Design Requirements for Connections to the UCL District Heating Network

Contents

1 Glossary

Term	Definition
AHU	Air handling unit
BMS	Building management system
CHP	Combined heat and power *(refers to engine for low-carbon heat generation)*
CIBSE	Chartered Institution of Building Services Engineers
CT	Constant temperature
Delta T	Temperature differential
DEN	District energy network
DHW	Domestic hot water
DHWS	Domestic hot water service
dP	Differential pressure
EM&I	Engineering, Maintenance and Infrastructure *(relating to team within UCL's Estates department)*
MEP	Mechanical, electrical and plumbing
MID	Measuring Instruments Directive *(European directive 2004/22/EC)*
PEX	Plate heat exchanger
PPE	Personal protective equipment
RIBA	Royal Institute of British Architects
TRV	Thermostatic radiator valve
VRF	Variable refrigerant flow
VSD	Variable speed drive
VT	Variable temperature

Disclaimer

This guidance is for information only, UCL accepts no liability for any loss, damage or inconvenience caused as a result of reliance on this information.

Before signing agreements for any design work, appropriate legal and engineering professionals should be consulted.

2 Who is this guide for?

The following guidance should be provided to all parties relevant in connecting buildings to UCL's Bloomsbury campus district heating network. This may include, but is not limited to:

- **"The UPO/ EPM"**
  - Building developers and the wider client-side project stakeholders, project teams/sponsors etc. who are developing buildings on the Bloomsbury campus, i.e. UCL Capital and SMP Project Management teams and their consultants,
- **"The Building Operator"**
  - Building operators who manage buildings' heating systems, generally UCL Estates but not exclusively,
- **"The Designer"**
  - Any M&E or other engineers designing buildings for connection to the district heating network,
- **"The District Heating Operator"**
  - UCL Estates – Facilities and Infrastructure, represented by the Head of Engineering, Maintenance and Infrastructure (EM&I) and the "CHP Team".

3 Scope of this guide

This document provides guidance for connection of new, existing (see definition below) and refurbished buildings to the district heating network, as well as disconnections and network diversions. These are defined as:

- Any building proposed for construction on the Bloomsbury campus that is to be connected to the district heating network,
- Any existing building to be added to the district heating network,
- Any works that require the existing network to be diverted or modified,
- Any existing building being refurbished where there is an opportunity to rearrange the building's mechanical heating systems,
- Any building being extended or where significant alterations or additions are being made to the building's mechanical services (e.g. consequential improvements).

It is not possible in this document to go into the details of all types and permutations of heating systems within existing buildings, which either are connected or could be connected, to the district heating network. However, the principles set out herein should be used by the Designer when refurbishing existing buildings or connecting existing building to the district heating network. Where a wider refurbishment is not envisaged, it is essential that connection of existing buildings to the district heating network are subject to a feasibility study to achieve the standards for connection identified herein.

Projects wishing to connect to UCL's high voltage network should refer to the standards contained within UCL's "Design Guide for Mechanical, Electrical and Public Health Services".

4 Introduction

4.1 Context

UCL has a comprehensive district heating network serving buildings on its main Bloomsbury campus, which is part of its aim to improve energy efficiency and reduce carbon emissions. UCL is determined to reduce its carbon footprint through good standards of design of its buildings and services.

The purpose of this guide is to set a standard in assisting the Designer in implementing the connection of buildings and/or heating systems to the district heating network. These standards are applicable to a variety of building types found on the main campus and elsewhere, and consideration is made for new developments and major refurbishments.

The standards are intended to ensure that any new or altered connections are fully considered and authorised by UCL, so that the network can be operated in the most efficient manner. The aim is to help the UPO/ EPM and the Designer to understand the system and provide secondary heating networks that achieve UCL's ambitions for cost and carbon emission reductions. If these standards are not adhered to permission to take heat from the network will be withheld.

4.2 District heating

A district heating system provides space heating and domestic hot water (DHW) to buildings and facilities that are connected via a pipe network. This heat is generated centrally, at a number of 'energy centres', and then distributed via the pipe network to each connection, as oppose to each building or facility generating its own heat demands with individual gas boilers. District heating can reduce the cost of heat provision and lifecycle costs, enables resilient delivery of heat generated from low-carbon technologies, saves plant-related space within buildings, and allows for further decarbonisation through flexibility in future heat supply. District heating is also promoted by Camden Council as a means to achieve its carbon reduction commitments. Figure 4—1 provides a typical district heating network configuration.

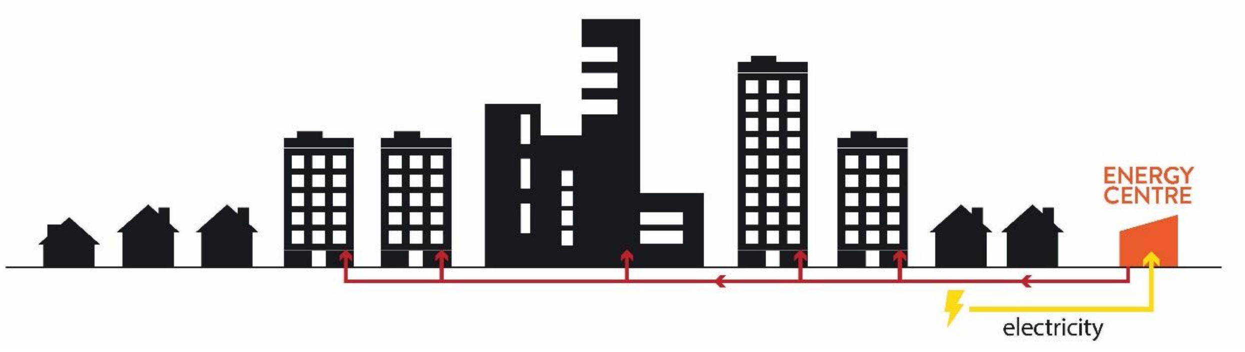


Figure 4—1 Typical district heating network configuration

UCL supplies space heating and DHW to connected buildings on its Bloomsbury campus via a primary hot water network, fed from four energy centres (as well as a number of contaminated gas-fired boilers, e.g. stand-alone boilers at BSUs). The system uses 2no. combined heat and power (CHP) engines as a low-carbon heat source. CHP engines generate heat and power simultaneously, providing carbon savings through off-setting the use of grid electricity. Heat from the engines is supplemented directly by gas and oil boilers, as well as indirectly by steam.

A district heating network has specific operational criteria that must be achieved, in order to deliver reliable and efficiently-generated heat to connected buildings on the campus. One example is achieving a large temperature differential, which is a function of how the buildings interact with the network.

This document does not contain any information regarding the district heating network, the energy centres and associated components, but advises on the technical requirements in order to connect to the network. The scope of this document in relation to the wider campus district heating system is provided in Figure 4—2.

