



TS1

Heat Network Technical Standard

TS1 2025
DRAFT

Disclaimer

The technical contents of this document 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, which underwent review through a formal independent Peer Review process and review by the HNTAS Technical Standards Committee.

This document has been issued in a draft format to give the sector early sight of the standards within this document, and due to its interaction with other HNTAS documentation. There may be changes to this document in future, such as those to:

- align the terminology of this document with that used other HNTAS documentation;
- rectify errors in this draft version; or
- improve clarity of contents.

Additionally, there may be changes to this document to align with other aspects of HNTAS which are subject to public consultation, or are updated as a result of changes within HNTAS. The final version of this document, which will underpin the requirements set out through HNTAS, will be released before the launch of HNTAS.

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Foreword

Technical Foreword

Heat Networks are a key part of the UK Government's strategy to improve energy security and reach net zero emissions by 2050. In support of this, Heat Networks in Great Britain are on track to become a regulated utility in 2026, with oversight by Ofgem, broadly aligning with the regulatory frameworks already in place for gas and electricity. This transformation is due to start in 2026, with new regulation being phased in over time, including the introduction of:

- consumer protection frameworks;
- designated Heat Network zones;
- statutory minimum technical standards.

To support development of the sector, the UK Government is encouraging growth with financial support. With this support and a new regulatory regime, the market is expected to grow rapidly - creating substantial opportunities for businesses across the sector.

However, to ensure this growth is sustainable and delivers value to consumers and investors, Heat Networks must consistently perform to a high standard. There is evidence that many networks are not being designed, installed, or operated in ways that deliver reliable, low-cost, low-carbon heat to consumers. In addition, in some cases, capital costs are unnecessarily high due to oversizing and over complexity, undermining investor confidence.

To address these challenges, a formal technical standard is needed.

TS1 supersedes the Heat Networks: Code of Practice for the UK (CP1) (CIBSE & ADE, 2020). It is largely based on the content from CP1 (2020), but transitions from a code of practice to a formal standard. Funded by the Department for Energy Security and Net Zero (DESNZ), it will act as the primary technical reference point for the Heat Network Technical Assurance Scheme (HNTAS) Code Documents under the regulations. The technical standards set out within TS1 are the "minimum" requirements necessary for the proper design, installation, and operation of Heat Networks. While there has been some development in certain areas, to reflect the advances in technical knowledge, for the most part these standards reflect what developers and operators should already be doing to protect consumers through reducing bills and improving reliability.

In areas of high heat density like cities, Heat Networks are often the most cost-effective way to decarbonise heat supply to buildings. However, Heat Networks are complex systems, with multiple constituent parts that are often designed, built, owned, and operated by different parties. Regulating Heat Networks and introducing new mechanisms like technical assurance is not straightforward. It is therefore essential that the new regulatory framework is underpinned by robust technical standards to ensure high performance and good consumer outcomes.

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Note from the Department for Energy Security & Net Zero (DESNZ)

DESNZ would like to thank the authors at FairHeat for their hard work in producing this key technical standard. DESNZ would also like to thank the important contributions made by more than a hundred industry experts and stakeholders, without whom we could not have completed this work. The work of the three independent Peer Reviewers is also recognised with thanks as being vital in the production of this standard.

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Background

The Heat Network Technical Standard (TS1) replaces the *Heat Networks: Code of Practice for the UK* (CP1) (CIBSE & ADE, 2020), transitioning it from a voluntary code of practice to a formal standard. TS1 will serve as the principal reference point for the Heat Network Technical Assurance Scheme (HNTAS), supporting the sector's move to regulation.

CP1 (2020) provided a strong foundation for the sector and has been widely adopted in project specifications, resulting in many networks producing good outcomes for consumers. However, its implementation has varied significantly in quality and rigour. This has resulted in a wide range of outcomes, with evidence that many networks are not being designed, installed, or operated in ways that deliver reliable, low-cost, low-carbon heat to consumers.

Regulation will formally establish Heat Networks as a utility service. While this represents a significant step forward for the sector, it is also a step change with regards to expectations, which will need to be aligned with those applied to other utilities, such as gas and electricity.

Within the new regulatory regime, there will be a requirement to meet minimum technical standards, to ensure Heat Networks deliver reliable, affordable, and low-carbon heat. These standards are essential in protecting consumers and improving overall system performance.

As such, there is a clear need for a new standard specifically designed to underpin the forthcoming regulatory regime. Funded by the Department for Energy Security and Net Zero, TS1 is the document that sets out the minimum technical standards for Heat Networks.

The Heat Network landscape

Heat Networks are a key part of the government's strategy to reach net zero emissions by 2050. The Heat Network market is expected to grow rapidly, supported by targeted financial incentives and the introduction of a regulatory framework.

This growth aligns with the government's ambition for 20 % of the UK's heat demand to be met by Heat Networks by 2050 (UK Government, 2023).

Currently, Heat Networks supply an estimated 2 - 3 % of the UK's total heat demand, with roughly 12,000 existing Heat Networks currently supplying heat to around 500,000 domestic consumers and numerous large non-domestic buildings.

Growth is being delivered via an increasing number of "new build" Heat Networks. Current industry literature, such as the Technical Standard for the BESA UK HIU Test Regime BESA UK HIU Test Regime (BESA, 2023, or latest edition), estimates that over 50,000 Heat Interface Units (HIUs) are being installed per annum. This indicates that around 500 new Heat Networks are becoming operational each year, with roughly 2,500 "new build" networks going through design/construction at any given time. It can be expected that these numbers will increase significantly as a result of the forthcoming government financial support and regulation.

While a proportion of "new build" Heat Networks follow CP1 (2020), with many examples of well performing Heat Networks in the industry, the degree of implementation is varied. As such, there are many examples of Heat Networks that are not being designed, installed, or operated in ways that deliver reliable, low-cost, low-carbon heat to consumers.

This standard (TS1) will drive improvements in "new build" Heat Networks, by setting technical standards for the design and construction of those networks, and for both new build and existing networks by setting standards for operation.

The forthcoming regulatory regime

The Energy Act 2023 grants powers to mandate Heat Network technical standards through regulation. These statutory technical standards are to be enforced via a Heat Network Technical Assurance Scheme (HNTAS), which is being introduced to ensure that Heat Networks meet a minimum level of performance and reliability.

In late 2022, the Department for Energy Security and Net Zero (DESNZ) initiated the development of a suite of normative documents that will form the Code Documents for HNTAS. These documents define:

- mandatory technical requirements for Heat Networks;
- Key Performance Indicators (KPIs) to be achieved;
- assessment procedures to verify compliance.

Compliance with these requirements will ultimately lead to the certification of Heat Networks under the HNTAS framework. The Code Documents refer to this standard - the Heat Network Technical Standard (TS1) - as the core technical reference.

TS1 and CP1 (2020)

A large proportion of the content in TS1 is based on CP1 (2020). However, the following changes have been made to create a more comprehensive technical standard:

- The structure of this standard has been developed to align with HNTAS, which includes updating the stages set out in CP1 (2020) to fit the assessment regimes in HNTAS.
- Entirely new Minimum Requirements have been introduced in key technical areas, including new requirements surrounding the operating pressures, resilience, water quality, insulation, and condition of Heat Networks.
- Large parts of the requirements text in CP1 (2020) have been improved to tighten and clarify the individual technical requirements.
- All retained CP1 (2020) Minimum Requirements have been rewritten to ensure that they are suitable for a regulatory technical standard. In particular, to:
 - ensure that language is in line with ISO guidelines;
 - resolve any ambiguity and ensure suitability in an assessment context;
 - align terminology with HNTAS;
 - split requirements where there are different requirements for the different Heat Network Elements defined in HNTAS (as set out in the [Elements](#) section).
- New materials have been added into TS1 that were originally developed for HNTAS, but sit better within TS1.
- New requirements have been included where there are clear gaps and/or significant shifts in thinking that have taken place in the market, industry literature, and standards since 2020.

Document Development Structure and Governance

The management of the HNTAS Code will be within the powers of a Code Manager, which will be overseen by a Code Management Committee. The Code Management Committee will be the highest-level governance committee within HNTAS, responsible for overseeing the scheme and advising the Code Manager on changes.

During the development of HNTAS, a Shadow Code Management Committee has been established, with representation from the Department for Energy Security & Net Zero (DESNZ), the Scottish Government, and Ofgem.

As TS1 underpins HNTAS, the document has been developed under the Shadow HNTAS Governance Structure.

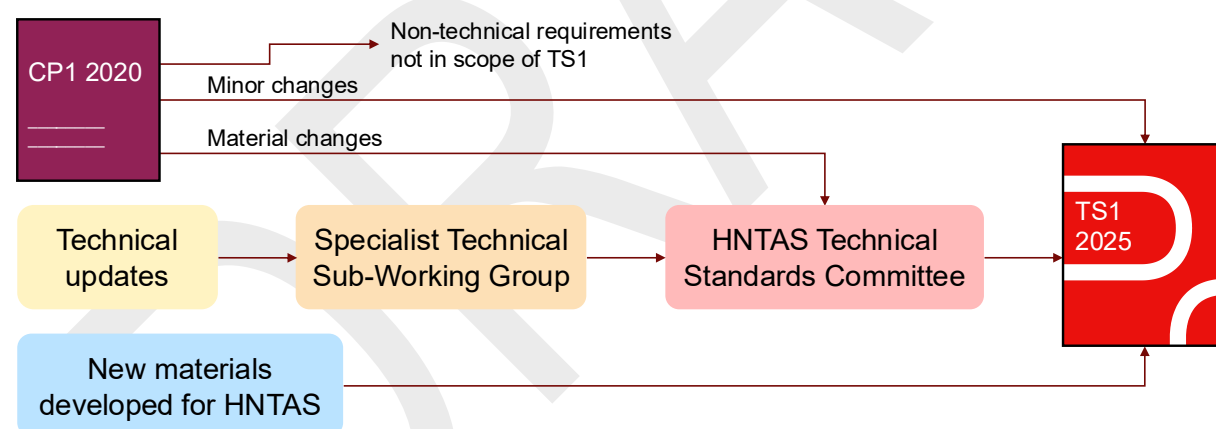
Material technical decisions made in the development of this standard were made with approval from a Technical Standards Committee (TSC), which reported to the Shadow HNTAS Code Management Committee (CMC).

The materials which are contained in TS1 include:

- content from CP1 (2020);
- materials developed with sector engagement;
- materials initially developed for HNTAS, which have now been carried into TS1.

This is indicated in [Figure 1](#).

Figure 1: High-level summary of document development structure



Following the development of these materials, the production of this document included extensive review by the Corresponding Authors of this document, which was followed by a formal independent Peer Review process and review by the TSC.

Sector engagement

The development of TS1 has been carried out under a strong governance structure with extensive engagement from the CMC and the TSC.

A key aspect of this development has been close consultation with experts and stakeholders from the sector. The TSC, made up of Heat Network experts, has been closely involved throughout the production of TS1.

Four specialist Technical Sub-Working Groups were also formed to develop sets of standards

which were subsequently proposed to the TSC. These groups were formed for the development of requirements regarding topics such as pressure, resilience, water quality, insulation, and the condition of components in Heat Networks. The outputs of engagement with these Technical Sub-Working Groups were subsequently proposed to the TSC for further discussion, before an agreed position was reached on the materials.

The engagement process for the CMC, TSC, and specialist Technical Sub-Working Groups has involved a highly rigorous process of:

- reviewing proposed standards;
- providing feedback through structured methods for review and commentary;
- discussion of feedback and proposed changes in structured meetings; and
- reaching final agreement of specific changes.

Over 40 industry stakeholders were engaged from 39 organisations, covering the whole range of the Heat Network sector. This collaboration with industry has been an important part in reaching a strong consensus in TS1.

In addition, there was content created as part of the HNTAS development process which has been carried across into TS1. This material was developed by engaging with five Technical Sub-Working Groups, across 30 half-day workshops.

As with the TS1 process, this involved a highly rigorous process of:

- reviewing proposed technical requirements;
- providing feedback through structured methods for review and commentary;
- discussion of feedback and proposed changes in structured meetings; and
- reaching final agreement of specific changes.

For the HNTAS specific materials, over 130 industry stakeholders were engaged from over 70 organisations, covering the whole range of the Heat Network sector.

Future development

It is anticipated that there will be future updates to the Heat Network Technical Standard. The transition into the regulatory regime of Heat Networks will provide continual feedback, which will inevitably require updates to this standard. The production of this standard was also subject to time constraints which meant that it was not possible to include all the new materials that might be required.

It is expected that future developments of TS1 might include:

- updates to reflect industry feedback as part of the introduction of the regulatory regime;
- splitting TS1 into separate documents covering the different **Elements** of Heat Networks;
- the inclusion of Heat Networks other than low-temperature hot water (LTHW) technologies (which is discussed further in the **Scope** section of this standard);
- technical updates to reflect changes in industry practice and technological advances.

i Introduction

i.i Key Aims

This technical standard has been developed to ensure that Heat Networks are designed, built and operated to minimum acceptable standards throughout their life cycle.

This can be done through achieving the following Key Aims.

1. Meet consumers' heat demands reliably.

- Improve the consumer experience of heat delivery by ensuring high level of reliability and a high quality of the heat supplied by the Heat Network.

2. Minimise the cost of heat over the lifespan of the Heat Network.

- Optimise the capital and operational expenditure imposed by the Heat Network.
- Reduce the cost of heat to end consumers by improving the efficiency of the Heat Network.

3. Ensure sufficient performance and reliability during the design, construction, and operation of the Heat Network.

4. Reduce carbon emissions associated with the provision of heat.

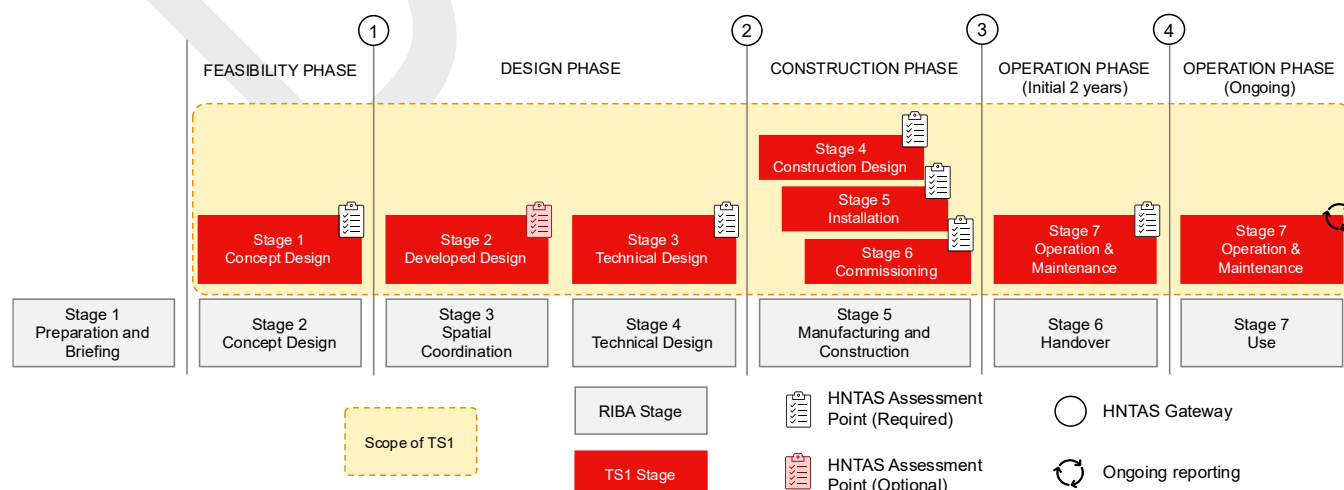
The standards in this document have been developed such that meeting each standard will aid in achieving these Key Aims.

i.ii TS1 Stages

The design, construction, and operation of Heat Networks typically involve processes which are broken into levels of detail corresponding to how far the Heat Network has progressed. It can be helpful to set out the level of detail required and activities undertaken at particular points in the development process by the use of "stages" - this approach has been adopted by literature including the Royal Institute of British Architects (RIBA) Plan of Work (RIBA, 2020).

There are seven stages in TS1 which correspond to the stages used in HNTAS. These are shown in Figure 2, alongside their correspondence to the stages used in the RIBA Plan of Work (RIBA, 2020).

Figure 2: Stages of TS1



Within **Figure 2**:

- the **scope** of TS1 is shown in yellow;
- the clipboards indicate when an **assessment** is undertaken under HNTAS;
- the **gateways** which are passed following completion of assessment of the preceding stages are shown by vertical lines.

The typical activities which are undertaken at each stage are provided below.

Some of the activities set out in TS1 have been brought forward compared to previous industry practice. This is in the interest of:

- mitigating the risk of disruptive and costly design variations at later design stages;
- this standard working with HNTAS, which has been developed with a core principle of being a preventative assurance scheme.

A key benefit of bringing these activities into earlier stages is the ability to make changes to the design of a Heat Network while there is still a relatively high amount of flexibility in the design of the Heat Network alongside the wider systems it can be part of (e.g. other building services in a “new build” scenario).

This is illustrated in **Figure 3**.

Figure 3: Impact of design changes over time

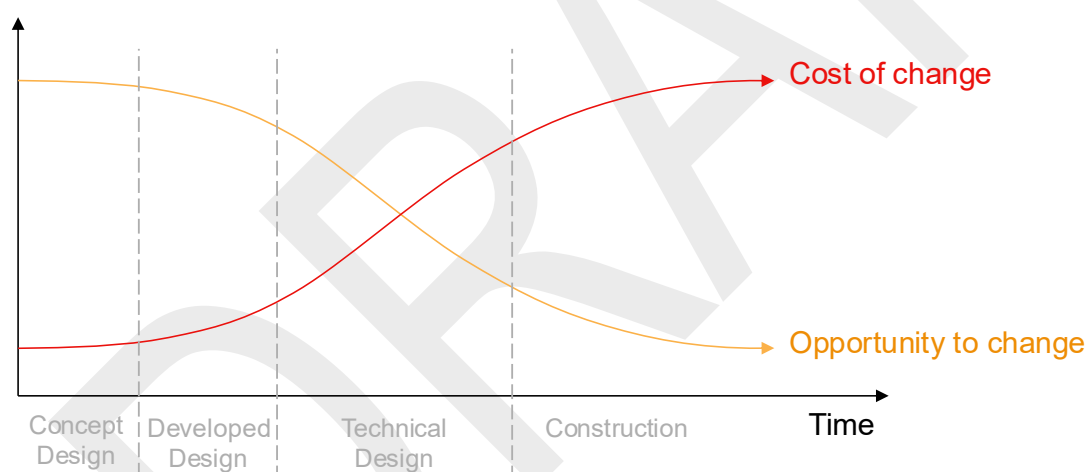


Figure based on materials produced in the RIBA Plan of Work (RIBA, 2020).

1. Stage 1: Concept Design

This stage is broadly aligned with RIBA Stage 2 (Concept Design).

The Concept Design stage typically includes consideration of the heat demands present, heat source(s), operating temperatures, network routing, operating pressures, and initial estimates of pipe sizing and insulation thicknesses. There is a particular focus on the spatial requirements of the Heat Network.

It should be noted that a number of feasibility activities (i.e. those at RIBA Stage 1) will have occurred before or alongside the Concept Design stage which are outside the scope of this standard. These could include the production of a project brief, the development of feasibility studies, and the identification of different responsibilities at later design stages.

2. Stage 2: Developed Design

This stage is broadly aligned with RIBA Stage 3 (Spatial Coordination).

The Developed Design stage includes the development of the Heat Network design such that, at the end of the stage, the design will be sufficiently detailed to allow the co-ordination of the spatial requirements and operational strategy of the Heat Network with other building services and the wider system (where applicable). The design of the Heat Network at the end of the Developed Design stage should be sufficiently detailed to allow for the Technical Design of other aspects of the wider system to be developed independently.

Activities undertaken at this stage include:

- the calculation of system parameters (e.g. heat demands, sizing of plant and equipment) to a higher level of detail due to the information available for the wider system;
- the production of drawings, which may be shown through centre-lines for some Distribution Network pipework; and
- the production of schematics, which include all of the engineering components needed to make the Heat Network operate sufficiently and operational parameters such as the flow rate through each distinct pipe section.

Note on assessment at Stage 2

It is proposed that assessment under HNTAS is optional at the Developed Design stage. The set of Minimum Requirements which apply at the Developed Design stage is slightly smaller than the set at the Technical Design stage. Additionally, some requirements at the Developed Design stage do not apply to the same extent as those applicable at the Technical Design stage (with only specific aspects of the requirement being applicable).

3. Stage 3: Technical Design

This stage is broadly aligned with RIBA Stage 4 (Technical Design).

The Technical Design stage includes the development of the design to a position which is suitable for the Construction phase to begin, with all aspects of the design being complete except for relatively minor variations which might arise from activities during the Construction phase. Where subcontractors are required for design activities, this is complete by the end of the Technical Design stage.

The activities undertaken during the Technical Design stage are similar to those undertaken at the Developed Design stage. However, they will be carried out with:

- a higher level of precision, incorporating the information available for the wider system;
- further consideration for how the plant, equipment, and pipework will be installed;
- spatial coordination with the wider system being completed and suitable for installation.

4. Stage 4: Construction Design

TS1 Stage 4 (Construction Design) - Stage 6 (Commissioning) broadly align with RIBA Stage 5 (Manufacturing and Construction).

The Construction Design stage typically includes the production of technical submittals for components on the Heat Network, production of fully developed installation drawings, production of an operation and maintenance (O&M) manual, and updates to documentation to reflect any agreed changes from the design of the system at the Technical Design stage which might have occurred during the Installation and Commissioning stages.

5. Stage 5: Installation

The Installation stage includes the installation of all of the required components on the Heat Network. This includes the installation of pipework, equipment and insulation on the Heat Network, filling and flushing of the network, pressure testing, and quality assurance activities on the Heat Network installation such as pipework joints.

6. Stage 6: Commissioning

The Commissioning stage includes the commissioning of equipment throughout all Elements of the Heat Network, Acceptance Testing, recording of water quality parameters and verification that they are within control limits, and assessment of the condition of pipework and equipment on the Heat Network.

At the end of the Construction Design, Installation, and Commissioning stage, the Heat Network is typically ready to begin operating.

7. Stage 7: Operation & Maintenance

This stage is broadly aligned with RIBA Stage 6 (Handover) and Stage 7 (Use).

The Operation & Maintenance stage includes the necessary activities to ensure that the performance and reliability of the Heat Network remain within acceptable levels when heat is being supplied to consumers. This includes planned preventative maintenance, regular assessment of the condition of pipework and equipment on the Heat Network, regular recording of water quality parameters, and the maintenance of documentation such as the operation and maintenance (O&M) manual

i.iii Structure within each TS1 stage

Within each stage of TS1, there is a set of **Objectives** which need to be met. These Objectives set out the principles underpinning the standards, and have been developed such that meeting the objectives will aid in achieving the Key Aims at that stage. The set of Objectives which are applicable at a given stage varies on a stage-by-stage basis.

A diagram illustrating which **Key Aims** the Objectives will aid in achieving is provided at the start of each Objective, accompanied by an informative overview of the Objective at that stage, shown in yellow.

This is an example of informative text, such as that provided at the start of an **Objective**.

Within each Objective, there is a set of **Minimum Requirements** which need to be met in order to meet the given Objective. The Minimum Requirements set out the required action(s) at that stage.

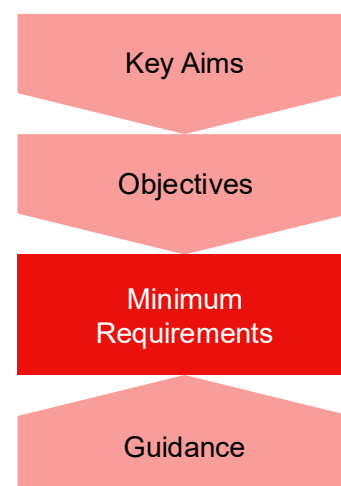
Where appropriate, a Minimum Requirement is accompanied by **guidance**, which is shown through guidance boxes, in red.

1.1.1. This is an example of Minimum Requirement text.

This is an example of guidance box text.

The hierarchy of the Key Aims, Objectives, Minimum Requirements and guidance is shown in **Figure 4**.

Figure 4: Hierarchy of structure within each TS1 stage



i.iv Objectives

What is an Objective?

An Objective is a set of Minimum Requirements which are grouped together to improve the readability of this standard.

The Objectives in this standard have been developed with the intention of indicating:

- how fulfilling a set of Minimum Requirements will aid in achieving the **Key Aims** of this standard;
- where there is **precedence** between Minimum Requirements in the same stage;
- which Minimum Requirements are more closely **linked** to one another;
- how the principles of this standard apply to the **design, construction, and operation** of Heat Networks.

TS1 Objectives

The Objectives set out in TS1 are provided below.

1. Determine the consumer heat demands from the network

- Identify peak heat demand (kW) and annual heat consumption (kWh/year).
- Estimate heat demands from space heating, domestic hot water, other consumer heat demands, and system losses.
- Facilitate the accurate sizing of equipment and pipework in the Heat Network.

2. Ensure that Consumer Systems meet consumer heat demands in a controlled manner

- Ensure that the expected range of demands from the end consumer can be met by Consumer Systems.
- Provide end consumers with a high quality of heat supply.
- Deliver heat to end consumers with a sufficient level of control.
- Achieve low return temperatures from consumer heat systems.

3. Minimise the length of the Heat Network

- Minimise heat losses from the Heat Network.
- Reduce the CapEx of the Heat Network.

4. Minimise operating temperatures within the constraints present

- Minimise heat losses from the Heat Network.
- Maximise the efficiency / coefficient of performance of heat generation plant.
- Reduce the risk posed by the operation of the Heat Network.

5. Optimise distribution pipe diameters

- Minimise the OpEx (largely from heat losses and pumping energy) of the Heat Network.
- Reduce the CapEx of the Heat Network.
- Reduce the space occupied by Distribution Network pipework.

6. Minimise the risk posed by operating pressures

- Understand the risk posed by operating pressures.
- Consider the risk posed by operating pressures in the design, construction, and operation of the Heat Network.
- Incorporate mitigation measures as necessary.

7. Ensure that Energy Centres and Substations can meet the expected range of demands

- Produce an operating model to calculate energy flows.
- Identify appropriate heat sources for the Heat Network.
- Determine optimal sizes for heat generation plant and thermal storage.

8. Ensure that Energy Centres and Substations operate in a controlled manner

- Ensure stable temperatures, pressures, and flow rates within the Heat Network.
- Operate Energy Centres and Substations to minimise the cost of heat generation.
- Maximise the benefits of thermal storage.

9. Ensure sufficient resilience in the Heat Network

Resilience refers to the ability to:

- prepare and plan for;
- absorb;
- recover from; and
- more successfully adapt to, adverse events or threats.

This definition is in line with that provided in the National Academy of Sciences report *Disaster Resilience: A National Imperative* (National Academy of Sciences, 2012). In the context of Heat Networks, threats could refer to interruptions to the supply of heat to consumers or incidents which cause damage to the Heat Network.

- Incorporate resilience within the design, construction, and operation of the Heat Network.
- Minimise the impact of interruptions to the supply of heat.
- Consider future-proofing in the design, construction, and operation of the Heat Network.

10. Simplify designs where feasible

- Reduce the CapEx and OpEx of the Heat Network.
- Reduce complexity in the operation and control of the Heat Network.
- Minimise the risk of component failure.

11. Ensure sufficient water quality in the Heat Network

- Clearly set out how water quality will be upheld in the Heat Network.
- Reduce the risk of poor water quality through the design of the Heat Network.
- Record and assess the water quality in the Heat Network.
- Keep water quality within acceptable limits to maximise the lifespan of the Heat Network.

12. Ensure that the performance of the Heat Network can be monitored

- Aid in contributing to controlled operation of the Heat Network.
- Monitor and assess the performance of Heat Networks.
- Facilitate the metering of heat consumption from the Heat Network.

13. Ensure that the Heat Network is sufficiently insulated

- Ensure that appropriate insulation types and thicknesses are specified and installed.
- Minimise heat losses from the network.
- Prevent overheating in buildings (e.g. corridors).

14. Minimise the risk posed by construction activities and the operation of the Heat Network

- Understand the risk posed by construction activities.
- Understand the risk posed by the operation of the Heat Network.
- Incorporate mitigation measures against the risks which present themselves in the design, construction, and operation of the Heat Network.

15. Ensure sufficient maintenance of the Heat Network

- Reduce the risk of the deterioration and failure of components on the Heat Network.
- Incorporate maintenance requirements in the design of the Heat Network.
- Perform effective planned preventative maintenance (PPM) during the operation of the Heat Network.

16. Manage and maintain the condition of components in the Heat Network

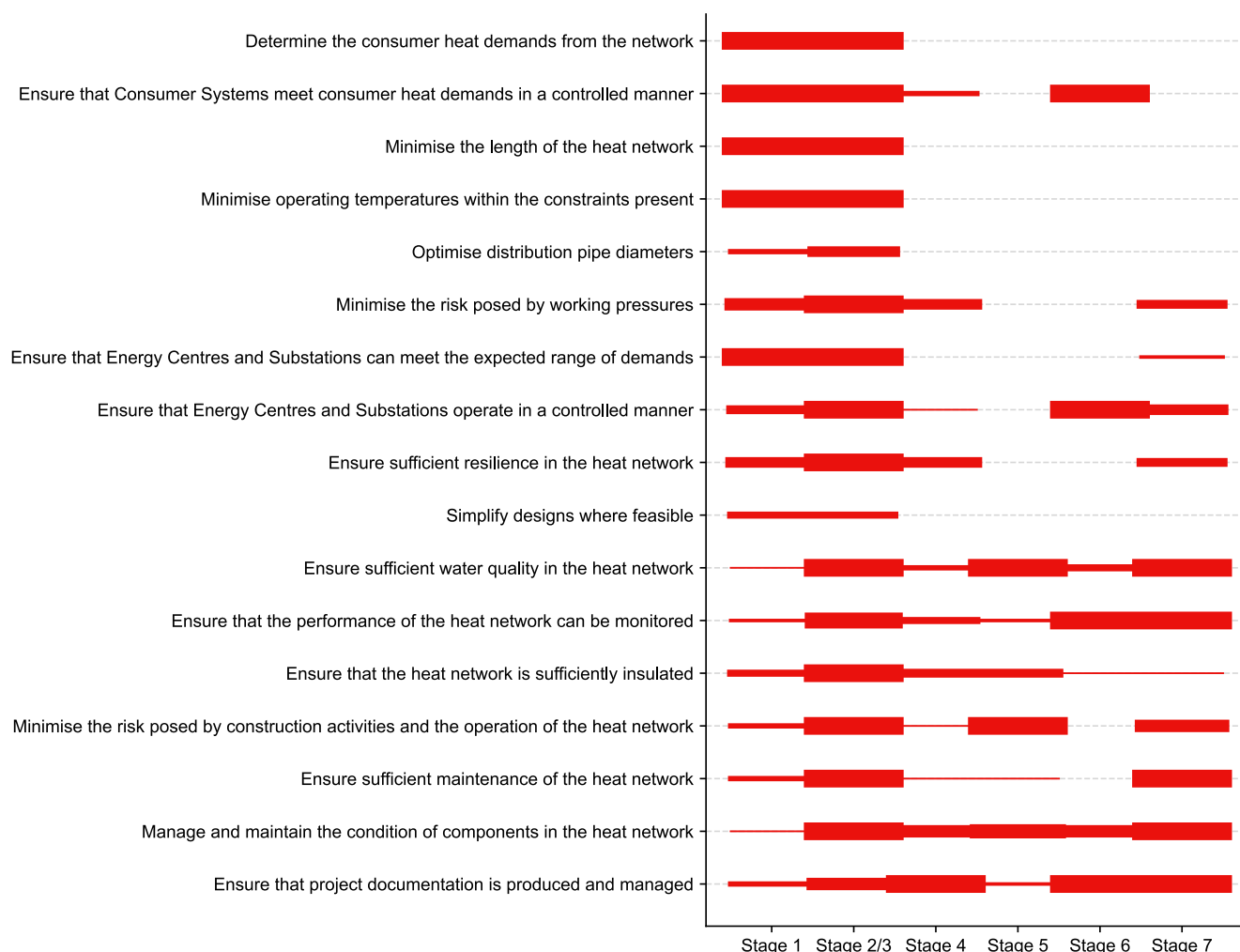
- Reduce the risk of the deterioration and failure of components on the Heat Network.
- Assess the condition of components regularly during the network's operation.

17. Ensure that project documentation is produced and managed

- Develop and maintain clarity in the design intent of the Heat Network.
- Build and operate a Heat Network with its operation in accordance with the design intent.
- Make sufficient information available to relevant parties during the operation of the Heat Network.

Each Objective applies to a number of the stages of this standard; some Objectives are applicable at every stage, and some are not. **Figure 5** indicates the size of each Objective for each stage of this standard.

Figure 5: Objectives throughout TS1 stages



i.v Writing conventions

Throughout this standard, the following auxiliary verbs have been used such that:

- **shall** indicates a requirement of this standard;
- **should** indicates a recommendation in this standard;
- **may** indicates a permissible action;
- **can** indicates a possible action; and
- **must** indicates a constraint or an obligation which is defined outside of this standard.

References

Where internal references are made in this document, this is indicated through hyperlinked pink text.

Where external references are made in this document, the document title is provided alongside a citation. A list of external references is provided in the [References](#) section of this document.

i.vi What is a Heat Network?

A Heat Network is a network that, by distribution of a liquid or a gas, enables the transfer of thermal energy for the purpose of supplying heating, cooling, and/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). Cooling networks are outside the scope of this standard.

There are two categories of Heat Networks.

- Communal Heat Network

A Heat Network by means of which heating and/or hot water is supplied only to a single building divided into separate premises or persons in those premises.

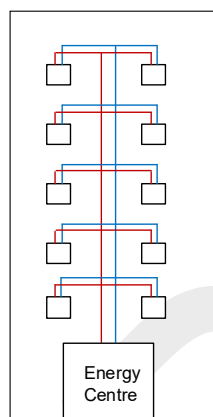
- District Heat Network

A Heat Network by means of which heating and/or hot water is supplied to two or more buildings or persons in those buildings.

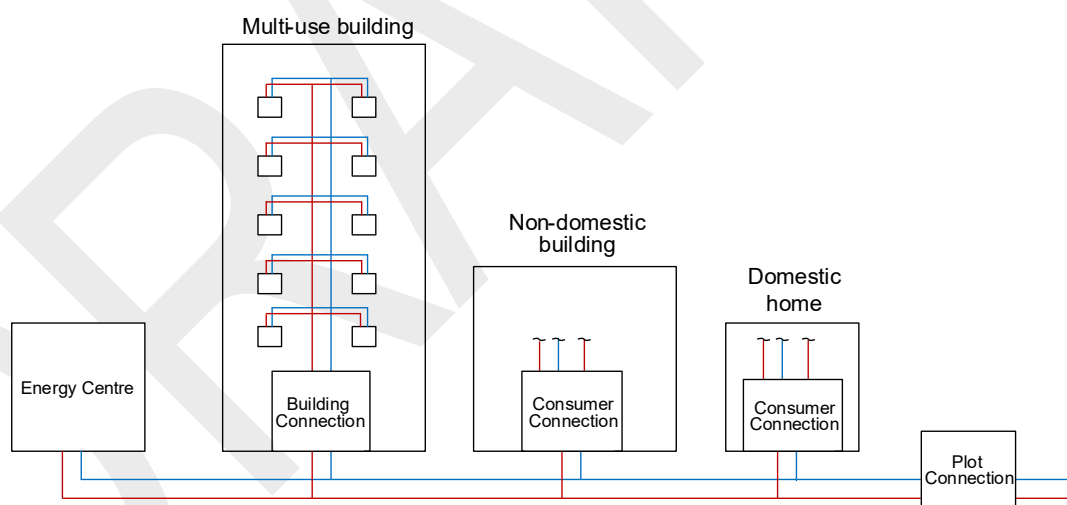
Examples of a Communal Heat Network and a District Heat Network are illustrated in [Figure 6](#).

Figure 6: Examples of types of Heat Network

a: Communal Heat Network



b: District Heat Network



The terminology used in [Figure 6](#) to identify the components of a Heat Network is set out in the [Elements](#) sub-section within [Scope](#) section of this document.

Pipework which is used to supply heat to the network's Termination Points (such as connections to end consumers, or building connections) is referred to as "flow" pipework, shown in red.

Pipework which is fed from Termination Points back to the network's Initiation Point (such as the Energy Centre, or a Substation) is referred to as "return" pipework, shown in blue.

The performance outcomes of a Heat Network can be measured using Key Performance Indicators (KPIs), which aim to give an indication of the Heat Network's performance in a way which is measurable, controllable, internally valid, and manageable. Tables of the KPIs which are reported for each Element under HNTAS are provided in [Annex M: HNTAS KPIs](#).

ii Scope

ii.i Temperature

This standard applies to low-temperature hot water (LTHW) Heat Networks, which supply consumers with heat at temperatures that are sufficiently high to meet consumer heat demands without temperature boosting (e.g. through the use of heat pumps) at the connection to the end consumer.

This standard applies to Heat Networks with a flow temperature of ≤ 110 °C.

There are additional considerations which should be taken into account for systems operating with higher temperatures (e.g. above 90 °C). There are technical requirements and health & safety considerations for these types of systems which are not covered in this standard, but need to be considered in the design, construction and operation of Heat Networks.

The following types of Heat Network are outside the scope of this standard.

- Networks with a flow temperature of less than 50 °C.
- Networks which supply cooling through the transfer of fluids.

ii.ii Size

This standard can be applied to Heat Networks of all sizes. However, some minimum technical requirements in this standard are only applicable to networks of a certain size. Where this is the case, this is indicated within the requirement text.

ii.iii Elements

A Heat Network can be broken down into a number of unique components which can be:

- subject to different technical requirements and constraints;
- developed within different timescales;
- assigned to different parties throughout the lifecycle of the Heat Network.

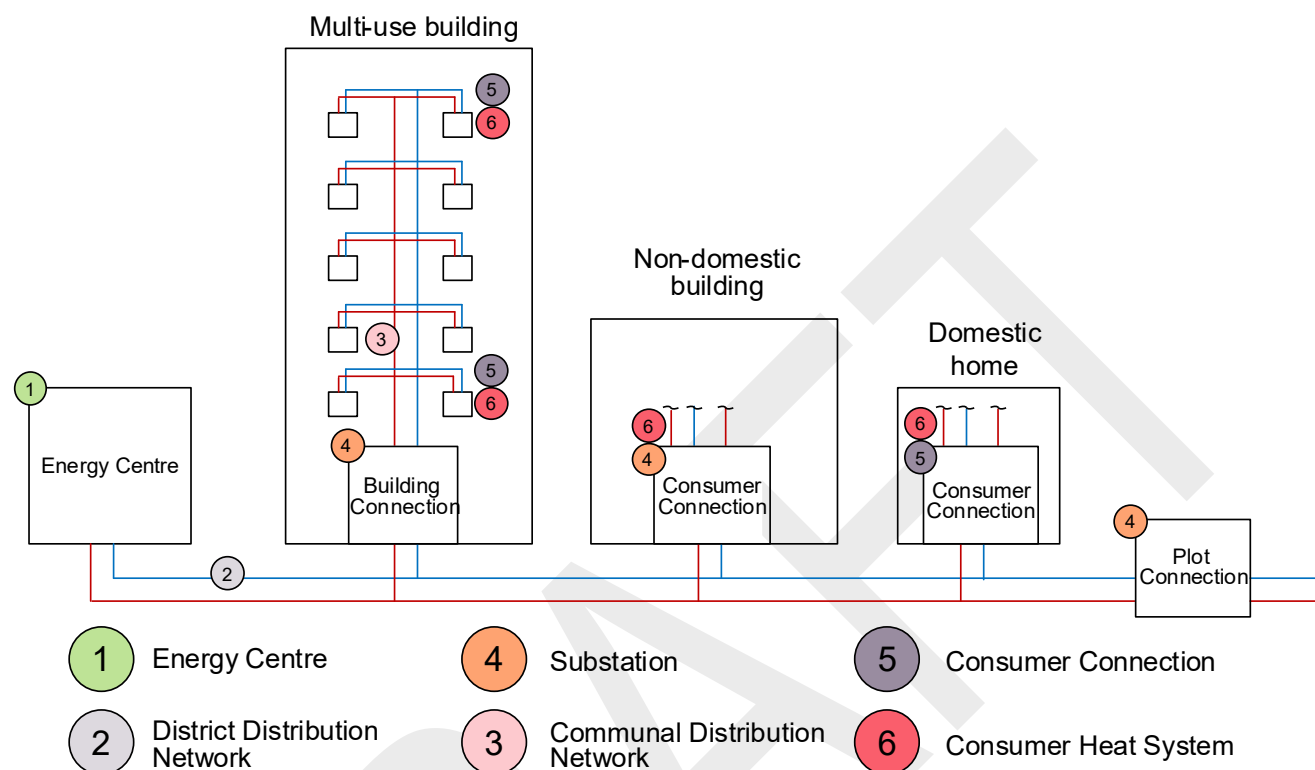
The components which make up the Heat Network are categorised into the following **Elements**:

1. An **Energy Centre** contains heat generation and the other necessary ancillary equipment to provide thermal energy to, and distribute thermal energy around, a Heat Network.
2. A **District Distribution Network** is a pipework system that distributes thermal energy between buildings, which can be comprised of buried or above-ground pipework.
3. A **Substation** is a connection between Distribution Networks which contains an exchange of thermal energy (e.g. via plate heat exchangers) together with the necessary equipment to distribute thermal energy around the Heat Network it is supplying thermal energy to.
4. A **Communal Distribution Network** is a pipework system within a building that distributes thermal energy to Consumer Connections.
5. A **Consumer Connection** is the connection (e.g. a Heat Interface Unit) between a Distribution Network and a Consumer Heat System.
6. A **Consumer Heat System** is the set of heating, cooling, and/or domestic hot water systems which serve a consumer (e.g. radiators within a consumer property).

An example of the Elements present within a District Heat Network is provided in [Figure 7](#).

Where a requirement is applicable to a particular Element, this is indicated in the requirement text.

Figure 7: Element mapping on example District Heat Network



A Consumer Connection is defined as Substation above a certain size - refer to [Annex A: Terms and Definitions](#). District and Communal Distribution Networks can connect without a Substation at Building Connections and Plot Connections.

ii.iv Stages

Stages 1 to 6 of this standard apply only to new Heat Networks, or sections of an operational network which undergo significant changes and/or replacement works.

Stage 7 of this standard applies to all operational Heat Networks.

Refer to [Figure 2](#) for an illustration of how the stages of this document align with HNTAS and correspond to the RIBA stages.

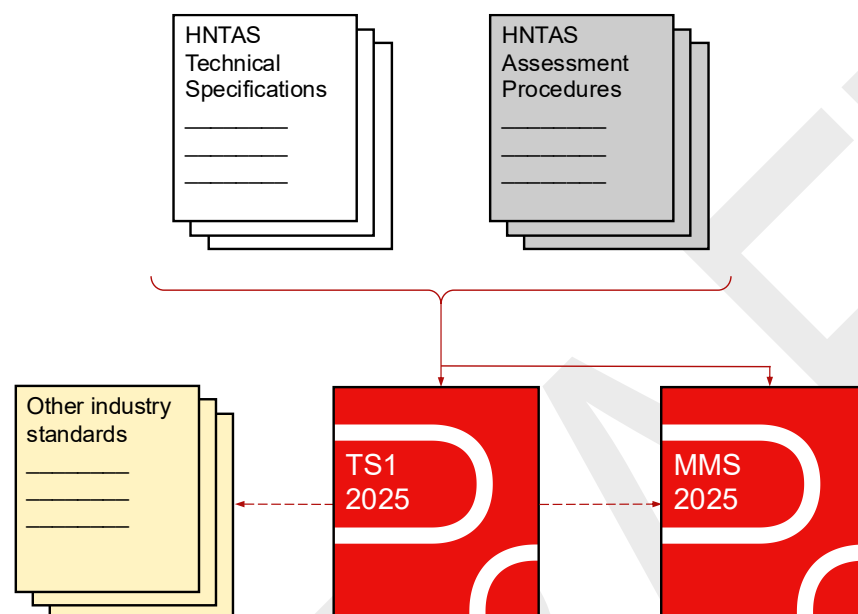
ii.v Interaction with other industry standards

This standard is referenced as the principal technical reference point for HNTAS.

TS1 and other HNTAS documentation reference the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025), as well as other industry standards and HNTAS documentation.

This is indicated in [Figure 8](#).

Figure 8: Interaction of TS1 with other industry standards



The purpose of this standard is not to identify where other obligations (e.g. due to legal and/or statutory requirements) can apply. It is the responsibility of those involved in the development and/or operation of the Heat Network to ensure compliance with all obligations which apply to that system.

Wherever references are made to standards or regulatory frameworks which apply at a national level within this document (such as Building Regulations), readers should refer to the specific standards and guidance applicable to their jurisdiction (e.g. England, Wales, or Scotland) due to devolved powers.

iii Normative references

Throughout this standard, there are references to other documents, such as external technical standards.

Where a document is referenced in the text in such a way that some or all of their content constitutes requirements of this document, this is indicated within the context of the reference itself.

See the **References** section of this document for the normative and informative references of this document.

For undated references, the latest edition of the referenced document (including any amendments) applies.

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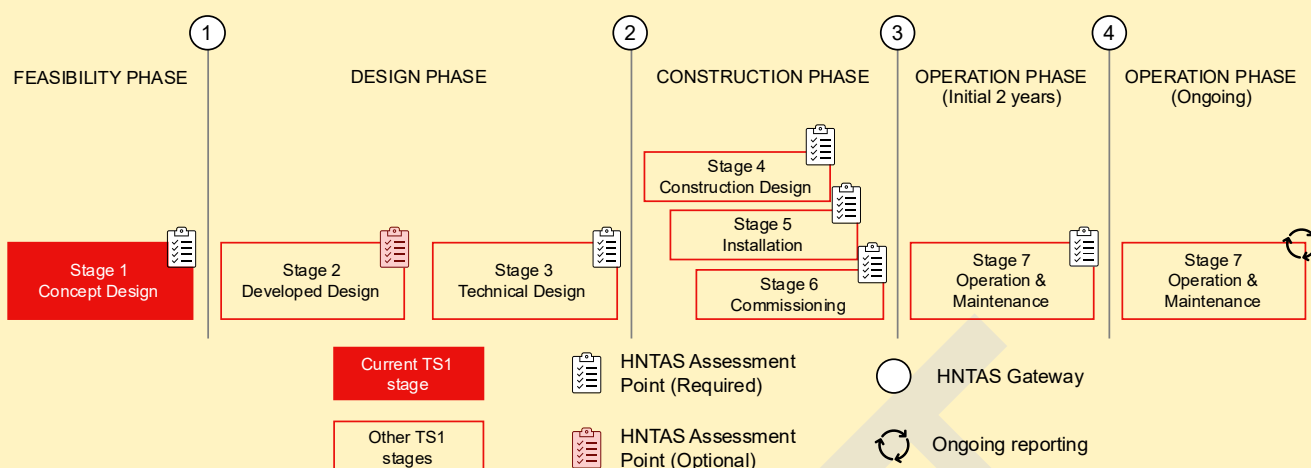
iv Terms, definitions and symbols

See [Annex A: Terms and Definitions](#).

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1 Stage 1: Concept Design

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Concept Design stage overview

The Concept Design stage of this standard contains requirements which broadly correspond to the activities which occur after the preparation and briefing stage of a Heat Network project.

A Heat Network may enter the Concept Design stage of this standard at any time from the conception of the Heat Network project until after the end of the preparation and briefing stage. However, it should be noted that there are a number of activities not covered in the Concept Design stage of this standard. This includes:

- non-technical requirements which might happen at a similar time to the activities listed within the Concept Design stage of this standard; and
- activities which typically happen before the Concept Design stage of this standard.

A primary purpose of the Concept Design stage is to ensure that sufficient space is made available for the Heat Network to fulfil its design intent, while mitigating the risks posed on or by the Heat Network. To determine the spatial requirements of the system, an understanding is needed of the design intent and operation of the Heat Network.

At the end of the Concept Design stage, it is expected that:

- the peak heat demand and annual heat consumption which the Heat Network will serve have been determined;
- the heat source(s) serving the Heat Network has been determined;
- the operating temperatures have been determined, including the operating temperatures at consumer heat systems and at the heat source(s);
- initial estimates of the routing of the network, pipe sizes, and required levels of insulation thickness have been determined;
- an operating model which shows the energy flows throughout the network have been produced;
- a Resilience Strategy will have been produced;
- product documentation such as a document register has been produced and readily available to update at later stages.

1.1 Determine the consumer heat demands from the network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

One of the most influential factors on the design of a Heat Network is the consumer heat demand which it needs to satisfy.

It is key to the design process to obtain and use relevant information available, alongside appropriate calculation methodologies, to produce accurate estimates for the consumer heat demands from the network. These estimates can then be used for subsequent design activities at the Concept Design stage and updated as more of the information regarding the wider system becomes available.

Establishing heat demands

- 1.1.1. An assessment of the potential stakeholders in the Heat Network's surrounding location (including those in future developments) shall be undertaken to establish likely heat consumption and demands. This shall include:
- consideration of whether stakeholders in existing buildings are public or private;
 - an assessment of the appetite for, and likelihood of, connecting to future Heat Networks;
 - identification of possible anchor loads;
 - identification of possible Energy Centre locations;
 - an assessment of the timing and phasing of ongoing and future developments in the local area of the Heat Network.

Total heat demands

- 1.1.2. Values shall be determined for the heat demand profiles and annual heat consumption from:
- space heating;
 - domestic hot water;
 - other consumer heat demands which are neither space heating nor domestic hot water;
 - system losses from the Communal Distribution Network.

These values shall be determined using data where it is available; where data is not available, an estimate shall be used.

The methodology and any assumptions used in this analysis shall be clearly documented.

A heat demand profile indicates how the heat demand changes over time. Determining the heat demand profiles and the annual heat consumption can be useful for subsequent design activities, such as the sizing of heat generation plant and thermal storage.

1.1.3. The annual heat consumption, peak heat demands, and heat demand profiles for new buildings shall be estimated using:

- modelling software - this may be either established software or using bespoke models in commonly-available software (such as Microsoft Excel); or
- accurate and appropriate data from recently constructed operational buildings.

The development of the models shall include consideration of the building fabric standards at the time of the building's construction and the potential use of passive methods and dynamic methods (e.g. mechanical ventilation with heat recovery) for improvements to the building's thermal performance.

Where use of modelling software is not feasible due to deliverability constraints, benchmarks may be used for estimates if technical justification on the approach used is provided.

The estimation of annual heat consumption and peak heat demands shall be undertaken with calculation methodologies which are robust, reliable and auditable.

1.1.4. For existing buildings, heat, cooling and electricity (if appropriate) demands shall be based on the highest-frequency data available, with heat generation efficiencies being estimated from plant of a similar type and condition. Half-hourly consumption data shall be used if available - this data shall:

- be sourced from actual consumption readings which are accurate and appropriate;
- cover periods of peak demand from the network;
- be reflective of the future use of the building.

Hourly data may be used if half-hourly data is unavailable.

If neither dataset of actual consumption is available, accurate and appropriate energy benchmarks may be used alongside appropriate software (either established software or using bespoke models in commonly-available software, such as Microsoft Excel) to estimate annual consumption, with demand profiles reflective of actual usage being used to estimate half-hourly consumption patterns.

Periods of down-time (where the meter is offline) shall be identified and appropriately interpolated or imputed (or determined through an equivalent method) when using meter data; this is to mitigate against incorrect peak demand estimates from the large difference in readings when the meter comes back online.

1.1.5. Temporary monitoring of heat demands in existing Key Buildings and existing atypical heat loads shall be undertaken unless it is not reasonably practicable to do so. Where possible, this monitoring should continue for at least a year. This should be used to obtain accurate data on annual heat consumption, peak demands and seasonal and daily variations in heat demands. If it is infeasible for monitoring data to be used at this stage, installation of monitoring equipment should be undertaken regardless to make data available for subsequent design stages.

A “Key Building” is defined as a building with significant influence on the overall heat load of the Heat Network; this is likely to be an anchor load.

An “atypical heat load” is defined as a heat load which deviates from the typical pattern for a building of the same use and occupancy.

Heat demand data can also be estimated from half-hourly utility meter data where this is available to the building owner.

1.1.6. Where actual consumption data is not available, annual heat consumption, peak heat demands and heat demand profiles for existing buildings shall be estimated from a combination of the following, supplemented by modelling using CIBSE TM54: *Evaluating Operational Energy Use at the Design Stage* (CIBSE, 2022).

- Installed boiler capacity and information on how the boilers are operated in practice.
- Benchmarks of annual consumption and peak demands specific to the building type.
- Heated floor areas.
- The age of the building.

Benchmarks for annual consumption and peak demand estimates are available from the following.

- CIBSE Energy Benchmarking Tool (CIBSE, 2019).
- CIBSE TM46: *Energy benchmarks* (CIBSE, 2008).
- CIBSE Guide F: *Energy efficiency in buildings* (CIBSE, 2012) (for existing buildings).
- BSRIA BG 85/2024: *Rule of Thumb - Mechanical Criteria* (BSRIA, 2024).
- BSRIA BG 87/2024: *Rule of Thumb - Useful Information Guide* (BSRIA, 2024).
- Building Energy Efficiency Survey (BEES): *Overarching Report* (BEIS, 2016).

Additionally, many public buildings need a Display Energy Certificate (DEC), and some private buildings need an Energy Performance Certificate (EPC), which can be used to inform estimates where it is not possible to obtain other information for benchmarks. Further information can be found using GOV.UK resources (HM Government, n.d.).

Benchmarks should only be used as the sole information source when actual consumption data is not available and shall be clearly referenced. An iterative approach of gradually replacing benchmark estimates with actual consumption data shall be adopted where possible. Data from local Heat Network operators or data obtained from similar operational schemes may also be used.

Space heating

1.1.7. An external air temperature shall be defined at which the capacity for heat supply from the network shall be at its maximum. The selection of this design external air temperature shall consider the location of the network and appropriate industry guidance. Where there are multiple types of space heating emitter (e.g. radiators and air handling units (AHUs)), different design external air temperatures may be used and attributed to the different types of emitters.

Further information regarding design external air temperatures can be found in:

- CIBSE Guide A: *Environmental Design* (CIBSE, 2015);
- CIBSE Guide B: *Heating, Ventilating, Air Conditioning and Refrigeration* (CIBSE, 2016).

- 1.1.8. The intended maximum space heating supply capacity (in kW) for each consumer shall be defined at the design external air temperature(s).

Where appropriate, consumers may be grouped by type (e.g. by number of bedrooms, building type, or usage type) for this calculation at the Concept Design stage.

- 1.1.9. Estimates of space heating consumption from actual consumption data shall be adjusted by weather correction (such as using “degree day” analysis between the year(s) of measurement and historic averages at the building's location) to provide estimates of space heating annual consumption and demand profiles for a typical year. Sensitivity analysis shall be performed between the adjusted space heating demand profile and the design winter temperature provided in CIBSE Guide A: *Environmental Design* (CIBSE, 2015).

Further information regarding “degree day” analysis can be found in CIBSE TM41: *Degree Days - Theory and Application* (CIBSE, 2006)

Domestic hot water

- 1.1.10. The intended domestic hot water supply capacity (in kW) for each consumer shall be defined based on:

- the domestic hot water supply temperatures at each outlet;
- the mains cold water supply temperature;
- the estimated flow rates at each outlet.

Where appropriate, consumers may be grouped by type (e.g. by number of bedrooms, build type, or usage type) for this calculation at the Concept Design stage.

An example methodology for determining the required domestic hot water flow rate at outlets served by thermostatic mixing valves is provided in [Figure 18](#).

Phased Heat Networks

- 1.1.11. Where there is reason to believe that there could be future expansion to the Heat Network impacting specific Elements, the estimation of future heat, cooling and electricity demands shall be calculated in a similar way to the demands in the network's current scope. Where appropriate, a sensitivity analysis shall be undertaken to determine the impact of future demands and external air temperatures (e.g. due to climate change) on the design of the Heat Network.

Further information regarding the impact of climate change on external air temperatures can be found in CIBSE TM48: *Use of Climate Change Data in Building Simulation* (CIBSE (in collaboration with Arup), 2009).

- 1.1.12. For developments with phased construction, a phasing plan shall be produced indicating the list and order of building connections, and the subsequent profile of heat demand over the development of the network.

1.2 Ensure that Consumer Systems meet consumer heat demands in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The design development of Consumer Systems can affect:

- the design of other Elements in the Heat Network; and
- system-wide parameters of the Heat Network (such as operating temperatures).

Therefore, it is important to ensure that Consumer Systems meet consumer heat demands in a controlled manner at the Concept Design stage, to aid in designing a Heat Network which can meet consumers' heat demand reliably.

Space heating

1.2.1. Consumer Heat Systems shall be designed with flow rates to individual emitters such that:

- the flow and return temperatures are compliant with the values provided in [Table B.1](#) unless it is infeasible to do so (e.g. due to spatial restrictions);
- the design return temperature can be accurately achieved across all emitters (including at low- and part-load conditions, which is typically the prevailing load condition).

For Consumer Heat Systems with low demands, lower flow temperatures should be considered to prevent low flow rates and mitigate difficulty in commissioning and control.

1.2.2. Wet towel rails should not be connected to the Consumer Heat System; electrical towel rails should be used instead.

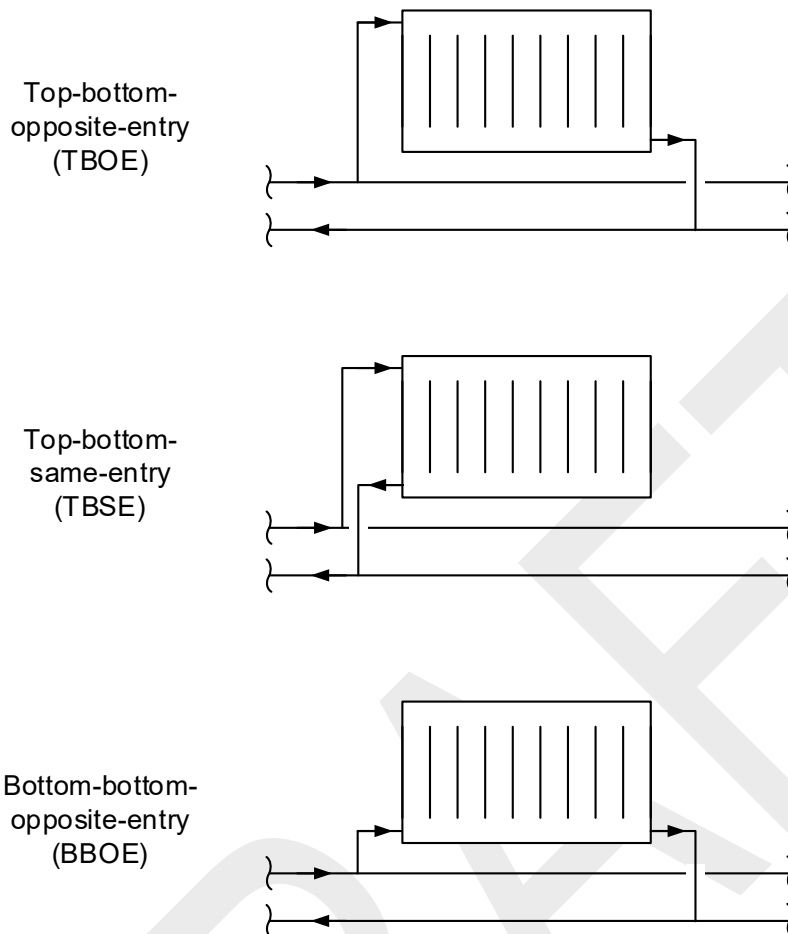
Where specifying a wet towel rail cannot be avoided, it shall be designed with a lockable return temperature limiting (RTL) valve with a return temperature setting not exceeding 35 °C. The risk of increased return temperatures from dual-fuel towel rails (where the electric Element can increase the return temperature from the rail) shall be considered and managed (e.g. through appropriate use of an RTL, or an alternative equally effective method).

Placing an unheated towel rail above a radiator can provide the function of heating towels while mitigating the risk of elevated return temperatures from the Consumer Heat System.

1.2.3. Radiators shall be specified to connect to the Consumer Heat System with the flow (inlet) into the top of the radiator and the return (outlet) from the bottom of the radiator, unless there are specific technical constraints which would make bottom-bottom-opposite entry connections preferable.

Refer to [Figure 9](#) for illustrations of different radiator connection arrangements.

Figure 9: Radiator connection arrangements



- 1.2.4. Where thermostatic radiator valves (TRVs) with wall-mounted temperature sensors are used, the temperature sensor shall be located to not be affected by the heating effect of the radiator.

Thermostatic radiator valves (TRVs) shall be orientated with the thermostatic head away from the heating effect of the radiator and Consumer Heat System pipework; this shall be with the valve head orientated horizontally away from the radiator unless it is not spatially feasible to do so, or an assessment demonstrates another orientation provides more accurate ambient temperature detection.

- 1.2.5. Pre-settable pressure-independent radiator valves designed for low flow rates shall be used on all radiators, with and without thermostatic radiator valves (TRVs), to maintain required flow rates through the radiators regardless of changes in differential pressure across the radiator inlet and outlet which may arise due to variations in flow rates across other emitters.

- 1.2.6. Room temperature control capable of adapting the heating output in each room shall be provided to ensure that flow rates and return temperatures under part-load conditions are suitable; this shall be achieved by the use of thermostatic radiator valves (TRVs) for radiator systems.

TRVs with wall-mounted temperature sensors may be used where appropriate, such as in scenarios where ease of access is required for the adjustment of settings.

Where a room thermostat is used for control of the Consumer Heat System space heating, all radiators in the same room or 'heating zone' (as defined in Paragraph 5.21 of Approved Document L: *Conservation of Fuel and Power* (DLUHC, 2023)) shall not have a TRV installed to prevent conflict between the Consumer Connection and TRV controlling the flow rate through the emitter (known as reference radiators), but should still have a pressure-independent valve to limit the flow rate.

- 1.2.7. Where a system shuts off space heating supply in summer months, the strategy outlining when the space heating system shuts down shall be defined. This shall include defining either:

- the dates when space heating will be unavailable; or
- the temperature above which space heating will be unavailable.

Where a system is planned to operate intermittently, the operating times of the system shall be defined.

Domestic hot water

- 1.2.8. The instantaneous domestic hot water generation temperature shall be set to achieve 50 °C at the tap outlet (or hot inlet to thermostatic mixing valve, where fitted), unless there is an additional requirement for a higher temperature as identified in the project-specific risk assessment. Refer to Section 5.2 of the CIBSE Guidance Note: *Domestic Hot Water Temperatures from Instantaneous Heat Interface Units* (CIBSE, 2021).

This temperature requirement is acceptable provided the volume of stored water in the unit is less than 15 litres and the risk of Legionella growth can be controlled. Refer to Section 5.2 of the CIBSE Guidance Note: *Domestic Hot Water Temperatures from Instantaneous Heat Interface Units* (CIBSE, 2021).

Alternative methods of Legionella control can be used to permit the use of lower flow temperatures if those alternative methods can be shown by a project-specific risk assessment to be equivalent or more effective than a conventional temperature control regime.

For further information, refer to:

- HSG274 Part 2: *The Control of Legionella Bacteria in Hot and Cold Water Systems* (HSE, 2024).
- HSE Approved Code of Practice and Guidance L8: *Legionnaires' Disease - The Control of Legionella Bacteria in Water Systems* (HSE, 2013).
- CIBSE TM13: *Minimising the Risk of Legionnaires' Disease* (CIBSE, 2013).

- 1.2.9. Where it is not proposed to provide instantaneous domestic hot water at the Consumer Connection at a temperature of at least 50 °C from the outlet, a specific design assessment shall be undertaken on the technical benefits of various types of domestic hot water provision at the Substation and/or Consumer Connection. This assessment shall be developed by the domestic hot water system designer/operator with support from the District Heat Network designer/operator.

Where recirculation is proposed in the domestic hot water system, this would require a specific design assessment (as described in the above paragraph) to be undertaken, as this system is distinct from instantaneous domestic hot water production.

Consumer connection specification

- 1.2.10. The designer shall specify the keep-warm strategy in the Distribution Network, and whether this is achieved through a keep-warm function in the Consumer Connection (e.g. HIU) or through the network design.

The keep-warm strategy shall ensure that the specified domestic hot water delivery times are met, in accordance with Requirement [2.2.11/3.2.11](#).

There are two categories of keep-warm strategy.

1. The use of “keep-warm functions” within Consumer Connections (e.g. HIUs), such that the unit is always ready to supply domestic hot water. This functions by maintaining the distribution pipework at temperatures required for the Consumer Connection to deliver domestic hot water sufficiently quickly.
2. A Distribution Network design, where the volume of terminal pipework serving the Consumer Connection is sufficiently low such that domestic hot water delivery times remain acceptable. The use of this type of keep-warm strategy can result in lower heat losses from the Distribution Network. However, this approach can require more detailed consideration by the designer of the Distribution Network to ensure that domestic hot water delivery times are sufficiently low.

The use of smaller diameters for domestic hot water pipework within the Consumer Heat System can result in lower domestic hot water deliver times and reduced water consumption.

- 1.2.11. The provisional specification of the Consumer Connection (e.g. HIU) shall be compatible with the keep-warm strategy specified for the Distribution Network (refer to Requirement [1.2.10](#)).

1.3 Minimise the length of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Minimising the length of the Heat Network aids in reducing the heat loss from the network and the capital expenditure for the Heat Network.

There is typically far less scope to reduce the length of the network at later stages, making it important to take opportunities to minimise the length of the Heat Network at the Concept Design stage.

1.3.1. At least one suitable Energy Centre site shall be selected across a range of options; the selection shall involve comparison of criteria including:

- proximity to heat demands;
- visual impact;
- the impact of noise and vibration;
- flue emissions;
- refrigerant gas emissions (particularly where these can be hazardous);
- air quality impact;
- viability of fuel supply, storage (e.g. for biomass or energy-from-waste (EfW) systems), and electrical connection;
- spatial requirements for plant in the initial scope and for future expansions;
- overall planning constraints of the scheme;
- climate resilience, including:
 - proximity to environmentally sensitive locations (e.g. rivers);
 - the potential of flooding;
- phasing of the network;
- fresh air supply for combustion and ventilation of refrigeration systems (where used);
- access for plant installation, maintenance and subsequent removal/replacement;
- delivery of fuel (e.g. for biofuels).

Where there is only one option for the Energy Centre (e.g. for small networks), justification shall be provided that this option is suitable based on the same criteria.

1.3.2. Where a phased development of the network is proposed, the use of temporary plant (and associated fuel and utility supplies) during the build-out of the network shall be considered, as well as its retention during the operation of the network as part of the network's resilience strategy.

Communal Distribution Network

- 1.3.3. Communal Distribution Network pipework routes shall be selected with the aim of minimising total network length to reduce capital costs, heat losses and pumping energy. In blocks of flats, this should be achieved through multiple vertical risers to minimise horizontal distribution pipework in communal areas (see [Figure 10](#)).
- In addition to the use of multiple risers, placement of Consumer Connections within external enclosures, or as close as possible to vertical risers locations within dwellings, can aid in minimising distribution pipework length (see [Figure 11](#)).
- 1.3.4. The selection of location of Substations and Consumer Connections shall include consideration of the ownership and maintenance of the equipment (for example, Consumer Connections external to dwellings can be more accessible for servicing and maintenance). Justification shall be provided where the selected location of Consumer Connections is not external to dwellings (see [Figure 11](#)).

Figure 10: Variations in pipe length required for different Communal Distribution Network layouts

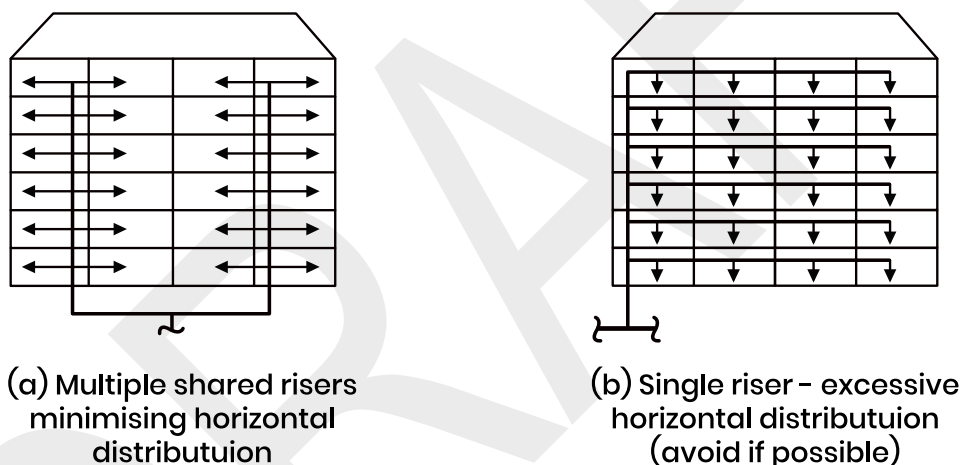
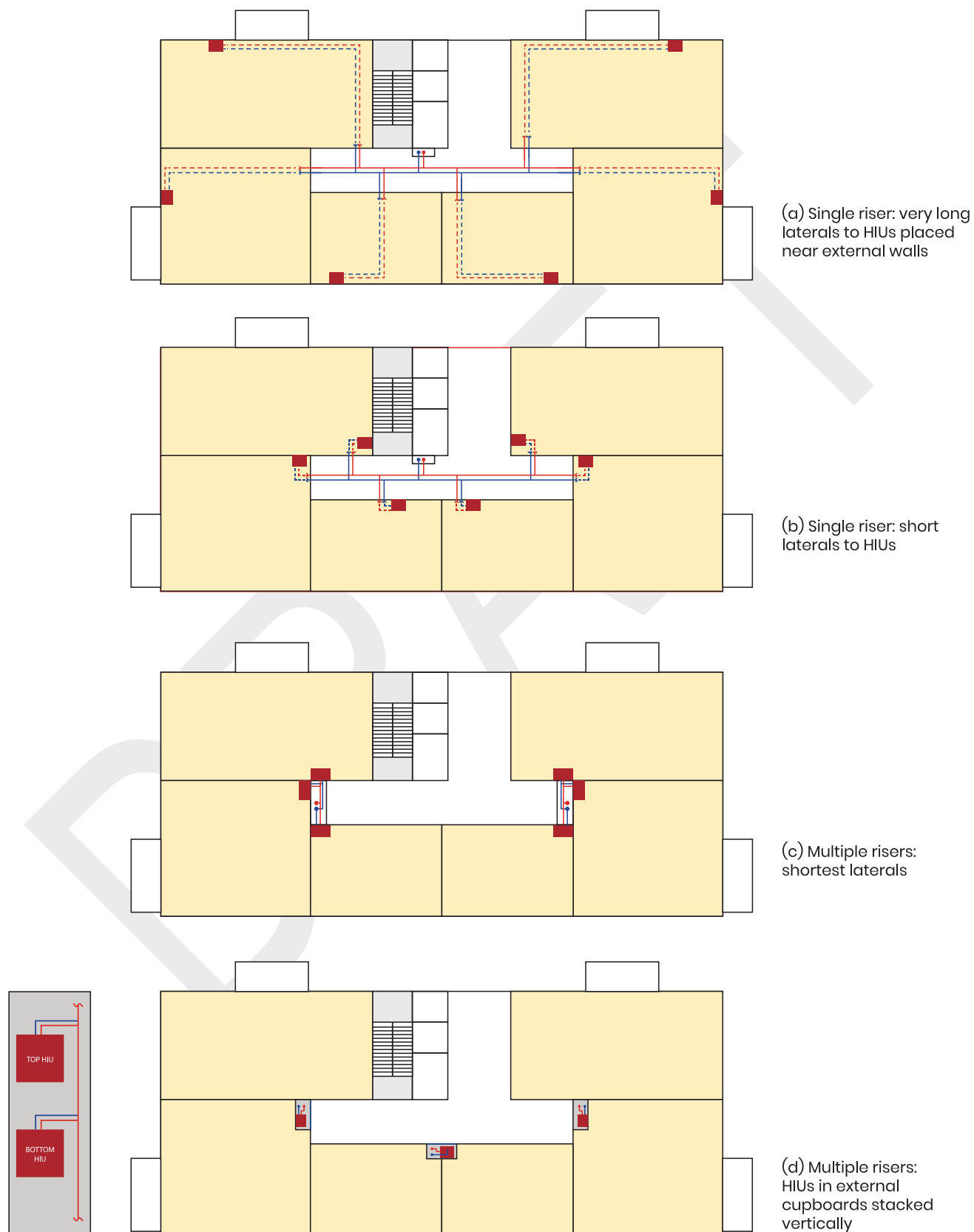


Figure 11: Effect of Consumer Connection location on Communal Distribution Network length



District Distribution Network

- 1.3.5. District Distribution Network pipework routes shall be selected with the aim of minimising network length to reduce lifecycle costs - this shall consider the capital costs, network heat losses and pumping energy. For networks in new developments, a concept diagram showing District Distribution Network routes shall be provided including justification where the shortest route is not taken. Where the network runs through existing infrastructure, evidence should be provided showing existing utilities, embargoed routes or other barriers which will cause longer network routes.
- 1.3.6. The selection of District Distribution Network routes shall include consideration of the route's feasibility against major barriers such as major roads, railways, rivers, canals, and land ownership.
- 1.3.7. District Distribution Network routes shall avoid running underneath existing or future buildings, or structures that may hinder future access to pipework. Where running District Distribution Network pipework underneath buildings cannot be avoided, ductwork or voids shall be used to enable future access to pipework.
- 1.3.8. Existing utility service plans shall be reviewed when selecting District Distribution Network routes. Existing utility service passages and areas where services are known to be congested should be avoided.
- 1.3.9. District Distribution Network routes in new developments should be integrated with other utility routes if the project programme and development's layout makes this feasible. Other routes may be selected if the network length is minimised and justification of lifecycle costs is provided.
- 1.3.10. The selection of District Distribution Network routes shall include consideration of constraints posed by below-ground risks including (but not limited to) existing basement structures, contaminated land, and archaeological areas.
- 1.3.11. District Distribution Network routes to existing buildings shall be coordinated around other utility services if the project layout makes this feasible. Other routes may be selected to avoid undue disruption to existing utility services if the network length is minimised and justification is provided.
- 1.3.12. Street works required for buried District Distribution Network pipework shall follow the NRSWA *Code of Practice for the Co-ordination of Street and Road Works* (DfT, 2023), Advice Note SA 10/05: *New Roads and Street Works Act 1991: Diversionary Works* (Highways Agency, 2005), and Street Works UK Guidelines (volumes 1-6) (Street Works UK, 2007-2023).

1.4 Minimise operating temperatures within the constraints present

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Minimising operating temperatures where possible aids in reducing heat losses from the network.

The operating temperatures of the Heat Network interact with many other design decisions made at this stage and subsequent stages, making it important to identify the constraints present and take opportunities at the Concept Design stage to minimise operating temperatures within these constraints.

- 1.4.1. The operating temperatures of space heating and domestic hot water circuits at peak demand shall be optimised to minimise lifecycle cost and maximise carbon savings. The peak operating temperatures of Consumer Heat Systems shall also lie within the limits shown in [Table B.1](#) unless the designer provides evidence that higher temperatures produce higher efficiency or carbon savings.
- 1.4.2. The flow temperature of the Heat Network shall be selected to heat domestic hot water to the required temperature (refer to Requirement [1.2.8](#)) with good temperature control.
- 1.4.3. The minimum flow temperature supplied by the Energy Centre and the minimum flow temperature supplied to the Consumer Connection shall be defined; this should be developed with consideration of factors including:
 - the expected demand from consumers in summer months;
 - the use of variable-flow temperature control;
 - heat losses from the network.
- 1.4.4. The presence of hydraulic breaks (e.g. through plate heat exchangers) shall be considered when defining operating temperatures; refer to Requirement [1.10.1](#) for requirements surrounding the presence of hydraulic separation.

Where there is a hydraulic break in a system, there will need to be an increase in the distribution flow temperature to provide the same flow temperature on the consumer side of the hydraulic break. Introducing a hydraulic break can also increase the return temperature on the generation side of the hydraulic break, which can increase heat losses and impact heat generation efficiency. This is true for hydraulic breaks in Substations and Consumer Connections.

