Heat Interface Unit

heat network design guide

CALEFFI Hydronic Solutions

altecnic CALEFFI group

Introduction

This guide explains how to design and commission heating systems for apartment buildings and district heating schemes incorporating Altecnic SATK Heat Interface Units (HIUs).

Altecnic HIUs incorporate one or two plate heat exchangers to transfer heat from a central boiler plant to individual heating and hot water systems within apartments.

Altecnic HUIs incorporate an internal electronic control unit which ensures maximum efficiency, improved reaction time and control but also incorporates other additional features.

Modulating valves control the supply of hot water to both the space heating and domestic hot water within the apartment.

The thermally insulated casings minimises heat loss from the unit.

Maximum energy savings from the HIUs can only be achieved if the system is designed, installed and commissioned correctly and HIUs selected and sized correctly.

Included in this guide are recommendations for:

- HIU selection
- Primary pipe-work layout and sizing
- The benefits of low return temperatures and large delta T's
- General plant-room layouts and the integration of renewables/low carbon heat sources
- Primary flow rate calculations
- Boiler sizing
- Thermal Store sizing
- System pump control
- Bypass locations and valving
- Diversity
- Prediction of hot water demands
- Flushing and commissioning

SAP Rating

SAP has been adopted by the Government as part of the UK's national standard for calculating the energy performance of buildings.

Every new building has to have an SAP rating. It provides a simple means of reliably estimating the energy efficiency.

SAP ratings are expressed on a scale of 1 to 100, the higher the number the more energy efficient the building

Benefits

The benefits to designers and building managers of using Altecnic HIUs are;

- Compact design requiring a minimum amount of space they take up far less room than an equivalent thermal store or an equivalent capacity -boiler.
- Low maintenance since they do not require regular servicing or maintenance.
- All the SATK units incorporate a spool piece which can be easily removed and a heat meter fitted inside the unit. This allows the energy used by each individual apartment to be recorded and charged accordingly.

Benefits

- Depending upon the meter chosen the energy used can be monitored and recorded automatically which enables automatic billing to the tenants.
- A central boiler in an apartment building or district heating system using a low carbon fuel will be more efficient than individual combi boilers or hot water cylinders improving the SAP rating of the building.

  This will also help to achieve target ratings under the Code for Sustainable Homes.
- The flexibility of a heat network allows various low carbon energy sources to be utilised. The energy centre can use waste energy rejected from local sources, combined heat and power (CHP), heat pumps, solar panels, biomass boilers etc.
- The heat network 'future proofs' the supply of energy to those connected to the network. Any advances in energy generation technology can be integrated into the plant-room and immediately everyone connected to the network benefits.
- An Altecnic HIU maximises the energy efficiency of the central boiler plant by enabling the return water from the primary system to have a lower temperature. A low return water temperature is important to the efficiency of gas fired condensing boilers, combined heat and power units, solar panels and ground and air source heat pumps.
- Part L recommends that the return water temperature from a community heating scheme should not exceed 40˚C for hot water systems and 50˚C for radiator systems.
- The Legionella bacteria can multiply in stored or stagnant water between 25 to 45˚C. Below 20˚C the bacteria can survive but are dormant and above 60˚C most die within 2 minutes.
- The SATK20/22 and SATK30/32 HIUs provide instantaneous hot water minimising the risk of legionella bacteria multiplying since there is no stored hot water.
- The SATK22 and SATK32 models have the ability to be set to provide an automatic pasteurisation cycle of the DHW plate heat exchanger. On these models, if DHW recirculation is utilised, the HIU can automatically pasteurise the circulation loop at the same time.
- The SATK40 HIU although heating hot water stored in a cylinder maintains the temperature of the hot water at 60˚C or above and during periods of frequent draw-off the water will not be stagnant.
- All Altecnic HIUs are supplied with a lockable fully insulated cover, manufactured from PPE which fully insulates the unit and a sliding or removable window allows the tenant access to the heat meter if fitted.
- The insulated cover (SATK20/30) and clamshell insulation (SATK22/32), minimises heat loss from the HIU, resulting in lower energy use. This ensures that the heat delivered to the apartment is useful, controllable heat and that wasted energy is minimised.

Altecnic HIUs

The 5 main Altecnic HIU are detailed on the following pages but for more detailed information on each unit please refer to the individual product brochure.

SATK22105 - Direct Heating

The SATK22 range is available for low (UFH), medium (radiator) and high(radiator) space heating systems.