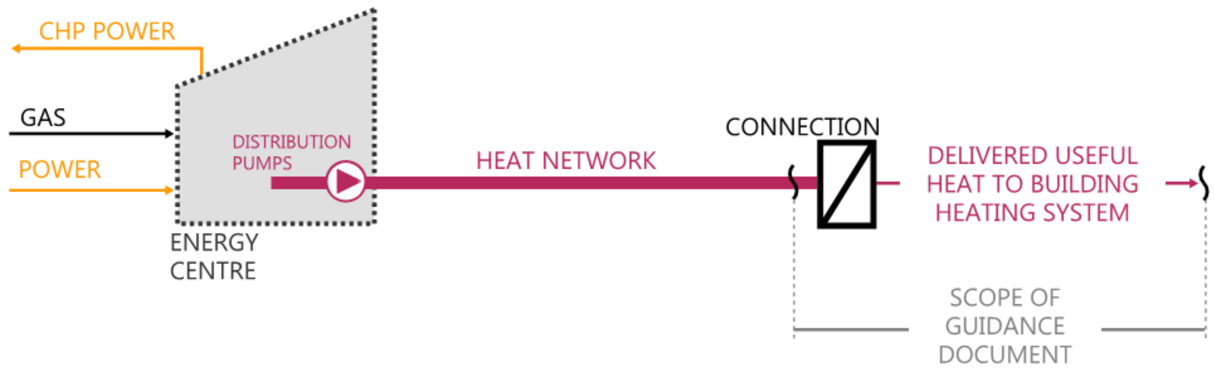


Figure 4—2 Scope of guidance document

4.3 Summary of secondary heating system design

This guidance document is intended to help designers reduce return temperatures and flow rates within buildings' secondary heating systems, in order to allow efficient operation of the district heating network. This is ultimately to reduce costs and carbon emissions associated with UCL's heating systems and building performances.

The following sections provide a summary of the secondary heating system design requirements for new and refurbished buildings on the UCL Bloomsbury campus that are to connect with the district heating network.

Key to the efficient operation of the network is the interfacing with the buildings it serves. A typical building (secondary) heat system connection with the district (primary) heat network is provided in the schematic in Figure 4—3. A secondary heat system will include the following when connecting to the primary district heat network:

- Heat substation plant room,
- Secondary heating system,
- Metering.

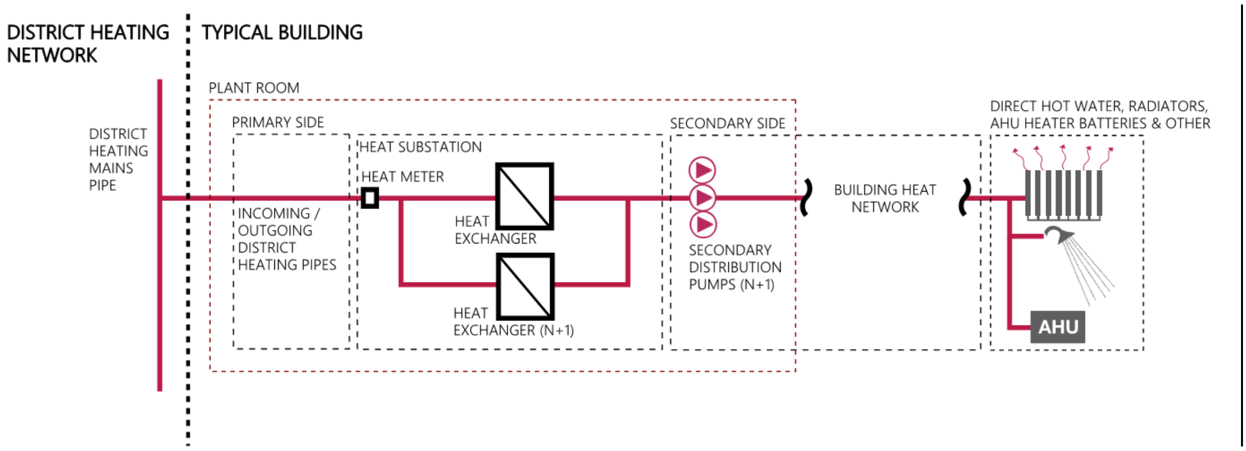


Figure 4—3 Typical primary (district)-secondary (building) interface

The following are the main aspects of building side heating system design for new and refurbished buildings:

- Variable flow control at all heat emitters (2-port control valves at all demands within buildings),
- Constant temperature systems,
- Variable speed pumping strategy,
- Bypass valve on index run of building's heat circuits,
- Lower design flow temperature to accommodate low temperature systems such as heat pumps.

See Section 8 and 9 for full secondary heating system design description and schematic respectively.

4.4 Standards and codes

Table 4—1 provides standards and codes that should be followed by the Designer when connecting buildings to the district heating network.

Table 4—1 District heating standards and codes to be followed by the Designer

Subject	Standard reference	Standard title
District heating networks	CIBSE 2015	Heat Networks: Code of Practice for the UK
Building heating systems	ASHRAE Handbook 2015	HVAC applications
	ASHRAE Handbook 2012	HVAC systems and equipment
	CIBSE Guide B1 2016	Heating
Pipe standards	BS 3974	Specification for pipe supports
	BS EN 10217-1:2002	Welded steel tubes for pressure purposes. Technical delivery conditions. Non-alloy steel tubes with specified room temperature properties
	BS EN ISO 12241:2008	Thermal insulation for building equipment and industrial installations. Calculation rules
	BS 5422:2009	Method for specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40°C to +700°C
	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
	BS EN 10255:2004	Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions
	BG 29/2012	Pre-commission cleaning of pipework systems
	BS EN 488:2015	District heating pipes. Preinsulated bonded pipe systems for directly buried hot water networks. Steel valve assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene
Water quality	BS 8552/2013	Monitoring water quality in building services closed systems

5 Design approval process

The UPO/ EPM and the Designer will comply with this document and follow the approval and acceptance process. Key stages and the UPO/ EPM's responsibilities are demonstrated in Figure 5—1 in line with the recommended RIBA 2013 plan of work and UCL's Stage Gate process. Additional information is provided in the sections below on aspects of the design approval process specific to UCL's district heating network (***bold and italic***). The District Heating Operator can request to review the design, inspect the installation and if deemed necessary ask for changes to be made, in order for the installation/design to comply with the standards, as detailed in this document.