- 1.4.5. The intended types of space heating and domestic hot water Consumer Heat Systems shall be established and used to determine the required flow and return temperatures of the Consumer Heat System, Communal Distribution Network and District Distribution Network (where present).

- 1.4.6. The optimal operating temperatures for each heat source shall be identified from considering the variation in efficiencies with operating temperatures; where multiple technologies are being used, the use of different supply temperatures from the different heat sources may be used.

Where multiple heat sources are used, the efficiency of each heat source shall be considered when altering flow temperatures to deal with peaks in demand.

A hydraulic design which uses a different ΔT across the network compared to the ΔT across the heat source can be used.

- 1.4.7. The targeted return temperature on:

- Communal Distribution Networks in new buildings; and
 - new Communal Distribution Networks in existing buildings,
- should be no greater than 35 °C.

- 1.4.8. The targeted return temperature on existing systems in existing buildings connecting to a District Distribution Network should be no greater than 50 °C.

Where existing buildings are to be connected to a District Heat Network, the initial targeted operating temperatures may initially be higher with gradual reduction in operating temperatures as the buildings are retrofitted over time, provided that a plan for temperature reduction is outlined and implemented.

Results from the monitoring of current operating temperatures of existing systems in buildings in accordance with Requirement 1.4.9 can be used to aid in determining if the operating temperatures of space heating systems can be reduced without emitter replacement (e.g. due to the potential oversizing of emitters in the original design).

- 1.4.9. Any information on existing buildings shall be obtained to determine the current and original design operating temperatures. The potential to reduce operating temperatures (especially return temperatures) shall be assessed, and the causes of any deviations between current and original design temperatures should be investigated.

- 1.4.10. The operating temperatures of existing potential Key Buildings in District Heat Networks shall be monitored unless there is a clear technical justification that it is not reasonably practicable to do so. This data should be used to determine a temperature profile for the District Distribution Network which is feasible across the District Heat Network, while aiming to minimise the heat losses from the network. Where monitoring is not reasonably practicable, evidence supporting assumed temperatures and seasonal variations shall be provided. Where monitoring is necessary in subsequent stages, a monitoring plan shall be produced.

Refer to Requirement 1.1.5 for the definition of a Key Building.

- 1.4.11. In the context of retrofit projects in existing buildings, the space heating demand should be assessed to determine if it is feasible to retain existing space heating emitters (e.g. radiators) with the proposed flow and return temperatures (which can be lower than the design temperatures of the original installation). This should include consideration of fabric improvements which have been undertaken after the original installation of the space heating emitters.

- 1.4.12. The designer should consider the impact of fluctuations on the Substation offtake flow temperature, which can be more significant for Substations with small forward approach temperatures.

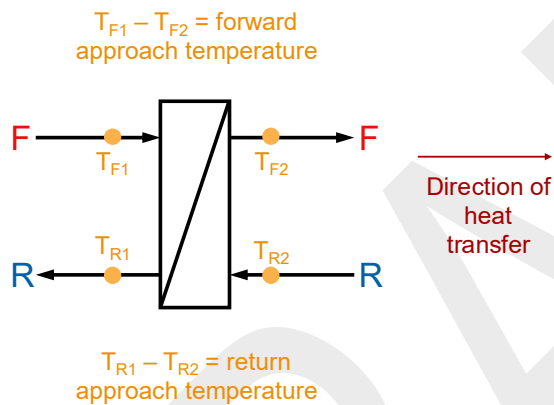
It can be preferable to avoid the use of mixing circuits on the offtake circuit to prevent control issues such as the diverting of flow from the heat exchanger.

The forward approach temperature is the temperature difference between the flow inlet and the flow outlet of a heat exchanger.

The return approach temperature is the temperature difference between the return inlet and the return outlet of a heat exchanger.

These temperature differences are illustrated in [Figure 12](#).

Figure 12: Forward and return approach temperature illustration



1.5 Optimise distribution pipe diameters

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The pipe diameters specified on a Heat Network can affect other aspects of the design of the system (such as the frictional pressure loss across pipework). Therefore, it is important to take opportunities to optimise pipe diameters throughout the network at the Concept Design stage with the aim of minimising diameters where possible, while identifying and adhering to the constraints present.

Flow rate

- 1.5.1. The maximum flow rates throughout the Heat Network shall be defined from:
- the calculated ΔT from heat demands including space heating and domestic hot water events;
 - the maximum space heating and domestic hot water supply capacities (in kW); and
 - appropriate application of diversity factors (refer to Objective 2/3.1).

Communal Distribution Network

- 1.5.2. Communal Distribution Network pipes shall be sized using the design information available at the Concept Design stage to establish estimates of spatial requirements. Manufacturer's literature should be consulted to ensure that maximum velocity limits are not exceeded; however, the guidelines in Table 1 provide recommended minimum and maximum velocities. A more detailed approach as described in Objective 2/3.5 may also be used at this stage.

District Distribution Network

- 1.5.3. District Distribution Network pipes shall be sized using the design information available at the Concept Design stage to establish estimates of pipework costs and assess potential opportunities to improve the routing of pipework (refer to Objective 1.3)
- Manufacturer's literature should be consulted to ensure that maximum velocity limits are not exceeded; however, the guidelines in Table 2 and Table 3 on typical flow velocities may be used. A more detailed approach as described in Objective 2/3.5 may also be used at this stage.

The sizing of distribution pipes involves a balance of capital cost, pipework heat losses and pumping energy to minimise lifecycle costs as covered in Objective 2/3.5.

While guidance historically pointed towards set differential pressure limits due to the wide use of constant-flow systems, the use of variable-flow control and variable speed pumps has resulted in economic benefits for smaller pipework. Variable-flow control also reduces the impact of pipe erosion due to the low frequency of peak flow rates, permitting the use of higher velocities.

Table 1: Typical flow velocity ranges for initial sizing of Communal Distribution Networks

Nominal diameter	Outside diameter of pipe (mm)	Minimum velocity (m/s)	Maximum velocity (m/s)	
			Copper	Steel
≤ DN50	≤ 60.3	0.5	1.0	1.5
> DN50	> 60.3	0.5	1.5	3.0

Values in accordance with CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration (CIBSE, 2016)

Table 2: Typical flow velocities for initial sizing of District Distribution Networks (steel)

Nominal diameter (DN)	Inner diameter of pipe (mm)	Typical velocity (m/s)
25	29.1	0.9
32	37.2	0.9
40	43.1	1.0
50	54.5	1.0
65	70.3	1.3
80	82.5	1.4
100	107.1	1.5
125	132.5	1.8
150	160.3	2.0
200	210.1	2.4
250	263.0	2.4
300	312.7	2.5

Values based on Kostnadskatalog Fjärrvärme guidance (Energiföretagen Sverige - Swedenergy AB, 2023).

Pipe diameters in accordance with BS EN 253:2019+A1:2023: District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks - Factory Made Pipe Assembly of Steel Service Pipe, Polyurethane Thermal Insulation and a Casing of Polyethylene (BSI, 2023).

Table 3: Typical flow velocities for initial sizing of District Distribution Networks (polymer)

Outer diameter (OD)	Inner diameter (mm)	Typical velocity (m/s)
25	20.4	1.0
32	26.2	1.0
40	32.6	1.1
50	40.8	1.3
63	51.4	1.4
75	61.0	1.5
90	73.6	1.6
110	90.0	1.6
125	102.2	1.7
140	114.6	1.8
160	130.8	1.9

Values based on *Kostnadskatalog Fjärrvärme* guidance (Energiföretagen Sverige - Swedenergy AB, 2023).

Pipe diameters in accordance with BS EN 15632: District Heating Pipes - Pre-insulated Flexible Pipe Systems (Parts 1-4) (BSI, 2022)

1.6 Minimise the risk posed by working pressures

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Many aspects of the design of Heat Networks which impact working pressures are often established relatively early within the design process, making it important for the designer of the Heat Network to understand and appropriately mitigate the risk posed by working pressures in the Heat Network at the Concept Design stage.

1.6.1. At the Concept Design stage, the designer shall include consideration of the risks posed by working pressures in each hydraulic circuit in their design risk assessment using relevant information available. This shall include:

- calculation of the System Maximum Working Pressure in accordance with Requirement 1.6.2;
- calculation of the Local Maximum Working Pressure in accordance with Requirement 1.6.3;
- identification of the risks that arise as a result of these two calculated maximum working pressures;
- assessment of the likelihood and impact of the identified risk; and
- mitigation of the risks posed by working pressures by applying “ERIC” safety by design hierarchy approach.
 1. Eliminate.
 2. Reduce.
 3. Isolate.
 4. Control.

The following factors are relevant for risk identification in the context of working pressures:

- The person at risk - the person at risk will vary across a Heat Network. Residential environments will pose a risk to residents who are un-trained and have no awareness of the risk that may be associated with elevated pressure within their home.

The risk posed to those individuals who may be vulnerable on the network, for example, due to mobility issues, requires consideration.

Plant room areas with controlled access may not pose a risk to residents, but will to clients, engineers and operators etc.

- The position on the network at which the risk is being considered - the working pressure will alter for a given point of the network. As the static height of the network varies, so will the working pressure at that point on the network.
In many instances, the static height makes the greatest single contribution to the working pressure, so particular consideration is required for:
 - elevational changes in the network such as topographical variations where the network runs underground; and
 - the vertical height of the network in tall buildings.

Consideration is therefore required of the working pressures local to the extremities of the network and how this varies between them.

Example risks that can arise include but are not limited to:

- hydraulic injection injury (e.g. due to events such as pinhole leaks);
- system failure (e.g. from exceeding equipment's safe operating limits) - this may include pipework, equipment, joints and fittings;
- uncontrolled release of stored energy from pressure vessels (e.g. pressurisation equipment or boilers);
- impact on system reliability and security of heat supply;
- scalding of occupants from discharges of hot water (e.g. fractured pipework joints).

Working pressure calculations

- 1.6.2. At the Concept Design stage, the designer shall calculate the System Maximum Working Pressure (SMWP) of each hydraulic circuit using relevant information available. Refer to [Annex D: Pressure calculation examples](#) for more information.

The System Maximum Working Pressure (SMWP) is the maximum gauge pressure which can be present across an entire hydraulic circuit when considering reasonably foreseeable operating conditions. The System Maximum Working Pressure (SMWP) may be determined by considering the sum of:

- the maximum Static Pressure present on the network - this includes the Static Height Pressure, the Static Pressure Margin applied to the system, pressure which arises from expansion equipment due to the thermal expansion of system water, and any allowances of alarms in pressurisation equipment;
- the maximum dynamic pressure present on the network - this is commonly the maximum differential pressure the distribution equipment can produce.

1.6.3. At the Concept Design stage, the designer shall calculate the Local Maximum Working Pressure (LMWP) using relevant information available at locations including (but not limited to):

- where a pressure safety system will be specified;
- where there is an increased risk (e.g. due to proximity of building occupants and the presence of vulnerable individuals);
- where the pressure rating of equipment, pipework or pipework ancillary equipment will be specified;
- any other locations deemed appropriate by the designer.

Refer to [Annex D: Pressure calculation examples](#) for more information.

The Local Maximum Working Pressure (LMWP) is the maximum gauge pressure which can be present at a given location in the system when considering reasonably foreseeable operating conditions. This may be determined by considering the sum of:

- the Static Pressure present at the point of interest - this includes the Static Height Pressure, the Static Pressure Margin applied to the system, pressure which arises from expansion equipment due to the thermal expansion of system water, and any allowances of alarms in pressurisation equipment;
- the maximum dynamic pressure present on the network - this is commonly the maximum differential pressure the distribution equipment can produce.

Note - the calculated values of the working pressures at the Concept Design stage will be limited by the information available at the Concept Design stage. It is likely that the calculated values of the working pressures will vary as further design information is made available at subsequent design stages. Refer to [Annex D: Pressure calculation examples](#) for more information.

Instances of hydraulic injection injury (injury sustained by an individual following an injection of fluid) are typically more serious at higher working pressures.

A maximum guide value of 10 bar for the maximum system pressure for groups of floors in boosted cold water service (BCWS) systems is provided in CIBSE Guide G: *Public Health and Plumbing Engineering* (CIBSE, 2014). Guidance is also provided in the ASHRAE *Design Guide for Tall, Supertall, and Megatall Building Systems* (ASHRAE, 2015).

Where the design of an LTHW system at the Concept Design stage exceeds this value, consideration should be given to implementing mitigation measures to reduce the maximum working pressures as set out in [Figure 13](#).

1.6.4. Protection against unauthorised interference and accidental damage shall be provided for:

- District Distribution Network pipework forming main distribution routes; and
- Communal Distribution Network pipework which is located in areas accessible to un-trained persons.

1.6.5. Where required by the risk assessment undertaken in Requirement 1.6.1, consideration shall be given to adopting mitigation measures such as:

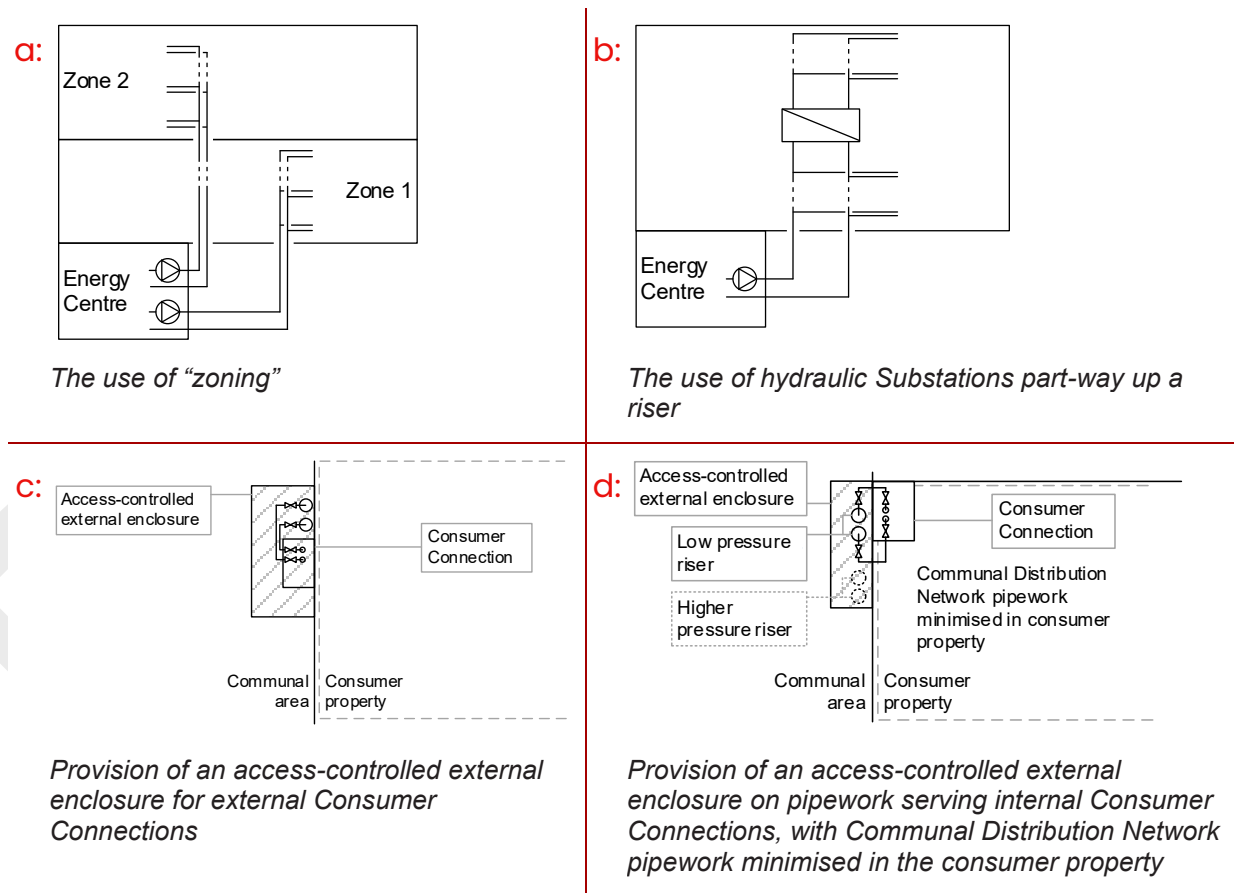
- the use of “zoning” through multiple sets of risers serving different floors (see Figure 13a);
- the use of hydraulic Substations part-way up a riser (see Figure 13b).

The impact of approach temperatures within Substations can typically make the adoption of “zoning” preferable to the use of hydraulic Substations part-way up risers.

Subsequent mitigation measures which should be considered include:

- provision of an access-controlled external enclosure (see Figure 13c);
- minimising the length of Communal Distribution Network pipework within consumer premises, where internal Consumer Connections are used (see Figure 13d);

Figure 13: Example mitigations of the risks posed by working pressures in Heat Networks



1 - BS 8635-1:2024: Hydraulic Interface Units for Heat Network Applications - Specification (BSI, 2024) is applicable to HIUs which operate in Heat Networks up to 16 bar(g).

2 - The presence of plant or equipment on rooftops (e.g. in Energy Centres) can result in higher working pressures in Heat Networks. Some mitigation measures such as the use of “zoning” are less effective for such Heat Networks.

1.7 Ensure that Energy Centres and Substations can meet the expected range of demands

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The sizes of plant and equipment in the Heat Network (such as heat generation and thermal storage) can impact many other aspects of the design of the Heat Network and the wider system due to constraints such as spatial requirements.

Identification of the most appropriate heat source(s) which can meet the expected range of demands can also impact other aspects of the design of the Heat Network, making it important at the Concept Design stage.

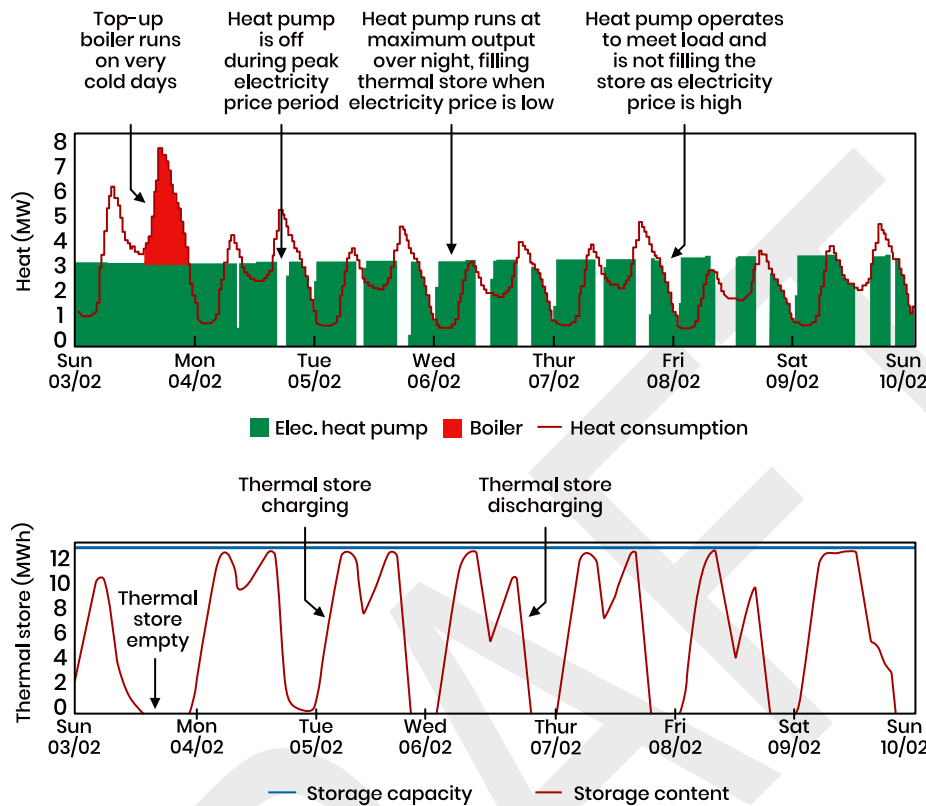
- 1.7.1. An operating model with hourly resolution shall be developed using relevant available information on the daily, weekly, and annual demand profiles of the consumers served by the Heat Network (which will vary subject to building use). The model's outputs shall show the energy flows through the network, including how multiple consumer types, heat sources and thermal stores (if present) operate. The detail used in the model's construction should be proportionate to the size and complexity of the Heat Network.

An example of the outputs from an operating model with hourly resolution for an Energy Centre with a heat pump and thermal storage is provided in [Figure 14](#).

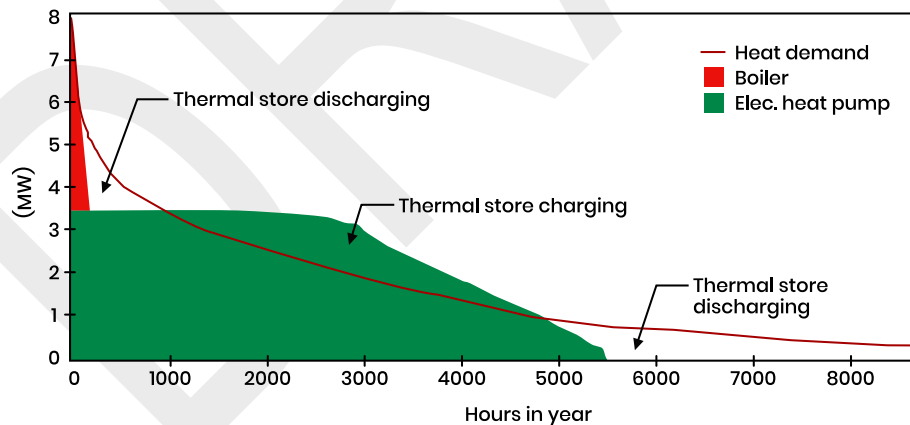
- 1.7.2. The operating model shall calculate the energy balance for the network including network heat losses. This model shall be used to determine lifecycle operating costs and revenues, which shall be used in the economic analysis and for determining the cost of heat.
- 1.7.3. The operating model shall include estimation of the likely economic and environmental benefits and space requirements of thermal storage. The operating model shall also include realistic assumptions for the efficiency, availability and output of each item of plant and an analysis of heat losses from the network. When calculating fuel use, the heat of combustion used shall be the gross (higher calorific) value; the use of the net (lower) calorific value shall be avoided as can result in under-estimation of fuel costs.
- 1.7.4. Relevant available data on the daily, weekly and annual occupancy patterns for each building should be used to inform the Energy Centre and Substation design (including the requirement for thermal storage, and expected future changes which may impact the Heat Network).
- 1.7.5. The operating model of the Heat Network shall be used to optimise the size of each heat source with respect to whole-life cost and establish the energy flows from each heat source over a typical year. This model shall produce estimates of:
- fuel and electricity consumption by the Energy Centre;
 - electricity generated (if a combined heat and power (CHP) unit is installed);
 - operating costs and revenues - these shall be used in the network's techno-economic model.

Figure 14: Outputs from example operating model for Energy Centre

Example operation of Energy Centre



Annual duration curve



Example Energy Centre includes a heat pump and thermal storage.

- 1.7.6. Systems should be future-proofed if possible to provide robustness to external changes (e.g. changes in fuel prices and tariff structures). Future potential heat sources and demands, the projected carbon intensity of electricity, and replacement of plant should be assessed when deciding the types of heat sources in the Energy Centre.

- 1.7.7. The heat sources shall be compared primarily on the basis of the whole-life costs and CO₂ emissions (incorporating predicted trajectories of energy prices and electricity decarbonisation) and level of technology risk. Where biofuels or other low-carbon fuels are considered, wider environmental impacts (such as sustainability credentials related to their production, processing and transport requirements) shall also be assessed.
- 1.7.8. The use of a mixture of heat sources shall be assessed on the bases of the cost of heat, lifecycle cost, and CO₂ emissions. The use of hybrid systems with lower capital costs but higher running costs during peak demand (e.g. using top-up boilers) should be considered in this assessment.
- 1.7.9. A feasibility study shall make recommendations on the incorporation of existing boilers based on the location, capacity, and condition of any existing boilers.
- 1.7.10. The requirements of the local planning authority shall be incorporated into the design from an early stage; this includes the local environmental impacts of visual intrusion, noise, and emissions to air.
- 1.7.11. Substations and Consumer Connections for non-domestic consumers shall be sized to meet its peak demand, including consideration for any distributed top-up/standby boilers to prevent oversizing of equipment such as heat exchangers and control valves. The assumptions and methodology used to size any equipment shall be provided.
- 1.7.12. An assessment of the available heat and electricity sources and technologies (including renewable and waste heat sources, renewable electricity sources, and existing/planned Heat Networks in the locality of the proposed network) shall be undertaken. The comparison bases shall include:
 - the carbon intensity of heat;
 - the local environmental impact;
 - the impact of noise on the local environment;
 - spatial and access requirements;
 - available space for thermal storage;
 - energy supply (fuel sustainability credentials including origins of biofuels, transport requirements and security of supply);
 - the available electrical supply capacity and the impact that incorporating renewable electricity sources would have on the required capacity.

Economic factors should be considered as part of this assessment - this may include consideration of:

- whole-life costs (including Capital Expenditure (CapEx), Operational Expenditure (OpEx), and Replacement Expenditure (RepEx));
- the cost of heat (generated and supplied).

The level of detail of the assessment should be appropriate for the size and complexity of the Heat Network. The assessment of available heat sources and technologies for a large-scale retrofit Heat Network can require a higher level of detail in its assessment (across a range of considerations) compared to that of a small Heat Network in a new building.

- 1.7.13. Lifecycle costs shall be estimated for overheads throughout all phases of the Heat Network's development including staffing, management, business rates and insurances. Organisations with relevant experience such as existing operators should be engaged if necessary.
- 1.7.14. An assessment shall be made of the implementation of centralised or distributed top-up/standby boilers, which includes consideration of:
- the potential benefits of incorporating existing boilers into the scheme;
 - the potential benefits of using decentralised boilers to the phasing of new developments;
 - the ongoing maintenance and capital replacement costs of centralised and distributed boilers;
 - the impact on the sizing of distribution pipework;
 - the impact on the security of heat supply;
 - the spatial requirements and associated cost of any required building area for the use of distributed boilers.
- 1.7.15. The operating model shall be used when determining the heat source type and size and the size of the thermal storage, while ensuring that any additional objectives agreed by the Heat Network designer and the client are achieved.

For systems including peaking boilers and heat pumps (sometimes referred to as "hybrid" systems), the capacity of the thermal storage should be at least $75 \text{ l/kW}_{\text{heat pump}}$ (where $\text{kW}_{\text{heat pump}}$ indicates the heat pump output during design conditions). Where the proposed size of thermal storage is below $75 \text{ l/kW}_{\text{heat pump}}$, optimisation through analysis of whole-life economic indicators such as the internal rate of return (IRR) and net present value (NPV) of the various options shall be undertaken.

Where it is proposed to provide 100 % of the heat from heat pumps (i.e. without the use of a hybrid system), optimisation should be undertaken to determine an appropriate level of thermal storage.

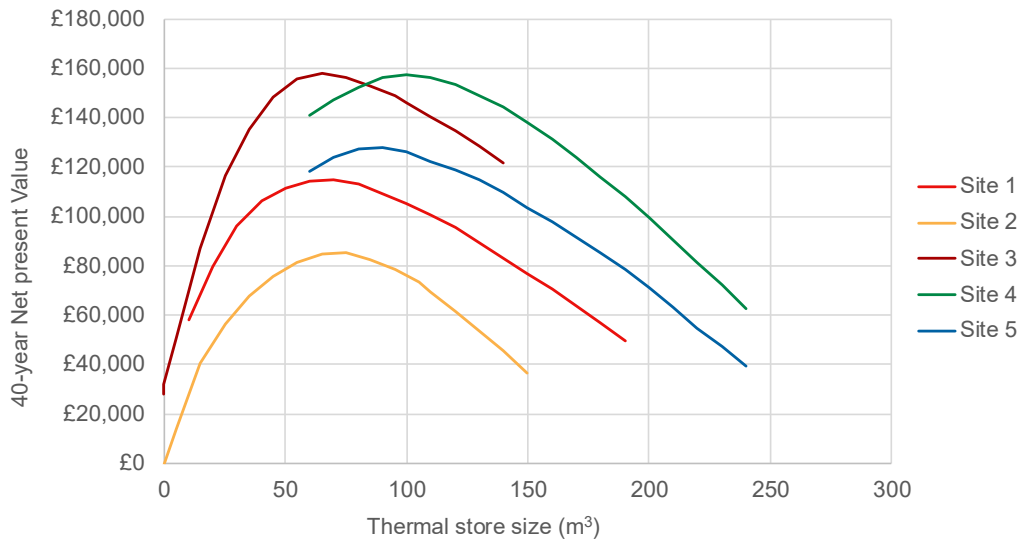
The incorporation of the electrical import tariff structure and electrical connection costs (upfront and on an ongoing basis) shall be used when determining the optimal size of heat generation assets and thermal storage.

The intended use of the thermal storage (e.g. whether "load-shifting" is proposed in the Energy Centre operation) is relevant when assessing the optimal size of thermal storage. Refer to the CIBSE Design Guide: *Heat Networks* (CIBSE, 2021) for further information.

The use of inter-seasonal storage can be beneficial for certain heat sources (e.g. solar thermal or ground source heat pumps).

The optimal size of a piece of plant can be demonstrated by showing that both a larger and a smaller piece of plant have lower economic returns. An example for thermal storage in Energy Centres with air source heat pumps is shown in [Figure 15](#). The selected size of a piece of plant can also be demonstrated with sufficient reference to work previously undertaken for similar sites, published studies or reference designs.

Figure 15: Example of optimising thermal storage size



Courtesy of Carbon Descent and GreenSCIES.

- 1.7.16. The use of a higher flow temperature from the heat source and thermal store compared to the distribution pipework flow temperature shall be considered; this would increase the heat stored per unit of volume by the thermal store. Justification for the flow temperature from the heat source shall be provided.
- 1.7.17. The parasitic energy consumption (such as electricity for pumping energy, ventilation and burner fans, and lighting) within the Energy Centre and Substations shall be included when assessing the network's operation.

Fuel and electricity provision

- 1.7.18. The fuel supply requirements for the heat generation shall be identified at an early stage, with particular consideration given to:
 - pressure and volume for gas supply;
 - capacity (kVA or MVA), voltage and potential additional transformer capacity for electrical supply to heat pumps;
 - storage volume, delivery methods and fuel handling for biomass.
- 1.7.19. The options for the sale of electricity shall be considered. This should include consideration of the implications of the design of the wider electricity network.
- 1.7.20. The proposed grid import and export tariff structures (e.g. day/night or seasonal-time-of-day (STOD)) shall be considered and outlined; the chosen tariff structure shall be incorporated when developing the operating model.

Particulate and noise emissions

1.7.21. CO₂ emissions shall be calculated using published emission factors and realistic efficiencies for plant for:

- the full build-out of the Heat Network; and
- the early years of growth of the Heat Network.

Emission calculations in feasibility studies shall use emission factors from Green Book Supplementary Guidance: *Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal* (DESNZ, 2023, or latest edition) to reflect grid decarbonisation in electrical grid emission factors.

For assessing compliance with planning and building control in new-build networks, emission factors used in the relevant Building Regulations should be used.

1.7.22. The CO₂ emissions calculations shall include the emissions associated with heat losses from the network and electrical energy used for pumping and other purposes.

1.7.23. At the Concept Design stage, the emissions from gas-fired CHP units (where proposed) shall be considered such that Requirement 2.7.11/3.7.11 will be met at the Technical Design stage.

1.7.24. The potential impact of NO_x and particulate emissions from the Heat Network shall be assessed alongside the local environmental policies regarding air quality. It can be beneficial to undertake a full dispersion model to assess ground-level concentrations at this stage if:

- the predicted NO_x emissions and particulate emissions are considered a significant factor in the project's viability;
- the potential stack height could present planning or aesthetic issues.

The use of low-NO_x boilers can aid in mitigating the impact of NO_x emissions.

Local regulations in certain jurisdictions might not permit gas systems.

1.7.25. The selection of the type of, and refrigerant used in, low-carbon heat sources (e.g. heat pumps) shall include an assessment of the lifecycle global warming potential (GWP) using predicted refrigerant leakage rates. The estimated greenhouse gas emissions shall be expressed as CO₂ equivalent emissions. The selection should include consideration of the longevity and phasing out of different refrigerants.

1.8 Ensure that Energy Centres and Substations operate in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Producing designs for Energy Centres and Substations with sufficient provision for control aids in facilitating low return temperatures from the Heat Network, which can aid in reducing heat losses from the network and maximising the use of low-carbon heat sources.

Establishing how Energy Centres and Substations will be controlled at the Concept Design stage also aids in producing a design which can be successfully built upon at future stages.

Heat generation

- 1.8.1. The hydraulic arrangement of Energy Centres and Substations shall be developed to facilitate a control strategy which maximises the use of low-carbon heat sources, especially where implementing multiple heat generation sources or distributed top-up/standby boilers.
- 1.8.2. Where distributed top-up/standby boilers are specified for peak-load scenarios in Communal Heat Networks connected to District Heat Networks, the control strategy of such boilers shall be coordinated with the operator of the District Heat Network.

Return temperature

- 1.8.3. The production of centralised domestic hot water, where used, shall use a plate heat exchanger which is external to the domestic hot water storage cylinder, rather than an LTHW coil within the cylinder. This is to reduce return temperatures to values compliant with those in [Table B.1](#).
- 1.8.4. For Substations and Consumer Connections not in the scope of the BESA UK HIU Test Regime (BESA, 2023, or latest edition), the return approach temperature for plate heat exchangers providing heat for either the total heating demand or the space heating demand:

- should not exceed 3 °C; and
- shall not exceed 5 °C,

at the design heat transfer value through the connection. This does not apply to connections providing exclusively domestic hot water, for which larger approach temperatures may be used.

Refer to Requirement [1.4.12](#) for definitions and an illustration of the forward approach temperature and return approach temperature.

Control systems

- 1.8.5. The types of control systems in existing buildings shall be established. Where constant-flow systems and three-port control valves are present, the designer should consider changing to a variable-flow, two-port control valve system due to the benefits in performance such as reduced heat losses and lower return temperatures.

1.9 Ensure sufficient resilience in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The measures included to ensure resilience of a Heat Network affect many aspects of its design and can impose significant spatial requirements, making it important for the threats to the Heat Network to be understood and resilience measures to be determined at the Concept Design stage.

In the context of Heat Networks, threats could refer to interruptions to the supply of heat to consumers.

1.9.1. At the Concept Design stage, the designer shall identify the key threats to system and equipment failure throughout the Heat Network using the relevant information available.

The designer shall quantify the risk associated with the identified threats using the definitions of severity and likelihood in [Table F.1](#) and [Table F.2](#), and the methodology set out in [Table F.3](#).

The designer shall ensure that the risk score of each threat identified is:

- sufficiently low as agreed by the risk assessor; and
- no higher than 6 out of 30.

For threats which are initially above this threshold, the designer shall reduce the risk score to levels within this threshold through improved redundancy and/or recovery measures against the identified threat.

Where information is not available regarding the presence of vulnerable consumers at the Concept Design stage, the assumed occupancy levels of vulnerable consumers should be agreed between the system designer, the client, and the future system operator (if known).

The redundancy strategy implemented for an asset may include active redundancy or passive redundancy.

- Active redundancy typically involves provision of backup equipment which is periodically operational during the normal operation of the system and can be automatically introduced into operation to compensate for the loss or failure of equipment.
- Passive redundancy refers to provision of equipment, critical spares, or other components for individual assets which are pre-procured and are readily available for use as part of measures to restore heat supply.

The recovery strategy for a given asset may include:

- reducing lead times for the procurement and installation of equipment or critical spares;
- setting out recommended repair works and their expected timescales (i.e. restoration of the asset to an “A” or “B” condition grade (refer to [Table L.1](#));
- provision of temporary plant in the event that asset failure would result in a major outage to heat supply. This could include central generation, generation at impacted building connections on a District Heat Network, or provision for electric heating and temporary domestic hot water supply for dwellings impacted by the outage;
- installation of remote monitoring and alarm systems to indicate where:
 - faults have occurred; or
 - there are indicators that a fault is likely to occur; and
- the relevant isolation strategy to be followed where appropriate.

1.9.2. A Resilience Strategy shall be produced following the risk assessment in Requirement [1.9.1](#). As a minimum, this shall include information regarding:

- the key threats identified in Requirement [1.9.1](#);
- the risk score of each threat without any resilience measures in place;
- the redundancy and recovery measures implemented across the system;
- the risk score of each threat with resilience measures in place;
- any residual risks associated with each threat.

The design of the system should aim to maximise the resilience over the entire system, rather than solely for the aspect(s) of the system design that an individual party is responsible for.

The Resilience Strategy typically needs to be developed with consideration of the design across the whole system. Coordination between different parties can be necessary for the development of the Resilience Strategy where different aspects/Elements of the system design are undertaken by different parties.

Refer to [Annex G: Resilience Strategy example](#) for an example Resilience Strategy at the Concept Design stage.

1.9.3. The designer shall ensure that provision is made for the required spatial allowances and connection points necessary to successfully implement the Resilience Strategy produced in accordance with Requirement [1.9.2](#).

Aspects of the Resilience Strategy which influence the required spatial allowances can include (but are not limited to):

- where temporary plant provision will be installed on site in the event of a Heat Network major outage;
- any air quality restrictions associated with the potential temporary plant provision;
- any acoustic restrictions associated with the potential temporary plant provision;
- how temporary plant will be delivered to its install location (for example, how the required plant will be lifted to Energy Centres located on rooftops);
- where redundant equipment will be located;
- provision for access to all equipment;
- provision for sufficient space to repair and replace all equipment;
- provision for the maintainability of all equipment;
- how replacement equipment will be delivered to its install location and redundant equipment removed from site;
- how any heat generation fuel (including for temporary plant) will be stored and monitored; and
- where critical spares will be located.

Future connections

- 1.9.4. The sizing of pipes to allow for future expansions to the network in later phases shall be considered; this shall include engagement from the relevant building owners. Justification shall be provided where pipework is sized for additional future demands, including the assumptions and methodologies used. A future-proofing plan should be developed which considers potential future expansion not in the scope of the initial network development.
- 1.9.5. Connection points (e.g. stubs with isolation valves and flanged ends) shall be provided where there is a requirement (e.g. for “Heat Network zoning”, or as part of the system’s Resilience Strategy), to allow for connection to:
- future District Heat Networks;
 - temporary heat generation plant.

Certain types of buildings and low-carbon heat sources can be required to connect to future Heat Networks within a prescribed timeframe through “Heat Network zoning”. Refer to documentation regarding Heat Network Zoning from the Department for Energy Security and Net Zero (DESNZ, n.d.) for further information.

1.10 Simplify designs where feasible

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Adopting a simpler design early within the design process can result in benefits for many aspects of the design of a Heat Network, making it important to consider opportunities to simply designs at the Concept Design stage.

- 1.10.1. Hydraulic separation shall be avoided unless necessary - this is to reduce:
- operating temperatures at the Energy Centre and District Distribution Network;
 - network heat losses;
 - hydraulic complexity;
 - CapEx.
- 1.10.2. A technical assessment of the building connection options shall be undertaken. Hydraulic breaks should be avoided; where indirect connections are used, these shall be accompanied by supporting technical justification or contractual arrangements.
- Refer to Requirement 1.4.4 for guidance regarding the impact of hydraulic breaks on operating temperatures.
- 1.10.3. The respective technical benefits of direct and indirect connections at Consumer Connections shall be assessed to determine the most appropriate solution for the overall network. This shall include consideration of:
- the working pressures throughout the network - refer to Objective 1.6 and BS 8635-1:2024: *Hydraulic Interface Units for Heat Network Applications - Specification* (BSI, 2024);
 - the potential use of indirect systems for demarcation purposes.
- BS 8635-1:2024: *Hydraulic Interface Units for Heat Network Applications - Specification* (BSI, 2024) covers Heat Interface Units (HIUs) with low temperature hot water (LTHW) pressures up to 16 bar(g), and direct Consumer Heat System space heating systems of up to 6 bar(g). Where the working pressures will exceed these values, a pressure break can be used to reduce the working pressure at the Consumer Connection.
- 1.10.4. Irrespective of the keep-warm strategy (refer to Requirement 1.2.10), constant-flow bypasses shall not be used in the Distribution Network; any bypasses shall be temperature-controlled to only operate when flow temperatures are below a minimum set-point. The standby Heat Network temperatures shall be specified and incorporated into pipework heat loss calculations.

1.11 Ensure sufficient water quality in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important to consider how water quality will be maintained at the Concept Design stage, as the type of water quality system to be followed (e.g. Chemically Treated System or Depleted Water System) can affect many other aspects of the design of the Heat Network. The spatial requirements for the water quality equipment to be specified on the network also needs to be incorporated into the design of the system at the Concept Design stage.

- 1.11.1. A Water Quality Statement shall be produced and clearly documented for each hydraulic system. The Water Quality Statement shall include:
- the type of water quality system to be followed (e.g. Chemically Treated System or Depleted Water System);
 - preliminary selection of the fill water source;
 - preliminary selection of the material of plant, equipment, and distribution pipework (which, for retrofit scenarios, should include consideration of its compatibility with the current existing system);
 - initial performance specification for water treatment and conditioning (e.g. filtration, softening, demineralisation, chemical dosing etc.);
 - a spatial assessment of the plant room, which shall include consideration of:
 - the spatial dimensions and maintenance requirements for each item of water quality equipment;
 - the transportation and storage of chemicals (where chemicals are proposed to be used);
 - equipment and plant room accessibility requirements.

The designer shall ensure that the spatial assessment of the Energy Centre and/or Substation is compatible with the spatial requirements of the water quality equipment specified.

1.12 Ensure that the performance of the Heat Network can be monitored

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Establishing provisional requirements for the monitoring of the system at the Concept Design stage is key in ensuring that the monitoring of the system can be built upon at future design stages.

This Objective references the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025) which provides detail on requirements surrounding Metering and Monitoring Systems.

1.12.1. A Metering and Monitoring Strategy shall be developed.

The strategy shall contain a description of how:

- the data required to calculate the Key Performance Indicators (KPIs) for the Heat Network will be:
 - measured;
 - extracted;
 - recorded; and
 - stored;
- the raw data will be transformed;
- KPIs will be calculated; and
- KPIs will be reported.

The strategy shall be developed such that it will be in accordance with Section 4.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025) at future stages.

1.12.2. Lifecycle costs shall be estimated for systems, infrastructure and associated equipment included in the Metering and Monitoring System.

1.13 Ensure that the Heat Network is sufficiently insulated

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The spatial requirements of insulation on Heat Networks can affect many aspects of the design of the Heat Network, as well as the wider system (for example, the total space allocated to building services within buildings for Communal Distribution Networks).

At the Concept Design stage, appropriate estimates of the required levels of insulation and heat losses from the Heat Network need to be made, and the Heat Network designer should ensure that sufficient space is allocated for the insulation of the Heat Network.

Communal Distribution Networks

- 1.13.1. The space occupied by Communal Distribution Network pipework insulation shall be considered at an early stage in relation to pipework routing and coordination with other building services. This shall include an assessment of the thickness of insulation required to meet:
 - the minimum insulation thickness as set out in [Table J.1](#); and
 - the heat loss limits set out in Requirement [2.13.3/3.13.3](#) and [Table J.2](#).
- 1.13.2. The heat losses from the Communal Distribution Network shall be calculated, taking into account:
 - variations in ambient temperature throughout the building; and
 - weather compensation of operating temperatures (if present).

District Distribution Networks

- 1.13.3. The space occupied by District Distribution Network pipework insulation shall be considered at an early stage in relation to pipework routing and coordination with other utilities and underground services. This shall include an assessment of the thickness of insulation required to meet:
 - the heat loss limits set out in Requirement [2.13.11/3.13.11](#) and [Table J.3](#); and
 - the insulation requirements set out in Requirement [2.13.12/3.13.12](#) and [Table J.3](#).
- 1.13.4. The heat losses from the District Distribution Network shall be calculated, taking into account:
 - variations in ambient temperature (in the air for above-ground pipework, and in the ground for buried pipework); and
 - weather compensation of operating temperatures (if present).

1.14 Minimise the risk posed by construction activities and the operation of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Although the risk posed by construction activities and the operation of the Heat Network might present themselves at later stages, it is important to identify, understand, and mitigate these risks at the Concept Design stage, as measures taken to minimise these risks can affect multiple aspects of the design of the Heat Network.

- 1.14.1. The risk of Legionella growth in the cold water service posed by the presence of the Heat Network shall be mitigated through adequate insulation and separation between the Heat Network and cold water services pipework and components.

Refer to HSG274 Part 2: *The Control of Legionella Bacteria in Hot and Cold Water Systems* (HSE, 2024) for further information.

- 1.14.2. An assessment shall be made on the impact of any micro-climatic effects which might occur at the Energy Centre (e.g. due to the operation of heat generation equipment such as air source heat pumps). This should include an airflow study and acoustic survey. The assessment shall include consideration of:

- the likelihood and impact of ice formation (e.g. locally on supporting or surrounding structures) due to cold air being emitted by air source heat pumps;
- the impact on the coefficient of performance (CoP) of heat pumps;
- the likelihood and impact of the release of refrigerants to the atmosphere;
- the impact of release of flue emissions to the atmosphere;
- health and safety risks related to the selected refrigerant or fuel and its storage;
- health and safety risks which may arise due to cold air being emitted by heat pumps;
- the impact of noise on the local environment and local buildings (e.g. from evaporators).

- 1.14.3. A statement shall be made on the proposed approach to the management of the potential impact of water leakage and the consequential impact to property during the construction and operation of the Heat Network.

1.15 Ensure sufficient maintenance of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The estimation of maintenance and replacement costs needs to be done at the Concept Design stage, as this can feed into wider financial considerations.

The maintenance required on a Heat Network can also impose spatial constraints which need to be understood and appropriately managed at the Concept Design stage.

1.15.1. Maintenance costs (including for spare and consumable parts) shall be estimated for the Heat Network. This includes (but is not limited to):

- CHP units;
- any integrated renewable sources of electricity (e.g. solar PV systems);
- heat pumps (or other primary sources of heat);
- top-up/standby boilers (or equivalent plant);
- water treatment;
- continuous water quality monitoring equipment (where applicable);
- Energy Centre buildings;
- thermal energy meters and the meter reading system;
- distribution pipework and ancillary equipment;
- controls and IT systems;
- Substations;
- Consumer Connections.

Refer to the following documentation for further information.

- *Assessment of the Costs, Performance, and Characteristics of UK Heat Networks* (DECC, 2015).
- CIBSE Guide M: *Maintenance Engineering and Management* (CIBSE, 2023).

1.15.2. Replacement costs shall be estimated for major items of plant and equipment which are likely to need future replacement during the lifespan of the Heat Network.

1.15.3. The designer shall estimate the spatial requirements for maintenance works to be carried out effectively and allocate sufficient space in the design of the Heat Network to allow for spatial requirements for maintenance to be met during subsequent design stages (refer to Requirement 2.15.1/3.15.1).

1.16 Manage and maintain the condition of components in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

A number of the system parameters determined early within the design process (such as the operating temperatures and pressures) can have a significant impact on the condition of the system.

The condition of the components needs to be considered at the Concept Design stage, to ensure that subsequent design activities result in a system with a sufficient lifespan and reduced risk of the deterioration and failure of components.

1.16.1. The designer shall set the operating temperature and pressure of the Heat Network design such that the limits used in lifespan calculations for pipework and equipment are not exceeded.

The resulting operating temperature and pressure constraints shall be clearly documented for future issue to the designer, construction contractor and future Heat Network operator to ensure that:

- the selected pipe material's impact on operating temperatures and pressures is fully understood; and
- the design life of the distribution pipework is maintained and compatible with the design life of the overall Heat Network.

Where the use of polymer distribution pipes (or any other material where lifetime is dependent on operating temperature and pressure) is being proposed, the maximum acceptable temperatures and pressures which deliver the required design life shall be determined. The overall benefit of such pipe system should be assessed accordingly, taking account of the use of variable flow temperatures.

Specialist consultation or manufacturer guidance should be sought for lifespan calculations of polymer or any other material where lifetime is dependent on operating temperature and pressure.

1.17 Ensure that project documentation is produced and managed

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Establishing the production and management of project documentation at the Concept Design stage is key in the communication of the design intent, and can aid in ensuring that design activities undertaken at future design stages reflect the constraints identified at the Concept Design stage.

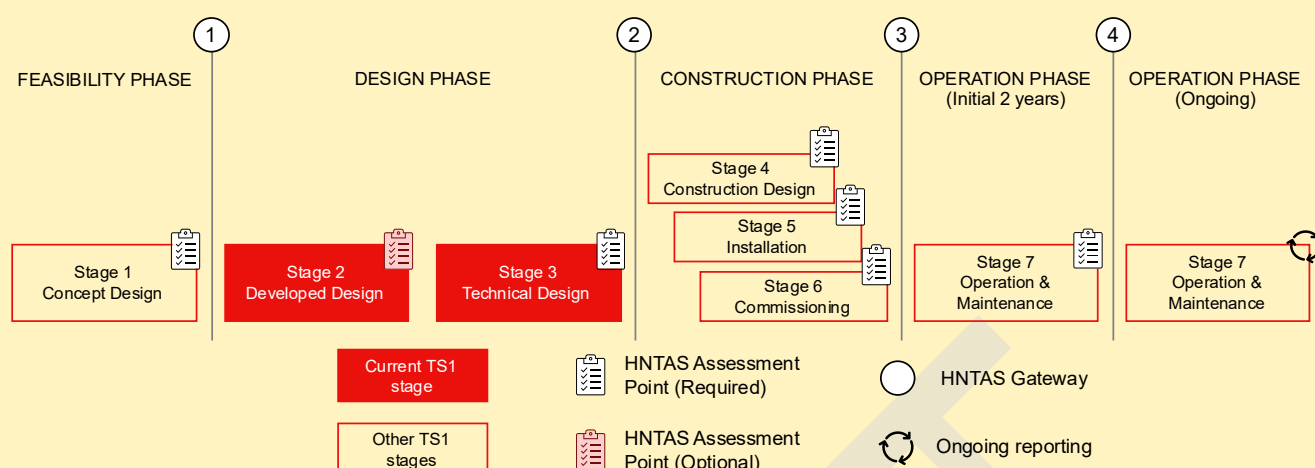
It is important to communicate where there is unavailability of relevant information at the Concept Design stage, as this could affect the development of more refined design information at later stages.

Document register

- 1.17.1. A document register shall be created and managed using an established document management system.

2/3 Stage 2: Developed Design & Stage 3: Technical Design

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Note on Developed Design and Technical Design stages

The requirements in the Developed Design and Technical Design stages of this standard have been merged into one section. This is because many of the requirements at the Technical Design stage involve very similar activities to those at the Developed Design stage, performed with a higher level of precision.

Whilst it is expected that all Heat Networks will undergo the Developed Design and Technical Design stages, assessment under HNTAS at the Developed Design is optional.

It is expected that assessment at the Developed Design stage would be particularly aimed at networks adopting a Design and Build procurement route, where the main contractor would be appointed at the start of the Technical Design stage. This differs from a traditional procurement route, where the main contractor would typically be appointed at the start of the Construction Design stage.

Layout of Developed Design and Technical Design stages

Where a Minimum Requirement is the same at the Developed Design stage and the Technical Design stage, it has been merged into one Minimum Requirement, with two paragraph numbers corresponding to Stage 2 (Developed Design) and Stage 3 (Technical Design).

Where a Minimum Requirement is not the same or not applicable at the Developed Design stage and the Technical Design stage, separate requirements are shown for Stage 2 (Developed Design) and Stage 3 (Technical Design).

Examples of the above are provided below.

2.0.1 3.0.1	This is an example of a Minimum Requirement which is the same at the Developed Design stage and the Technical Design stage.
2.0.2	This is an example of a Minimum Requirement which is only applicable to the Developed Design stage. Note that, where a Minimum Requirement is not applicable at the Developed Design stage, this is indicated through text.
3.0.2	This is an example of a Minimum Requirement which is only applicable to the Technical Design stage.

Developed Design stage overview

At the start of the Developed Design stage, it is expected that:

- the heat demands which the Heat Network will serve and the heat source(s) have been determined;
- the operating temperatures of the Heat Network have been determined;
- the spatial requirements of the Heat Network have been determined, including consideration of network routing, pipe sizes, required levels of insulation, and the Resilience Strategy.

At the boundary between the Developed Design stage and the Technical Design stage, it is expected that a design for the Heat Network has been developed which is sufficiently detailed to allow for:

- the Heat Network to be spatially co-ordinated with other building services and the wider system;
- the operational strategy of the Heat Network to be co-ordinated with other building services;
- the Technical Design of other aspects of the wider system to be independently developed.

Technical Design stage overview

The activities undertaken during the Technical Design stage are similar to those undertaken at the Developed Design stage. However, they will be carried out with:

- a higher level of precision, incorporating the information available for the wider system;
- detailed consideration for how the plant, equipment, and pipework will be installed, commissioned, and operated;
- spatial coordination with the wider system being completed and suitable for installation.

At the end of the Technical Design stage, it is expected that:

- the heat demands and heat consumption which the network will serve have been calculated;
- operating temperatures of all Elements in the Heat Network have been specified;
- all equipment, pipework, and insulation in the Heat Network has been spatially coordinated (including spatial coordination with the wider system);
- the sizes of the heat source(s) and thermal storage have been specified;
- the hydraulic design, equipment selection, and a Description of Operation (DesOps) of the control systems used in Energy Centres and Substations have been produced;
- the Resilience Strategy has been refined;
- the approach used to manage water quality in the Heat Network has been specified;
- the provision of metering and monitoring throughout the Heat Network has been specified;
- project documentation has been produced such as an updated document register, outline structure for the operation and maintenance (O&M) manual, drawings, and schematics.

2/3.1 Determine the consumer heat demands from the network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

At the Developed/Technical Design stage, there will be more refined design information available from the wider system which allows for more refined calculation of demands from the system.

A number of the Minimum Requirements within this Objective include activities for which further guidance can be found in the CIBSE Design Guide: *Heat Networks* (CIBSE, 2021).

Total heat demands

2.1.1. The peak demand from Communal Distribution Networks serving domestic consumers shall be determined with consideration of:

3.1.1.

- the diversified space heating peak demand;
- the diversified domestic hot water peak demand;
- other consumer heat demands which are neither space heating nor domestic hot water;
- system losses from the Communal Distribution Network.

The methodologies and assumptions used, including the design external air temperature (initially defined in accordance with Requirement 1.1.7), shall be clearly documented.

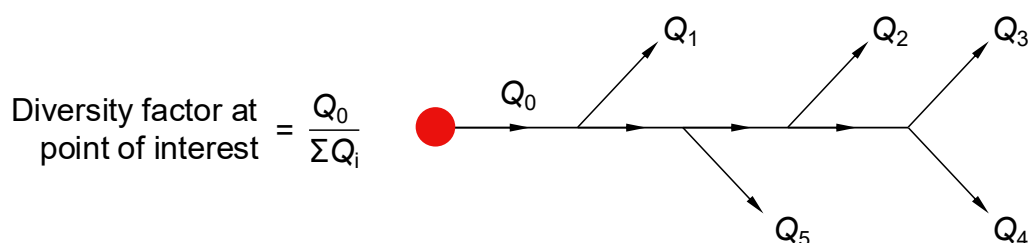
The diversity factor of demands served by a given point in the Heat Network can be defined as below.

$$\text{Diversity factor} = \frac{\text{peak demand that occurs at the given point in the Heat Network (kW)}}{\sum \text{peak demand at each end consumer served by the given point (kW)}}$$

The diversity factor typically arises due to peak demand events from multiple consumers not being coincident, and is dependent on the number and type of consumers served by a given point in the Heat Network.

This is illustrated in Figure 16.

Figure 16: Illustration of diversity factor definition



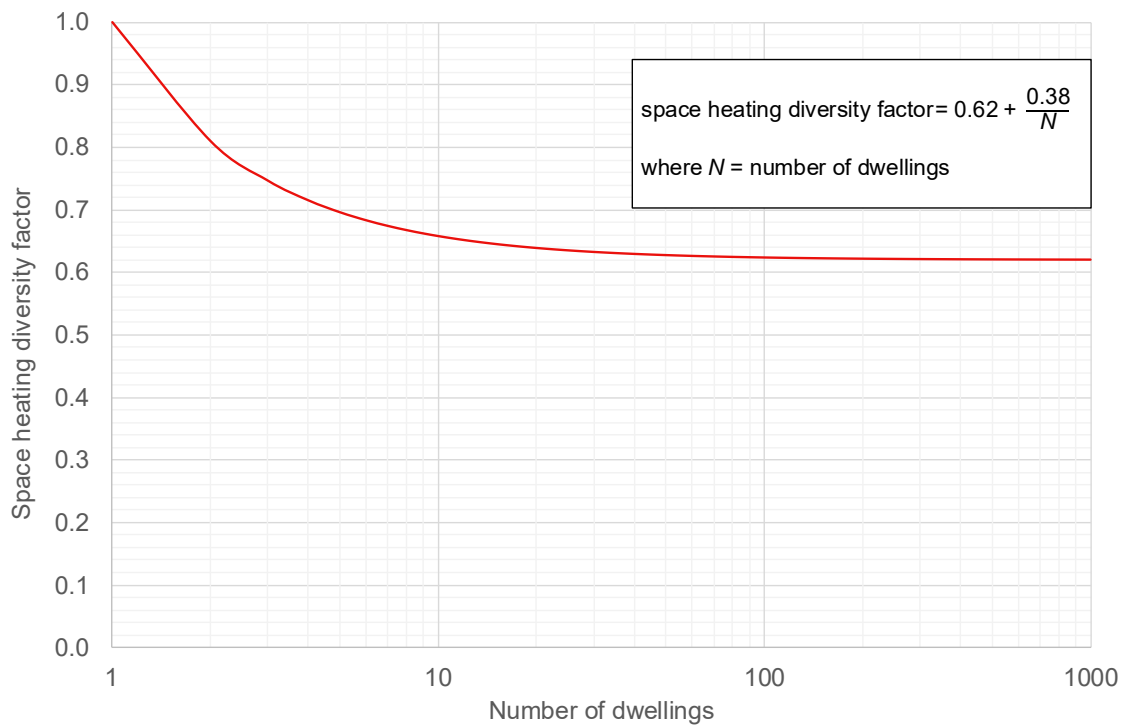
2.1.2. 3.1.2.	The total peak demand from a non-domestic building shall be determined with the methodologies and assumptions used being clearly documented. The use of domestic hot water priority can be used to reduce the total peak demand from the non-domestic building provided that the period of the expected peak does not exceed 15 - 30 minutes; using domestic hot water priority for longer peaks can result in noticeable discomfort in the building. Refer to CIBSE AM14: <i>Non-domestic Hot Water Heating Systems</i> (CIBSE, 2010) for further information.
2.1.3. 3.1.3.	The peak demand and annual consumption from existing buildings shall be assessed by the designer from a combination of data on fuel use (accounting for system efficiency) and existing boiler use, and established heat loss modelling (such as building simulation modelling). This assessment should be supported by the District Heat Network designer (if present), who might be able to use data from similar buildings to assist in the estimation.
2.1.4. 3.1.4.	Temporary monitoring shall be considered when estimating peak demands from existing buildings was not previously undertaken at the Concept Design stage.
2.1.5. 3.1.5.	For existing residential buildings, sample dwelling types may be used where necessary to determine peak demand and annual consumption values from space heating and domestic hot water which can then be extrapolated for the entire area or building. Where extrapolation is used, the methodology for determining the loads from the sample dwellings and the extrapolation methodology shall be clearly documented.

Space heating

2.1.6. 3.1.6.	The estimation of space heating demands for new and existing buildings shall use a combination of: • relevant fuel or thermal energy meter data where available; • “degree day” analysis; • calculations using established calculation methodologies - these calculations shall be agreed with the District Heat Network designer (where present); • guidance in CIBSE Guide F: <i>Energy efficiency in buildings</i> (CIBSE, 2012) and CIBSE TM46: <i>Energy benchmarks</i> (CIBSE, 2008); • benchmark data from other sources (including the local Heat Network operator, or similar operational schemes) and the CIBSE Energy Benchmarking Tool (CIBSE, 2019). • other data sources such as Display Energy Certificates (DECs) or Energy Performance Certificates (EPCs) where available.
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2.1.7. 3.1.7.	In new Communal Heat Networks serving domestic consumers, the peak space heating demand from the entire building shall be calculated assuming: • full occupancy in the building; • no heat transfer between dwellings; • no margin for heat-up times of Consumer Heat Systems (i.e. a steady-state heat loss). This is to avoid overestimation of the peak space heating demand from the entire building which would otherwise arise from adding up the space heating demands from individual dwellings (which might have been calculated with methods considering heat transfer between dwellings). The calculated peak space heating demand from the entire building with diversity applied as appropriate shall be used for sizing the building connection for District Heat Networks or Energy Centre capacity for Communal Heat Networks. For buildings connecting to District Heat Networks, the diversity methodology applied within the District Heat Network shall be shared between the building designer and the District Heat Network designer.
2.1.8. 3.1.8.	In Communal Heat Networks serving domestic consumers, the peak space heating demands shall be diversified using an appropriate diversity factor which may be derived from: • operational data from a Communal Distribution Network of a similar size and type of consumer(s); • outputs of detailed modelling (such as dynamic simulation modelling on an hourly basis); • outputs of building heat loss calculations developed with sufficient accuracy and precision (e.g. in accordance with BS EN 12831:2017 <i>Energy performance of buildings. Method for calculation of the design heat load - Space heating load, Module M3-3</i> (BSI, 2017), or CIBSE Guide A: <i>Environmental Design</i> (CIBSE, 2015)). Where the use of operational data or detailed modelling is not possible, the rule of thumb formula shown in Figure 17 may be used provided that the peak heating demand from each dwelling is calculated assuming heat losses to adjacent dwellings.

Figure 17: “Rule of thumb” space heating diversity factor



Rule of thumb space heating diversity factor extracted from *Varme Ståbi* (Frederiksen, et al., 2021)

2.1.9.

3.1.9.

The peak space heating demand from a non-domestic building shall be determined, and may be derived from:

- outputs of detailed modelling (such as dynamic simulation modelling on an hourly basis);
- outputs of building heat loss calculations (e.g. in accordance with BS EN 12831:2017 *Energy performance of buildings. Method for calculation of the design heat load - Space heating load, Module M3-3* (BSI, 2017)).

The peak space heating demand should be determined considering the impact of:

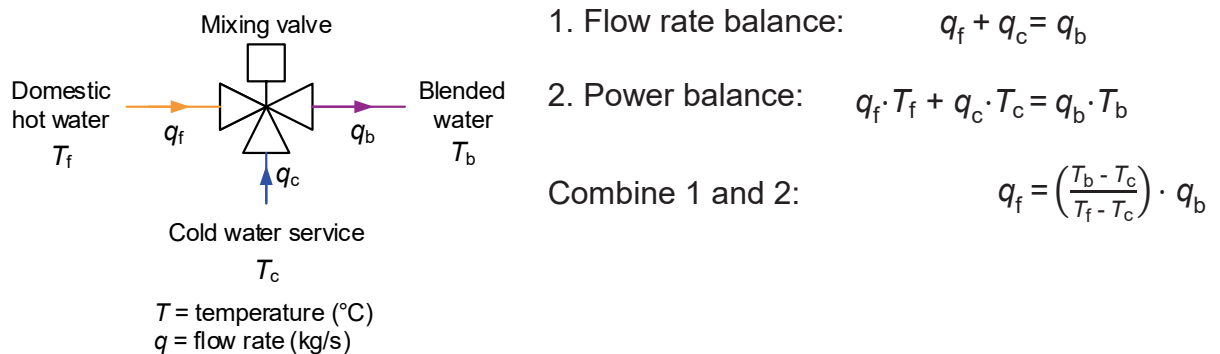
- net infiltration into the building - note that CIBSE Guide A: *Environmental Design* (CIBSE, 2015) Section 5.8.2 states that this can be about half the sum of the rates for the separate rooms;
- the use of mechanical ventilation combined with heating, which may result in different hours of use and different times of peak demand from the different pieces of plant.

Refer to CIBSE Guide A: *Environmental Design* (CIBSE, 2015) for further information.

Domestic hot water

- 2.1.10. The flow rates of domestic hot water at each outlet upstream of thermostatic mixing valves (where used) shall be determined, with consideration given to:
- 3.1.10.
- the temperature at the outlet (where thermostatic mixing valves are incorporated);
 - the required flow rate at the outlet - where thermostatic mixing valves are incorporated, this will be the required flow rate of the blended water; and
 - the difference between the temperature of the domestic hot water feeding into the thermostatic mixing valve and the blended water outlet temperature (e.g. where a minimum temperature difference is required for certification purposes).
- An example methodology for determining the required domestic hot water flow rate at outlets served by thermostatic mixing valves is provided in [Figure 18](#).

Figure 18: Example calculation of the domestic hot water flow rate from blended outlets



Example flow rates and temperatures from typical domestic hot water outlets are provided in [Table B.2](#).

- 2.1.11. The peak domestic hot water demand at each Consumer Connection shall be determined by considering:
- 3.1.11.
- the flow rate from each domestic hot water outlet in the Consumer Heat System;
 - the number and type of domestic hot water outlets in the Consumer Heat System;
 - the diversity of domestic hot water demands within the Consumer Heat System.
- Domestic hot water demands from typical dwelling types may be determined in accordance with [Table B.3](#).
- The application of “usage scenarios” may be used to determine the peak domestic hot water demand at a Consumer Connection if this is technically justified by the designer.

	Other requirements for the Consumer Connection sizing (such as conformity with the NHBC Standards (NHBC, 2025, or latest edition)) can require consideration when specifying and sizing Consumer Connections.
2.1.12. 3.1.12.	The seasonal variation in domestic hot water demands due to variations in mains cold water temperature and temperatures used for baths and showers shall be included in calculations when estimating domestic hot water consumption.
2.1.13. 3.1.13.	The peak domestic hot water demand at each section of the system serving multiple domestic consumers with instantaneous domestic hot water shall be determined using the equation provided in Figure 19 , which is in accordance with DS 439: <i>Code of Practice for Domestic Hot Water Supply Systems</i> (Danish Standards, 2024).

Figure 19: Calculation for peak domestic hot water demand from multiple domestic consumers

$$q_d = 2 \cdot q_m + \theta \left((\Sigma q_f) - 2 \cdot q_m \right) + A \cdot \sqrt{q_m \theta} \cdot \sqrt{(\Sigma q_f) - 2 \cdot q_m}$$

Where: q_d is the diversified peak load flow rate through a section of pipe;
 Σq_f is the maximum flow rate from all outlets served by the pipe;
 q_m is the weighted mean water flow to several outlets connected to the distributing pipe;
 θ is the probability of draining q_m in a peak load period;
 A is a safety factor.

Equation applicable for determining the peak domestic hot water demand from multiple domestic connections with instantaneous domestic hot water.

Equation extracted from DS 439: Code of Practice for Domestic Hot Water Supply Systems (Danish Standards, 2024).

The value for Σq_f shall be determined by considering the number and type of domestic hot water outlets and their maximum design flow rates. The required flow rate from each outlet shall be determined in accordance with the assumed domestic hot water outlet flow rates, such as those provided in [Table B.2](#).

The value for Σq_f may also be determined at a dwelling-level (refer to [Table B.3](#)) where the underlying assumptions made in [Table B.3](#) are applicable.

The values shown in [Table 4](#) should be used for constants θ , q_m , and A , as recommended by DS 439: *Code of Practice for Domestic Hot Water Supply Systems* (Danish Standards, 2024) for residential buildings, unless it can be justified why these constants have not been used.

Table 4: Recommended values for domestic hot water diversity constants

Constant	DS 439 (2024) recommended value
θ	0.011
q_m	0.075
A	3.1

Recommended values in accordance with DS 439: Code of Practice for Domestic Hot Water Supply Systems (Danish Standards, 2024).

The selection of constants A and θ can impact the probability of the actual water flow rate (created by random end consumer demands) exceeding the design flow rate predicted by the equation provided in [Figure 19](#).

q_m is the weighted mean water flow rate for several outlets served by the pipe section, and may alternatively be calculated as set out in [Figure 20](#).

Figure 20: Calculation of weighted mean water flow q_m

$$q_m = \frac{\sum_k G_k q_{i,k}}{\sum_k G_k}$$

Where: G is a relative quantity calculated on the basis of measured usage frequencies and tapping times at different outlets;

q_i is the average water flow at each individual outlet;

k denotes an outlet;

G and q_i are attributed to the same demand period.

Combining demands

2.1.14. Consumer Connections (and terminal sections of distribution pipework serving an individual Consumer Connection) shall be sized using outputs from accurate calculations of the expected temperature differences from each operating mode to appropriately meet:

3.1.14.

- the peak space heating demand of the Consumer Heat System;
- the peak domestic hot water demand of the Consumer Heat System (refer to Requirement [2.1.11/3.1.11](#)); and
- other heat demands of the Consumer Heat System.

The impact of diversity within the Consumer Heat System and the operation mode of the Consumer Connection (such as “domestic hot water priority”) shall be considered when sizing the Consumer Connections and terminal section of distribution pipework serving a single Consumer Connection.

Stored domestic hot water cylinders in Consumer Heat Systems should be avoided within dwellings: however, where stored domestic hot water is used within dwellings, an alternative diversity methodology should be applied.

	The diversity within non-domestic Consumer Heat Systems can be different to that from domestic Consumer Heat Systems. Consumer Connections which provide instantaneous domestic hot water should be used for non-domestic consumers where possible. Appropriate diversity should be applied where possible. Refer to the Hot Water Association Design Guide DG1: <i>Stored Hot Water Solutions in Heat Networks</i> (HWA, 2018) for example diversity calculations for stored domestic hot water cylinders in dwellings.
2.1.15. 3.1.15.	The total peak demands from multiple non-domestic buildings should be multiplied by an appropriate diversity factor when assessing the demand in sections of a District Distribution Network. Refer to Table 5.13 of CIBSE Guide A: <i>Environmental Design</i> (CIBSE, 2015) for a set of example values.
2.1.16. 3.1.16.	If the total peak demand from a Communal Heat Network containing multiple Consumer Connections (e.g. a residential block) has been multiplied by a diversity factor, the total peak demands from multiple Communal Heat Networks shall not be multiplied by a further diversity factor when assessing the demand in sections of a District Distribution Network. An alternative approach for determining the demand may involve applying an appropriate diversity factor in sections of the District Distribution Network which is based on the sum of the individual dwellings served by that section of District Distribution Network pipe. For either approach, the designer shall ensure that a diversity factor is only applied once.
2.1.17. 3.1.17.	Local climatic variations such as the urban heat island effect should be incorporated in calculations when estimating space heating peak demands and consumption where required by the siting of the Heat Network.

2/3.2 Ensure that Consumer Systems meet consumer heat demands in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The presence of more refined information at the Developed/Technical Design stage will allow for more precise design of Consumer Connections and Consumer Heat Systems. Appropriate specification of:

- the type of Consumer Connection and Consumer Heat System;
- ancillary equipment; and
- the control systems used,

is important in ensuring that consumer heat demands are sufficiently met.

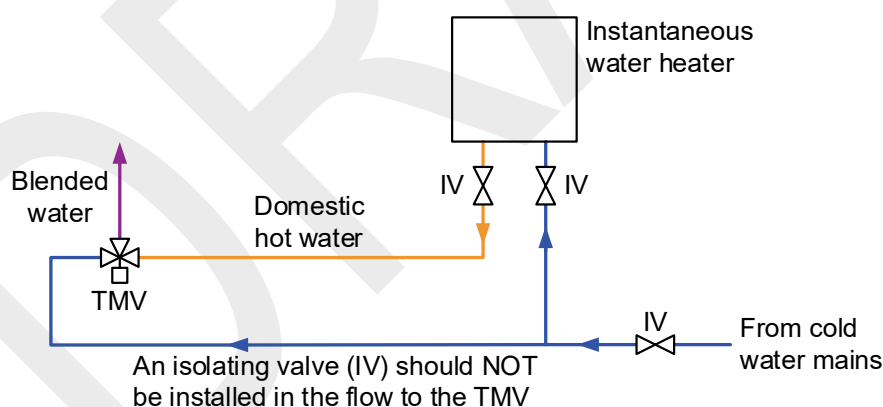
Space heating

2.2.1. 3.2.1.	An assessment of the types of residential consumers shall be undertaken to establish if low surface temperature radiators and/or temperature control of hot water outlets are required; this can include scenarios where such controls are not a regulatory requirement.
2.2.2. 3.2.2.	Radiators in Consumer Heat Systems shall be specified with pre-settable pressure-independent radiator valves designed for the expected range of flow rates through the system.
2.2.3. 3.2.3.	The designer shall ensure that the required flow rate is within the pressure-independent valve's range of flow rate settings, and that the differential pressure (dP) available across every radiator is sufficient for the pressure-independent valve and TRV (if present) to accurately control the flow rate through the radiator.
2.2.4. 3.2.4.	The small internal apertures of pressure-independent valves should be considered when designing the Water Quality Strategy (including the flushing methodology) of Consumer Heat Systems, as these valves can be sensitive to contaminants.
2.2.5. 3.2.5.	For direct Consumer Connections, appropriate measures shall be implemented to mitigate the risk of high differential pressures across the Consumer Heat System. This may be through the use of differential pressure control valves (DPCVs).
2.2.6. 3.2.6.	For indirect Consumer Connections, the Consumer Heat System space heating pump shall respond to the room thermostat or programmer and stop when heat is not required (refer to Paragraph 5.15 of Approved Document L: <i>Conservation of Fuel and Power</i> (Volume 1) (DLUHC, 2023)). The Consumer Heat System space heating pump shall also be set to a variable-speed mode to reduce pumping energy and noise pollution.

Domestic hot water

2.2.7. 3.2.7.	Instantaneous domestic hot water generators shall be set to generate instantaneous domestic hot water at 50 °C at the tap outlet (or hot inlet to thermostatic mixing valve, where fitted), unless there is a site-specific requirement for higher domestic hot water temperatures.
	This temperature requirement is acceptable provided the volume of stored water in the unit is less than 15 litres and the risk of Legionella growth can be controlled - this is supported by the CIBSE Guidance Note: <i>Domestic Hot Water Temperatures from Instantaneous Heat Interface Units</i> (CIBSE, 2021).
2.2.8. 3.2.8.	Manufacturer information should be sought when assessing the suitability of thermostatic mixing valves with the proposed domestic hot water outlet temperature. The thermostatic mixing valve should be capable of stable operation at the minimum hot supply temperature of the system.
2.2.9. 3.2.9.	The pipework arrangement of instantaneous domestic hot water systems shall not allow for domestic hot water to reach any thermostatic mixing valve whilst the cold water supply to the thermostatic mixing valve is isolated (i.e. isolation of the cold water supply to any thermostatic mixing valve shall also shut off supply to the instantaneous domestic hot water generator). A pipework arrangement is provided in Figure 21 - refer to the CIBSE Guidance Note: <i>Domestic Hot Water Temperatures from Instantaneous Heat Interface Units</i> (CIBSE, 2021) for further information.

Figure 21: Pipework arrangement to prevent hot water bypass in event of cold water failure



Extracted from the CIBSE Guidance Note: *Domestic Hot Water Temperatures from Instantaneous Heat Interface Units* (CIBSE, 2021).