The single plate design hydraulically separates the domestic water with the space heating supplied directly from the central boiler plant, but controlled by the HIU.

The on-board electronic control unit ensures maximum efficiency and control but crucially also enables additional important features.

The SATK22 is supplied with a heating circuit support pump except for SATK2230

The unit is supplied as standard with a room controller and thermostat that can be mounted away from the HIU, in a hall or living room for example. If the controller is mounted within the HIU cover, the thermostat function can be disabled.

The integral HIU controller has the option for MODbus connection to a BMS or separate MODbus network. Once connected, all settings have the option to be checked, set or changed remotely.

The MODbus network can also be used for remote fault diagnosis.

Domestic hot water – DHW

The DHW function takes priority over the heating function controlled by the DHW priority flow switch (component 18).

Set point – DHW temperature 42 to 60°C.

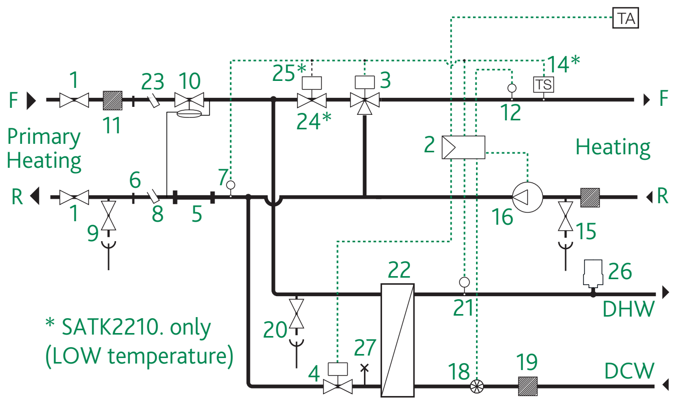
Product Range

	Heating temp. range	- Output
SATK22103	25 to 45°C	50 kW
SATK22105	25 to 45°C	75 kW
SATK22203	45 to 75°C	50 kW
SATK22205	45 to 75°C	75 kW
SATK22303	max. 90°C	50 kW
SATK22305	max. 90°C	75 kW
SATK22403	max. 90°C	50 kW
SATK22405	max. 90°C	75 kW

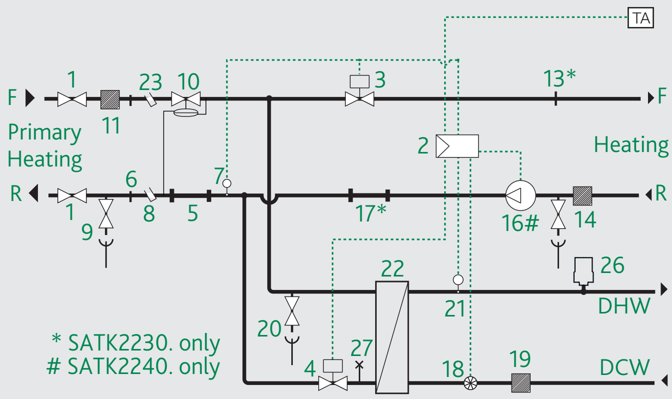
Components - SATK22

Item	Component
1	Primary isolation valve
2	Electronic regulator
3	2-way modulating valve - heating
4	2-way modulating valve - DHW
5	130 mm space for heat meter
6	¼"F pressure port
7	Return temperature probe
8	Connection for M10 x 1 heat meter return probe
9	Primary drain cock
10	Differential pressure control valve
11	Mesh strainer + ¼" F pressure port
12	Heating flow temperature probe
13	1/8" connection for DPCV code 789122
14	Safety thermostat
15	Secondary drain cock + mesh strainer
16	Pump
17	Spool piece
18	Flow meter (turbine + sensor)
19	Mesh strainer
20	Heating exchanger primary drain
21	DHW temperature probe
22	DHW heat exchanger
23	Connection for M10 x 1 heat meter flow probe
24	Thermal safety solenoid valve (normally closed)
25	Thermal safety valve actuator
26	Water hammer arrester
27	Heat exchanger primary circuit air vent

Schematic SATK 2210 & SATK2220



Schematic SATK 2230 & SATK2240



SATK20103 - Direct Heating

The SATK20 range is available for low (UFH), medium (radiator) and high (radiator) space heating systems.

The single plate design hydraulically separates the domestic water with the space heating supplied directly from the central boiler plant, but controlled by the HIU.

The on-board electronic control unit ensures maximum efficiency and control but crucially also enables additional important features.