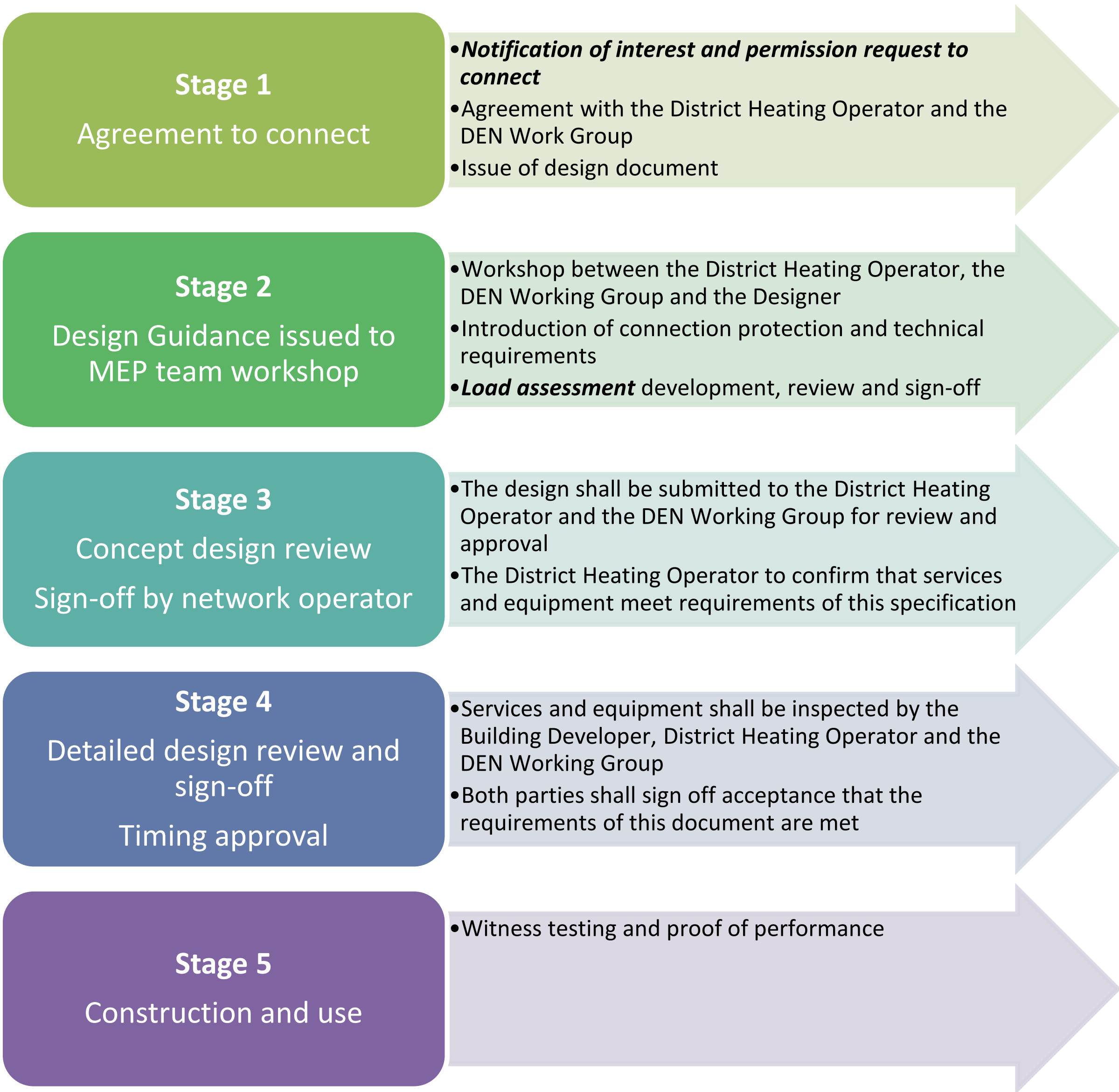


Figure 5—1 Key project stages

5.1 Notification of interest and permission request to connect

Connection to the district heating network is prioritised over installation of a standalone heating system. Serving heat demands from a district heating network provides cost and carbon reduction benefits, which aids in achieving UCL's ambitions for more sustainable operation of its estates.

Any works taking place which may impact the campus either directly or indirectly should be brought to the attention of the Head of Engineering, Maintenance and Infrastructure as early as possible and definitely before Stage 2 is complete (see Figure 5—1). This will ensure that consideration of how the works may affect the wider system can be given and mitigation measures if required can be investigated. It will also allow an impact assessment to be made to ensure other consumers are not adversely affected by any works elsewhere on the system.

Table 5—1 provides the four basic areas for notification when undertaking works to connect to the district heating network.

Table 5—1 Areas of notification when connecting to district heating network

Area of notification	Description
Permission to connect (new connections)	This includes: • Existing secondary systems proposed for connection to the district heating network, • New developments which will require a new connection, • Substantial extension to existing connections where the main connection to the network would require upgrading to meet the new load.
Alteration of existing connections	This will include but is not limited to: • Alterations of/to district heat network connections, • Replacement of district heat network-secondary system interface plant, • Alteration to/addition of secondary systems, i.e. new loads.
Disconnection of existing connections	This will include disconnections due to: • A building being demolished, • A building being sold, • A building temporarily disconnected whilst undergoing substantial refurbishment,

	• A building being temporarily severed from the network, due to unrelated development works on the campus.
Diversion of existing pipework	This relates to any work that is required on the district heating mains where their route may need to be altered or temporarily severed in order to carry out other development works.

At the earliest opportunity the project should be notified in writing to the Head of Engineering, Maintenance and Infrastructure in UCL's Estates department. If necessary, a project manager from the Engineering, Maintenance and Infrastructure department will be assigned to assist with the project.

A full description of the project will be required along with design data on loads (kW) to be connected, removed or replaced. Additional information requested as part of this review may include, but is not limited to:

- Flow and return temperatures,
- Point of connection,
- Metering strategy,
- Pumping strategy,
- Controls proposal and configuration,
- Plate heat exchanger or heat interface unit selection and configuration.

Further assessment of other parts of the network which may be affected may also need to be carried out as part of the review process. This would be charged to the project.

Once sufficient information has been provided for an assessment a decision will be made as to the next steps to progress the project.

5.2 Load assessment

The heat load/profile assessment plays an important role in district heating design, by allowing for appropriate central plant and network sizing. Adding new or altering existing loads can have an impact on the operation of the network, such as undesirable network water flow conditions through pipework, poor CHP performance and under-heating due to insufficient central heating plant.

The UPO/ EPM is responsible for the design and installation of the building heating system up to and including the heat substation and, prior to connection with the district heating network, shall commission the Designer to conduct a heat load analysis, including a hydraulic simulation, to be provided to the District Heating Operator and the DEN Working Group for sign-off.

The Designer shall refer to section 2.1 of the CIBSE Heat Network Code of Practice (2015) for best practice guidance on estimating heat loads. Where the proposal is to connect a refurbished building to the district heating network, advice should be sought from UCL's Energy Manager to help determine the load based on existing meter data.

The Designer shall provide the calculated heat loads to the District Heating Operator as per Table 5—2. which will be reviewed and approved at the third stage of the project (see Figure 5—1).

Overstating the required capacities must be avoided in order to maintain good control at low demands, and to avoid unnecessary network and heat substation equipment costs.

Table 5—2 Heat loads to be provided to the District Heating Operator by the Designer for approval

Heat load to provide	Space heating	DHW
Peak load excluding warm-up from cold (kW)		
Peak load including warm-up from cold (kW)		

6 Project responsibilities

6.1 General principles of project responsibility

For clarity of responsibilities for projects connecting buildings to the district heating network, the general principles are:

- The project pays for the connection, which includes design, enabling works, civil works, all mechanical, electrical and control works and any other elements which enable connection to the network, including time spent by the District Heating Operator (CHP Team) operatives / engineers to arrange and attend network shutdowns and other necessary works,
- District heating network design will be through consultants designated or approved by the District Heating Operator,
- The District Heating Operator will set the specification and type of equipment to be installed on the district heating side,
- Installation of district heating equipment and pipework may fall to the Building District Heating Operator to implement or may be carried out by the project contractors subject to permissions,
- No system is to be made live without sign-off from the District Heating Operator (Figure 5—1),
- No system will be connected or services provided until the controls and monitoring are in place to ensure the services can be managed effectively.

Where any third party connections are to be made a heat supply agreement (including details on agreed pricing) must be in place prior to construction.

