring Requirements and avoidance of Key Failures.
Heat Network	A network that, by distributing a liquid or a gas, enables the transfer of thermal energy for the purpose of supplying heating, cooling or hot water to a building or persons in that building (and includes any appliance the main purpose of which is to heat or cool the liquid or gas).
Key Failures	Key Failures are identified failures which occur frequently within the industry and lead to poor performance outcomes.
Key Performance Indicators (KPIs)	A quantifiable metric used to measure the performance of a heat network. Key Performance Indicator values and thresholds are to be defined during the design stages, and the heat network shall be designed to ensure KPIs can be achieved in operation.
Performance Monitoring Requirements	Requirements of a technical nature which relate to the performance monitoring of the heat network, using KPIs, and the Metering and Monitoring systems that facilitate performance monitoring.
Stage 1: Concept Design	Stage 1 is the first HNTAS Stage. This stage corresponds to RIBA Stage 2. This will likely align with pre-planning applications and will be prior to the progression of design, with potential handover of design to additional parties.

Term	Definition
Stage 2: Developed Design	Stage 2 is the second HNTAS Stage. This stage corresponds to RIBA Stage 3 design. Assessment at this stage is optional. This stage occurs prior to progression of design in RIBA Stage 4. This will likely align with submission of planning applications and may have potential handover of design to additional parties.
Stage 3: Technical Design	Stage 3 is the third HNTAS Stage. This stage corresponds to pre-construction activities at RIBA Stage 4 design, prior to design sign off and procurement and construction commencing.
Stage 4: Construction Design	Stage 4 is the fourth HNTAS Stage. This stage corresponds to RIBA Stage 4/5 design items that occur within the Construction Phase.
Stage 5: Installation	Stage 5 is the fifth HNTAS Stage. This stage corresponds to the installation activities of a heat network.
Stage 6: Commissioning	Stage 6 is the sixth HNTAS Stage. This stage corresponds to the commissioning activities of a heat network, prior to commissioning sign off, practical completion and handover to the heat network operator.
Stage 7: Operation and Maintenance (initial 2 years)	Stage 7 is the seventh HNTAS Stage. This stage corresponds to the operation and maintenance activities of a heat network during the first two years of operation.
Stage 8: Ongoing Monitoring	Stage 8 is the eighth HNTAS Stage. This stage corresponds to the ongoing operation and maintenance of a heat network during operation.

Term	Definition
Substation	Connection between distribution networks, which contains an exchange of thermal energy (e.g. via plate heat exchangers), together with requisite ancillary equipment. For example: 1. District Distribution Network serving District Distribution Network (such as a district pumping station) 2. District Distribution Network serving Communal Distribution Network (such as a building connection) 3. Communal Distribution Network serving Communal Distribution Network (such as a pressure break in a high-rise building) Or a connection between a Distribution Network and a single Consumer Heat System, where the instantaneous hot water system is > 70 kW and/or the heating/cooling system is > 20 kW. Typically contains plate heat exchangers, pumps, expansion and pressurisation equipment, water quality equipment, strainers, heat meters, and control valves.
Technical Requirements	Requirements of a technical nature which relate to the generation and delivery of heat, specific to an element and stage, which are to be fulfilled. The Technical Requirements are predominantly based on existing industry requirements (from codes, guidance and other standards). Where existing industry requirements could not be identified, these have been developed.
Technical standards	Technical Standards consist of all the types of technical obligations under HNTAS. These include: • Conformity with the Technical Requirement • Conformity with Performance Monitoring Requirements • Avoidance of Key Failures • Submission of evidence