The SATK20 is available with a heating circuit support pump as standard on the LOW and MEDIUM temperature units and is optionally available on the HIGH temperature unit.

The low temperature heating version, for UFH, includes a heating pump, bypass and safety thermostat, allowing the space heating circuit temperature to be set and controlled as required.

All models with a heating support pump come, as standard, with a pump bypass loop in case of complete radiator TRV shutdown.

Product Range

	Heating temp. range	- Output
SATK20103	25 to 45°C	50 kW
SATK20203	45 to 75°C	50 kW
SATK20303	45 to 85°C	50 kW

SATK20103 For under floor heating.

SATK20203 For radiator heating with compensated temperatures.

SATK20303 For radiator heating.

Operation

Domestic Hot Water - DHW

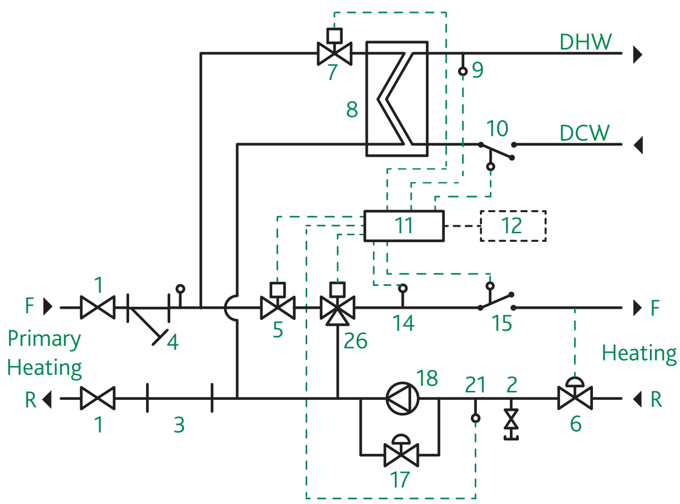
The DHW function takes priority over the heating function controlled by the DHW priority flow switch (component 10).

Set Point - DHW temperature 42 to 60°C

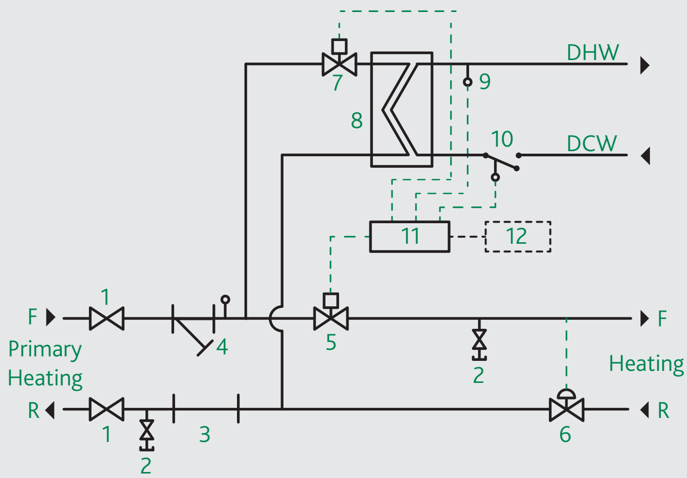
Components

Item	Component
1	Primary isolation valve
2	Drain cock
3	Heat meter spool piece - replaced by heat meter when fitted
4	Primary filter and heat meter probe pocket
5	Heating circuit on/off valve
6	Differential pressure control valve (DPCV)
7	Modulating primary control valve (DHW)
8	Plate heat exchanger (DHW)
9	DHW temperature sensor
10	DHW flow switch
11	Electronic control unit
12	Room controller (not supplied)
14	Heating flow temperature sensor
15	Temperature control stat
17	Pump safety bypass and DP switch
18	Pump
26	Modulating heating control valve

Schematic SATK 20103 - Under Floor Heating



Schematic SATK 20303 - Radiator Heating



SATK32103 - Indirect Heating

The indirect twin plate design hydraulically separates both domestic and space heating from the central primary supply.

The advanced electronic features of the SATK32 can protect the heat network from inefficiency.

The unit has the ability for the maximum allowable primary return temperature to be set independently for both heating and DHW.

In this way, the network is protected from low delta T's and therefore inefficiency.

The unit is supplied as standard with a room controller and thermostat that can be mounted away from the HIU, in a hall or living room for example. If the controller is mounted within the HIU cover, the thermostat function can be disabled.

The integral HIU controller has the option for MODbus connection to a BMS or separate MODbus network. Once connected, all settings have the option of being checked, set or changed remotely.