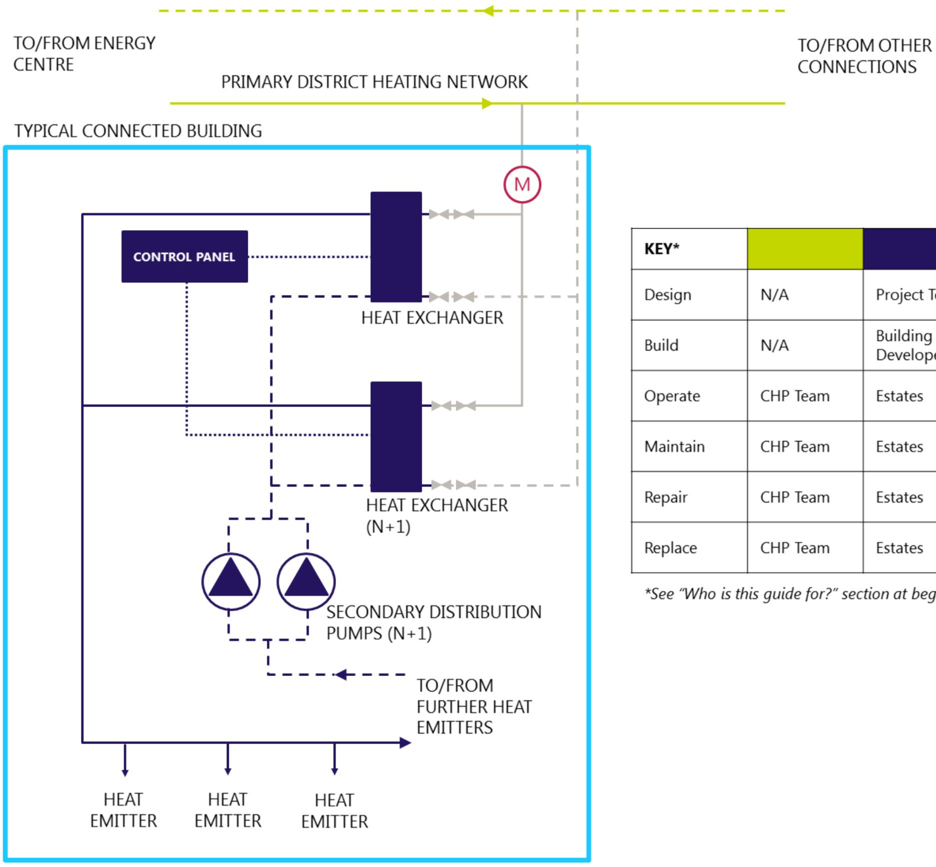
6.2 Design responsibilities

Table 6—1 provides the design responsibilities that include, but are not limited to, the various parties that may be involved in connecting buildings to the district heating network.

Further detail on the responsibilities of each party for designing, building, operation, maintenance, repair and plant replacement is provided in Figure 6—1.

Table 6—1 Design responsibilities matrix

Role	Responsibilities
Secondary heating system design consultant, the Designer	• Secondary heating system arrangement and design • Familiarise with connection Design Guidance prior to commencing design of secondary heating system • Liaise with the District Heating Operator to ensure the primary-secondary system interface is designed as per the connection Design Guidance • Liaise with the District Heating Operator to ensure flow and return temperatures on the secondary side are optimised with the district heat network
District Heating Operator	• Liaise with the Designer to ensure the primary-secondary system interface is designed as per the connection Design Guidance • Liaise with the Designer to ensure flow and return temperatures on the secondary side are optimised with the district heat network • Confirm adequate capacity is available on the district heating network for proposed new connection



KEY*				
Design	N/A	Project Team	CHP Team, EM&I	Project Team
Build	N/A	Building Developer	CHP Team, EM&I	Project Team
Operate	CHP Team	Estates	CHP Team, EM&I	CHP Team, EM&I
Maintain	CHP Team	Estates	CHP Team, EM&I	CHP Team, EM&I
Repair	CHP Team	Estates	CHP Team, EM&I	CHP Team, EM&I
Replace	CHP Team	Estates	CHP Team, EM&I	CHP Team, EM&I

**See "Who is this guide for?" section at beginning of document for definitions*

Figure 6—1 Design, build, operate, maintain, repair and replace responsibilities for district heating network connections

7 Heat substation room design

The substation acts as an interface between the district (primary) heating network and building (secondary) heating systems to serve the needs of the connected buildings, allowing the pre-defined operating conditions to be met. It ensures that the higher operating temperatures of the district heat network are not being routed directly to the buildings.

The UPO/ EPM is responsible for providing adequate space within the building's plant room for a heat substation, i.e. the interface between the district heat network and secondary system. This should be located on the ground floor or at a step-free basement level. It should be easy and safe to access the plant room for maintenance, operation and equipment replacement purposes. Access to the plant room shall be permanent. It must also be possible for the district heating network to be accessed within the plant room (e.g. for metering and isolation purposes).

The substation room consists of incoming district heating pipework and the secondary heating system equipment, interfaced at the plate heat exchangers. The Designer shall consider in their design the following items:

- Plate heat exchangers,
- Substation plant room,
- Secondary heating system equipment,
- Easily maintained plant room,
- A suitable and sufficient plant replacement strategy,
- Ensuring Principal Designer duties are carried out as per CDM Regulations 2015.

The following sections consider the plate heat exchanger and substation plant room design. Guidance for BMS, metering and other secondary heating system equipment design is provided in section 8.

7.1 Heat exchanger design

All plate heat exchangers shall be duplex in an N+1 configuration, i.e. an additional heat exchanger for resiliency. Each heat exchanger shall be sized to carry 100% of the heat load, but under normal conditions shall run at 50% capacity. In the event that one heat exchanger fails, the other shall run at full capacity to ensure adequate heat is delivered to the building.

If two separate building heating systems are to be served from a single plant room, the redundant heat exchanger can be used for resiliency for both systems.

Where an N+1 configuration is not feasible (e.g. in a refurbished building with restricted plant room space) a spare plate heat exchanger unit shall be kept onsite in case of a failure. This should not be the preferred option for heat exchanger design and it must be demonstrated by the Designer why the preferred N+1 configuration is not feasible.

Strainers shall be used to protect the plate heat exchangers, and flushing loops installed on the secondary side to bypass the heat exchanger. Heat exchangers have relatively small clearances and can become partially or fully blocked by debris, which is true particularly with new buildings that are connected without adequate flushing systems. Use of strainers will marginally increase pumping energy requirements; this should be accounted for by the Designer. Preference for DHW generation is via use of plate heat exchangers connected to the district heating network. Where storage is required, this should be provided using buffer vessels, i.e. calorifiers with coils shall not be used.

All plate heat exchangers shall include insulation jackets which are fully removable for maintenance purposes.

7.2 Plant room design

The Designer shall design the plant room to ensure adequate space is provided for the district heating-building system interconnection. The following minimum space requirement guidance shall be adhered to:

- Buildings with peak heating loads < 2,000kW – 5m x 6m = 30m^2,
- Buildings with peak heating loads > 2,000kW – 7.5m x 7.5m = 56m^2.

In addition to plant heating equipment, adequate space shall be provided for the plant room components listed in Table 7—1.

Table 7—1 Non-heating equipment components of plant room

Category	Component
Electrical requirements	Electrical supply for control panel Small power electrical sockets, 240V, IP55 rated Lighting Signals from secondary heating system
Maintenance and replacement	Area for maintenance of plant equipment Space and route for removal and replacement of plant equipment
Water requirements	Water supply to feed secondary heating system Water drainage
Ventilation	Ventilation system for plant room
Health and safety	Visible floor plan with accompanying schematic Visitor sign-in and sign-out book Anti-slip floor finish Noise and vibration attenuation

Category	Component
	Fire detection, suppression and means of escape PPE requirements Fire stopping in all walls and floor perforations All UCL Health and Safety standards to be followed
Building	Water tight/penetration sealed Concrete stands for heating equipment Equipment protection Trench/pit covers Lockable doors (UCL electronic access control) Minimum door dimension requirement: - 1.5m W x 2.5m H for 30m^2 plant room - 2.0m W x 2.5m H for 56m^2 plant room
Pipework labelling	All district heating pipework through each wall penetration and/or duct of plant room should identify: - Size of pipework - Type of service and temperatures - Area of building served (including via, where applicable) - Area of building returning from

8 Secondary heating system design

This section sets out the specific requirements – design, conditions, noise and vibration, heat losses, materials, and water quality – for secondary (building) heating systems, to allow a building to receive heat from the primary district heating network in an efficient manner.