2.2.10. 3.2.10.	Where it is not proposed to provide instantaneous domestic hot water at the Consumer Connection, the type of domestic hot water provision shall be specified, based on the assessment undertaken in accordance with Requirement 1.2.9 .
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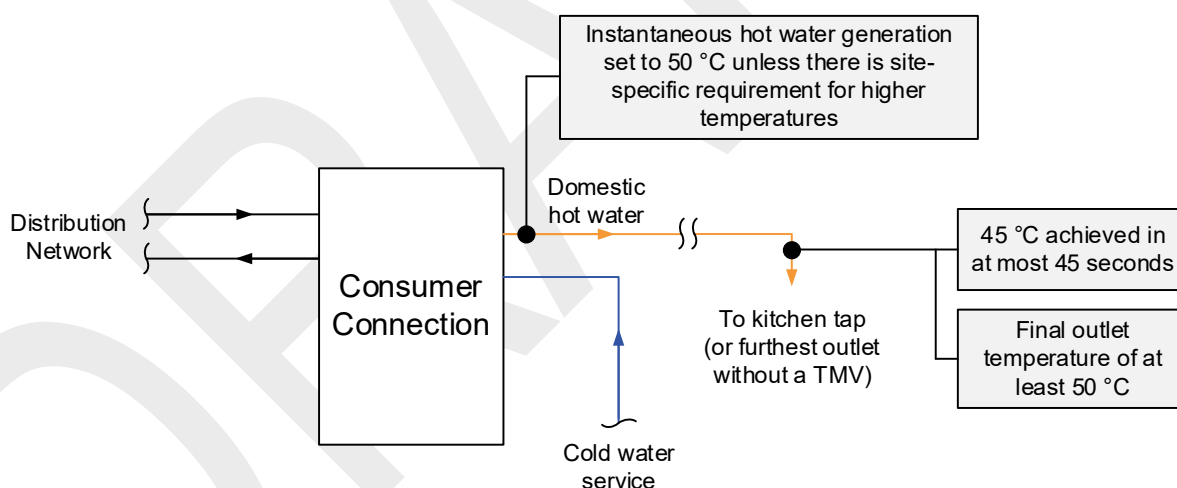
- 2.2.11. The design of the domestic hot water system in Consumer Heat Systems shall ensure that domestic hot water is delivered to the kitchen tap (or the furthest outlet without a thermostatic mixing valve) at a temperature of 45 °C in at most 45 seconds with the tap opened to full flow rate, with a final outlet temperature of at least 50 °C (see [Figure 22](#)) - refer to CIBSE Guidance Note: *Domestic Hot Water Temperatures from Instantaneous Heat Interface Units* (CIBSE, 2021) for further information.
- 3.2.11.

There can be additional requirements for the output temperatures from domestic hot water systems (e.g. in healthcare facilities).

The requirement for the domestic hot water to achieve a temperature of 45 °C in at most 45 seconds includes the reaction time of the Consumer Connection (e.g. HIU) from its standby operation, as well as the time taken for delivery through the pipework in the Consumer Heat System.

The domestic hot water reaction time for an HIU can be estimated from its BESA UK HIU Test Regime (BESA, 2023, or latest edition) test results, if the unit is within the scope of the regime.

Figure 22: Domestic hot water generation and delivery temperature requirements



Applicable for instantaneous domestic hot water generators.

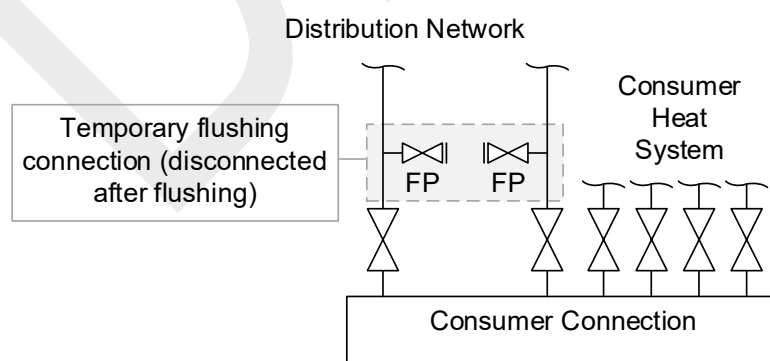
- 2.2.12. Trace heating should not be used within domestic hot water systems unless its inclusion can be technically justified.
- 3.2.12.

Consumer Connection Specification

2.2.13. 3.2.13.	The use of direct or indirect hydraulic interface connections shall be assessed for Substations and Consumer Connections. The assessment may be project-specific or for multiple projects which are to be developed to a standardised design. The assessment may be quantitative or qualitative; contractual or commercial justifications may also be used. The assessment shall also be made with consideration given to: - the sizing of Consumer Heat Systems due to the flow and return approach temperatures; - return temperatures in the Communal Distribution Network and District Distribution Network; - the need for hydraulic breaks to minimise working pressures within the Consumer Heat System; - operation and maintenance costs due to the additional equipment required in indirect connections; - maintaining water quality - this can be more complex for indirect connections due to the increased number of hydraulic systems; - capital cost and space requirements for plant, electrical connections and monitoring and control systems.
2.2.14. 3.2.14.	Where HIUs are used, the designer shall specify HIUs that conform with BS 8635-1:2024: <i>Hydraulic Interface Units for Heat Network Applications - Specification</i> (BSI, 2024).
2.2.15. 3.2.15.	Where HIUs are used, the designer shall specify HIUs that will achieve the required output and design return temperatures. If the HIU selected is within the scope of the BESA UK HIU Test Regime (BESA, 2023, or latest edition), it shall be tested under the regime and registered with BESA; HIUs not within the scope of the BESA UK HIU Test Regime (BESA, 2023, or latest edition) shall be tested and registered under an equivalent accredited independent HIU testing and registration scheme.
2.2.16. 3.2.16.	For Heat Interface Units (HIUs) not within the scope of (and hence not registered under) the BESA UK HIU Test Regime (BESA, 2023, or latest edition), the HIU shall either be installed with an insulating enclosure or with insulation of its constituent components (such as pipework and heat exchangers). HIUs at: - domestic connections; and - non-domestic connections for which: - the peak instantaneous domestic hot water demand is ≤ 70 kW; and - the peak space heating demand is ≤ 20 kW, shall achieve average overall heat losses of no greater than 1.0 kWh/day.
2.2.17. 3.2.17.	Indirect Consumer Connections which are not in the scope of the BESA UK HIU Test Regime (BESA, 2023, or latest edition) shall be sized to achieve the return approach temperatures set out in Requirement 1.8.4.

2.2.18. 3.2.18.	Where the keep-warm strategy of the Distribution Network uses keep-warm functionality within Consumer Connections (e.g. HIUs): - the Consumer Connections (e.g. HIUs) on the system shall be specified to have keep-warm functionality; and - the system shall be designed such that consumers cannot turn off the keep-warm functionality or alter its operation (e.g. by changing temperature setpoints in the keep-warm function of the unit).
2.2.19. 3.2.19.	Where the keep-warm strategy of the Distribution Network solely uses the design of the Distribution Network (i.e. without any keep-warm functionality in the Consumer Connections), the HIUs specified on the system shall have passed the domestic hot water non-keep-warm tests within the BESA UK HIU Test Regime (BESA, 2023, or latest edition) (or an equivalent independent HIU testing and registration scheme, if the unit is not in scope of the BESA UK HIU Test Regime (BESA, 2023, or latest edition)) to demonstrate that the domestic hot water delivery times will be sufficiently low in accordance with Requirement 2.2.11/3.2.11.
2.2.20.	No applicable requirement at the Developed Design stage.
3.2.20.	The designer shall use the results from the BESA UK HIU Test Regime (BESA, 2023, or latest edition) (or an equivalent accredited independent HIU testing and registration scheme) or manufacturer declared data to inform commissioning and Acceptance Testing requirements (for example, to set performance requirements for acceptable return temperatures during space heating operation and domestic hot water operation).
2.2.21. 3.2.21.	Where HIUs are used, a flushing bypass shall be specified on the Distribution Network pipework to the HIU (which can include the HIU first-fix valve rail) to protect sensitive equipment in the HIU during network flushing; this bypass should comply with the HIU manufacturer's requirements. The flushing bypass shall be temporary (refer to Figure 23).

Figure 23: Example temporary flushing connection on Consumer Connection



2.2.22. 3.2.22.	The design of a Consumer Connection shall ensure that:
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- user controls are located in an accessible location internal to the dwelling served by that Consumer Connection;
- there is sufficient provision of isolation for emergency use (refer to Requirement 2.15.10/3.15.10); and
- in-house displays (IHDs) (where the IHD is a physical device) are located in accordance with Section 3.1.2 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).

DRAFT

2/3.3 Minimise the length of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Ensuring that the length of the Heat Network is minimised during the Developed/Technical Design stage aids in minimising heat losses. At the Developed/Technical Design stage, this includes consideration of the constraints posed by spatial coordination with other aspects of the wider system and other technical requirements present on the system.

Communal Distribution Network

- 2.3.1. The Communal Distribution Network shall be designed to minimise the total pipework length, in accordance with Requirement 1.3.3.
- 3.3.1. Consumer Connections (such as HIUs) shall be located as close as reasonably practicable to both the vertical and horizontal distribution pipework to minimise the total length of terminal run pipework (pipework serving only one Consumer Connection). Individual pairs of pipes supplying each Consumer Connection running in parallel along corridors from the vertical riser shall be avoided.
- It can be beneficial to design the system such that Consumer Connections are in enclosures outside dwellings (e.g. in corridors), as this can result in lower lengths of distribution pipework, and can be beneficial for maintenance and isolation purposes. Refer to Figure 11.

District Distribution Network

- 2.3.2. Drawings of all existing buried services shall be obtained as part of the District Distribution Network route selection process.
- 3.3.2.
- 2.3.3. The design of the District Distribution Network shall be developed to minimise lifecycle costs. This is typically achieved through minimising the overall network length, although longer routes may be justified where 'soft digging' is possible or to avoid barriers such as railways and busy road crossings (see Requirement 2.3.6/3.3.6).
- 3.3.3.
- 2.3.4. The design of the District Distribution Network shall seek to minimise the length of the network as far as reasonably practicable.
- 3.3.4.
- The selection of the Energy Centre location is required during the Concept Design stage, in accordance with Requirement 1.3.1.
- 2.3.5. The District Distribution Network pipework routes shall be assessed using the information available at the Developed/Technical Design stage. Where the network runs through existing infrastructure, evidence shall be provided showing existing utilities, embargoed routes or other barriers which will cause longer network routes.
- 3.3.5.

2.3.6. 3.3.6.	District Distribution Network routes shall be selected, where appropriate, to avoid barriers such as major roads and to utilise “soft dig” areas, subject to consultation with local stakeholders (e.g. residents) as these areas may have high amenity value. Street works shall follow the recommendations in the NRSWA <i>Code of Practice for the Co-ordination of Street and Road Works</i> (DfT, 2023), Advice Note SA 10/05: <i>New Roads and Street Works Act 1991: Diversionary Works</i> (Highways Agency, 2005), and Street Works UK Guidelines (volumes 1-6) (Street Works UK, 2007-2023) after liaison with the appropriate authorities. Where trees impede a proposed route, permission shall be sought to remove the trees or the designer shall re-route the distribution pipework. It can be necessary to seek wayleaves in some areas of land ownership.
2.3.7. 3.3.7.	The use of above-ground routes for District Distribution Network pipework (e.g. in underground car parks and other service areas within connected buildings) should be considered. Whilst the use of above-ground pipework in District Distribution Networks can lead to capital cost savings, the management of thermal expansion differs to that in buried pipework, and its use can result in higher heat losses and greater risk of damage.
2.3.8. 3.3.8.	Surveys shall be undertaken to establish a viable route for District Distribution Networks, including (but not limited to): • surveys of all surface equipment and inspection chambers; • ground surveys using ground-penetrating radar to identify underground obstructions (e.g. other utilities); • trial holes at critical points in the District Distribution Network route. The survey works should be undertaken in accordance with PAS 128:2022: <i>Underground Utility Detection, Verification and Location - Specification</i> (BSI, 2022).
2.3.9. 3.3.9.	The minimum distance between buried District Distribution Network pipework and the exterior of other conduits should be in accordance with the Street Works UK Guidelines (volumes 1-6) (Street Works UK, 2007-2023) unless agreed otherwise with the relevant utility owner(s). Consideration should also be given to: • relevant standards and guidelines such as BS EN 13941:2019+A1:2021 <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021); • spacing distance requirements from other utilities present; • manufacturer requirements and guidance. This can reduce the risk of third party damage to the District Distribution Network pipework, or to other utilities. Other spacing distances can be required specific to each utility type and whether the crossing is parallel or perpendicular.

2/3.4 Minimise operating temperatures within the constraints present

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

At the Developed/Technical Design stage, the development of the design of the Heat Network and the wider system will result in more a refined understanding of the constraints present when minimising operating temperatures.

This will result in more refined values being determined for the operating temperatures on the Heat Network.

2.4.1. The rationale for the operating temperatures throughout the Heat Network shall be provided, including consideration of:

- 3.4.1.
- heat losses from distribution pipework;
 - pumping energy required at the Energy Centre and/or Substation(s);
 - capital expenditure of the Heat Network;
 - the coefficient of performance (CoP) of heat pumps (where used), which typically reduce as the operating temperatures of the Heat Network increase;
 - the cost of heat production - this depends on the heat source and type of plant, as is influenced by the coefficient of performance for plant such as heat pumps;
 - flow temperature reduction under part-load conditions - although pumping energy will increase, the lower heat losses may make this economically and environmentally favourable;
 - the network's ability to operate at these temperatures in future scenarios as well as current scenarios.

For variable flow temperatures on District Distribution Network to be advantageous, the designer should ensure that the flow temperature set-points on Communal Distribution Network and Consumer Heat System circuits do not exceed the District Distribution Network flow temperature; this is to prevent control valves in the District Distribution Network fully opening, which could cause return temperatures to increase.

2.4.2. The Heat Network designer shall inform the building designer and/or owner of:

- 3.4.2.
- the operating temperatures of the Heat Network; and
 - the heat losses from the Heat Network.

The building designer and/or owner shall consider the presence of the Heat Network when assessing the risks associated with Legionella in:

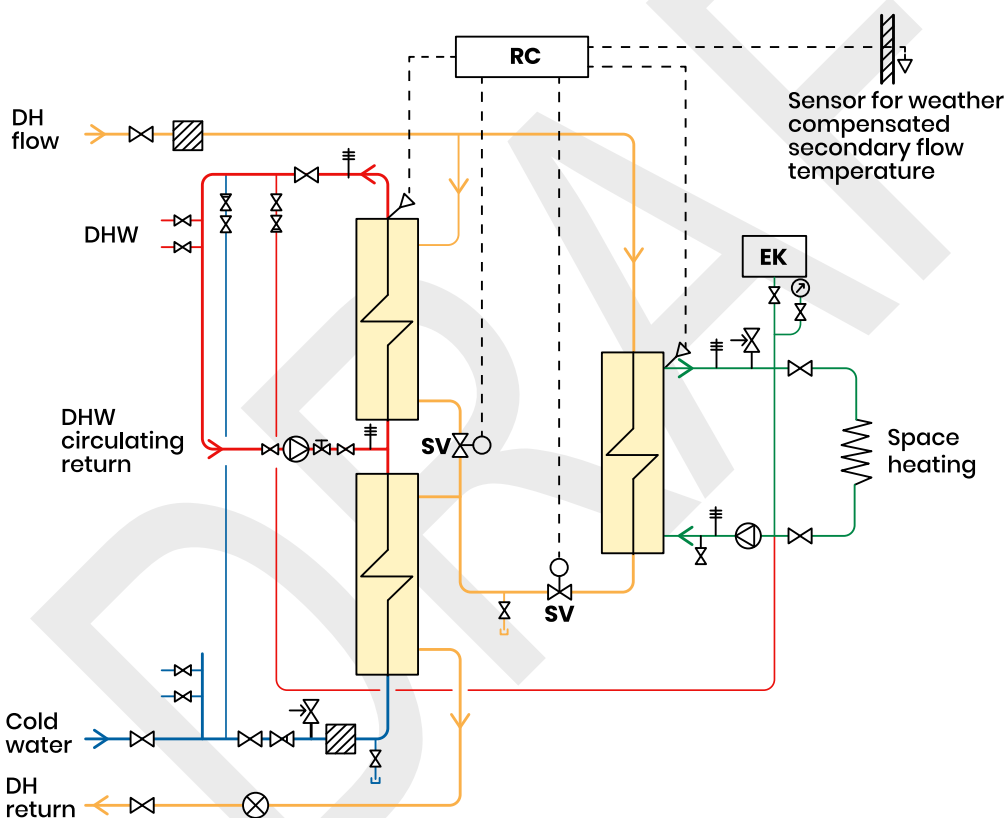
- all domestic hot water systems; and
- the cold water system (e.g. if affected by the presence of the Heat Network, or where modifications are required as an enabling measure to install the Heat Network.

	Further information can be found in the following. • CIBSE Guidance Note: <i>Domestic Hot Water Temperatures from Instantaneous Heat Interface Units</i> (CIBSE, 2021). • HSE Approved Code of Practice and Guidance L8: <i>Legionnaires' Disease - The Control of Legionella Bacteria in Water Systems</i> (HSE, 2013). • <i>HSG274 Part 2: The Control of Legionella Bacteria in Hot and Cold Water Systems</i> (HSE, 2024). • BS 8558:2015: <i>Guide to the Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use within Buildings and Their Curtilages</i> (BSI, 2015). • BS EN 806: <i>Specifications for Installations Inside Buildings Conveying Water for Human Consumption</i> (BSI, 2000 - 2012). • BS 8580-1:2019: <i>Water Quality - Risk Assessments for Legionella Control - Code of Practice</i> (BSI, 2019). • CIBSE TM13: <i>Minimising the Risk of Legionnaires' Disease</i> (CIBSE, 2013). • BSRIA BG 57/2015: <i>Legionnaires' Disease - Risk Assessment</i> (BSRIA, 2015).
2.4.3. 3.4.3.	New Consumer Heat Systems shall be designed to achieve design temperatures in accordance with Table B.1. These temperatures shall be used to inform the design of the other Elements present in the Heat Network. Where spatial constraints in existing buildings (e.g. in retrofit scenarios) make these temperatures technically unachievable, the operating temperatures should be reduced as far as practicable given the constraints present on the system.
2.4.4. 3.4.4.	An assessment shall be undertaken on the potential to reduce the flow temperature during periods of low demand ("weather compensation") to reduce network heat losses, including the impacts on pumping electricity requirements and return temperatures. The assessment shall ensure that the flow temperature is always sufficiently high to safely produce domestic hot water for all consumers; the domestic hot water generation equipment (e.g. HIUs) shall be specified to deliver the full design output at the reduced flow temperature.
2.4.5. 3.4.5.	Where an existing building is to be connected to a District Heat Network, a study shall be developed which assesses: • the building's space heating and domestic hot water demand; • the operating temperatures of the Consumer Heat System.
2.4.6. 3.4.6.	Domestic hot water equipment shall be designed to ensure that the safe provision of domestic hot water is possible across the entire range of Distribution Network flow temperatures (which may vary between winter and summer months).
2.4.7. 3.4.7.	The target return temperature at the entry to the Energy Centre shall be as low as reasonably practicable (subject to the constraints present at Substations and Consumer Connections). The designer shall model expected return temperatures and demonstrate that the Energy Centre and Substation(s) are able to operate at the entire range of expected return temperatures.

2.4.8. 3.4.8.	The return temperatures on: • new Communal Distribution Networks shall be in accordance with Requirement 1.4.7; and • existing systems in existing buildings connecting to a District Distribution Network shall be in accordance with Requirement 1.4.8.
2.4.9. 3.4.9.	Where existing buildings are to be connected to a District Heat Network, the reduction of operating temperatures in the existing heating system(s) shall be investigated. The investigation should consider the use of weather-compensated flow temperatures on the heating system (which can result in reduced return temperatures during part-load operation) The initial operating temperatures may initially be initially higher with gradual reduction in operating temperatures as the buildings are retrofitted over time, provided that a plan for temperature reduction is produced and implemented. The use of on-site testing and monitoring of ambient and operating temperatures can be used to determine the possible reduction in operating temperatures. This data can be used to assess the interventions required to reduce operating temperatures to those required by the District Heat Network.
2.4.10. 3.4.10.	The network's operating temperatures under part-load conditions shall be assessed; the designer shall aim to minimise return temperatures under part-load conditions. Control strategies such as weather compensation of flow temperatures and variable-flow control may be investigated in this assessment.
2.4.11. 3.4.11.	The design of thermal Substations shall aim to deliver low return temperatures over a wide range of the expected loads. To achieve this, the designer should consider: • the selection and control of the control valve on the side of the network upstream of the Substation; • the selection and design of the heat exchanger; • the use of two control valves (with one sized to operate during periods of lower demand) or the specification of a single control valve which provides similar functionality; • the use of two heat exchangers, each with their own control valve and controlled in a duty/assist arrangement. This would improve security of supply, and help to ensure that the flow conditions within the heat exchanger are turbulent rather than laminar at lower flow rates; • the use of a forward approach temperature of more than 5 °C at the Substation, to account for variations in flow temperatures in the network upstream of the Substation; Refer to Requirement 1.4.12 for a definition of the forward approach temperature.

- a control system which ensures that the flow temperature set-point of the network downstream of the Substation is always below the flow temperature of the network upstream of the Substation by a suitable margin;
- a control system which incorporates return temperature control;
- for four-pipe systems within buildings, connecting the domestic hot water heat exchanger directly to the District Distribution Network in parallel with the space heating heat exchanger (rather than connecting the domestic hot water heat exchanger to the building's space heating circuit). This can allow the heat exchanger supplying the building's space heating circuit to be shut off during summer months;
- for large buildings with high domestic hot water demands, the use of a two-stage design where domestic hot water is pre-heated by the return from the space heating circuit (see Figure 24).

Figure 24: Example arrangement of an indirect two-stage Substation



Source: Swedish District Heating Association, 2016

2/3.5 Optimise distribution pipe diameters

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The accurate and precise sizing of distribution pipes leads to lower lifecycle costs due to optimised capital expenditure, heat losses, and pump energy consumption.

Flow rate

- 2.5.1. The calculated flow rate through each section of Distribution Network pipework serving multiple consumers shall include diversification of demands from space heating and domestic hot water and realistic temperature differences (between flow and return pipework) as outlined in Objective 2/3.1 and [Annex C: Pipe sizing example](#).
- 3.5.1.

Communal Distribution Network

- 2.5.2. The sizing of Communal Distribution Network pipework shall use outputs from accurate calculations of the expected temperature differences under peak-demand conditions for:
- 3.5.2.
- space heating;
 - domestic hot water; and
 - other heat demands on the network,
- to determine the required flow rate to each Consumer Connection.
-
- 2.5.3. Communal Distribution Network pipework should be sized to achieve a peak demand velocity of at least 0.5 m/s at all points as specified in CIBSE Guide B: *Heating, Ventilating, Air Conditioning and Refrigeration* (CIBSE, 2016).
- 3.5.3.
-
- 2.5.4. The Communal Distribution Network pipework shall be sized subject to the constraints present including (but not limited to):
- 3.5.4.
- heat loss;
 - fluid velocity;
 - noise constraints;
 - pressure loss per unit length; and
 - size constraints on branches to Consumer Connections.
- Due to the reduced capital cost and heat losses from smaller pipework diameters, the smallest feasible pipe diameter should be considered early within the pipe sizing process to prevent oversizing of Communal Distribution Network pipework.

For typical UK dwellings, the pipe diameters for terminal run pipework to dwellings should not exceed:

- DN20 for steel pipework;
- 22 mm for copper pipework;
- 25 mm for crosslinked polyethylene (PEX) and polybutene (PB) pipework.

Consumer Heat System

2.5.5. Consumer Heat System space heating pipework shall be sized to:

- 3.5.5.
- provide a sufficiently rapid response; and
 - mitigate the risk of build-up of debris.

District Distribution Network

2.5.6. Pipe sizing of District Distribution Network pipework shall be undertaken to minimise the lifecycle cost, including consideration of:

- 3.5.6.
- the capital cost of pipework and plant (including distribution pumps);
 - the costs of pumping energy and heat loss,

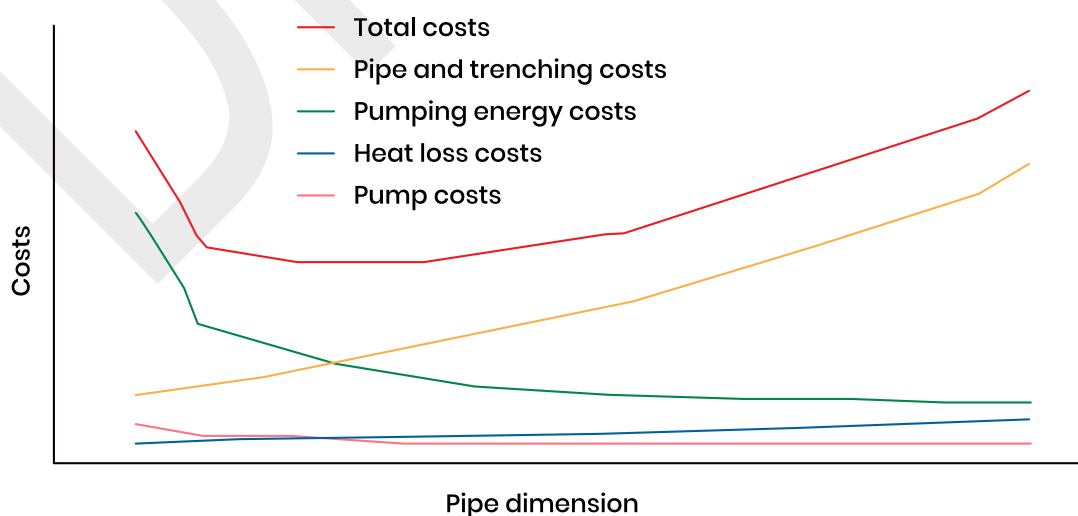
as illustrated in [Figure 25](#).

The District Distribution Network pipework shall be sized subject to the constraints present including (but not limited to):

- heat loss;
- fluid velocity; and
- pressure loss per unit length.

The pipe sizing calculations shall incorporate the requirements for future demands; justification shall be provided on the allowance of potential growth in demand from future expansion of the network.

Figure 25: Example optimisation of pipe sizes on lifecycle cost basis



2/3.6 Minimise the risk posed by working pressures

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

At the Developed/Technical Design stage, there will be more refined design information for the Heat Network which can be used to assess and mitigate the risk posed by working pressures in a more refined manner.

Considerations regarding effects such as transient pressure and specification of the pressure safety system(s) will also need to be undertaken as part of the Developed/Technical Design stage.

2.6.1. At the Developed/Technical Design stage, the designer shall include consideration of the risks posed by working pressures in each hydraulic circuit in their design risk assessment using relevant information available. This shall include:

3.6.1.

- calculation of the System Maximum Working Pressure;
- calculation of the Local Maximum Working Pressure;
- identification of the risks that arise as a result of these two calculated maximum working pressures;
- assessment of the likelihood and impact of the identified risk; and
- mitigation of the risks posed by working pressures by applying “ERIC” safety by design hierarchy approach.
 1. Eliminate.
 2. Reduce.
 3. Isolate.
 4. Control.

Refer to Requirement 1.6.1 for guidance regarding risk identification in the context of working pressures.

Working pressure calculations

2.6.2. At the Developed/Technical Design stage, the designer shall calculate the System Maximum Working Pressure (SMWP) of each hydraulic circuit using relevant information available. Refer to [Annex D: Pressure calculation examples](#) for more information.

3.6.2.

Refer to Requirement 1.6.2 for guidance regarding calculation of the System Maximum Working Pressure (SMWP).

2.6.3. 3.6.3.	At the Developed/Technical Design stage, the designer shall calculate the Local Maximum Working Pressure (LMWP) using relevant information available, at locations including (but not limited to): • where a pressure safety system will be specified; • where there is an increased risk (e.g. due to proximity of building occupants and the presence of vulnerable individuals); • where the pressure rating of equipment, pipework or pipework ancillary equipment will be specified; • any other locations deemed appropriate by the designer. Refer to Annex D: Pressure calculation examples for more information. Refer to Requirement 1.6.3 for guidance regarding calculation of the Local Maximum Working Pressure (LMWP).
2.6.4. 3.6.4.	At the Developed/Technical Design stage, the designer shall calculate the minimum working pressure using relevant information available at locations including (but not limited to) the inlets of pumps to ensure that the risk of cavitation is sufficiently mitigated.

Transient pressure

2.6.5.	No applicable requirement at the Developed Design stage.
3.6.5.	The risk of transient pressure (“water hammer”) in Distribution Network pipework shall be taken into consideration and mitigated in the design of the system. This should include consideration of measures including: • the use of slow-acting valves; • the provision of pressure reducing valves (PRVs); • the use of check valves at distribution pumps to prevent reverse flow (e.g. in the event of pump failure); • the use of soft-start pumps; • the use of swept bends.
2.6.6.	The risk of transient pressure shall be assessed with consideration of: • the pipework materials used in the system; • the presence of intermediate pumping stations; • the elevation changes present across the Distribution Network; • the length of the Distribution Network; • the calculated water velocities during peak demand conditions; • the complexity of the network.

3.6.6.	The risk of transient pressure shall be assessed with consideration of: • the pipework materials used in the system; • the presence of intermediate pumping stations; • the elevation changes present across the Distribution Network; • the length of the Distribution Network; • the calculated water velocities during peak demand conditions; • the complexity of the network. For systems with an elevated risk of transient pressure, a check shall be undertaken which simulates the effect of: • valve closure; • pump trips and the resultant pump discharge pressures from the Energy Centre. Hydraulic modelling should be undertaken on complex systems and systems with an elevated risk of transient pressure.
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Pressure safety systems

2.6.7.	Each hydraulic circuit shall be designed to include a pressure safety system; this should normally include the use of Safety Relief Devices. The pressure safety system shall: • be sized for all reasonably foreseeable relief cases; • be designed to mitigate the risks associated with static and dynamic pressures, as identified by the risk assessment - this should include consideration of the pressures which can be present during: ◦ the normal operation of the network; and ◦ pressure relief events. For further guidance, refer to BSRIA BG 82/2022 <i>Pressurisation of Closed Heating and Cooling Systems</i> (BSRIA, 2022), SAFed PEC 13: <i>Safety Valve Examinations - Setting and Sizing Requirements</i> (SAFed, 2021) and SAFed PSG 23: <i>Guidance for the Competent Person in Relation to the Examination Requirements for Relief Systems</i> (SAFed, 2021).
3.6.7.	
2.6.8.	The design of heat generation sources shall include provision of a Safety Relief Device between each individual source of heat generation and any isolation points.
3.6.8.	The design of heat generation sources shall be in accordance with BS EN 12828:2012+A1:2014: <i>Heating Systems in Buildings - Design for Water-Based Heating Systems</i> (BSI, 2014). This shall include provision of a Safety Relief Device between each individual source of heat generation and any isolation points.

2.6.9.	The design of sources of pressure such as pressurisation equipment shall be designed to include a pressure safety system. Refer to BSRIA BG 82/2022 <i>Pressurisation of Closed Heating and Cooling Systems</i> (BSRIA, 2022) for further information.
3.6.9.	The design of sources of pressure such as pressurisation equipment shall be in accordance with BS EN 12828:2012+A1:2014: <i>Heating Systems in Buildings - Design for Water-Based Heating Systems</i> (BSI, 2014). Sources of pressure such as pressurisation equipment shall be designed to include a pressure safety system. Refer to BSRIA BG 82/2022 <i>Pressurisation of Closed Heating and Cooling Systems</i> (BSRIA, 2022) for further information.
2.6.10. 3.6.10.	The presence of any isolation points in the Energy Centre or Substation shall not have the potential to hinder the operation of the pressure safety system.
2.6.11. 3.6.11.	The design of Substations shall ensure that the hydraulic circuit on each side of the hydraulic break has sufficient provision of pressure safety systems. This may be achieved through the specification of a Safety Relief Device on the flow outlet (downstream) of the plate heat exchanger, upstream of any isolation points. The system designer shall confirm with the Substation supplier (where applicable) that there is sufficient provision of pressure safety systems on each side of the hydraulic separation.
2.6.12.	No applicable requirement at the Developed Design stage.
3.6.12.	The risk of elevated pressures from pump bypasses shall be assessed. Where a pump bypass comprises a small isolated section of pipe with no allowance for thermal expansion of the fluid, a Safety Relief Device should be incorporated. Refer to the CIBSE Design Guide: <i>Heat Networks</i> (CIBSE, 2021) for further information.
2.6.13.	No applicable requirement at the Developed Design stage.
3.6.13.	The size and capacity of each Safety Relief Device shall be determined in accordance with BS EN 12828:2012+A1:2014: <i>Heating Systems in Buildings - Design for Water-Based Heating Systems</i> (BSI, 2014). This shall include consideration given to: • the volume of the hydraulic circuit the device is connected to; • the heating capacity of the heat generator (in kW); • the static location (static height) of the Safety Relief Device and its relation to other pieces of equipment (such as expansion vessels). Consideration should be given to the volume of hydraulic circuits for phased schemes, where the system volume may change over time.

- 2.6.14. Provision of expansion traps shall be included within the relief pipe in the immediate vicinity of Safety Relief Devices connected to the outlets of:
- heat exchangers with a capacity of more than 300 kW;
 - heat exchangers from which the risk of steam forming in the case of system failure cannot be ruled out.
- An expansion trap may not be necessary in cases where each heat generator or heat exchanger is served by an additional temperature limiter and an additional pressure limiter.
-
- 3.6.14. The design of expansion traps shall be in accordance with BS EN 12828:2012+A1:2014: *Heating Systems in Buildings - Design for Water-Based Heating Systems* (BSI, 2014). This shall include provision of expansion traps within the relief pipe in the immediate vicinity of Safety Relief Devices connected to the outlets of:
- heat exchangers with a capacity of more than 300 kW;
 - heat exchangers from which the risk of steam forming in the case of system failure cannot be ruled out.
- An expansion trap may not be necessary in cases where each heat generator or heat exchanger is served by an additional temperature limiter and an additional pressure limiter.

2/3.7 Ensure that Energy Centres and Substations can meet the expected range of demands

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The presence of more refined estimates of the expected range of demands developed during the Developed/Technical Design stage will allow for the operating model, initially developed in Objective 1.7, to be refined. This can be incorporated into other aspects of the design of the Heat Network, such as the control systems specified.

2.7.1. 3.7.1.	The low-carbon heat source shall be selected and sized to achieve an appropriate balance between its economic and environmental performance.
2.7.2. 3.7.2.	The location of thermal storage shall be determined, with consideration given to: - the impact that the store location has on the operational costs of the network; and - the store's resistance against damage (e.g. from vehicles or vandalism). Locating the thermal stores closer to consumers has the potential to reduce the required capacity of District Distribution Network pipework and can provide economic and efficiency benefits to the operation of Energy Centre plant.
2.7.3. 3.7.3.	For existing buildings being connected to District Distribution Networks, the existing operating temperatures shall be established and considered when determining the required connection capacity for connecting the building to the network. It can be techno-economically beneficial to reduce the peak demands and return temperature from existing buildings which are connecting to District Distribution Networks.
2.7.4. 3.7.4.	The capacity of the primary heat source(s) and thermal storage shall be updated from the values established at the Concept Design stage (see Requirement 1.7.15) to reflect updates to the operating model and design data during the Developed/Technical Design stage. This exercise should consider any potential future growth in demand and any client-specific CO ₂ emission reduction requirements.
2.7.5. 3.7.5.	The sizing of thermal storage shall account for a mixing zone (which reduces the thermal capacity of the thermal storage) of at least 10 % of the total storage volume.
2.7.6. 3.7.6.	The selection of biofuels (where used) shall include consideration of sustainability credentials from their production and the energy required for its transportation to the Energy Centre.
2.7.7.	The techno-economic operating model outlined in Requirement 1.7.1 shall be updated using higher-accuracy data produced as part of the design process.

3.7.7.

Fuel and electricity provision

2.7.8.
3.7.8. The connection to the local Distribution Network operator (DNO) systems shall be considered at an early stage to identify any fault level constraints or other operating conditions, and to establish the cost and timescales for the connection.

2.7.9.
3.7.9. The options for the sale of electricity shall be updated following the consideration at the Concept Design stage (see Requirement 1.7.19), with consideration for the design information available at the Developed/Technical Design stage and the implications of the design of the wider electricity network.

For example:

- there could be an opportunity for the direct supply of electricity to:
 - meet the electricity demand of local buildings;
 - act as emergency generation; or
 - act as an electrical load sink; or
- the use of the “Licence Lite” regulations could be feasible - refer to the *Licence Lite Factsheet* (Ofgem, 2015) for further information.

Particulate and noise emissions

2.7.10.
3.7.10. The refrigerant selection made in Requirement 1.7.25 shall be reviewed with consideration for design information available during the Developed/Technical Design stage.

2.7.11.
3.7.11. At the Developed/Technical Design stage, the emissions from gas-fired CHP units shall be specified such that the emissions without further treatment in an air quality management area are in accordance with regulatory and local planning authority requirements.

2.7.12.
3.7.12. An assessment of the particulate emissions from biomass boilers (where used) shall be developed; this shall inform the extent and selection of emission control technologies.

2.7.13.
3.7.13. An appropriate stack height (where necessary) shall be determined using relevant information available at the Developed/Technical Design stage.
Consideration should be given to whether a dispersion model is required to calculate particulate concentrations (including NO_x and, where appropriate, PM₁₀ levels) at nearby ground-level or other sensitive receptors.

2.7.14.
3.7.14. An assessment of the background noise levels in the Energy Centre / Substation plant room and outside the Energy Centre building shall be made; this shall include an acoustic survey where deemed necessary by the initial assessment. This shall inform the requirements for the acoustic control design in the Energy Centre / Substation.

2.7.15.

3.7.15.

For District Heat Networks, the average CO₂ content of heat delivered to District Distribution Network Termination Points over a year shall be calculated (in kg(CO₂)/kWh_{th} or equivalent), accounting for network heat losses and pumping energy. The emission factors used shall reflect expected grid decarbonisation. This value shall be made available to designers of buildings which may potentially connect to the District Heat Network, and to operators of existing buildings.

The average CO₂ content should be compared to realistic counterfactual scenarios. Factors such as the reduction in carbon intensity in the electrical grid shall be considered when determining a counterfactual scenario, rather than only considering gas boilers (particularly in new-build scenarios).

The Green Book Supplementary Guidance: *Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal* (DESNZ, 2023, or latest edition) provides guidance on how analysts should quantify and value energy use and emissions of greenhouse gases.

Where CHP is used, fuel emissions factors are typically quoted against the gross calorific value (GCV) of the fuel.

There can be other constraints and obligations which apply to the CO₂ content of the heat supplied by Heat Networks, including (but not limited to) Part L of the Building Regulations (refer to Approved Document L: *Conservation of Fuel and Power* (DLUHC, 2023)).

2/3.8 Ensure that Energy Centres and Substations operate in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

At the Developed/Technical Design stage, the presence of more refined design information will allow for more refined design of Energy Centres and Substations to be produced, ensuring that they operate in a controlled manner with stable operating temperatures and pressures. This will also allow for further specification of some aspects of the system including (but not limited to) the thermal storage and control systems used on the system.

2.8.1. 3.8.1. The hydraulic design and equipment selection of central plant in the Energy Centre and Substation(s) shall be developed, alongside a control philosophy, including a Description of Operation (DesOps).

Refer to the CIBSE Design Guide: *Heat Networks* (CIBSE, 2021) for guidance regarding the hydraulic design of Energy Centres and Substations.

2.8.2. No applicable requirement at the Developed Design stage.

3.8.2. The designer shall consider the commissioning process when developing the design of the system.

2.8.3. 3.8.3. The proposed operating temperatures shall be considered in the development of the design of the Energy Centre. The design of the Energy Centre and wider network shall include a suitable margin on return temperatures to mitigate against the risk of the return temperatures in operation exceeding design conditions, especially at part-load conditions.

Central plant such as heat pumps, condensing boilers, CHP units and thermal stores are sensitive to return temperature; the design of the Energy Centre should hence ensure the return water flowing into plant is within appropriate temperature ranges.

The selection of central plant can have a large impact on operating temperatures for both design and part-load conditions (for example, when using centralised heat pumps).

Refer to the CIBSE Design Guide: *Heat Networks* (CIBSE, 2021) for further information.

Heat generation

2.8.4. 3.8.4.	The Energy Centre shall be designed with consideration of the requirements of the heat generation source, including (where applicable) its: • minimum and maximum operating temperature difference requirements; • minimum and maximum flow rate requirements. A suitable control strategy shall be developed to meet the requirements of the distribution and heat generation source.
2.8.5. 3.8.5.	The use and locations of top-up and standby boilers (including whether these are to be located within existing buildings, centrally, or a combination between the two) shall be determined from consideration of the recommendations from the feasibility study (see Requirement 1.7.14) alongside higher-accuracy data available made available during the Developed/Technical Design stage. While there can be a cost benefit in the retention of some existing boilers, it can result in more complicated control strategies.
2.8.6. 3.8.6.	Where existing boilers are retained as top-up boilers in buildings served by a District Heat Network, prioritisation of heat supply from different sources shall be clearly specified with appropriate justification provided. The hydraulic design of the top-up boilers (e.g. whether the top-up boilers are connected to the building connection in a “parallel” or “series” arrangement) shall be developed to ensure that the specified prioritisation of heat supply is technically achievable.
2.8.7. 3.8.7.	The design of Energy Centres containing condensing boilers shall aim to maximise condensing conditions within the boiler; this shall include the measures set out in Requirement 2.8.10/3.8.10.
2.8.8. 3.8.8.	Gas pressure boosters shall be avoided (for example, by selecting plant that operates on standard gas pressures or by direct use of medium-pressure gas, where it is feasible) if their use will result in the additional energy consumption adding significantly to operating costs. Where it is unavoidable to use a gas pressure booster, it shall be specified to operate in accordance with IGEM/UP/2: <i>Installation Pipework on Industrial and Commercial Premises</i> (IGEM, 2025)

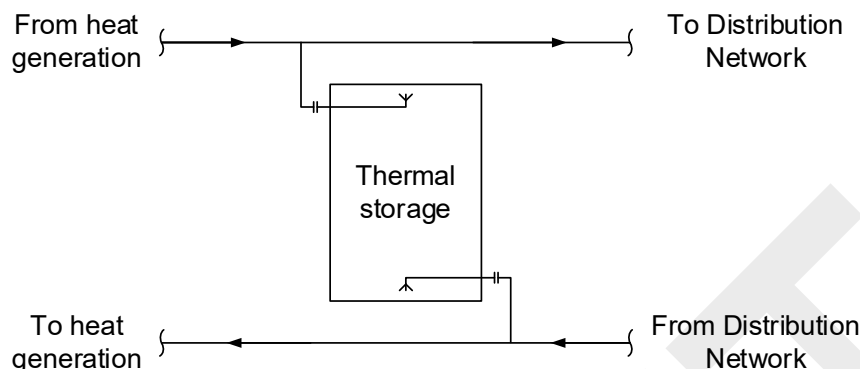
Return temperature

2.8.9. 3.8.9.	Substations with indirect connections shall be sized to achieve the return approach temperatures set out in Requirement 1.8.4.
2.8.10. 3.8.10.	The Energy Centre hydraulic design shall be designed with the aim to mitigate the risk of any heat generation source prematurely shutting down from high return temperatures. The designer shall: • avoid the use of low-loss headers where reasonably practicable; and • ensure the provision of recirculation around the boilers to control the operating temperatures when boilers are off at start-up and shutdown.

Thermal storage

2.8.11.	The hydraulic arrangement of the Energy Centre should facilitate:
3.8.11.	- the maximum available heat generation outlet temperature (within reasonable limits, taking into account the impact on aspects of heat generation such as coefficients of performance) to be fed into the hot inlet of the thermal store; and - the temperature at the cold inlet to the thermal store to not exceed the return temperature from the Distribution Network.
2.8.12.	The height of each thermal store unit:
3.8.12.	- should be at least 2 times its diameter; and - shall be at least 1.5 times its diameter, to minimise the volume of the inactive separation layer. Designers specifying a smaller height-to-diameter ratio shall provide justification for the height of the thermal store (for example, if the design of the diffusers facilitates smaller height-to-diameter ratios; see Requirement 3.8.17). The use of taller thermal stores (e.g. a thermal store height which is 2 times its diameter) can further reduce the impact of the inactive separation layer.
2.8.13.	The dimensions of the thermal stores shall be selected with consideration of practical requirements including:
3.8.13.	- spatial constraints; - replacement of the thermal store; - transport constraints; - planning requirements; - structural implications; and - manufacturing and fabrication processes.
2.8.14.	The hydraulic arrangement of thermal stores shall minimise the flow of water through the store - this is to reduce:
3.8.14.	- turbulence within the store; and - disruption to thermal stratification within the store. This can be achieved through the use of a two-pipe connection to the thermal store (indicated in Figure 26). A four-pipe connection to the thermal store shall not be used.

Figure 26: Schematic of example two-pipe connection for a thermal store

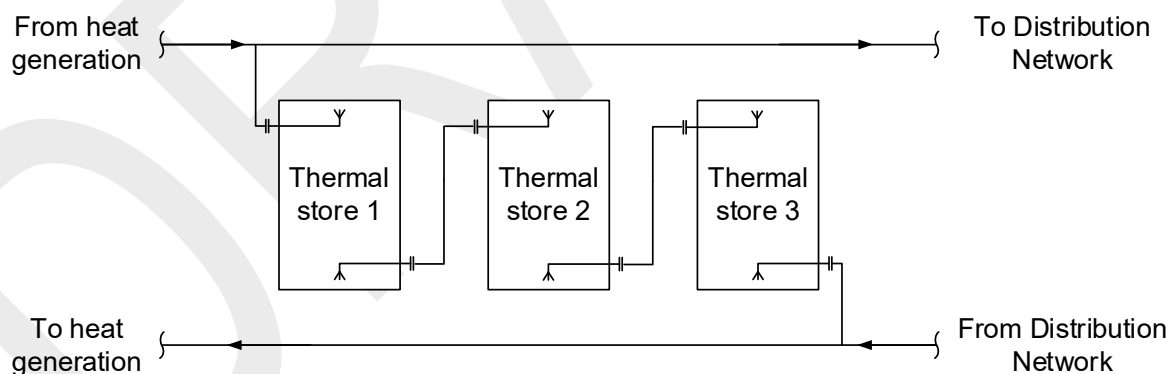


2.8.15. The number of thermal stores shall be reduced as far as reasonably practicable to mitigate against the effects of heat conduction across store walls and mixing at flow entry points.
3.8.15.

2.8.16. Where multiple thermal stores are used, they shall be connected in a "series" configuration to maximise the useful thermal storage volume (see Figure 27). In this case, the height of the store (in relation to Requirement 2.8.12/3.8.12) shall be considered to be the sum of the heights of the individual stores.
3.8.16.

A "series" configuration refers to a configuration where the top connection of one thermal store is connected to the bottom connection of the next thermal store.

Figure 27: Example arrangement of multiple thermal stores



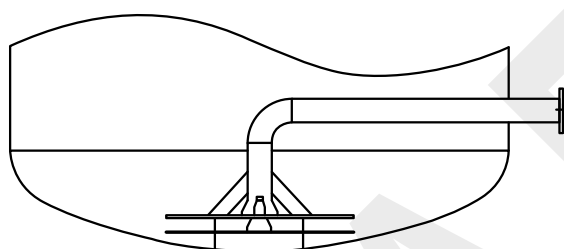
2.8.17. The design of the Energy Centre shall assume flow velocities below 0.2 m/s at the thermal store's entry and exit points to minimise turbulence within the store. Multiple entry and/or exit points into the tank (at the same level of exit or entry) may be used to further reduce turbulence.

- 3.8.17. The thermal store shall be designed with internal diffusers to minimise turbulence at their entry and exit points, and to limit flow velocities through the diffusers to below 0.2 m/s. This can minimise the mixing layer between hotter and colder fluids, which promotes stratification and maximises the volume available for energy storage.

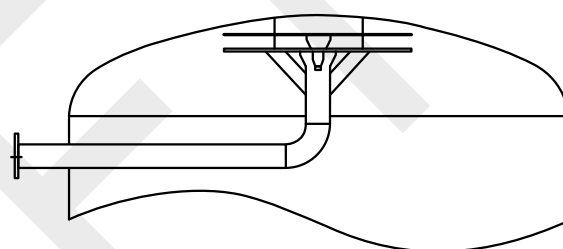
Multiple entry and/or exit points into the tank (at the same entry or exit level) may be used to further reduce turbulence. An example of good diffuser design is shown in **Figure 28**, where two horizontal circular plates reduce flow velocities at the exit and entry points.

Figure 28: Example design of diffusers at connections to thermal store

Bottom connection



Top connection



- 2.8.18. A minimum of five temperature sensors shall be installed on each thermal store to enable monitoring of the store's operation; the sensors shall be aligned vertically and equally distributed. An alternative system may be used if it provides an equal or improved fidelity of measurements.
- 3.8.18.

Control systems

- | | |
|---------|---|
| 2.8.19. | A functional specification for the control system shall be produced. Where feasible, the future operators of the plant shall be consulted on the proposed control strategy. |
| 3.8.19. | |
| 2.8.20. | The control systems at Substations, Consumer Connections or other types of building connection shall use a variable-flow control principle, for both direct and indirect connections. |
| 3.8.20. | |
| 2.8.21. | The Description of Operation (DesOps) for the Energy Centre shall: <ul style="list-style-type: none"> define how the usage and efficiency of the low-carbon heat source will be maximised in hybrid systems (in preference to peaking boilers) through the control of central plant; and reflect anticipated electricity seasonal time of day (STOD) tariffs, where this would affect the operation of the central plant. |
| 3.8.21. | |
| 2.8.22. | The control strategy shall ensure that the delivery of heat to meet the demand of the network is prioritised, with any surplus available heat being used to charge the thermal stores. |
| 3.8.22. | |

2.8.23. 3.8.23.	The Energy Centre shall be controlled such that, during the normal operation of the network, the low-carbon heat sources are operated to fill the thermal store at times that minimise the operational cost of the network. The Description of Operation (DesOps) shall reflect the intent of the techno-economic operating model (see Requirement 1.7.1 and Requirement 2.7.7/3.7.7). Simpler controls, such as controls that simply: • turn plant on when the temperature at the top of the thermal store drops below a set-point (indicating that the store is empty); and • turn plant off when the temperature at the bottom of the thermal store rises above a set-point (indicating that the store is full), shall be avoided, as this approach can lead to unstable control and fail to achieve the maximum benefit from the low- or zero-carbon plant and thermal storage.
2.8.24. 3.8.24.	The Energy Centre controls shall include consideration of transient conditions when heat generation plant is turned on or off to ensure that water delivered to the top of the thermal store is always sufficiently hot. This is to prevent the heat generation plant receiving spurious temperature measurements from the thermal store.

Distribution pumps

2.8.25. 3.8.25.	The network distribution pumps shall be variable-speed pumps capable of supplying the lowest demand (e.g. the average Consumer Connection standby flow rate) without needing bypasses in the network (refer to Requirement 2.10.3/3.10.3). The pumps shall be controlled to maintain minimum design differential pressures at the index point of the network by reducing the dynamic pressure produced at the pump during part-load conditions - the control may either use: • direct measurement of differential pressures across the network, or; • predicted required pump differential pressures inferred from flow rate measurements - this shall involve monitoring of the system and calibration of controls where feasible.
2.8.26. 3.8.26.	Multiple pumps shall be used for network distribution to maintain high pumping efficiency at part-load conditions (which typically occur for most of the time) and provide sufficient redundancy at peak demand. Refer to Requirement 1.9.1 for guidance surrounding the redundancy strategy implemented for a given asset.
2.8.27. 3.8.27.	The use of a smaller pump to operate at times of low demand shall be considered during the selection of network distribution pumps to maintain high pumping efficiency at part-load conditions. This pump should have a design flow rate to enable the pump to operate effectively at minimum demand conditions, and a lower differential pressure due to the lower differential pressures present across the network at minimum demand. This can require careful consideration of a pump control strategy due to switching between pumps with differing differential pressures.

2/3.9 Ensure sufficient resilience in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The presence of more design information at the Developed/Technical Design stage for the Heat Network, as well as the wider system, will allow for the key threats to the system to be identified and addressed with greater accuracy.

The Resilience Strategy, which provides detail regarding the resilience of the Heat Network, needs to be updated at the Developed/Technical Design stage, which needs to be compatible with the design of the wider system.

2.9.1. At the Developed/Technical Design stage, the designer shall build upon the risk assessment undertaken at the Concept Design stage in accordance with Requirement 1.9.1 and identify the key threats to the system and equipment failure throughout the Heat Network using the relevant information available.

3.9.1.

The designer shall quantify the risk associated with the identified threats using the definitions of severity and likelihood in Table F.1 and Table F.2, and the methodology set out in Table F.3.

The designer shall ensure that the risk score of each threat identified is:

- sufficiently low as agreed by the risk assessor; and
- no higher than 6 out of 30.

For threats which are initially above this threshold, the designer shall reduce the risk score to levels within this threshold through improved redundancy and/or recovery measures against the identified threat.

Consideration should be given to the resilience of single points of failure within the risk assessment.

Single points of failure, such as pressurisation units, can be a common cause of Heat Network major outages. The use of multiple equipment items (e.g. dual-pump pressurisation units) can eliminate single points of failure on a system.

Refer to Requirement 1.9.1 for guidance regarding the development of the redundancy strategy and the recovery strategy.

2.9.2. 3.9.2.	At the Developed/Technical Design stage, the designer shall produce a Resilience Strategy following the risk assessment in Requirement 2.9.1/3.9.1 and using the Resilience Strategy produced at the Concept Design stage in accordance with Requirement 1.9.2. As a minimum, this shall include information regarding: • system- and equipment- level threats; • the risk score of each threat with no resilience measures in place; • the redundancy and recovery measures implemented; • the risk score of each threat with resilience measures in place; • any residual risks associated with each threat; • the Disaster Recovery Plan (see Requirement 2.9.5/3.9.5); • the critical spares log (see Requirement 2.9.6/3.9.6); and • the plant replacement strategy (see Requirement 2.9.7/3.9.7). Refer to Annex G: Resilience Strategy example for an example Resilience Strategy at the Developed/Technical Design stage.
2.9.3. 3.9.3.	The Resilience Strategy shall include consideration for maintaining heat supply in the event of a leak at any point in the District Distribution Network. This shall include consideration of: • the use of further in-line isolation valves; • provision of looped networks; • locations of standby boilers; • provision for connecting temporary boilers.
2.9.4. 3.9.4.	The Resilience Strategy shall include consideration for maintaining heat supply in the event of a leak in the Communal Distribution Network. This shall include consideration of: • the use of further in-line isolation valves at strategic positions in the Communal Distribution Network; • the use of appropriately located drain valves and air vents in sections of the Communal Distribution Network containing in-line isolation valves to facilitate the draining and venting of pipework sections.

2.9.5. 3.9.5.	At the Developed/Technical Design stage, the designer shall produce a Disaster Recovery Plan using the relevant information available which details the procedures required in the event of a major incident on the Heat Network. The Disaster Recovery Plan should include (but not be limited to) details outlining: • how temporary heat will be provided to consumers in the event of a shutdown to the system; • the assumed response time for restoring heat supply following shutdown of the system; • the required sizing of temporary plant; • where temporary heat connections are included in the design; • where temporary plant could be located; • any air quality and/or planning restrictions associated with the potential temporary plant provision; • the information (timing and reason) given to consumers in advance of a major outage (where known); and • contact details of who to contact in the event of an emergency; and • any utility supply provisions.
2.9.6. 3.9.6.	Where critical spares form a core part of the system design at the Developed/Technical Design stage, the designer shall: • identify the critical spares within a critical spares log; • detail the timeframe in which each critical spare should be installed in the event of failure for the given piece of equipment; • identify the shelf life of the critical spare part; • identify any specific tools and skills needed to replace items; and • identify any supply chain restrictions, and whether the critical spare should be pre-procured by the operator. For example, if passive redundancy is specified for plate heat exchangers, the critical spares log would include provision of a spare plate heat exchanger to be stored at the site. Spare parts provided for routine maintenance purposes would typically not be categorised as a critical spare.
2.9.7. 3.9.7.	At the Developed/Technical Design stage, the designer shall develop an initial strategy for the replacement of key items of plant, with consideration given to: • the type of the key items of plant; • the arrangement for plant replacement; and • arrangements for the use of temporary plant during replacement works.

Future-proofing

2.9.8. 3.9.8.	Plant rooms shall be future-proofed as far as reasonably practicable. The layout design of plant rooms shall consider the requirement for future replacement of heat generation plant to be done without undue disruption, while considering: • compatibility for plant to be replaced by a different technology; and • the spatial requirements of upgrades to plant from potential future loads.
2.9.9. 3.9.9.	The design of Substations shall be future-proofed as far as reasonably practicable through consideration of technical aspects such as the spatial requirements of upgrades to plant from potential future loads.
2.9.10. 3.9.10.	Consideration should be given to the future-proofing the system's thermal storage by planning for the addition of storage which can be potentially required in the future.
2.9.11. 3.9.11.	The design of the network shall be future-proofed by considering the phasing of the network's construction and potential future extensions to serve new consumers; pipe routes, isolation valves and tees should be selected to allow for potential future connections.

2/3.10 Simplify designs where feasible

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

As the design of the system becomes more detailed at the Developed/Technical Design stage, it is important to continue to take opportunities to simplify the design, while ensuring it can meet its expected range of demands and operates in a controlled manner.

The presence of unnecessary and/or uncontrolled bypasses can result in negative performance outcomes from the Heat Network, including (but not limited to):

- increased pumping energy at the Energy Centre / Substation due to increased flow rates at time of low demand;
- elevated return temperatures from the Distribution Network;
- insufficient differential pressure at Termination Points of the network (e.g. the index point(s));
- increased capital expenditure and complexity during the Installation and Commissioning stages.

2.10.1. 3.10.1.	The use of fixed bypasses shall be avoided unless it can be technically demonstrated that one is required. If a fixed bypass is required, the bypass flow rate shall be limited through: • the use of a differential pressure control valve and a regulating valve; or • similar controls. The total bypass flow in a network should be less than 1 % of the flow rate at peak demand, unless a detailed calculation demonstrates that a higher flow rate is required.
2.10.2. 3.10.2.	Automatic bypasses shall not be installed onto the space heating circuit, nor the LTHW supply to a domestic hot water cylinder coil.
2.10.3.	Bypasses shall only be used for protection of distribution pumps from low flow where a multiple-pump strategy or location of a side-stream filtration (SSF) unit cannot satisfy minimum loads; justification shall be provided if this is the case. Where a bypass needs to be installed, it shall be installed locally to the pumps between the outlet and inlet of the pumps.
3.10.3.	Bypasses shall only be used for protection of distribution pumps from low flow where a multiple-pump strategy or location of a side-stream filtration (SSF) unit cannot satisfy minimum flow rates; justification shall be provided if this is the case. Where a bypass needs to be installed, it shall be installed locally to the pumps between the outlet and inlet of the pumps. The small-bore bypass pipework shall be sized for the specific required flow rate and controlled to only open when the distribution flow rate is too low for the pump as indicated in manufacturer requirements.

A form of heat dissipation and/or a Safety Relief Device in the bypass can be required to prevent excessively high temperatures and pressures in the event of a long zero-/low-flow period (refer to Requirement 3.6.12).

The pump manufacturer shall be consulted if a dedicated pump bypass is specified.

- | | |
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| 2.10.4. | Where a bypass is required to maintain the flow temperature above a minimum level at times of low demand, the bypass shall be designed to include a temperature-controlled bypass valve. |
| 3.10.4. | |

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2/3.11 Ensure sufficient water quality in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The design of the Heat Network at the Developed/Technical Design stage needs to be developed with sufficient consideration for water quality, including the filling of the system, proposed recording of water quality metrics, and the equipment specified to ensure sufficient water quality.

Key documentation which needs to be produced at the Developed/Technical Design stage includes:

- the Water Quality Strategy, which details how water quality is managed by the system; and
- the Water Quality Recording Programme, which details how the water quality of the system will be recorded and assessed.

Water Quality Strategy

- 2.11.1. A Water Quality Strategy shall be produced and clearly documented for each hydraulic system, making use of the system's Water Quality Statement (as set out in Requirement 1.11.1) and relevant information made available at the Developed/Technical Design stage.
- 3.11.1.

The Water Quality Strategy shall include:

- the type of water quality system to be followed (e.g. Chemically Treated System or Depleted Water System);
- the selection of the fill water source;
- the selection of the material of plant, equipment, and distribution pipework (which, for retrofit scenarios, should include consideration of its compatibility with the current existing system);
- the specification for water treatment and conditioning (e.g. filtration, softening, demineralisation, chemical dosing etc.);
- the presence of hydraulic breaks between distribution pipework and space heating circuits on the Consumer Heat Systems;
- initial specification of the flushing methodology (e.g. closed loop pre-treatment cleaning (CPC) or flush-to-drain).

Filling of the system

2.11.2. 3.11.2.	For Chemically Treated Systems the method for filling the system shall be specified in the Water Quality Strategy - this may involve: - the use of the mains cold water service, if the parameters of the mains cold water service are within the limits set out in Table H.5; - the use of water bowsers. Where the use of the mains cold water service is proposed, the method shall specify inclusion of testing of the mains cold water service at the site of the system. The method for filling the system shall be developed such that any water entering the system is in accordance with the limits set out in Table H.5. Where a fire hydrant is used to supply mains cold water, the method used for filling the system shall specify that the lines used to fill the system are sufficiently purged (e.g. through the use of flushing) to ensure the water entering the system is within the limits set out in Table H.5. Refer to Requirement 5.11.2 for requirements regarding the filling of Chemically Treated Systems.
2.11.3. 3.11.3.	For Depleted Water Systems, the method for filling the system shall be specified in the Water Quality Strategy. The system may be filled through: - the use of the mains cold water service, if the parameters of the mains cold water service are within the limits set out in Table H.6; - in-line conditioning of the mains cold water service before it enters the system; - the use of tanks filled with conditioned water. The method the filling the system shall be developed such that any water entering the system is in accordance with the limits set out in Table H.6. Where a fire hydrant is used to supply mains cold water, the method used for filling the system shall specify that the lines used to fill the system are sufficiently purged (e.g. through the use of flushing) to ensure the water entering the system is within the limits set out in Table H.6. Refer to Requirement 5.11.4 for requirements regarding the filling of Depleted Water Systems. For further information, refer to VDI 2035: <i>Prevention of Damage in Water Heating Installations</i> (VDI, 2021).
2.11.4. 3.11.4.	The local water supplier shall be consulted as early as reasonably practicable within the design phase of the Heat Network.

- 2.11.5. The Water Quality Strategy for a new network which is to be connected to an existing network shall be reviewed to ensure that it is compatible with the existing system's strategy.
- 3.11.5.

For direct connections, the Water Quality Strategies on either side of the connection should be compatible.

For indirect connections, the heat exchanger used to separate the hydraulic systems should be compatible with the Water Quality Strategies on both sides of the heat exchanger.

Water Quality Recording Programme

- 2.11.6. A Water Quality Recording Programme shall be produced which provides information regarding the recording of water quality metrics throughout the Heat Network; this should be in accordance with the recommended minimum information contained in a water treatment programme set out in BSRIA BG 50/2021: *Water Treatment for Closed Heating and Cooling Systems* (BSRIA, 2021). This should typically include:
- 3.11.6.
- the water quality parameters that will be recorded in accordance with Requirement 2.11.7/3.11.7 and KPI control limits;
 - the method for recording water quality parameters (e.g. through online monitoring or laboratory sampling);
 - the locations at which the water quality parameters will be recorded, including:
 - indication of where these are on the Heat Network; and
 - the total number of recording locations,which shall be in accordance with Requirement 2.11.11/3.11.11;
 - the frequency and dates at which the water quality parameters will be reported during:
 - the period between system filling and pre-commission cleaning;
 - the period between pre-commission cleaning and practical completion;
 - the operation of the Heat Network from practical completion onwards,which shall be in accordance with Requirement 2.11.13/3.11.13;
 - the process to be followed when the value of a water quality parameter has exceeded its control limits - this shall include:
 - the frequency at which water quality parameters will be reported;
 - additional water quality parameters to be recorded;
 - the remedial actions that will be taken.

2.11.7. 3.11.7.	The Water Quality Recording Programme shall specify the parameters to be recorded in the Heat Network during: • the period between system filling and pre-commission cleaning; • the period between pre-commission cleaning; • the operation of the Heat Network from practical completion onwards. The water quality KPIs shall be in line with the minimum KPIs and metrics detailed in Table H.7 for Chemically Treated Systems or Table H.8 for Depleted Water Systems.
2.11.8. 3.11.8.	The Water Quality Recording Programme shall specify what is identified as an abnormal detrimental trend in the water quality parameters recorded (in accordance with Requirement 2.11.7/3.11.7) indicates an abnormal detrimental trend in the system water quality (for example, over 3 consecutive reporting instances, or above a defined threshold for the change between readings). For further information, refer to: • BSRIA BG 29/2021: <i>Pre-Commission Cleaning of Pipework Systems</i> (BSRIA, 2021); • BSRIA BG 50/2021: <i>Water Treatment for Closed Heating and Cooling Systems</i> (BSRIA, 2021).

Recording of water quality parameters

2.11.9. 3.11.9.	Hydraulic systems serving more than 20 dwellings (or equivalent) shall have the capability for continuous monitoring as set out in Table H.7 for Chemically Treated Systems or Table H.8 for Depleted Water Systems. For a Chemically Treated System to be categorised as having “advanced online monitoring capability”, the equipment specified in the design of the system shall be in accordance with the equipment specified in Table H.1. For Depleted Water Systems, the equipment specified in the design of the system shall be in accordance with the equipment specified in Table H.2.
2.11.10. 3.11.10.	Each system with a size of: • at least 250 end Consumer Connections; or • at least 20,000 litres of system volume, with the value of the system volume: ◦ excluding thermal storage volume; ◦ including the volume of any direct Consumer Heat Systems connected to the Distribution Network, shall be specified to have advanced online monitoring capability, with capability for the online monitoring of (in addition to the corrosion rate): • conductivity; • dissolved oxygen; and • pH.

2.11.11. 3.11.11.	The minimum number of sampling locations specified on the network shall be in accordance with Table H.3 . For further information, refer to BS 8552:2012: <i>Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice</i> (BSI, 2012).
2.11.12. 3.11.12.	The Water Quality Recording Programme shall specify that, when a water quality KPI as set out in Table H.7 (for Chemically Treated Systems) or Table H.8 (for Depleted Water Systems) exceeds its control limit(s) or the trend of a water quality metric (as set out in Table H.7 and Table H.8) indicates a deterioration in water quality (in accordance with Requirement 2.11.8/3.11.8): - the reporting frequency of water quality parameters shall become twice as frequent until the water quality KPIs are within their control limits and additional metrics indicate stable water quality; - a competent water treatment specialist shall be engaged; - appropriate remedial actions shall be undertaken.
2.11.13. 3.11.13.	The frequency at which each water quality parameter is recorded shall be specified and compliant with the minimum frequencies provided in Table H.9 .

Water quality equipment

2.11.14. 3.11.14.	The water quality equipment (and other equipment to aid the preservation of water quality) specified for the system shall be in accordance with Table H.1 for Chemically Treated Systems. For equipment requirements which apply to networks of a particular size, the system size for networks serving a mixture of domestic and non-domestic connections, the total system size shall be determined by the equation below: $\text{Total Heat Network size (dwellings equivalent)} = \text{no. domestic connections} + \frac{\sum kW_{\text{connection}}}{45.0 \text{ kW/connection}}$
2.11.15. 3.11.15.	The water quality equipment (and other equipment to aid the preservation of water quality) specified for the system shall be in accordance with Table H.2 for Depleted Water Systems. For equipment requirements which apply to networks of a particular size, the system size for networks serving a mixture of domestic and non-domestic connections, the total system size shall be determined by the equation below: $\text{Total Heat Network size (dwellings equivalent)} = \text{no. domestic connections} + \frac{\sum kW_{\text{connection}}}{45.0 \text{ kW/connection}}$
2.11.16. 3.11.16.	Depleted Water Systems shall be specified with equipment to sufficiently remove dissolved oxygen from the system in accordance with Table H.2 , such that the system water will be able to be in accordance with the parameters in Table H.8 during operation.
2.11.17. 3.11.17.	Water conditioning equipment required for the conditioning of water within Depleted Water Systems shall be specified in the Water Quality Strategy in accordance with Table H.2 unless it can be technically justified that the mains cold water service at the site location will meet the requirements in Table H.8 .

System design

2.11.18. 3.11.18.	Where there is an elevated risk of scaling in domestic hot water heat exchangers due to hard water, an assessment of actions mitigating scaling shall be developed. This may include: - the use of controls in HIUs which reduce the risk of scaling through rapid shut-off of LTHW flow through the heat exchanger; - the use of centralised softening plant or other scale prevention. In “hard water” areas, there is an increased risk of scaling in DHW heating coils and plate heat exchangers, reducing heat transfer and increasing return temperatures. The risk from scaling is significantly reduced where domestic hot water temperatures are below 55 °C and if there is turbulent flow on the heating surface. The BESA UK HIU Test Regime (BESA, 2023, or latest edition) includes a scaling temperature threshold for return temperatures on the Communal Distribution Network side to not exceed 55 °C at any point during the domestic hot water tests.
2.11.19. 3.11.19.	Depleted Water Systems which contain aluminium (including aluminium alloys) shall not use artificial water softening for the water conditioning of the system; demineralisation should be used instead for such systems where water conditioning equipment is required (in accordance with Requirement 2.11.17/3.11.17).
2.11.20. 3.11.20.	All components specified on the system that contact system water shall be oxygen diffusion-tight as detailed in Table H.4.
2.11.21. 3.11.21.	A water meter connected to the top-up technology (such as pressurisation unit); this shall be located: - upstream of the quick-fill connection; and - downstream of any water conditioning equipment (such as demineralisation units). There can be additional constraints that apply to the connection to the mains cold water service (e.g. the Water Supply (Water Fittings) Regulations 1999 (HM Government, 1999)).
2.11.22. 3.11.22.	Replaceable filter media shall be specified on hydraulic systems serving more than 20 dwellings (or equivalent) in a side-stream configuration and equipped with differential pressure sensors across the filter, which shall be connected to the BMS (or an equivalent system) to provide early warning of when filter media needs to be replaced. The hydraulic connections for replaceable filter media may be specified as indicated in Figure 30. The designer shall ensure that the differential pressure across the replaceable filter media does not exceed the product’s maximum value, to prevent degradation to the filter media. Refer to Requirement 2.11.14/3.11.14 for equivalency of system sizes.

2.11.23.	Flushing points shall be specified: • adjacent to key plant; • at the entry points to buildings where required; • at appropriate points on the network to facilitate phased flushing of the Heat Network where required. Flushing bypasses shall be temporary.
3.11.23.	Flushing points shall be designed to be adequately sized to allow for the required flushing of the network. These shall be specified: • adjacent to key plant; • at the entry points to buildings where required; • at appropriate points on the network to facilitate phased flushing of the Heat Network where required. Flushing bypasses shall be temporary.
2.11.24. 3.11.24.	All systems shall be specified to include a Static Pressure Margin of at least 0.7 bar(g) (in accordance with BSRIA BG 29/2021: <i>Pre-Commission Cleaning of Pipework Systems</i> (BSRIA, 2021) to mitigate the risk of air ingress resulting in unacceptable levels of dissolved oxygen in the system water. A higher Static Pressure Margin can be necessary to account for other considerations in the system (such as the vapour pressure at the system's operating temperatures).
2.11.25. 3.11.25.	The system shall be designed to eliminate the presence of sections of pipework receiving no flow of water ("dead legs") during the construction and normal operation of the system, unless it can be demonstrated that this is not technically feasible. Where the presence of dead legs is unavoidable: • the length of the dead leg should not exceed 3 times the inner diameter of the pipe section - for further information, refer to BSRIA BG 29/2021: <i>Pre-Commission Cleaning of Pipework Systems</i> (BSRIA, 2021); • provision shall be made for: ○ circulation of the system water through the pipework section at suitable intervals and suitable flow rates, or through temperature-controlled valves; ○ appropriate control to mitigate against the risk of microbiological proliferation (e.g. through the use of appropriate biocide or ultraviolet treatment). The flow of water through permanent bypasses (unless the bypass is temperature-controlled) shall be avoided, as this can result in increased return temperatures from the network. Where a bypass is needed across equipment to maintain flow through the system during maintenance events, a temporary bypass can be used instead of a permanent bypass, which can reduce the risk of stagnation in the network.
2.11.26.	Dirt pockets at the bottoms of risers shall be included to enable collection of debris.
3.11.26.	Dirt pockets at the bottoms of risers shall be designed to:

- minimise the risk of stagnation;
- allow sufficient capacity for debris collection;
- allow for the depressurisation of pipework which will be drained during maintenance events.

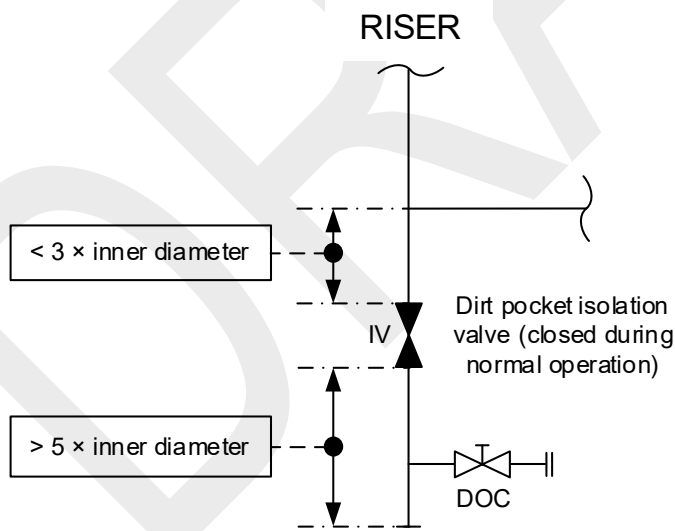
This may be achieved by designing the dirt pocket in line with **Figure 29**, including specification of:

- a pipe length of less than 3 times the pipe sections' inner diameter above the dirt pocket isolation valve;
- a pipe section length below the dirt pocket isolation valve of at least 5 times the pipe section's inner diameter to allow sufficient capacity for debris collection;
- a drain-off valve to allow for the depressurisation of the pipework beneath the dirt pocket isolation valve;
- a removable blanked end of the pipework beneath the dirt pocket isolation valve for emptying and cleaning of dirt pocket surfaces.

The dirt pocket isolation valve shall be closed during the normal operation of the Heat Network, with the pipework beneath the isolation valve being drained. The isolation valve should be opened during maintenance where the dirt pocket is emptied - refer to **Figure 29**.

For further information refer to BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021).

Figure 29: Required lengths of dirt pocket pipework



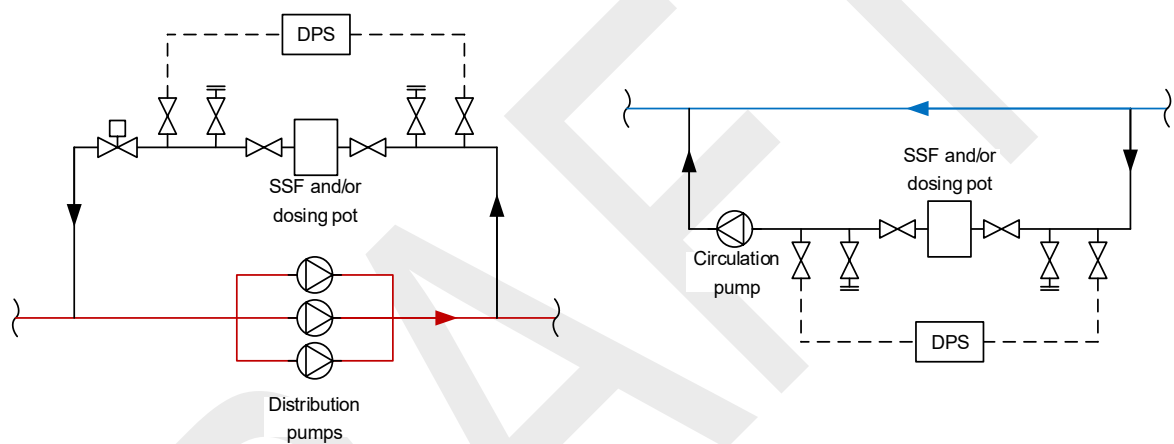
2.11.27. Where a dosing pot is specified, it shall be designed to:

- 3.11.27.
- enable continuous flow through the unit;
 - not create a bypass in the network; and
 - minimise the impact on the control of the system.

A dosing pot shall not be designed to have hydraulic connections between flow and return pipework.

The hydraulic connections of dosing pots may be specified as indicated in Figure 30.

Figure 30: Installation configuration of a side stream filter and/or dosing pot



2.11.28. Communal Heat Networks shall be closed systems.

3.11.28.

2.11.29. District Heat Networks shall be specified to include sufficient measures to mitigate the ingress of oxygen. This can include:

3.11.29.