The MODbus network can also be used for remote fault diagnosis.

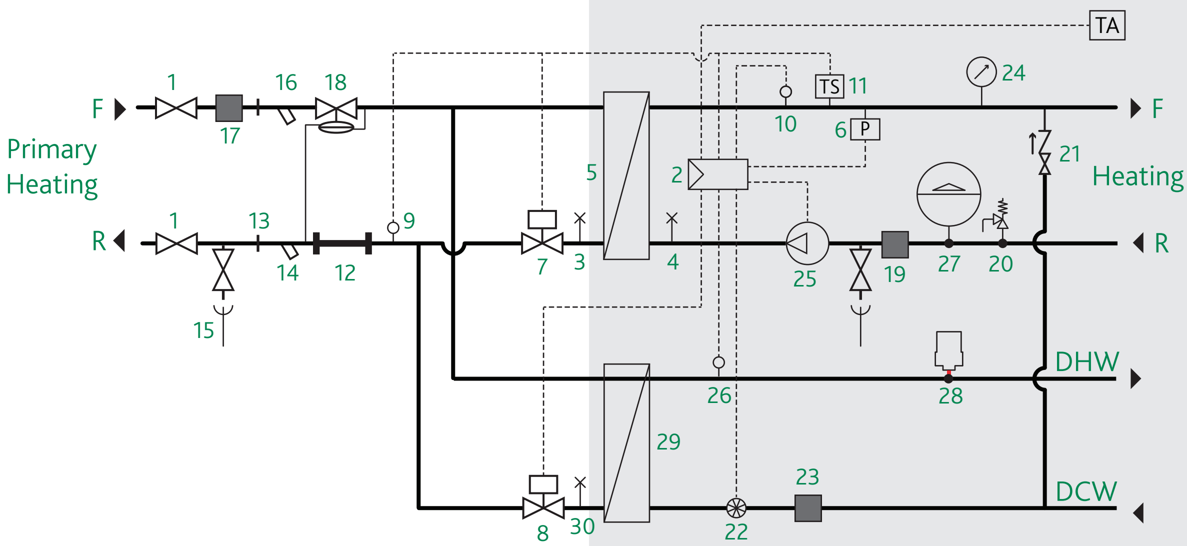
Product Range

	Heating temp. range	DHW Output
SATK32103	25 to 75°C	50 kW
SATK32105	25 to 75°C	75 kW

Components

Item	Component
1	Primary isolating valve
2	Wiring centre
3	Air vent/drain (primary heating PHE)
4	Air vent/drain (secondary heating)
5	Heating plate heat exchanger (PHE)
6	Pressure switch
7	2-port modulating valve (heating)
8	2-port modulating valve (DHW)
9	Return temperature probe
10	Heating flow temperature probe
11	Safety thermostat
12	130 mm space for heat meter
13	¼"F pressure port
14	M10 x 1 connection for heat meter return temp. probe
15	Primary drain cock
16	M10 x 1 connection for heat meter flow temp. probe
17	Strainer with mesh + ¼"F pressure port
18	DPCV
19	Secondary drain cock + strainer with mesh
20	Safety relief valve
21*	Filling loop with backflow preventer (optional)
22	Flow meter
23	Strainer with mesh
24	Pressure gauge
25	Pump
26	DHW temperature probe
27	Expansion vessel
28	Water hammer arrester
29	DHW plate heat exchanger
30	Air vent/drain (primary DHW PHE)
*	Not shown on Components illustration

Schematic SATK 32103 & SATK32105



SATK30103 - Indirect Heating

The twin plate design hydraulically separates the domestic water from the space heating supplied directly from the central boiler plant.

The on-board electronic control unit ensures maximum efficiency and control but crucially also enables additional important features.

The standard unit can be set to hold a stable heating flow temperature, to suit the installation (radiators, UFH for example), but crucially, can also be set to vary the heating flow temperature automatically depending on the temperature of the heating return water.

This allows the unit to automatically compensate for changes due to external influences, such as outside temperature etc. thereby ensuring that the unit and the system operate at maximum efficiency.

Operation

Heating

The temperature setting operates on the principle of set point regulation and can be fixed within application limits.