The secondary heating system refers to the network and associated services between the secondary side of the heat exchanger, located in the substation plant room, and each connection point for space heating or DHW purposes. This includes the associated mechanical components such as pumps, speed controllers, pipes, pressurisation units, control panels and electrical supplies. Plate heat exchanger and plant room design guidance is provided in section 7.

Failure to comply with the following secondary system design requirements will be detrimental to the efficient operation of UCL's district heating network, hindering potential cost and carbon reductions from its use, and could result in the building connection being refused. It is essential that the Designer adheres to the following guidelines for any building proposed for connection to the district heating network.

8.1 General requirements

As discussed in the following sections, the secondary heat system should be designed in order to:

- Be compatible with the primary district heating network,
- Be reliable, efficient and easily accessible for maintenance,
- Minimise operating costs and optimise carbon savings,
- Accommodate the variations in demand-side and environmental conditions (load and temperature),
- Minimise heat losses, avoiding wasted heat and overheating during summer,
- Lower the operating temperature of the district heating network.

Each secondary system will be indirectly connected to the district heating network via a plate heat exchanger, which hydraulically separates the two systems (see section 7).

8.2 Specific design requirements

The key design principle of the district heating network is that it operates with a large temperature differential (delta T). A large delta T:

- Increases the network's capacity for carrying heat,

- Reduces required sizes of pipes,
- Reduces pump power requirements,
- Maximises operation of the CHP plant.

8.2.1 Flow control strategy

The flow control strategy for secondary heat systems will be to utilise variable flow-constant temperature (CT) circuits, as shown in Figure 8—1.

Variable temperature (VT) circuits shall only be permitted for radiator circuits, to reduce temperatures under low load or high external ambient temperatures. The temperature variation shall be achieved by a 3-port mixing valve between the flow and return. This arrangement requires separate pumping for VT and CT circuits. Designers shall ensure the pump control principles described below are applied in each case. Radiators shall be equipped with 2-port control via TRV. For radiator circuits multi-zone control via the building management system (BMS) is preferred.

The BMS for each individual terminal load within buildings shall control the secondary system motorised valves. This regulates the flow of heating water to the heat emitters at the loads based on demand.

The secondary system pump shall be variable speed drive (VSD) in order to maintain the required differential pressure (dP) set point as the regulation valves open and close to meet demands. A dP sensor at the index run of the secondary system shall control the VSD pump to maintain this pressure difference. In the case of extreme low building heat load (e.g. out of term-time in summer) when all regulation valves are shut, an automatic 2-port bypass valve, located on the index run of the secondary circuit, will divert secondary heating water to the return. This ensures minimum flow through the pump is achieved as a safety measure, i.e. to avoid damage caused by operating at low flow. Should this extreme low heat demand persist for a period of time (to be agreed with UCL on a project-specific basis) the BMS shall be programmed to switch of the pumps until the heat demand increases (using a logic to be agreed with UCL on a project-specific basis).

The automatic bypass valve on the index run is closed under normal operation. Utilisation of the bypass arrangement shall be kept to an absolute minimum as this decreases delta T.

VSD pumping with 2-port control at heat emitters reduces pumping energy consumption as the pump reacts to fluctuations in demand, i.e. it only pumps the volume of water necessary to meet demand.

It must be noted that under no circumstance should 3-port control valves be installed at heat emitters with a VSD flow control strategy in place. This will return high temperatures to the plate heat exchanger, reducing delta T on the district heating network and ultimately reducing its overall efficiency.

The flow of district heating network water circulating through the plate heat exchanger within the heat substation is regulated by a motorised valve, which is controlled by a temperature sensor on the secondary flow side, i.e. if secondary flow temperature drops the valve is opened to allow more primary flow through the heat exchanger. The measures described herein should help to reduce return temperature on the district side (see Section 8.2.2 for details). As a further precaution, return temperature limiting should be employed at each substation.

The flow control strategy described above provides pumping energy savings over other arrangements due to the VSD pumps which can match building demand.

The secondary heating system shall be designed as a single circuit (note comments above on use of VT circuits). Using a single circuit reduces return water temperatures to the plate heat exchangers as the water passes through the full heating system, maximising the opportunities to lose heat. A single circuit also reduces complexity and costs of the system as fewer pumps are required.

The secondary system shall not use low loss headers. Use of low loss headers diverts a significant portion of the flow in the primary circuit from the terminal units, meaning it is not cooled. This approach is often used with boiler systems but is not compatible with district heating connections, where the temperature differential is a key factor in efficient operation of the district heat network (see section 8.2).

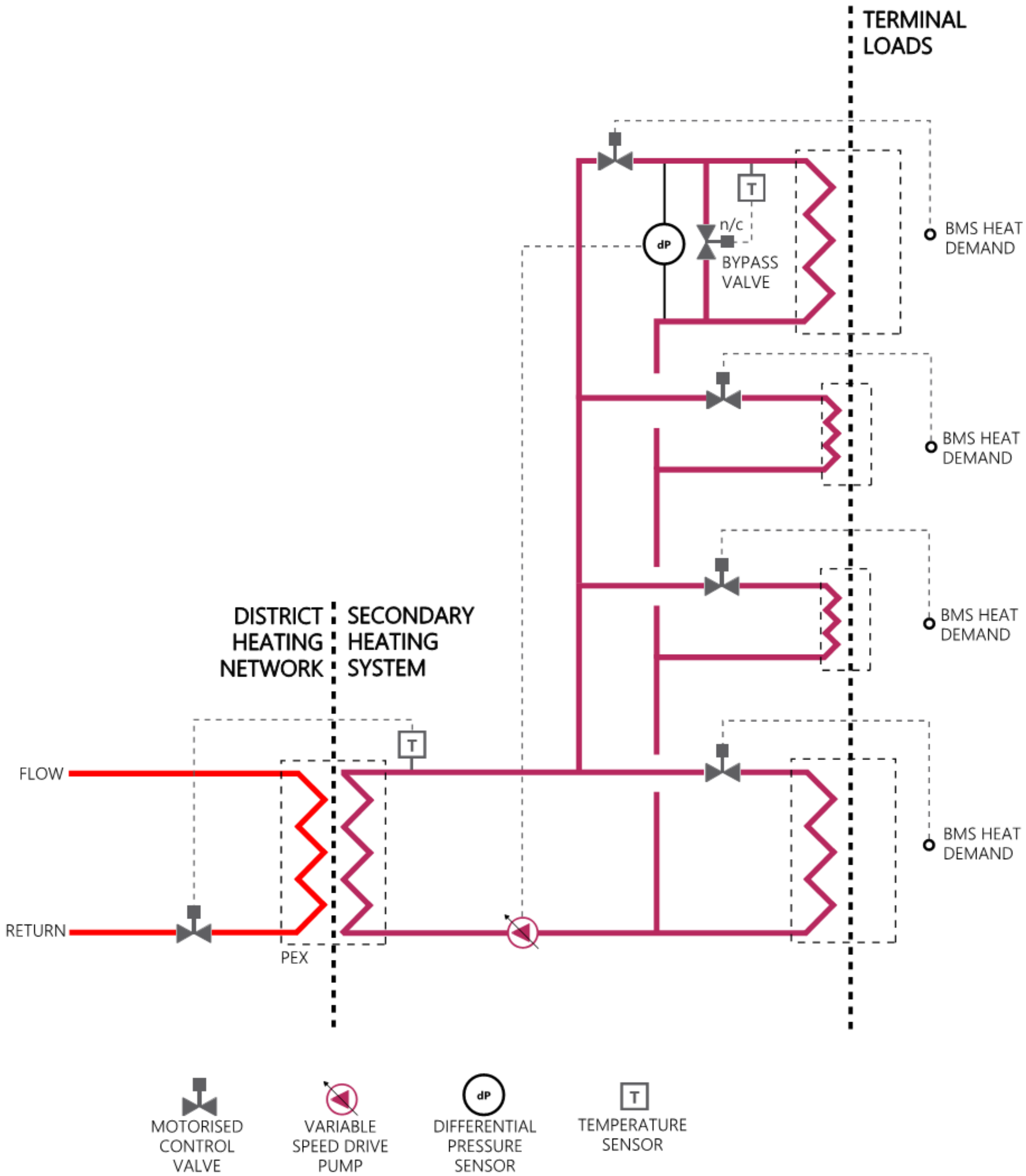


Figure 8—1 Secondary heating system and connection with district heating network

8.2.2 Flow and return temperatures

The CIBSE Heat Network Code of Practice (2015) states that approach temperatures for heat exchangers at primary-secondary plate heat exchanger interfaces should not exceed 3°C