- the use of a closed system;
- the use of gas (such as nitrogen or steam) “cushions” above the system water surface level in equipment such as unpressurised thermal storage;
- degassing of system water in equipment such as unpressurised thermal storage.

The size of the District Heat Network should be considered when determining the measure used to mitigate the ingress of oxygen.

2/3.12 Ensure that the performance of the Heat Network can be monitored

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is key to ensure at the Developed/Technical Design stage that the design of the Heat Network has sufficient provision for monitoring, as this affects many aspects of the system such as:

- the measurement of performance;
- the control systems used;
- how heat consumption will be metered;
- the detection of leaks from the Heat Network.

This Objective references the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025) which provides detail on requirements surrounding Metering and Monitoring Systems.

2.12.1. 3.12.1.	The Metering and Monitoring Strategy shall be updated using relevant information available at the Developed/Technical Design stage. The Metering and Monitoring Strategy shall be in accordance with Section 4.1 of the <i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025).
2.12.2. 3.12.2.	Thermal energy meters shall be specified in accordance with Section 1.1 of the <i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025).
2.12.3. 3.12.3.	Other utility meters (water, gas, and electricity) shall be specified in accordance with Section 1.4 of the <i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025).
2.12.4. 3.12.4.	Monitoring Points shall be specified throughout the system in accordance with Annex A of the <i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025).
2.12.5. 3.12.5.	An Automatic and Remote Monitoring System (ARMS) shall be specified in accordance with Section 2.1 of the <i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025).
2.12.6. 3.12.6.	A data communication system shall be selected early in the design phase to ensure the correct interfaces are specified for all equipment, in accordance with Section 2.1 of the <i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025).
	It can be beneficial to specify in the design of the Heat Network for new communication infrastructure required for the data communication system (e.g. fibre network) to be installed at the same time as the pipe network.

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| 2.12.7. | A smart metering system / advanced meter infrastructure (AMI) shall be specified in accordance with Section 3.1 of the <i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025). |
| 3.12.7. | |

Detection of Leaks

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| 2.12.8. | For steel systems, a leak detection system shall be specified to detect potential leaks on buried District Distribution Network pipework. The leak detection system shall include automatic monitoring capability (e.g. connection to the network's BMS).

The design of steel pipe systems shall include a surveillance system which is in accordance with BS EN 14419:2019: <i>District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems</i> (BSI, 2019). |
| 3.12.8. | |
| 2.12.9. | The water meter connected to the top-up technology (such as a pressurisation unit) shall be connected to the Automatic and Remote Monitoring System (ARMS) for early warning indication of leaks. |
| 3.12.9. | |

2/3.13 Ensure that the Heat Network is sufficiently insulated

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The presence of more refined information for the design of the Heat Network and the wider system will allow for the heat losses to be calculated more accurately.

At the Developed/Technical Design stage, the designer needs to determine the specification and thicknesses of insulation throughout the Heat Network which will result in acceptable levels of heat loss from the Heat Network. This involves calculation of heat losses from the network and the initial specification of insulation products.

The specification and communication of the required insulation thicknesses for the Heat Network is also key for the spatial coordination of the wider system.

Refer to [Annex K: Heat loss model example](#) for an example application of the requirements regarding heat losses on an example network.

Above-ground pipework

2.13.1. 3.13.1.	The heat loss per unit length (W/m) from each above-ground pipe section should not exceed the values set out in Table 19C/20C of BS 5422:2023: <i>Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C</i> (BSI, 2023).
2.13.2. 3.13.2.	The minimum thickness of insulation applied to above-ground pipework shall be in accordance with Table J.1. There are the following exceptions to this requirement. 1. The thickness of insulation may be less than the minimum thicknesses set out in Table J.1 if it can be demonstrated that the heat loss per unit length (W/m) is less than the maximum value set out in Table 19C/20C of BS 5422:2023: <i>Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C</i> (BSI, 2023) across the range of reasonably foreseeable operating conditions. The return temperature used in this assessment shall not be lower than 20 °C below the flow temperature. This threshold on the minimum return temperature in the assessment has been included to mitigate against the risk of under-insulated pipework once the system is in operation, where the return temperature can potentially rise above design conditions. The assumed ambient temperature used in any pipework calculations shall be the lower of: ○ the minimum ambient temperature the pipework will be exposed to; or ○ 20 °C.

2. The thickness of insulation may be less than the minimum thicknesses set out in [Table J.1](#) if necessary for meeting fire safety standards and there is not a product available in the applicable minimum thickness. In this instance:
 - the thickest available product shall be used; and
 - the length of pipework with insulation thickness below the minimum value set out in [Table J.1](#) shall be minimised.

The insulation thickness values arising from this requirement are not necessarily intended to provide protection against freezing for above-ground pipework in unheated areas. For smaller diameter pipework, and pipework sections for which heat supply or water circulation may cease unexpectedly during cold weather, refer to BS 5422:2023: *Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C* (BSI, 2023).

Communal Distribution Networks

- 2.13.3. The total heat loss from the Communal Distribution Network at the Developed/Technical Design stage (including ancillary equipment - refer to Requirement [2.13.5/3.13.5](#)) shall not exceed the Developed/Technical Design stage heat loss limit provided in [Table J.2](#).
- 3.13.3.

When calculating the predicted heat losses across a whole network to obtain the total heat loss figure, the average design flow and average design return temperatures shall be used.

If applying the minimum insulation thickness to each pipe section results in a higher total Communal Distribution Network heat loss than the limits stated above, the design of the Communal Distribution Network shall be modified to reduce the heat losses until the total heat loss limit across the network is met.

Methods of further reducing heat loss may include:

- reduction in operating temperatures (provided that this remains compatible with the temperature requirements of the Consumer Heat System(s));
- adoption of a more efficient pipework arrangement, resulting in a lower overall length of the Communal Distribution Network;
- specification of insulation with greater thickness or lower thermal conductivity.

For Communal Distribution Networks which serve a mixture of domestic and non-domestic Consumer Connections, the total heat loss limit for the network is determined by taking the sum of:

- the allowable heat loss from all of the domestic Consumer Connections which the Communal Distribution Network serves; and
- the allowable heat loss from all of the non-domestic Consumer Connections which the Communal Distribution Network serves.

This may be expressed as below:

$$\text{Total heat loss limit / boundary (W)} = \text{total domestic heat loss limit} + \text{total non-domestic heat loss limit}$$

$$\text{Total heat loss limit / boundary (W)} = (\text{no. connected dwellings}) \cdot (\text{W/dwelling}) + (\Sigma(\text{kW}_{\text{connection}})) \cdot (\text{W/kW}_{\text{connection}})$$

For example, the total heat loss limit at the Developed/Technical Design stage from a network serving 120 dwellings and an additional 250 kW of non-domestic connections would be as below:

$$\begin{aligned} \text{Total heat loss limit (W)} &= (\text{no. dwellings}) \cdot (\text{W/dwelling}) + (\Sigma(\text{kW}_{\text{connection}})) \cdot (\text{W/kW}_{\text{connection}}) \\ &= (120) \cdot (75) + (250) \cdot (1.66) \\ &= \mathbf{9,417 \text{ W}} \end{aligned}$$

Refer to Requirement 6.13.1 for the heat loss limits from Communal Distribution Networks at the point of commissioning.

2.13.4.
3.13.4. Calculations for heat loss from pipework within buildings undertaken at the Developed/Technical Design stage shall be undertaken in accordance with BS EN ISO 12241:2022: *Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules* (BSI, 2022); this may be done through the use of software which adopts the methodology set out in the standard.

2.13.5.
3.13.5. The calculated heat loss from the Communal Distribution Network shall include the heat loss from ancillary equipment. This may be achieved through either:

- calculating the heat losses from valves and other ancillary equipment with sufficient accuracy and precision (e.g. by following the methodologies set out in BS EN ISO 12241:2022: *Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules* (BSI, 2022)); or
- applying an allowance of 20 % (multiplication of 1.2) of the heat losses from pipework on the Communal Distribution Network.

For example, if the calculated heat loss from all pipework in a Communal Distribution Network is equivalent to 50 W/dwelling, the total Communal Distribution Network heat loss figure would be 60 W/dwelling.

The calculation methodology of thermal bridges present due to ancillary equipment provided in BS EN ISO 12241:2022: *Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules* (BSI, 2022) includes the calculation of heat losses from insulation boxes for flanges, valves and other components.

Consumer Connections

- | | |
|---------|--|
| 2.13.6. | Bespoke insulation products shall be specified on the Heat Interface Unit (HIU) and valve rail to reduce heat losses from the Consumer Connection. |
| 3.13.6. | |

Ancillary equipment

- | | |
|---------|---|
| 2.13.7. | <p>Load bearing pipe supports shall be specified on above-ground pipework which:</p> <ul style="list-style-type: none"> • sufficiently takes the load of the distribution pipe and its contents; • is matched to the dimensions of the adjacent insulation material; • is made from material with a thermal conductivity no greater than 180 % of the adjacent insulation material. <p>For large diameter pipework (typically DN200 and above), specific loading calculations should be sought from the pipe support manufacturer. While the use of wood blocks should be avoided (refer to BS 5970:2012 <i>Thermal insulation of Pipework, Ductwork, Associated Equipment and Other Industrial Installations in the Temperature Range of -100°C to +870°C - Code of Practice</i> (BSI, 2012)), wood blocks may be used as an alternative material for large diameter pipework if evidence is provided that a more thermally efficient product cannot be sourced - refer to BESA TR70: <i>A Guide to Good Practice - External Corrosion Protection and Insulation of Building Services Pipework</i> (BESA, 2021).</p> <p>The selection of load bearing pipe supports shall also consider:</p> <ul style="list-style-type: none"> • temperature limits of the pipe support; • the impact on the deflection of the pipework. |
| 3.13.7. | |
-
- | | |
|---------|--|
| 2.13.8. | <p>The following components shall be insulated.</p> <ul style="list-style-type: none"> • Heat Network equipment and ancillary equipment in the Energy Centre and Substation(s). • Ancillary equipment on the District Distribution Network(s) and Communal Distribution Network(s). <p>Ancillary equipment such as flanges, valves and strainers shall be insulated with insulation products designed for the specific ancillary equipment (where available) and of the same thickness as the adjacent pipework insulation (where available). Where specific products are not available, well-fitted insulation products shall be used. In all cases, the insulation of ancillary items shall be easily removable and replaceable for maintenance purposes.</p> <p>Pump volute casings, strainers, and other equipment shall be insulated with insulation products (such as jackets) that are easily removable and replaceable for maintenance purposes; these insulation products shall be of the same thickness as the adjacent pipework insulation (where available).</p> <p>Where flexible mineral fibre is used for the insulation of ancillary equipment, the installed thickness shall be assumed to be 75 % of the nominal thickness (25 % compression), unless the insulation can be shown to not be used in a compressed form.</p> |
| 3.13.8. | |

- 2.13.9. Valves shall be fitted with extended spindles and handle designs which allow for the full insulation thickness to be applied, unless it can be demonstrated that this is technically infeasible.
- 3.13.9.

Weather protection

- 2.13.10. Above-ground pipework which requires weather protection (including all pipework external to the internal envelope of the building) shall be designed to include additional cladding to the external vapour barrier as stated in BS 5422:2023: *Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C* (BSI, 2023). The emissivity of the outer surface of the insulated system shall be incorporated in all heat loss calculations.
- 3.13.10.

District Distribution Networks

- 2.13.11. The total heat loss from the District Distribution Network shall not exceed the Heat Loss Limit provided in [Table J.3](#). The heat loss calculation shall be undertaken using the following assumptions.
- 3.13.11.
- The thermal performance of the insulation used in the heat loss calculation shall be based on average values over a 30-year period, to account for the degradation of insulation performance over time. Manufacturer consultation should be sought to determine an appropriate value.
 - Realistic time-weighted average flow and return temperatures across summer and winter operation shall be used in the heat loss calculation.

For District Distribution Networks which serve a mixture of domestic connections and non-domestic connections directly connected to the District Distribution Network, the total Heat Loss Limit or Insulation Specification Boundary is determined by the sum of:

- the allowable heat loss due to all of the domestic connections directly connected to the District Distribution Network; and
- the allowable heat loss due to all of the non-domestic connections to the District Distribution Network (including Substations to residential blocks).

Where a Communal Distribution Networks which is connected to the District Distribution Network serves domestic end consumers, the Substation serving the Communal Distribution Network is treated as a non-domestic connection.

This may be expressed as below:

$$\text{Total heat loss limit / boundary (W)} = \text{total domestic heat loss limit} + \text{total non-domestic heat loss limit}$$

$$\text{Total heat loss limit / boundary (W)} = (\text{no. connected dwellings}) \cdot (\text{W/dwelling}) + (\sum (\text{kW}_{\text{connection}})) \cdot (\text{W/kW}_{\text{connection}})$$

The use of twin-pipe systems (where two pipes are within one insulated casing) can lead to reduced heat losses from District Distribution Network pipework.

- 2.13.12. Series 2 insulation (or insulation with an equivalent thermal performance for
3.13.12. pipework not in the scope of BS EN 253:2019+A1:2023: *District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks - Factory Made Pipe Assembly of Steel Service Pipe, Polyurethane Thermal Insulation and a Casing of Polyethylene* (BSI, 2023)) shall be specified as a minimum on the District Distribution Network if it can be demonstrated with sufficient accuracy and precision that the heat loss from the District Distribution Network is equal to or below the Insulation Specification Boundary provided in [Table J.3](#) when Series 2 or a combination of Series 2 and Series 3 insulation (or insulation with an equivalent thermal performance) is applied.

If the heat loss from the District Distribution Network is above the Insulation Specification Boundary provided in [Table J.3](#):

- Series 3 insulation (or insulation with an equivalent thermal performance) shall be specified on the District Distribution Network;
- if the District Distribution Network pipework systems is not in the scope of BS EN 253:2019+A1:2023: *District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks - Factory Made Pipe Assembly of Steel Service Pipe, Polyurethane Thermal Insulation and a Casing of Polyethylene* (BSI, 2023) and there is not a specification of insulation available with equivalent thermal performance to Series 3 insulation, a lifecycle cost assessment shall be undertaken to determine the optimal insulation thickness, which includes consideration of:
 - the pipework material of the District Distribution Network used (e.g. steel or polymer);
 - the manufacturer of the District Distribution Network pipework and insulation system(s); and
 - the thickness of insulation specified on the pipework system.

The thickness of insulation on pipework sections serving a single domestic Consumer Connection may be reduced if necessary due to spatial constraints; where this occurs, the length of pipework with reduced insulation thickness shall be minimised.

Refer to Requirement [2.13.11/3.13.11](#) for guidance regarding calculating the heat loss of District Distribution Networks serving a mixture of domestic connections and non-domestic connections directly connected to the District Distribution Network.

A flowchart indicating the interaction between Requirement [2.13.11/3.13.11](#) and Requirement [2.13.12/3.13.12](#) is provided in [Figure J.1](#).

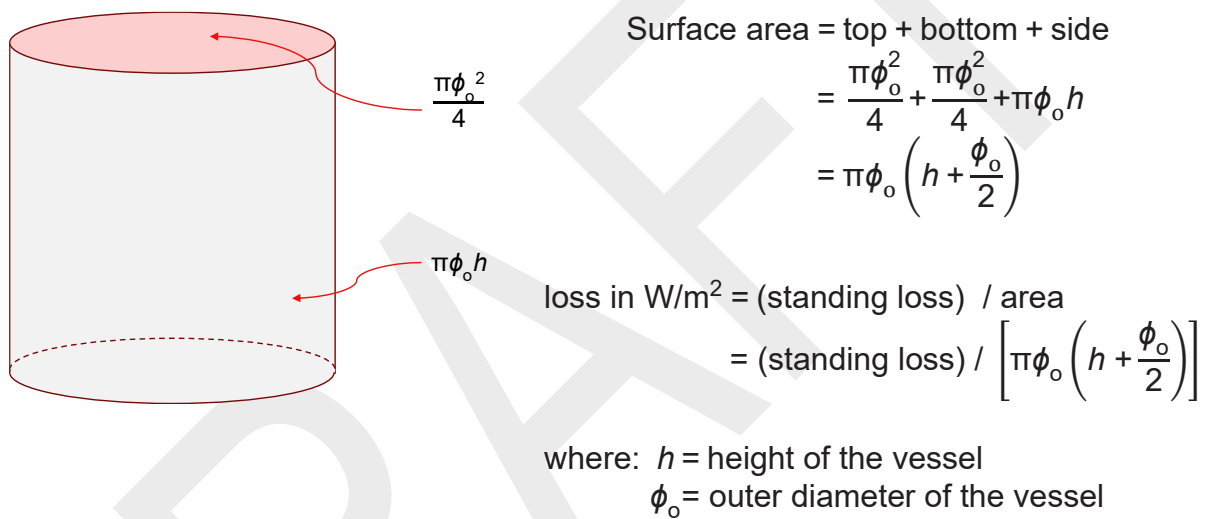
Further information regarding the use of lifecycle cost assessments to determine economic insulation thicknesses is provided Annex A and Annex G of BS 5422:2023: *Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range - 40 °C to +700 °C* (BSI, 2023).

Thermal stores

- 2.13.13. Thermal stores and buffer vessels shall be insulated such that the average heat loss is no greater than 22.0 W/m². This heat loss may be an average of the total standing heat loss divided by total surface area. The heat loss calculation shall be undertaken assuming the full charge temperature of the thermal store, and including consideration of the ambient temperature and exposure of the installed location of the thermal store (e.g. outdoors, unheated space).
- 3.13.13.

An average heat loss per unit area (in W/m²) may be calculated as shown in Figure 31.

Figure 31: Example calculation of heat loss per unit area from thermal vessel



2/3.14 Minimise the risk posed by construction activities and the operation of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important to ensure that the design of the Heat Network at the Developed/Technical Design stage is developed to minimise the risk posed by construction activities and the operation of the Heat Network, as some of these risks are impacted by the design of the Heat Network and cannot be minimised as easily during later stages.

2.14.1. 3.14.1.	An assessment shall be undertaken of the airflows present: • in the Energy Centre plant room; and • in the vicinity of rooftop plant (where present). The assessment shall include an airflow study where deemed necessary by the initial assessment. This shall inform the requirements for the airflow design in the Energy Centre.
2.14.2. 3.14.2.	Substations should be naturally ventilated where feasible, to reduce electricity consumption and avoid additional points of failure.
2.14.3. 3.14.3.	Energy Centres should be naturally ventilated where appropriate, with due consideration given to: • the requirements present (e.g. statutory requirements) on the system; • the usage of the Energy Centre (e.g. if it also a place of work); • the equipment specified in the Energy Centre; • the hazards associated with energy equipment (e.g. natural gases or refrigeration gases); • other constraints and obligations applicable to the Energy Centre.

	Other constraints and obligations which can apply to the ventilation of plant rooms can include (but are not limited to): • the fire strategy; • Part F of the Building Regulations (refer to Approved Document F: <i>Ventilation</i> (UK Government, 2021)); • Section 3 (Environment) of the Building Standards Technical Handbook - Domestic (Scottish Government, 2024); • the <i>Dangerous Substances and Explosive Atmospheres Regulations 2002</i> (DSEAR) (UK Government, 2002); • BS 6644:2011: <i>Specification for the Installation and Maintenance of Gas-Fired Hot Water Boilers of Rated Inputs Between 70 kW(net) and 1.8 MW (net) (2nd and 3rd Family Gases)</i> (BSI, 2011); • IGEN/UP/10: <i>Installation of Flued Gas Appliances in Industrial and Commercial Premises</i> (IGEM, 2017); • requirements surrounding emissions limit values; • the need for acoustic measures.
2.14.4. 3.14.4.	Where a Consumer Connection is installed in an enclosure (e.g. an HIU in a utility cupboard), the ambient temperature within the enclosure and its effect on any equipment shall be assessed. If there is a risk of high enclosure temperatures, high- and low-level ventilation openings should be provided. Manufacturer guidance should be sought to determine specific requirements for the Consumer Connection equipment (e.g. HIU) specified.
2.14.5. 3.14.5.	Where Communal Distribution Network pipework runs through communal areas, the full effect of heat loss from pipework to the communal area shall be calculated and added to all other internal heat gains within the communal area, and the risk of overheating shall be subsequently assessed. This assessment can be co-ordinated with the activities undertaken in Requirement 2.14.6/3.14.6. Justification shall be provided where the full effect of pipework heat gains to a communal area has not been accounted for in the overheating assessment. Mitigation measures shall be implemented where necessary to avoid unacceptably high internal temperatures during warmer weather - these may include: • alternative Communal Distribution Network pipework routes; • specifying insulation above the minimum thicknesses stated in Requirement 2.13.1/3.13.1 and Requirement 2.13.2/3.13.2; • ventilation in communal areas. Refer to CIBSE TM59: <i>Design methodology for the assessment of overheating risk in homes</i> (CIBSE, 2017) for further information.

2.14.6. 3.14.6.	The heat transfer from the Heat Network distribution pipework to mains cold water service and potable water pipework shall be minimised to mitigate the risk of Legionella growth. The heat transfer between pipework can be reduced by one of, or a combination of: • using separate riser cupboards for mains cold water pipework and Heat Network distribution pipework; • increasing the thickness of insulation on cold water pipework; • reducing the heat loss from the Heat Network (LTHW) pipework; • where mains cold water pipework and Heat Network distribution pipework share horizontal service voids: ○ maximising the horizontal separation between the different services; ○ routing mains cold water pipework below the level of the Heat Network distribution pipework. Temperature stratification within vertical risers containing Heat Network distribution pipework can create elevated air temperatures at the upper level of those risers. This can mean that increasing insulation thickness alone might not be sufficient to reduce Legionella risk. Refer to <i>HSG274 Part 2: The Control of Legionella Bacteria in Hot and Cold Water Systems</i> (HSE, 2024) for further information.
2.14.7. 3.14.7.	The risk of water leakage during the construction and operation of the Heat Network shall be appropriately mitigated through the design of the Heat Network, building on the statement produced in accordance with Requirement 1.14.3.
2.14.8. 3.14.8.	A Water Management Plan should be produced to inform the isolation procedures and emergency responses to water leakage, building on the statement produced in accordance with Requirement 1.14.3.

2/3.15 Ensure sufficient maintenance of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The design of the Heat Network at the Developed/Technical Design needs to be developed with sufficient provision for maintenance, including (but is not limited to) ensuring:

- sufficient space, accessibility, and facilities for maintenance;
- specification of sufficient ancillary equipment; and
- sufficient provision of isolation, throughout the Heat Network.

2.15.1. 3.15.1.	The design of the Heat Network shall ensure that the spatial requirements are met for maintenance works to be carried out to a high quality and in a safe manner. This shall include consideration of: • engaging the future operator of the Heat Network when developing the design of plant rooms; • including appropriate facilities which would reduce operational costs; • the use of low-level installations or provision of access gantries/facilities for equipment that: ○ could need to be operated in an emergency; or ○ requires regular maintenance.
2.15.2. 3.15.2.	The design of plant rooms shall include provision of sufficient facilities and space for the operation of maintenance work and the replacement of plant and equipment (e.g. heat generation plant, thermal storage, and plate heat exchangers) without excessive disruption. This shall include provision of a suitable electrical power supply (including during maintenance events), lighting, ventilation, water supply, and drainage facilities. There can be statutory requirements for maintenance activities (such as inspections) on the system, depending on factors including (but not limited to) its operating conditions and the size of pressurised vessels.
2.15.3. 3.15.3.	Ancillary equipment shall be specified to ensure that all equipment can be sufficiently depressurised, drained, maintained, and that air can be removed from all system high points.
2.15.4.	Strainers shall be specified in Energy Centres and Substations to reduce the risk of the accumulation of debris in equipment such as valves and heat exchangers and to ensure that all items (including HIUs, pumps, valves and flow meters) are sufficiently protected.

3.15.4.	Strainers shall be specified in Energy Centres and Substations to reduce the risk of the accumulation of debris in equipment such as valves and heat exchangers. An appropriate mesh size in each strainer shall be specified following consultation with equipment manufacturers to ensure that all items (including HIUs, pumps, valves and flow meters) are sufficiently protected.
2.15.5. 3.15.5.	The design of the plant room shall mitigate the risk of damage due to water leakage from plant failure. This may be achieved through measures including (but not limited to): • adequate drainage provision; • raised plinths for plant; • upstands at entry doors; • waterproof bunding to the perimeter of the room; • installation of electrical and control equipment at a higher level.
2.15.6. 3.15.6.	Oil tanks and oil-filled transformers shall be bunded to contain leakage in the event of a fault.
2.15.7. 3.15.7.	Where a Consumer Connection is included within a dwelling, its location shall allow for removal and replacement of the Consumer Connection without major disruption or changes to walls, fixtures or fittings.

Isolation of Consumer Connections

2.15.8. 3.15.8.	Isolation valves (IVs) shall be located to allow a fault in a local circuit to be isolated and keep the remainder of the network in operation. Refer to Requirement 2.15.10/3.15.10 and Figure 32 for required levels of isolation at Consumer Connections.
2.15.9. 3.15.9.	Isolation valves (IVs) on Communal Distribution Network pipework shall be located with good access from landlord areas.

2.15.10.

3.15.10.

The design of the Consumer Connection shall include provision of isolation for emergency use in the following locations. This shall include two points of isolation on the Distribution Network side of the Consumer Connection.

- A point of isolation shall be located within the consumer premises as close as practicable to the point of entry which can be easily operated by the consumer in the event of a leak within the property (e.g. through the use of quarter-turn lever valves).

For internal Consumer Connections, this may be provided through isolation valves on the first-fix valve rail if the valves can be easily operated for emergency use by consumers (e.g. a quarter-turn lever valve) and the Consumer Connection is as close as practicable to the point of entry. If the first-fix valve rail does not contain valves suitable for emergency use, specific emergency valves shall be specified.

For external Consumer Connections, this shall be provided through quarter-turn lever valves on the Consumer Heat System at the point of entry into the consumer premises.

- A point of isolation shall be located externally to the consumer premises in a location which:
 - is accessible (e.g. through the use of an access hatch);
 - can be easily operated in case of emergency or maintenance (e.g. through the use of quarter-turn lever valves);
 - is unlikely to be susceptible to tampering.

In Communal Distribution Networks, this shall be provided by isolation valves which are accessible and can be easily operated for emergency use and/or maintenance purposes.

A single isolation valve may be used for multiple Consumer Connections where deemed appropriate by the designer (e.g. within external enclosures containing multiple external Consumer Connections). Where it is proposed to use a single isolation valve for multiple Consumer Connections, this shall be incorporated into the Resilience Strategy (refer to Requirement 2.9.2/3.9.2)

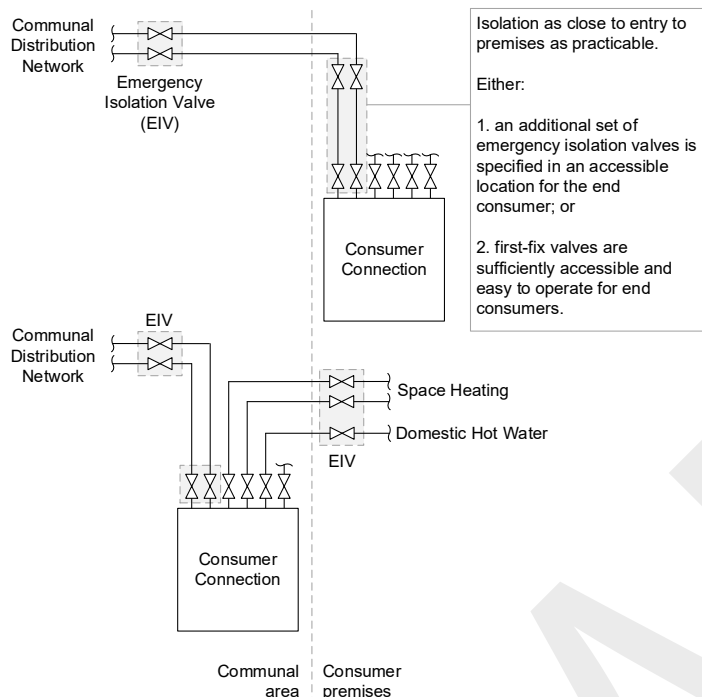
In District Distribution Networks directly serving domestic Consumer Connections (such as houses), this shall be provided by either:

- isolation valves in an above-ground compartment which is accessible to the Heat Network operator; or
- a strategy for isolating the consumer from outside the consumer property.

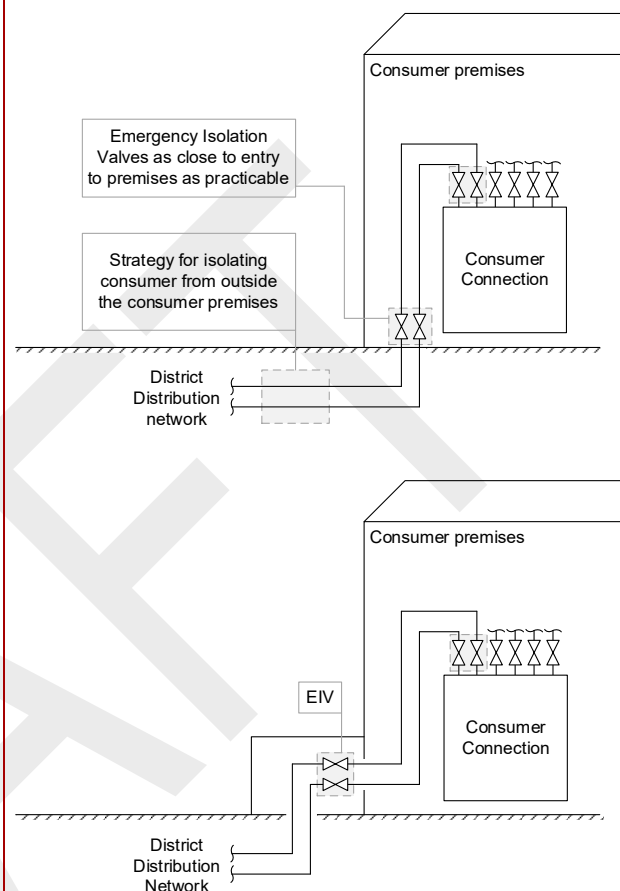
Refer to [Figure 32](#).

Figure 32: Required levels of isolation at Consumer Connections

High-density Consumer Connections



Low-density Consumer Connections



Accessibility of equipment

- 2.15.11. Communal Distribution Network ancillary equipment which requires planned preventative maintenance (PPM), or would be used in an emergency (such as an emergency shut-off valve), shall be accessible for use (e.g. by placement within a hatch or cupboard).
- 3.15.11.

Communal Distribution Network ancillary equipment which does not require maintenance as part of PPM activities shall be accessible for inspection, maintenance, and repair purposes without destructive works to the finished surfaces of the building fabric (e.g. by placement within a hatch or cupboard, behind removable screwed panels, or above suspended ceilings).

There can be an elevated risk from the failure of pipework joints behind finished surfaces, particularly where welded, brazed, or soldered joints are not used.

- 2.15.12. Suitable provision for venting and draining (with appropriate isolation) of each section of the Distribution Network shall be provided.
- 3.15.12.

2.15.13. 3.15.13.	To ensure maintainability of the District Distribution Network, appropriate access rights shall be agreed with the landowner as part of the wayleave or easement.
2.15.14. 3.15.14.	Pre-insulated isolation valves shall be used to provide isolation of sections of the buried network.
2.15.15. 3.15.15.	Valve chambers and other facilities in the District Distribution Network which require access (such as terminal units for monitoring systems) shall be designed and located to facilitate sufficient operation and maintenance.
2.15.16. 3.15.16.	Marker tape shall be specified to be installed above each line of buried pipework.

2/3.16 Manage and maintain the condition of components in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

A number of the system parameters determined early within the design process (such as the operating temperatures and pressures) can have a significant impact on the condition of the system.

The condition of the components needs to be considered at the Developed and Technical Design stages to ensure that subsequent design activities result in a system with a sufficient lifespan and reduced risk of the deterioration and failure of components.

2.16.1. 3.16.1.	The designer shall assess the full range of pipe materials and jointing systems available and select the optimal material and jointing system for each section of the network. This assessment shall include consideration of: • lifecycle cost - this shall be determined with inclusion of capital and operational costs including heat losses; • performance across the expected range of operating temperatures and pressures; • reliability and maintainability; • compatibility with the system's Water Quality Strategy (refer to Requirement 2.11.1/3.11.1). This may consist of a study of the options available where a standardised design has been developed to reduce costs.
2.16.2. 3.16.2.	The designer shall validate that the predicted life of any pipework other than steel is in accordance with the techno-economic requirements of the Heat Network; the predicted life of the pipework shall be assessed at the expected operating temperatures and pressures of the pipework of interest.

District Distribution Networks

2.16.3. 3.16.3.	Where steel carrier pipe is used for buried sections of District Distribution Network pipework, the designer shall specify pre-insulated pipe systems that comply with BS EN 253:2019+A1:2023: <i>District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks - Factory Made Pipe Assembly of Steel Service Pipe, Polyurethane Thermal Insulation and a Casing of Polyethylene</i> (BSI, 2023) and associated standards, and the design shall be developed in accordance with BS EN 13941:2019+A1:2021: <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021).
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2.16.4. 3.16.4.	Pre-insulated steel pipe systems shall have a project class defined under BS EN 13941:2019+A1:2021: <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021) which shall include consideration of special requirements for the network (e.g. railways, tunnels and high-risk areas). The project class determines the appropriate stress calculation methodology and the inspection and non-destructive testing (NDT) requirements (see Section 4.4.2 of BS EN 13941-1:2019+A1:2021 <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021)).
2.16.5. 3.16.5.	Where flexible polymer carrier pipe is used for buried sections of District Distribution Network pipework, the designer shall specify pre-insulated pipe systems that comply with BS EN 15632: <i>District Heating Pipes - Pre-insulated Flexible Pipe Systems (Parts 1-4)</i> (BSI, 2022).
2.16.6. 3.16.6.	The joint closure system used in buried pipework shall allow for an air test to be undertaken to demonstrate that the joint is sufficiently sealed against groundwater ingress.
2.16.7. 3.16.7.	Shrink-sleeve joints installed on District Distribution Network pipework shall be installed with an additional protection seal at each end of the joint (known as “dual sealing”).
2.16.8. 3.16.8.	A risk-based assessment shall be undertaken to determine the level of non-destructive testing (NDT), other than visual inspection, to be carried out on site and factory welds on buried steel pipework. The assessment shall include consideration of: • the risk of inaccessibility of the pipework of interest; and • the impact of the potential major outage to supply caused by a failure of the pipework of interest. The NDT shall be in accordance with the requirements of BS EN 13941-1:2019+A1:2021 <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021) as a minimum. Due to the cost associated with performing remedial action on welds which have failed on buried pipework, it can be beneficial to perform additional NDT of steel welds (for example, on 100 % of welds) on the pipework system.
2.16.9. 3.16.9.	The designer shall review soil conditions and contaminated soil reports when selecting the jointing method for buried pipework, as some jointing methods can be incompatible with contaminated soil. Where contaminated soil is identified, measures for its safe handling and disposal shall be implemented; these shall be included in the waste strategy and cost plan for the installation of buried pipework.
2.16.10. 3.16.10.	Diffusion barriers around the outside of polymer carrier pipes shall be specified to limit the diffusion of oxygen into the system water and diffusion of water into the insulation.

2.16.11. 3.16.11.	A analysis of expansion in buried pipework shall be undertaken by either an independent specialist or the manufacturer; this analysis shall be in accordance with BS EN 13941-1:2019+A1:2021: <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021) for steel pipework or BS EN 15632: <i>District Heating Pipes - Pre-insulated Flexible Pipe Systems (Parts 1-4)</i> (BSI, 2022) for flexible polymer pipes.
2.16.12. 3.16.12.	Thermal expansion of buried pipework shall be facilitated through the use of expansion bends and/or loops. The use of pre-stressing techniques may be used. The use of expansion bellows shall be avoided on buried pipework.
2.16.13. 3.16.13.	Trench depths shall be minimised as far as reasonably practicable during the District Distribution Network design, provided that the depths are in accordance with: • pipework manufacturer's guidance; • relevant requirements for highway works (e.g. the Street Works UK Guidelines (volumes 1-6) (Street Works UK, 2007-2023)); • relevant BS EN standards. The maximum and minimum trench depths should be documented. The depth of buried pipework may be increased locally beyond the minimum required where necessary, such as to avoid existing buried services or to mitigate against the risk of increased anticipated traffic loads.
2.16.14. 3.16.14.	The design of pre-insulated District Distribution Network pipework shall specify for the pipework to terminate: • with an end cap; and • above ground level or inside the connected building, to prevent water ingress.

Above-ground pipework

2.16.15.	The accommodation of expansion in above-ground pipework shall be outlined and assessed against the tolerances assumed in the pipework design.
3.16.15.	An analysis of expansion in above-ground pipework shall be undertaken to confirm that maximum deflections at all fittings are within the tolerances set by the manufacturer.
2.16.16. 3.16.16.	The class of any welding required on above-ground steel pipework (e.g. Class II or Class I) shall be determined for the system in accordance with the classes of operating conditions provided in Appendix A of BS 2971:1991: <i>Specification for Class II Arc Welding of Carbon Steel Pipework for Carrying Fluids</i> (BSI, 1991).

- 2.16.17. Site and factory welds on above-ground steel pipework determined as Class I in accordance with Requirement 2.16.16/3.16.16 shall be specified as being subject to non-destructive testing (NDT); the NDT shall be specified in accordance with the requirements of BS 2633:1987: *Specification for Class I Arc Welding of Ferritic Steel Pipework for Carrying Fluids* (BSI, 1987).
- 3.16.17.

It can be beneficial to perform additional NDT on welds to increase certainty in the integrity of welds (e.g. in critical sections of the Distribution Network, or areas where a weld failure and large-scale leakage can result in widespread disruption to critical facilities).

- 2.16.18. All above-ground pipework which is vulnerable to damage and unauthorised interference shall be mechanically protected with a suitable cladding material (e.g. metal sheet cladding) - refer to BS 5970:2012 *Thermal insulation of Pipework, Ductwork, Associated Equipment and Other Industrial Installations in the Temperature Range of -100°C to +870°C - Code of Practice* (BSI, 2012). This shall include all accessible pipework in public areas and any pipework in areas vulnerable to pest damage.
- 3.16.18.

The mechanical protection of pipework less than 2.0 m above ground level should be considered.

Pipework which is vulnerable to damage can include areas such as:

- back of house;
- car parks;
- bike stores;
- service corridors;
- plant rooms.

2/3.17 Ensure that project documentation is produced and managed

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

As the design of the Heat Network becomes more detailed during the Developed/Technical Design stage, it is important to produce project and design documentation which communicates the design of the Heat Network.

Key documentation includes the document register, the operation & maintenance (O&M) manual, drawings, and schedules. This is to ensure that there is sufficient information available during the Construction phase and the operation of the network.

Document register

- | | |
|---------|--|
| 2.17.1. | The document register produced in accordance with Requirement 1.17.1 shall be updated to reflect the design of the Heat Network during the Developed/Technical Design stage. |
| 3.17.1. | |

O&M manual

- | | |
|---------|--|
| 2.17.2. | No applicable requirement at the Developed Design stage. |
| 3.17.2. | The designer shall outline the required structure and contents of the operation and maintenance (O&M) manual for the system. |
- Refer to BSRIA BG 79/2020: *Handover Information and O&M Manuals* (BSRIA, 2020) for further information.

Drawings and schedules

- | | |
|---------|---|
| 2.17.3. | <p>Drawings shall be produced which reflect the design of the system at the end of the Developed Design stage.</p> <p>The drawings shall contain information needed for the Heat Network to be spatially co-ordinated with other building services and the wider system, including:</p> <ul style="list-style-type: none"> the locations and sizes of all items of equipment and pipework, using spatial demarcation representing actual intended equipment, in suitable positions for spatial co-ordination with engineering services, architecture and structure; spatial allowances for installation methodologies, and access for maintenance and replacement. <p>Aspects of the Heat Network which require works to building fabric shall be identified.</p> |
|---------|---|

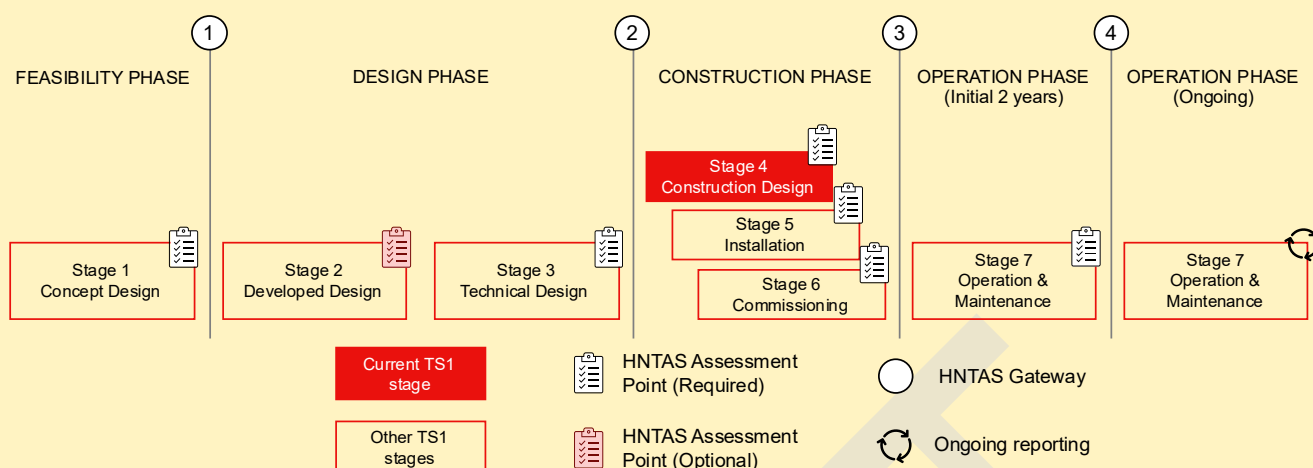
3.17.3.	Installation drawings shall be produced which reflect the design of the system at the end of the Technical Design stage. The installation drawings shall contain information needed by tradespeople on site to install the works, including: • the precise locations and sizes of all items of equipment and pipework, using specific objects representing actual intended or procured equipment, in positions that have been spatially coordinated between engineering services, architecture and structure; • the supports and fixings required to install the works; • spatial allowances for installation and commissioning methodologies, and access for maintenance and replacement. Where applicable, any details of works required to the building fabric and manufacturer drawings shall be produced in accordance with the design of the system at the Technical Design stage.
2.17.4.	Schematics shall be produced which reflect the design of the system at the end of the Developed Design stage. The schematics shall contain information needed for the Heat Network to be spatially co-ordinated with other building services and the wider system, including: • the functional, sensing, control and measuring items to be installed - this includes flushing provision, air vents and drainage provision, isolation valves, sensors (pressure, temperature, flow); • the pipework sizes, working pressures, flow rates, and differential pressures through pipework sections. All items shall be labelled with references to schedules.
3.17.4.	Installation schematics shall be produced which reflect the design of the system at the end of the Technical Design stage. The installation schematics shall contain information needed by tradespeople on site to install the works, including: • the functional, sensing, control and measuring items to be installed - this includes flushing provision, air vents and drainage provision, isolation valves, sensors (pressure, temperature, flow); • the pipework sizes, working pressures, flow rates, and differential pressures through pipework sections adjusted for any changes during construction. All items shall be labelled with references to schedules.

Commissioning documentation

2.17.5.	No applicable requirement at the Developed Design stage.
3.17.5.	The designer shall produce an outline commissioning plan and programme, including the commissioning approach and the parameters to be achieved. The commissioning shall follow the recommendations in CIBSE Commissioning Code M: <i>Commissioning Management</i> (CIBSE, 2022). The plan shall cover all aspects of the Heat Network (or relevant phase, for phased developments) - as a minimum, this shall include every Element present in the system.

4 Stage 4: Construction Design

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Construction Design stage overview

At the start of the Construction Design stage, it is expected that all aspects of the design of the Heat Network are complete except for relatively minor variations which might arise from activities during the Construction phase. This includes specification of:

- the system parameters such as heat demands, sizes of plant and equipment, and operating temperatures;
- the spatial layout of the Heat Network, shown through drawings which demonstrate spatial coordination with the wider system;
- the hydraulic design of the Heat Network, shown through schematics;
- the Description of Operation (DesOps) for the control systems used in Energy Centres and Substations.

The Construction Design stage will likely overlap with the Installation stage and the Commissioning stage as different parts of the Heat Network are constructed at different times. This means that some activities undertaken during the Construction Design stage may commence and/or finish after certain other activities in either the Installation stage or the Commissioning stage.

At the end of the Construction Design stage, it is expected that:

- technical submittals for all equipment in the Heat Network have been produced, and reviewed and agreed by the relevant designer(s);
- the equipment used in all Elements of the Heat Network has been specified with sufficient information for installation;
- methodologies for installation activities (such as pressure testing) have been produced;
- documentation has been updated throughout the Construction phase such as the document register, operation and maintenance (O&M) manual, drawings, and schematics.

4.2 Ensure that Consumer Systems meet consumer heat demands in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Activities undertaken at the Construction Design stage, such as the specification of the models of Consumer Connections, need to be carried out with consideration of the design intent of the system at the Technical Design stage to ensure that the system can meet consumer heat demands prior to the installation of the Heat Network.

- 4.2.1. The specification of HIUs (as determined in Requirement 2.2.14/3.2.14, Requirement 2.2.15/3.2.15, Requirement 2.2.16/3.2.16, and Requirement 2.2.17/3.2.17) shall be reviewed and updated where appropriate (e.g. due to agreed changes from the design of the system at the Technical Design stage).
Where an HIU is used, the unit specified shall conform with BS 8635-1:2024: *Hydraulic Interface Units for Heat Network Applications - Specification* (BSI, 2024).
If the HIU selected is within the scope of the BESA UK HIU Test Regime (BESA, 2023, or latest edition), it shall be tested under the regime and registered with BESA; HIUs not within the scope of the BESA UK HIU Test Regime (BESA, 2023, or latest edition) shall be tested and registered under an equivalent accredited independent testing and registration scheme.
- 4.2.2. Where the keep-warm strategy of the Distribution Network uses keep-warm functionality within Consumer Connections (e.g. HIUs), the specification of the Consumer Connection shall be reviewed and updated where appropriate (e.g. due to agreed changes from the design of the system at the Technical Design stage) to ensure that the requirements set out in Requirement 2.2.18/3.2.18 are met by the unit specified.
- 4.2.3. Where the keep-warm strategy of the District Distribution Network solely uses the design of the Distribution Network (i.e. without any keep-warm functionality in the Consumer Connections), the specification of the Consumer Connection shall be reviewed and updated where appropriate (e.g. due to agreed changes from the design of the system at the Technical Design stage) to ensure that the requirements set out in Requirement 2.2.19/3.2.19 are met by the unit specified.

4.6 Minimise the risk posed by working pressures

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Activities at the Construction Design stage, such as the specification of equipment and setpoints in pressure safety systems, need to be done with consideration of the working pressures of the system (as determined at the Technical Design stage).

Pressure ratings of equipment

- 4.6.1. Technical submittals provided for the equipment on the system (refer to Requirement 4.17.3) shall include the nominal pressure rating of each piece of equipment.
- 4.6.2. The designer shall review the provided technical submittals and determine the Maximum Allowable Pressure (MAP) of equipment considering the range of operating temperatures of the system.

The use of pressure head diagrams can be beneficial for designers and construction contractors to visually represent the working pressures which are present at different locations on a Heat Network.

- 4.6.3. The Maximum Allowable Pressure (MAP) of each piece of equipment shall be equal to or exceed the Local Maximum Working Pressure (LMWP) at the location of interest.

Pressure safety systems

- 4.6.4. The setpoint of each Safety Relief Device shall be determined with consideration given to:
 - the maximum tested pressure of the equipment at the location of interest;
 - the static location (static height) of the Safety Relief Device and its relation to other pieces of equipment (such as expansion vessels);
 - the Maximum Allowable Pressure (MAP) of the equipment at the location of interest;
 - the Lowest Pressure Rated Component (LPRC) in the hydraulic circuit and its location relative to the Safety Relief Device.
- 4.6.5. Each heat generator with a nominal heat output of more than 300 kW shall be served by the required additional pressure safety equipment specified in BS EN 12828:2012+A1:2014: *Heating Systems in Buildings - Design for Water-Based Heating Systems* (BSI, 2014). The required additional equipment shall prevent the Maximum Allowable Pressure of the heat generator and other components in the vicinity of the heat generator from being exceeded. The pressure limiter shall be set such that it responds prior to the Safety Relief Device(s) operating.

- 4.6.6. The pressure characteristics of each hydraulic circuit and the pressure safety system shall be clearly documented. This may include:
- the Local Maximum Working Pressure (LMWP) at the location of the pressure safety system;
 - the System Maximum Working Pressure (SMWP) of the hydraulic circuit the pressure safety system is connected to;
 - the pressure ratings of the system (including pipework, equipment, joints and fittings);
 - the pressure setpoints of pressure safety system.

It can be beneficial to represent the pressure characteristics of a system graphically. Refer to [Annex E: Pressure box diagram](#) for further information.

4.8 Ensure that Energy Centres and Substations operate in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

A key activity at the Construction Design stage is the specification of the Description of Operation, initially developed in Objective 2/3.8, which outlines how the design intent and control strategies will be achieved by the control systems used on the Heat Network.

- 4.8.1. The Description of Operation (DesOps) initially developed in accordance with Objective 2/3.8 shall be developed to sufficiently communicate the Heat Network's operating procedures for the Energy Centre / Substation.
- The Description of Operation shall include information regarding:
- the safety interlocks;
 - the operating modes of the system;
 - the control strategies implemented;
 - the Automatic and Remote Monitoring System (ARMS);
 - alarms and faults for:
 - individual items of equipment;
 - sensors and meters; and
 - the overarching system;
 - manual override procedures;
 - the levels of access provided by the BMS (or equivalent system);
 - the provision of remote access to the BMS (or equivalent system);
 - a description of the "head end" supervisor (or equivalent interface for operator use);
 - timeclock control setpoints (where used);
 - the automatic control, exercising, and sequencing of equipment (where applicable) including (but not limited to);
 - heat generation equipment;
 - network distribution pumps;
 - pressurisation and expansion systems;
 - heat exchangers,
 including the setpoints and sensors which are used as part of the automatic control;
 - the points list (including hard and soft points);
 - signals used for the monitoring of the system (e.g. from continuous water quality monitoring equipment);
 - the charging/discharging of thermal storage.

4.9 Ensure sufficient resilience in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Changes made to the design of the system at the Construction Design stage can impact the resilience of the Heat Network. It is therefore important to update relevant documentation regarding resilience, incorporating any design changes and the design information made available during the Construction Design stage. It is also key to review and assess the threats to the system prior to the Installation stage.

4.9.1. The Resilience Strategy, including:

- the Disaster Recovery Plan, in accordance with Requirement 2.9.5/3.9.5; and
- the critical spares log, in accordance with Requirement 2.9.6/3.9.6,

shall be updated throughout the Construction Design, Installation, and Commissioning stages to reflect the as-procured, as-installed, and commissioned status of the Heat Network.

4.9.2. The designer shall review the Resilience Strategy prior to finalising any design changes proposed during the Construction Design stage to determine whether the change would lead to any threats posing a risk score of:

- above 6; or
- deemed excessively high by the risk assessor.

Where a change results in a threat that poses a risk score above this threshold, the designer shall work with the contractor to:

- amend the proposed design change to reduce the assessed risk score to a value within this threshold; or
- propose changes to the Resilience Strategy to reduce the risk score to a value within this threshold.

Refer to Requirement 1.9.1 for guidance regarding the implementation of a redundancy and recovery strategy.

4.9.3. Technical submittals provided by the contractor shall be compatible with the Resilience Strategy; this shall be reviewed by the designer.

4.9.4. The Resilience Strategy, including updates throughout the construction phase as set out in Requirement 4.9.1, shall be included within the operation and maintenance (O&M) manual.

4.9.5. Prior to handover and following appointment of the organisation responsible for the operation of the system, the Disaster Recovery Plan shall be updated to include written procedures outlining the implementation of the Disaster Recovery Plan as agreed between the contractor and the incoming Designated Operator of the Heat Network.

Refer to Requirement 2.9.5/3.9.5 and Requirement 4.9.1 for requirements regarding the production of the Disaster Recovery Plan.

4.9.6. At the Construction Design stage, the designer shall develop a strategy for the replacement of plant, building on the initial strategy set out in Requirement 2.9.7/3.9.7. This shall include:

- a schedule of plant, detailing the size and weight of pieces of plant;
- access arrangements for plant replacement;
- a lifting plan for large/heavy items of plant including requirements for any specialist lifting requirements; and
- arrangements for the use of temporary plant during replacement works.

The strategy shall be updated throughout the Construction Design, Installation, and Commissioning stages to reflect the as-procured, as-installed and commissioned status of the Heat Network.

4.11 Ensure sufficient water quality in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important that the design of the system at the Construction Design stage has been developed with sufficient consideration for:

- how water quality will be maintained;
- the recording of water quality once the system is filled; and
- the activities during the Installation and Commissioning stages which are required to bring the water quality of the system to acceptable levels.

Water Quality Strategy

- 4.11.1. The Water Quality Strategy (refer to Requirement [2.11.1/3.11.1](#)) shall be updated throughout the Construction Design, Installation, and Commissioning stages to reflect the as-installed and commissioned status of the Heat Network.

Water Quality Recording Programme

- 4.11.2. The Water Quality Recording Programme (refer to Requirement [2.11.6/3.11.6](#)) shall be updated throughout the Construction Design, Installation, and Commissioning stages to reflect the as-installed and commissioned status of the Heat Network.

System design

- 4.11.3. The Consumer Connection shall be specified with a flushing bypass at the connection to the Distribution Network. The flushing bypass shall be temporary (refer to [Figure 23](#)).

Flushing methodology

- 4.11.4. Prior to flushing of pipework, a methodology shall be developed which details the flushing procedures outlined in Requirement [5.11.3](#) (for Chemically Treated Systems) or Requirement [5.11.5](#) (for Depleted Water Systems).

4.12 Ensure that the performance of the Heat Network can be monitored

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The specification of the equipment and systems used for the monitoring of the Heat Network needs to be considered at the Construction Design stage.

This Objective references the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025) which provides detail on requirements surrounding Metering and Monitoring Systems.

- 4.12.1. The specification of thermal energy meters at the Construction Design stage shall be in accordance with Section 1.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).
- 4.12.2. The specification of the Automatic and Remote Monitoring System (ARMS) at the Construction Design stage shall be in accordance with Section 2.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).
- 4.12.3. The specification of the smart metering system / advanced meter infrastructure (AMI) at the Construction Design stage shall be in accordance with Section 3.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).
- 4.12.4. The Metering and Monitoring Strategy at the end of the Construction Design, Installation, and Commissioning stages shall be in accordance with Section 4.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025). This shall include:
 - the Monitoring Points schedule;
 - the KPI schedule;
 - the data flow diagram.

4.13 Ensure that the Heat Network is sufficiently insulated

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The insulation specified for installation on the Heat Network at the Construction Design stage needs to meet the required level of performance from insulation as determined in the Technical Design stage, and heat losses need to be calculated to account for any changes in the design of the Heat Network after the Technical Design stage.

- 4.13.1. Technical submittals for the pipework insulation, pipe support blocks and other insulation products for ancillary equipment which is specified for all distribution pipework shall be provided to the Heat Network designer. This shall include:
- a Declaration of Performance for the product, including:
 - a thermal conductivity curve against temperature;
 - the thermal conductivity at each calculated mean temperature of the insulation;
 - the emissivity of the outer surface.
 - the thickness of the insulation on the pipe section specified in accordance with:
 - Requirement 2.13.2/3.13.2 for above-ground pipework;
 - Requirement 2.13.12/3.13.12 for buried pipework;
 - the heat loss per unit length (W/m) from the pipe section specified in accordance with Requirement 2.13.1/3.13.1 for Communal Distribution Network pipework;
 - the vapour sealing of the insulation in accordance with Requirement 5.13.4;
 - the weather protection of the insulation in accordance with Requirement 2.13.10/3.13.10;
 - the mechanical protection of the insulation in accordance with Requirement 2.16.18/3.16.18;
 - evidence that the product meets the necessary safety and performance requirements of the relevant directives allowing the manufacturer to affix the CE or UKCA marking on their product;
 - evidence that the calculations have been performed using the provided thermal conductivity;
 - details of the proposed solution(s) for the insulation of ancillary equipment.
- 4.13.2. The risk of corrosion under insulation on above-ground pipework shall be mitigated as far as reasonably practicable; mitigation measures should include those stated in BS 5970:2012 *Thermal insulation of Pipework, Ductwork, Associated Equipment and Other Industrial Installations in the Temperature Range of -100°C to +870°C - Code of Practice* (BSI, 2012).

- 4.13.3. The designer shall review the design of the Communal Distribution Network prior to finalising any design changes proposed during the Construction Design stage to determine whether the change would lead to the heat loss from the Communal Distribution Network (in W) exceeding the Construction Design stage heat loss limit in [Table J.2](#). This shall include a calculation of the total heat loss from the Communal Distribution Network including:
- the insulation specified at the Construction Design stage;
 - an allowance for ancillary equipment in accordance with Requirement [2.13.5/3.13.5](#).
- 4.13.4. The designer shall review the design of the District Distribution Network prior to finalising any design changes proposed during the Construction Design stage to determine whether the change would lead to the heat loss from the District Distribution Network (in W) exceeding the Heat Loss Limit in [Table J.3](#). This shall include a calculation of the total heat loss from the District Distribution Network including the insulation specified at the Construction Design stage, using the assumptions detailed in Requirement [2.13.11/3.13.11](#).
- 4.13.5. Calculations for heat loss from pipework undertaken at the Construction Design stage shall be undertaken in accordance with BS EN ISO 12241:2022: *Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules* (BSI, 2022); this may be done through the use of software which adopts the methodology set out in the standard.

4.14 Minimise the risk posed by construction activities and the operation of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

At the Construction Design stage, a key activity is the specification of methodologies to be undertaken during the Installation and Commissioning stages of the Heat Network to aid in minimising the risk posed by these activities.

- 4.14.1. Prior to the pressure testing of pipework, a methodology shall be developed in accordance with BESA TR/6: *Site Pressure Testing of Pipework - Guide to Good Practice* (BESA, 2022) or pipework manufacturer guidance where BESA TR/6: *Site Pressure Testing of Pipework - Guide to Good Practice* (BESA, 2022) is not applicable (e.g. polymer pipework systems).

4.15 Ensure sufficient maintenance of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Construction Design stage, any agreed changes from the design of the system at the Technical Design stage need to be made with consideration for future maintenance requirements.

- 4.15.1. The design of the system at the end of the Construction Design stage shall include consideration of future needs for the maintenance and replacement of plant and equipment. This shall be reflected in installation drawings.

4.16 Manage and maintain the condition of components in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important that the system design at the Construction Design stage is produced with sufficient consideration for the condition of components in the Heat Network prior to the installation of the Heat Network, to account for any changes in the design of the Heat Network after the Technical Design stage.

District Distribution Networks

4.16.1. The design of pre-insulated pipe systems selected for buried sections of the District Distribution Network at the end of the Construction Design stage shall be in accordance with (where applicable, due to pipe material):

- Requirement 2.16.3/3.16.3;
- Requirement 2.16.4/3.16.4;
- Requirement 2.16.5/3.16.5;
- Requirement 2.16.6/3.16.6;
- Requirement 2.16.7/3.16.7;
- Requirement 2.16.10/3.16.10;
- Requirement 2.16.14/3.16.14.

The methodology for the installation of pre-insulated steel pipe systems selected for buried sections of the District Distribution Network shall be in accordance with:

- BS EN 13941-1:2019+A1:2021 *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021) for steel pipe systems; and
- manufacturer's instructions and guidance.

4.16.2. The project class of any pre-insulated steel pipe system under BS EN 13941:2019+A1:2021 *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021) defined in Requirement 2.16.4/3.16.4 shall be reviewed and updated where appropriate (e.g. due to agreed changes from the design of the system at the Technical Design stage); the stress calculation methodology and inspection and NDT requirements shall be reviewed and updated where appropriate (see Section 4.4.2 of BS EN 13941:2019+A1:2021 *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021)).

- 4.16.3. Prior to the installation of buried pre-insulated steel pipe systems, the designer shall confirm that the necessary expansion analysis check has been undertaken in accordance with BS EN 13941:2019+A1:2021 *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021). This design check shall also be undertaken for any potential agreed changes in the route which arise during installation. The stress analysis documented shall be for the as-installed pipework route.
- 4.16.4. Prior to the installation of above-ground pipework systems, the designer shall confirm that the necessary expansion analysis check has been undertaken and that there is sufficient expansion provision. The design check shall also be undertaken for any potential agreed routing changes which arise during installation. The expansion analysis documented shall be for the as-installed pipework route.

Above-ground pipework

- 4.16.5. The class of welding (as determined in Requirement 2.16.4/3.16.4) and NDT requirements (as determined in Requirement 2.16.17/3.16.17) of above-ground steel pipework shall be reviewed and updated where appropriate (e.g. due to agreed changes from the design of the system at the Technical Design stage).
- 4.16.6. Fittings connecting the Consumer Connection to the Communal Distribution Network pipework shall be selected to operate under current and future network working pressures and temperatures.

4.17 Ensure that project documentation is produced and managed

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Construction Design stage, further detail will be added to the documentation for the Heat Network. It is important to reflect this in project documentation prior to the installation of the Heat Network.

Documentation needs to be updated throughout the Construction Design, Installation, and Commissioning stages to reflect the as-installed and commissioned status of the network, incorporating any agreed changes that could have occurred from the design of the system at the end of the Technical Design stage.

Document register

- 4.17.1. The document register shall be updated throughout the Construction Design, Installation, and Commissioning stages to reflect the as-installed and commissioned status of the Heat Network.

O&M manual

- 4.17.2. An operation and maintenance (O&M) manual shall be produced in sufficient detail to enable the Designated Operator to adequately maintain the Heat Network. As a minimum the O&M manual shall include:
- a system description;
 - a condition log which is in accordance with Requirement 6.16.6;
 - commissioning and testing certification for all plant and ancillary equipment (including equipment in Consumer Connections and Consumer Heat Systems);
 - maintenance instructions;
 - a planned preventative maintenance (PPM) regime;
 - a Description of Operation (DesOps) which is in accordance with Requirement 4.8.1, which is cross-referenced to drawings and schedules (where appropriate) including:
 - access management (including the list of setpoints and/or control inputs that can be varied at each level of access control);
 - a full points list;
 - control loops;
 - manufacturers literature;
 - water quality documentation;
 - a Resilience Strategy which is in accordance with Requirement 4.9.1;
 - as-installed drawings and schematics which are in accordance with Requirement 3.17.3, Requirement 3.17.4 and Requirement 4.17.5;

- the Metering and Monitoring Strategy which is in accordance with Section 4.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025);
- the Monitoring Points specification which is in accordance with Section 1.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025);
- the ARMS specification which is in accordance with Section 2.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025);
- the smart metering / advanced meter infrastructure specification which is in accordance with Section 3.1 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).

Section 4 of BSRIA BG 79/2020: *Handover Information and O&M Manuals* (BSRIA, 2020) provides further detail on the documentation to be provided at practical completion, for example:

- contractual and legal records;
- system descriptions;
- asset register or equipment schedule;
- parts identification, spares and spares policy;
- commissioning information;
- operation instructions;
- maintenance instructions;
- maintenance schedules;
- modification information;
- fault finding;
- lubrication;
- disposal instructions;
- names and addresses of manufacturers;
- index of plans and drawings;
- emergency information; and
- manufacturers information.

There can be obligations which apply to the documentation produced during the Construction Design, Installation, and Commissioning stages of a given system (e.g. the requirements in the relevant Building Regulations).

Technical submittals

4.17.3. Technical submittals shall be produced which are in accordance with the requirements of the design of the system at the end of the Technical Design stage.

The technical submittals shall contain the site-specific information which is:

- used to inform the equipment selection; and
- required for installation, commissioning, and operation and maintenance of the equipment (for example, setpoints).

The technical submittals shall be reviewed and agreed by the designer.

Updates throughout Construction phase

- 4.17.4. Documentation shall be updated throughout the Construction Design, Installation, and Commissioning stages to reflect the as-installed and commissioned status of the Heat Network. This shall include:
- a Description of Operation (DesOps) and control system points schedule;
 - drawings and schematics, produced in accordance with Requirement 3.17.3 and Requirement 3.17.4.

Drawings and schedules

- 4.17.5. The contractor shall provide as-installed layout drawings and schematics of all sections of the Heat Network within their scope at the end of the Construction Design stage, indicating agreed changes from the design of the system at the end of the Technical Design stage. These drawings shall contain the correct labelling of equipment, Monitoring Points and control system points. These drawings shall be included in the system's operation and maintenance (O&M) manual.
- 4.17.6. The following shall be affixed to the wall of each plant room.
- As-installed drawings showing:
 - the Heat Network pipework within the plant room and its immediate connections;
 - gas, cold water and electrical supplies (as appropriate);
 - the correct labelling of equipment;
 - Monitoring Points; and
 - control system points.
 - A valve schedule for the valves in the plant room, coordinated with a valve tag system.

It can be beneficial to include boundary lines depicting the demarcation of ownership and maintenance responsibility between different parties (where applicable) in plant rooms containing Substations.

- 4.17.7. The contractor shall document the joint positions (e.g. with survey station and/or GPS coordinates as appropriate) and agreed route changes from the design of the system at the end of the Technical Design stage within the as-installed layout drawings for the District Distribution Network.
- 4.17.8. Where a pre-insulated pipe system includes a surveillance system, a detailed wiring diagram shall be provided for the installation of the system, which will be held as part of the drawings for the District Distribution Network. This diagram shall be updated following installation to reflect the as-installed status of the system, including the lengths of each channel at each field terminal and above-ground connection / Termination Point.

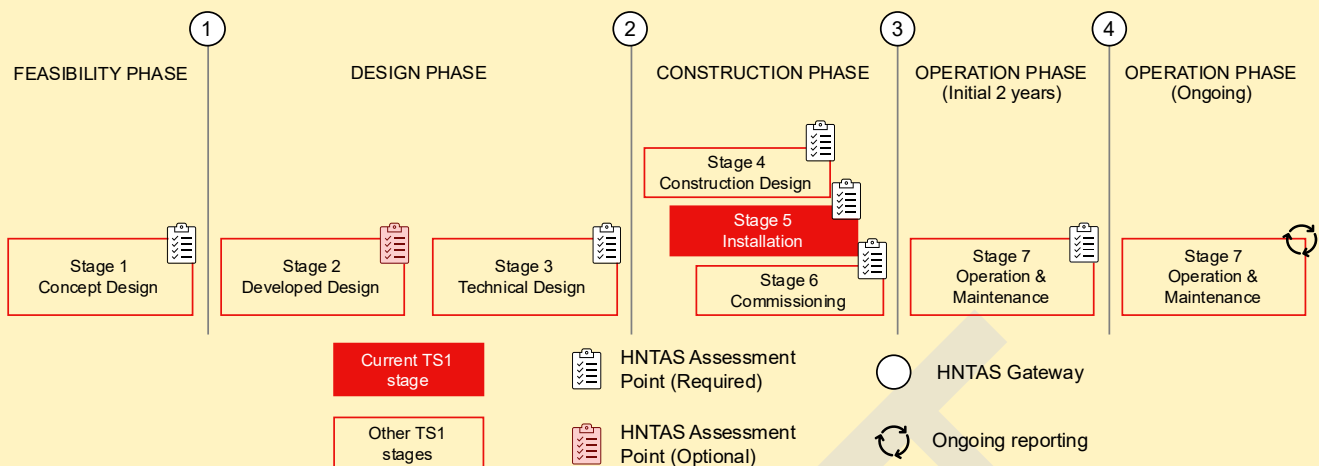
Commissioning documentation

- 4.17.9. The contractor shall produce a detailed commissioning plan and programme, building on that developed in accordance with Requirement 3.17.5. The duration of the commissioning programme should be sufficient to allow commissioning activities to be successfully completed in advance of the expected handover date.

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5 Stage 5: Installation

- 5.1 Determine the consumer heat demands from the network
- 5.2 Ensure that Consumer Systems meet consumer heat demands in a controlled manner
- 5.3 Minimise the length of the Heat Network
- 5.4 Minimise operating temperatures within the constraints present
- 5.5 Optimise distribution pipe diameters
- 5.6 Minimise the risk posed by working pressures
- 5.7 Ensure that Energy Centres and Substations can meet the expected range of demands
- 5.8 Ensure that Energy Centres and Substations operate in a controlled manner
- 5.9 Ensure sufficient resilience in the Heat Network
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Installation stage overview

The Installation stage will likely overlap with the Construction Design stage and the Commissioning stage as different parts of the Heat Network are constructed at different times. This means that some activities undertaken during the Installation stage may:

- finish before certain other activities in the Construction Design stage;
- commence and/or finish after certain other activities in the Commissioning stage.

Prior to undertaking an activity during the Installation stage, it is expected that there is sufficient documentation available which provides the technical definition of the relevant section of the Heat Network, and that methodologies have been produced for key activities. This documentation may have been produced at the Technical Design stage or the Construction Design stage.

At the end of the Installation stage, it is expected that:

- all equipment, pipework, and insulation in the Heat Network has been installed with good workmanship;
- the Heat Network has been filled, pressure tested, and flushed (with water treatment/conditioning as appropriate);
- quality assurance activities such as non-destructive testing (NDT) have been done as necessary.

Good workmanship

A number of requirements in this stage refer to good workmanship. This refers to the undertaking of construction, installation, and commissioning activities which results in work that is:

- functional according to the design intent;
- safe;
- durable; and
- compliant with applicable standards and obligations.

Activities which are performed with good workmanship are customary with skilled contractors in the relevant trade/industry.

5.11 Ensure sufficient water quality in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

There are a number of activities during the Installation stage which need to be undertaken to minimise the risk of deterioration in the Heat Network (e.g. due to corrosion or microbiological proliferation). Activities which are required to achieve sufficient levels of water quality include:

- the filling of the system; and
- the use of flushing to aid in cleaning the internal surfaces of pipework and equipment in the Heat Network.

The risks of the creation of bypasses and the presence of stagnant water also need to be considered at the Installation stage.

Filling and flushing of the system

5.11.1. The water used to fill/flush the system shall be sampled, analysed and recorded two weeks before the system is initially filled in accordance with BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021) via the use of:

- on-site test equipment (e.g. ATP monitors); or
- laboratory testing of samples.

Where on-site test equipment is used, it shall be calibrated to ensure that the results produced are sufficiently accurate.

This analysis of the water used to fill/flush the system shall be used to determine appropriate measures to fulfil the requirements regarding the filling of the system set out in:

- Requirement 5.11.2 for Chemically Treated Systems;
- Requirement 5.11.4 for Depleted Water Systems.

5.11.2. Chemically Treated Systems shall be filled and treated in accordance with:

- the procedures and guidance outlined in BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021) including:
- minimising the delay between first wetting of the system pipework and pre-commission cleaning (which should be less than 48 hours);
- the use of pulse-injecting chemicals into the system to a pre-determined concentration (depending on the chemicals selected for the system);
- the system's Water Quality Strategy (refer to Requirement 2.11.1/3.11.1).

The water quality parameters of any water used to fill the system shall be in accordance with the limits set out in Table H.5.

The system may be filled through:

- the use of the mains cold water service, if the parameters of the mains cold water service are within acceptable limits;
- the use of water bowsers.

- 5.11.3. For Chemically Treated Systems, each section of the network shall be flushed to remove debris using specialist flushing equipment in accordance with BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021).

Closed-loop pre-treatment cleaning (CPC) can typically be utilised for all sizes of pipework. Alternatively (particularly for straight sections of pipework), pigging may be undertaken using conventional or ice methods. Where ice methods are used, the impact of the use and subsequent removal of saline solutions should be appropriately considered.

Where closed-loop pre-treatment cleaning (CPC) is used, it shall be done so in accordance with the procedures and guidance outlined in BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021).

- 5.11.4. Depleted Water Systems shall be filled in accordance with the system's Water Quality Strategy (refer to Requirement 2.11.1/3.11.1).

The water quality parameters of the water used to initially fill the system shall be in accordance with the limits set out in Table H.6. This can include:

- the use of the mains cold water service, if the parameters of the mains cold water service are within acceptable limits;
- in-line conditioning of the mains cold water service before it enters the system;
- the use of tanks filled with conditioned water.

The equipment used to provide the initial fill water shall remain connected during the closed-loop pre-treatment process to ensure any top-up water meets the water quality parameter limits set out in Table H.6.

The system should be filled from the lowest point (where this is technically feasible). Venting procedures shall be undertaken during the filling of the system. The use of deoxygenation and/or deaeration equipment should be considered to further assist in oxygen removal during the system filling.

- 5.11.5. Depleted Water Systems shall be flushed using a closed-loop pre-treatment cleaning process which is compatible with the system's Water Quality Strategy (refer to Requirement 2.11.1/3.11.1).

Dynamic flushing of the system shall be undertaken in accordance with Section 6.2 of BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021).

- 5.11.6. Where a fire hydrant is used to supply mains cold water, the lines used to fill the system shall be sufficiently purged (e.g. through the use of flushing) to ensure the water entering the system is within the limits set out in:

- Table H.5 for Chemically Treated Systems;
- Table H.6 for Depleted Water Systems.

Recording of water quality parameters

- 5.11.7. Where continuous monitoring equipment for dissolved oxygen is specified on a system, it shall be installed and commissioned such that it is functional during construction activities after the filling of the system.

Laboratory testing of the system's water quality can commence once the system cleaning is completed. It can be beneficial to begin testing at an earlier time during the installation and commissioning stages, to more quickly identify any necessary remedial actions.

Flushing bypasses

- 5.11.8. Temporary flushing bypasses (including those installed at Consumer Connections) shall be disconnected/removed and capped off as soon as reasonably practicable after flushing of the network.

Stagnation

- 5.11.9. An assessment shall be made of the risk to water quality posed by sections of the Heat Network which are expected to not be in operation or receive circulation for any period of time. The assessment shall include consideration of:
- the materials used in the system;
 - the expected length of time for which the section of the network is not expected to operate;
 - the possibility of maintaining circulation in the section of the network, while ensuring sufficient system control (e.g. through the appropriate use of thermally-controlled bypasses).

Further information can be found in BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021).

- 5.11.10. Pre-insulated buried distribution pipework shall terminate:
- with an end cap; and
 - above ground level or inside the connected building,
- to prevent water ingress. This can be especially important during the Installation and Commissioning stages of the District Distribution Network.

5.12 Ensure that the performance of the Heat Network can be monitored

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Sufficient functionality of equipment such as thermal energy meters and Monitoring Points is needed for a number of activities during the Installation and Commissioning stages, making the proper installation of such equipment important.

This Objective references the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025) which provides detail on requirements surrounding Metering and Monitoring Systems.

- 5.12.1. Thermal energy meters shall be installed with good workmanship and in accordance with Section 1.2 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).
- 5.12.2. Monitoring Points shall be installed with good workmanship and in accordance with the system's Metering and Monitoring Strategy (refer to Requirement [4.12.4](#)).

5.13 Ensure that the Heat Network is sufficiently insulated

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The quality of the installation of insulation can have a significant impact on its performance, and the cost of remedial insulation installation works during the operation of the Heat Network can be significant if insulation is poorly installed.

To ensure that the network is sufficiently insulated at the Installation stage, the insulation needs to be installed with good workmanship by competent contractors and individuals, and the installation needs to be inspected as a means of quality assurance.