Heating Set Point - 25 to 75˚C

Domestic Hot Water - DHW

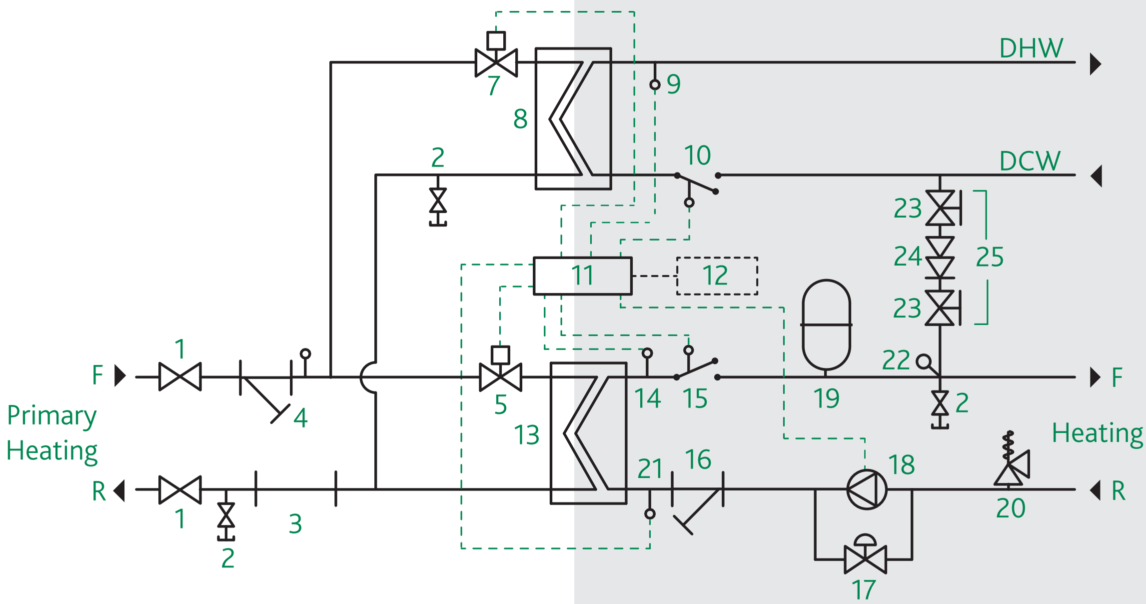
The DHW function takes priority over the heating function controlled by the DHW priority flow switch (component 10).

Set Point - DHW temperature 42 to 60˚C

Components

Item	Component
1	Primary isolation valve
2	Drain cock
3	Heat meter spool piece - replaced by heat meter when fitted
4	Primary filter and heat meter probe pocket
5	Heating circuit on/off valve
6	Differential pressure control valve (DPCV)
7	Modulating primary control valve (DHW)
8	Plate heat exchanger (DHW)
9	DHW temperature sensor
10	DHW flow switch
11	Electronic control unit
12	Room controller (not supplied)
13	Plate heat exchanger (space heating)
14	Heating flow temperature sensor
15	Temperature control stat
16	Strainer (heating circuit)
17	Pump safety bypass and DP switch
18	Pump
19	Expansion vessel
20	Safety relief valve - 3 bar
21	Heating return temperature sensor
22	Pressure gauge
23	Filling loop isolation valve
24	Filling loop double check valve
25	Filling loop

Schematic SATK 30103



SATK40103 - Indirect Heating and connections for an indirect DHW storage cylinder

The SATK40 is intended to be connected to an indirect cylinder complete with temperature thermostat, control valve, pressure reducing valve, safety valves and immersion heater.

The SATK40 is also available mounted on a frame and connected to a pre-plumbed cylinder. Please refer to our ProCyl data sheets for more information.

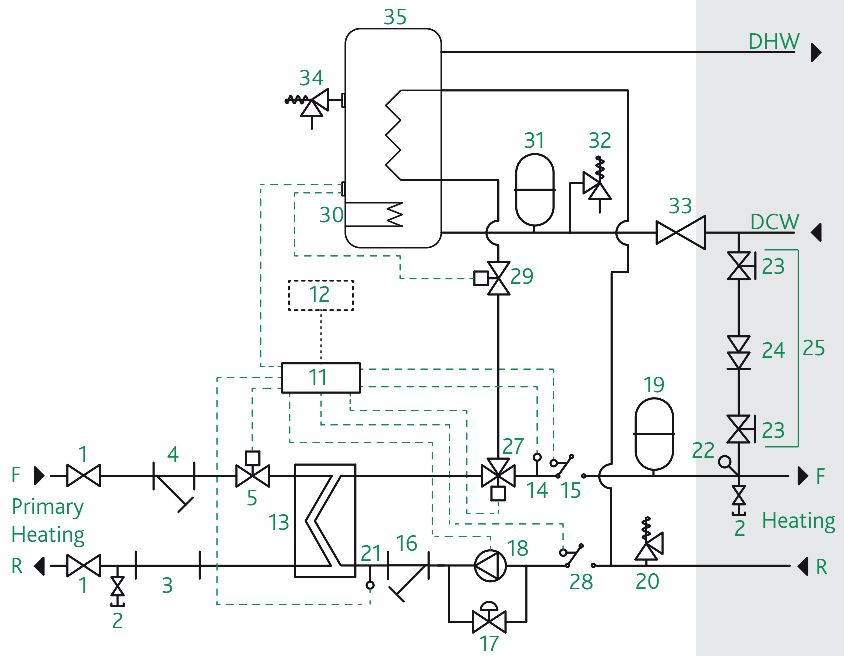
The hot water cylinder provides a secure source of domestic hot water should the primary supply from the central boiler plant be interrupted for a short period of time.