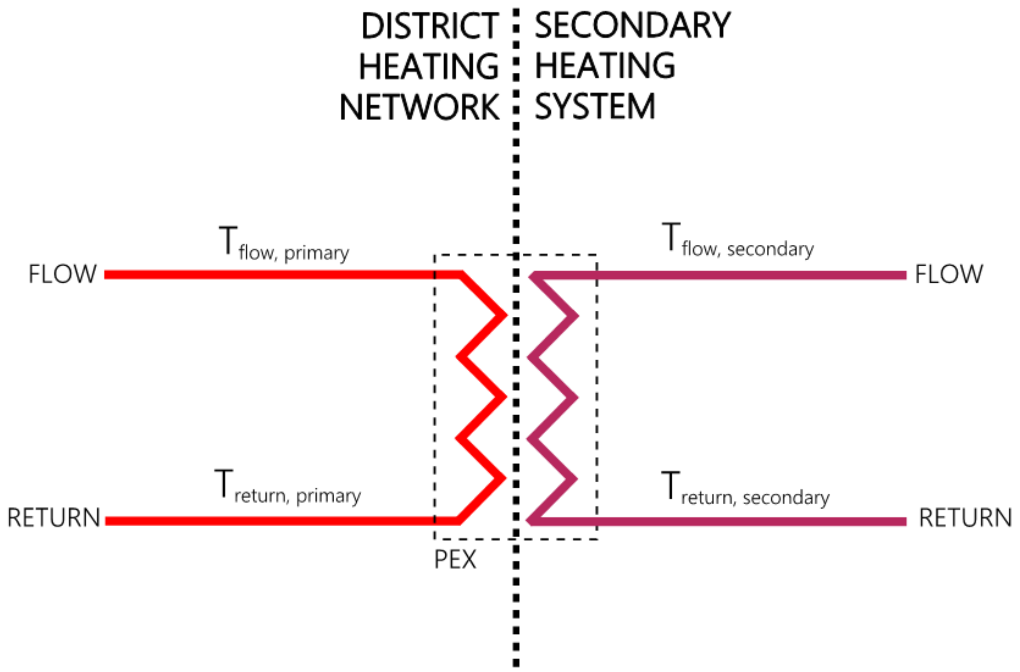
(Figure 8—2). The Designer must check whether sufficient heat transfer occurs at low loads and flow rates with the chosen heat exchanger and these approach temperatures. Consultation with the heat exchanger supplier is recommended.

The Designer should liaise with the District Heating Operator to confirm flow and return temperatures available from the district heat network, in order to achieve these approach temperatures and to optimise the building's connection with the network.

Guidance on flow and return temperatures for the district heating network and secondary systems is provided in Table 8—1. These temperatures are indicative of typical buildings – actual design temperatures must be confirmed through liaison between the Designer and the District Heating Operator (see section 5).

It may be the case that the district heating network's operating temperatures are reduced during summer months to reduce standing pipe heat losses. The Designer must liaise with the District Heating Operator to confirm this operating strategy, and shall incorporate this into their design.

The secondary heating system flow temperature shall be designed to avoid the risks of Legionella occurring in the hot water systems, and accounts for heat losses within the secondary system.



$$T_{flow,\ secondary} = T_{flow,\ primary} - 3°C$$

$$T_{return,\ secondary} = T_{return,\ primary} - 3°C$$

Figure 8—2 Approach temperatures for building connections to the district heating network

It should be noted that a long-term ambition (over the next 15 years) for UCL is to reduce district heating network operating temperatures, in order to reduce operating costs associated with heating equipment and standing network losses. It is the responsibility of the UPO/ EPM to confirm the district heating operating temperatures for the building being proposed for connection, at the planned time of connection. These temperatures should be incorporated into the secondary heat system design.

Table 8—1 Indicative district heating and secondary system operating temperatures

Building for connection	Season	District heating network		Secondary heating system	
-	-	T_{flow}	T_{return}	T_{flow}	T_{return}
New	Winter	95	65	70	40
	Summer	70	40	60	30
Refurbished	Winter	95	65	80	60
	Summer	70	40	70	50

8.2.3 Pumping strategy

Secondary pumps shall be VSD to match supply with demand and save pumping power. As shown Figure 8—3 the secondary pumps shall be installed on the return leg, just before the primary-secondary heat exchanger interface, to avoid cavitation issues within heat exchangers. Pumps shall be installed in parallel to accommodate any buildings with a wide variety in loading, i.e. a staged pumping strategy to reduce power consumption by reducing pump modulation. By employing multiple pumps in parallel, the system will be able to meet the required return temperature at all times.

Pumps connected to the district heating network where a run and standby unit is required must not be twin head units and must be piped and connected independently. This avoids interrupting service during maintenance or replacement.

The number of pumps selected is a function of the maximum and minimum flow rates experienced on the secondary heating system, i.e. the daily and annual variations in heat demand. As a general rule each secondary heating system should have:

- 2no. main flow pumps,
- 1no. spare pump (for main flow pump redundancy),
- 1no. low flow jockey pump (covers secondary system heat losses and very low loads, e.g. DHW loads during summer).

For buildings with high maximum loads it may be necessary for the secondary system to have more than the 2no. recommended main flow pumps. It is up to the Designer to justify the installation of more than the recommended main flow pumps.

For buildings with low maximum loads it may be necessary for the secondary system to have only 1no. main flow pump.

The minimum turndown of a single main flow pump shall be 25% of its peak flow, and shall meet the minimum winter demand of the secondary heating system, so that the system's minimum flow can always be met by the pumps. The jockey pump shall be sized for very low loads, e.g. to cover secondary system heat losses.

Given that pump speed and flow rate are not proportional in a variable volume system, care must be taken to adhere to the manufacturer's minimum operating conditions.