- 5.13.1. The installation of insulation shall be performed with good workmanship.
- 5.13.2. A specialist thermal insulation contractor shall be appointed to install all thermal insulation to pipework and associated equipment. Organisational capability shall be demonstrated either through membership of the *Thermal Insulation Contractors Association* (TICA, n.d.) or by evidencing compliance with an equivalent third party accreditation scheme, demonstrating the on-site technical competence of the organisation.
- 5.13.3. The competence of each individual to carry out the thermal insulation function shall be evidenced and verified. All thermal insulation operatives shall hold a TICA Thermal Insulator Skill Card or an equivalent qualification through an approved third party accreditation scheme.
The ratio of Level 2 : Level 3 (Gold Carded / Supervisory) thermal insulators (or equivalent qualification levels if a different accreditation scheme is used) shall be a maximum of 5 : 1.
- 5.13.4. Pipe insulation shall be installed following the manufacturer's installation guidance. The insulation shall be continuous & close-fitting to heated surfaces at all points to ensure air gaps are not created. Insulation shall be installed with a vapour seal. The continuity of any factory-applied protective covering to the insulation shall be maintained along all longitudinal and circumferential joints in the insulation.
- 5.13.5. Quality assurance inspections specific to the insulation installed on all above-ground pipework shall be undertaken and documented prior to cladding or covering up by building finishes. The inspection shall be used to confirm:
 - compliance with the specification for the thickness and type of insulation; and
 - continuity of insulation at joints, supports, flanges, valves and all other fittings.The inspection records for the insulation installation shall include:
 - clear photographs (with no blur) of the installed insulation on all above-ground pipework;
 - a snagging log with remedial actions undertaken to fix these;
 - justification for non-compliances with requirements (where present).

A thermographic survey can assist in identifying areas with poor insulation continuity.

5.14 Minimise the risk posed by construction activities and the operation of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

There are a number of considerations to make at the Installation stage regarding the risk posed by construction activities and the operation of the Heat Network. These include the training of operatives, standards and workmanship of the installation, and testing activities.

There can also be requirements and obligations regarding the risk posed by construction activities which are outside the scope of this standard.

Installer qualifications

- 5.14.1. All fitters employed to install the pipe system shall have received appropriate training and hold current certificates demonstrating competence for the type of pipe system being installed. For buried steel pipe systems, this shall be in accordance with BS EN 489-1: *District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Joint Casing Assemblies and Thermal Insulation for Hot Water in Accordance with EN 13941-1* (BSI, 2019); for polymer pipe systems, this shall be specific to the pipe system and joint system being installed.
- 5.14.2. All steel welders shall be qualified to weld the size and thickness of pipe specified under the given site conditions, and shall provide up-to-date certificates as evidence prior to commencing any work on-site.

Installation of the system

- 5.14.3. Each steel weld or polymer pipe joint and each joint closure shall be numbered to uniquely identify an individual responsible welder or joiner; this shall be recorded in a register.
- 5.14.4. The installation of all Heat Network equipment shall be performed with good workmanship.
- 5.14.5. The installation of the Heat Network shall be in accordance with applicable relevant standards (refer to [Annex N: Relevant standards](#)).
- 5.14.6. The installation of all Heat Network equipment shall be in accordance with relevant manufacturer requirements.

Buried pipework

- 5.14.7. The construction and dewatering of trenches shall be done in a way which prevents damage to the system.
- 5.14.8. Welding equipment for high-density polyethylene (HDPE) casings or polymer pipe shall be checked regularly and calibration certificates made readily available.

- 5.14.9. The backfilling material for the District Distribution Network shall have a grading curve suitable to the requirements of the pipework and be suitably compacted in accordance with BS EN 13941-2: *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021) and any manufacturers requirements.

Labelling

- 5.14.10. Pipework in the Energy Centre, Substation(s), Communal Distribution Network and above-ground sections of the District Distribution Network shall be labelled upon completion of the installation of insulation and cladding in accordance with BS 1710:2014: *Specification for Identification of Pipelines and Services* (BSI, 2014). This shall include labelling of the LTHW flow and return on the Communal Distribution Network, and in the vicinity of connections to the Energy Centre / Substations / Consumer Connections within riser cupboards and in access panels.

It can be beneficial (e.g. through labelling) where there is pipework and/or equipment within consumer premises at an elevated pressure. Exit pressures from other building services such as boosted cold water service (BCWS) systems typically do not exceed 3 bar(g) - refer to CIBSE Guide G: *Public Health and Plumbing Engineering* (CIBSE, 2014) for further information.

- 5.14.11. Buried pipework shall be labelled upon completion of the installation of insulation and cladding in accordance with BS 1710:2014: *Specification for Identification of Pipelines and Services* (BSI, 2014).

The labelling of buried pipework shall include labelling of the flow and return in all valve chambers and in the vicinity of Substations and Consumer Connections connected to the District Distribution Network.

- 5.14.12. Isolation valves (IVs) within dwellings for emergency use by residential consumers shall be clearly labelled as “emergency shut-off”.

Pressure testing

- 5.14.13. Pressure testing of pipework shall be carried out on the system in accordance with the pressure testing methodology (refer to Requirement 4.14.1) and prior to flushing, applying thermal insulation, or covering up any part of the pipework system.

Local considerations

- 5.14.14. Consideration shall be given to minimising the impact of the construction of the Heat Network on the local landscape and trees.
- 5.14.15. Consideration shall be given to the discharge of wastewater, including any licencing and permitting requirements from the water authority and regulations which can be applicable to the network.

Requirements which can be applicable to the system include the *Environmental Permitting (England and Wales) Regulations 2016* (UK Government, 2016) and the *Water Environment (Controlled Activities) (Scotland) Regulations 2011* (Scottish Government, 2011).

5.15 Ensure sufficient maintenance of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important that the installation of the system is done so with sufficient consideration and provision of the maintenance requirements during the operation of the system.

- 5.15.1. Ancillary equipment shall be installed to ensure that Capital Equipment can be sufficiently depressurised, drained, maintained, and that air can be removed from all network high points.

5.16 Manage and maintain the condition of components in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The quality of the installation of a Heat Network can significantly impact the condition of components.

At the Installation stage, the system needs to be installed in accordance with relevant standards and guidance to minimise the risk of poor condition in later stages, and activities such as non-destructive testing need to be undertaken as necessary.

- 5.16.1. Throughout the Installation stage, reasonably practicable actions shall be undertaken to preserve the condition of equipment which has been installed but not yet commissioned. These actions shall be sufficient to avoid material damage or deterioration to the equipment, and to ensure that the validity of manufacturer warranties is not compromised.

District Distribution Networks

- 5.16.2. Where a pre-insulated steel pipe system is selected for the District Distribution Network, it shall be installed in accordance with:
- BS EN 13941: *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021); and
 - manufacturer's instructions and guidance.
- 5.16.3. Where a pre-insulated polymer pipe system is selected for the District Distribution Network, it shall be installed in accordance with manufacturer's instructions and guidance.
- 5.16.4. Non-destructive testing (NDT) of steel welds on buried pipework shall be carried out in accordance with BS EN 13941: *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021) for the relevant project class; additionally, the first ten welds by each individual welder shall be subject to NDT, and all welds on pipework which will be relatively inaccessible or would cause major disruption during a maintenance event (e.g. at a major road or rail crossing) shall be subject to NDT.
- The most appropriate testing method (e.g. visual examination, radiographic, ultrasonic, dye penetrant, or magnetic particle examination) shall be reviewed and agreed prior to the installation works commencing; the requirements of each method (e.g. the use of permits, or the requirement to inform relevant bodies) shall be considered.

Due to the cost associated with performing remedial action on welds which have failed on buried pipework, it can be beneficial to perform additional NDT of steel welds (for example, on 100 % of welds) on the pipework system.

Above-ground pipework

5.16.5. Welds on above-ground steel pipework shall be carried out in accordance with relevant standards, such as:

- BS 2971:1991: *Specification for Class II Arc Welding of Carbon Steel Pipework for Carrying Fluids* (BSI, 1991); or
- BS 2633:1987: *Specification for Class I Arc Welding of Ferritic Steel Pipework for Carrying Fluids* (BSI, 1987),

depending on the class of welding required on the pipework.

5.16.6. Non-destructive testing (NDT) shall be carried out on welds on above-ground steel pipework determined as Class I (see Requirement 2.16.17/3.16.17 and Requirement 4.16.5) in accordance with BS 2633:1987: *Specification for Class I Arc Welding of Ferritic Steel Pipework for Carrying Fluids* (BSI, 1987).

The most appropriate testing method (e.g. visual examination, radiographic, ultrasonic, dye penetrant, or magnetic particle examination) shall be reviewed and agreed prior to the installation works commencing; the requirements of each method (e.g. the use of permits, or the requirement to inform relevant bodies) shall be considered.

It can be beneficial to perform additional NDT on welds to increase certainty in the integrity of welds (e.g. in critical sections of the Distribution Network, or areas where a weld failure and large-scale leakage and result in widespread disruption to critical facilities).

5.16.7. Fittings connecting the Consumer Connection to the Communal Distribution Network pipework shall be installed to operate under current and future network working pressures and temperatures. Quality assurance inspections of the installation of the fittings shall be undertaken.

Storage of materials

5.16.8. Pre-insulated materials shall be stored in accordance with the manufacturer's instructions; site foaming materials shall be kept in insulated containers.

5.17 Ensure that project documentation is produced and managed

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The production of documentation that evidences quality assurance inspections of relevant activities is key in ensuring that quality is maintained throughout the Installation stage.

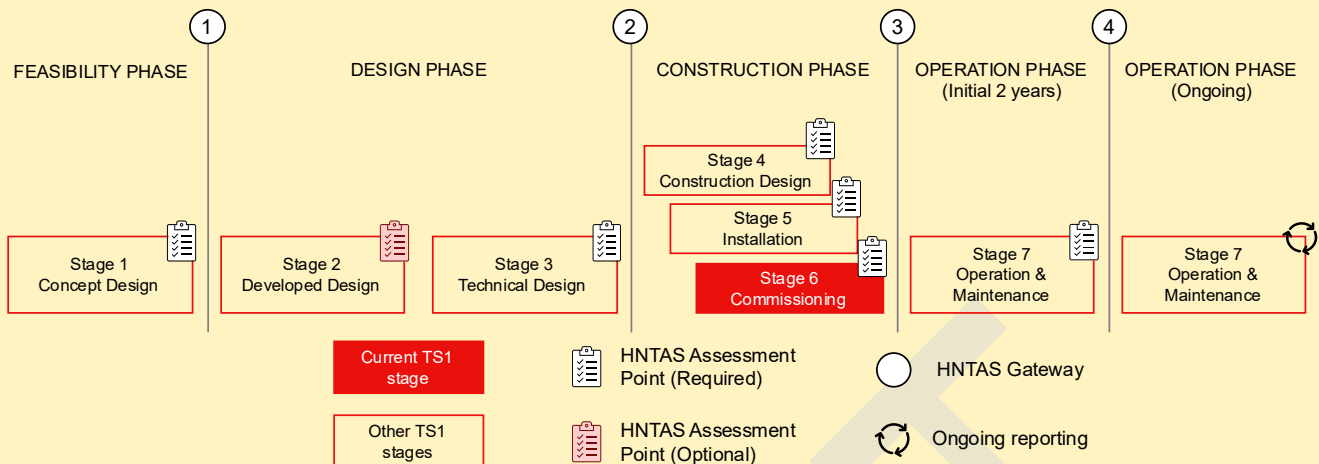
- 5.17.1. The contractor shall provide evidence that quality assurance inspections have been undertaken at each stage of the installation process, including (but not limited to):
- trench inspections prior to the installation of pipework;
 - steel welding non-destructive testing (NDT) (where applicable);
 - fusion welding (where applicable);
 - closure welding or shrinking;
 - closure air tests prior to foaming (where it is feasible to undertake a closure air test on the pipework system);
 - continuity checks on the surveillance system (where applicable);
 - trench inspections prior to backfilling;
 - compaction around pipework and marker tape;
 - system pressure tests;
 - system flushing;
 - final surfacing and reinstatement.

For pre-insulated buried steel pipe systems, refer to Annex D of BS EN 13941-2: *District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks* (BSI, 2021) for further details of quality control documentation.

- 5.17.2. Written records of sample checks undertaken during the quality assurance inspections shall be produced, and photographs shall be clearly presented with no blur.

6 Stage 6: Commissioning

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Commissioning stage overview

The Commissioning stage will likely overlap with the Construction Design stage and the Installation stage as different parts of the Heat Network are constructed at different times. This means that some activities undertaken during the Commissioning stage may commence and/or finish before certain other activities in either the Construction Design stage or the Installation stage.

Prior to undertaking an activity during the Commissioning stage, it is expected that the relevant section of the Heat Network has been:

- installed with good workmanship;
- filled, pressure tested, and flushed (with water treatment/conditioning as appropriate);
- subjected to the relevant quality assurance activities such as non-destructive testing (NDT).

At the end of the Commissioning stage, it is expected that:

- all plant, equipment, and pipework across all Elements on the Heat Network has been commissioned in accordance with written procedures;
- Acceptance Testing has been undertaken across all Elements on the Heat Network;
- the water quality KPIs for the system water are within their control limits;
- the Automatic and Remote Monitoring System (ARMS) is operating correctly;
- the heat loss from the Heat Network is within thresholds;
- the condition of the Heat Network is acceptable and has been assessed through a Condition Audit (and Condition Survey if necessary);
- project documentation such as the document register and the operation and maintenance (O&M) manual capture relevant data from commissioning activities.

The end of the Commissioning stage broadly corresponds to the handover of the Heat Network.

6.2 Ensure that Consumer Systems meet consumer heat demands in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The commissioning of Consumer Connections and Consumer Heat Systems is a key activity in ensuring good operation in the Heat Network, due to the impact that the performance of Consumer Systems can have on the overall Heat Network.

At the Commissioning stage, it is important to ensure that Consumer Systems can operate in accordance with the design intent (e.g. meeting consumer demands whilst achieving design return temperatures and flow rates). This is aided by Acceptance Testing on Consumer Systems, which demonstrates that the performance of the Consumer System is in accordance with the design intent, Description of Operation, and the Key Performance Indicators (KPIs) which the Consumer System needs to meet.

- 6.2.1. The commissioning procedures for the Consumer Connection(s) and Consumer Heat System(s) shall be developed to ensure that the system is commissioned to operate in accordance with:
 - the design intent;
 - the Description of Operation (DesOps);
 - the Metering and Monitoring Strategy; and
 - the KPI limits on the system, including at low and zero heat demands.
- 6.2.2. Prior to commissioning of the Consumer Connection, activities shall be completed on the Distribution Network that will provide heat to the Consumer Connection. Pre-commissioning activities shall include:
 - filling, pressure testing, and pre-commissioning cleaning (including flushing); and
 - demonstration that the Distribution Network provides the required flow temperature and differential pressure to the Consumer Connection at a stable level.
- 6.2.3. Commissioning shall be carried out on each of the Consumer Connections and Consumer Heat Systems. The commissioning shall be in accordance with the manufacturer's recommendations and with performance specification / acceptance criteria developed by the network designers. The results of the commissioning shall be documented.

The commissioning shall follow the recommendations in CIBSE Commissioning Code M: *Commissioning Management* (CIBSE, 2022). The commissioning shall also follow other CIBSE Commissioning Codes where appropriate, including CIBSE Commissioning Code W: *Water Distribution Systems* (CIBSE, 2025).

Refer to the following items for requirements regarding commissioning documentation of Consumer Connections and Consumer Heat Systems.

- Requirement 6.17.1.
- Requirement 6.17.2.
- Requirement 6.17.3.
- Requirement 6.17.5.
- Requirement 6.17.6.

6.2.4. The commissioning of the Consumer Connection(s) and Consumer Heat System(s) shall be in accordance with applicable relevant standards (refer to [Annex N: Relevant standards](#)).

6.2.5. Pressure-independent thermostatic radiator valves shall be commissioned to achieve the design flow rate and return temperature for each radiator.

Refer to Requirement 2.2.2/3.2.2 for the specification of pressure-independent thermostatic radiator valves.

6.2.6. At points in the Communal Distribution Network where flow rate is to be controlled, the maximum flow rate received by the section of Communal Distribution Network shall be adjusted to the design value at peak conditions. This can be achieved by using an adjustable differential pressure control valve (DPCV) or a pressure-independent control valve (PICV) (see BSRIA AG 16/2002: *Variable-Flow Water Systems - Design, Installation and Commissioning Guidance* (BSRIA, 2002)).

6.2.7. At points in the Consumer Connection where flow rate is to be controlled, the maximum flow rate received by the Consumer Connection shall be adjusted to the design value at peak conditions. This can be achieved by using an adjustable differential pressure control valve (DPCV) or a pressure-independent control valve (PICV) (see BSRIA AG 16/2002: *Variable-Flow Water Systems - Design, Installation and Commissioning Guidance* (BSRIA, 2002)).

6.2.8. The removal of temporary bypasses in accordance with Requirement 5.11.8 shall be demonstrated prior to the commissioning of the Consumer Connection.

6.2.9. The return temperatures from space heating circuits during the steady-state operation of the circuit shall be measured and recorded as part of the commissioning of the system.

The ambient temperature can affect the return temperature which is achieved from space heating circuits.

6.2.10. The return temperatures from domestic hot water circuits during the operation of the domestic hot water circuits shall be measured and recorded as part of the commissioning of the system.

The cold water service temperature can affect the return temperature which is achieved from Consumer Connections during domestic hot water operation.

- 6.2.11. The commissioning of the Consumer Connection(s) and Consumer Heat System(s) shall ensure that design return temperatures are achieved for all consumers served by the Distribution Network; tests and further rectification work shall be undertaken as necessary to ensure that this is achieved.
- An overall summary of the commissioning results for the Consumer Connection(s) and Consumer Heat System(s) shall be produced, including any rectification measures taken.
- 6.2.12. The commissioning team shall be trained on the particular Consumer Connection(s) used to ensure a full understanding of the system prior to commissioning. This training should be led by the person leading the team, with input from the network designer and manufacturers as necessary.
- 6.2.13. Operatives involved in commissioning shall receive training in the importance of achieving design return temperatures from the Consumer Connection(s) and the Consumer Heat System(s), and the impact of high return temperatures on the entire Heat Network.

Acceptance Testing

- 6.2.14. Prior to Acceptance Testing of the Consumer Connection(s) and Consumer Heat System(s), an Acceptance Testing methodology and criteria shall be produced, in accordance with the [Heat Network Technical Assurance Scheme (HNTAS) Acceptance Testing Standard] (HNTAS, Forthcoming).
- 6.2.15. The cold water service temperature shall be measured immediately prior to Acceptance Testing of the Consumer Connection(s) and Consumer Heat Systems(s). The measured cold water service temperature shall be considered when determining the Acceptance Testing requirements for the return temperature from the Consumer Connection during domestic hot water events.
- 6.2.16. The ambient temperature shall be measured immediately prior to Acceptance Testing of the Consumer Connection(s) and Consumer Heat System(s).
- The Acceptance Testing requirements from the Consumer Connection during space heating events (including the return temperature) shall be determined with consideration for:
- the measured ambient temperature;
 - the design setpoints of the Distribution Network and the Consumer Heat System;
 - the control systems used in the Consumer Connection.
- 6.2.17. Pre-testing shall be carried out on a small number of Consumer Connections and Consumer Heat Systems to identify and resolve common issues ahead of Acceptance Testing of all of the Consumer Connections and Consumer Heat Systems in accordance with Requirement 6.2.18.
- 6.2.18. On-site Acceptance Testing shall be undertaken on each of the Consumer Connections and Consumer Heat Systems in accordance with the [Heat Network Technical Assurance Scheme (HNTAS) Acceptance Testing Standard] (HNTAS, Forthcoming).

6.8 Ensure that Energy Centres and Substations operate in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The commissioning of Energy Centres and Substations is key to ensuring that the Heat Network operates in a controlled manner. It is important to develop suitable commissioning procedures and conduct checks as necessary prior to the commissioning of Energy Centres and Substations, and for the operation of the Heat Network to be verified against the design intent and other relevant design documentation such as the Description of Operation (DesOps).

This is aided by Acceptance Testing on Energy Centres and Substations, which demonstrates that the performance of Energy Centres and Substations is in accordance with the design intent, Description of Operation, and the Key Performance Indicators (KPIs) which need to be met.

- 6.8.1. The commissioning procedures for the Energy Centre and Substation(s) shall be developed to ensure that the system is commissioned to operate in accordance with:
 - the design intent;
 - the Description of Operation (DesOps);
 - the Metering and Monitoring Strategy; and
 - the KPI limits on the system, including at low and zero heat demands.
- 6.8.2. The commissioning of the Energy Centre, Substation and distribution pipework shall follow the recommendations in CIBSE Commissioning Code M: *Commissioning Management* (CIBSE, 2022). The commissioning shall also follow other CIBSE Commissioning Codes where appropriate, including:
 - CIBSE Commissioning Code A: *Air Distribution Systems* (CIBSE, 2024)
 - CIBSE Commissioning Code B: *Boilers* (CIBSE, 2002);
 - CIBSE Commissioning Code C: *Automatic Controls* (CIBSE, 2001);
 - CIBSE Commissioning Code R: *Refrigerating Systems* (CIBSE, 2002);
 - CIBSE Commissioning Code W: *Water Distribution Systems* (CIBSE, 2025).
- 6.8.3. The control systems in Energy Centres and Substations shall be checked prior to commissioning; this shall include a point-to-point check to ensure correct operation and addressing of all sensors.
- 6.8.4. Each item of plant and equipment (where applicable) shall be commissioned. The commissioning procedure shall ensure that the operation of the equipment is in accordance with its design and provides the required levels of service at the expected level of efficiency.

There can be benefits to subjecting major items of plant and equipment (where applicable) to factory Acceptance Testing (FAT) at the manufacturer's works. Where FAT is undertaken, the procedure can be used to aid in ensuring that the operation of the equipment is in accordance with its design and provides the required levels of service at the expected level of efficiency.

- 6.8.5. Commissioning shall be carried out on the Energy Centre and Substation(s). The commissioning shall be in accordance with the manufacturer's recommendations and with performance specification / acceptance criteria developed by the network designers. The results of the commissioning shall be documented.

Refer to the following items for requirements regarding commissioning documentation of Energy Centres and Substations.

- Requirement 6.17.1.
- Requirement 6.17.2.
- Requirement 6.17.4.
- Requirement 6.17.5.

- 6.8.6. The commissioning of the Energy Centre and Substation(s) shall be in accordance with applicable relevant standards (refer to [Annex N: Relevant standards](#)).
- 6.8.7. The stable and efficient operation of all plant in the Heat Network shall be demonstrated at all expected demand conditions; this shall include demonstration of stable and efficient operation at the minimum demand expected from the network.
- 6.8.8. In Energy Centres with multiple sources of heat, there shall be a specific demonstration to show that the low-carbon heat source is operated as the lead unit and that low carbon heat is still produced while heat is produced by the secondary heat source.
- 6.8.9. A specific demonstration of the correct operation and control of bypass flows shall be undertaken at a time of minimum demand from the network.
- 6.8.10. The operation of the variable speed pump systems in the Energy Centre and Substation(s) shall be checked to verify that:

- the required differential pressure (Δp) is achieved at every point in the network;
- excessive pressure differences are not present, including during periods of low flow;
- their operation meets the design intent and the Description of Operation (DesOps).

The control of pumps in multi-pump arrangements should also aim to minimise the overall energy consumption across the expected range of flow rates.

Where differential pressure sensors are used in the Distribution Network, their location should be considered as part of this assessment.

The correct operation of distribution pumps can be particularly important for the introduction of newly-installed phases to a Heat Network.

- 6.8.11. The control, temporary commissioning and differential pressure (Δp) sensor location(s) used for the distribution pumps shall be assessed as new phases of a Heat Network are commissioned; where necessary, these shall be adjusted to ensure the network's operation is as intended by the network's design.

- 6.8.12. The contractor should consider undertaking full dynamic testing on the building management system (BMS) software off-site prior to implementation on-site; this is to identify any discrepancy between the actual operation of the control system and the intent of the Description of Operation (DesOps).
- 6.8.13. Measurements shall be taken during commissioning from the thermal energy meter at the boundary of the Energy Centre and/or Substation including the:
- flow rate (m^3/h or l/s);
 - flow temperature ($^{\circ}\text{C}$);
 - return temperature ($^{\circ}\text{C}$).
- The volume-weighted average temperature difference shall be determined and measured from the readings for energy consumption and volume.
- 6.8.14. Each thermal energy meter in the Energy Centre, Substation and distribution pipework (excluding Consumer Connections) shall be monitored for a short period of time while meeting a load downstream of the Monitoring Point; this shall be used to establish that flow rates and temperatures are being correctly recorded and that the data received by the Automatic and Remote Monitoring System (ARMS) is credible.

Acceptance Testing

- 6.8.15. Prior to Acceptance Testing of the Energy Centre, Substation(s) and Distribution Network(s), an Acceptance Testing methodology and criteria shall be produced, in accordance with the [Heat Network Technical Assurance Scheme (HNTAS) Acceptance Testing Standard] (HNTAS, Forthcoming).
- 6.8.16. On-site acceptance tests shall be undertaken on the Energy Centre, Substation(s) and Distribution Network(s) in accordance with the [Heat Network Technical Assurance Scheme (HNTAS) Acceptance Testing Standard] (HNTAS, Forthcoming).

6.11 Ensure sufficient water quality in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

At the Commissioning stage, the water quality of the system needs to be recorded and remedial actions undertaken as necessary to ensure that the water quality in the Heat Network is acceptable prior to the operation of the network.

Recording of water quality parameters

- 6.11.1. Water quality parameters shall be recorded in accordance with [Table H.9](#), with at least two sets of results taken at least two weeks apart in accordance with BSRIA BG 29/2021: *Pre-Commission Cleaning of Pipework Systems* (BSRIA, 2021). For the final two sets of samples, there shall not be any system interference (such as dosing, for Chemically Treated Systems):
 - in the two weeks preceding the first set of results; and
 - in the period between recording measurements.
- 6.11.2. The water quality KPIs at the point of commissioning, as detailed in the Water Quality Recording Programme (refer to Requirement [2.11.6/3.11.6](#)), shall be maintained within their control limits in accordance with [Table H.7](#) (for Chemically Treated Systems) or [Table H.8](#) (for Depleted Water Systems) and be recorded at a frequency in accordance with the minimum frequencies detailed in [Table H.9](#).
- 6.11.3. All water sampling activities during the Commissioning stage shall be carried out in accordance with BS 8552:2012: *Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice* (BSI, 2012).
- 6.11.4. The number of sampling locations for water quality samples conducted during the Commissioning stage shall be in accordance with [Table H.3](#). For further information, refer to BS 8552:2012: *Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice* (BSI, 2012).

6.12 Ensure that the performance of the Heat Network can be monitored

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important to confirm correct installation and operation of equipment and systems used for monitoring of the Heat Network at the Commissioning stage. There are also a number of commissioning activities which need to be undertaken to ensure the correct operation of the Heat Network which involve the use of monitoring, as well as specific activities for surveillance systems on pipework in Distribution Networks.

Checks on equipment used for monitoring

- 6.12.1. Commissioning checks shall be undertaken on all Monitoring Points to ensure correct installation and operation of each Monitoring Point (e.g. thermal energy meter, temperature sensor, and pressure sensor), and that readings from each Monitoring Point are reasonable and as expected.
- 6.12.2. The end-to-end operation of the Automatic and Remote Monitoring System (ARMS) shall be confirmed; readings from all Monitoring Points should be visible on any central ARMS.
- 6.12.3. Each Monitoring Point connected to the Automatic and Remote Monitoring System (ARMS) (including the building management system (BMS) or supervisory control and data acquisition (SCADA) system, where present) shall be checked to prove that:
 - the sensor point is correctly addressed;
 - all sensors listed within the points schedule are present; and
 - the sensor is providing a consistent and correct signal.

Use of monitoring in commissioning activities

- 6.12.4. Data from the Automatic and Remote Monitoring System (ARMS) shall be used to verify the performance of Consumer Heat Systems after commissioning where possible.
- 6.12.5. The commissioning methodology, where applicable, shall include:
 - an energy balance to ensure the correct operation of meters throughout the Heat Network (refer to Requirement 6.12.6);
 - where thermal energy meters require calibration to match the heat transfer fluid (for example, where glycol is used).
- 6.12.6. A heat reconciliation calculation shall be undertaken using readings from thermal energy meters in the Energy Centre, Substations (if present) and Consumer Connections; this calculation shall be used to determine the heat loss from the Distribution Network(s).
- 6.12.7. For Communal Distribution Networks, the heat reconciliation calculation shall be used to verify that the heat loss from the Communal Distribution Network is within the limit set out in Requirement 6.13.1.

- 6.12.8. For District Distribution Networks, the heat reconciliation calculation shall be used to review the heat loss against the value calculated at the Construction Design stage.

Surveillance systems

- 6.12.9. Where a surveillance system is installed (e.g. on buried steel pipework systems), a commissioning and testing methodology shall be developed in accordance with BS EN 14419:2019: *District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems* (BSI, 2019).

This methodology shall outline the strategy for commissioning and testing the surveillance system on a joint-by-joint basis, a sectional basis (if sectional completion will occur), and a whole-network basis.

The accuracy in location detection shall be applicable to the measuring equipment specified and the manufacturer's instructions. This shall be detailed in this methodology.

- 6.12.10. The surveillance system shall be commissioned in accordance with the written commissioning methodology in accordance with Requirement 6.12.9.

The surveillance system shall be mapped with time-domain reflectometer (TDR) instruments both following installation and prior to filling the network to create baseline datum for future reference.

The wire lengths shall be checked against as-installed drawing lengths. Key parts of the surveillance system, for example, valves and surveillance test points shall be marked on datum.

- 6.12.11. Upon commissioning of a section of the surveillance system, an active detector shall be commissioned in accordance with BS EN 14419:2019: *District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems* (BSI, 2019).

This shall include provision for fault alerts to be generated and analysed if a fault was to occur.

- 6.12.12. The surveillance system in District Distribution Network pipework shall be "mapped" between installation and charging of the network; the system shall be tested and calibrated to achieve an accuracy in location detection of ± 1 m. The wiring diagram for the surveillance system in the installation drawings shall be updated and certified as correct following the commissioning of the system and included in the O&M manual for the system.

6.13 Ensure the Heat Network is sufficiently insulated

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

At the end of the Commissioning stage, the heat loss from a Communal Distribution Network needs to be within acceptable limits before the Heat Network enters the Operation & Maintenance stage.

- 6.13.1. The total heat loss from the Communal Distribution Network at the point of commissioning shall not exceed the Commissioning stage limit provided in [Table J.2](#). The total heat loss shall be determined through a heat reconciliation calculation, in accordance with Requirement [6.12.7](#).

For Communal Distribution Networks which serve a mixture of domestic and non-domestic Consumer Connections, the total heat loss limit for the network is determined by taking the sum of:

- the allowable heat loss from all of the domestic Consumer Connections which the Communal Distribution Network serves; and
- the allowable heat loss from all of the non-domestic Consumer Connections which the Communal Distribution Network serves.

This may be expressed as below:

$$\text{Total heat loss limit / boundary (W)} = \text{total domestic heat loss limit} + \text{total non-domestic heat loss limit}$$

$$\text{Total heat loss limit / boundary (W)} = (\text{no. connected dwellings}) \cdot (\text{W/dwelling}) + (\sum (\text{kW}_{\text{connection}})) \cdot (\text{W/kW}_{\text{connection}})$$

6.16 Manage and maintain the condition of components in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important to ensure that the condition of the components on the Heat Network is acceptable prior to the Operation & Maintenance stage, to mitigate the risk of component deterioration and failure of components once the system becomes operational.

At the Commissioning stage, an assessment of the condition of the components in the Heat Network needs to be undertaken through a Condition Audit (and Condition Survey if necessary), and the condition of components needs to be at acceptable levels prior to practical completion.

Condition Audits

- 6.16.1. No earlier than 3 months prior to practical completion, a Condition Audit shall be undertaken of:
- all accessible pipework and equipment within the Energy Centre and Substation; and
 - all accessible pipework and equipment in the District Distribution Network and Communal Distribution Network.

The Condition Audit shall include the applicable Condition Auditor activities set out in [Table L.3](#).

Condition Surveys

- 6.16.2. A Condition Survey shall be undertaken on any pipework and/or equipment which has been filled at least 24 months prior to the expected date of practical completion.

The Condition Survey shall include the applicable audit and specialist survey activities set out in [Table L.3](#).

The survey shall be undertaken by a Condition Surveyor who has the minimum competency to assess and report on the condition of equipment present on the Heat Network as detailed in [Table L.4](#) and [Table L.5](#).

If it is still not possible to determine the condition grade (in accordance with [Table L.1](#)) and/or priority grade (in accordance with [Table L.2](#)) of equipment through NDT methods (e.g. where equipment has been exposed to higher pressures/temperatures than it is rated for, or there are major concerns of potential failures due to poor water quality), a specialist shall be engaged to carry out destructive testing.

All pipework and equipment shall be assessed in sufficient detail to enable a condition grade to be assigned in line with the definitions outlined in [Table L.1](#).

BSRIA BG 35/2012: *Condition Surveys and Asset Data Capture* (BSRIA, 2012) provides further detail on the range of simple and specialist activities available to enable the condition of above-ground pipework and equipment to be accurately determined.

For complex systems involving buried pipework, some of the content in the following documents can be useful.

- API RP 579-1 / ASME FFS-1: *Fitness for Service* (API & ASME, 2021).
- ASME B 31G: *Manual for Determining the Remaining Strength of Corroded Pipelines* (ASME, 2023).
- DNVGL-RP-F101: *Corroded Pipelines* (DNVGL, 2019).

6.16.3. Prior to the outset of the Condition Survey, the contractor shall provide the basic asset data, in accordance with [Table L.6](#), to the Condition Surveyor.

Remedial actions

6.16.4. Where equipment does not achieve a condition grade of 'A' or 'B' in a Condition Audit or a Condition Survey, the construction team shall:

- produce a remedial action plan detailing the actions required to restore the condition grade of the equipment to 'A' or 'B'; and
- carry out those actions prior to practical completion.

There are the following exceptions to this requirement.

- If pipework or equipment achieves a condition grade of 'E' because there are opportunities to improve its efficiency, energy, or environmental performance, but it is still expected that the Key Performance Indicators (KPIs) of the system will be achieved without replacing the pipework or equipment, it is not required to restore the condition grade of the pipework or equipment to a condition grade of 'A' or 'B'.
- If pipework or equipment achieves a condition grade of 'E' because of changes in legislation, the timelines of the remedial action may extend beyond practical completion if this is permitted under the legislation of interest.

6.16.5. Where an abnormal number of failures of the same type are observed during the Commissioning stage of a given system, an investigation shall be carried out to determine the root cause of the failures. Remedial actions shall be undertaken to rectify the root cause of the identified failure; this should include engagement with the manufacturer where appropriate due to the type of the failure.

Non-destructive and/or destructive testing, where used, should be done with consideration to manufacturer requirements and warranties. Where necessary, the manufacturer should be engaged to carry out this testing.

Recording the condition of the network

- 6.16.6. The outputs of all Condition Audits and Condition Surveys shall be detailed in a condition log. This shall include all condition data in accordance with [Table L.6](#), including the current condition grade (in accordance with [Table L.1](#)) and priority grade (in accordance with [Table L.2](#)) of all assets.

BSRIA BG 35/2012: *Condition Surveys and Asset Data Capture* (BSRIA, 2012) outlines supplementary information that the surveyor(s) may collate in order to justify their findings.

- 6.16.7. The condition log (refer to Requirement [6.16.6](#)) and evidence of the completion of any remedial action works required shall be included within the operation and maintenance (O&M) manual. The condition log may be documented in the same document as a snag list.

6.17 Ensure that project documentation is produced and managed

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Many of the activities undertaken at the Commissioning stage require specific documentation to be produced before and after the activity has taken place, including:

- the commissioning plan;
- the commissioning programme;
- commissioning sheets;
- documentation from the Acceptance Testing of the Heat Network.

The status of the Heat Network needs to also be reflected in documentation such as the Heat Network's operation and maintenance (O&M) manual.

Commissioning documentation

- 6.17.1. Written commissioning procedures shall be produced for each Element within the Heat Network which builds on the commissioning plan and programme developed during the Technical Design stage (refer to Requirement 3.17.5). The plan shall include coordination of commissioning of different Elements of the Heat Network as these may be the responsibility of different parties.

The commissioning methodologies shall be produced in accordance with:

- the design of the system at the end of the Technical Design stage;
- the Description of Operation (DesOps);
- CIBSE Commissioning Code M: *Commissioning Management* (CIBSE, 2022); and
- any manufacturer requirements.

The procedure shall involve testing and demonstration of correct operation at various times during the network's first year of operation, when there are suitable demands on the system. The load may be artificially induced by changing set-points or using load banks where necessary.

- 6.17.2. The commissioning plan shall outline any specific prerequisites of commissioning. In all cases, the commissioning of the Metering and Monitoring System shall not be undertaken until the Heat Network is providing heat.
- 6.17.3. The commissioning plan of Consumer Connections and Consumer Heat Systems shall include Acceptance Testing as outlined in the [Heat Network Technical Assurance Scheme (HNTAS) Acceptance Testing Standard] (HNTAS, Forthcoming).
- 6.17.4. The commissioning plan of the Energy Centre, Substation(s) and Distribution Network shall include Acceptance Testing as outlined in the [Heat Network Technical Assurance Scheme (HNTAS) Acceptance Testing Standard] (HNTAS, Forthcoming).

- 6.17.5. The commissioning plan and programme produced by the contractor shall be reviewed by the designer and commissioning team, and a final plan/programme shall be agreed by the designer, contractor and commissioning team lead. The plan shall cover:
- all commissioning activities for each Element present in the Heat Network;
 - expected timeframes;
 - any required coordination with other Heat Network Elements;
 - the system controls; and
 - the Metering and Monitoring System, including the Automatic and Remote Monitoring System (ARMS).
- 6.17.6. A commissioning sheet shall be produced to record the commissioning process of each Consumer Connection and Consumer Heat System, which shall contain:
- relevant design values and setpoints (e.g. the design space heating flow temperature);
 - as-commissioned values of the performance of the system (e.g. the measured space heating flow temperature of the commissioned system);
 - setpoints of any equipment and/or components which are commissioned or tested during the commissioning process (e.g. the space heating control valve setpoint).
- The commissioning sheet from each commissioned Consumer Connection and Consumer Heat System shall be included in the operation and maintenance (O&M) manual for the Heat Network.
- 6.17.7. Measured data and setpoints (e.g. on valves) shall be recorded on the commissioning sheet and in the operation and maintenance (O&M) manual.

Handover

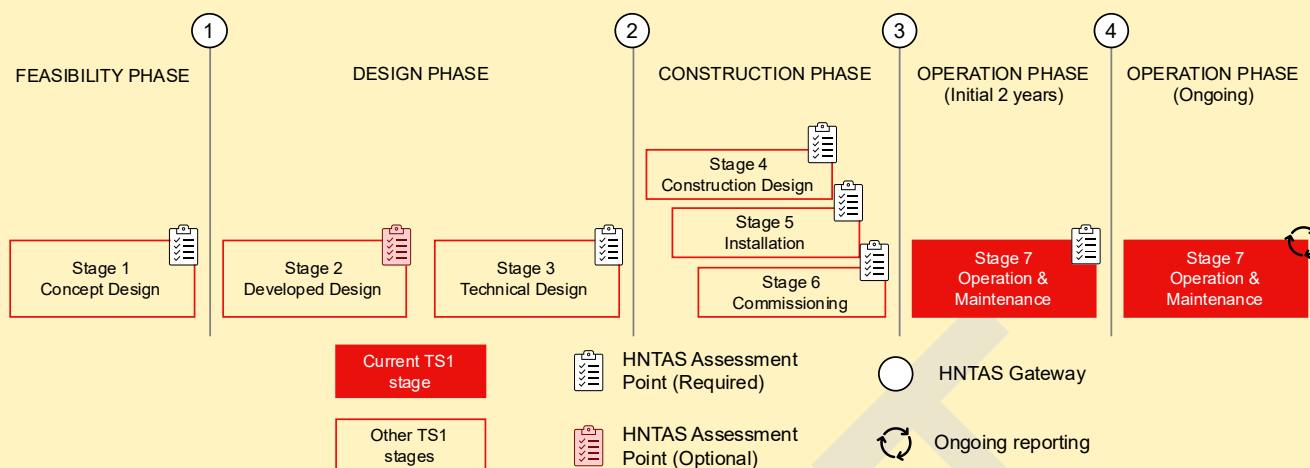
- 6.17.8. Prior to handover, the contractor shall develop a document storage solution that can allow the Designated Operator of the Heat Network to easily access relevant documentation. The document solution shall be developed such that:
- the Designated Operator will be able to facilitate easy access to the organisations responsible for carrying out operation and maintenance activities;
 - documents will be able to be stored in a format where updates can be made to the documentation following operation and maintenance activities,
- in accordance with Requirement 7.17.9.
- 6.17.9. The Designated Operator shall confirm through sign-off that sufficient information has been provided to operate the Heat Network within its design parameters.
- 6.17.10. The handover procedure from the contractor to the Designated Operator shall follow the recommendations outlined in:
- CIBSE Commissioning Code M: *Commissioning Management* (CIBSE, 2022); and
 - BSRIA BG 79/2020: *Handover Information and O&M Manuals* (BSRIA, 2020).

6.17.11. An information pack and instructions which are easily understandable for the expected consumers (e.g. residents, building managers) shall be produced which includes explanation of the functions and operation of the Consumer Heat System including:

- the Consumer Heat System controls;
- the thermal energy meter;
- the keep-warm facility if used, including explanation that the thermal energy meter may record a heat use even when there is no space heating demand or domestic hot water demand in the property;
- the locations of emergency shut-off valves;
- the procedures to follow if a leak is detected.

7 Stage 7: Operation & Maintenance

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Operation & Maintenance stage overview

The Operation & Maintenance stage contains the requirements which need to be met for the Heat Network to operate with an acceptable level of performance and reliability.

At the start of the Operation & Maintenance stage, it is expected that:

- all sections of the Heat Network which will be operational have been installed and commissioned, with acceptance being undertaken as appropriate;
- the operation of the Heat Network (including the water quality and heat loss from the network) is within the relevant thresholds;
- project documentation such as the operating risk register and operation and maintenance (O&M) manual has been produced and reflects the status of the network at the end of the Construction Design, Installation and Commissioning stages.

The Operation & Maintenance stage continues for the entirety of the operational lifespan of the Heat Network. Many of the requirements in this stage apply on a regular basis, or when triggered by events or changes which affect the operation of the Heat Network.

The Operation & Maintenance stage for a Heat Network typically comes to an end when the Heat Network is decommissioned (e.g. due to the Heat Network reaching the end of its operational lifespan).

Where works are required to maintain or upgrade a Heat Network while the Heat Network is operating, it is expected that the requirements in the preceding stages of this standard are met.

7.6 Minimise the risk posed by working pressures

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Operation & Maintenance stage, activities such as modification and/or replacement works can impact the risk of working pressures. This makes it important to minimise the risk posed by working pressures in the design and execution of modification and/or replacement works on the Heat Network.

Additional requirements can be applicable to part of the Heat Network which fall under existing standards and regulations.

- 7.6.1. The design of any modifications or repair works to pressurised parts of the Heat Network shall include consideration of:
- any changes in the system's characteristics (such as operation, configuration, and pressure) which have occurred since the construction of the network;
 - the competency of the individuals and organisations involved;
 - any constraints imposed from considering the original designer's risk assessment (if available);
 - the as-installed characteristics of the pressure safety system;
 - the as-installed Maximum Allowable Pressure of the equipment installed;
 - the duty for which the system is to be used after the repair or modification, including any change in relevant fluid and any change in system volume of the fluid;
 - the effects any such work can have on the integrity of the pressurised system;
 - whether the Safety Relief Devices are still adequate; and
 - continued suitability of the planned preventative maintenance (PPM) regime.

Additional requirements can be applicable to parts of the Heat Network which fall under existing standards and regulations (which can include, but are not limited to, the Pressure Systems Safety Regulations 2000 (UK Government, 2000))

- 7.6.2. Any works done on, or adjacent to, a live system shall be undertaken with appropriate consideration of the risks posed by the working pressures and temperatures within that system, and with all such risks adequately mitigated by suitable control measures.
- 7.6.3. Any modifications or repair works on a hydraulic circuit shall be undertaken such that the modified or repaired system:
- does not give rise to danger; and
 - does not impair the functionality or inspection facility of the pressure safety system.
- 7.6.4. A pressure test should be performed on sections of the system affected by any modification or repair works prior to the section of the system returning to service. Appropriate sections of the system should be isolated to reduce the impact of a major outage to the supply of heat.

7.6.5. Periodic examinations of each pressure safety system shall be undertaken by a competent person in line with manufacturer guidance. Where in-service examinations are undertaken, they should be done in accordance with recognised guidance such as SAFed PEC 13: *Safety Valve Examination - Setting and Sizing requirements* (SAFed, 2021). This should include:

- verification that the correct device has been fitted and that the set pressure indicated on the device enables the system to be protected safely;
- verification that the device has not been inadvertently isolated;
- testing of the device's functionality as required by the device manufacturer - this may include witnessing of live lift-testing of the device if applicable (e.g. fired boilers);
- review of the device's overhaul report, including scrutiny of the pre- and post-overhaul lift test.

For new devices, the certificate of conformity from the manufacturer may be sufficient.

7.7 Ensure that Energy Centres and Substations can meet the expected range of demands

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

It is important to ensure that the environmental impact associated with meeting heat demands is acceptable during the operation of the Heat Network.

Particulate and noise emissions

- 7.7.1. For District Heat Networks, the average annual CO₂ content of heat delivered to District Distribution Network Termination Points (in kg(CO₂)/kWh_{th} or equivalent), including network heat losses, pumping energy and other parasitic losses, shall be calculated regularly and recorded.

There can be other constraints and obligations which apply to the CO₂ content of the heat supplied by Heat Networks, including (but not limited to) Part L of the Building Regulations (refer to Approved Document L: *Conservation of Fuel and Power* (DLUHC, 2023)).

7.8 Ensure that Energy Centres and Substations operate in a controlled manner

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Operation & Maintenance stage, it is important that the operation of Energy Centres and Substations remains within acceptable thresholds, and that control is maintained. This can be achieved through activities including investigations to diagnose issues that could cause the performance of the Heat Network to fall outside acceptable thresholds, and the adoption of continual improvement processes regarding the operation of the network.

- 7.8.1. A continual improvement process shall be adopted for the operation of the network; this process shall include monitoring of all energy flows and investigations of optimising controls.
- 7.8.2. Where the system performance is outside of KPI thresholds, an investigation shall be undertaken to diagnose the issue causing the system's performance to deviate from its target; this shall be used to develop a plan for remedial actions necessary to resolve the issue.
- 7.8.3. The operation of the primary low-carbon heat generation plant shall be continuously monitored to identify issues that may be causing performance issues such as:
 - unnecessarily low heat fraction;
 - low heat generation efficiency (e.g. via a reduction in the level of heat recovery).Where issues are identified, corrective actions should be implemented to improve the network's performance.
- 7.8.4. Where the average return temperature to the Energy Centre during the operation of the system is at least 5 °C greater than the value determined in the Technical Design stage, a detailed investigation shall be undertaken across all Elements in the network to determine:
 - the root cause of the high average return temperature to the Energy Centre;
 - remedial actions necessary to reduce the average return temperature to the Energy Centre back to the target value.The outcome of this investigation shall be included in the monthly operating report detailed in Requirement 7.17.4.
- 7.8.5. The operator of the District Distribution Network and the offtaker at the Substation (or Consumer Connection, for non-domestic consumers) shall consider opportunities to reduce the return temperatures at the return inlet to the Substation or Consumer Connection. The District Distribution Network operator shall provide guidance and support to help the offtaker(s) achieve this.

A reduction in the return inlet temperature to a heat exchanger can lead to a reduction in the return outlet from a heat exchanger (e.g. in Substations). This can result in performance improvements on the Distribution Network(s) such as:

- reduced heat losses;
- reduced pumping electricity;
- improved efficiency of heat generation plant;
- increased capacity of the District Distribution Network.

7.8.6. Where the District Distribution Network heat loss during operation exceeds 120 % of the value determined in the Technical Design stage, a detailed investigation shall be undertaken across all Elements in the network to determine:

- the root cause of the high heat losses;
- remedial actions necessary to reduce losses back to the target value.

The outcome of this investigation shall be included in the monthly operating report detailed in Requirement 7.17.4.

The root cause of high heat loss from the District Distribution Network can be due to the performance of other Elements in the system.

7.9 Ensure sufficient resilience in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Operation & Maintenance stage, it is important that the relevant personnel understand the resilience measures in place for the Heat Network, and that relevant documentation is reviewed and updated to reflect changes in the operation of the Heat Network. If a threat to the Heat Network is realised, it is key that the Disaster Recovery Plan is followed accordingly.

- 7.9.1. The Designated Operator of the Heat Network shall share the Resilience Strategy with all relevant personnel so that they are aware of the procedure that should be followed in the event of a failure/outage.

A “Gold-Silver-Bronze” command structure is a common tool utilised for the incident management and escalation process.

- 7.9.2. The Designated Operator shall review and update the Resilience Strategy:
- when new risks are identified through the operational risk register;
 - when there is a change in the number and/or type of consumers served by the Heat Network; or
 - following an unplanned major outage that lasts longer than 12 hours.

Where threats are identified with a risk score of:

- above 6 (either due to the risk of known threats increasing, or the identification of new threats); or
- deemed excessively high by the risk assessor,

the Designated Operator shall implement additional redundancy and/or recovery measures to reduce the risk score to a maximum of 6.

Refer to Requirement 1.9.1 for guidance regarding the implementation of a redundancy and recovery strategy.

Refer to Annex M: HNTAS KPIs for a description of an unplanned major outage.

- 7.9.3. The Designated Operator shall maintain the critical spares log to ensure that it accurately reflects:

- the number of critical spares;
- the shelf life of spare parts held;
- the location at which spare parts are held.

The Designated Operator shall periodically check that parts are in date and stored in accordance with manufacturer recommendations.

The Designated Operator may utilise a “job card” software that automatically updates the critical spares log upon the completion of maintenance activities.

7.9.4. The following shall be affixed inside each plant room and control room area, and on the wall and/or door which is publicly accessible external to each plant room and each control room.

- Contact details of who maintains plant.
- Contact details of who to call in the event of an emergency.

Contact information shall be updated in all relevant locations in the event that it changes (for example, through a change in the organisation/individual responsible for the operation of the system).

7.9.5. The Disaster Recovery Plan shall be followed as far as reasonably practicable in the event of a major incident causing disruption to heat supply to consumers. All relevant staff shall be trained in the procedures detailed in the Disaster Recovery Plan.

7.11 Ensure sufficient water quality in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

The water quality of a Heat Network can be a significant contributor to outcomes such as leaks and component failure. It is therefore essential that water quality is considered during the Operation & Maintenance stage.

Activities which need to be undertaken on a regular basis include:

- the recording of water quality parameters and assessment of KPIs against control limits;
- planned preventative maintenance activities on water quality equipment; and
- measures to mitigate the risk of stagnation throughout the network.

Recording of water quality parameters

7.11.1. Water quality parameters shall be recorded during the operation of the system in line with the system's Water Quality Recording Programme. The parameters recorded shall be in accordance with [Table H.7](#) (for Chemically Treated Systems) or [Table H.8](#) (for Depleted Water Systems) as a minimum, and recorded at a frequency in accordance with the minimum frequencies detailed in [Table H.9](#).

The water quality parameters which have a KPI limit during the operation of the system shall be maintained within their control limits in accordance with [Table H.7](#) (for Chemically Treated Systems) or [Table H.8](#) (for Depleted Water Systems).

7.11.2. During the operation of the system, when a water quality KPI as set out in [Table H.7](#) (for Chemically Treated Systems) or [Table H.8](#) (for Depleted Water Systems) exceeds its control limit(s) or the trend of a water quality metric (as set out in [Table H.7](#) and [Table H.8](#)) indicates a deterioration in water quality (in accordance with Requirement [2.11.8/3.11.8](#)):

- the reporting frequency of water quality parameters shall become twice as frequent until the water quality KPIs are within their control limits and additional metrics indicate stable water quality;
- a competent water treatment specialist shall be engaged;
- appropriate remedial actions shall be undertaken.

7.11.3. All water sampling activities during the Operation & Maintenance stage shall be carried out in accordance with BS 8552:2012: *Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice* (BSI, 2012).

7.11.4. The number of sampling locations for water quality samples conducted during the operation of the network shall be in accordance with BS 8552:2012: *Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice* (BSI, 2012). The number of sampling locations should generally be in accordance with [Table H.3](#). The minimum number of sampling locations in the main plant area shall be one sample per system with additional sampling locations to be agreed with a water quality specialist.

- 7.11.5. A water quality sampling record shall be produced which contains:
- the date of each sample;
 - the locations at which samples were taken;
 - the test results from laboratory testing and on-site testing (where necessary) from that sample;
 - the specification and dosing quantity of chemicals dosed into the system (where chemical dosing is used);
 - repairs undertaken on the system to rectify the system's water quality.
- 7.11.6. A water quality remedial action log shall be produced and maintained which details the actions to remediate water quality in the system undertaken in accordance with Requirement 7.11.2.

Top-up of the system

- 7.11.7. For Depleted Water Systems, all top-up water shall meet the water quality parameter limits provided in Table H.6. Where the system is filled from the mains cold water service, the mains cold water service shall be sampled in accordance with the frequencies in Table H.9 and prior to any significant replacement of system water. The use of conditioning equipment on top-up water may be used to bring the water quality parameters of the top-up water into accordance with Table H.6.

Water quality maintenance activities

- 7.11.8. Dirt pockets shall be emptied on a regular basis. The dirt pocket isolation valve shall be isolated (closed) after the dirt pocket is emptied, and the pipework beneath the dirt pocket isolation valve shall be drained. This shall be included in the planned preventative maintenance (PPM) regime for the system.
- 7.11.9. Where replaceable filter media is installed, it shall be changed in accordance with manufacturer guidelines and as required to ensure that septic media conditions are prevented and the filter media is operating as intended. This shall be included in the planned preventative maintenance (PPM) regime for the system.
- 7.11.10. Continuous water quality monitoring equipment shall be calibrated at a frequency in accordance with the manufacturer's guidelines, or when laboratory testing results indicate that the installed equipment may have deviated from normal operation.
- 7.11.11. Water conditioning equipment (such as demineralisation beds) used in Depleted Water Systems shall be inspected and maintained regularly. The frequency of inspection for such equipment shall be at least:
- once every six months;
 - the minimum frequency stated in BESA SFG20: *The Industry Standard for Building Maintenance* (BESA, 2025, or latest edition); or
 - the recommended frequency stated in manufacturer literature,
- whichever is most frequent.
- The need for more frequent inspection of water conditioning equipment shall also be assessed through the consideration of the water quality parameters recorded from the system.

Stagnation

- 7.11.12. Where stagnant conditions could occur in parts of the network, temporary circulation of the system water shall be established in a controlled manner (as determined by an assessment from a water quality specialist) to minimise corrosion and microbiological proliferation.

Where temporary circulation is used, it should be done such that its operation minimises the impact on increasing the return temperatures from the network.

- 7.11.13. Any equipment that is no longer in use (including all associated pipework) shall be disconnected from the system and fully drained. This is to avoid creating stagnant water conditions. This shall be recorded within the O&M manual change log, and all documentation and drawings shall be updated to reflect the change.

Water Quality Strategy transition

- 7.11.14. Where it is proposed to change the Water Quality Strategy of a system between a Chemically Treated System and a Depleted Water System, an assessment of the design requirements for the new system shall be undertaken. The design requirements shall be developed to ensure that the new system will fulfil the requirements set out in Objective 2/3.11.
- 7.11.15. Where the Water Quality Strategy is changed after the filling of a Heat Network, the operator shall engage a water quality specialist to specify the Water Quality Transition Approach. The specified Water Quality Transition Approach shall be clearly documented for each Element.

7.12 Ensure that the performance of the Heat Network can be monitored

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Operation & Maintenance stage, it is important that the monitoring of the network remains sufficient. This is principally achieved through planned preventative maintenance and calibration of equipment used for monitoring of the Heat Network, and maintaining relevant documentation. The use of monitoring equipment to investigate events such as unexpected heat consumption or large quantities of top-up water can also be used to address issues early and maximise the lifespan of the network.

This Objective references the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025) which provides detail on requirements surrounding Metering and Monitoring Systems.

- 7.12.1. The planned preventative maintenance regime shall include the maintenance of thermal energy meters in accordance with Section 1.3 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).
- 7.12.2. The Metering and Monitoring Strategy shall be maintained in accordance with Section 4.1.2 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).
All changes to the strategy shall be recorded in the O&M change log, including where Monitoring Points are replaced, or thermal energy meters are recalibrated.
- 7.12.3. A thermal energy and utility meter maintenance strategy shall be produced in accordance with BESA SFG20: *The Industry Standard for Building Maintenance* (BESA, 2025, or latest edition) or an equivalent industry standard.
- 7.12.4. Thermal energy meters shall be recalibrated or replaced in accordance with the sampling and testing procedures detailed in Sections 1.3.3 - 1.3.5 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025). These procedures shall form part of the site's planned preventative maintenance (PPM) regime.
- 7.12.5. Where thermal energy meters are battery-operated, the batteries shall be replaced in accordance with Section 1.3.6 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025). The battery shall be replaced with one with a minimum lifetime compliant with Section 1.1.8 of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).
- 7.12.6. Heat consumption across the network, including at Consumer Connections, shall be monitored. Where a consumer's heat consumption diverges from the expected value, investigations shall be undertaken to ensure correct operation of the:
 - Thermal Energy Meter;
 - Automatic and Remote Monitoring System (ARMS);
 - Consumer Connection;
 - Distribution Network(s), Substation and/or Energy Centre.

- 7.12.7. The top-up water introduced into the network shall be monitored to detect leaks by recording of make-up water or daily recording for larger systems.
Where significant unexpected quantities of top-up water is identified, an investigation into where the leak is occurring shall be undertaken with an appropriate level of urgency.
Any remedial actions taken to fix issues shall be recorded in the maintenance and remedial action log.
- 7.12.8. Where a surveillance system is installed, this shall be monitored, tested, maintained and inspected in accordance with BS EN 14419:2019: *District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems* (BSI, 2019).
Alarms for the surveillance system shall be reported through the main control system. Each alarm raised by the surveillance system shall be investigated; the location of each fault shall be identified and necessary repairs shall be undertaken as soon as reasonably practicable.
Any remedial action taken to fix issues shall be recorded in the maintenance and remedial action log.
- 7.12.9. Consideration shall be given to the requirements surrounding the monitoring of emissions from the Heat Network.
- 7.12.10. Measurements of noise from Energy Centres and Substations shall be taken with a minimum frequency of once every 5 years to ensure that original design conditions are being maintained.

7.13 Ensure that the Heat Network is sufficiently insulated

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Operation & Maintenance stage, the heat loss from the Heat Network needs to stay within acceptable limits. Maintenance or repair activities need to be undertaken such that the insulation on the system retains an acceptable level of thermal performance.

- 7.13.1. When insulation needs to be removed for maintenance or repair purposes, it shall be re-fitted as soon as reasonably practicable. Where insulation is found to be wet, the source of wetness shall be investigated and rectified as soon as reasonably practicable; the wet insulation shall subsequently be removed and replaced.

Where insulation is replaced, opportunities to improve the thermal performance of the insulated system to the performance requirements set out in Objective 2/3.13 shall be investigated. As a minimum, the thermal performance of the replacement insulated system shall meet the thermal performance requirements specified at the design and installation stages of the original insulated system.

Pipework which is found to be corroded shall be rectified such that the risk of further corrosion to pipework is sufficiently mitigated prior to the installation of replacement insulation.

The method statement for the installation of replacement insulation should include consideration of the requirements set out in BS 5970:2012 *Thermal insulation of Pipework, Ductwork, Associated Equipment and Other Industrial Installations in the Temperature Range of -100°C to +870°C - Code of Practice* (BSI, 2012).

7.14 Minimise the risk posed by construction activities and the operation of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Considerations to make regarding the risk posed by the operation of the Heat Network can include the training and qualifications of operatives, the risk of discharges or leaks from the Heat Network, access to plant rooms, and substances present during the network's operation.

There can also be requirements and obligations regarding the risk posed by the operation of the Heat Network which are outside the scope of this standard.

- 7.14.1. Operatives responsible for carrying out operation and maintenance activities shall receive appropriate training specific to the relevant activity before carrying out these activities. The network specific training that each operative receives shall be recorded in a network induction & training register.
- 7.14.2. Operatives and specialists responsible for carrying out operation and maintenance activities shall be made aware of the specific network characteristics and the controls philosophy as part of a network induction process. Operatives that receive this induction shall be required to sign that they have understood those requirements prior to carrying out the works that they have been engaged for.
A list of operatives that have completed a network induction shall be recorded in a network induction & training register.
- 7.14.3. The operator shall advise consumers on the emergency procedures to be followed in the event of a leak within a dwelling.
- 7.14.4. A procedure shall be developed which details how leaks or discharges from the network are responded to.
- 7.14.5. Any discharges or leaks of system water from the network shall be identified and rectified as quickly as reasonably practicable.
- 7.14.6. Where regular failures or discharges of water are occurring from equipment or pipework, a review shall be undertaken to identify the cause(s) of failure. A plan shall then be developed and implemented to rectify the issues identified and prevent future recurrence.
- 7.14.7. Plant rooms containing equipment shall be kept locked with appropriate access control. This shall include plant rooms located on consumers' premises. Risers shall be kept locked with appropriate access control.
- 7.14.8. The risks posed by substances present during the operation of the network shall be considered.

Requirements can be applicable to the Heat Network which fall under existing standards and regulations (which can include, but are not limited to, the *Control of Substances Hazardous to Health (COSHH) Regulations 2002* (UK Government, 2002) and the *Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)* (UK Government, 2002).

7.15 Ensure sufficient maintenance of the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Planned preventative maintenance (PPM) is a key activity undertaken throughout the Operation & Maintenance stage to aid in minimising the risk of the deterioration and failure of components on the Heat Network and maximising the lifespan of the Heat Network.

Other activities which need to be done during the Operation & Maintenance stage include the regular independent inspection of operation and maintenance activities, and the appropriate management of maintenance activities (e.g. through appropriate system demarcation and document management).

Planned preventative maintenance (PPM)

- 7.15.1. Each Element of the Heat Network shall be operated and maintained in accordance with:
 - the health and safety file;
 - the operation and maintenance (O&M) manual(s);
 - the planned preventative maintenance (PPM) regime;
 - manufacturers requirements.
- 7.15.2. The basis for the planned preventative maintenance (PPM) regime should be in accordance with BS ISO 55000: *Asset Management - Vocabulary, Overview and Principles* (BSI, 2024), and follow the “plan-do-check-act” cycle of continual improvement.
- 7.15.3. The planned preventative maintenance (PPM) regime for the Energy Centre, Substation(s) and Distribution Network(s) shall be produced in accordance with
 - BESA SFG20: *The Industry Standard for Building Maintenance* (BESA, 2025, or latest edition), or an equivalent industry standard;
 - the operation and maintenance (O&M) manual(s); and
 - manufacturers' requirements.
- 7.15.4. The maintenance of all equipment on the Heat Network should be in accordance with:
 - BSRIA BG 66/2016: *Maintenance Contracts: A Guide to Best Practice for Procurement* (BSRIA, 2016); and
 - CIBSE Guide M: *Maintenance Engineering and Management* (CIBSE, 2023).
- 7.15.5. Maintenance activities shall be scheduled to minimise major outages to heat supply wherever possible, including through:
 - the use of redundant equipment; and
 - the scheduling of maintenance activities during the season with the lowest demand.

Consumer Connections

- 7.15.6. Consumer Connections which are direct Heat Interface Units (HIUs) shall be serviced at a minimum frequency of once every 5 years, or more frequently if required by the manufacturer.
- 7.15.7. Consumer Connections which are indirect Heat Interface Units (HIUs) shall be serviced at a minimum frequency of once every 2 years, or more frequently if required by the manufacturer.
- 7.15.8. The servicing of Consumer Connections shall be undertaken when there is a change of tenancy of the consumer served by that Consumer Connection.
- 7.15.9. The exercising of emergency shut-off valves at Consumer Connections shall be undertaken during the servicing of the Consumer Connection (see Requirement 7.15.6, Requirement 7.15.7, and Requirement 7.15.8).

Maintenance of plant and ancillary equipment

- 7.15.10. As part of the planned preventative maintenance (PPM) regime, the exercising of valves and any other ancillary equipment that requires regular exercising to avoid seizing shall be undertaken at a frequency of at least once every twelve months.
- 7.15.11. As part of the planned preventative maintenance (PPM) regime, strainers shall be inspected and cleaned regularly at a frequency of at least:
 - once every twelve months; or
 - the minimum frequency stated in BESA SFG20: *The Industry Standard for Building Maintenance* (BESA, 2025, or latest edition) where a higher frequency is stated for strainers on plant,whichever is most frequent.

The need for more frequent strainer cleaning shall also be assessed through consideration of:

 - the amount of debris cleaned from previous cleaning of the strainers on-site;
 - monitoring of pressure gauges on strainers;
 - system water sampling results.
- 7.15.12. As part of the planned preventative maintenance (PPM) regime, the differential pressure across heat exchangers shall be checked at least once every twelve months to assess the level of fouling in accordance with BESA SFG20: *The Industry Standard for Building Maintenance* (BESA, 2025, or latest edition).
- 7.15.13. As part of the planned preventative maintenance (PPM) regime, the inspection and maintenance of valve chambers shall be undertaken at a frequency of at least:
 - once every twelve months; or
 - in accordance with manufacturer requirements,whichever is higher.

Inspection of maintenance activities

7.15.14. An annual inspection of the O&M activities undertaken on the Heat Network shall be undertaken by a competent individual or individuals within a team separate to the team responsible for O&M activities on the Heat Network.

The competent individual (or at least one of the competent individuals) undertaking the inspection shall meet the competency requirements for a Category 1 Condition Auditor (refer to [Table L.5](#)).

System demarcation

7.15.15. The demarcation between parties responsible for different parts of the network shall be demonstrated through:

- clear signage; and
- lock offs to prevent tampering.

It can also be beneficial to include boundary lines depicting the demarcation of ownership and maintenance responsibility between different parties (where applicable) on drawings and schematics.

Maintenance documentation

7.15.16. The operation and maintenance (O&M) manual and all relevant documentation required for and produced during the maintenance of the Heat Network shall be stored in an accessible manner and be readily available to all parties requiring access to this information.

This information shall be retained digitally in an easily accessible format for at least 5 years.

Consideration should be given to:

- integrating the recording and storage of Heat Network information as part of an organisation's wider approach to facilities information management;
- increasing the document retention period of information (for example, the *Building Safety Act 2022* (UK Government, 2022) requires the storage of certain information for the entire lifecycle of higher-risk buildings).

Further information on the statutory requirements which can apply to the operation and maintenance of buildings can be found in BSRIA BG 80/2025: *Statutory Compliance Inspection Checklist* (BSRIA, 2025).

7.16 Manage and maintain the condition of components in the Heat Network

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

During the Operation & Maintenance stage, inadequate condition of the components on the system can be a key contributing factor to outcomes such as component failure and major outages to the supply of heat. It is therefore important that the condition of the components on the network is well understood, clearly documented, and assessed on a regular basis as part of planned preventative maintenance.

Activities which need to be undertaken during the Operation & Maintenance stage include the regular undertaking of Condition Audits (and Condition Surveys / non-destructive testing, if necessary), remedial actions to bring the condition of components to acceptable levels, investigation of root causes of abnormally common failures, and ensuring that installations from replacement works result in acceptable levels of condition.

It should be noted that some of the activities carried out as part of the Minimum Requirements within this objective may be undertaken as part of an engineering insurance inspection for the system.

Condition Audits

7.16.1. A Condition Audit of:

- all pipework and equipment within the Energy Centre and Substation Elements; and
- all accessible salient pipework and equipment in the District Distribution Network and Communal Distribution Network Elements, including (but not limited to):
 - the top of each riser;
 - the bottom of each riser;
 - expansion bellows;
 - valve chambers;
 - thermal energy meters on the Communal Distribution Network or District Distribution Network,

shall be carried out at a frequency of at least once a year.

The Condition Audit shall include the applicable audit activities set out in [Table L.3](#) as a minimum.

The Condition Auditor(s) undertaking the audit shall have a minimum competency to assess and report on the condition of equipment present on the Heat Network as detailed in [Table L.4](#) and [Table L.5](#).

Outputs of the audit shall be detailed in the condition log. This shall include all asset data included in [Table L.6](#).

BSRIA BG 35/2012: *Condition Surveys and Asset Data Capture* (BSRIA, 2012) provides further detail on the range of simple and specialist activities available to enable the condition of above-ground pipework and equipment to be accurately determined.

For complex systems involving buried pipework, some of the content in the following documents can be useful.

- API RP 579-1 / ASME FFS-1: *Fitness for Service* (API & ASME, 2021).
- ASME B 31G: *Manual for Determining the Remaining Strength of Corroded Pipelines* (ASME, 2023).
- DNVGL-RP-F101: *Corroded Pipelines* (DNVGL, 2019).

Condition Surveys

7.16.2. Where it is not possible for the Condition Auditor to determine a condition and/or priority grade for an asset in accordance with [Table L.1](#) and [Table L.2](#), for reasons such as:

- the complexity of the asset under inspection demands specialist surveyor activities;
 - insufficient maintenance records are available to the Condition Auditor; or
 - it not being possible to diagnose an issue through simple testing means alone,
- a Condition Surveyor shall be engaged to determine the condition grade (in accordance with [Table L.1](#)) and priority grade (in accordance with [Table L.2](#)) by carrying out the specialist activities outlined within [Table L.3](#).

If it is still not possible to determine the condition/priority grade of equipment through NDT methods (e.g. where equipment has been exposed to higher pressures/temperatures than it is rated for, or there are major concerns of potential failures due to poor water quality), a specialist should be engaged to carry out destructive testing where appropriate.

Outputs of any Condition Survey shall be detailed in the condition log, including the current condition grade (in accordance with [Table L.1](#)) and priority grade (in accordance with [Table L.2](#)).

For example, if polymer pipework has been exposed to higher pressures/temperatures than it is rated for, it can be at a significantly higher risk of failure or a reduction in operational lifespan. Destructive testing can be necessary in this scenario (or similar scenarios) to determine the condition and/or priority grade of the pipework.

The operator may undertake condition surveys more frequently than once a year.

BSRIA BG 35/2012: *Condition Surveys and Asset Data Capture* (BSRIA, 2012) outlines considerations that could lead to more frequent condition surveys being undertaken, including:

- the durability and reliability record of plant items;
- the extent to which conditions can be assessed during regular maintenance inspections;
- the frequency of use of plant items;
- the age of plant items relative to their economic life; and
- whether rapid or unusual deterioration has been observed.

Remedial actions

7.16.3. Where an abnormal number of failures of the same type (e.g. the same component failure across multiple Consumer Connections) are observed during the Operation & Maintenance stage of a given system, an investigation shall be carried out to determine the root cause of the failures. Remedial actions shall be undertaken to rectify the root cause of the identified failure; this should include engagement with the manufacturer where appropriate due to the type of the failure.

Non-destructive and/or destructive testing, where used, should be done with consideration to manufacturer requirements and warranties. Where necessary, the manufacturer should be engaged to carry out this testing.

7.16.4. Where equipment does not achieve a condition grade of 'A' or 'B', the operator shall:

- review the Resilience Strategy to determine whether there are sufficient measures in place to maintain operation of the Heat Network in the event of equipment failure;
- produce a remedial action plan detailing the actions required to restore the equipment grade to 'A' or 'B' and outline the timeframes for implementing these.

There is the following exception to this requirement.

- If pipework or equipment achieves a condition grade of 'E' because there are opportunities to improve its efficiency, energy, or environmental performance, but it is still expected that the Key Performance Indicators (KPIs) of the system will be achieved without replacing the pipework or equipment, it is not required to restore the condition of the pipework or equipment to a condition grade of 'A' or 'B'.

7.16.5. The operator shall record the completion of remedial actions in the maintenance and remedial action log and update the condition log.

7.16.6. If pipework achieves a condition grade of 'C' or 'D' in the Condition Survey, a risk-based assessment, based on:

- the likelihood of pipework failure;
- the impact of pipework failure; and
- the condition grade of the pipework,

shall be undertaken within 2 months of the initial grading to determine if destructive testing of pipework is required to gain further understanding of its condition. This risk-based assessment shall be provided alongside the condition log.

If it is determined that destructive testing is required on pipework that achieves a condition grade of 'D', this testing shall be carried out no later than 4 months following completion of the risk-based assessment.

If it is determined that destructive testing is required on pipework that achieves a condition grade of 'C', this testing shall be carried out:

- at a time which is proportionate to the outcome of the risk-based assessment; and
- no later than 10 months following completion of the risk-based assessment.

It can also be beneficial to perform destructive testing of pipework if:

- pipework is operated in excess of its maximum temperature or pressure rating, particularly for polymer pipework;
- pipework is visibly deformed due to a lack of expansion provision;
- pipework is known to have been exposed to historically poor water quality, particularly for thin wall carbon steel and mixed material pipework systems;
- pinhole leaks have occurred, or there is considered to be a risk of pinhole leaks occurring in the next 12 months; or
- the external surface of steel pipework is wetted for an extended period of time (e.g. due to contact with wet insulation because of a leak or poor weather proofing).

For complex systems involving buried pipework, some of the content in the following documents can be useful.

- API RP 579-1 / ASME FFS-1: *Fitness for Service* (API & ASME, 2021).
- ASME B 31G: *Manual for Determining the Remaining Strength of Corroded Pipelines* (ASME, 2023).
- DNVGL-RP-F101: *Corroded Pipelines* (DNVGL, 2019).

- 7.16.7. Where pipework has failed and needs to be removed to reinstate the supply of heat, and the root cause of this failure cannot be determined, destructive testing shall be undertaken on this section of pipework to investigate the potential causes of failure. This assessment shall be included within the condition survey report.

Recording the condition of the network

- 7.16.8. The operator shall maintain a condition log produced in accordance with Requirement 6.16.6, which shall be updated upon completion of:
- maintenance activities which change the condition grade of pipework or equipment;
 - Condition Audits; and
 - Condition Surveys.

The condition log shall include asset data in accordance with Table L.6.

- 7.16.9. The working pressures and temperatures of the system shall be recorded and checked on a regular basis to identify if the system has been subject to excess pressures and/or temperatures.

Excessive pressures and/or temperatures can significantly impact the lifespan of polymer pipe systems.

Recorded working pressures and temperatures can be used to identify cycling in the system.

Buried pipework

- 7.16.10. Where buried pipework is removed and re-fitted, a casing joint shall be installed in accordance with BS EN 489-1: *District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Joint Casing Assemblies and Thermal Insulation for Hot Water in Accordance with EN 13941-1* (BSI, 2019). This case joint shall be tested to ensure that all moisture has been removed prior to backfill.

Where a surveillance system is installed, this shall be re-tested following reinstallation of below-ground pipework. Any faults identified with the system shall be investigated and resolved where possible.

A certificate shall be produced following completion of the reinstallation of below-ground pipework, and all relevant documentation shall be updated to include the location (e.g. survey station and/or GPS co-ordinates) of the new joints or welds.

Change in responsible organisation

- 7.16.11. Prior to a change in the organisation responsible for the operation of the system, a Condition Survey of all pipework and equipment within the Energy Centre and Substation Elements, and all accessible salient pipework and equipment in the District Distribution Network and Communal Distribution Network Elements shall be carried out in accordance with Requirement 7.16.2.

The Condition Survey shall be undertaken by a Condition Surveyor who has the minimum competency to assess and report on the condition of equipment present on the Heat Network as detailed in Table L.4 and Table L.5.

Outputs of the Condition Survey shall be detailed in the condition log. This shall include all data fields, as per Table L.6.

Refer to Requirement 7.16.1 for guidance regarding the activities available to enable the condition of pipework and equipment to be accurately determined.

7.17 Ensure that project documentation is produced and managed

Meet consumers' heat demands reliably

Minimise cost of heat over lifespan of heat network

Ensure sufficient performance and reliability during the design, construction, and operation of the heat network

Reduce carbon emissions associated with the provision of heat

Key documentation to maintain during the Operation & Maintenance stage of the Heat Network includes:

- the operating risk register;
- change logs;
- operating reports;
- drawings and schedules.

Operating data can also be useful in assessing the performance of the Heat Network, and as part of wider feedback processes for future projects.

7.17.1. An operating risk register shall be developed and kept up-to-date; this shall include updating the risk register where:

- new risks are identified; or
- risks previously identified require alteration.

The operation & maintenance (O&M) change log and planned preventative maintenance (PPM) regime (if necessary) shall be updated as necessary where new risks are identified, or alterations to previously identified risks become apparent.