The hot water cylinder does not require instantaneous heat to raise the domestic hot water temperature but allows the volume of water in the cylinder to be heated over a short time period.

This ensures a more constant demand on the centralised boiler plant.

Schematic SATK 40103

DHW cylinder and associated valving not included, but shown for clarity of connections



Operation

Heating

The temperature setting operates on the principle of set point regulation and can be fixed within application limits.

Set Point - 25 to 75˚C

Domestic Hot Water - DHW

The DHW function works in tandem with the heating function ensuring both heating and DHW production.

Set Point - DHW temperature 60˚C+

Components

Item	Component
1	Primary isolation valve
2	Drain cock
3	Heat meter spool piece - replaced by heat meter when fitted
4	Primary filter and heat meter probe pocket
5	Heating circuit on/off valve
6	Differential pressure control valve (DPCV)
7	Modulating primary control valve (DHW)
8	Plate heat exchanger (DHW)
9	DHW temperature sensor
10	DHW flow switch
11	Electronic control unit
12	Room controller (not supplied)
13	Plate heat exchanger (space heating)
14	Heating flow temperature sensor
15	Temperature control stat
16	Strainer (heating circuit)
17	Pump safety bypass and DP switch
18	Pump
19	Expansion vessel
20	Safety relief valve - 3 bar
21	Heating return temperature sensor
22	Pressure gauge
23	Filling loop isolation valve
24	Filling loop double check valve
25	Filling loop
27	Modulating three port diverting valve
28	Flow switch
29	Thermostatic two port safety valve
30	Immersion heater
31	Expansion vessel
32	Safety relief valve
33	Pressure reducing valve
34	Temperature and pressure relief valve
35	Cylinder (90, 150 or 200 litres)

Features and Benefits of Altecnic HIUs

Note, not all features are available on all models. Please refer to the specific product data pages.

Control Unit

Both the domestic water exchanger and the heating exchanger (if fitted) are controlled by electronic valves.

The electronic valves are controlled by an integral control unit that monitors a number of sensors within the HIU. The electronic control valves respond extremely quickly to changes in primary system pressures (as variable speed pumps modulate) and to changes in demand within the apartment.

Return Temperature Limitation (RTL) (selectable and configurable)

Low return temperatures on heat networks are crucial for maximising efficiency. It is common for the low return temperature to be compromised due to poorly balanced heat emitters within the apartments. While we would always advocate that the radiators or UFH zones are correctly balanced, the RTL feature of the SATK22 and SATK32 can assist in maintaining the low primary return temperature.

When RTL is selected, the HIU will ‘request’ a required maximum primary return temperature. Once set, the HIU will modulate the secondary flow temperature to ensure that the set primary return temperature is never exceeded.

The RTL feature will also work should the tenant adjust the radiators, install radiator covers, dry their washing on the radiators.

RTL can also be set, independently for DHW production. In this way, the HIU will output DHW at the required temperature, but lower this temperature at the extreme high flow rates.

Primary Flow Rate Limitation

When the heating comes on in an apartment, it is very common to see the apartment take far greater energy from the system than it was designed to take for the first 10 to 15 minutes or so.

A ‘3kW apartment’ can take as much as 7 or 8kW’s for this short period of time.

If this happens to coincide with other apartments coming on heating at the same time and especially if there’s a high DHW demand at the same time (say a weekday morning at 7:00am for example), then the network could be prone to failure as the demand on the system is greater than the calculated design condition.

The SATK22 and SATK32 allow a specific maximum primary flow rate to be set into the HIU controller when the unit is in heating mode.