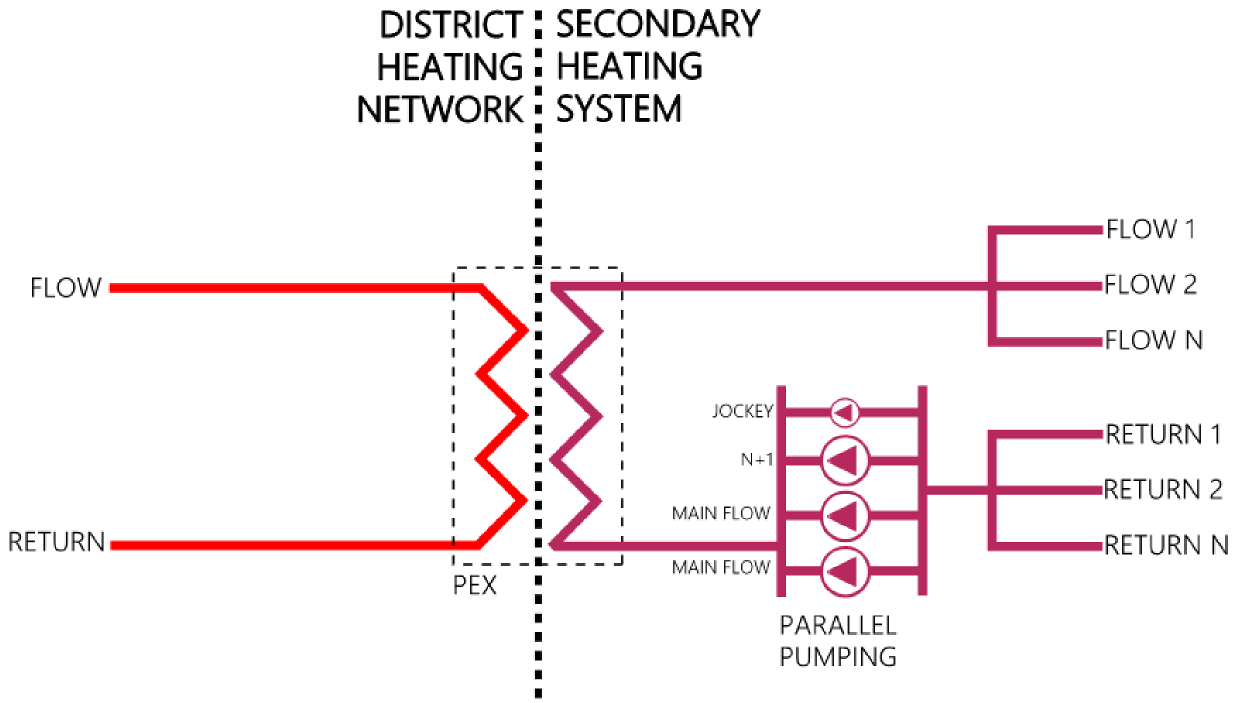


Figure 8—3 Secondary heat circuit pumping strategy

8.2.4 Plate heat exchangers

See section 7 for general design and section 8.2.4 for district heating and secondary system design temperatures.

8.2.5 Pipework

The following are pipework design requirements for the secondary heating system within the building.

Materials

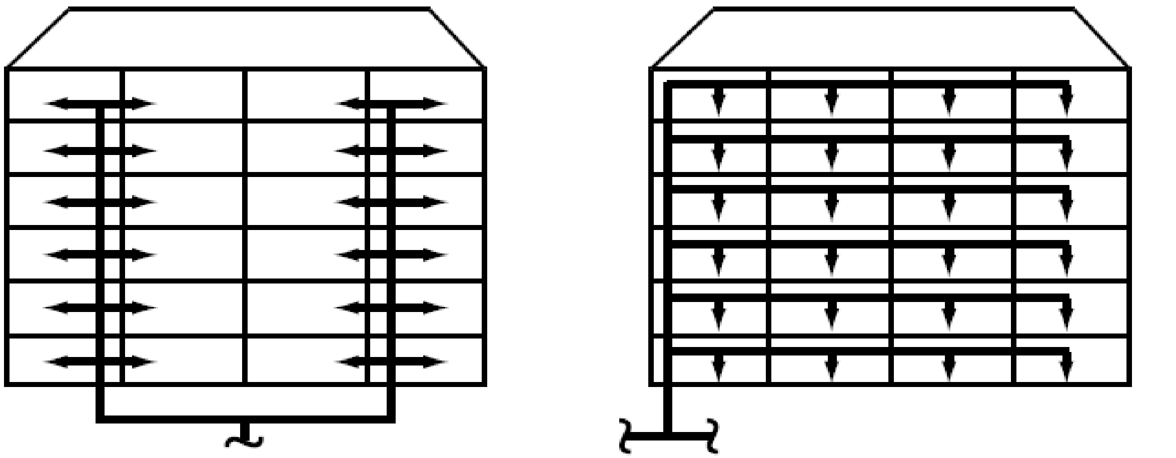
The pipes to be used for the secondary heating system within the substation plant room shall be of steel, constructed from standard pipe and fittings, i.e. no "cut-and-shut" joints. No plastic pipework shall be used. The support pipeline system shall comply with BS 3974. Additionally, the standards EN 10217-1, EN 10217-2, EN 253 should apply. See Table 4—1.

Heat losses

Heat losses in pipes depend on the following:

- Pipe lengths – reducing pipework lengths should be the first priority in the design. Unnecessary bends should be avoided and direct routes should be preferred. Risers that help minimise long pipe runs should be adopted,
- Pipe insulation – adequate pipe insulation should be installed to minimise heat losses (see next section),
- Fluid temperature in pipe – this is specified by the secondary system operation requirements set by the Building Operator,
- Internal surface finish.

The CIBSE Heat Network: Code of Practice (2015) suggests that pipe route design should follow the example installation shown in image (a) in Figure 8—4, using multiple risers that reduces overall pipe lengths.



(a) Shared risers, minimal horizontal distribution

(b) Single riser, horizontal distribution

Figure 8—4 Heat losses reduced in (a) compared to (b) via use of multiple risers, therefore reducing pipe lengths (CIBSE Heat Networks: Code of Practice, 2015)

Insulation

All pipework and pipeline auxiliaries shall be fully insulated and physical characteristics in accordance with BS 5422. The insulating materials should follow BS 5970. See standards and codes (Table 4—1) in Section 4.4.

Note that heat loss in practice will be higher than calculated at the design phase due to installation imperfections (e.g. lack of insulating material when joining pipes with their auxiliaries). The Designer should therefore ensure that:

- All plant components are fully insulated, e.g. pumps, expansion vessels, valves, strainers, flanges, pipe ends, etc. The type of insulation shall be easily removed for inspection and maintenance purposes and it should not interfere with any electrical or electronic parts, or with cooling of motors,
- All pipework supports should include an insulation level between the support and the pipe,
- All insulated components in external areas shall be polyisobutene (PIB) clad to provide a weather proof finish,
- Mechanical protection is provided where required, with clear labelling not to step on equipment.

The quality of installation is the responsibility of the contractor appointed by the UPO/ EPM, who should demonstrate this quality by undertaking thermal imaging of the installation. In case of non-continuous insulation, the contractor can be requested to rectify the problems.

The CIBSE Heat Network: Code of Practice (2015) recommends a minimum of 40mm insulation for internal secondary distribution systems, which is greater than is normally used for other building services installations. Insulation shall be Kingspan Kooltherm phenolic foil backed foam, or an equal and approved alternative.

8.2.6 Isolation valves

Sufficient valves shall be installed to allow effective isolation of the building without disturbing other users on the network, with isolation on mains being double valve. Isolation valves shall be easily accessible and shall be double valve and geared on the primary side.

8.2.7 Building management systems

All secondary heat systems should be designed to be incorporated into the BMS of each building, and should be programmed to avoid sharp peaks in demand. The BMS needs to be to UCL specifications and must be able to interface with the district heating network connections.

Pre-heat initiation shall be staggered across the campus to avoid peaking on the network. This shall be achieved via coordination with the District Heating Operator. This is to avoid issues with heat peaking on the network, i.e. each BMS switches on the heating at the same time on a cold

January Monday morning, causing a large spike in heat demand, putting strain on central plant and potentially creating hydraulic issues elsewhere on the network.