7.17.2. Any planned or reactive maintenance activities carried out on the Heat Network shall be recorded within a maintenance and remedial action log.

This shall include:

- the date the activity was carried out;
- the operative(s) that performed the activity;
- the remedial actions carried out on the system as part of the maintenance activity.

7.17.3. Any changes made to the network during its operation shall be recorded in an O&M manual change log. This includes:

- changes that result in deviations in the hydraulic arrangement of the network;
- significant changes to the heat demand connected to the network, or the expected heat demand profile within any part of the system;
- changes to the spatial layout of the network;
- changes to the control system, setpoints or Description of Operation (DesOps);
- changes to the Resilience Strategy;
- changes to the operating risk register; and
- the replacement of equipment.

This should not include activities noted in the maintenance and remedial action log for general maintenance activities carried out on the network.

- 7.17.4. An operating report shall be produced on a monthly basis and issued to the responsible party of the Heat Network; the report shall include performance data on all KPIs for the system as well as any remedial actions undertaken to rectify the system's performance.

Document register

- 7.17.5. The document register shall be kept up-to-date throughout the operation of the Heat Network.

Drawings and schedules

- 7.17.6. All documentation and drawings shall be kept updated as necessary to ensure documentation is accurate and reflective of actual operation and installation.
- 7.17.7. The as-installed drawings and valve schedule affixed to each plant room (refer to Requirement 4.17.6) shall be kept up-to-date to reflect the current installation of the system.

Refer to Requirement 7.12.2 for requirements regarding the maintenance of the Metering and Monitoring Strategy.

- 7.17.8. Relevant documentation and drawings shall be updated following any expansions to the network. All changes shall be recorded in the operation and maintenance (O&M) manual change log.
- 7.17.9. Documentation and drawings shall be stored in a location that can facilitate easy access to organisations responsible for carrying out operation and maintenance activities, and be in a format where updates can be made to the documentation following operation and maintenance activities.
- As a minimum, a copy of the as-installed schematic(s), layout drawings, and key network criteria shall be kept on site. Where physical copies are stored on site, a back-up version shall always be stored in a separate location.

Operating data

- 7.17.10. When major equipment, bypasses, valves, pipework and other equipment needs to be replaced, the operating data collected shall be used to determine the required specification of the replacement alongside the applicable requirements throughout the preceding stages of this standard. The operating data to be assessed shall include operating load, temperature, and pressures, including extreme operating scenarios. The replacement of equipment shall be recorded in the operation and maintenance (O&M) manual change log.
- 7.17.11. The operator of the network shall provide feedback to the designer regarding how the network has operated in practice, with recommendations as to how future designs can be improved.

Annexes

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Annex A: Terms and Definitions

The definitions provided in [Table A.1](#) can be related to the context of Heat Networks. Terms can have broad or alternative meanings in different contexts.

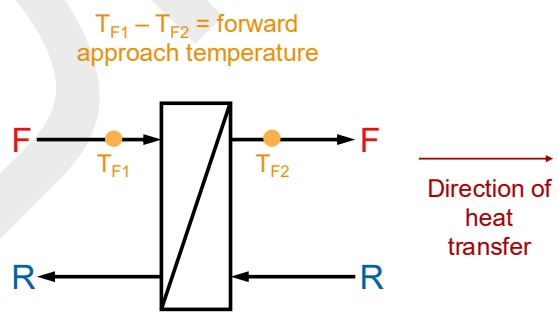
Table A.1: Terms and definitions

Term	Definition
Acceptance Testing	A demonstration that the performance of a Heat Network Element is in accordance with the design intent, DesOps, and KPIs.
Accumulation Pressure p_{acc}	The increase in pressure between the Maximum Allowable Pressure (MAP) and the Maximum Allowable Accumulation Pressure (MAAP).
Anchor loads	Buildings with a large, reliable and long-term demand for heat, often with a stable and constant use profile.
Annual heat consumption	Total amount of energy consumed to meet DHW and space heating demand throughout the year.
Atypical heat load	A heat load which deviates from the typical pattern for a pattern for a building of the same use and occupancy.
Automatic and Remote Monitoring System (ARMS)	All systems, infrastructure and associated equipment required for the: • extraction of data from Monitoring Points; • recording and storing of data from Monitoring Points at the required frequency in a centralised location; • transforming of raw data and calculation of KPIs; • reporting of KPIs to HNTAS. Whilst the requirements for billing are not in scope of HNTAS, the ARMS will also typically be used for billing of consumers. The ARMS typically will be an AMR, BMS or equivalent systems, or a combination of systems.

Term	Definition
Building Connection	Connection between Communal Distribution Network and District Distribution Network into a building. Depending on contents, a building connection may be considered to be one of the following: • Substation. • Energy Centre. • At the boundary between a District Distribution Network and a Communal Distribution Network. When the building connection is an arrangement of valves etc. and does not contain a hydraulic break. • Consumer Connection. A connection between a District Distribution Network and a Consumer Heat System.
Building management system (BMS)	System responsible for the control and monitoring of building services, used for interactive energy management. Can contain functionality for remote control and monitoring.
Capital Equipment	The Capital Equipment is the essential equipment and infrastructure required for the construction, operation, and maintenance of the Heat Network. This includes components necessary for heat generation, circulation, maintaining water quality, safety, monitoring devices, etc.
Chemically Treated System	A system where water quality is controlled through chemical treatment to ensure long-term protection of pipework and equipment against corrosion.
Closed loop pre-treatment cleaning (CPC)	A method of pre-treatment cleaning which involves the filtration of treated and/or conditioned system water until the water quality of the system water reaches acceptable levels.
Communal Distribution Network	Any pipework system that is wholly within a building and distributes thermal energy from either an Energy Centre or Building Connection to multiple Consumer Connections. Typically contains pipework, valves, heat meters, and other ancillary equipment.
Communal Heat Network	A Heat Network by means of which heating, cooling or hot water is supplied only to a single building divided into separate premises or persons in those premises.

Term	Definition
Consumer Connection	Connection between Distribution Network (either District or Communal) and a single Consumer Heat System, where the instantaneous hot water system is ≤ 70 kW and/or the heating/cooling system is ≤ 20 kW. The Consumer Connection typically includes HIUs and ancillary hot water storage (where applicable), direct hot water storage, dwelling level heat pumps and ancillary hot water storage (where applicable), CIUs, meters and monitoring equipment and other ancillary equipment.
Consumer Heat System	The heating and/or cooling, and hot water systems on the consumer side of a Consumer Connection or Substation. Heat systems consist of distribution pipework and ancillary equipment (such as distribution manifolds) connected to heat emitters which may include radiators, air handling units (AHUs), fan coil units (FCUs) or underfloor heating (UFH). Hot water systems consist of hot water distribution pipework and ancillary equipment connected to outlets and may contain de-centralised storage and/or re-circulation systems.
Consumer Systems	Refers to the Consumer Connection and Consumer Heat System combined.
Consumer type	Refers to a defined type of Consumer Connection / Consumer Heat System, where there are multiple of the same defined type which have the same characteristics. For example, apartment types.
Control system	The system that is used to control the Heat Network operation. This is typically a BMS.
Control system point	Individual items (e.g. inputs, outputs and setpoints) that is required for the operation of the control system. For example, a temperature sensor would be classed as a “point”.
Dead leg	A section of pipework which has receives no flow during normal operation of the system, which can lead to stagnant water which can increase risk of bacterial growth, impairing the water quality of the network.
Demineralisation	A method of removing ions from system water, commonly done through ion-exchange processes or membrane processes.
Depleted Water System	A system where water quality is controlled through demineralisation and preservation of low conductivity in the system water to ensure long-term protection of pipework and equipment against corrosion.
Description of Operation (DesOps)	A document setting out the control philosophy and detailed operating procedures for running an item of plant or a system.
Design intent	The design intent refers to the overall fundamental concepts, principles and goals of the design and operation of the Heat Network.

Term	Definition
Designated Operator	An organisation appointed by the Responsible Party to take control of the operation phase of a Heat Network project where there is more than one operator. They are responsible for conforming to the Technical Standards.
Domestic hot water operation	Mode of operation of the Consumer Connection where there is domestic hot water demand.
Direct connection	Type of Consumer Connection where the space heating Element of the Consumer Heat System is part of the same hydraulic system as the distribution network serving the Consumer Connection.
Dirt pocket	Section of pipe designed to capture dirt and debris in system water, typically installed at the bottom of long sections of vertical pipework (e.g. risers).
Distribution Network	Pipework that distributes thermal energy to end consumers. Can be either: • District (e.g. pipework connecting Energy Centre to buildings); • Communal (e.g. pipework within buildings up to consumer connections). Typically contains pipework, valves, heat meters, and other ancillary equipment.
District Distribution Network	Any pipework system that is not within a building and distributes thermal energy from one location within a Heat Network to another. For example, distributing thermal energy from an Energy Centre to a Building Connection underground. Typically contains pipework, valves, heat meters, and other ancillary equipment.
District Heat Network	A Heat Network by means of which heating, cooling or hot water is supplied to two or more buildings or persons in those buildings.
Diversity factor	The ratio between the peak demand that occurs at the given point in the Heat Network and the sum of the peak demands at each end consumer served by that given point. Typically arises due to peak demand events from multiple consumers not being coincident, and is dependent on the number and type of consumers served by a given point in the Heat Network.
Dynamic pressure	The increase in pressure caused by distribution equipment such as network distribution pumps.
Electronic limiter	An automatic operating device that causes shutdown and lock out of the heat supply when the maximum working pressure of the heating medium is exceeded.

Term	Definition
Electronic Limiter Pressure (ELP)	The pressure at which an electronic limiter begins to operate.
Energy Centre	Plant room that contains heat generation equipment; and/or equipment connecting to an energy source; or a substation which contains heat generation equipment (e.g. building connection with heat pumps or top-up boilers). Typically contains heat generation equipment (e.g. heat pumps, CHPs, chillers), top-up generation equipment (e.g. boilers), plate heat exchangers (PHE), pumps, expansion and pressurisation units, thermal storage, water quality equipment, BMS / control equipment, strainers, control valves, and heat meters.
Expansion system	Equipment specified to accommodate variations in the volume of system water due to thermal expansion/contraction; the connection point to the Heat Network is typically known as the “neutral point” of the system.
Fill Pressure p_{fill}	The pressure required to fill the network at the fill point.
Flushing	The removal of dirt and debris from system water through the use of elevated flow velocities in the system.
Flushing bypass	A component used in flushing to allow for the isolation and flushing of sections of the network.
Flush-to-drain	A method for cleaning a system by passing water throughout part or all of the system and subsequently discharging it through a drain to remove contaminants.
Forward approach temperature	The temperature difference between the flow inlet and the flow outlet of a heat exchanger. 
Gauge pressure	The pressure measured relative to the ambient atmospheric pressure, it does not include atmospheric pressure in its measurement.

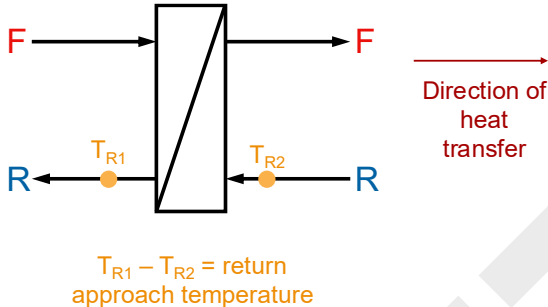
Term	Definition
Good workmanship	The undertaking of construction, installation, and commissioning activities which results in work that is: • functional according to the design intent; • safe; • durable; and • compliant with applicable standards and obligations. Activities which are performed with good workmanship are customary with skilled contractors in the relevant trade/industry.
Heat generation source	Equipment, or multiple pieces of equipment of the same technology in a single bank, which provides the Heat Network with heat. Separated by a distinction in: • the heat generation technology (e.g. heat pump, gas boiler, electric boiler); • the energy source used to generate heat (e.g. air source heat pumps, water source heat pumps, gas boilers, and electric boilers would be separate heat generation sources); or • the Element in which the equipment is located within the Heat Network (e.g. distributed top-up boilers in a District Heat Network would be a separate heat generation source to boilers in the Energy Centre).
Heat Interface Unit (HIU)	A self-contained unit that provides a connection point between the Distribution Network and the Consumer Heat System, and which also enables effective control of heating and/or hot water supplies to the Consumer Heat System.
Heat Network	A network that, by distribution of a liquid or a gas, enables the transfer of thermal energy for the purpose of supplying heating, cooling, and/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).
High Alarm Pressure Allowance Δp_{HA}	The difference in pressure between the Static Height Pressure of the pressurisation equipment and the high alarm pressure, to prevent nuisance instances of the pressurisation unit high alarm operating.
High Alarm Pressure Setpoint p_{HA}	The pressure at which the pressurisation unit high alarm activates.
Hydraulic break	A point in a Heat Network where heat is transferred between two hydraulic systems without any mixing of the system water in either hydraulic system.

Term	Definition
Hydraulic circuit	A path of fluid circulation in a system which does not contain any hydraulic separation. The inclusion of hydraulic separation in a system creates the presence of multiple hydraulic circuits.
Hydraulic separation	A connection or physical break in a system which enables the flow rate and temperature to be controlled independently on either side of the separation. Where hydraulic separation is provided through a heat exchanger, the working pressures on each side of the separation can be controlled independently; where hydraulic separation is provided through a connection such as a low loss header, the dynamic pressures on each side of the separation can be controlled independently. Note - a thermal store can be designed to provide hydraulic separation by functioning as a low-loss header.
Hydraulic system	A path of fluid circulation in a system which does not contain any hydraulic breaks.
Index point	The point in a Distribution Network with the highest resistance and, hence, pressure loss when each pipe is carrying its design flow rate. There can be multiple index points during operation.
Index run	The portion of the Heat Network which represents the largest differential pressure drop from source to end user. In networks with complex topologies such as 'mesh' style district Heat Networks, determining the index run may be non-intuitive; it can be possible for the index run of the network to move depending on the route travelled from the source to the end user.
Indirect connection	Type of Consumer Connection where the space heating Element of the Consumer Heat System is not part of the same hydraulic system as the distribution network serving the Consumer Connection.
Inhibitor	A chemical compound added to system water designed to inhibit the corrosion of system pipework and equipment.
Initiation Point	The start of a Distribution Network. For example, the Energy Centre or Substation exit, or building entry point. Will contain a Monitoring Point.
Internal design temperature	The internal ambient temperature within heated spaces used when determining space heating demands from the Heat Network.

Term	Definition
Keep-warm	The strategy that maintains the Heat Network at the temperature required for the Consumer Connection (HIU) to deliver domestic hot water in the required response time. This is typically either via HIU keep-warm functionality, that results in the HIU always being ready to supply domestic hot water, or an alternative strategy is to keep the risers warm and the pipework between the risers and HIU of sufficiently low volume such that the domestic hot water response time is acceptable.
Key Aim	A high-level principle used in this standard that guides the design, construction, and operation of Heat Networks.
Key Building	A building with significant influence on the overall heat demand or the operating temperatures of the Heat Network. A Key Building is likely to be an anchor load.
Key Performance Indicator (KPI)	A quantifiable metric used to measure performance of a Heat Network at commissioning and during operation. KPI 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.
Lateral pipework	Horizontal pipework within a building, which branches from a riser and typically runs within corridors to serve multiple terminal runs / Termination Points.
Load bank	A device used to apply a simulated heat demand on the Heat Network, to verify their performance and reliability under realistic operating conditions. It aims to ensure that the Heat Network can handle the expected demand and operate efficiently.
Local Maximum Working Pressure (LMWP)	The maximum gauge pressure which can be present at a given location in the system when considering reasonably foreseeable operating conditions.
Lowest Pressure Rated Component (LPRC)	The component in the system having the lowest Maximum Allowable Pressure (MAP) over the range of reasonably foreseeable operating temperatures.
Maximum Allowable Pressure (MAP)	The highest pressure that the equipment is able to safely operate at, across the range of operating temperatures of the system.
Maximum Allowable Accumulation Pressure (MAAP)	The highest pressure that the equipment is permitted to reach during an overpressure event, i.e. a pressure relieving event.
Mesh style network	A Heat Network which includes a 'rings' style pipe system, thereby allowing the index run of the system to change.

Term	Definition
Minimum Requirement	A specific action or condition which is essential in meeting the associated Objective at a given stage. Supported by guidance where appropriate.
Mode of operation	A term used to describe the different types of operation of a Heat Network and/or components. For example, where there is little demand on the Heat Network, this may be defined as low demand operation, or standby operation. As the Heat Network responds to demand, the network will transition to and between different modes of operation (e.g. low to medium to high demand). For Consumer Systems, the modes of operation are likely to be standby, DHW and/or space heating.
Monitoring Point	Defined points within a Heat Network Element that are required to measure specified data for measurement of KPIs. Covers metering points (Thermal Energy Meters or utility meters) and sensors (temperature, pressure).
Monitoring Point Display	Where a Monitoring Point is a heat meter, this refers to the component which displays the heat meter data. This could be the heat meter integrator or calculator unit.
Network distribution pump	Pump used to circulate the LTHW water through the network's distribution pipes to ensure delivery of heat to end users / consumers.
Node (pipework)	A point in the network where pipework intersects or branches.
Nominal pressure rating (PN)	A standardised designation which represents the Maximum Allowable Pressure (MAP) of equipment at a specified reference temperature. The reference temperature is dependent on the material in question.
Objective	A set of Minimum Requirements which are grouped together to improve the readability of this standard, developed with the intention of indicating: • how fulfilling a set of Minimum Requirements will aid in achieving the Key Aims of this standard; • where there is precedence between Minimum Requirements in the same stage; • which Minimum Requirements are more closely linked to one another; • how the principles of this standard apply to the design, construction, and operation of Heat Networks.
Operating temperature	The temperature the Heat Network operates at to meet the temperature requirements of the end consumer and/or end building.
Overpressure	The increase in pressure between the Safety Relief Device set pressure and the Safety Relief Device relief pressure.

Term	Definition
Peak heat demand	Maximum demand required by the Heat Network to meet sitewide demands, including domestic hot water, space heating, and other heat demands.
Points schedule	A schedule providing all points that are to be monitored by the control system (BMS or equivalent). Includes meters, sensors, faults and alarms, set points for equipment controlled by the control system, enable/disable status and emergency shut off status.
Pre-commission cleaning	The processes of cleaning of new pipework to bring the water quality of system water to acceptable levels.
Pressure difference Δp	Differential pressure (between specified points on the network).
Pressure head diagram	A diagram which visually represents how the working pressure varies across a system.
Pressure safety system	The final Element in place to protect against the risk posed by elevated pressures.
Pressurisation equipment	Equipment specified to maintain a consistent working pressure within the system. Pressurisation equipment commonly consists of top-up technology and an expansion system.
Resilience	The ability to: prepare and plan for; absorb; recover from; and more successfully adapt to adverse events or threats. This definition is in line with that provided in the National Academy of Sciences report <i>Disaster Resilience: A National Imperative</i> (National Academy of Sciences, 2012). In the context of Heat Networks, threats could refer to interruptions to the supply of heat to consumers or incidents which cause damage to the Heat Network.
Responsible Party	An organisation accountable for compliance with the Technical Standards and HNTAS requirements, and is typically the party developing or operating the Heat Network.

Term	Definition
Return approach temperature	The temperature difference between the return inlet and return outlet of a heat exchanger.  $T_{R1} - T_{R2} = \text{return approach temperature}$
Riser pipework	Vertical pipework within a building, serving multiple floors.
Safety Relief Device	A device which releases fluid from a system to reduce its working pressure and protect other equipment on the system from failing.
Safety Relief Device Relief Pressure SRD_{relief}	The pressure at which the Safety Relief Device is fully relieving.
Safety Relief Device Set Pressure SRD_{set}	The pressure at which the Safety Relief Device starts relieving.
Shunt pump	Pump used to regulate the flow of LTHW water within specific branches or circuits of the network e.g. boiler circuit.
Softening	A method of preventing scale formation by removing hardness from the system by exchanging calcium and magnesium ions with sodium ions.
Space heating operation	Mode of operation of the Consumer Connection where there is space heating demand.
Standby operation	Mode of operation of the Consumer Connection where there is no domestic hot water (including storage charging) or space heating demand.
Static Height Pressure p_h	The additional pressure due to the water column above the point of interest.

Term	Definition
Static Pressure p_{static}	The maximum pressure which may arise at a given point in the hydraulic circuit due to static effects.
Static Pressure Margin Δp_s	The additional Static Pressure applied to the network, determined by the designer with consideration for: - the minimum pressure requirements of equipment within the system; - the exclusion of air from the system; - the prevention of vaporisation of water within the system.
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: - District Distribution Network serving District Distribution Network (e.g. district pumping station); - District Distribution Network serving Communal Distribution Network (e.g. building connection); - Communal Distribution Network serving Communal Distribution Network (e.g. pressure break in high rise building), or a connection between a Distribution Network and a single Consumer Heat System, where the instantaneous hot water system is greater than 70 kW and/or space heating system is larger than 20 kW. Typically contains plate heat exchangers, pumps, expansion and pressurisation equipment, water quality equipment, strainers, heat meters, and control valves.
Surveillance system	The system used for detecting leaks throughout the buried network. Often known as the 'leak detection system'.
System Maximum Working Pressure (SMWP)	The maximum gauge pressure which can be present across an entire hydraulic circuit when considering reasonably foreseeable operating conditions.
Temperature difference ΔT	Temperature difference (between flow and return). Sometimes referred to as "Delta T".
Terminal run	Pipework serving one Termination Point, which could be a Consumer Connection or Substation.
Termination Point	The end points of a Distribution Network. For example, Consumer Connections or a Substation. Will contain a Monitoring Point.

Term	Definition
Thermal Energy Meters	Refers to: • heat meters; • cooling meters; and • heat and cooling meters.
Top-up technology	Equipment specified to provide an automated refilling of water systems in the event of planned and/or unplanned water loss.
Water conditioning	The management of water quality within Heat Networks which principally uses non-chemical means (such as demineralisation and the preservation of low conductivity in the system water) to mitigate against the risk of corrosion and microbiological proliferation, with the addition of chemicals limited to exceptional cases.
Water quality metrics	System water parameters which can be used to assess the water quality of the system water but are not KPIs.
Water Quality Recording Programme	Documentation produced regarding the recording of water quality parameters throughout the Heat Network.
Water Quality Strategy	Documentation produced for each hydraulic system which includes information regarding the management of water quality in the system.
Water treatment	The management of water quality within Heat Networks which uses the addition of chemicals to mitigate against the risk of corrosion and microbiological proliferation.
Working pressure	The total gauge pressure present at a given location in a Heat Network.

Annex B: Reference Consumer Heat System temperatures and flow rates

Table B.1: Design temperatures for sizing building services systems

System	Flow temperature ⁹		Return temperature	
	Recommended	Maximum	Recommended	Maximum
Radiators	50 °C	55 °C ¹	30 °C	35 °C
Fan coil units	50 °C	55 °C ¹	30 °C	35 °C
Air handling units	50 °C	55 °C ¹	30 °C	35 °C
Underfloor heating	- ²			
DHW instantaneous heat exchanger at peak demand (LTHW side) (assuming 10 °C mains cold water service)	- ^{3, 4, 6}		High Temp ⁷ : < 17 °C Low Temp ⁷ : < 20 °C	High Temp ⁷ : < 22 °C Low Temp ⁷ : < 27 °C
DHW calorifier with external plate heat exchanger	- ^{5, 6, 8}		- ^{5, 8}	

1 - For the maximum flow temperatures of newly installed wet heating systems, the maximum flow temperature should not exceed 55 °C - refer to Approved Document L: Conservation of Fuel and Power (DLUHC, 2023) and Section 6 (Energy) of the Building Standards Technical Handbook - Domestic (Scottish Government, 2024). This applies for flow temperatures to radiators, fan coil units and air handling units.

2 - Practical limits on the operating temperatures of underfloor heating systems are commonly a maximum value of the floor surface temperature. Refer to CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration (CIBSE, 2016) for additional information. This can typically be achieved by a flow temperature not exceeding 40 °C.

3 - Typical supply temperatures from instantaneous domestic hot water may be 50 °C - refer HSE Approved Code of Practice and Guidance L8: Legionnaires' Disease - The Control of Legionella Bacteria in Water Systems (HSE, 2013) and HSG274 Part 2: The Control of Legionella Bacteria in Hot and Cold Water Systems (HSE, 2024).

4 - Typical supply temperatures of instantaneous domestic hot water may be 55 °C in healthcare premises - refer to NHS Health Technical Memorandum 04-01: Safe Water in Healthcare Premises (NHS England, 2016).

5 - A central domestic hot water calorifier would typically be designed to store water at 60 °C, and with a minimum recirculation temperature of 50 °C (55 °C in healthcare premises) - refer to Technical guidance HSG274 Part 2: The Control of Legionella Bacteria in Hot and Cold Water Systems (HSE, 2024).

6 - It is preferable to reduce domestic hot water supply temperatures, where technically feasible, in line with any given system's Legionella risk assessment.

7 - Maximum return temperatures in accordance with the BESA UK HIU Test Regime (BESA, 2023, or latest edition). If a network is operating at a flow temperature of between 65 °C and 75 °C, comparisons should be made to the High Temperature regime results. If a network is operating at a flow temperature of below 65 °C, comparisons should be made to the Low Temperature regime results.

8 - There can be additional requirements for how the risk of Legionella is controlled of stored domestic hot water in calorifiers - refer to Technical Guidance HSG274 Part 2: The Control of Legionella Bacteria in Hot and Cold Water Systems (HSE, 2024).

9 - In all cases, the variation of flow temperature across the District Distribution Network and Communal Distribution Network needs to be considered, especially for the summer low-flow conditions where temperature drops can be significant. The temperatures given in the above notes are at the consumption point; higher flow temperatures may be required at the Energy Centre and/or Substation.

Table B.2: Example flow rates from typical domestic hot water outlets

Outlet type	Outlet flow rate (l/min) ¹	Outlet temperature (°C) ²
Wash hand basin (WHB)	5.0	43
Shower	8.0	41
Bath	8.0	44
Kitchen tap	6.0	50
Supply		Assumed temperature (°C)
Cold water service		10
Domestic hot water		50

1 - Flow rates at the outlet are equal to the maximum fittings consumption optional requirement set out in Approved Document G: Sanitation, Hot Water Safety and Water Efficiency (DLUHC, 2024) level where applicable. The maximum flow rate to baths is equal to the maximum flow rate for showers - this assumption is in line with the approach used for design flow rates for baths and showers specified in the NHBC Standards (NHBC, 2025, or latest edition).

2 - Outlet temperatures are in accordance with CIBSE Guide G: Public Health and Plumbing Engineering (CIBSE, 2014).

Table B.3: Example domestic hot water demands from typical dwellings

Dwelling type	Rooms with domestic hot water outlets	No. outlets				Flow rate ¹ (l/min)	Power (kW)
		WHB	Shower	Bath	Kitchen		
1 Bath	1no. Bathroom 1no. Kitchen	1	-	1	1	11.0	30.7
1 Bath 1 WC	1no. Bathroom 1no. WC 1no. Kitchen	2	-	1	1	11.5	32.1
1 Shower	1no. Shower room 1no. Kitchen	1	1	-	1	10.9	30.5
1 Shower 1 WC	1no. Shower room 1no. WC 1no. Kitchen	2	1	-	1	11.5	31.9
2 Bath	2no. Bathroom 1no. Kitchen	2	-	2	1	12.2	34.0
1 Bath 1 Shower	1no. Bathroom 1no. Shower room 1no. Kitchen	2	1	1	1	12.1	33.9
1 Bath 1 Shower 1 WC	1no. Bathroom 1no. Shower room 1no. WC 1no. Kitchen	3	1	1	1	12.5	34.9
2 Bath 2 WC	2no. Bathroom 2no. WC 1no. Kitchen	4	-	2	1	12.9	35.9
1 Bath 2 Shower 2 WC	1no. Bathroom 2no. Shower room 2no. WC 1no. Kitchen	5	2	1	1	13.6	37.9

The domestic hot water demands at the Consumer Connections in [Table B.3](#) have been determined by applying the equation set out in Requirement [2.1.13/3.1.13](#) to the design domestic hot water flow rates to each outlet (provided in [Table B.2](#)) in the Consumer Heat System.

1 - Refers to un-mixed flow rate of domestic hot water out of the Consumer Connection (e.g. HIU).

Annex C: Pipe sizing example

The following worked example provides an example methodology for sizing Communal Distribution Network pipework serving Heat Interface Units (HIUs) with instantaneous domestic hot water production.

Assumptions

The assumptions used throughout this example are provided in [Table C.1](#). Designers should make assumptions regarding the demands from space heating and domestic hot water on a system-specific basis.

The method presented here shows how peak demands can be determined in a Distribution Network with the diversification of demands determined in accordance with Requirement [2.1.13/3.1.13](#) and Requirement [2.1.8/3.1.8](#).

The peak demand from domestic hot water has been diversified using the approach set out in Requirement [2.1.13/3.1.13](#) in this worked example.

Table C.1: Parameters used for pipe sizing worked example

Parameter		Value	Source
Design information			
Distribution network flow temperature T_f		55 °C	BESA UK HIU Test Regime (BESA, 2023, or latest edition) Low Temperature scenario flow temperature
Distribution network domestic hot water return temperature $T_{r,DHW}$		20 °C	Low Temperature scenario return temperature in accordance with Table B.1
Distribution network space heating return temperature $T_{r,SH}$		33 °C	Consumer Heat System space heating return temperature in accordance with Table B.1 Return approach temperature in accordance with Requirement 1.8.4
Domestic hot water temperature T_{DHW}		50 °C	Temperatures in accordance with typical temperatures provided in Table B.1
BCWS supply temperature T_{BCWS}		10 °C	
Number of outlets N_{outlet} per dwelling	Bath	1 no.	Dwelling used for this pipe sizing example
	Shower	1 no.	
	Kitchen	1 no.	
	WHB	2 no.	

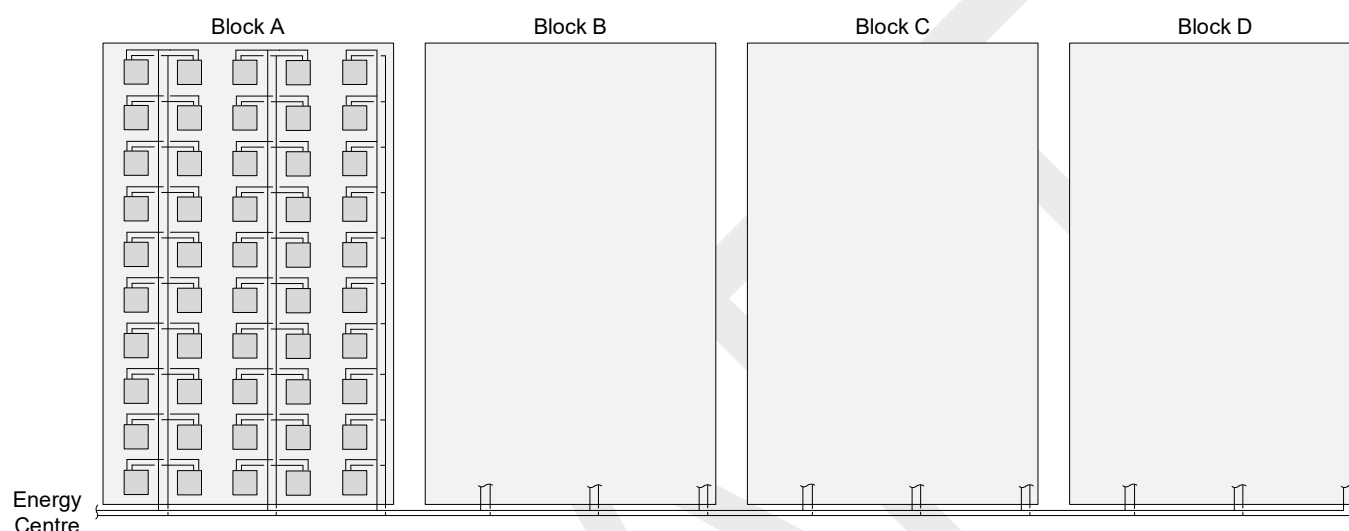
Parameter		Value	Source
Domestic hot water outlet temperature T_{outlet}	Bath	44 °C	Domestic hot water outlet temperatures in accordance with Table B.2
	Shower	41 °C	
	Kitchen	50 °C	
	WHB	43 °C	
Domestic hot water outlet (blended) flow rate q_{outlet}	Bath	8 l/min	Domestic hot water outlet flow rates in accordance with Table B.2
	Shower	8 l/min	
	Kitchen	6 l/min	
	WHB	5 l/min	
Dwelling peak space heating demand Q_{SH}		3.0 kW	BESA Reference Building space heating demand
Pipe material		Medium grade steel	Example material used for LTHW networks
Physical Parameters			
Density of water ρ		1.00 kg/l	Assumed to be constant with temperature
Heat capacity of water c_p		4.18 kJ/(kg·K)	

Values are based on the BESA UK HIU Test Regime (BESA, 2023, or latest edition) Low Temperature regime where applicable.

Reference building

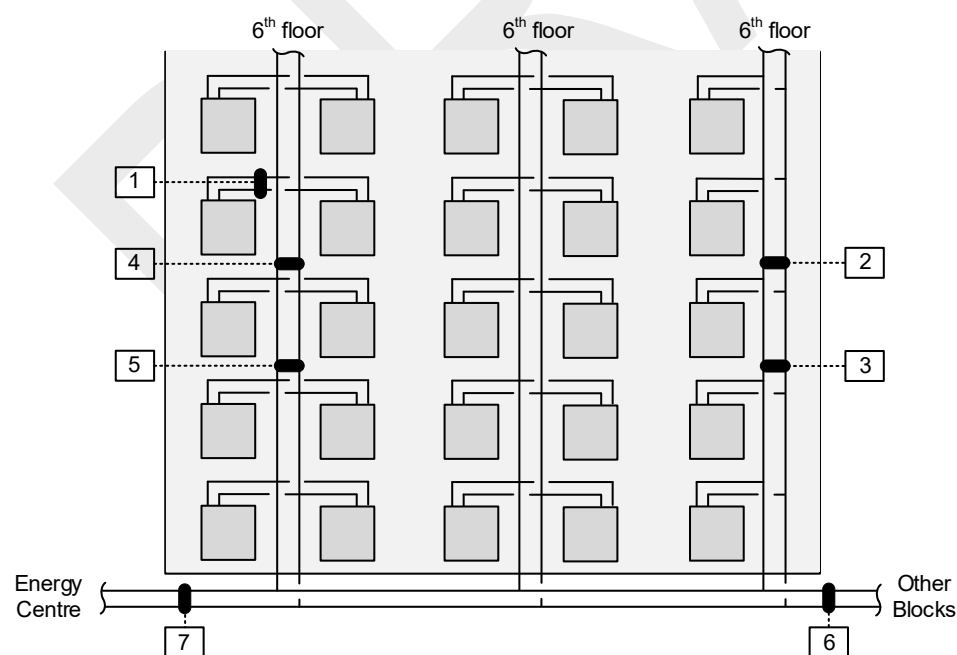
Figure C.1 shows the layout of the BESA Reference Building (which can be found in the Technical Standard for the BESA UK HIU Test Regime BESA UK HIU Test Regime (BESA, 2023, or latest edition)) with a multi-riser typology, which has been used in this example. The sections in the Distribution Network for which peak demands have been determined in this example are shown in Figure C.2.

Figure C.1: Network schematic of building used in pipe sizing worked example



This network schematic is based on the BESA Reference Building with a multi-riser typology. The network layout within Block B, C and D is identical to that indicated in Block A.

Figure C.2: Illustration of pipe sections considered in worked example



The sections illustrated are within Block A of the BESA Reference Building.

The number of dwellings served by each pipe section labelled in Figure C.2 is shown in Table C.2.

Table C.2: Description of pipe sections considered in worked example

Pipe section	Description	Dwellings served, $N_{\text{dwellings}}$
1	Terminal run	1
2	Small riser serving above 3 rd floor	7
3	Small riser serving above 2 nd floor	8
4	Large riser serving above 3 rd floor	14
5	Large riser serving above 2 nd floor	16
6	Supply serving blocks B, C, and D	150
7	Supply serving all blocks	200

Domestic hot water flow rate at individual outlet, q_f

The required domestic hot water flow rate for each outlet type has been determined using the equation provided in Figure 18, which is written below to match the temperatures provided in Table C.1.

$$q_f = \frac{T_{\text{outlet}} - T_{\text{BCWS}}}{T_{\text{DHW}} - T_{\text{BCWS}}} \times q_{\text{outlet}}$$

For example, for a bath tap with the blended flow rate and temperature given in Table C.1, q_f has been calculated as follows:

$$q_f = \frac{44 - 10}{50 - 10} \times 8$$

$$= 6.8 \text{ l/min}$$

$$q_f = 0.11 \text{ l/s}$$

An identical process has been applied to the other outlet types to determine the values for $q_{f,\text{outlet}}$ at other outlets.

Diversified peak domestic hot water flow rate, $q_{d,\text{DHW}}$

The diversified peak domestic hot water flow rate $q_{d,\text{DHW}}$ in a given pipe section has been determined based on the sum of the required domestic hot water flow rates from all outlets served by that pipe, using the equation given in Figure 18 and recommended values for A , θ , and q_m given in Table 4.

As the temperatures on either side of the Consumer Connection are not the same, with a different temperature difference across either side, the flow rates on either side of the Consumer Connection will not be the same. Therefore, a correction factor, based on the temperature differences on each side of the connection, has been applied in this example.

The diversified flow rate for pipe section 2 is calculated as follows:

$$\begin{aligned}\Sigma q_f &= \sum_{\text{outlets}} q_{f,\text{outlet}} \\ &= \sum_{\text{bath}} q_{f,\text{bath}} + \sum_{\text{shower}} q_{f,\text{shower}} + \sum_{\text{kitchen}} q_{f,\text{kitchen}} + \sum_{\text{WHB}} q_{f,\text{WHB}}\end{aligned}$$

Pipe section 2 in [Figure C.2](#) serves 7 dwellings, each of which contains 1 bath, 1 shower, 1 kitchen tap, and 2 wash hand basins.

Σq_f and the diversified peak demand flow rate due to domestic hot water $q_{d,\text{DHW}}$ are hence calculated as indicated as below:

$$\Sigma q_f = 7 \times (1 \cdot 0.11 + 1 \cdot 0.10 + 1 \cdot 0.10 + 2 \cdot 0.07)$$

$$\Sigma q_f = 3.2 \text{ l/s}$$

$$q_{d,\text{DHW}} = \left[2q_m + \theta \cdot ((\Sigma q_f) - 2q_m) + A \cdot \sqrt{q_m \theta} \cdot \sqrt{(\Sigma q_f) - 2q_m} \right] \times \frac{T_{\text{DHW}} - T_{\text{BCWS}}}{T_f - T_{r,\text{DHW}}}$$

$$q_{d,\text{DHW}} = \left[2 \cdot 0.075 + 0.011 \cdot (3.2 - 2 \cdot 0.075) + 3.1 \cdot (\sqrt{0.075 \cdot 0.011}) \cdot (\sqrt{3.2 - 2 \cdot 0.075}) \right] \times \frac{50-10}{55-20}$$

$$q_{d,\text{DHW}} = 0.39 \text{ l/s}$$

Diversified peak space heating flow rate, $q_{d,\text{SH}}$

To calculate the diversified peak space heating flow rate $q_{d,\text{SH}}$ in a given section of pipe, a diversity factor has been applied to the sum of the space heating demands of all dwellings served by that section.

The diversity factor in this example has been calculated in accordance with [Figure 17](#).

The diversified flow rate for pipe section 2 has been calculated as follows:

$$\text{Diversity factor} = 0.62 + \frac{0.38}{N}$$

$$= 0.62 + \frac{0.38}{7}$$

$$= 0.67$$

$$\sum \text{space heating demand} = N_{\text{dwellings}} \times Q_{\text{SH}}$$

$$= 7 \times 3.0$$

$$= 21 \text{ kW}$$

$$\begin{aligned}\text{Diversified peak space heating demand} &= \text{Diversity factor} \times \sum \text{space heating demand} \\ &= 0.67 \times 21\end{aligned}$$

Diversified peak space heating demand = 14 kW

$$\begin{aligned}q_{d,SH} &= \frac{\text{Diversified peak space heating demand}}{\rho \cdot c_p \cdot (T_f - T_{r,SH})} \\ &= \frac{14}{1 \cdot 4.2 \cdot (55 - 33)} \\ q_{d,SH} &= 0.15 \text{ l/s}\end{aligned}$$

Pipework sizing

Requirement 2.5.4/3.5.4 recommends that the smallest feasible pipe diameter should be considered early within the pipe sizing process to prevent oversizing of Communal Distribution Network pipework, due to the reduced capital cost and heat losses from smaller pipework diameters.

The pipe sizes in this example have hence been selected based on the smallest feasible pipe diameter, subject to flow velocity constraints. Additional constraints present on the design of the system will need to be considered when undertaking pipe sizing in a real-world system.

The diversified peak-demand flow rates for each of the pipe sections in Figure C.2 are shown in Table C.3.

Table C.3: Diversified peak-demand flow rates for pipe sections in worked example

Section	No. dwellings served	Diversified space heating flow rate (l/s)	Diversified DHW flow rate (l/s)	Peak demand flow rate (l/s)
1	1	0.03	0.23	0.26
2	7	0.15	0.39	0.54
3	8	0.17	0.41	0.58
4	14	0.30	0.50	0.80
5	16	0.34	0.53	0.87
6	150	3.05	1.86	4.91
7	200	4.06	2.28	6.34

CIBSE Guide B: *Heating, Ventilating, Air Conditioning and Refrigeration* (CIBSE, 2016) recommends maximum flow velocities (to avoid excessive noise and vibration) and minimum flow velocities (to avoid the settlement of air and debris), which are provided in Table 1 of this document. An extract of this table detailing velocity limits for steel pipes is presented in Table C.4.

Table C.4: Velocity limits for medium grade steel

Nominal diameter	Outside diameter of pipe (mm)	Minimum velocity (m/s)	Maximum velocity (m/s)
≤ DN50	≤ 60.3	0.5	1.5
> DN50	> 60.3	0.5	3.0

Values in accordance with CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration (CIBSE, 2016) for steel pipework.

To select the smallest practicable pipe size for a pipe section, a methodical approach has been taken starting with the minimum allowable nominal diameter. For medium grade steel, the assumed smallest pipe diameter available is a nominal diameter of DN20, as the majority of HIU connections are of this size.

This approach consists of:

1. calculating the flow velocity for DN20 pipework for each section;
2. determining if velocity limits are exceeded at this pipe size;
3. increasing the pipe size by one size; and
4. repeating steps 2 and 3 until the velocity limits present on the pipe section are not exceeded.

This application of this methodology is indicated in [Table C.5](#).

Table C.5: Demonstration of pipe sizing methodology using velocity limits

Section	Peak demand flow rate (l/s)	Flow velocity (m/s)						Selected pipe size
		DN20	DN25	DN32	DN40	DN50	DN65	
1	0.26	0.71	-	-	-	-	-	DN20
2	0.54	1.46	-	-	-	-	-	DN20
3	0.58	1.57	0.98	-	-	-	-	DN25
4	0.80	2.16	1.35	-	-	-	-	DN25
5	0.87	2.35	1.47	-	-	-	-	DN25
6	4.91	13.28	8.33	4.80	3.54	2.22	1.32	DN65
7	6.34	17.17	10.75	6.19	4.57	2.86	1.70	DN65

Amber shading indicates that the velocity exceeds limits presented in CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration (CIBSE, 2016).

Green shading indicates that a pipe size is potentially suitable.

The system designer should check whether other constraints present on the system (e.g. the heat loss from the Distribution Network, or the cost of electrical energy required for distribution pumps) can make it beneficial for an alternative pipe size to be selected.

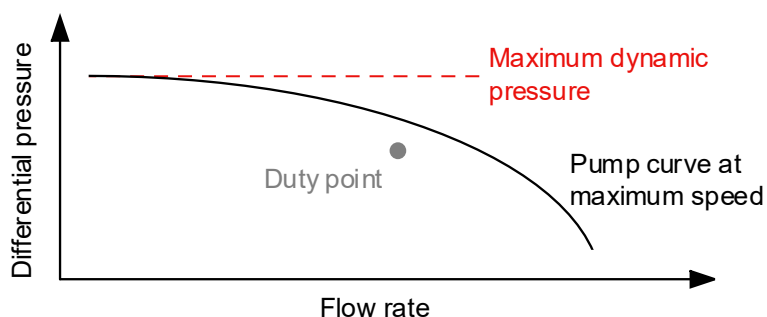
Annex D: Pressure calculation examples

These worked examples concern the following three Communal Distribution Networks:

1. A network with one pair of risers, with its Energy Centre in the lowest floor.
2. A network with one pair of risers, with its Energy Centre on the roof of the building.
3. A Communal Distribution Network with multiple pairs of risers (with different risers serving different floor zones), which is connected to a District Distribution Network by an indirect Substation.

The examples assume that the maximum differential pressure which each pump can develop is a known value. This should be determined by referring to the pump curve (such as that illustrated in [Figure D.1](#)) from manufacturer documentation in a real system.

Figure D.1: Example pump curve showing maximum dynamic pressure



Calculated values for the working pressure and Local Maximum Working Pressure (LMWP) at various points in each network are provided, as well as the calculated System Maximum Working Pressure (SMWP) for each hydraulic circuit.

The scenario considered in these worked examples assumes that all pumps have been set to operate 'in hand', and that there is a low-to-zero flow condition throughout the network.

This calculation does not explicitly account for thermal expansion. This is because thermal expansion is managed differently by different technologies (e.g. through the use of expansion vessels, or spill-and-fill units). This can lead to different pressure margins being applied to these calculations.

Where thermal storage is included within the example networks, it has been assumed that the sizing of pipework connected to the thermal storage is sufficient for it to exhibit similar hydraulic separation to a low-loss header.

The pressure margins used are in line with the pressure margin requirement set out in Requirement [2.11.24/3.11.24](#). Different margins can be used depending on the model of spill-and-fill unit used, or the use of expansion vessels. Manufacturer guidance should be sought to determine the appropriate margins to be applied, with consideration of the design approach to managing thermal expansion within the system.

The calculations in this annex also assume parameters for each system as set out in [Table D.1](#). Note that some literature, such as BS 7074-2:1989: *Application, Selection, and Installation of Expansion Vessels and Ancillary Equipment for Sealed Water Systems* (BSI, 1989) assumes a conversion of 10.2 metres for every bar(g) of Static Height Pressure (i.e. $(\rho g)^{-1} = 10.2 \text{ m/bar}$).

Table D.1: Assumed values for Static Height Pressure conversion

Parameter	Definition	Assumed value	Unit
ρ	Density of system water	1,000	kg/m ³
g	Acceleration due to gravity	9.81	m/s ²

Example Network 1 – Energy Centre in lowest floor

Concept Design

A diagram of the system with the level of information which may be expected at the Concept Design stage is provided in [Figure D.2](#). Example calculations to obtain a value for the System Maximum Working Pressure (SMWP) are given in [Table D.2](#).

Due to the lack of design information available at the Concept Design stage regarding the elevation of different equipment and pipework in a plant room, points in the grey hashed box have been assumed to be at the same elevation.

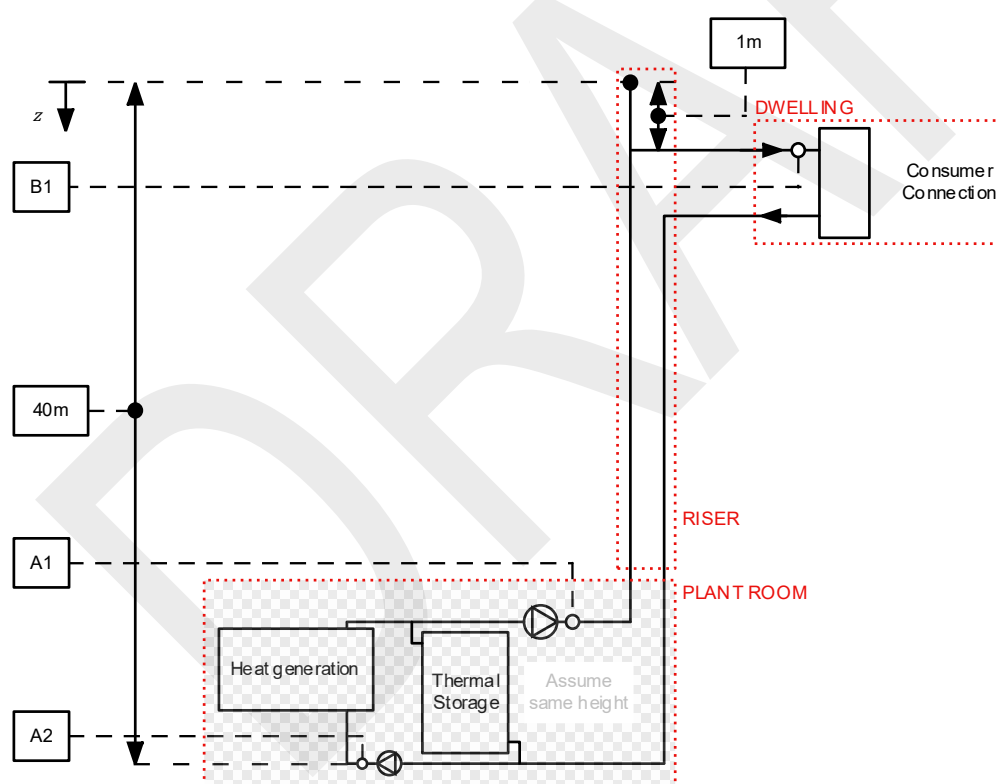
Figure D.2: Example Network 1 at Concept Design stage

Table D.2: Calculated values from Example Network 1 at Concept Design stage

Parameter	Definition	A1	B1	A2	Unit
Assumed values					
Δp_s	Example system Static Pressure Margin	0.7 ¹			bar(g)
Δp_{HA}	Example pressurisation unit high alarm allowance	0.5			bar(g)
Δp_{ex}	Example system pressure allowance for thermal expansion The value of this parameter depends on the size and type of pressurisation equipment. Manufacturer guidance should be sought when selecting an appropriate allowance for the system.	<i>Typical range (fixed gas cushion):</i> 1.0 - 4.0 <i>Typical range (spill-and-fill):</i> 0.6 - 1.0 <i>Example value: 2.0²</i>			bar(g)
$\max\{p_{dynamic}\}$	Example maximum possible dynamic pressure	2.0		1.0	bar(g)
H	Height difference between lowest point and highest point in the hydraulic circuit	40.0		40.0	m
z_{fill}	Height difference between fill point and highest point in the system ³	40.0			m
Calculated values					
z	Height difference between point of interest and highest point in system ³	40.0	1.0	40.0	m
p_h	$=\rho g \cdot z$	3.92	0.10	3.92	bar(g)
p_{fill}	$=\rho g \cdot z_{fill} + \Delta p_s$	4.62			bar(g)
p_{HA}	$=p_{fill} + \Delta p_{HA} + \Delta p_{ex}$	7.12			bar(g)
p_{static}	$=\rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12	3.30	7.12	bar(g)
$LMWP_{location}$	$=\left\{ \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex} \right\}_{location} + \max(p_{dynamic})$	9.12	5.30	7.72	bar(g)
$\max\{p_{static}\}$	$=\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12		7.12	bar(g)
$SMWP^4$	$= (\max\{p_{static}\}) + \max\{p_{dynamic}\}$ $= (\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}) + \max\{p_{dynamic}\}$	9.12		8.12	bar(g)

1 - A minimum value of 0.7 bar for the system Static Pressure Margin has been used in accordance with Requirement 2.11.24/3.11.24. Manufacturer guidance should be consulted.

Factors used to determine an appropriate system Static Pressure Margin can include:

- the pressure margin necessary to expel air from the system;
- the vapour pressure of the system water across the range of expected operating conditions of the system;
- the pressure margin necessary to mitigate the risk of cavitation in the system.

2 - This example calculation assumes that a fixed-gas cushion expansion vessel has been specified.

3 - The heights of all points in the plant room have been assumed to be at low-level within the plant room, to be representative of the design information available at a Concept Design stage.

4 - It is noted that the value of the System Maximum Working Pressure is only an estimate at the Concept Design stage. If the calculated System Maximum Working Pressure is close to pressure limits on conventional equipment (such as PN10), it can be prudent to select equipment at a higher pressure rating at the Concept Design stage until more detailed design information is made available at subsequent design stages.

Technical Design

A diagram of the system with the level of information which may be expected at the Technical Design stage is provided in Figure D.3. Example calculations to obtain a value for the System Maximum Working Pressure (SMWP) are given in Table D.3.

Changes to some of the system characteristic values (such as the static heights of the locations in the network and the maximum pump differential pressure) have been made to reflect updates to design information which can happen between the Concept Design stage and the Technical Design stage.

Figure D.3: Example Network 1 at Technical Design stage

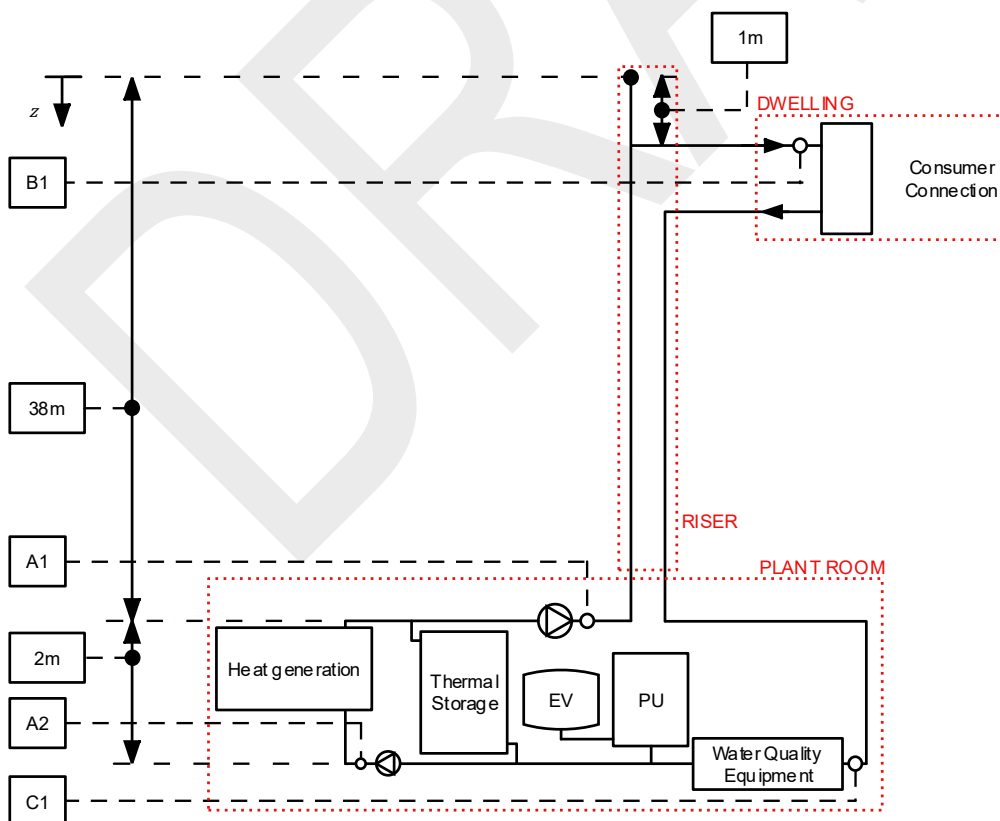


Table D.3: Calculated values from Example Network 1 at Technical Design stage

Parameter	Definition	A1	B1	C1	A2	Unit
Assumed values						
Δp_s	Example system Static Pressure Margin	0.7 ¹				bar(g)
Δp_{HA}	Example pressurisation unit high alarm allowance	0.5				bar(g)
Δp_{ex}	Example system pressure allowance for thermal expansion The value of this parameter depends on the size and type of pressurisation equipment. Manufacturer guidance should be sought when selecting an appropriate allowance for the system.	<i>Typical range (fixed gas cushion):</i> 1.0 - 4.0 <i>Typical range (spill-and-fill):</i> 0.6 - 1.0 <i>Example value:</i> 2.0 ²				bar(g)
$\max \left\{ p_{dynamic} \right\}$	Example maximum possible dynamic pressure	1.8			1.0	bar(g)
H	Height difference between lowest point and highest point in the hydraulic circuit	40.0			40.0	m
z_{fill}	Height difference between fill point and highest point in the system ³	40.0				m
Calculated values						
z	Height difference between point of interest and highest point in system	38.0	1.0	40.0	40.0	m
p_h	$= \rho g \cdot z$	3.73	0.10	3.92	3.92	bar(g)
p_{fill}	$= \rho g \cdot z_{fill} + \Delta p_s$	4.62				bar(g)
p_{HA}	$= p_{fill} + \Delta p_{HA} + \Delta p_{ex}$	7.12				bar(g)
p_{static}	$= \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	6.93	3.30	7.12	7.12	bar(g)
$LMWP_{location}$	$= \left\{ \begin{array}{l} \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex} \\ + \max \left(p_{dynamic} \right) \end{array} \right\}_{location}$	8.73	5.10	8.92	8.12	bar(g)
$\max \{ p_{static} \}$	$= \rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12			7.12	bar(g)
SMWP	$= \left(\max \{ p_{static} \} \right) + \max \{ p_{dynamic} \}$ $= \left(\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex} \right) + \max \{ p_{dynamic} \}$	8.92			8.12	bar(g)

1 - A minimum value of 0.7 bar for the system Static Pressure Margin has been used in accordance with Requirement 2.11.24/3.11.24. Manufacturer guidance should be consulted.

Factors used to determine an appropriate system Static Pressure Margin can include:

- the pressure margin necessary to expel air from the system;
- the vapour pressure of the system water across the range of expected operating conditions of the system;
- the pressure margin necessary to mitigate the risk of cavitation in the system.

2 - This example calculation assumes that a fixed-gas cushion expansion vessel has been specified.

DRAFT

Example Network 2 – Energy Centre on rooftop

Concept Design

A diagram of the system with the level of information which may be expected at the Concept Design stage is provided in [Figure D.4](#). Example calculations to obtain a value for the System Maximum Working Pressure (SMWP) are given in [Table D.4](#).

Due to the lack of design information available at the Concept Design stage regarding the elevation of different equipment and pipework in a plant room, points in the grey hashed box have been assumed to be at the same elevation.

Figure D.4: Example Network 2 at Concept Design stage

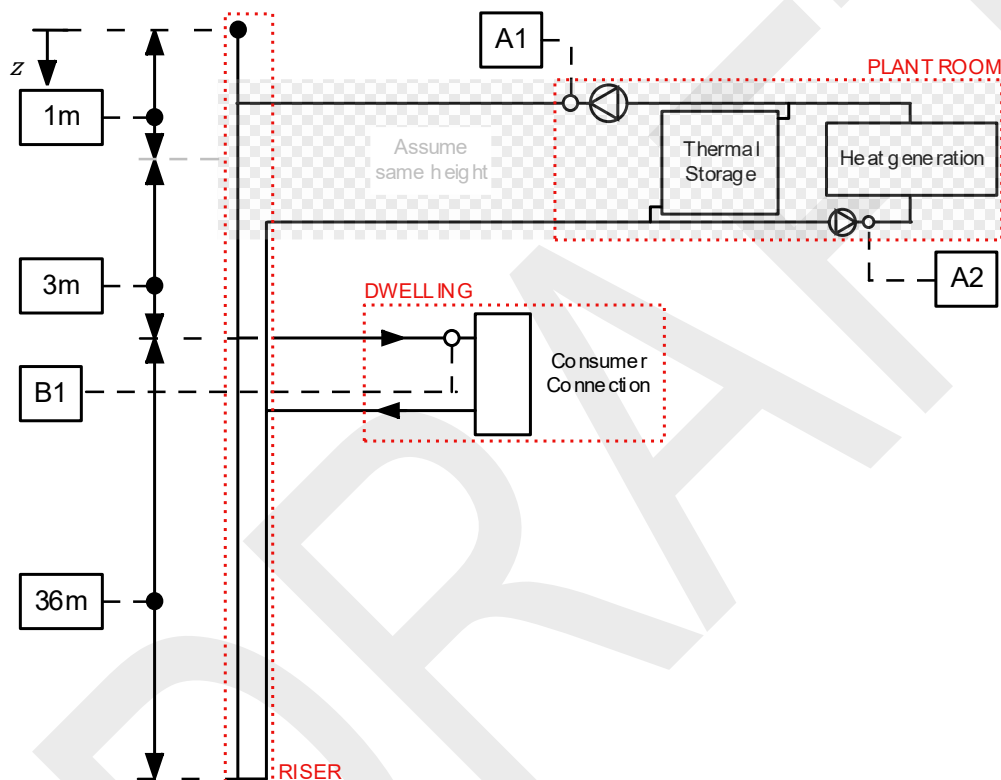


Table D.4: Calculated values from Example Network 2 at Concept Design stage

Parameter	Definition	A1	B1	A2	Unit
Assumed values					
Δp_s	Example system Static Pressure Margin	0.7 ¹			bar(g)
Δp_{HA}	Example pressurisation unit high alarm allowance	0.5			bar(g)
Δp_{ex}	Example system pressure allowance for thermal expansion The value of this parameter depends on the size and type of pressurisation equipment. Manufacturer guidance should be sought when selecting an appropriate allowance for the system.	<i>Typical range (fixed gas cushion):</i> 1.0 - 4.0 <i>Typical range (spill-and-fill):</i> 0.6 - 1.0 <i>Example value: 2.0²</i>			bar(g)
$\max\{p_{dynamic}\}$	Example maximum possible dynamic pressure	2.0		1.0	bar(g)
H	Height difference between lowest point and highest point in the hydraulic circuit	40.0		1.0	m
z_{fill}	Height difference between fill point and highest point in the system ³	1.0			m
Calculated values					
z	Height difference between point of interest and highest point in system ³	1.0	4.0	1.0	m
p_h	$=\rho g \cdot z$	0.10	0.39	0.10	bar(g)
p_{fill}	$=\rho g \cdot z_{fill} + \Delta p_s$	0.80			bar(g)
p_{HA}	$=p_{fill} + \Delta p_{HA} + \Delta p_{ex}$	3.30			bar(g)
p_{static}	$=\rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	3.30	3.59	3.30	bar(g)
$LMWP_{location}$	$=\left\{ \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex} \right\}_{location} + \max(p_{dynamic})$	5.30	5.59	4.30	bar(g)
$\max\{p_{static}\}$	$=\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12		3.30	bar(g)
$SMWP^4$	$= (\max\{p_{static}\}) + \max\{p_{dynamic}\}$ $= (\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}) + \max\{p_{dynamic}\}$	9.12		4.30	bar(g)

Table D.5: Calculated values from Example Network 2 at Technical Design stage

Parameter	Definition	A1	B1	C1	A2	Unit
Assumed values						
Δp_s	Example system Static Pressure Margin	0.7 ¹				bar(g)
Δp_{HA}	Example pressurisation unit high alarm allowance	0.5				bar(g)
Δp_{ex}	Example system pressure allowance for thermal expansion The value of this parameter depends on the size and type of pressurisation equipment. Manufacturer guidance should be sought when selecting an appropriate allowance for the system.	<i>Typical range (fixed gas cushion):</i> 1.0 - 4.0 <i>Typical range (spill-and-fill):</i> 0.6 - 1.0 <i>Example value:</i> 2.0 ²				bar(g)
$\max \left\{ p_{dynamic} \right\}$	Example maximum possible dynamic pressure	1.8			1.0	bar(g)
H	Height difference between lowest point and highest point in the hydraulic circuit	40.0			1.5	m
z_{fill}	Height difference between fill point and highest point in the system ³	2.0				m
Calculated values						
z	Height difference between point of interest and highest point in system	0.5	4.0	1.5	1.5	m
p_h	$= \rho g \cdot z$	0.05	0.39	0.15	0.15	bar(g)
p_{fill}	$= \rho g \cdot z_{fill} + \Delta p_s$	0.90				
p_{HA}	$= p_{fill} + \Delta p_{HA} + \Delta p_{ex}$	3.40				
p_{static}	$= \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	3.25	3.59	3.35	3.35	bar(g)
$LMWP_{location}$	$= \left\{ \begin{array}{l} \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex} \\ + \max \left(p_{dynamic} \right) \end{array} \right\}_{location}$	5.05	5.39	5.15	4.35	bar(g)
$\max \{ p_{static} \}$	$= \rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12			3.35	
SMWP	$= \left(\max \{ p_{static} \} \right) + \max \{ p_{dynamic} \}$ $= \left(\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex} \right) + \max \{ p_{dynamic} \}$	8.92			4.35	

1 - A minimum value of 0.7 bar for the system Static Pressure Margin has been used in accordance with Requirement 2.11.24/3.11.24. Manufacturer guidance should be consulted.

Factors used to determine an appropriate system Static Pressure Margin can include:

- the pressure margin necessary to expel air from the system;
- the vapour pressure of the system water across the range of expected operating conditions of the system;
- the pressure margin necessary to mitigate the risk of cavitation in the system.

2 - This example calculation assumes that a fixed-gas cushion expansion vessel has been specified.

Example Network 3 – Multiple sets of risers

Concept Design

A diagram of the system with the level of information which may be expected at the Concept Design stage is provided in [Figure D.6](#). Example calculations to obtain a value for the System Maximum Working Pressure (SMWP) are given in [Table D.6](#).

Due to the lack of design information available at the Concept Design stage regarding the elevation of different equipment and pipework in a plant room, points in the grey hashed box have been assumed to be at the same elevation.

Figure D.6: Example Network 3 at Concept Design stage

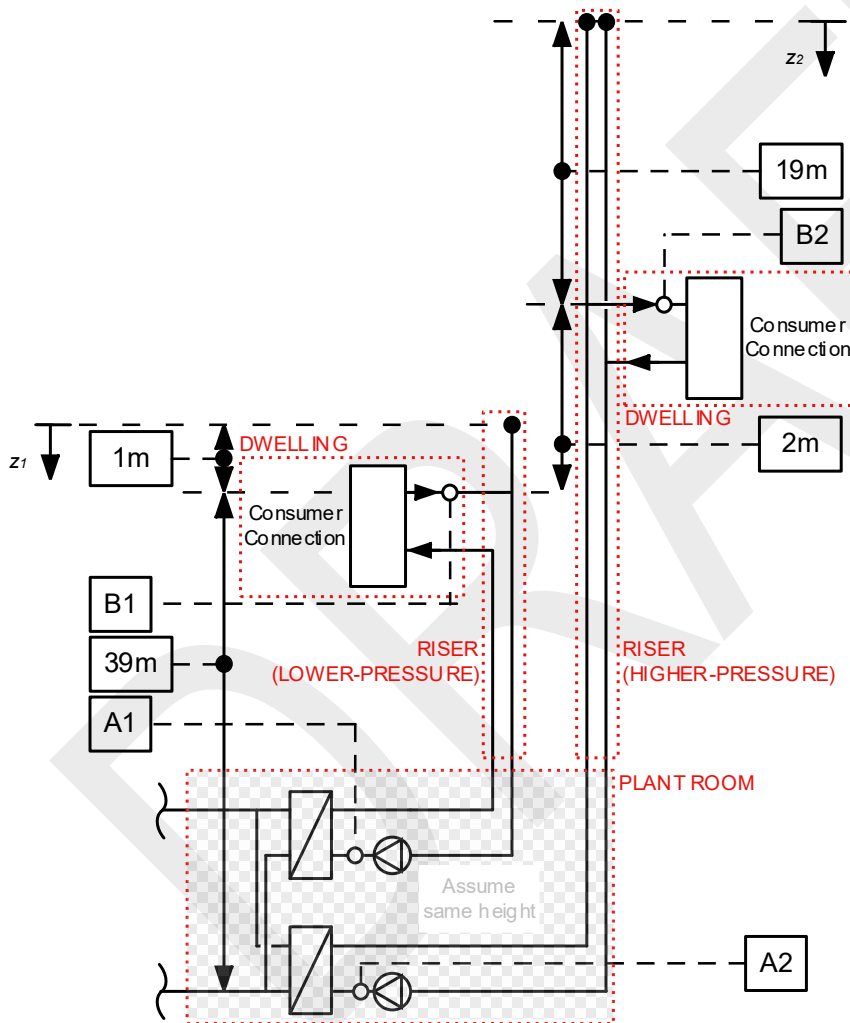


Table D.6: Calculated values from Example Network 3 at Concept Design stage

Parameter	Definition	A1	B1	A2	B2	Unit
Assumed values						
Δp_s	Example system Static Pressure Margin	0.7 ¹				bar(g)
Δp_{HA}	Example pressurisation unit high alarm allowance	0.5				bar(g)
Δp_{ex}	Example system pressure allowance for thermal expansion The value of this parameter depends on the size and type of pressurisation equipment. Manufacturer guidance should be sought when selecting an appropriate allowance for the system.	<i>Typical range (fixed gas cushion):</i> 1.0 - 4.0 <i>Typical range (spill-and-fill):</i> 0.6 - 1.0 <i>Example value: 2.0</i> ²				bar(g)
$\max \left\{ p_{dynamic} \right\}$	Example maximum possible dynamic pressure	2.0		2.5		bar(g)
H	Height difference between lowest point and highest point in the hydraulic circuit	40.0		60.0		m
z_{fill}	Height difference between fill point and highest point in the system ³	40.0		60.0		m
Calculated values						
z	Height difference between point of interest and highest point in system ³	40.0	1.0	60.0	19.0	m
p_h	$= \rho g \cdot z$	3.92	0.10	5.89	1.86	bar(g)
p_{fill}	$= \rho g \cdot z_{fill} + \Delta p_s$	4.62		6.59		bar(g)
p_{HA}	$= p_{fill} + \Delta p_{HA} + \Delta p_{ex}$	7.12		9.09		bar(g)
p_{static}	$= \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12	3.30	9.09	5.06	bar(g)
$LMWP_{location}$	$= \left\{ \begin{array}{l} \rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex} \\ + \max \left(p_{dynamic} \right) \end{array} \right\}_{location}$	9.12	5.30	11.59	7.56	bar(g)
$\max \{ p_{static} \}$	$= \rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12		9.09		bar(g)
SMWP ⁴	$= (\max \{ p_{static} \}) + \max \{ p_{dynamic} \}$ $= (\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}) + \max \{ p_{dynamic} \}$	9.12		11.59		bar(g)

1 - A minimum value of 0.7 bar for the system Static Pressure Margin has been used in accordance with Requirement 2.11.24/3.11.24. Manufacturer guidance should be consulted.

Factors used to determine an appropriate system Static Pressure Margin can include:

- the pressure margin necessary to expel air from the system;
- the vapour pressure of the system water across the range of expected operating conditions of the system;
- the pressure margin necessary to mitigate the risk of cavitation in the system.

2 - This example calculation assumes that a fixed-gas cushion expansion vessel has been specified.

3 - The heights of all points in the plant room have been assumed to be at low-level within the plant room, to be representative of the design information available at a Concept Design stage.

4 - It is noted that the value of the System Maximum Working Pressure is only an estimate at the Concept Design stage. If the calculated System Maximum Working Pressure is close to pressure limits on conventional equipment (such as PN10), it can be prudent to select equipment at a higher pressure rating at the Concept Design stage until more detailed design information is made available at subsequent design stages.

Technical Design

A diagram of the system with the level of information which may be expected at the Technical Design stage is provided in [Figure D.7](#). Example calculations to obtain a value for the System Maximum Working Pressure (SMWP) are given in [Table D.7](#).

Changes to some of the system characteristic values (such as the static heights of the locations in the network and the maximum pump differential pressure) have been made to reflect updates to design information which can happen between the Concept Design stage and the Technical Design stage.

Figure D.7: Example Network 3 at Technical Design stage

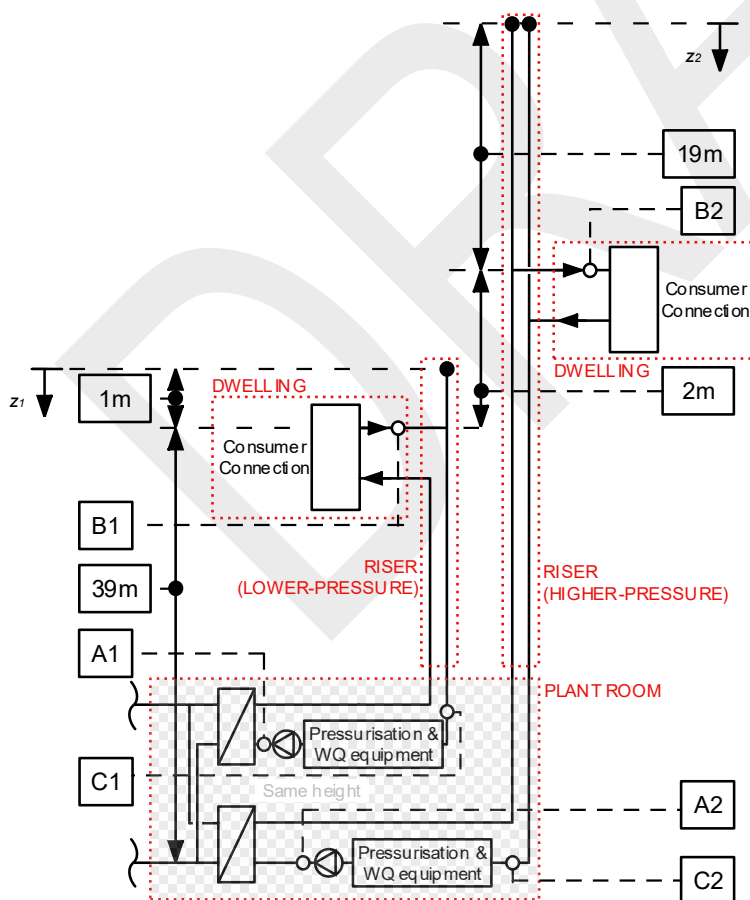


Table D.7: Calculated values from Example Network 3 at Technical Design stage

Parameter	Definition	A1	B1	C1	A2	B2	C2	Unit
Assumed values								
Δp_s	Example system Static Pressure Margin	0.7 ¹						bar(g)
Δp_{HA}	Example pressurisation unit high alarm allowance	0.5						bar(g)
Δp_{ex}	Example system pressure allowance for thermal expansion The value of this parameter depends on the size and type of pressurisation equipment. Manufacturer guidance should be sought when selecting an appropriate allowance for the system.	<i>Typical range (fixed gas cushion):</i> 1.0 - 4.0 <i>Typical range (spill-and-fill):</i> 0.6 - 1.0 <i>Example value: 2.0</i> ²						bar(g)
$\max\{p_{dynamic}\}$	Example maximum possible dynamic pressure	1.8			2.2			bar(g)
H	Height difference between lowest point and highest point in the hydraulic circuit	40.0			60.0			m
z_{fill}	Height difference between fill point and highest point in the system ³	40.0			60.0			m
Calculated values								
z	Height difference between point of interest and highest point in system ³	40.0	1.0	40.0	60.0	19.0	60.0	m
p_h	$=\rho g \cdot z$	3.92	0.10	3.92	5.89	1.86	5.89	bar(g)
p_{fill}	$=\rho g \cdot z_{fill} + \Delta p_s$	4.62			6.59			bar(g)
p_{HA}	$=p_{fill} + \Delta p_{HA} + \Delta p_{ex}$	7.12			9.09			bar(g)
p_{static}	$=\rho g \cdot z + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12	3.30	7.12	9.09	5.06	9.09	bar(g)
$LMWP_{location}$	$= \left\{ \begin{array}{l} \rho g \cdot z + \Delta p_s + \Delta p_{HA} \\ + \Delta p_{ex} + \max(p_{dynamic}) \end{array} \right\}_{location}$	8.92	5.10	8.92	11.29	7.26	11.29	bar(g)
$\max\{p_{static}\}$	$=\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}$	7.12			9.09			bar(g)
SMWP	$=(\max\{p_{static}\}) + \max\{p_{dynamic}\}$ $=(\rho g \cdot H + \Delta p_s + \Delta p_{HA} + \Delta p_{ex}) + \max\{p_{dynamic}\}$	8.92			11.29			bar(g)

1 - A minimum value of 0.7 bar for the system Static Pressure Margin has been used in accordance with Requirement 2.11.24/3.11.24. Manufacturer guidance should be consulted.