As an example, the SATK32105 HIU requires a primary flow rate of 199 l/hour to provide 4.2kW to the apartment space heating, (based on a primary flow temperature of 70˚C, a secondary flow temperature of 65˚C and a 20˚C apartment delta T).

The HIU can be set to provide 200 l/hour as a maximum when the HIU is in heating mode. This ensures that no HIU on the network can take more than its allotted amount thereby protecting the network from failure.

Features and Benefits Continued

Modbus Output

The SATK22 and SATK32 HIU’s have a Modbus output.

When connected (either via the BMS or via a stand-alone Modbus network) the network operator can configure the HIU’s to match the individual demands of the network or even the individual apartments.

The units can then be remotely commissioned.

This Modbus connection also allows the HIU to be interrogated and any fault messages read. This can ensure that when a maintenance engineer attends site, he has the required spare parts before he arrives. It is even possible to read the current apartment temperature and compare and change the heating set point on the HIU.

All of the advanced features, such as RTL, flow rate limitation the preheat methodology can also be read and changed via the Modbus network.

Configurable Preheat.

Preheat reduces the time it takes for hot water to be delivered to the taps. However, preheat also uses energy, making the network less efficient and therefore costs money.

Most HIU’s have a primary ‘trickle’ bypass, but what exactly is a trickle?

Every manufacturers HIU is different, but they all use energy.

Very often, mechanical HIU’s have their bypass open 24 hours a day, 365 days a year, with the obvious resultant wasted energy. Wasted energy that the tenant has to pay for. All Altecnic HIU’s have the ability for their preheat to be switched on or off.

The SATK22 and SATK32 HIU’s also have a third option, the preheat can be timed.

This timed function can be set into the controller or it can be offered for the tenant to set to meet their individual needs.

As an example, the tenant could set preheat to come on at 7:00am just before they wake up and then go off at 7:30am when they’re leaving the house to go to work. It’s then off all day and set to come on at 6:00pm when they arrive home from work, it’s then on all evening until 11:00pm when they go to bed. In this way, the tenant gets the benefit of preheat only when he needs it and doesn’t pay for it when he’s at work or asleep.

Domestic Hot Water Priority

Altecnic HIUs are set to give 100% domestic hot water priority.

The priority of SATK40 HIU can be set within the controller to deliver a mix of heating and DHW if required, such as 90/10, 80/20 etc, thereby ensuring that rooms do not go cold during periods of long hot water demand.

Features and Benefits Continued

Electronic Control Valves

Utilising electronic control valves also allows the HIU to be made smaller and lighter.

Firstly, the valves are far smaller than most mechanical valves.

Secondly it's now possible to 'wire in' multi functions for each valve.

As an example, on the HIU heating circuit of a conventional mechanical control HIU, you'll have the mechanical plate control valve, a two port on/off valve wired to a room controller, so that the tenant can turn the heating off and on by the time clock and a DPCV valve to protect this two port valve from high and varying differential pressure.

However, the electronic valve in the Altecnic HIU can provide both functions, controlling the primary flow through the plates and acting as the on/off valve for the tenant's room controller.

Heating Circuit Pressure Sensor

The secondary heating circuit is fitted with a pressure sensor that feeds back information into the controller. If the heating circuit loses pressure, due to a leak, for example, this will be detected by the HIU and the unit will automatically cut the power to the integral Grundfos pump and display a heating error warning LED on the front display. This ensures that the pump cannot burn out and the problem is highlighted quickly ensuring fast rectification.

Pump Anti-clog Feature

During the summer months or if the tenant is away on holiday, an apartments heating system might not be used for many weeks. It's possible in these situations that pumps can clog and/or their bearings become rusty. All SATK series units with a pump, include an anti-clog feature. Every 24 hours, if the heating system has not been used, the HIU will run the pump for 5 seconds ensuring that it stays in optimum condition.

Automatic Floor Drying Cycle

The SATK20/22 low temperature models and all SATK22/32 models have a built in floor drying cycle.

It's important with under-floor heating that the floor slab dries out slowly to reduce the possibility of cracking.

With the aforementioned models, when the under-floor heating drying cycle is selected, holds the secondary heating temperature at 25°C and then automatically, but slowly, increases the heating temperature over 240 hours up to 40°C, ensuring a consistent and gradual drying of the floor slab.

Pump Bypass and Differential Pressure Switch

The majority of conventional HIU's require the installer to fit an 'open' radiator or a separate, valve controlled bypass, on the apartments heating circuit.