Table 4: Terms and definitions

4. Technical specification structure

4.1 Structure of technical specification: series

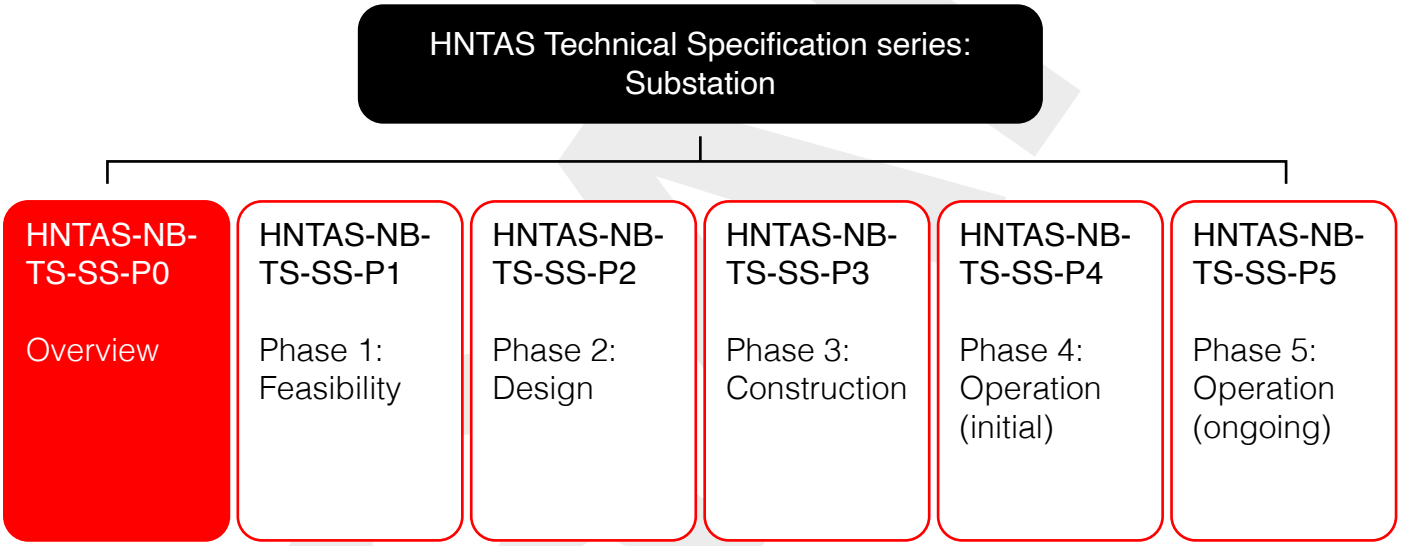
This document provides an overview of the technical specification for the Substation element.

This document sits within a series of technical specifications for the Substation.

The series contains 5 separate documents for each HNTAS phase, which contains the specific Technical Standards for the Substation at each stage.

Figure 6 illustrates the technical specification series for an element. Table 1 outlines this series of Substation technical specifications alongside the other HNTAS elements

Figure 6: Illustration of the technical pecification series



4.2 Structure of technical specifications: individual phase documents

The technical specifications for each phase are split into sections for each HNTAS Stage.

A description of HNTAS phases and stages is provided in Heat Network Technical Assurance Scheme – Scheme Rules – New Build Heat Networks: Assessment Regime (HNTAS-SR-NB-AS).

Each section contains the Technical Standards for each HNTAS Stage. This consists of the following:

- The Technical Requirements to be met
- The Performance Monitoring Requirements
- The Key Failures to be avoided at each stage
- The Evidence Requirements to be provided, to demonstrate conformity with the Technical Standards and avoidance of Key Failures

4.2.1 Technical Requirements section

Within each Technical Requirements section, a table is presented which contains a list of the HNTAS Technical Requirements and any applicable referenceable Technical Standards that must be achieved to meet the requirement. For each HNTAS Technical Requirement a reference to the expected evidence item has been outlined.

All Technical Requirements are based on current industry documentation. The predominant Technical Standard referenced is the Heat Network Technical Standard (HTS1) .. For topics which were not present in any reference industry documentation, additional Technical Requirements have been added to address these gaps.

4.2.2 Performance Monitoring Requirements section

Within this section, the requirements in relation to Key Performance Indicators and the Metering and Monitoring System are outlined.

It is expected that the Metering and Monitoring System for the Substation will also cover multiple other elements within a heat network. For example, it would be likely that the Metering and Monitoring System for a Substation is provided by monitoring points within other elements, such as Energy Centre and Substations. As a result, the evidence provided for the Metering and Monitoring System will likely contain multiple elements.

Whilst the evidence can be provided which covers multiple elements, all KPIs are to be assessed on an element basis.

4.2.3 Key Failures section

Within each Key Failures section, a table is presented which contains a list of Key Failures, the outcome to avoid, and a reference to the expected evidence item to demonstrate that the Key Failure is or has been avoided.

4.2.4 Evidence Requirements section

Within each Evidence Requirements section, the expected evidence item, which is referred to within Key Failures and Technical Requirements sections for each stage, is detailed.

A table is presented which contains a description and the requirements of each evidence item to provide clarity as to what evidence is expected to prove fulfilment of the Technical Standards.

The evidence is expected to be appropriate for the scale of heat network and project specifics. The example typologies are outlined in Section 1.1.

It is understood that the evidence items referenced in each table may be presented in different formats or multiple Evidence Requirements may be contained together within larger reports.