Factors used to determine an appropriate system Static Pressure Margin can include:

- the pressure margin necessary to expel air from the system;
- the vapour pressure of the system water across the range of expected operating conditions of the system;
- the pressure margin necessary to mitigate the risk of cavitation in the system.

2 - This example calculation assumes that a fixed-gas cushion expansion vessel has been specified

3 - This example assumes that points A1, C1, A2 and C2 are at the same height. They have been shown at different vertical locations in the interest of producing a clear schematic diagram.

Annex E: Pressure box diagram

The setpoints of a pressure safety system need to be made with consideration to both the operating characteristics of the system, determined by the calculation for local and System Maximum Working Pressures, as well as consideration for the Maximum Allowable Pressure of the equipment selected.

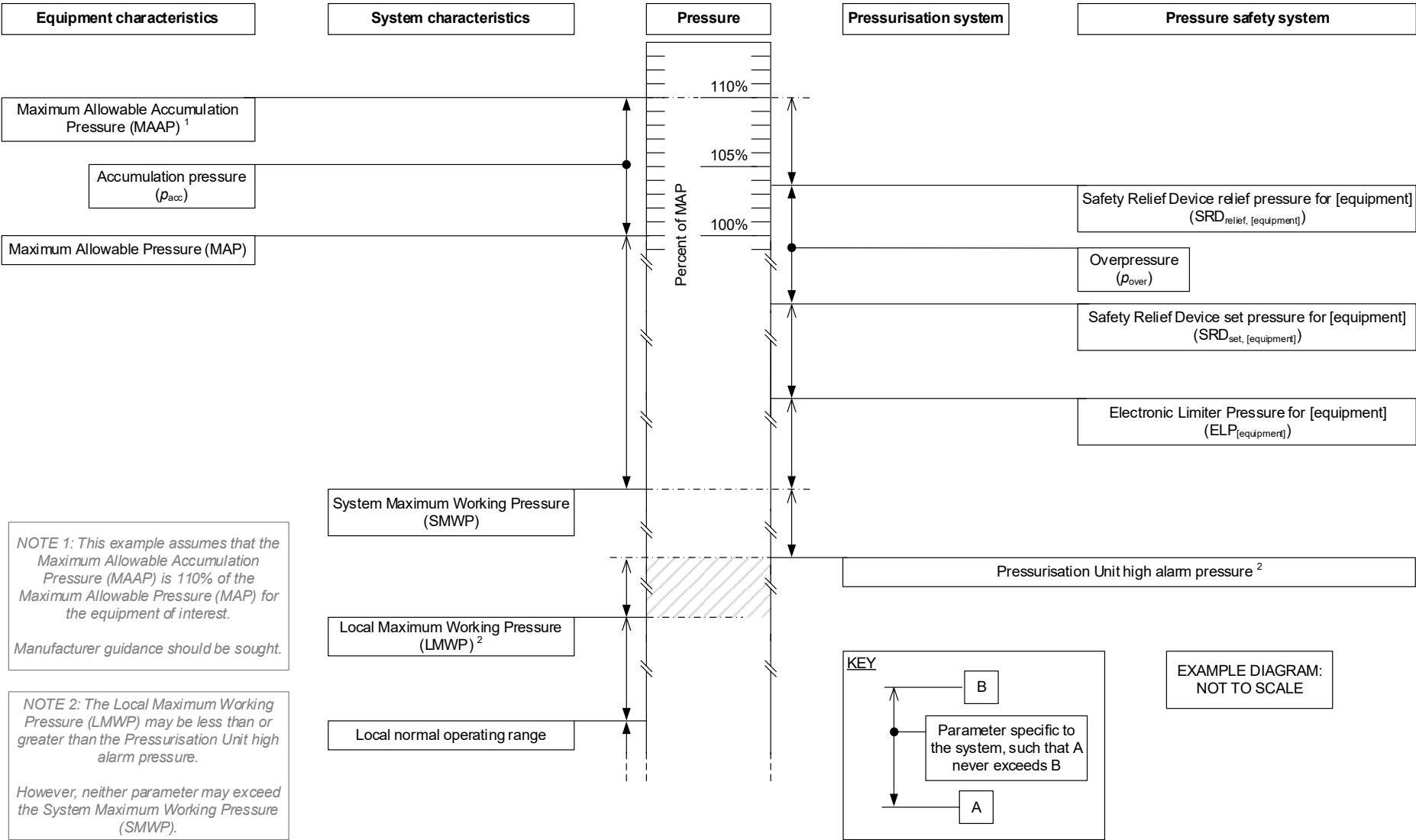
Due to the relationships between the Heat Network's system characteristics and the pressure safety system setpoints, it can be beneficial to represent the system characteristics and setpoints of the pressure safety system in a box diagram, as shown in [Figure E.1](#).

[Figure E.1](#) shows the interdependencies between the system characteristics and the subsequent requirements of the pressure safety system setpoints.

Throughout these interdependencies, “shall” and “shall not” have been used to indicate a requirement set out within the Minimum Requirements in this document, and “cannot” has been used where the definitions of parameters impose a constraint between two or more parameters.

- The normal operating range at the location of interest cannot exceed any Local Maximum Working Pressure.
- The Local Maximum Working Pressure cannot exceed the System Maximum Working Pressure.
- The pressurisation unit high alarm cannot exceed the System Maximum Working Pressure.
- The electronic limiter pressure shall exceed the Local Maximum Working Pressure at the location of interest.
- The Safety Relief Device set pressure shall exceed the electronic limiter pressure at the location of interest.
- The Safety Relief Device relief pressure cannot be less than or equal to the Safety Relief Device set pressure.
- The Safety Relief Device relief pressure shall not exceed the Maximum Allowable Accumulation Pressure.

Figure E.1: Example pressure box diagram



Annex F: Resilience tables

Table F.1: Severity scoring methodology for a major outage to heat supply

Severity		Domestic consumers	Non-domestic consumers	Vulnerability
Severe	6	Outage affects more than 1,000 domestic consumers and outage lasts longer than 48 hours	Outage affects more than 45,000 kW of non-domestic connection and outage lasts longer than 48 hours	-
Major	5	Outage affects 2 - 1,000 domestic consumers and lasts longer than 48 hours or Outage affects more than 1,000 domestic consumers and lasts 12 - 48 hours	Outage affects at least 1no. non-domestic connection and lasts longer than 48 hours or Outage affects more than 45,000 kW of non-domestic connection and lasts 12 - 48 hours	Outage affects at least 1no. critical non-domestic connection, regardless of length of outage
Serious	4	Outage affects more than 1,000 domestic consumers and lasts less than 12 hours or Outage affects 2 - 1,000 domestic consumers and lasts 12 - 48 hours or Outage affects a single domestic consumer and lasts longer than 48 hours	Outage affects more than 45,000 kW of non-domestic connection and lasts less than 12 hours or Outage affects at least 1no. non-domestic connection but less than 45,000 kW of non-domestic connection and lasts 12 - 48 hours	-

Severity		Domestic consumers	Non-domestic consumers	Vulnerability
Moderate	2	Outage affects 201 - 1000 domestic consumers and lasts less than 12 hours or Outage affects 2 - 200 domestic consumers and lasts 4 - 12 hours or Outage affects a single consumer and lasts between 4 - 48 hours	Outage affects 2,250 - 45,000 kW of non-domestic connection and lasts less than 12 hours or Outage affects at least 1no. non-domestic connection less than 2,250 kW of commercial connection and lasts 4 - 12 hours	Outage affects at least 1no. vulnerable person, regardless of length of outage
Minor	1	Outage affects 1 - 200 domestic consumers and lasts less than 4 hours	Outage affects at least 1no. non-domestic connection but less than 2,250 kW of commercial connection and lasts less than 4 hours	-
Negligible	0	Outage does not trigger a consumer complaint	Outage does not trigger a consumer complaint	-

Table F.2: Likelihood scoring methodology for a major outage to heat supply

Likelihood		Definition
Very likely	5	Expected to occur frequently. Happens multiple times per year or in the near future.
Likely	4	Likely to occur. Happens regularly (once every year or more frequently).
Possible	3	Could occur. Happens occasionally (once every 1-5 years).
Unlikely	2	Unlikely to occur, but possible. Happens once every 5-10 years.
Very unlikely	1	Very unlikely to occur. Happens once every 10+ years. Low probability.

Table F.3: Resilience Strategy risk scoring methodology

Risk score			Likelihood				
			Very unlikely 1	Unlikely 2	Possible 3	Likely 4	Very likely 5
Severity	Severe	6	6	12	18	24	30
	Major	5	5	10	15	20	25
	Serious	4	4	8	12	16	20
	Moderate	2	2	4	6	8	10
	Minor	1	1	2	3	4	5
	Negligible	0	0	0	0	0	0

Annex G: Resilience Strategy example

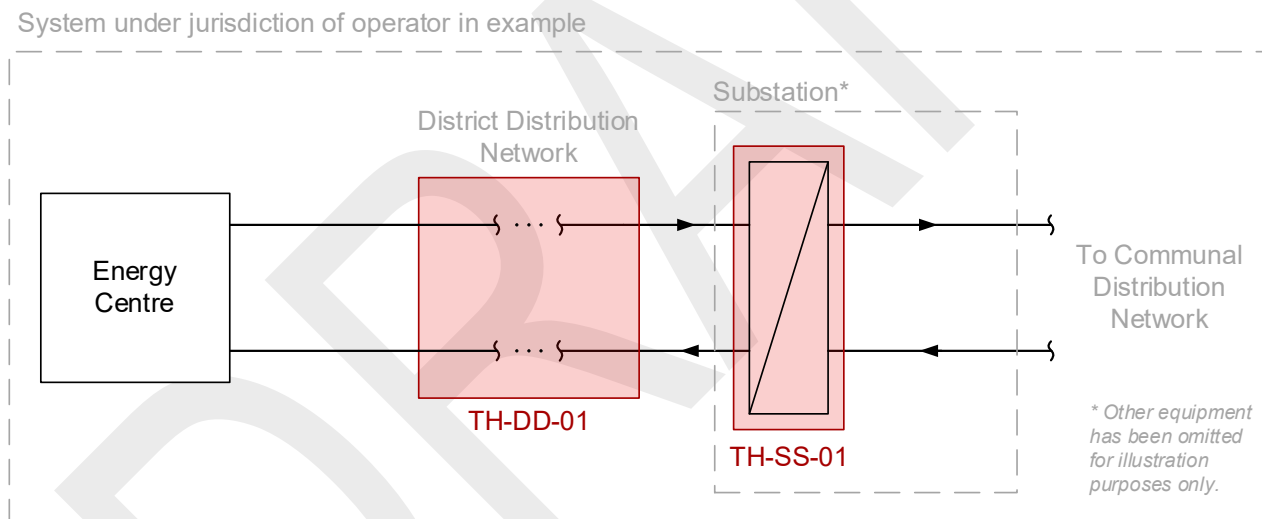
This annex has been written to demonstrate an example identification of a select number of the threats which can be identified for an example network considered at the Concept Design stage and the Technical Design stage. For the purposes of this example, only two of the threats present have been shown; it is expected that more threats will be identified for real systems. The number of threats which can be identified varies on a system-specific basis, and designers should choose appropriate redundancy and/or recovery measures on a system-specific basis depending on the priorities and constraints which present themselves.

Example system

The system in the scope of this example is a section of a District Heat Network which contains a Substation serving a Communal Distribution Network which provides space heating and domestic hot water to 100 domestic consumers.

An illustration of the points of interest in the example system is provided in [Figure G.1](#). The Substation in this example contains one plate heat exchanger which is sufficiently sized to fulfil the expected range of demands from the Communal Distribution Network.

Figure G.1: System in scope of Resilience Strategy example



The identified threats which are discussed in this example are below.

- TH-DD-01 (system failure)
A major leak occurring in the section of the District Distribution Network serving the Substation of interest.
- TH-SS-01 (equipment failure)
Failure of the plate heat exchanger in the Substation.

The Heat Network served by the Substation serves 100 domestic consumers (none of which are vulnerable), meaning that a major outage to the supply from the Substation leading to a consumer complaint could pose a severity score (see [Table F.1](#)) of between 1 (Minor) and 5 (Major), depending on the duration of the major outage. The likelihood of a major outage (see [Table F.2](#)) is dependent on factors including (but not limited to) the active redundancy of the system, and the likelihood of failure of equipment.

Stage 1: Concept Design

At the Concept Design stage, the designer has identified the key threats to system and equipment failure using the information available, and quantified the risk associated with these threats, in accordance with Requirement 1.9.1.

Table G.1 outlines an example of the risks posed by these threats and associated risk score without any mitigation measures in place, which makes up part of the Resilience Strategy produced in accordance with Requirement 1.9.2.

Table G.1: Unmitigated risks at Concept Design stage

Ref No.	Threat identified	Risk considered	Likelihood	Severity	Risk score
		Unmitigated risk			
TH-DD-01	System failure: Major leak on District Distribution Network	Major leak on the section of the District Distribution Network (indicated in Figure G.1) which would result in a major outage to heat supply to the block of 100 domestic consumers. Consumers served by the Substation would be without space heating and domestic hot water for the duration of the outage caused by the leak. At the Concept Design stage, it has been estimated that this leak could last in excess of one week whilst the source of the leak is identified and repaired.	4	5	20
⋮	⋮	⋮	⋮	⋮	⋮
TH-SS-01	Equipment failure: Plate heat exchanger	Failure of the plate heat exchanger in the substation would result in a major outage to heat supply to the block of 100 domestic consumers. Consumers served by the Substation would be without space heating and domestic hot water for the duration that the plate heat exchanger is in fault. At the Concept Design stage, it is expected that replacement of the plate heat exchanger could last up to 72 hours if no resilience measures were to be implemented.	3	5	15

The designer of the system in the scope of this example has identified a set of resilience measures shown in [Table G.2](#) (through redundancy and/or recovery measures) for each identified threat, in accordance with Requirement [1.9.2](#).

Table G.2: Resilience measures implemented at Concept Design stage

Ref No.	Redundancy approach	Recovery approach	Likelihood	Severity	Risk score	Residual risk information
Resilience measures implemented						
TH-DD-01	None	Provision of temporary boilers at the Substation to restore heat supply to Communal Distribution Network served by Substation while source of leak is located, isolated, and repaired. Spatial requirement of temporary plant provision incorporated into spatial design of the wider system. It has been assumed that this would result in a reduction in major outage time to 10 hours.	3	2	6	Response time of temporary boiler provision to be determined with higher accuracy and precision at subsequent design stages.
⋮	⋮	⋮	⋮	⋮	⋮	⋮
TH-SS-01	Provision of passive redundancy through provision of an un-connected (“dry”) PHE in the plant room containing the Substation. Spatial requirement for storage of redundant PHE considered in Substation spatial design.	Assumed that the O&M contract would include obligations for a sufficiently rapid response time in the event of a PHE failure. Assumed that this would result in a reduction in major outage time to 6 hours.	3	2	6	Resilience strategy to be communicated to operator at the appropriate time to ensure awareness of the resilience approach.

Stage 3: Technical Design

At the Technical Design stage, the designer has built on the resilience risk assessment, identified the key threats to system and equipment failure using the information available, and quantified the risk associated with these threats, in accordance with Requirement 2.9.1/3.9.1

Table G.3 outlines an example of the risks posed by these threats and associated risk score without any mitigation measures in place, which makes up part of the Resilience Strategy produced in accordance with Requirement 2.9.2/3.9.2.

Table G.3: Unmitigated risks at Technical Design stage

Ref No.	Threat identified	Risk considered	Likelihood	Severity	Risk score
		Unmitigated risk			
TH-DD-01	System failure: Major leak on District Distribution Network	Major leak on the section of the District Distribution Network (indicated in Figure G.1) which would result in a major outage to heat supply to the block of 100 domestic consumers. Consumers served by the Substation would be without space heating and domestic hot water for the duration of the outage caused by the leak. At the Technical Design stage, it has been estimated that this leak could last in excess of one week whilst the source of the leak is identified and repaired.	4	5	20
⋮	⋮	⋮	⋮	⋮	⋮
TH-SS-01	Equipment failure: Plate heat exchanger	Failure of the plate heat exchanger in the substation would result in a major outage to heat supply to the block of 100 domestic consumers. Consumers served by the Substation would be without space heating and domestic hot water for the duration that the plate heat exchanger is in fault. At the Technical Design stage, it is expected that replacement of the plate heat exchanger could last up to 72 hours if no resilience measures were to be implemented.	3	5	15

The designer of the system in the scope of this example has identified a set of resilience measures shown in [Table G.4](#) (through redundancy and/or recovery measures) for each identified threat, in accordance with Requirement [2.9.2/3.9.2](#).

Given that, as determined at the Concept Design stage, critical spares form a core part of the system design, the designer has included requirements surrounding the passive redundancy implemented to mitigate the risk posed by the threat TH-SS-01.

Table G.4: Resilience measures implemented at Technical Design stage

Ref No.	Redundancy approach	Recovery approach	Likelihood	Severity	Risk score	Residual risk information
Resilience measures implemented						
TH-DD-01	None	Provision of temporary boilers at the Substation to restore heat supply to Communal Distribution Network served by Substation while source of leak is located, isolated, and repaired. Technical requirements of connecting temporary boilers incorporated into design of the Substation (in accordance with Requirement 2.9.3/3.9.3). It has been assumed that this would result in a reduction in major outage time to 8 hours.	3	2	6	-
⋮	⋮	⋮	⋮	⋮	⋮	⋮

Ref No.	Redundancy approach	Recovery approach	Likelihood	Severity	Risk score	Residual risk information
Resilience measures implemented						
TH-SS-01	Provision of passive redundancy through provision of an un-connected (“dry”) PHE in the plant room containing the Substation. Initial strategy developed for safe replacement (in accordance with Requirement 2.9.7/3.9.7). Critical spares log produced and contains: - the specification of the unit; - the shelf life of the unit; - the specific tools and skills needed to replace the item; - supply chain restrictions associated with the implementation of the passive redundant item	Sufficiently rapid response time to undertake PHE replacement works. Assumed that this would result in a reduction in major outage time to 8 hours. Critical spares log updated to contain: - the timeframe in which the spare PHE should be installed in the event of the Substation PHE failing; - the specific tools and skills needed to replace the item; - supply chain restrictions associated with the implementation of the passive redundant item	3	2	6	Resilience strategy to be communicated to operator at the appropriate time to ensure awareness of the resilience approach.

Annex H: Water quality tables

Table H.1: Water quality equipment requirements for Chemically Treated Systems

Function	Equipment	Requirement level	Condition/Comment
Pressurisation equipment	Top-up technology (e.g. pressurisation unit)	Absolute requirement	Top-up technology shall be specified for all systems.
	Expansion system (e.g. fixed-gas cushion expansion vessel, spill-and-fill unit)	Absolute requirement	An expansion system shall be specified for all systems.
Air removal	Air vents	Absolute requirement	Air vents shall be specified at all high points (including local high points) for all systems.
	Air separator	Conditional requirement	Either an air separator or a vacuum degasser shall be specified as a minimum on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.14/3.11.14 for equivalency of system sizes.
Dissolved oxygen removal	Vacuum degasser	Recommendation	A vacuum degasser should be used on hydraulic systems serving more than 20 dwellings (or equivalent) if necessary to reduce the dissolved oxygen level to levels in accordance with Table H.7 (e.g. where the total height of the water column exceeds the critical height, which is influenced by the operating temperatures of the system). Refer to Requirement 2.11.14/3.11.14 for equivalency of system sizes.
Debris removal	Drain valves at all low points (including local low points)	Absolute requirement	Drain valves shall be specified at all low points (including local low points) on all systems.
	Dirt pockets at base of risers	Absolute requirement	A dirt pocket shall be specified at the base of each riser (on the flow and return pipes) for all systems.

Function	Equipment	Requirement level	Condition/Comment
	Strainers upstream of modules of heat generation equipment	Absolute requirement	Manufacturer guidance should be sought to determine the requirements for strainers upstream of equipment.
	Strainers upstream of pumps	Absolute requirement	
	Strainers upstream of other sensitive equipment	Recommendation	
	Replaceable filter media (e.g. filter cartridges or bags) in a side-stream configuration	Absolute requirement	Replaceable filter media shall be specified on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.14/3.11.14 for equivalency of system sizes. Water treatment specialist consultation should be sought to determine an appropriate filter media and flow rate. The pore size of the filter media to be used after pre-commission cleaning activities shall be a maximum of 5 µm by default; the pore size of the filter media can be varied and reduced over time. Combined filters with replaceable media and magnetic filters may be specified.
	Magnetic filter	Conditional requirement	A magnetic filter shall be specified for all systems which contain steel or other materials which can produce magnetic debris. The impact of downtime during cleaning of magnetic filters should be considered when determining the proposed configuration (in-line or side-stream). Combined filters with replaceable media and magnetic filters may be specified.

Function	Equipment	Requirement level	Condition/Comment
	Dirt separator	Absolute requirement	A dirt separator shall be specified on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.14/3.11.14 for equivalency of system sizes.
Measurement	Water meter on the top-up connection to the top-up technology	Absolute requirement	A water meter on the top-up connection to the top-up technology shall be specified on all systems.
	Pressure sensor	Recommendation	A pressure sensor which measures and records the working pressure (i.e. in kPa) to the Automatic and Remote Monitoring System (ARMS) should be specified on all systems. This may be included as part of the pressurisation system (where it is able to record the working pressure to the ARMS).
	Flow rate measurement devices, such as orifice plates, to allow for flushing velocities to be determined on all pipework sections	Absolute requirement	Flow rate measurement devices shall be specified in sufficient number on all systems.
	Test points in strategic locations to facilitate on-site sampling of system water	Absolute requirement	Test points shall be specified in suitable locations on all systems.
	Corrosion monitor with capability for continuous monitoring	Absolute requirement	A corrosion monitor with capability for continuous monitoring shall be specified on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.14/3.11.14 for equivalency of system sizes. An in-line monitor shall be specified for the predominant material of the system. Corrosion coupons shall be specified for other metals in the system.

Function	Equipment	Requirement level	Condition/Comment
	Continuous monitoring equipment for the measurement of: • conductivity; • pH; • dissolved oxygen	Conditional requirement	Continuous monitoring equipment shall be specified on hydraulic systems serving at least 250 end Consumer Connections or at least 20,000 litres of system volume (refer to Requirement 2.11.10/3.11.10). The continuous monitoring equipment specified is required for a system to be categorised as having 'advanced' online monitoring capability. Results from continuous monitoring equipment shall be compared with laboratory test results (where applicable) to verify that the equipment is sufficiently calibrated.
Dosing	Dosing pot / dosing unit	Absolute requirement	A dosing pot / dosing unit shall be specified for dosing of inhibitor and biocides which are suitable for the materials used in the system. Combined side-stream filtration and dosing units may be used. An automatic dosing system should be used where this is compatible with the method used for recording water quality parameters.
Flushing provision	Flushing points with temporary flushing bypasses	Absolute requirement	Flushing points with connections to temporary flushing bypasses shall be specified.

Table H.2: Water quality equipment requirements for Depleted Water Systems

Function	Equipment	Requirement level	Condition/Comment
Pressurisation equipment	Top-up technology (e.g. pressurisation unit)	Absolute requirement	Top-up technology shall be specified for all systems.
	Expansion system (e.g. fixed-gas cushion expansion vessel, spill-and-fill unit)	Absolute requirement	An expansion system shall be specified for all systems.
Air removal	Air vents	Absolute requirement	Air vents shall be specified at all high points (including local high points) for all systems.
	Air separator	Conditional requirement	Either an air separator or a vacuum degasser shall be specified as a minimum on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.15/3.11.15 for equivalency of system sizes.
Dissolved oxygen removal	Vacuum degasser	Absolute requirement	The equipment specified to remove dissolved oxygen from the system shall include at least one of these items of equipment. A vacuum degasser should be used on hydraulic systems serving more than 20 dwellings (or equivalent) if necessary to reduce the dissolved oxygen level to levels in accordance with Table H.8 (e.g. where the total height of the water column exceeds the critical height, which is influenced by the operating temperatures of the system). Refer to Requirement 2.11.15/3.11.15 for equivalency of system sizes.
	Ion-exchange resin bed		
	Electro-chemical reaction tank		
	Fine-pored membranes (e.g. for use in reverse osmosis process)		
Debris removal	Drain valves at all low points (including local low points)	Absolute requirement	Drain valves shall be specified at all low points (including local low points) on all systems.

Function	Equipment	Requirement level	Condition/Comment
	Dirt pockets at base of risers	Absolute requirement	A dirt pocket shall be specified at the base of each riser (on the flow and return pipes) for all systems.
	Strainers upstream of modules of heat generation equipment	Absolute requirement	Manufacturer guidance should be sought to determine the requirements for strainers upstream of equipment.
	Strainers upstream of pumps	Absolute requirement	
	Strainers upstream of other sensitive equipment	Recommendation	
	Replaceable filter media (e.g. filter cartridges or bags) in a side-stream configuration	Absolute requirement	Replaceable filter media shall be specified on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.15/3.11.15 for equivalency of system sizes. Water treatment specialist consultation should be sought to determine an appropriate filter media and flow rate. The pore size of the filter media to be used after pre-commission cleaning activities shall be a maximum of 5 µm by default; the pore size of the filter media can be varied and reduced over time. Combined filters with replaceable media and magnetic filters may be specified.

Function	Equipment	Requirement level	Condition/Comment
	Magnetic filter	Conditional requirement	A magnetic filter shall be specified for all systems which contain steel or other materials which can produce magnetic debris. The impact of downtime during cleaning of magnetic filters should be considered when determining the proposed configuration (in-line or side-stream). Combined filters with replaceable media and magnetic filters may be specified.
	Dirt separator	Absolute requirement	A dirt separator shall be specified on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.15/3.11.15 for equivalency of system sizes.
Measurement	Water meter on the top-up connection to the top-up technology	Absolute requirement	A water meter on the top-up connection to the top-up technology shall be specified on all systems.
	Pressure sensor	Absolute requirement	A pressure sensor which measures and records the working pressure (i.e. in kPa) to the Automatic and Remote Monitoring System (ARMS) should be specified on all systems. This may be included as part of the pressurisation system (where it is able to record the working pressure to the ARMS).
	Flow rate measurement devices, such as orifice plates, to allow for flushing velocities to be determined on all pipework sections	Absolute requirement	Flow rate measurement devices shall be specified in sufficient number on all systems.

Function	Equipment	Requirement level	Condition/Comment
	Test points in strategic locations to facilitate on-site sampling of system water	Absolute requirement	Test points shall be specified in suitable locations on all systems.
	Corrosion monitor with capability for continuous monitoring	Absolute requirement	A corrosion monitor with capability for continuous monitoring: • should be specified on Depleted Water hydraulic systems serving ≤ 20 dwellings (or equivalent); and • shall be specified on hydraulic systems serving more than 20 dwellings (or equivalent). Refer to Requirement 2.11.15/3.11.15 for equivalency of system sizes. An in-line monitor shall be specified for the predominant material of the system. Corrosion coupons shall be specified for other metals in the system.
	Continuous monitoring equipment for the measurement of: • conductivity; • pH; • dissolved oxygen	Conditional requirement	The continuous monitoring equipment specified: • should be specified on Depleted Water hydraulic systems serving ≤ 20 dwellings (or equivalent); and • shall be specified on Depleted Water hydraulic systems serving more than 20 dwellings (or equivalent), and hence for the system to be categorised as having ‘advanced’ online monitoring capability. Refer to Requirement 2.11.15/3.11.15 for equivalency of system sizes. Results from continuous monitoring equipment shall be compared with laboratory test results (where applicable) to verify that the equipment is sufficiently calibrated.

Function	Equipment	Requirement level	Condition/Comment
Flushing provision	Flushing points with temporary flushing bypasses	Absolute requirement	Flushing points with connections to temporary flushing bypasses shall be specified.
Water conditioning	Demineralisation bed	Conditional requirement	Either a demineralisation bed or water softening shall be specified. Water softening shall only be done through cation exchange. Water softening shall not be specified on systems containing aluminium (including aluminium alloys). <i>In some parts of the UK, the conductivity levels of the mains cold water service can result in water softening being insufficient to meet the required water quality levels of fill water for Depleted Water Systems. Demineralisation should be considered for these locations.</i>
	Water softener (cation exchange)		

Table H.3: Minimum sampling locations for water quality sampling

System size	Minimum number of representative sampling points
≤ 3,000 L and < 2 end Consumer Connections	1 sample location in main plant area ¹
≤ 3,000 L and 2 to 25 end Consumer Connections	1 sample location in main plant area ¹ plus 2 remote locations
≤ 8,000 L and 25 to 80 end Consumer Connections	1 sample location in main plant area ¹ plus 3 remote locations
≤ 20,000 L and 80 to 250 end Consumer Connections	1 sample location in main plant area ¹ plus 4 remote locations
≤ 40,000 L and 250 to 500 end Consumer Connections	1 sample location in main plant area ¹ plus 5 remote locations
> 40,000 L or > 500 end Consumer Connections	1 sample location in main plant area ¹ plus 1 remote locations per 100 end Consumer Connections <i>For example, a system with 1,500 end Consumer Connections would have one sample taken in main plant area and 15 samples taken in remote locations.</i> $\begin{aligned} \text{No. locations} &= 1 + \frac{\text{no. terminal units}}{100} \\ &= 1 + \frac{1500}{100} \\ &= 1 + 15 \\ &= 16 \end{aligned}$

Values in accordance with BS 8552:2012: Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice (BSI, 2012).

1 - "main plant area" can refer to either an Energy Centre or Substation.

Table H.4: Oxygen diffusion levels of components

Oxygen diffusion-tight	Open to oxygen diffusion
All common metals used in plant construction for pipes and containers are considered to be oxygen diffusion-tight Components made of plastics can be classified as oxygen diffusion-tight by means of suitable barrier layers ¹ , application limits shall be observed	Components such as pipes and containers made of plastics without a corresponding manufacturer's certificate ¹ are to be classified as open to oxygen diffusion
Multilayer composite pipe with metal barrier layer ¹ , plastic pipe with co-extruded barrier layer ¹	Unblocked plastic pipes (e.g. capillary tube mats ² , plastic distributors)
Corrugated stainless steel pipe, flex hoses with barrier layer ¹	Unblocked EPDM connection hoses ² ("flex hoses", for example, in the connection of transfer systems and refrigeration consumers)
Diaphragms made of butyl rubber (e.g. in expansion vessels)	EPDM membranes (e.g. in expansion vessels)
-	Containers made of diffusion-open plastics (e.g. as water reservoirs in pump pressure maintenance)
Screw, press or similar connection systems ³	-

Extracted from VDI 6044: Prevention of Damage in Cold and Cooling Water Circuits (VDI, 2023).

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1 - Manufacturers of these components shall provide suitable proof of diffusion tightness (e.g. according to DIN 4726: Underfloor Heating - Plastic Piping - Requirements and Test Methods (DIN, 2024), AGFW FW510).

2 - Corresponding circuits are to be considered as corrosion open plants.

3 - If the design and creation of circuits involves a large number of screwed, pressed or similar connections with seals made of non-oxygen-tight elastomers, their oxygen permeability shall be taken into account.

Table H.5: Water quality parameters for fill water for Chemically Treated Systems

Fill water quality parameter (Chemically Treated System)	Unit	Limit(s)
pH	-	6.0 - 8.5
Total Viable Count (TVC)	cfu/ml	< 1,000
Pseudomonads	cfu/ml	< 1,000 at 30 °C
Total hardness	mg/l	As recommended by water treatment specialist
Chloride	mg/l	< 250
Sulphate	mg/l	< 250

Extracted from BSRIA BG 29/2021: Pre-Commission Cleaning of Pipework Systems (BSRIA, 2021).

Table H.6: Water quality parameters for fill water for Depleted Water Systems

Fill water quality parameter (Depleted Water System)	Unit	Limit(s)
Conductivity	µS/cm	10 - 100
pH	-	System without aluminium alloys: 8.2 - 10.0 System with aluminium alloys: 8.2 - 9.0 <i>Note: there can be additional system-specific constraints on the pH of the system water.</i>
Total Viable Count (TVC)	cfu/ml	< 1,000
Pseudomonads	cfu/ml	< 1,000 at 30 °C
Total hardness	mg/l	0 ≤ 200 kW: < 200 200 ≥ 600 kW: < 150 > 600 kW: > 5.5
Chloride	mg/l	< 10 (measured at 80 °C)
Sulphate	mg/l	< 10

Contains values extracted from BSRIA BG 29/2021: Pre-Commission Cleaning of Pipework Systems (BSRIA, 2021) and VDI 2035: Prevention of Damage in Water Heating Installations (VDI, 2021).

Table H.7: Water quality KPIs for Chemically Treated Systems

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
Chemically Treated System (limited continuous monitoring)				
Continuous monitoring	Top-up volume	% system volume / month	< 0.17 <i>System volume value excludes thermal storage</i>	
	Corrosion rate	mm/yr	Mild steel / iron: < 0.040 Copper: < 0.005 Extruded aluminium: < 0.100 Brass: < 0.005 Stainless steel: < 0.002 Corrosion rates of specific materials shall be measured in accordance with the materials in the system	
Laboratory testing	Conductivity	µS/cm	To be specified by water treatment specialist	
	pH	-	Exact pH range for system water to be specified by water treatment specialist Guidance pH range: Aluminium: 7.0 - 8.5 Steel-based: 9.0 - 11.0 Copper and brass: 7.5 - 9.2 <i>There can be additional system-specific constraints on the pH of the system water. Guidelines from component manufacturers should be obtained and followed</i>	

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
	Inhibitor ²	mg/l	To be specified by water treatment specialist <i>Where multiple compounds are used (such as molybdates and/or nitrates), separate limits should be set for each compound</i>	
	Total Viable Count (TVC)	cfu/ml	< 10,000 at 30°C for 48 hours	
	Sulphate Reducing Bacteria (SRB)	-	Absent Determined by a five-day test with sample split into four inoculated tubes (which gives a 92 % probability of detection as indicated in Table C.1 of BS 8552:2012: <i>Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice</i> (BSI, 2012))	
	Suspended solids	mg/l	Distribution pump: < 30 System extremities: < 45	Reported metric only
	Calcium hardness	mg/l	To be specified by water quality specialist <i>Calcium hardness depends on the amount and type of softening applied</i>	Reported metric only
	Chloride	mg/l	< 250	Reported metric only

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
	Sulphate	mg/l	> 90 % of: - fill water; or - system water after remedial action (where remedial action has taken place), when tested not less than two weeks after completion of remedial action - and - No decreasing trend <i>The effect of remedial action (such as the addition of chemicals) can alter sulphate levels in the system water</i>	Reported metric only
	Total iron	mg/l	< 6.0	Reported metric only
	Total copper	mg/l	< 1.0	Reported metric only
	Total aluminium	mg/l	< 1.0	Reported metric only
	Total zinc	mg/l	< 1.0	Reported metric only
	Dissolved iron	mg/l	< 3.0	Reported metric only
	Dissolved copper	mg/l	< 1.0 <i>Copper should be tested prior to pre-commission cleaning of the system to determine whether additional measures are required to reduce dissolved copper levels. The presence of contaminants such as soldering flux can result in increased dissolved copper levels during installation practices</i>	Reported metric only
On-site testing	Inhibitor ²	mg/l	To be specified by water treatment specialist <i>Where multiple compounds are used (such as molybdates and/or nitrates), separate limits should be set for each compound</i>	

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
Chemically Treated System: advanced continuous monitoring capability ¹				
Continuous monitoring	Top-up volume	% system volume / month	< 0.17 <i>System volume value excludes thermal storage</i>	
	Corrosion rate	mm/yr	Mild steel / iron: < 0.040 Copper: < 0.005 Extruded aluminium: < 0.100 Brass: < 0.005 Stainless steel: < 0.002 Corrosion rates of specific materials shall be measured in accordance with the materials in the system	
	Conductivity	µS/cm	To be specified by water treatment specialist	
	pH	-	Exact pH range for system water to be specified by water treatment specialist Guidance pH range: Aluminium: 7.0 - 8.5 Steel-based: 9.0 - 11.0 Copper and brass: 7.5 - 9.2 <i>There can be additional system-specific constraints on the pH of the system water. Guidelines from component manufacturers should be obtained and followed</i>	
	Dissolved oxygen	mg/l	< 1.0	

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
Laboratory testing	Conductivity ³	µS/cm	To be specified by water treatment specialist	
	pH ³	-	Exact pH range for system water to be specified by water treatment specialist Guidance pH range: Aluminium: 7.0 - 8.5 Steel-based: 9.0 - 11.0 Copper and brass: 7.5 - 9.2 <i>There can be additional system-specific constraints on the pH of the system water. Guidelines from component manufacturers should be obtained and followed</i>	
	Inhibitor ²	mg/l	To be specified by water treatment specialist <i>Where multiple compounds are used (such as molybdates and/or nitrates), separate limits should be set for each compound</i>	
	Total Viable Count (TVC)	cfu/ml	< 10,000 at 30 °C for 48 hours	
	Sulphate Reducing Bacteria (SRB)	-	Absent Determined by a five-day test with sample split into four inoculated tubes (which gives a 92 % probability of detection as indicated in Table C.1 of BS 8552:2012 <i>Sampling and monitoring of water from building services closed systems - Code of practice</i> (BSI, 2012))	
	Suspended solids	mg/l	Distribution pump: < 30 System extremities: < 45	Reported metric only
	Calcium hardness	mg/l	To be specified by water quality specialist <i>Calcium hardness depends on the amount and type of softening applied.</i>	Reported metric only
	Chloride	mg/l	< 250	Reported metric only

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
	Sulphate	mg/l	> 90 % of: - fill water; or - system water after remedial action (where remedial action has taken place), when tested not less than two weeks after completion of remedial action - No decreasing trend <i>The effect of remedial action (such as the addition of chemicals) can alter sulphate levels in the system water</i>	Reported metric only
	Total iron	mg/l	< 6.0	Reported metric only
	Total copper	mg/l	< 1.0	Reported metric only
	Total aluminium	mg/l	< 1.0	Reported metric only
	Total zinc	mg/l	< 1.0	Reported metric only
	Dissolved iron	mg/l	< 3.0	Reported metric only
	Dissolved copper	mg/l	< 1.0 <i>Copper should be tested prior to pre-commission cleaning of the system to determine whether additional measures are required to reduce dissolved copper levels. The presence of contaminants such as soldering flux can result in increased dissolved copper levels during installation practices</i>	Reported metric only
On-site testing	Inhibitor ²		To be specified by water treatment specialist <i>Where multiple compounds are used (such as molybdates and/or nitrates), separate limits should be set for each compound</i>	

- 1 - A system will only be treated as having advanced continuous monitoring capability once all continuous monitoring equipment has been installed, commissioned, and is functioning properly.*
- 2 - On-site sampling and laboratory testing of inhibitor levels is required to aid in mitigating against the risk of degradation of volatile components, such as amines, during transportation of the sample.*
- 3 - Laboratory sampling to verify results from continuous monitoring equipment.*

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Table H.8: Water quality KPIs for Depleted Water Systems

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
Online monitoring	Top-up volume	% system volume / month	< 0.17 <i>System volume value excludes thermal storage</i>	
	Corrosion rate	mm/yr	Mild steel / iron: < 0.040 Copper: < 0.005 Extruded aluminium: < 0.100 Brass: < 0.005 Stainless steel: < 0.002 Corrosion rates of specific materials shall be measured in accordance with the materials in the system	
	Conductivity ¹	µS/cm	10 - 100	
	pH ¹	-	System without aluminium alloys: 8.2 - 10.0 System with aluminium alloys: 8.2 - 9.0 <i>There can be additional system-specific constraints on the pH of the system water</i>	
	Dissolved oxygen ¹	mg/l	< 0.10	
Laboratory testing	Conductivity ²	µS/cm	10 - 100	
	pH ²	-	System without aluminium alloys: 8.2 - 10.0 System with aluminium alloys: 8.2 - 9.0 <i>There can be additional system-specific constraints on the pH of the system water</i>	

Recording type	Parameter	Unit	KPI Limit (Commissioning)	KPI Limit (Operation)
	Total Viable Count (TVC)	cfu/ml	< 10,000 at 30 °C for 48 hours	
	Sulphate Reducing Bacteria (SRB)	-	Absent Determined by a five-day test with sample split into four inoculated tubes (which gives a 92 % probability of detection as indicated in Table C.1 of BS 8552:2012 <i>Sampling and monitoring of water from building services closed systems - Code of practice</i> (BSI, 2012))	
	Suspended solids	mg/l	Distribution pump: < 30 System extremities: < 45	Reported metric only
	Total hardness	mg/l	0 ≤ 200 kW: < 200 200 ≥ 600 kW: < 150 > 600 kW: > 5.5	Reported metric only
	Chloride	mg/l	< 10.0 (measured at 80 °C)	Reported metric only
	Sulphate	mg/l	< 10.0	Reported metric only
	Total iron	mg/l	< 6.0	Reported metric only
	Total copper	mg/l	< 1.0	Reported metric only
	Total aluminium	mg/l	< 1.0	Reported metric only
	Total zinc	mg/l	< 1.0	Reported metric only

1 - The continuous monitoring of conductivity, pH and dissolved oxygen is not required for Depleted Water Systems serving ≤ 20 dwellings (or equivalent).

2 - Laboratory sampling to verify results from continuous monitoring equipment.

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Table H.9: Minimum sampling frequencies for water quality sampling

Time period	Minimum frequency ¹	
	Continuous monitoring	Laboratory testing
System fill to pre-commission cleaning	-	Once every four weeks
Pre-commission cleaning to practical completion	-	Once every two weeks
Initial six months of operation (commencing at practical completion)	Monthly reporting of readings from continuous monitoring equipment	Systems serving > 20 dwellings ² : once every month Systems serving ≤ 20 dwellings ² : once every three months
Ongoing operation (after initial six months of operation)	Monthly reporting of readings from continuous monitoring equipment	Once every three months

1 - A distinct set of samples will need to be produced for each instance of reporting a set of KPIs.

2 - Refer to Requirement 2.11.15/3.11.15 for equivalency of system sizes.

Annex J: Insulation and heat loss tables

Above-ground pipework

Table J.1: Minimum thickness values for pipework insulation on above-ground pipework

Outside diameter of pipe (mm)	Minimum insulation thickness (mm)					
	Thermal conductivity at 40 °C [W/(m·K)] (low-emissivity outer surface ($\epsilon = 0.05$))			Thermal conductivity at 40 °C [W/(m·K)] (high-emissivity outer surface ($\epsilon = 0.90$))		
	≤ 0.030	(0.030, 0.040]	> 0.040	≤ 0.030	(0.030, 0.040]	> 0.040
≤ 26.9	35	60	105	40	70	120
≤ 33.7	45	80	135	50	90	155
≤ 42.4	50	85	140	55	95	160
> 42.4	55	95	160	65	110	180

Communal Distribution Network

Table J.2: Communal Distribution Network heat loss limits

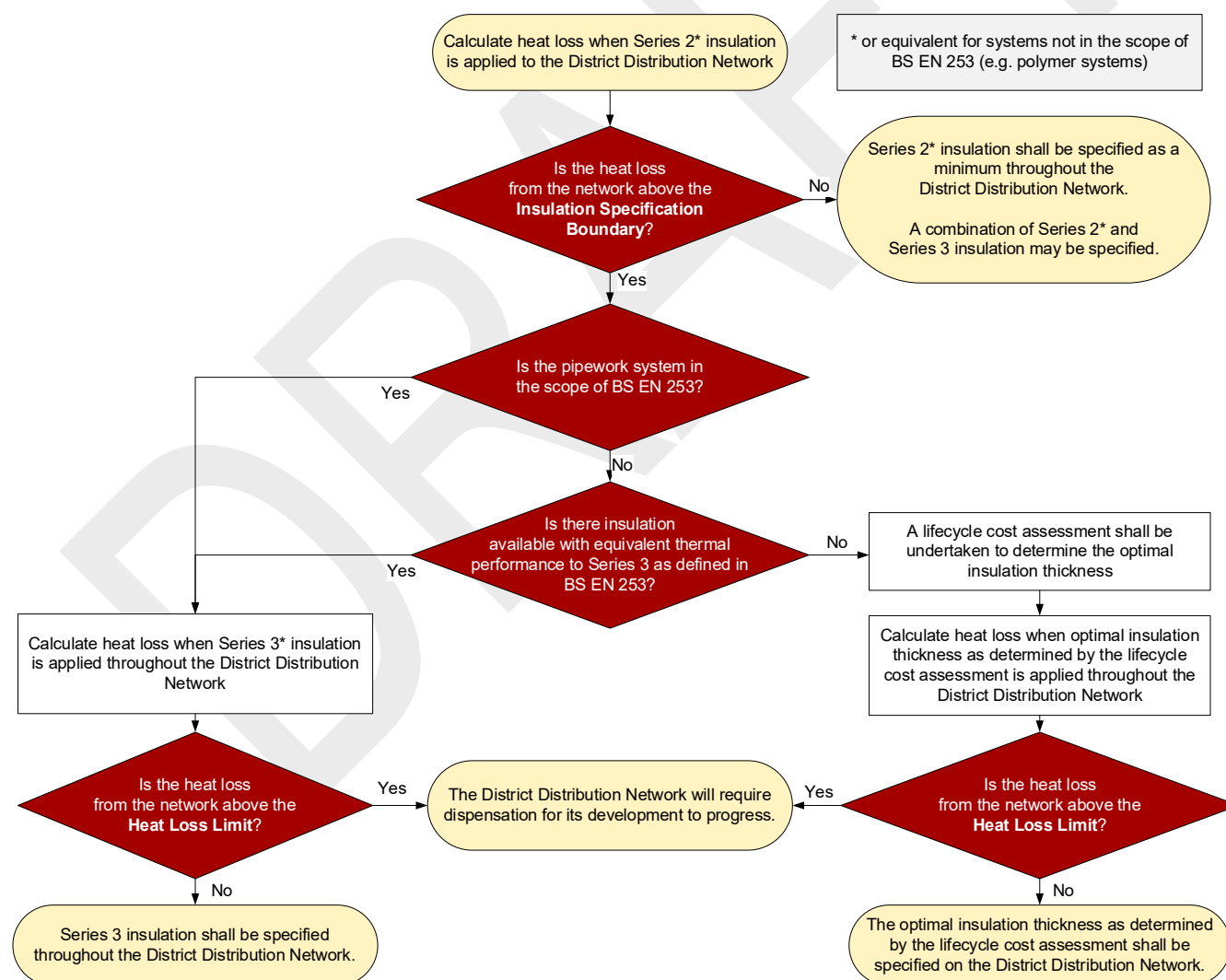
Stages	Domestic connections to Communal Distribution Network	Non-domestic connections to Communal Distribution Network
1. Concept Design 2. Developed Design 3. Technical Design 4. Construction Design	75 W/dwelling	1.66 W/kW _{connection}
6. Commissioning 7. Operation & Maintenance	100 W/dwelling	2.22 W/kW _{connection}

District Distribution Networks

Table J.3: Design District Distribution Network Heat Loss Limits and Insulation Specification Boundaries

Parameter	Non-domestic connections to District Distribution Network	Domestic connections directly connected to District Distribution Network
Heat Loss Limit	12.0 W/kW _{connection}	265 W/dwelling
Insulation Specification Boundary	6.0 W/kW _{connection}	170 W/dwelling

Figure J.1: Guidance flowchart for District Distribution Network heat loss and insulation requirements



Annex K: Heat loss model example

The following worked example provides an example methodology for determining the heat losses from a Communal Distribution Network at the Technical Design stage through the construction of a “heat loss model”. This model includes consideration of the heat losses from the network which occur through conduction, convection, and thermal radiation.

This annex includes:

- an overview of the theory and methodology used to calculate heat loss;
- commentary surrounding the interactions between the requirements regarding heat loss;
- an example of the determination of the insulation thicknesses required to meet Requirement 2.13.1/3.13.1, Requirement 2.13.2/3.13.2 and Requirement 2.13.3/3.13.3 on the BESA Reference Building.

Heat loss calculation methodology

This section discusses the calculation of heat losses following the methodology set out in BS EN ISO 12241:2022: *Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules* (BSI, 2022), which is required for the calculation of heat losses from pipework in buildings at the Technical Design stage in accordance with Requirement 2.13.4/3.13.4.

Heat transfer mechanisms

There are multiple mechanisms of heat transfer which are present in the heat loss from pipework and equipment in Heat Networks.

Heat transfer through solid components (e.g. the pipe insulation and the pipework itself), denoted as q_{cond} , occurs through conduction.

Heat transfer between the surface of the insulation and the surroundings, denoted as q_{surf} , occurs through:

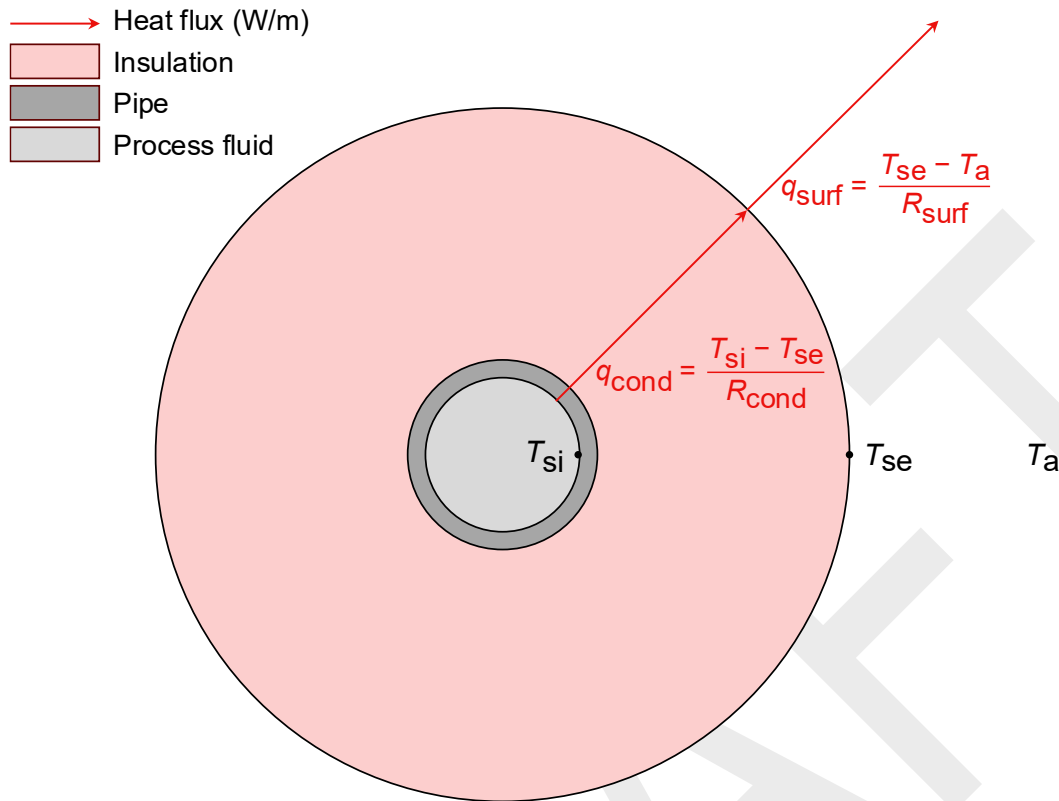
- convection (which occurs due to the effects of the air surrounding the system); and
- thermal radiation (which occurs between all objects).

All of these types of heat transfer can be expressed through defining a “thermal resistance”, which can be a useful way of determining how much heat is lost per unit length of pipework for a given temperature difference.

As the heat transfer through conduction happens in “series” with the heat transfer from the surface of the system, the thermal resistances R_{cond} (conduction) and R_{surf} (surface) are considered to act in a “series” configuration.

These thermal resistances are calculated following the methodologies set out in BS EN ISO 12241:2022: *Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules* (BSI, 2022) alongside assumptions of the thermal properties of the materials present in the system.

The interaction of these mechanisms of heat transfer is illustrated in Figure K.1.

Figure K.1: Illustration of heat loss mechanisms from distribution pipe**Total heat loss (W/m)**

The heat loss from a unit length of pipework is determined by its linear thermal transmittance U , and the difference in process fluid temperature T_{si} and the ambient temperature T_a .

The linear thermal transmittance U has been determined in accordance with the following equation.

$$U = \frac{1}{R_{surf} + R_{cond}}$$

The heat loss per unit length (W/m) for a single pipe section can be determined through the following equation.

$$q_{pipe} = U \cdot (T_{si} - T_a)$$

The heat loss value per unit length (W/m) for each pipe section has subsequently been multiplied by the total pipe length of that section $L_{pipe\ section}$ to obtain the network's total heat loss Q (W). This considers heat losses from both the flow and return pipework.

$$Q = \sum_{pipe\ sections} q_{pipe} \cdot L_{pipe\ section}$$

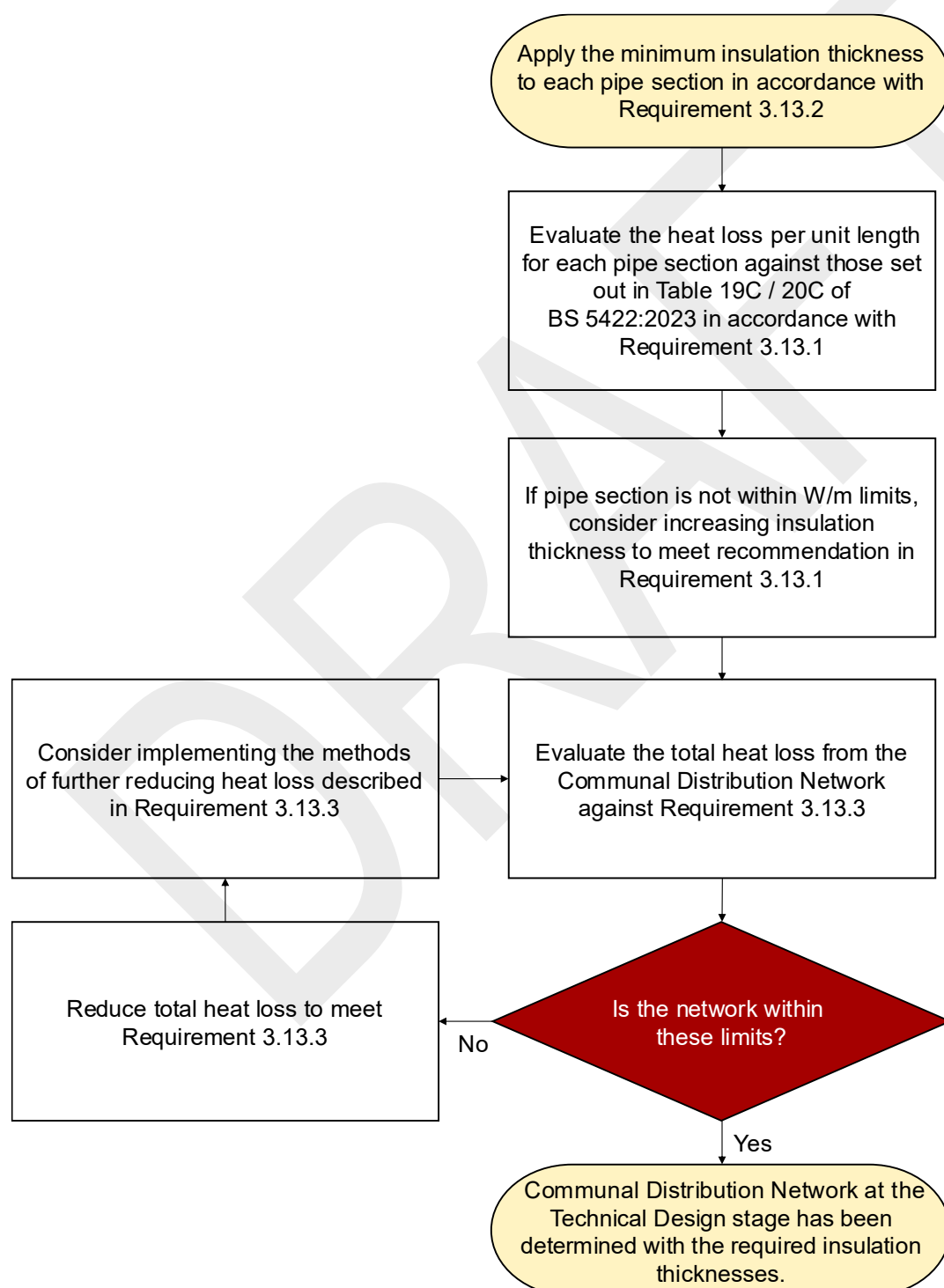
The pipework heat loss from the entire Communal Distribution Network, plus the allowance to account for the heat loss from ancillary equipment, is used to determine the heat loss per dwelling from the network.

Requirement overview

Once the material properties, pipe sections, and pipe lengths have been defined, the required insulation thickness for the flow and return pipework in each section must be determined.

A typical process for this is outlined in [Figure K.2](#). Where actions would be undertaken to meet recommendations set out in this standard, this is indicated through dotted lines.

Figure K.2: Typical process to determine required insulation thicknesses on above-ground pipework



Worked example – BESA Reference Building

Assumptions

The assumptions used throughout this example are provided in [Table K.1](#). Designers should make assumptions for these parameters on a system-specific basis.

Table K.1: Parameters assumed for heat loss model example

Parameter	Value	Source
Design information		
Distribution Network flow temperature T_f	55 °C	BESA UK HIU Test Regime (BESA, 2023, or latest edition) Low Temperature scenario Communal Distribution Network flow and return temperature
Distribution Network return temperature $T_{r,SH}$	33 °C	
Ambient (building internal) temperature T_a	20 °C	Assumed ambient temperature in accordance with Requirement 2.13.2/3.13.2
Pipe properties		
Pipe material	Medium grade steel	Example material used for LTHW Heat Networks ²
Pipe thermal conductivity $\lambda_{D,1}$	50 W/(m·K)	
Insulation properties		
Insulation material	Phenolic	Example material used for LTHW Heat Networks
Pipework insulation coverage	100 %	
Insulation thermal conductivity $\lambda_{D,2}$ ¹	0.03 W/(m·K)	
Insulation surface emissivity ε_2	0.05 W/(m ² ·K)	

1 - Assumed to be equal to the thermal conductivity at 40 °C.

2 - It should be noted that plastic pipework (single wall) is treated as having no insulative value of its own in BS 5422:2023: Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C (BSI, 2023).

In this example, the following assumptions have been made in addition to those in [Table K.1](#).

- All pipework in the scope of this example is assumed to be internal to the building.
- The internal surface temperature of the pipe has assumed to be equal to the process fluid temperature.

Designers should make assumptions for these parameters on a system-specific basis.

Reference Building

The Communal Distribution Network used in this example is Block D of the multi-riser BESA Reference Building (which can be found in the Technical Standard for the BESA UK HIU Test Regime (BESA, 2023, or latest edition)), shown in [Figure K.3](#). The pipework in the scope of this example has been split into sections by pipe size and type, as indicated in [Figure K.4](#).

Figure K.3: Network schematic of building used in heat loss model example

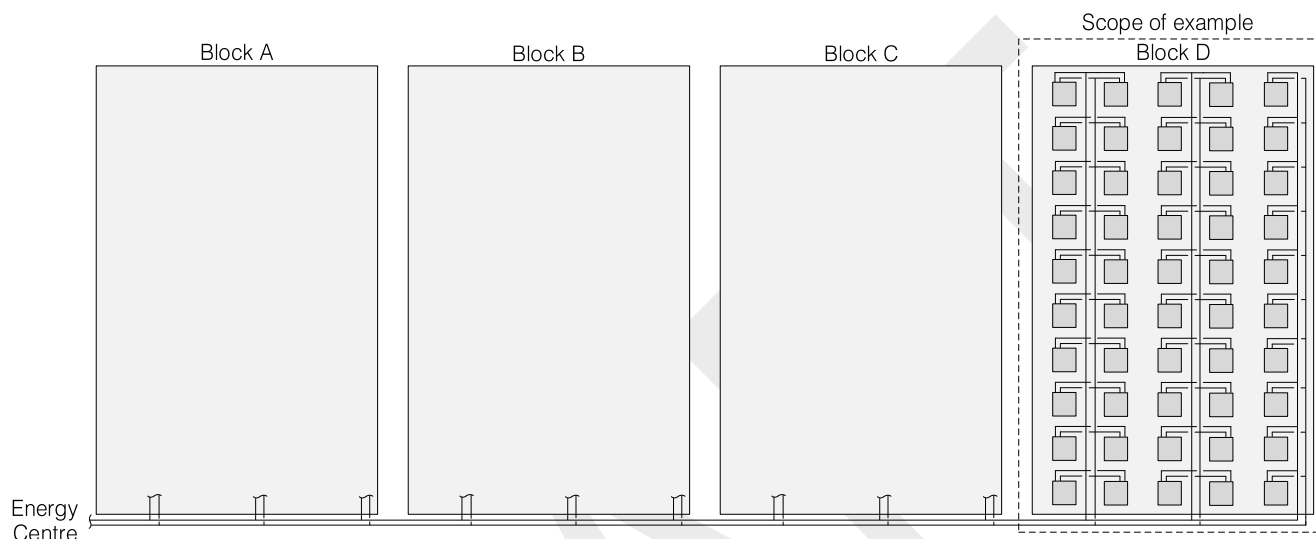
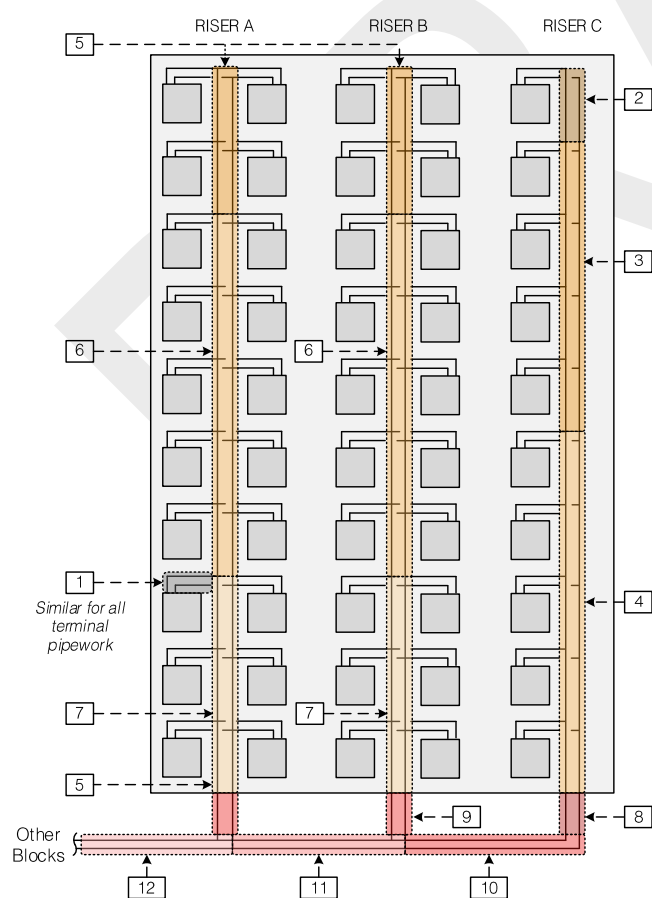


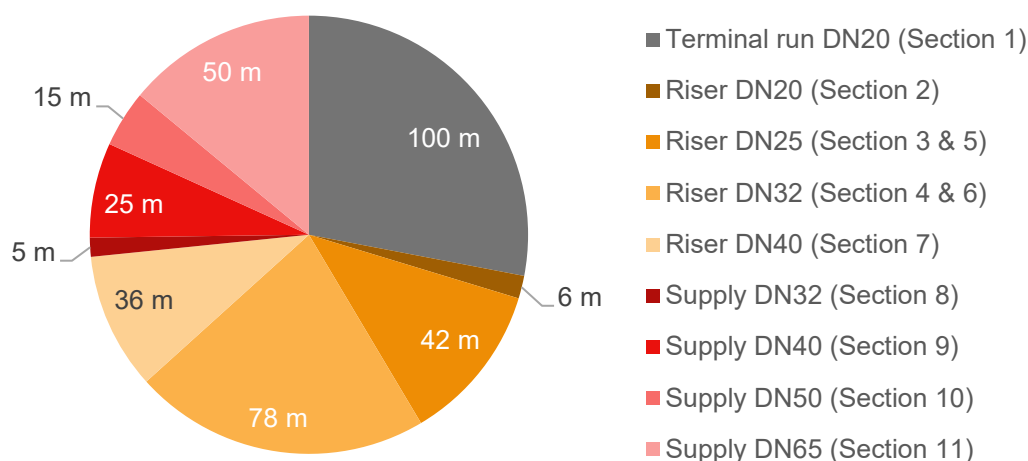
Figure K.4: Illustration of pipe sections in scope of example



A summary of each pipe section, including the total pipe lengths (flow and return), is provided in [Table K 2](#). A summary of the total pipe lengths is shown in [Figure K.5](#).

Table K 2: Description of pipe sections, sizes, and lengths

Pipe section	Description	Pipe size	Pipe orientation	Unit length (flow or return only)	No. units	Total length (flow + return) (m)
Terminal run						
1	Terminal run	DN20	Horizontal	1.0 m/dwelling	50	100
Riser						
2	Riser C Floor 10	DN20	Vertical	3.0 m/floor	1	6
3	Riser C Floors 6 - 9	DN25	Vertical	3.0 m/floor	3	18
4	Riser C Floors 1 - 5	DN32	Vertical	3.0 m/floor	5	30
5	Risers A & B Floors 9 - 10	DN25	Vertical	3.0 m/floor	4	24
6	Risers A & B Floors 4 - 8	DN32	Vertical	3.0 m/floor	8	48
7	Risers A & B Floors 1 - 3	DN40	Vertical	3.0 m/floor	6	36
Supply						
8	Riser C Floor 0	DN32	Vertical	2.5 m	1	5
9	Risers A & B Floor 0	DN40	Vertical	2.5 m	2	10
10	Supply serving Riser C	DN40	Horizontal	7.5 m	1	15
11	Supply serving Risers B & C	DN50	Horizontal	7.5 m	1	15
12	Supply serving Risers A, B & C	DN65	Horizontal	25.0 m	1	50

Figure K.5: Pipe section lengths (flow and return)

Determining insulation thicknesses

The initial insulation thickness modelled for each pipe section has been selected to match the minimum thicknesses set out in [Table J.1](#). The average heat loss per unit length which result from these insulation thicknesses is provided in [Table K.3](#).

As indicated through red text, the flow pipework for pipe section 9 exceeds the heat loss limit set out in BS 5422:2023: *Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C* (BSI, 2023).

Table K.3: Average heat loss per pipe section with minimum insulation thicknesses

Pipe section	Pipe size	Outside diameter of pipe (mm)	Minimum insulation thickness (mm)	Average ¹ heat loss (W/m)		BS 5422:2023 limit (W/m)
				Flow	Return	
1	DN20	26.9	35	4.42	1.58	4.7
2	DN20	26.9	35	4.33	1.56	4.7
3	DN25	33.7	45	4.37	1.58	4.7
4	DN32	42.4	50	4.72	1.71	5.1
5	DN25	33.7	45	4.38	1.58	4.7
6	DN32	42.4	50	4.72	1.71	5.1
7	DN40	48.3	55	4.87	1.75	5.1
8	DN32	42.4	50	4.81	1.74	5.1

Pipe section	Pipe size	Outside diameter of pipe (mm)	Minimum insulation thickness (mm)	Average ¹ heat loss (W/m)		BS 5422:2023 limit (W/m)
				Flow	Return	
9	DN40	48.3	55	4.95	1.79	5.1
10	DN40	48.3	55	4.95	1.79	5.1
11	DN50	60.3	55	5.60	2.03	5.4
12	DN65	76.1	55	6.47	2.32	5.8

¹ For vertical pipework, the calculation methodology set out in BS EN ISO 12241:2022: Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules (BSI, 2022) requires consideration of the length of the pipework. This can lead to subtle differences in W/m values for pipework sections with identical parameters other than the total length of the pipe section.

Requirement 2.13.1/3.13.1 recommends that pipework heat losses do not exceed these values. The insulation thickness applied to the flow pipework has hence been increased until the heat loss per unit length from all pipe sections is in accordance with the limit set out in BS 5422:2023: Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C (BSI, 2023), as set out in Table K.4.

Table K.4: Insulation thicknesses for flow and return pipework

Pipe sections	Pipe size	Insulation thickness (mm)	
		Flow	Return
1, 2	DN20	35	35
3, 5	DN25	45	45
4, 6, 8	DN32	50	50
7, 9, 10	DN40	55	55
11	DN50	60 ¹	55
12	DN65	70 ¹	55

¹: Insulation thickness increased to meet W/m limits set out in BS 5422:2023: Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C (BSI, 2023).

Heat loss summary

With the insulation thicknesses for the network now being determined such that Requirement 2.13.1/3.13.1 and Requirement 2.13.2/3.13.2 are met, the heat loss from the communal Distribution Network can be determined.

The heat loss calculations above only consider heat losses from pipework within the communal Distribution Network; however, they do not include heat losses from ancillary equipment.

As outlined in Requirement 2.13.5/3.13.5, the heat losses from ancillary equipment need to be included in the calculated heat loss from the network. In this example, this has been done by applying an allowance of 20 % of the calculated total heat losses from pipework.

A summary of the calculated heat loss from the communal Distribution Network in the scope of this example is provided in Table K.5.

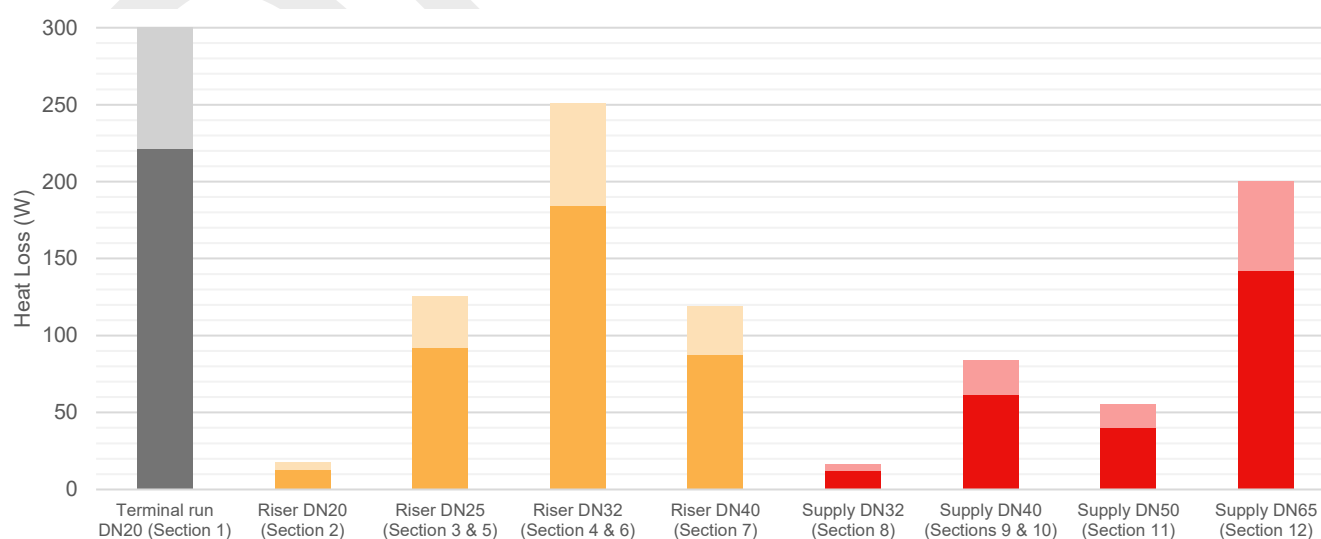
Table K.5: Communal Distribution Network heat loss summary

Building type		Single block of BESA Reference Building (Multi-riser)
Number of dwellings		50
Flow temperature (°C)		55
Return temperature (°C)		33
Total heat losses (kW)	Pipework heat loss	1.17
	Including 20 % ancillary allowance	1.40
Heat loss per dwelling (W/dwelling)	Pipework heat loss	23.38
	Including 20 % ancillary allowance	28.05
Compliance with Requirement 2.13.3/3.13.3 (75 W/dwelling)		Compliant

The calculated heat loss per dwelling for this example including the 20 % ancillary allowance, set out in Requirement 2.13.5/3.13.5, is in accordance with Requirement 2.13.3/3.13.3.

The heat loss distribution from different pipework sections is shown in Figure K.6.

Figure K.6: Heat loss distribution from BESA Reference Building



Methods for further reducing heat losses

As outlined in the process shown in [Figure K.2](#), if the total heat loss (W/dwelling) were to exceed the maximum heat loss values set out in Requirement [2.13.3/3.13.3](#), the Communal Distribution Network design would need to be altered until this requirement is met.

As indicated in Requirement [2.13.3/3.13.3](#), methods of reducing the heat loss from Communal Distribution Networks may include the interventions listed below.

- Reduce operating temperatures.

Adopting a lower operating temperature can significantly reduce the heat loss from the Distribution Network due to the reduction in temperature difference between the system and the surroundings.

- Adopt a more efficient pipework arrangement which results in a lower overall length of the Communal Distribution Network.

The overall length of the Communal Distribution Network has a significant impact on the losses from the network. As well as reducing heat losses from the network, a reduced length of the Communal Distribution Network can result in reduced CapEx and OpEx.

- Specify an insulation with greater thickness or lower thermal conductivity.

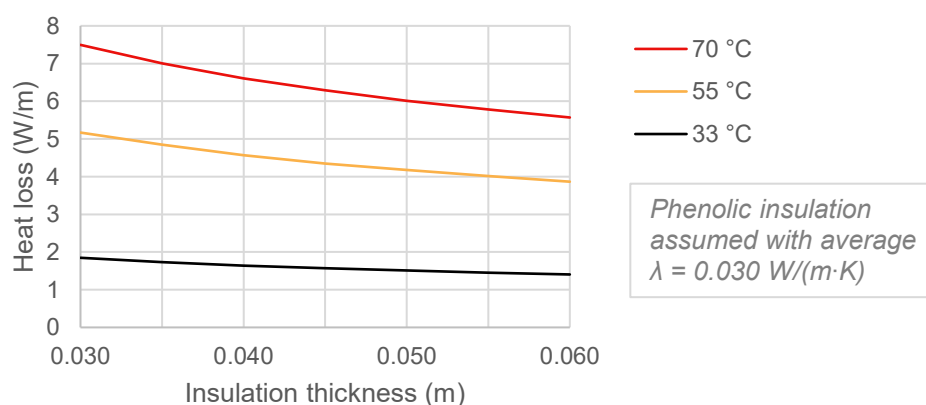
If operating temperatures and the overall length of the network cannot be feasibly reduced any further, the heat loss per unit length of pipework can be reduced through the specification of insulation with greater thickness or lower thermal conductivity.

In this example, the flow temperature is as low as it could feasibly be due to the domestic hot water temperature requirements at the consumer heat system and the assumed forward approach temperature present at consumer connections, and it is assumed that the design of the BESA Reference Building with a multi-riser typology could not be changed to be more efficient.

To meet the heat loss (W/m) limits set out in BS 5422:2023: *Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C* (BSI, 2023), the thickness of insulation was subsequently increased until the limits were met for all pipe sections in the scope of the example.

The effect that insulation thickness and operating temperature have on the heat loss per unit length (W/m) for a given pipe size is shown in [Figure K.7](#).

Figure K.7: Impact of insulation thickness on heat loss per unit length



Annex L: Condition tables

Table L.1: Condition grading methodology

Grade	Definition	
A	As new:	Requires only relevant PPM
B	Serviceable:	Operational, but exhibiting some signs of ageing or deterioration. Requires PPM and infrequent corrective minor repairs to it
C	Requires repair:	Operational, but in need of repairs to the asset or its sub-assets to make it serviceable and arrest frequent corrective intervention, negate business and operational risk
D	Major repair or replacement:	Inoperable or unsafe, considered at risk of imminent failure, requires an economically unviable major repair or is obsolete. Intervention would have little impact on prolonging asset life or reducing corrective repairs
E	Upgrade:	To meet changes in legislation or improve efficiency, energy or environmental performance
F	Asset required:	Does not currently exist, but required for operational or health and safety reasons
X	Unknown:	Asset not found or inaccessible

Grades based on condition category examples outlined in BS 8544:2013 - Guide for Life Cycle Costing of Maintenance During the In Use Phases of Buildings (BSI, 2013).