8.2.8 Heat metering

All connections should be metered on the district side of the plate heat exchangers and linked back to the BMS and UCL's online monitoring system, Demand Logic. Meters shall be Kampstrup Multical 602 and will be Article 9 or MID compliant to satisfy current and future billing needs. Meters shall be enabled to log kWh heat consumption and kW peak demands. All metering should follow UCL's Energy Monitoring Specification.

8.2.9 Domestic hot water service

All DHWS will come directly from the district heating network using plate heat exchangers to charge buffer vessels. Buffer vessels shall be fitted with immersion heaters, so DHWS can operate independently of the network. Immersion heaters shall be fitted with a control interlock such that they can only be operated under a district heating outage under the supervision of the District Heating Operator.

8.2.10 Noise and vibration

The Designer should ensure that the noise and vibration from the secondary heating plant will not be transferred to adjacent areas and should be within the acceptable limits set by the District Heating Operator, following the "UCL Noise and Vibration Standard". All pipework connected to the pumps shall be supported by spring hangers throughout the plant room. "Bridges" that bypass the spring hangers between the pipework and structure within the plant room should be avoided as they allow the transfer of vibration.

The noise and vibration strategy should be a part of the documentation to be submitted to the District Heating Operator for approval (see Section 5). The specialist who conducts the noise and vibration assessment shall be required to confirm in writing that the strategy has been delivered for the installation as part of the system acceptance procedure.

8.2.11 Water quality

The UPO/ EPM should ensure that the secondary heating system is cleaned and flushed in compliance with BSRIA BG29/2012 or later standards, in order to avoid any damage to substation components and particularly to heat exchangers. See Table 4—1.

A flushing bypass shall be used for flushing of the secondary heating system, either side of each plate heat exchanger. Flushing must not be allowed through heat exchangers; the installing contractor and commissioning engineer are obliged not to compromise the performance of heat exchangers.

The UPO/ EPM is responsible for installing the appropriate chemical dosing equipment that treats the secondary system circulating water in a safe manner. A small domestic style water softener should be installed to soften the water. The water consumed during the water treatment process shall be metered and recorded weekly; any increase in water usage should be recorded and rectified immediately as high and/or continuous usage indicates leakage, causes corrosion and can increase fouling. The Designer shall refer to the UCL's Design Guide for Mechanical, Electrical and Public Health Services.

Inline side stream filtration shall be used for filtering solids from the circulating water. Note that these should not be installed so as to affect flow and return temperatures.

Several tests should be undertaken prior to the handover to the District Heating Operator for operation, in order to ensure that the water quality requirements are fulfilled. BS 8552:2011 should be followed and an on-site log book should be kept, recording the actions, sampling dates and results. See standards and codes (Table 4—1) in Section 4.4.

Prior to the commencement of operation, the water hardness shall be demonstrated to be less than 40ppm and the on-site log book should be handed over to the District Heating Operator.

Evidence of the compliance with the water requirements shall be provided to the District Heating Operator before water is allowed to circulate in the secondary side of the heat exchanger within the substation.

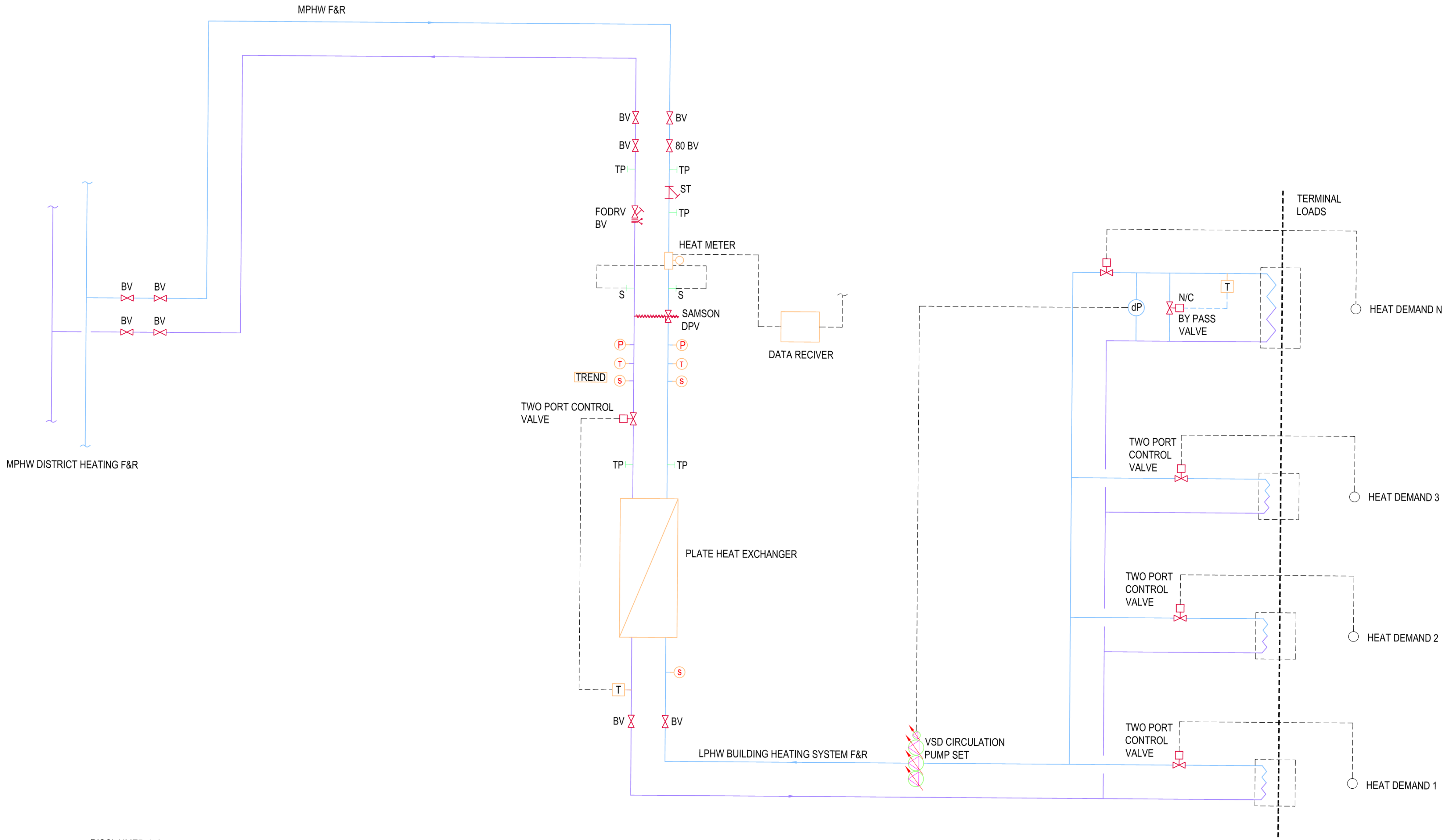
8.2.12 Direct district heating connections

Plate heat exchangers will separate primary and secondary systems unless specific permission is given by the District Heating Operator for a direct connection. Direct connections will not normally be considered unless appropriate, e.g. remote air handling unit (AHU) heater batteries located close to the district heating mains.

8.2.13 Standalone systems

The district heating network shall be utilised for heating as a priority, especially for DHW provision as this helps with summer loads (and therefore increased generation of low-carbon heat). Where point-of-use electric water heating, VRF systems or other heat sources are proposed, the Designer shall undertake an energy efficiency and carbon emissions comparison assessment between the proposed system and use of the district heating network.

9 Appendix: Typical required secondary heat system schematic



DISCLAIMER: NOT ALL DETAIL IS SHOWN ON THIS SCHEMATIC