It is also expected that evidence items may be applicable to multiple elements across the heat network. Therefore, evidence does not need to be provided on an element-specific basis where it covers multiple elements.

Further evidence may be required by the Assessor to demonstrate fulfilment with the Technical Standards.

5. Note on applicability

The applicability of the Technical Standards within the technical specifications for Substation will depend on the specific heat network characteristics. This includes the typology of heat network and materials selection.

At each stage a Statement of Applicability shall be produced, which determines the applicable Technical Standards for the specific heat network.

Further requirements on the Statement of Applicability are outlined in Heat Network Technical Assurance Scheme – Scheme Rules – New Build Heat Networks: Assessment Regime (HNTAS-SR-NB-AS).

6. Key Performance Indicators

Table 5 contains the Key Performance Indicators for the Substation.

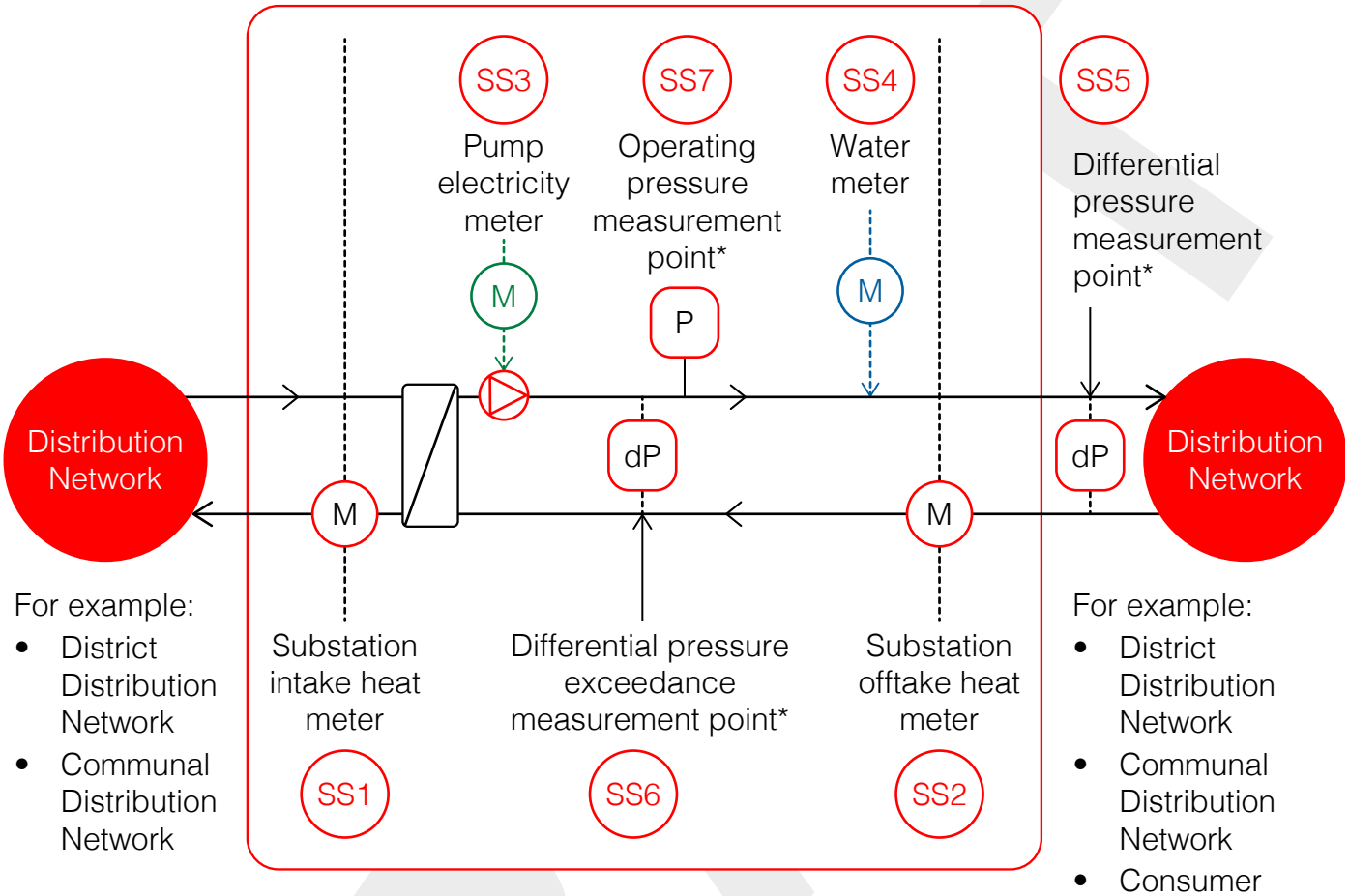
KPIs are split into two types:

- **Assessed KPIs:** These are KPIs which are assessed against pre-determined targets throughout the Operation and Maintenance phase in order to achieve and maintain HNTAS Certification.
- **Reported KPIs:** These are KPIs which are not assessed against a pre-determined target through the Operation and Maintenance phase, but still provide valuable information, so are to be reported in the same format.