Table L.2: Priority grading methodology

Priority	Definition	
1	Urgent:	Work required to address serious health and safety issues and correct any breach of legislation
2	Necessary:	Work required to prevent the deterioration of the performance and service provided by the asset
3	Recommended:	Work recommended to overcome obsolescence or meet current legislation
4	Normal:	No work required beyond normal maintenance

Priorities based on priority categories outlined in CIBSE Guide M: Maintenance Engineering and Management (CIBSE, 2023).

Table L.3: Condition Auditor and Condition Surveyor activities

Condition Auditor activities
• Visual inspection of equipment including the look, sound, smell and feel of equipment. • Review of maintenance records, so as to: ◦ understand whether or not the equipment is being maintained appropriately; or ◦ highlight whether a defective condition has been previously highlighted through routine maintenance. • Review of current and historic alarms on both individual assets and the building management system (BMS). • Review of outage reports. • Interviewing of personnel responsible for the maintenance of equipment. • Reviewing of any recorded data available for the equipment. • Simple tests and inspections that can be adopted, for example: ◦ monitoring temperature stability; ◦ monitoring pressure stability; ◦ monitoring pump speeds; ◦ monitoring valve position; ◦ ambient temperature monitoring; ◦ relative humidity monitoring; and ◦ water quality testing.
Example non-destructive testing (NDT) activities
The following activities are not expected to take place during a Condition Audit, but can be undertaken by a Condition Surveyor where necessary. • Thermography. • Power quality surveys. • Vibration analysis. • Ultrasonic flaw detection and thickness gauging. • Eddy current testing. • Leak detection methods.

Activities based on the those outlined in BSRIA BG 35/2012: Condition Surveys and Asset Data Capture (BSRIA, 2012).

Table L.4: Competency requirements of a Condition Auditor and Condition Surveyor

Attributes	A: Academic points	B: Experience points
CEng	75	25 (total)
MEng	75	-
BEng (honours)	50	-
NVQ Level V (engineering surveying)	70	30 (total)
NVQ level V (other engineering subject)	70	10 (total)
IEng	50	25 (total)
BEng (non-honours)	50	-
Eng Tech	25	25 (total)
NVQ IV (engineering surveying)	50	30 (total)
NVQ IV (other engineering subject)	50	10 (total)
Marine engineering 1 st class certificate	50	30 (total)
HND	50	-
HNC	50	-
Full technical certificate (FTC)	50	-
OND	25	-
ONC	25	-
Marine engineering 2 nd class certificate	25	20 (total)
Licentiatehip of City and Guild Institute (LCGI)	25	20 (total)
NVQ III (engineering)	25	10 (total)
Relevant indentured/recognised/accredited apprenticeship	-	30 (total)
Specialised training (e.g. COMPEX, LEEA exams)	-	10 for each course
Direct relevant engineering experience combined with responsibility	-	30 for each year attained
Direct relevant engineering experience	-	20 for each year attained
Indirect relevant engineering experience	-	10 for each year attained

1 - Points from Column A are not accumulative, only the highest attribute points shall be counted.

2 - Total points will be the addition of the points obtained from columns A and B.

3 - Industry-specific or foreign qualifications will need to be assessed against the Engineering Council (UK) requirements.

4 - Direct relevant engineering experience refers to experience with installing, maintaining, repairing, testing or inspection of the types of engineering plant within the core discipline for which it is planned the candidate is to be employed.

5 - Indirect relevant engineering refers to experience with the design or management of engineering plant within and/or out with the candidate's core discipline.

6 - The maximum number of years that experience points can be accumulated is five.

Competency points based on competency points outlined in SAFed Standard 01: Recruitment, Training and Competency of Engineer Surveyors (SAFed, 2023).

Table L.5: Competency categories for a Condition Auditor and Condition Surveyor

Category	Minimum points required	Condition Auditor	Condition Surveyor
Category 1	200 total 50 points from column A of Table L.4	Has jurisdiction to: execute and approve a Condition Audit of assets which they have achieved competency for	Has jurisdiction to: - execute and approve a Condition Audit of assets which they have achieved competency for; and - execute and approve a Condition Survey of assets for which they have achieved competency for
Category 2	100 total 25 points from column A of Table L.4	Has jurisdiction to: execute a Condition Audit of assets which they have achieved competency for under the supervision of a Category 1 Condition Auditor	- <i>All Condition Survey activities are undertaken by a Category 1 Condition Surveyor</i>

Competency categories based on competency categories outlined in SAFed Standard 01: Recruitment, Training and Competency of Engineer Surveyors (SAFed, 2023).

Table L.6: Data field requirements of a condition log

Field	Data Field	Description	Example inputs	Comments	Rationale
Basic asset data					
1	Asset Name	A name which identifies the asset	Gas fired boiler	Asset descriptor e.g. RICS NRM 3 and/or Uniclass classifications	Provide a descriptive name of what the asset is <i>Note: use of the asset classification description to contain consistent naming</i>
2	Asset ID	A unique asset ID number	Code for tagging	-	Provide a unique identifier for each individual asset
3	Asset classification code	The asset classification code	20-04	BESA SFG20 code (or equivalent)	Provide consistent asset classification codes aligned with industry standards.
4	Asset classification description	The asset classification description	Expansion Vessels	"SFG20 Task Schedule Description / NRM 3 Maintain & Renewal Description"	Provide consistent asset classification descriptions aligned with industry standards
5	Asset criticality	The level of criticality of this asset to the building/organisation (based on location or specific assets)	Red	BESA SFG20 criticality codes (or equivalent)	Provide consistent criticality ratings to inform prioritisation of maintenance activities and support investment decisions

Annex L: Condition tables

Field	Data Field	Description	Example inputs	Comments	Rationale
6	Asset maintainer	Identification of person responsible for maintaining asset	Operator X	Supplier name / operator name / landlord name	Provide details on parties responsible for maintaining assets to avoid either assets not being maintained or being maintained excessively
7	Asset location	Where the asset is located building/floor/zone/room	Energy Centre, ground floor	Uniclass spaces/locations	Provide the location of the asset
8	Asset install date	Date the asset was installed	01/10/2015	DD/MM/YYYY	Inform asset's life expectancy
Condition data					
9	Asset condition grade	The current condition of the asset	B	Condition grade as per Table L.1	Consistently capture asset condition to inform maintenance and investment decisions
10	Asset priority grade	Priority of maintenance requirements for the asset	3	Priority grade as per Table L.2	Consistently capture the priority of maintenance activities to inform maintenance and investment decisions
11	Asset beyond economic repair	Whether or not the asset is beyond economic repair	Yes/No	Determined in accordance with contractual provisions	Support investment decisions
12	Asset operational status	Whether or not the asset is currently in operational use	Operational / Not in use	-	Inform maintenance and investment decisions

Field	Data Field	Description	Example inputs	Comments	Rationale
13	Date of last applicable maintenance activity	Date which maintenance activity was carried out that last altered the asset's condition grade	14/01/2024	DD/MM/YYYY	Inform when condition grade was last updated
14	Date of last Condition Survey	Date the asset's condition was last assessed	03/02/2024	DD/MM/YYYY	Inform how up to date condition data and life expectancy data is
15	Remaining life expectancy (years)	Length of the asset's life expectancy in years	10	CIBSE life expectancy reference service life as per CIBSE Guide M: <i>Maintenance Engineering and Management</i> (CIBSE, 2023)	Inform maintenance and investment decisions

Based on data fields outlined in Facilities Management Standard FMS 002: Asset Data (UK Government, 2022).

Annex M: HNTAS KPIs

The items in [Table M.1](#) - [Table M.6](#) provide descriptions and methodologies for the KPIs which apply to each Element within a Heat Network. The Monitoring Points used to measure and calculate KPIs are indicated in orange. Required Monitoring Points are provided in Annex A of the *Heat Network Metering and Monitoring Standard (MMS)* (HNTAS, 2025).

Table M.1: Energy Centre KPIs

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-01	Automatic and Remote Monitoring System (ARMS) connectivity	Total number of days where Monitoring Points has connected to the ARMS within 24 hours of last connection.	$\frac{\sum \left(\begin{array}{c} \text{number of days each Monitoring Point} \\ \text{has connected to the ARMS} \\ \text{within 24 hours of last connection} \end{array} \right)}{\text{Total Monitoring Points} \times \text{Total days in period}}$
EC-KPI-02	Energy Centre 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.	$\left(\frac{\text{Total number of reads recorded across [time period]}}{\text{Total reads expected across [time period]}} \right) \times 100$ Where: $\text{Total reads expected} = \sum \left(\left(\begin{array}{c} \text{Monitoring} \\ \text{Point} \end{array} \right) \times \left(\begin{array}{c} \text{frequency of} \\ \text{Monitoring Point} \end{array} \right) \times \left[\begin{array}{c} \text{time} \\ \text{period} \end{array} \right] \right)$

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-03	Energy Centre Monitoring Points operational	Of the Monitoring Points which are connected to the ARMS (as per EC-KPI-01) and have complete data (as per EC-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): 1. no error codes (meters); 2. no negative readings (meters); 3. 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.

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-04	Energy Centre unplanned major outages*	Number of unplanned major outages* reported per annum. An Energy Centre major outage is defined as an event causing: - the flow temperature at the Energy Centre boundary (EC3) to be below the minimum required flow temperature for more than 12 hours; - the differential pressure at the specified differential pressure measurement point(s) (EC6) (note 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 Energy Centre. An unplanned major outage is a major outage as defined above, where the Heat Network end user has not been provided with at least 48 hours written notice of such major outage.	$\sum \left(\begin{array}{l} \text{unplanned major outages} \\ \text{for a given [time period]} \end{array} \right)$

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-05	Energy Centre planned major outages*	Number of planned major outages* reported per annum. An Energy Centre major outage is defined as an event causing: - the flow temperature at the Energy Centre boundary (EC3) to be below the minimum required flow temperature for more than 12 hours; - the differential pressure at the specified differential pressure measurement point(s) (EC6) (note 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 Energy Centre. A planned major outage is a major outage as defined above where notice has been given to the end user at least 48 hours prior to the major outage occurring.	$\sum \left(\begin{array}{l} \text{planned major outages} \\ \text{for a given [time period]} \end{array} \right)$
EC-KPI-06	Energy Centre average flow temperature	Average flow temperature for given [time period] measured at the Energy Centre boundary (EC3) .	$\frac{\sum \left(\begin{array}{l} \text{flow temperature at each} \\ \text{time point for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$
EC-KPI-07	Energy Centre average return temperature	Average return temperature for given [time period] measured at the Energy Centre boundary (EC3) .	$\frac{\sum \left(\begin{array}{l} \text{return temperature at each} \\ \text{time point for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-08	Energy Centre flow temperature variance from setpoint	Average difference between the actual flow temperature measured at the Energy Centre boundary (EC3) and the setpoint.	$\frac{\sum \left(\left(\begin{array}{c} \text{actual flow} \\ \text{temperature} \end{array} \right) - \left(\begin{array}{c} \text{setpoint at each time point} \\ \text{for given [time period]} \end{array} \right) \right)}{\sum (\text{time points for given [time period]})}$
EC-KPI-09A	Energy Centre Volume Weighted Average Flow Temperature (VWAFT)	Energy Centre flow temperature weighted against volumetric flow rate, measured at the Energy Centre boundary (EC3) .	$\frac{\sum (T_t \times q_t)}{\sum q_t}$ Where: T_t = flow temperature for each time recording (t) for given [time period]; and q_t = flow rate for each time recording (t) for given [time period] or cumulative volume for each time recording (t) for given [time period].
EC-KPI-09B	Energy Centre Volume Weighted Average Flow Temperature (VWAFT) variance from setpoint Note: Applicable for Heat Networks which do not have a fixed flow temperature (e.g. weather compensated Heat Networks)	Energy Centre flow temperature difference from its setpoint weighted against volumetric flow rate, measured at the Energy Centre boundary (EC3) .	$\frac{\sum ((T_t - T_{\text{setpoint}}) \times q_t)}{\sum q_t}$ Where: T_t = flow temperature for each time recording (t) for given [time period]; T_{setpoint} = setpoint temperature for each time recording (t) for given [time period]; and q_t = flow rate for each time recording (t) for given [time period] or cumulative volume for each time recording (t) for given [time period].

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-10A	Energy Centre flow temperature stability	The percentage of time flow temperature, measured at the Energy Centre boundary (EC3) is within upper and lower bounds of the design setpoint. The upper and lower bounds shall not exceed ± 5 °C from the flow temperature setpoint. The lower bound shall also be: • equal to or greater than the minimum flow temperature of the network required to deliver > 45 °C DHW to outlets within Consumer Heat System; or • the minimum required flow temperature required at the Substation to deliver the minimum required flow temperature for the network it is supplying.	$\frac{\sum \left(\text{time points spent within the upper and lower threshold of the design setpoint for given [time period]} \right)}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-10B	Energy Centre flow temperature stability Note: Applicable for networks which do not have a fixed flow temperature (e.g. weather compensated systems)	The percentage of time the flow temperature differential from its setpoint, measured at the Energy Centre boundary (EC3), is within the upper and lower bounds. The upper and lower bounds shall not exceed $\pm 5^{\circ}\text{C}$ from the flow temperature setpoint. The lower bound shall also be: • equal to or greater than the minimum required flow temperature of the network required to deliver $> 45^{\circ}\text{C}$ DHW to outlets within Consumer Heat System; or • the minimum flow temperature required at the Substation to deliver the minimum required flow temperature for the network it is supplying.	$\frac{\sum \left(\text{time points that the difference between the flow temperature and its setpoint is within the upper and lower threshold for given [time period]} \right)}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-11	Energy Centre flow temperature uptime	The percentage of time flow temperature, measured at the Energy Centre boundary (EC3) is above the minimum required flow temperature. Minimum required flow temperature will be project specific and shall be set for each Energy Centre. Minimum required flow temperature of the network is: - the flow temperature required to deliver >45 °C DHW to outlets within Consumer Heat System; or - the minimum flow temperature required at the Substation to deliver the minimum required flow temperature for the network it is supplying.	$\frac{\sum (\text{time points spent above minimum required flow temperature for given [time period]})}{\sum (\text{time points for given [time period]})}$
EC-KPI-12	Pressure differential uptime	The percentage of time the pressure differential spends above the minimum differential pressure setpoint at the specified differential pressure measurement point(s) (EC6) Minimum differential pressure setpoint is defined as the differential pressure setpoint minus 10 %, or [setpoint - 10 %].	$\frac{\sum (\text{time points spent above [setpoint - 10 %] for given [time period]})}{\sum (\text{time points for given [time period]})}$
EC-KPI-13	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 (EC7).	$1 - \left[\frac{\sum (\text{reads above maximum for given [time period]})}{\sum (\text{reads for given [time period]})} \right]$

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-14	Maximum allowable working pressure exceedance	The percentage of time the working pressure spends below the maximum allowable working pressure at the specified working pressure measurement point(s) (EC8).	$1 - \frac{\sum \left(\begin{array}{l} \text{working pressure reads greater} \\ \text{than the maximum working pressure} \\ \text{requirement for given [time period]} \end{array} \right)}{\sum (\text{working pressure reads for given [time period]})}$
EC-KPI-15	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 Energy Centre water meter (EC5). Network may include other Elements, such as the Distribution Network pipework served by Energy Centre.	$\frac{\left(\begin{array}{l} \text{volume added measured} \\ \text{in [time period] (m}^3 \text{)} \end{array} \right)}{(\text{total system pipework volume (m}^3 \text{)})}$
EC-KPI-16	Heat fraction	Proportion of total annual heat generation supplied by each heat source, measured at the Energy Centre heat source(s) (EC2). To be calculated for each heat source, where more than one heat source used.	$\frac{\left(\begin{array}{l} \text{total heat generated by heat source} \\ \text{for a given [time period] (kWh)} \end{array} \right)}{\left(\begin{array}{l} \text{total heat generated by all heat} \\ \text{sources for a given [time period] (kWh)} \end{array} \right)}$
EC-KPI-17	Efficiency of each heat generation item	Heat generated by heat source, measured at the Energy Centre heat source (EC2) as a proportion of the input fuel energy, measured at the Energy Centre energy input (EC1), displayed as a percentage (%) per heat generation item. To be done as a combined source rather than individual modules of the same type of heat generation. E.g. bank of boilers or heat pump modules.	$\frac{\left(\begin{array}{l} \text{heat source heat generation} \\ \text{(kWh) for given [time period]} \end{array} \right)}{\left(\begin{array}{l} \text{heat source energy input at} \\ \text{(kWh) for given [time period]} \end{array} \right)}$ Note: this calculation methodology applies unless otherwise specified.

KPI ID	KPI	KPI description	Calculation methodology
EC-KPI-18	Network distribution pump energy use	Total pump energy use (kWh) measured at the Energy Centre pump electricity meter (EC4) over the given [time period]. Applicable for network distribution pumps. Not applicable for equipment shunt pumps.	Total pump energy use (kWh) over given [time period].

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

Table M.2: District Distribution Network KPIs

KPI ID	KPI	KPI description	Calculation methodology
DD-KPI-01	Automatic and Remote Monitoring System (ARMS) connectivity	Total number of days where Monitoring Points has connected to the ARMS within 24 hours of last connection.	$\frac{\sum \left(\begin{array}{c} \text{number of days each Monitoring Point} \\ \text{has connected to the ARMS} \\ \text{within 24 hours of last connection} \end{array} \right)}{\text{Total Monitoring Points} \times \text{Total days in period}}$
DD-KPI-02	District Distribution Network 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.	$\left(\frac{\text{Total number of reads recorded across [time period]}}{\text{Total reads expected across [time period]}} \right) \times 100$ Where: $\text{Total reads expected} = \sum \left(\left(\begin{array}{c} \text{Monitoring} \\ \text{Point} \end{array} \right) \times \left(\begin{array}{c} \text{frequency of} \\ \text{Monitoring Point} \end{array} \right) \times \left[\begin{array}{c} \text{time} \\ \text{period} \end{array} \right] \right)$
DD-KPI-03	District Distribution Network Monitoring Points operational	Of the Monitoring Points which are connected to the ARMS (as per DD-KPI-01) and have complete data (as per DD-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): 1. no error codes (meters); 2. no negative readings (meters); 3. 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.

KPI ID	KPI	KPI description	Calculation methodology
DD-KPI-04	District Distribution Network unplanned major outages*	Number of unplanned major outages* reported per annum. A District Distribution Network major outage is defined as an event causing: - the flow temperature at the District Distribution Network Termination Point (DD2) to be below the minimum required flow temperature for more than 12 hours, due to an issue originating in the District Distribution Network; - the differential pressure at the specified differential pressure measurement point(s) (DD3) (note 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 District Distribution Network. An unplanned major outage is a major outage as defined above, where the network end user has not been provided with at least 48 hours written notice of such major outage.	$\sum \left(\begin{array}{l} \text{unplanned major outages} \\ \text{for a given [time period]} \end{array} \right)$

KPI ID	KPI	KPI description	Calculation methodology
DD-KPI-05	District Distribution Network planned major outages*	Number of planned major outages* reported per annum. A District Distribution Network major outage is defined as an event causing: - the flow temperature at the District Distribution Network Termination Point (DD2) to be below the minimum required flow temperature for more than 12 hours, due to an issue originating in the District Distribution Network; - the differential pressure at the specified differential pressure measurement point(s) (DD3) (note 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 District Distribution Network. A planned major outage is a major outage as defined above where notice has been given to the end user at least 48 hours prior to the major outage occurring.	$\sum \left(\begin{array}{l} \text{planned major outages} \\ \text{for a given [time period]} \end{array} \right)$

KPI ID	KPI	KPI description	Calculation methodology
DD-KPI-06	District Distribution Network heat loss	Calculated heat loss between the District Distribution Network Initiation Point (DD1) and the District Distribution Network Termination Point(s) (DD2).	Design: $\sum \left(\begin{array}{c} \text{heat losses} \\ \text{for each} \\ \text{pipe section} \\ \text{(kW)} \end{array} \right) + \sum \left(\begin{array}{c} \text{heat losses from fittings,} \\ \text{ancillary equipment, etc.} \\ \text{within District Distribution} \\ \text{Network (kW)} \end{array} \right)$ Operation: $\sum \left(\begin{array}{c} \text{heat demand at each} \\ \text{meter at the District} \\ \text{Distribution Network} \\ \text{Initiation Point} \\ \text{(DD1) (kW) for} \\ \text{given [time period]} \end{array} \right) - \sum \left(\begin{array}{c} \text{heat demand at each} \\ \text{meter at the District} \\ \text{Distribution Network} \\ \text{Termination Point(s)} \\ \text{(DD2) (kW) for} \\ \text{given [time period]} \end{array} \right)$
DD-KPI-07	District Distribution Network average flow temperature	Average flow temperature for given [time period] measured at the District Distribution Initiation Point (DD1).	$\frac{\sum \left(\begin{array}{c} \text{flow temperature at each} \\ \text{time point for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$
DD-KPI-08	District Distribution Network average return temperature	Average return temperature for given [time period] measured at the District Distribution Initiation Point (DD1).	$\frac{\sum \left(\begin{array}{c} \text{return temperature at each} \\ \text{time point for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$
DD-KPI-09	District Distribution Network bypass flow rate	Sum of measured flow rates from all Termination Points against the flow rate measured at the Initiation Point.	$\frac{\sum \left(\begin{array}{c} \text{volume delivered} \\ \text{from District} \\ \text{Distribution Network} \\ \text{Initiation Point} \\ \text{(DD1) (m}^3\text{) for} \\ \text{given [time period]} \end{array} \right) - \sum \left(\begin{array}{c} \text{volume consumed} \\ \text{at all District} \\ \text{Distribution Network} \\ \text{Termination Point(s)} \\ \text{(DD2) (m}^3\text{) for} \\ \text{given [time period]} \end{array} \right)}{[\text{time period}]}$

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

Table M.3: Substation KPIs

KPI ID	KPI	KPI description	Calculation methodology
SS-KPI-01	Automatic and Remote Monitoring System (ARMS) connectivity	Total number of days where Monitoring Points has connected to the ARMS within 24 hours of last connection.	$\frac{\sum \left(\begin{array}{c} \text{number of days each Monitoring Point} \\ \text{has connected to the ARMS} \\ \text{within 24 hours of last connection} \end{array} \right)}{\text{Total Monitoring Points} \times \text{Total days in period}}$
SS-KPI-02	Substation Monitoring Points data completeness	Number of total reads received in comparison to the total reads expected within the given [time period] for each Monitoring Point.	$\left(\frac{\text{Total number of reads recorded across [time period]}}{\text{Total reads expected across [time period]}} \right) \times 100$ Where: $\text{Total reads expected} = \sum \left(\left(\begin{array}{c} \text{Monitoring} \\ \text{Point} \end{array} \right) \times \left(\begin{array}{c} \text{frequency of} \\ \text{Monitoring Point} \end{array} \right) \times \left[\begin{array}{c} \text{time} \\ \text{period} \end{array} \right] \right)$
SS-KPI-03	Substation Monitoring Points operational	Of the Monitoring Points which are connected to the ARMS (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): 1. no error codes (meters); 2. no negative readings (meters); 3. 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.

KPI ID	KPI	KPI description	Calculation methodology
SS-KPI-04	Substation unplanned major outages*	Number of unplanned major outages* reported per annum. A Substation major outage 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 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 major outage is a major outage as defined above, where the network end user has not been provided with at least 48 hours written notice of such major outage.	$\sum \left(\begin{array}{l} \text{unplanned major outages} \\ \text{for a given [time period]} \end{array} \right)$

KPI ID	KPI	KPI description	Calculation methodology
SS-KPI-05	Substation planned major outages*	Number of planned major outages* reported per annum. A Substation major outage 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 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 major outage is a major outage as defined above where notice has been given to the end user at least 48 hours prior to the major outage occurring.	$\sum (\text{planned major outages for a given [time period]})$
SS-KPI-06	Substation average flow temperature	Average flow temperature for given [time period] measured at the Substation offtake (SS2) .	$\frac{\sum (\text{flow temperature at each time point for given [time period]})}{\sum (\text{time points for given [time period]})}$
SS-KPI-07	Substation average return temperature	Average return temperature for given [time period] measured at the Substation intake (SS1) .	$\frac{\sum (\text{return temperature at each time point for given [time period]})}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
SS-KPI-08	Substation flow temperature variance from setpoint	Average difference between the actual flow temperature measured at the Substation offtake (SS2) and the setpoint.	$\frac{\sum \left(\left(\text{actual flow temperature} \right) - \left(\text{setpoint at each time point for given [time period]} \right) \right)}{\sum (\text{time points for given [time period]})}$
SS-KPI-09A	Substation Volume Weighted Average Flow Temperature (VWAFT)	Substation flow temperature weighted against volumetric flow rate, measured at the Substation offtake (SS2) .	$\frac{\sum (T_t \times q_t)}{\sum q_t}$ Where: T_t = flow temperature for each time recording (t) for given [time period]; and q_t = flow rate for each time recording (t) for given [time period] or cumulative volume for each time recording (t) for given [time period].
SS-KPI-09B	Substation Volume Weighted Average Flow Temperature (VWAFT) variance from setpoint Note: Applicable for Heat Networks which do not have a fixed flow temperature (e.g. weather compensated Heat Networks)	Substation flow temperature difference from its setpoint weighted against volumetric flow rate, measured at the Substation offtake (SS2) .	$\frac{\sum ((T_t - T_{\text{setpoint}}) \times q_t)}{\sum q_t}$ Where: T_t = flow temperature for each time recording (t) for given [time period]; T_{setpoint} = setpoint temperature for each time recording (t) for given [time period]; and q_t = flow rate for each time recording (t) for given [time period] or cumulative volume for each time recording (t) for given [time period].

KPI ID	KPI	KPI description	Calculation methodology
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 setpoint. The upper and lower bounds shall not exceed $\pm 5^{\circ}\text{C}$ from the flow temperature setpoint. The lower bound shall also be: • equal to or greater than the minimum flow temperature of the network required to deliver $> 45^{\circ}\text{C}$ 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.	$\frac{\sum \left(\text{time points spent within the upper and lower threshold of the design setpoint for given [time period]} \right)}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
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 $\pm 5^{\circ}\text{C}$ from the flow temperature setpoint. The lower bound shall also be: • equal to or greater than the minimum required flow temperature of the network required to deliver $> 45^{\circ}\text{C}$ 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.	$\frac{\sum \left(\text{time points that the difference between the flow temperature and its setpoint is within the upper and lower threshold for given [time period]} \right)}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
SS-KPI-11	Substation flow temperature uptime	The percentage of time flow temperature, measured at the Substation offtake (SS2) is above the Minimum Required 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 - the minimum flow temperature required at the Substation to deliver the minimum required flow temperature for the network it is supplying.	$\frac{\sum (\text{time points spent above minimum required flow temperature for given [time period]})}{\sum (\text{time points for given [time period]})}$
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).	$\frac{\sum \left(\begin{array}{l} \text{difference between } \text{Substation offtake (SS2)} \text{ return temperature} \\ \text{and } \text{Substation intake (SS1)} \\ \text{return temperature (°C) per time} \\ \text{point for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
SS-KPI-13	Pressure differential uptime	The percentage of time the pressure differential spends above the minimum differential pressure setpoint at the specified differential pressure measurement point(s) (SS5) . Minimum differential pressure setpoint is defined as the differential pressure setpoint minus 10 %, or [setpoint - 10 %].	$\frac{\sum \left(\begin{array}{c} \text{time points spent} \\ \text{above [setpoint-10 \%]} \\ \text{for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$
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) .	$1 - \left[\frac{\sum \left(\begin{array}{c} \text{reads above maximum} \\ \text{for given [time period]} \end{array} \right)}{\sum (\text{reads for given [time period]})} \right]$
SS-KPI-15	Maximum allowable working pressure exceedance	The percentage of time the working pressure spends below the maximum allowable working pressure at the specified working pressure measurement point(s) (SS7) .	$1 - \frac{\sum \left(\begin{array}{c} \text{working pressure reads greater} \\ \text{than the maximum working pressure} \\ \text{requirement for given [time period]} \end{array} \right)}{\sum (\text{working pressure reads for given [time period]})}$
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.	$\frac{\left(\begin{array}{c} \text{volume added measured} \\ \text{in [time period] (m}^3\text{)} \end{array} \right)}{(\text{total system pipework volume (m}^3\text{)})}$
SS-KPI-17	Network distribution pump energy use	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].

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

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Table M.4: Communal Distribution Network KPIs

KPI ID	KPI	KPI description	Calculation methodology
CD-KPI-01	Automatic and Remote Monitoring System (ARMS) connectivity	Total number of days where Monitoring Points has connected to the ARMS within 24 hours of last connection.	$\frac{\sum \left(\begin{array}{c} \text{number of days each Monitoring Point} \\ \text{has connected to the ARMS} \\ \text{within 24 hours of last connection} \end{array} \right)}{\text{Total Monitoring Points} \times \text{Total days in period}}$
CD-KPI-02	Communal Distribution network 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.	$\left(\frac{\text{Total number of reads recorded across [time period]}}{\text{Total reads expected across [time period]}} \right) \times 100$ Where: $\text{Total reads expected} = \sum \left(\left(\begin{array}{c} \text{Monitoring} \\ \text{Point} \end{array} \right) \times \left(\begin{array}{c} \text{frequency of} \\ \text{Monitoring Point} \end{array} \right) \times \left[\begin{array}{c} \text{time} \\ \text{period} \end{array} \right] \right)$
CD-KPI-03	Communal Distribution Network Monitoring Points operational	Of the Monitoring Points which are connected to the ARMS (as per CD-KPI-01) and have complete data (as per CD-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): 1. no error codes (meters); 2. no negative readings (meters); 3. 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.

KPI ID	KPI	KPI description	Calculation methodology
CD-KPI-04	Communal Distribution Network unplanned major outages*	Number of unplanned major outages* reported per annum. A Communal Distribution Network major outage is defined as an event causing: - the flow temperature at the Communal Distribution Network Termination Point (CD2) to be below the minimum required flow temperature for more than 12 hours, due to an issue originating in the Communal Distribution Network; - the differential pressure at the Communal Distribution Network Termination Points or alternative specified differential pressure measurement point (CD3) (note 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 Communal Distribution Network. An unplanned major outage is a major outage as defined above, where the network end user has not been provided with at least 48 hours written notice of such major outage.	$\sum \left(\begin{array}{l} \text{unplanned major outages} \\ \text{for a given [time period]} \end{array} \right)$

KPI ID	KPI	KPI description	Calculation methodology
CD-KPI-05	Communal Distribution Network planned major outages*	Number of planned major outages* reported per annum. A Communal Distribution Network major outage is defined as an event causing: - the flow temperature at the Communal Distribution Network Termination Point (CD2) to be below the minimum required flow temperature for more than 12 hours, due to an issue originating in the Communal Distribution Network; - the differential pressure at the Communal Distribution Network Termination Points or alternative specified differential pressure measurement point (CD3) (note 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 Communal Distribution Network. A planned major outage is a major outage as defined above where notice has been given to the end user at least 48 hours prior to the major outage occurring.	$\sum \left(\begin{array}{l} \text{planned major outages} \\ \text{for a given [time period]} \end{array} \right)$

KPI ID	KPI	KPI description	Calculation methodology
CD-KPI-06	Communal Distribution Network heat loss	Calculated heat loss between the Communal Distribution Network Initiation Point (CD1) heat meter and the Communal Distribution Network Termination Point(s) (CD2) heat meter(s).	Design: $\sum \left(\begin{array}{c} \text{heat losses} \\ \text{for each} \\ \text{pipe size} \\ \text{(kW)} \end{array} \right) + \sum \left(\begin{array}{c} \text{heat losses from fittings,} \\ \text{ancillary equipment, etc.} \\ \text{within Communal Distribution} \\ \text{Network (kW)} \end{array} \right)$ Operation: $\sum \left(\begin{array}{c} \text{heat demand} \\ \text{at each meter} \\ \text{at the } \textbf{Communal} \\ \textbf{Distribution Network} \\ \textbf{Initiation Point} \\ \textbf{(CD1)} \text{ (kW) for} \\ \text{given [time period]} \end{array} \right) - \sum \left(\begin{array}{c} \text{heat demand} \\ \text{at each meter} \\ \text{at the } \textbf{Communal} \\ \textbf{Distribution Network} \\ \textbf{Termination Point(s)} \\ \textbf{(CD2)} \text{ (kW) for} \\ \text{given [time period]} \end{array} \right)$
CD-KPI-07	Communal Distribution Network average flow temperature	Average flow temperature for given [time period] measured at the Communal Distribution Network Initiation Point (CD1) .	$\frac{\sum \left(\begin{array}{c} \text{flow temperature at each} \\ \text{time point for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$
CD-KPI-08	Communal Distribution Network average return temperature	Average return temperature for given [time period] measured at the Communal Distribution Network Initiation Point (CD2) .	$\frac{\sum \left(\begin{array}{c} \text{return temperature at each} \\ \text{time point for given [time period]} \end{array} \right)}{\sum (\text{time points for given [time period]})}$

KPI ID	KPI	KPI description	Calculation methodology
CD-KPI-09	Communal Distribution Network bypass flow rate	Sum of measured flow rates from all Termination Points against the flow rate measured at the Initiation Point.	$\frac{\sum \left(\begin{array}{l} \text{volume delivered} \\ \text{from Communal} \\ \text{Distribution Network} \\ \text{Initiation Point} \\ \text{(CD1) (m}^3\text{) for} \\ \text{given [time period]} \end{array} \right) - \sum \left(\begin{array}{l} \text{volume consumed} \\ \text{at all Communal} \\ \text{Distribution Network} \\ \text{Termination Point(s)} \\ \text{(CD2) (m}^3\text{) for} \\ \text{given [time period]} \end{array} \right)}{[\text{time period}]}$

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

Table M.5: Consumer Connection KPIs

KPI ID	KPI	KPI description	Calculation methodology
CC-KPI-01	Automatic and Remote Monitoring System (ARMS) connectivity	Total number of days where Monitoring Points has connected to the ARMS within 24 hours of last connection.	$\frac{\sum \left(\begin{array}{c} \text{number of days each Monitoring Point} \\ \text{has connected to the ARMS} \\ \text{within 24 hours of last connection} \end{array} \right)}{\text{Total Monitoring Points} \times \text{Total days in period}}$
CC-KPI-02	Consumer Connection 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.	$\left(\frac{\text{Total number of reads recorded across [time period]}}{\text{Total reads expected across [time period]}} \right) \times 100$ Where: $\text{Total reads expected} = \sum \left(\left(\begin{array}{c} \text{Monitoring} \\ \text{Point} \end{array} \right) \times \left(\begin{array}{c} \text{frequency of} \\ \text{Monitoring Point} \end{array} \right) \times \left[\begin{array}{c} \text{time} \\ \text{period} \end{array} \right] \right)$
CC-KPI-03	Consumer Connection Monitoring Points operational	Of the Monitoring Points which are connected to the ARMS (as per CC-KPI-1) and have complete data (as per CC-KPI-2), the number of which are operating as expected. Monitoring Points that are operating as expected will have (dependent on type of Monitoring Point): 1. no error codes (meters); 2. no negative readings (meters); 3. 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.

KPI ID	KPI	KPI description	Calculation methodology
CC-KPI-04	Consumer Connection unplanned major outages*	Number of unplanned major outages* reported per annum for a Heat Network. A Consumer Connection major outage is defined as any reported issue at the Consumer Connection that leads to consumers not receiving heating or hot water for more than 12 hours, due to an issue originating in the Consumer Connection. Note this is not to include issues within the Consumer Heat Systems (e.g. a problem with the heating circuit), issues under the control of the Consumer rather than the Heat Network Operator, or issues originating in upstream Elements. An unplanned major outage is a major outage as defined above, where the network end user has not been provided with at least 48 hours written notice of such major outage.	$\sum \left(\begin{array}{l} \text{unplanned major outages} \\ \text{for a given [time period]} \end{array} \right)$

KPI ID	KPI	KPI description	Calculation methodology
CC-KPI-05	Consumer Connection planned major outages*	Number of planned major outages* reported per annum for a Heat Network. A Consumer Connection major outage is defined as any reported issue at the Consumer Connection that leads to consumers not receiving heating or hot water for more than 12 hours, due to an issue originating in the Consumer Connection. Note this is not to include issues within the Consumer Heat Systems (e.g. a problem with the heating circuit), issues under the control of the Consumer rather than the Heat Network Operator, or issues originating in upstream Elements. A planned major outage is a major outage as defined above where notice has been given to the end user at least 48 hours prior to the major outage occurring.	$\sum \left(\begin{array}{l} \text{planned major outages} \\ \text{for a given [time period]} \end{array} \right)$
CC-KPI-06	Efficiency of each heat generation item (%) Note: only applicable for Consumer Connections where there is heat generation (e.g. heat pump).	Useful heat delivered to the Consumer Heat System divided by the input fuel energy (%).	$\frac{\left(\begin{array}{l} \text{heat generated at the} \\ \text{Consumer Connection (kWh)} \\ \text{for given [time period]} \end{array} \right)}{\left(\begin{array}{l} \text{energy input to} \\ \text{Consumer Connection (kWh)} \\ \text{for given [time period]} \end{array} \right)}$

KPI ID	KPI	KPI description	Calculation methodology
CC-KPI-07	Consumer Connection overall Volume Weighted Average Return Temperature (VWART)	Consumer Connection return temperature weighted against volumetric flow rate, measured at the Consumer Connection Boundary (CC1) .	$\frac{\sum (T_t \times q_t)}{\sum q_t}$ Where: T_t = return temperature for each time recording (t) for given [time period]; and q_t = flow rate for each time recording (t) for given [time period] or cumulative volume for each time recording (t) for given [time period].
CC-KPI-08	Standby return temperature	Consumer Connection return temperature during standby operation, measured at the Consumer Connection Boundary (CC1) .	stabilised return temperature measured at the Consumer Connection Boundary (CC1) during standby operation
CC-KPI-09	Domestic hot water (DHW) return temperature	Consumer Connection return temperature during DHW operation, measured at the Consumer Connection Boundary (CC1) .	stabilised return temperature measured at the Consumer Connection Boundary (CC1) during DHW operation
CC-KPI-10	Space heating return temperature	Consumer Connection return temperature during space heating operation, measured at the Consumer Connection Boundary (CC1) .	stabilised space heating return temperature measured at the Consumer Connection Boundary (CC1) during space heating operation
CC-KPI-11	DHW generation temperature	The DHW temperature generated at the Consumer Connection during DHW operation.	temperature measured at a Consumer Heat System DHW outlet (where the temperature has not been blended) during stabilised DHW operation
CC-KPI-12	Space heating generation temperature	The space heating temperature generated at the Consumer Connection during Space Heating operation.	temperature measured at the Consumer Connection space heating outlet during stabilised space heating operation

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

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Table M.6: Consumer Heat System KPIs

KPI ID	KPI	KPI description	Calculation methodology
CHS-KPI-01	DHW delivery time at kitchen tap (or the furthest outlet without a thermostatic mixing valve) Note: only applicable to domestic Consumer Heat Systems.	The time taken from opening the kitchen DHW tap (or furthest outlet without a thermostatic mixing valve) to deliver 45 °C DHW.	time taken from opening the kitchen DHW tap (or furthest outlet without a thermostatic mixing valve) to deliver 45 °C DHW
CHS-KPI-02	Space heating circuit return temperature	Return temperature from space heating circuit during steady state space heating operation.	space heating circuit return temperature measured during steady state operation of the space heating system

Annex N: Relevant standards

Table N.1: Standards relevant to the installation, commissioning, and operation of Heat Networks

Area of Installation	Applicable Standards	Applicable Elements
Installation		
Above-ground Insulation	BS 5970:2012: <i>Thermal Insulation of Pipework, Ductwork, Associated Equipment and Other Industrial Installations in the Temperature Range of -100°C to +870°C - Code of Practice</i> (BSI, 2012)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection
BMS	AG/9: <i>Standard Specification for BMS</i> (BSRIA, 2001)	Energy Centre Substation
Boilers	BS EN 656:2000: <i>Gas-Fired Central Heating Boilers. Type B Boilers of Nominal Heat Input Exceeding 70 Kw, But Not Exceeding 300 kW</i> (BSI, 2000) IGEM Technical Gas Standards (IGEM, n.d.)	Energy Centre
Butt-welding of steel pipes	BS EN 10253-2:2021: <i>Butt-Welding Pipe Fittings - Non Alloy and Ferritic Alloy Steels with Specific Inspection Requirements</i> (BSI, 2021)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
CHP	CHPQA (DESNZ, n.d.)	Energy Centre
Code of practice for building services in ducts	BS 8313:1997: <i>Code of Practice for Accommodation of Building Services in Ducts</i> (BSI, 1997)	Consumer Connection Consumer Heat System
Code of practice for the preparation, commissioning and maintenance of domestic central heating and cooling water systems	BS 7593:2019+A1:2024: <i>Code of Practice for the Preparation, Commissioning and Maintenance of Domestic Central Heating and Cooling Water Systems</i> (BSI, 2019+A1:2024)	Consumer Connection

Area of Installation	Applicable Standards	Applicable Elements
Communication systems for meters	BS EN 13757: <i>Communication Systems for Meters</i> (BSI, 2013-2025)	Energy Centre Substation Communal Distribution Network Consumer Connection
Communications Ducting	BS EN 61386: <i>Conduit Systems for Cable Management</i> (BSI, 2008-2019)	District Distribution Network
Copper and iron threaded fittings	BS 143 and 1256:2000: <i>Threaded Pipe Fittings in Malleable Cast Iron and Cast Copper Alloy</i> (BSI, 2000)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
Cylinder	BS EN 12897:2016+A1:2020: <i>Water Supply - Specification for Indirectly Heated Unvented (Closed) Storage Water Heaters</i> (BSI, 2016+A1:2020)	Consumer Connection
DH Pipework - Factory Assemblies	BS EN 448:2025: <i>District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks - Factory Made Fitting Assemblies of Steel Service Pipes, Polyurethane Thermal Insulation and A Casing of Polyethylene</i> (BSI, 2025)	District Distribution Network
DH Pipework - Factory Valves	BS EN 448:2025: <i>District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks - Factory Made Fitting Assemblies of Steel Service Pipes, Polyurethane Thermal Insulation and A Casing of Polyethylene</i> (BSI, 2025)	District Distribution Network
Flanges	BS EN 1092: <i>Flanges and Their Joints. Circular Flanges for Pipes, Valves, Fittings and Accessories, PN Designated</i> (BSI, 2002 - 2023)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
Floor heating	BS EN 1264:2021: <i>Water Based Surface Embedded Heating and Cooling Systems</i> (BSI, 2021)	Consumer Connection Consumer Heat System

Area of Installation	Applicable Standards	Applicable Elements
Heat meters	BS EN 1434:2022: <i>Thermal Energy Meters</i> : (BSI, 2022)	Energy Centre Substation Communal Distribution Network Consumer Connection
	<i>Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025)	Consumer Connection Consumer Heat System
Heat Pumps	BS EN 14511:2022: <i>Air Conditioners, Liquid Chilling Packages and Heat Pumps for Space Heating and Cooling and Process Chillers, With Electrically Driven Compressors</i> (BSI, 2022)	Energy Centre
Heating systems	BS EN 12828:2012+A1:2014: <i>Heating Systems in Buildings - Design for Water-Based Heating Systems</i> (BSI, 2014)	Consumer Heat System
Heating systems in buildings	BS EN 14336:2004: <i>Heating Systems in Buildings - Installation and Commissioning of Water Based Heating Systems</i> (BSI, 2004)	Consumer Connection Consumer Heat System
HIU	BS 8635-2: <i>Hydraulic Interface Units for Heat Network Applications - Installation, Commissioning and Maintenance - Code of Practice</i> (BSI, Forthcoming) BS 8635-1:2024: <i>Hydraulic Interface Units for Heat Network Applications - Specification</i> (BSI, 2024)	Consumer Connection
Hot and Cold Water Pipework	The Water Supply (Water Fittings) Regulations 1999 (HM Government, 1999) BS EN 806: <i>Specifications for Installations Inside Buildings Conveying Water for Human Consumption</i> (BSI, 2000 - 2012)	Consumer Heat System

Area of Installation	Applicable Standards	Applicable Elements
Insulation	BS 5422:2023: <i>Method for Specifying Thermal Insulating Materials for Pipes, Tanks, vessels, Ductwork and Equipment Operating Within the Temperature Range -40 °C to +700 °C</i> (BSI, 2023) BS 5970:2012: <i>Thermal insulation of Pipework, Ductwork, Associated Equipment and Other Industrial Installations in the Temperature Range of -100°C to +870°C - Code of Practice</i> (BSI, 2012)) Approved Document L: <i>Conservation of Fuel and Power</i> (DLUHC, 2023)	Consumer Heat System
Manhole Tops	BS EN 124:2015: <i>Gully Tops and Manhole Tops for Vehicular and Pedestrian Areas</i> (BSI, 2015)	District Distribution Network
Pea Gravel	BS 1438:2004: <i>Aggregates - Single-Sized Aggregates for Use as A Medium in Biological Percolating Filters</i> (BSI, 2004)	District Distribution Network
PHE	BS EN 307:1999: <i>Heat Exchangers - Guidelines for Preparing Installation, Operating and Maintenance Instructions Required to Maintain the Performance of Each Type of Heat Exchanger</i> (BSI, 1999)	Energy Centre Substation Consumer Connection
Pipework Support and Brackets	BS EN 13480:2024: <i>Metallic industrial piping</i> (BSI, 2024)	Communal Distribution Network
Plastic pipe	BS 7291:2010+A1:2023 <i>Thermoplastics Pipe and Fitting Systems for Hot and Cold Water for Domestic Purposes and Heating Installations in Buildings</i> (BSI, 2023)	Consumer Connection Consumer Heat System
Plumbing fittings	BS EN 1254: <i>Copper and Copper Alloys - Plumbing Fittings</i> (BSI, 1998 - 2021)	Consumer Connection Consumer Heat System
Polybutylene pipe & fittings	BS EN ISO 15876: <i>Plastics Piping Systems for Hot and Cold Water Installations - Polybutylene (PB)</i> (BSI, 2003 - 2017)	Consumer Heat System

Area of Installation	Applicable Standards	Applicable Elements
Polybutylene pipes and fittings for hot and cold water supply and underfloor heating systems	BS EN ISO 15876: <i>Plastics Piping Systems for Hot and Cold Water Installations - Polybutylene (PB)</i> (BSI, 2003 - 2017)	Consumer Connection
Polymer pipe jointing systems	BS EN 15632: <i>District Heating Pipes - Pre-insulated Flexible Pipe Systems (Parts 1-4)</i> (BSI, 2022)	District Distribution Network
Pre-insulated buried polymer services	BS EN 15632: <i>District Heating Pipes - Pre-insulated Flexible Pipe Systems (Parts 1-4)</i> (BSI, 2022)	District Distribution Network
Pre-insulated buried steel services	BS EN 253:2019+A1:2023: <i>District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks - Factory Made Pipe Assembly of Steel Service Pipe, Polyurethane Thermal Insulation and a Casing of Polyethylene</i> (BSI, 2023) BS EN 13941: <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021) BS EN 489-1: <i>District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Joint Casing Assemblies and Thermal Insulation for Hot Water in Accordance with EN 13941-1</i> (BSI, 2019)	District Distribution Network
Pressure testing (polymer)	BESA TR/6: <i>Site Pressure Testing of Pipework - Guide to Good Practice</i> (BESA, 2022)	District Distribution Network
Pressurisation & Expansion Equipment	BS 7074-2:1989: <i>Application, Selection, and Installation of Expansion Vessels and Ancillary Equipment for Sealed Water Systems</i> (BSI, 1989)	Energy Centre Substation Consumer Connection

Area of Installation	Applicable Standards	Applicable Elements
Pumps	BS EN 809: <i>Pumps and Pump Units for Liquids - Common Safety Requirements</i> (BSI, 1998 - 2010)	Energy Centre District Distribution Network Substation Consumer Connection Consumer Heat System
Sand	BS EN 1295: <i>Structural Design of Buried Pipelines Under Various Conditions of Loading</i> (BSI, 1998 - 2019)	District Distribution Network
Sensors	BS EN 60730: <i>Automatic Electrical Controls for Household and Similar Use</i> (BSI, 1991 - 2024)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection
Specification for identification of pipelines and services	BS 1710:2014 - <i>Specification for Identification of Pipelines and Services</i> (BSI, 2014)	Consumer Connection
Steel Tubes	BS EN 10255: <i>Non-Alloy Steel Tubes Suitable for Welding and Threading - Technical Delivery Conditions</i> (BSI, 2004 - 2023)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
Surveillance Systems	BS EN 14419:2019: <i>District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems</i> (BSI, 2019)	District Distribution Network
Thermal Stores	Hot Water Association (HWA) <i>Performance Specification for Thermal Stores</i> (HWA, 2010)	Consumer Connection
Threaded pipe fittings	BS EN 10242: <i>Threaded Pipe Fittings in Malleable Cast Iron</i> (BSI, 1995 - 2024)	Communal Distribution Network

Area of Installation	Applicable Standards	Applicable Elements
Trace heating	BS EN 62395: <i>Electrical Resistance Trace Heating Systems for Industrial and Commercial Applications</i> (BSI, 2006 - 2016)	Energy Centre
Warning Tape	BS EN 12613: <i>Plastics Warning Devices for Underground Cables and Pipelines with Visual Characteristics</i> (BSI, 2009 - 2021)	District Distribution Network
Water quality	BSRIA BG 29/2021: <i>Pre-Commission Cleaning of Pipework Systems</i> (BSRIA, 2021) VDI 2035: <i>Prevention of Damage in Water Heating Installations</i> (VDI, 2021)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
	BS 7593:2019 <i>Code of practice for the preparation, commissioning and maintenance of domestic central heating and cooling water systems</i> (BSI, 2019+A1:2024)	Consumer Connection
	BS 7593:2019 <i>Code of practice for the preparation, commissioning and maintenance of domestic central heating and cooling water systems</i> (BSI, 2019+A1:2024) (indirect systems)	Consumer Heat System
Welders Competence	BS EN ISO 9606: <i>Qualification Testing of Welders - Fusion Welding</i> (BSI, 1994 - 2017)	District Distribution Network
Workmanship on site	BS 8000-15:1990: <i>Workmanship on Building Sites - Part 15 - Code of Practice for Hot and Cold Water Services (Domestic Scale)</i> (BSI, 1990)	Consumer Connection Consumer Heat System

Area of Installation	Applicable Standards	Applicable Elements
Commissioning		
Boilers	CIBSE Commissioning Code B: <i>Boilers</i> (CIBSE, 2002)	Energy Centre
Commissioning and maintenance	CIBSE Guide M: <i>Maintenance Engineering and Management</i> (CIBSE, 2023)	Energy Centre District Distribution Network
Commissioning Management	CIBSE Commissioning Code M: <i>Commissioning Management</i> (CIBSE, 2022)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
Controls (including automatic controls)	CIBSE Commissioning Code C: <i>Automatic Controls</i> (CIBSE, 2001) CIBSE Guide H: <i>Building control systems</i> (CIBSE, 2009)	Energy Centre Substation Consumer Connection Consumer Heat System
	Approved Document L: <i>Conservation of Fuel and Power</i> (DLUHC, 2023)	Consumer Heat System
General buried network design & installation	BS EN 13941:2019+A1:2021 <i>District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks</i> (BSI, 2021)	District Distribution Network
Metering & Billing	<i>The Heat Network Metering and Monitoring Standard (MMS)</i> (HNTAS, 2025) CIBSE TM39: <i>Building Energy Metering</i> (CIBSE, 2009)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
O&M Manual	BSRIA BG 79/2020: <i>Handover Information and O&M Manuals</i> (BSRIA, 2020)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System

Area of Installation	Applicable Standards	Applicable Elements
	Approved Document L: <i>Conservation of Fuel and Power</i> (DLUHC, 2023) BS EN 12170:2002: <i>Heating Systems in Buildings - Procedure for the Preparation of Documents for Operation, Maintenance and Use - Heating Systems Requiring a Trained Operator</i> (BSI, 2002)	Communal Distribution Network
Record drawings	BSRIA BG 6/2018: <i>Design Framework for Building Services</i> (BSRIA, 2018)	District Distribution Network Substation Communal Distribution Network Consumer Connection
	(Swedish) F101: <i>District Heating Substations - Design and Installation - Technical Regulations</i> (Energiföretagen Sverige – Swedenergy AB, 2016) (Danish) Guidelines for Low-Temperature District Heating 2014 (Olsen, et al., 2014)	Substation
Refrigeration Systems	CIBSE Commissioning Code R: <i>Refrigerating Systems</i> (CIBSE, 2002)	Energy Centre
Surveillance System	BS EN 14419:2019: <i>District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems</i> (BSI, 2019)	District Distribution Network
Water distribution systems	CIBSE Commissioning Code W: <i>Water Distribution Systems</i> (CIBSE, 2025)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System

Area of Installation	Applicable Standards	Applicable Elements
Water Quality	BSRIA BG 29/2021: <i>Pre-Commission Cleaning of Pipework Systems</i> (BSRIA, 2021) BSRIA BG 50/2021: <i>Water Treatment for Closed Heating and Cooling Systems</i> (BSRIA, 2021) VDI 2035: <i>Prevention of Damage in Water Heating Installations</i> (VDI, 2021)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection Consumer Heat System
Operation		
Casing joints	BS EN 489-1: <i>District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Joint Casing Assemblies and Thermal Insulation for Hot Water in Accordance with EN 13941-1</i> (BSI, 2019)	District Distribution Network
Handover	BSRIA BG 79/2020: <i>Handover Information and O&M Manuals</i> (BSRIA, 2020)	District Distribution Network
HIU	BS 8635-2: <i>Hydraulic Interface Units for Heat Network Applications - Installation, Commissioning and Maintenance - Code of Practice</i> (BSI, Forthcoming) BS 8635-1:2024: <i>Hydraulic Interface Units for Heat Network Applications - Specification</i> (BSI, 2024)	Consumer Connection
Large industrial peak load boiler operation	BOAS - Boiler Operators Accreditation Scheme (CEA, 2020)	Energy Centre
Maintenance contracts	BSRIA BG 66/2016: <i>Maintenance Contracts: A Guide to Best Practice for Procurement</i> (BSRIA, 2016)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection

Area of Installation	Applicable Standards	Applicable Elements
Maintenance engineering and management	CIBSE Guide M: <i>Maintenance Engineering and Management</i> (CIBSE, 2023)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection
Maintenance task schedules	BESA SFG20: <i>The Industry Standard for Building Maintenance</i> (BESA, 2025, or latest edition)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection
Plant & equipment	<i>The Provision and Use of Work Equipment Regulations (PUWER) 1998</i> (UK Government, 1998)	Energy Centre
Surveillance systems	BS EN 14419:2019: <i>District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems</i> (BSI, 2019)	District Distribution Network
Water Quality	BSRIA BG 50/2021: <i>Water Treatment for Closed Heating and Cooling Systems</i> (BSRIA, 2021) VDI 2035: <i>Prevention of Damage in Water Heating Installations</i> (VDI, 2021)	Energy Centre District Distribution Network Substation Communal Distribution Network Consumer Connection

References

This bibliography contains both normative and informative references. The nature of the reference (normative or informative) is indicated within the text containing the reference.

References

- API & ASME. (2021). *API RP 579-1 / ASME FFS-1: Fitness for Service*. Washington, D.C. (API); New York, NY (ASME): American Petroleum Institute (API) and American Society of Mechanical Engineers (ASME).
- ASHRAE. (2015). *Design Guide for Tall, Supertall, and Megatall Building Systems*. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- ASME. (2023). *ASME B 31G: Manual for Determining the Remaining Strength of Corroded Pipelines*. New York, NY: American Society of Mechanical Engineers (ASME).
- BEIS. (2016). *Building Energy Efficiency Survey (BEES): Overarching Report*. London: Department for Business, Energy & Industrial Strategy (BEIS).
- BESA. (2021). *TR70: A Guide to Good Practice - External Corrosion Protection and Insulation of Building Services Pipework*. London: Building Engineering Services Association (BESA).
- BESA. (2022). *TR/6: Site Pressure Testing of Pipework - Guide to Good Practice*. London: Building Engineering Services Association (BESA).
- BESA. (2023, or latest edition). *Technical Standard for UK HIU Test Regime*. London: Building Engineering Services Association (BESA) Publications.
- BESA. (2025, or latest edition). *SFG 20: The Industry Standard for Building Maintenance*. Retrieved from <https://www.sfg20.co.uk/>
- BSI. (1987). *BS 2663:1987: Specification for Class I Arc Welding Ferritic Steel Pipework for Carrying Fluids*. London: British Standards Institution (BSI).
- BSI. (1989). *BS 7074-2:1989: Application, Selection and Installation of Expansion Vessels and Ancillary Equipment for Sealed Water Systems: Code of practice for Low and Medium Temperature Hot Water Heating Systems*. London: British Standards Institution (BSI).
- BSI. (1990). *BS 8000-15: Workmanship on Building Sites – Part 15 – Code of Practice for Hot and Cold Water Services (Domestic Scale)*. London: British Standards Institution (BSI).
- BSI. (1991 - 2024). *BS EN 60730: Automatic Electrical Controls for Household and Similar Use*. London: British Standards Institution (BSI).
- BSI. (1991). *BS 2971:1991: Specification for Class II Arc Welding of Carbon Steel Pipework for Carrying Fluids*. London: British Standards Institution (BSI).
- BSI. (1994 - 2017). *BS EN ISO 9606: Qualification Testing of Welders - Fusion Welding*. London: British Standards Institution (BSI).
- BSI. (1995 - 2024). *BS EN 10242: Threaded Pipe Fittings in Malleable Cast Iron*. London: British Standards Institution (BSI).
- BSI. (1997). *BS 8313:1997 Code of practice for accommodation of building services in ducts*. London: British Standards Institution (BSI).
- BSI. (1998 - 2010). *BS EN 809: Pumps and Pump Units for Liquids - Common Safety Requirements*. London: British Standards Institution (BSI).
- BSI. (1998 - 2019). *BS EN 1295: Structural Design of Buried Pipelines Under Various Conditions of Loading*. London: British Standards Institution (BSI).

- BSI. (1998 - 2021). *BS EN 1254: Copper and Copper Alloys - Plumbing Fittings*. London: British Standards Institution (BSI).
- BSI. (1999). *BS EN 307:1999 Heat exchangers – Guidelines for preparing installation, operating and maintenance instructions required to maintain the performance of each type of heat exchanger*. London: British Standards Institution (BSI).
- BSI. (2000 - 2012). *BS EN 806: Specifications for Installations Inside Buildings Conveying Water for Human Consumption*. London: British Standards Institution (BSI).
- BSI. (2000). *BS 143 and 1256:2000 Threaded pipe fittings in malleable cast iron and cast copper alloy*. London: British Standards Institution (BSI).
- BSI. (2000). *BS EN 656:2000 Gas-fired central heating boilers – Type B boilers of nominal heat input exceeding 70 kW, but not exceeding 300 kW*. London: British Standards Institution (BSI).
- BSI. (2002 - 2023). *BS EN 1092: Circular Flanges for Pipes, Valves, Fittings and Accessories - PN Designated*. London: British Standards Institution (BSI).
- BSI. (2002). *BS EN 12170:2002: Heating Systems in Buildings – Procedure for the Preparation of Documents for Operation, Maintenance and Use – Heating Systems Requiring a Trained Operator*. London: British Standards Institution (BSI).
- BSI. (2003 - 2017). *BS EN ISO 15876: Plastics Piping Systems for Hot and Cold Water Installations - Polybutylene (PB)*. London: British Standards Institution (BSI).
- BSI. (2004 - 2023). *BS EN 10255: Non-Alloy Steel Tubes Suitable for Welding and Threading - Technical Delivery Conditions*. London: British Standards Institution (BSI).
- BSI. (2004). *BS 1438:2004 Aggregates – Single-sized aggregates for use as a medium in biological percolating filters*. London: British Standards Institution (BSI).
- BSI. (2004). *BS EN 14336:2004 Heating systems in buildings – Installation and commissioning of water based heating systems*. London: British Standards Institution (BSI).
- BSI. (2006 - 2016). *BS EN 62395: Electrical Resistance Trace Heating Systems for Industrial and Commercial Applications*. London: British Standards Institution (BSI).
- BSI. (2008-2019). *BS EN 61386 Conduit systems for cable management*. London: British Standards Institution (BSI).
- BSI. (2009 - 2021). *BS EN 12613: Plastics Warning Devices for Underground Cables and Pipelines With Visual Characteristics*. London: British Standards Institution (BSI).
- BSI. (2011). *BS 6644:2011: Specification for the Installation and Maintenance of Gas-Fired Hot Water Boilers of Rated Inputs Between 70 kW (net) and 1.8 MW (net) (2nd and 3rd Family Gases)*. London: British Standards Institution (BSI).
- BSI. (2012). *BS 5970:2012: Thermal Insulation of Pipework, Ductwork, Associated Equipment and Other Industrial Installations in the Temperature Range –100 °C to +870 °C – Code of Practice*. London: British Standards Institution (BSI).
- BSI. (2012). *BS 8552:2012: Sampling and Monitoring of Water from Building Services Closed Systems - Code of Practice*. London: British Standards institution (BSI).
- BSI. (2013). *BS 8544:2013 - Guide for Life Cycle Costing of Maintenance During the In Use Phases of Buildings*. London: British Standards institution (BSI).
- BSI. (2013-2025). *BS EN 13757: Communication systems for meters*. London: British Standards Institution (BSI).
- BSI. (2014). *BS 1710:2014 – Specification for Identification of Pipelines and Services*. London: British Standards Institution (BSI).
- BSI. (2014). *BS EN 12828:2012+A1:2014: Heating Systems in Buildings - Design for Water-Based Heating Systems*. London: British Standards Institution (BSI).

- BSI. (2015). *BS 8558:2015: Guide to the Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use within Buildings and Their Curtilages*. London: British Standards Institution (BSI).
- BSI. (2015). *BS EN 124:2015 Gully tops and manhole tops for vehicular and pedestrian areas*. London: British Standards Institution (BSI).
- BSI. (2016+A1:2020). *BS EN 12897:2016+A1:2020 Water supply – Specification for indirectly heated unvented (closed) storage water heaters*. London: British Standards Institution (BSI).
- BSI. (2017). *BS EN 12831-1:2017 – Energy performance of buildings. Method for calculation of the design heat load - Space heating load, Module M3-3*. London: British Standards Institution (BSI).
- BSI. (2019). *BS 8580-1:2019: Water Quality - Risk Assessments for Legionella Control - Code of Practice*. London: British Standards Institution (BSI).
- BSI. (2019). *BS EN 14419:2019: District Heating Pipes - Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Surveillance Systems*. London: British Standards Institution (BSI).
- BSI. (2019). *BS EN 489-1: District Heating Pipes – Bonded Single and Twin Pipe Systems for Buried Hot Water Networks - Joint Casing Assemblies and Thermal Insulation for Hot Water Networks in Accordance with EN 13941-1*. London: British Standards Institution (BSI).
- BSI. (2019+A1:2024). *BS 7593:2019 Code of practice for the preparation, commissioning and maintenance of domestic central heating and cooling water systems*. London: British Standards Institution (BSI).
- BSI. (2021). *BS EN 10253-2:2021 Butt-welding pipe fittings – Non alloy and ferritic alloy steels with specific inspection requirements*. London: British Standards Institution.
- BSI. (2021). *BS EN 1264:2021 Water based surface embedded heating and cooling systems*. London: British Standards Institution (BSI).
- BSI. (2021). *BS EN 13941:2019+A1:2021 District Heating Pipes - Design and Installation of Thermal Insulated Bonded Single and Twin Pipe Systems for Directly Buried Hot Water Networks*. London: British Standards Institution (BSI).
- BSI. (2022). *BS EN 1434:2022 Thermal energy meters*. London: British Standards Institution (BSI).
- BSI. (2022). *BS EN 14511:2022: Air Conditioners, Liquid Chilling Packages and Heat Pumps for Space Heating and Cooling and Process Chillers, with Electrically Driven Compressors*. London: British Standards Institution (BSI).
- BSI. (2022). *BS EN 15632 - District Heating Pipes - Pre-insulated Flexible Pipe Systems (Parts 1-4)*. London: British Standards Institution (BSI).
- BSI. (2022). *BS EN ISO 12241:2022: Thermal Insulation for Building Equipment and Industrial Installations - Calculation Rules*. London: British Standards Institution (BSI).
- BSI. (2022). *Underground Utility Detection, Verification and Location - Specification*. London: British Standards Institution (BSI).
- BSI. (2023). *BS 5422:2023: Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range –40 °C to +700 °C*. London: British Standards Institution (BSI).
- BSI. (2023). *BS 7291:2010+A1:2023: Thermoplastics Pipe and Fitting Systems for Hot and Cold Water for Domestic Purposes and Heating Installations in Buildings*. London: British Standards Institution (BSI).
- BSI. (2023). *BS EN 253:2019+a1:2023: District Heating Pipes - Bonded Single Pipe Systems for Directly Buried Hot Water Networks – Factory Made Pipe Assembly of Steel Service Pipe, Polyurethane Thermal Insulation and a Casing of Polyethylene*. London: British Standards Institution (BSI).
- BSI. (2024). *BS EN 13480:2024 Metallic industrial piping*. London: British Standards Institution (BSI).

- BSI. (2024). *BS ISO 55000: Vocabulary, Overview and Principles*. London: British Standards Institution (BSI).
- BSI. (2024). *Hydraulic Interface Units for Heat Network Applications - Specification*. London: British Standards Institution (BSI).
- BSI. (2025). *BS EN 448:2025 District heating pipes – Bonded single pipe systems for directly buried hot water networks – Factory made fitting assemblies of steel service pipes, polyurethane thermal insulation and a casing of polyethylene*. London: British Standards Institution (BSI).
- BSI. (Forthcoming). *Hydraulic Interface Units for Heat Network Applications – Installation, Commissioning and Maintenance – Code of Practice*. London: British Standards Institution (BSI).
- BSRIA. (2001). *AG/9: Standard Specification for BMS*. Bracknell: Building Services Research & Information Association (BSRIA).
- BSRIA. (2002). *AG 16/2002: Variable-Flow Water Systems: Design, Installation and Commissioning Guidance*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2012). *BG 35/2012: Condition Surveys and Asset Data Capture*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2015). *BG 57/2015: Legionnaire's Disease - Risk Assessment*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2016). *BG 66/2016: Maintenance Contracts - A Guide to Best Practice for Procurement*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2018). *BG 6/2018: Design Framework for Building Services*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2020). *BG 79/2020: Handover Information and O&M Manuals*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2021). *BG 29/2021: Pre-Commission Cleaning of Pipework Systems*. Bracknell: Building Services Research and Information Association.
- BSRIA. (2021). *BG 50/2021: Water Treatment for Closed Heating and Cooling Systems*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2022). *BG 82/2022: Pressurisation of Closed Heating and Cooling Systems*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2024). *BG 85/2024: Rule of Thumb - Mechanical Criteria*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2024). *BS 87/2024: Rule of Thumb - Useful Information Guide*. Bracknell: Building Services Research and Information Association (BSRIA).
- BSRIA. (2025). *BG 80/2025: Statutory Compliance Inspection Checklist*. Bracknell: Building Services Research and Information Association (BSRIA).
- CEA. (2020). *BOAS Handbook - Boiler Operators Accreditation Scheme*. London: Combustion Engineering Association (CEA).
- CIBSE & ADE. (2020). *CP1: Heat Networks Code of Practice for the UK*. London: Chartered Institution of Building Services Engineers (CIBSE); Association for Decentralised Energy (ADE).
- CIBSE (in collaboration with Arup). (2009). *Use of Climate Change Data in Building Simulation*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2001). *Commissioning Code C: Automatic Controls*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2002). *Commissioning Code B: Boilers*. London: Chartered Institution of Building Services Engineers (CIBSE).

- CIBSE. (2002). *Commissioning Code R: Refrigerating Systems*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2006). *TM41: Degree Days - Theory and Application*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2008). *TM46: Energy Benchmarks*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2009). *Guide H: Building Control Systems*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2009). *TM39: Building Energy Metering*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2010). *AM14: Non-domestic Hot Water Heating Systems*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2012). *Guide F: Energy Efficiency in Buildings*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2013). *TM13: Minimising the Risk of Legionnaires' Disease*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2014). *Guide G: Public Health and Plumbing Engineering*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2015). *Guide A: Environmental Design*. London: Chartered Institution of Building Service Engineers (CIBSE).
- CIBSE. (2016). *Guide B: Heating, Ventilating, Air Conditioning and Refrigeration*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2017). *TM59: Design methodology for the assessment of overheating risk in homes*. London: Chartered Institution of Building Services Engineers.
- CIBSE. (2019). *CIBSE Energy Benchmarking Tool*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2021). *Design Guide: Heat Networks*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2021). *Guidance Note: Domestic Hot Water Temperatures from Instantaneous Heat Interface Units*. Chartered Institution of Building Services Engineers (CIBSE): London.
- CIBSE. (2022). *Commissioning Code M: Commissioning Management*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2022). *TM54: Evaluating Operational Energy Use at the Design Stage*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2023). *Guide M: Maintenance Engineering and Management*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2024). *Commissioning Code A: Air Distribution Systems*. London: Chartered Institution of Building Services Engineers (CIBSE).
- CIBSE. (2025). *Commissioning Code W: Water Distribution Systems*. London: Chartered Institution of Building Services Engineers (CIBSE).
- Danish Standards. (2024). *DS 439:2024 - Code of Practice for Domestic Water Supply Systems*. Copenhagen: Danish Standards.
- DECC. (2015). *Assessment of the Costs, Performance, and Characteristics of UK Heat Networks*. London: Department of Energy & Climate Change (DECC).

- DESNZ. (2023, or latest edition). *Green Book Supplementary Guidance: Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal*. London: Department for Energy Security and Net Zero (DESNZ).
- DESNZ. (n.d.). *Heat Network Zoning*. Retrieved from GOV.UK: <https://www.gov.uk/government/collections/heat-network-zoning>
- DESNZ. (n.d.). *Combined Heat and Power Quality Assurance Programme*. Retrieved from <https://www.gov.uk/guidance/combined-heat-power-quality-assurance-programme>
- DfT. (2023). *Code of Practice for the Co-ordination of Street and Road Works*. London: Department for Transport (DfT).
- DIN. (2024). *DIN 4726: Underfloor Surface Heating and Radiator Connections – Plastic and Composite Pipe Systems*. Berlin: Deutsches Institut für Normung e.V. (DIN).
- DLUHC. (2023). *Approved Document L: Conservation of Fuel and Power*. London: Department for Levelling Up, Housing and Communities.
- DLUHC. (2024). *Approved Document G: Sanitation, Hot Water Safety and Water Efficiency*. London: Department for Levelling Up, Housing and Communities.
- DNVGL. (2019). *DNVGL-RP-F101: Corroded Pipelines*. Høvik: Det Norske Veritas Germanischer Lloyd.
- Energiföretagen Sverige – Swedenergy AB. (2016). *F101: District Heating Substations – Design and Installation – Technical Regulations*. Stockholm: Energiföretagen Sverige.
- Energiföretagen Sverige - Swedenergy AB. (2023). *Kostnadskatalog Fjärrvärme*. Stockholm: Energiföretagen Sverige.
- Frederiksen, J., Nielsen, J., Nielsen, M. B., Poulsen, H., Andreasen, B., de Wit, J., . . . Paulsen, O. (2021). *Varme Ståbi*. Copenhagen: Nyt Teknisk Forlag.
- Highways Agency. (2005). *SA 10/05: New Roads and Street Works Act 1991 - Diversionary Works*. London: Highways Agency.
- HM Government. (1999). *The Water Supply (Water Fittings) Regulations 1999*. London: The Stationery Office.
- HM Government. (n.d.). *Find an energy certificate*. Retrieved from GOV.UK: <https://www.gov.uk/check-energy-performance-public-building>
- HNTAS. (2025). *Heat Network Metering and Monitoring Standard (MMS)*. London: HNTAS.
- HNTAS. (Forthcoming). *Heat Network Acceptance Testing Standard (ATS)*. London: HNTAS.
- HSE. (2013). *Legionnaires' Disease - The Control of Legionella Bacteria in Water Systems (L8)*. London: Health and Safety Executive (HSE).
- HSE. (2024). *HSG274 Part 2: The Control of Legionella Bacteria in Hot and Cold Water Systems*. London: Health and Safety Executive (HSE).
- HWA. (2010). *Performance Specification for Thermal Stores*. London: Hot Water Association (HWA).
- HWA. (2018). *Design Guide HWA/DG1: Stored Hot Water Solutions in Heat Networks*. Kenilworth: Hot Water Association (HWA).
- IGEM. (2017). *IGEM/UP/10: Installation of Flued Gas Appliances in Industrial and Commercial Premises*. Kegworth: Institution of Gas Engineers and Managers (IGEM).
- IGEM. (2025). *IGEM/UP/2: Installation Pipework on Industrial and Commercial Premises*. Kegworth: Institution of Gas Engineers and Managers (IGEM).
- IGEM. (n.d.). *IGEM Technical Standards*. Retrieved from https://www.igem.org.uk/technical/buy-technical-standards/all-technical-gas-standards.html?sortBy=recent&information_type=gas-measurement

- National Academy of Sciences. (2012). *Disaster Resilience: A National Imperative*. Washington, D.C.: The National Academies Press.
- NHBC. (2025, or latest edition). *NHBC Standards 2025*. Milton Keynes: National House Building Council (NHBC).
- NHS England. (2016). *Health Technical Memorandum 04-01: Safe Water in Healthcare Premises*. London: NHS England.
- Ofgem. (2015). *Licence Lite Factsheet*. London: Ofgem.
- Olsen, P. K., Christiansen, C. H., Hofmeister, M., Svendsen, S., Thorsen, J. E., Gudmundsson, O., & Brand, M. (2014). *Guidelines for Low-Temperature District Heating*. Copenhagen: Danish Energy Agency.
- RIBA. (2020). *Plan of Work 2020 Overview*. London: Royal Institute of British Architects (RIBA).
- SAFed. (2021). *PEC 13: Safety Valve Examination - Setting and Sizing Requirements*. London: Safety Assessment Federation Ltd (SAFed).
- SAFed. (2021). *PEC 13: Safety Valve Examinations – Setting and Sizing Requirements*. Stockport: Safety Assessment Federation (SAFed).
- SAFed. (2021). *PSG 23: Guidance for the Competent Person in Relation to the Examination Requirements for Relief Systems*. Stockport: Safety Assessment Federation (SAFed).
- SAFed. (2023). *SS01: Recruitment, Training and Competency of Engineer Surveyors*. London: Safety Assessment Federation (SAFed).
- Scottish Government. (2011). *The Water Environment (Controlled Activities) (Scotland) Regulations 2011*. Edinburgh: The Stationery Office.
- Scottish Government. (2024). *Building Standards Technical Handbook - Domestic*. Edinburgh: Building Standards Division, Scottish Government.
- Street Works UK. (2007-2023). *Street Works UK Guidelines (volumes 1-6)*. London: Street Works UK.
- TICA. (n.d.). *Thermal Insulation Contractors Association*. Retrieved from <https://tica-acad.co.uk/tica-home/>
- UK Government. (1998). *The Provision and Use of Work Equipment Regulations (PUWER)*. London: The Stationery Office.
- UK Government. (2000). *The Pressure Systems Safety Regulations*. London: The Stationery Office.
- UK Government. (2002). *Control of Substances Hazardous to Health Regulations 2002*. London: The Stationery Office.
- UK Government. (2002). *Dangerous Substances and Explosive Atmospheres Regulations 2002*. London: The Stationery Office.
- UK Government. (2016). *The Environmental Permitting (England and Wales) Regulations 2016*. London: The Stationery Office.
- UK Government. (2021). *Approved Document F: Ventilation*. London: Department for Levelling Up, Housing and Communities (DLUHC).
- UK Government. (2022). *Facilities Management Standard FMS 002: Asset Data*. London: The Stationery Office.
- UK Government. (2022). *The Building Safety Act 2022*. London: The Stationery Office.
- UK Government. (2023). *UK Heat Networks: Market Overview*. London: UK Government.
- VDI. (2021). *Prevention of Damage in Water Heating Installations*. Düsseldorf: Verein Deutscher Ingenieure (VDI).
- VDI. (2023). *Prevention of Damage in Cold and Cooling Water Circuits*. Düsseldorf: Verein Deutscher Ingenieure (VDI).

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