The specific requirements for each stage in relation to KPIs are included in the Performance Monitoring Requirement section, including setting KPI targets on a project specific basis. Where this is required, the target is illustrated in green in Table 5.

Figure 7 illustrates the required monitoring points for measuring Substation KPIs. The monitoring points are also listed in Table 6, along with the data required from each monitoring point and the minimum read frequency. The monitoring points to be used to measure KPIs are illustrated in orange in Table 5.

Figure 7: Diagram indicating required Substation monitoring points



For example:

- District Distribution Network
- Communal Distribution Network

For example:

- District Distribution Network
- Communal Distribution Network
- Consumer Heat System

*Location(s) to be identified by the designer

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-01	Automatic Remote Monitoring System (ARMS) connectivity	Total number of days where monitoring points have connected to the ARMS system within 24 hours of last connection.	(Number of monitoring point days) / (total monitoring points * total days in period). Number of monitoring point days = Σ number of days each monitoring point has connected to the (ARMS) system within 24 hours of last connection.	Assessed KPI	Commissioning stage: 100% O&M stage: ≥ 99%.	Monthly
SS-KPI-02	Substation monitoring point data completeness	Number of total reads received in comparison to the total reads expected within the given [time period] for each monitoring point.	(Total number of reads recorded across [time period] / total reads expected across [time period]) x 100. Total reads expected = Σ (monitoring point x frequency of monitoring point x [time period]).	Assessed KPI	≥ 95%.	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-03	Substation monitoring points operational	Of the monitoring points which are connected to the ARMS system (as per SS-KPI-01) and have complete data (as per SS-KPI-02), the number of which are operating as expected. Monitoring points that are operating as expected will have (dependent on type of monitoring point): • No error codes (meters) • No negative readings (meters) • No signals outside of operating parameters (sensors)	Verification that each monitoring point is operating as expected. Measurement will be dependent on ARMS and may be automated.	Assessed KPI	100% of monitoring points, which are connected to ARMS (as per SS-KPI-01) and have complete data (as per SS-KPI-02)	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-04	Substation unplanned interruptions*	Number of unplanned interruptions reported per annum. • A Substation interruption is defined as an event causing: The flow temperature at the **Substation offtake (SS2)** to be below the minimum required flow temperature for more than 12 hours, due to an issue originating in the Substation. • The differential pressure at the **specified differential pressure measurement point(s) (SS5)** (note that this location may change during operation) to be below the minimum required differential pressure for more than 12 hours, due to an issue originating in the Substation. An unplanned interruption is an interruption as defined above, where the network end user has not been provided with at least 48 hours written notice of such interruption.	Number of unplanned interruptions = ∑ (unplanned interruptions for given [time period]).	Assessed KPI	≤ 3 interruptions per annum.	Previous 12 months Measured on monthly rolling basis

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-05	Substation planned interruptions*	Number of planned interruptions reported per annum. A Substation interruption is defined as an event causing: • A Substation interruption is defined as an event causing: The flow temperature at the **Substation offtake (SS2)** to be below the minimum required flow temperature for more than 12 hours, due to an issue originating in the Substation. • The differential pressure at the **specified differential pressure measurement point(s) (SS5)** (note that this location may change during operation) to be below the minimum required differential pressure for more than 12 hours, due to an issue originating in the Substation. A planned interruption is an interruption as defined above where notice has been given to the end user at least 48 hours prior to the interruption occurring.	Number of planned interruptions = ∑ (planned interruptions for given [time period]).	Assessed KPI	≤ 1 interruption per annum.	Previous 12 months Measured on monthly rolling basis

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-06	Substation average flow temperature	Average flow temperature for given [time period] measured at the Substation offtake (SS2).	Average flow temperature = ∑ (Flow temperature at each time point for given [time period])/ ∑(time points for given [time period]).	Reported KPI	**[expected average flow temperature]**	Monthly
SS-KPI-07	Substation average return temperature	Average return temperature for given [time period] measured at the **Substation intake (SS1)**.	Average return temperature = ∑ (Return temperature at each time point for given [time period])/ ∑(time points for given [time period]).	Reported KPI	**[expected average return temperature range]**	Monthly
SS-KPI-08	Substation flow temperature variance from set point	Average difference between the actual flow temperature measured at the **Substation offtake (SS2)** and the set point.	Average variance = ∑ (Actual flow temperature - set point at each time point for given [time period])/ ∑(time points for given [time period]).	Assessed KPI	± 2 °C	Monthly
SS-KPI-09A	Substation Volume Weighted Average flow Temperature (VWAFT)	Substation flow temperature weighted against volumetric flow rate, measured at the Substation offtake (SS2).	$\mathrm{VWART} = \frac{\sum(T_t \times q_t)}{\sum q_t}$ Where T = flow temperature for each time recording (t) for given [time period], and q = flow rate for each time recording (t) for given [time period] or cumulative volume for each time recording (t) for given [time period].	Assessed KPI	**[network flow temperature]** ± 3 °C	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-09B	Substation Volume Weighted Average Flow Temperature (VWAFT) *Note: Applicable for networks which do not have a fixed flow temperature (for example,. weather compensated systems)*	Substation flow temperature difference from its set point weighted against volumetric flow rate, measured at the **Substation offtake (SS2)**.	$\mathrm{VWART} = \frac{\sum(T_t \times q_t)}{\sum q_t}$ Where T = difference between flow temperature and its setpoint for each time recording (t) for given [time period], and q = flow rate for each time recording (t) for given [time period] or cumulative volume for each time recording (t) for given [time period].	Assessed KPI	± 3 °C	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-10A	Substation flow temperature stability	The percentage of time flow temperature, measured at the Substation offtake (SS2) is within upper and lower bounds of the design set point. The upper and lower bounds shall not exceed ± 5 °C from the flow temperature set point. The lower bound shall also be equal to or greater than the minimum flow temperature of the network required to deliver >45 °C domestic hot water (DHW) to outlets within Consumer Heat Systems, or is the minimum required flow temperature required at the Substation to deliver the minimum required flow temperature for the network it is supplying.	Stability = ∑ (time points spent within the upper and lower threshold of the design set point for given [time period]) / ∑(time points for given [time period]).	Assessed KPI	≥ 95 % spent within the thresholds Upper threshold: **[Upper temperature stability threshold (for example, 60 °C)]** Lower threshold: **[Lower temperature stability threshold (for example, 50 °C)]**	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-10B	Substation flow temperature stability *Note: Applicable for networks which do not have a fixed flow temperature (e.g.weather compensated systems)*	The percentage of time flow temperature differential from its setpoint, measured at the **Substation offtake (SS2)**, is within the upper and lower bounds. The upper and lower bounds shall not exceed ± 5 °C from the flow temperature set point. The lower bound shall also be equal to or greater than the minimum required flow temperature of the network required to deliver >45 °C DHW to outlets within Consumer Heat Systems, or is the minimum flow temperature required at the Substation to deliver the minimum required flow temperature for the network it is supplying.	Stability = ∑ (time points that the difference between the flow temperature and its setpoint is within the upper and lower threshold for given [time period])/ ∑(time points for given [time period]).	Assessed KPI	≥ 95 % spent within the thresholds Upper threshold: **[Upper temperature stability threshold (for example, + 5°C)]** Lower threshold: **[Lower temperature stability threshold (for example, -5°C)]**	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-11	Substation flow temperature uptime	The percentage of time flow temperature, measured at the **Substation offtake (SS2) is above the Minimum Req**uired Flow Temperature. Minimum required flow temperature will be project specific and is to be set for each Substation. Minimum required flow temperature of the network is the flow temperature required to deliver >45 °C DHW to outlets within Consumer Heat Systems, or is the minimum flow temperature required at the Substation to deliver the minimum required flow temperature for the network it is supplying.	Uptime = ∑ (time points spent above minimum required flow temperature for given [time period])/ ∑ (time points for given [time period]).	Assessed KPI	≥ 98 % above **[minimum required flow temperature]**	Monthly
SS-KPI-12	Substation average approach temperature	Average approach temperature for given [time period]. Approach temperature is defined as the temperature difference between the return temperature at the **Substation offtake (SS2)** and the return temperature at the **Substation intake (SS1)**.	Average return temperature = ∑(Difference between **Substation offtake (SS2)** return temperature and **Substation intake (SS1)** return temperature (°C) per time point for given [time period])/ ∑ (time points for given [time period]).	Assessed KPI	≤ **[design maximum approach temperature]**	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-13	Pressure differential uptime	The percentage of time the pressure differential spends above the minimum differential pressure set point at the **specified differential pressure measurement point(s) (SS5).**	Uptime = ∑ (time points spent above [setpoint – 10%] for given [time period])/ ∑ (time points for given [time period]).	Assessed KPI	≥ 99 % spent above **[minimum differential pressure]**	Monthly
SS-KPI-14	Maximum allowable differential pressure exceedance	The percentage of time the pressure differential spends below the maximum allowable differential pressure at the specified differential pressure **exceedance measurement point (SS6).**	Percentage time below maximum = 1 – [∑ (reads above maximum for given [time period]) / ∑ (reads for given [time period])].	Assessed KPI	100% spent below [maximum allowa**ble differential at the defined measurement point]**	Monthly
SS-KPI-15	Maximum allowable operating pressure exceedance	The percentage of time the operating pressure spends below the maximum allowable operating pressure at the **specified operating pressure measurement point(s) (SS7)**.	1 – [∑ (operating pressure reads greater than the maximum operating pressure requirement for given [time period]) /∑(operating pressure reads for given [time period])].	Assessed KPI	100% spent below **[maximum allowable operating pressure at the defined measurement point]**	Monthly
SS-KPI-16	Volume of top up water added to the network	Volume of top up water added to the network as percentage of total system pipework volume per [time period], measured at the **Substation water meter (SS4)**. Network may include other elements, such as the Distribution Network pipework served by Substation.	Amount of top-up water = volume added measured in [time period] (m3) / total system pipework volume (m3).	Assessed KPI	≤ 1% of total system pipework volume per month. **Volume: [system pipework volume]**	Monthly

KPI ID	KPI	KPI description	KPI measurement methodology	Assessed KPI or Reported KPI	KPI target (at O&M stages unless specified)	Time period (at O&M stages unless specified)
SS-KPI-17	Network distribution pump energy	Total pump energy use (kWh) measured at the **Substation pump electricity meter (SS3)** over the given [time period].	Total pump energy use (kWh) over given [time period].	Assessed KPI	**Design:** <1% of annual heat generation (kWh) **Operation:** ≤ 120% of **[design annual pump energy use]**	Previous 12 months Measured on monthly rolling basis

Table 5: Key Performance Indicators – Substation

**It should be noted that interruptions are to be assigned to the element which they originated in. Therefore, an interruption at an element which was caused by an issue outside of the control of that element, would not count towards the total interruptions for that element.*

6.1 Monitoring points

ID	Element	Location	Data required at monitoring point	Minimum frequency of reads	Further comments
SS1	Substation	Boundary (intake)	Meter read (kWh) Instantaneous power (kW) Flow rate (m^3/h or l/s) Flow temperature (°C) Return temperature (°C) Volume (m^3 or l)	5 minutes	Shall be located in the intake boundary to the Substation. To measure heat delivered to the Substation.
SS2	Substation	Boundary (offtake)	Meter read (kWh) Instantaneous power (kW) Flow rate (m^3/h or l/s) Flow temperature (°C) Return temperature (°C) Volume (m^3 or l)	5 minutes	Shall be located in the offtake boundary to the Substation. To measure heat delivered to the network from Substation.
SS3	Substation	Network distribution pump	Meter read (kWh)	30 minutes	Required to measure pump energy consumption. Required per pump set, rather than individual pumps when contained within pump set.
SS4	Substation	Water meter	Volume (m^3 or l)	30 minutes	Required to measure volume of top-up water entering the network.

ID	Element	Location	Data required at monitoring point	Minimum frequency of reads	Further comments
SS5	Substation	Defined differential pressure measurement point	Differential pressure (kPa, bar)	5 minutes	Location is determined by the Designer on a project basis. Likely to be located externally to the Substation at the index point(s) of the distribution network. Where this isn't the case, this differential pressure measurement may be within the Substation (across the pumps).
SS6	Substation	Defined differential pressure exceedance measurement point	Pressure (kPa, bar)	5 minutes	Location is to be determined by the Designer on a project basis.
SS7	Substation	Defined operating pressure measurement point	Static pressure (kPa, bar)	5 minutes	Location is to be determined by the Designer on a project basis.

Table 6:Minimum required monitoring points – Substation