This is to ensure that the HIU pump doesn't pump against a closed 'head', should all the radiator TRV's close down. Fitting an external bypass involves more work and cost, or potentially over-heating a room, if the open radiator is the chosen option.

Features and Benefits Continued

Pump Bypass and Differential Pressure Switch

The Altecnic HIU solves both of these problems by including a pump bypass and differential pressure switch inside the unit.

Every radiator can then have a TRV and if they all close down, the pump is protected by the internal bypass.

Lockable Insulated Cover

The SATK22 and SATK32 HIU's utilise a clamshell insulation arrangement. The HIU itself is built into a fully insulated enclosure and when the front cover is installed, the whole HIU is completely encased in insulation. This reduces heat loss from the HIU to an absolute minimum.

All Altecnic HIUs have a lockable insulated cover ensuring minimal heat losses from the unit.

To avoid the possibility of the tenant opening or removing the cover and thereby touching hot pipes or changing the units settings, the cover is lockable. However, it's important that the tenant can see how much energy he's used and to facilitate this, the Altecnic HIU has two important features.

The cover of the HIU has an integral window that slides up or can be removed (depending on model) revealing the energy meter's display window. Alternatively, the display part of the meter can be removed from the body of the meter and installed outside of the HIU.

Reduced Weight and Dimensions

As mentioned earlier, the electronic control of the HIU has allowed the unit to be reduced in weight and overall size. In

addition to this, rather than use individual valves, bespoke castings are utilised that include groups of the required valves.

On the heating circuit for example, one casting includes the safety valve, strainer, 2 drain valves and a flow switch. The net result is dramatically reduced weight and smaller overall dimensions. The SATK30 (twin plate) HIU for example weighs just 19kg, compared to more than 30kg for a comparable competitors unit.

LCD Digital Display

The control unit of the HIU has an integral LCD window with a digital display, making the set-up of the unit quick and easy.

With conventional HIU's, setting the temperature of the domestic hot water involves multiple trips back and forth from the HIU to the hot water outlet, constantly adjusting a valve until the water meets the required temperature.

With all the SATK models, the temperature of the DHW can be set digitally via the display. Simply dial in the temperature required and it's done!

It's exactly the same for the required heating temperature.

The SATK22 and SATK32 have an integral room controller. This is a multi-functional device that allows the HIU to be configured and commissioned, but once completed, can also be used as a room controller and thermostat.

Features and Benefits Continued

Benefits of Low Return Temperatures

This is a key aspect to system efficiency that has been recognised by various documents including the Domestic Building Compliance Guide (HM Government – a support document for Part L), CIBSE's CP1, BSRIA's BG62/2015, that stipulate the recommended return temperatures of communal systems."

On page forty nine of the Domestic Building Compliance Guide is a list detailing recommended return temperatures for the different systems.

It states that the primary return temperature should be less than 40˚C for both instantaneous systems and stored systems domestic water systems.

With an instantaneous system, when on domestic water load, the return temperature will be as low as 20 to 25˚C (depending on manufacturers equipment used) and therefore well below this maximum figure.

Return Water Temperature

The return temperature has significant effect on system sizing and efficiency.

When sizing the primary pipework and the energy centre, the flow rates and or kW's required are calculated based on the following equation

$$ls = \frac{kW}{4.2 * \Delta T.}$$

The larger the ΔT (i.e. the difference between flow and return temperatures), the smaller the required flow rate.

A typical instantaneous DHW system may have a primary flow temperature between 65 and 85˚ C. Depending on the heat emitters in the apartments (UFH or radiators), the typical return could be circa 40˚C (UFH) or circa 45 to 60˚C (radiators) onto the network.

However, any apartment that is on DHW demand will be adding return water into the network at temperatures around 20 to 25˚C. This lowers the overall return temperature and increases the overall Δ T significantly.

This increase in the system Δ T gives rise to many benefits including, smaller thermal stores, smaller primary pipe-work, smaller plant-room pumps, valves and fittings, improved performance of many renewable energy sources and can help reduce the potential for heat build up in the corridors.

Condensing Boilers and Renewable Energy Sources

This low return temperature also has a major effect on performance of the condensing boilers in the plant room as well as the renewable energy sources integrated within.

Condensing boilers need to condense to be efficient. To be able to condense, they need a low return temperature.

However, the lower the return temperature, the more the boiler will condense and the more efficiently it will run.

Heat pumps and solar systems typically give a maximum temperature increase of around 50˚C with a reasonable COP. If the return temperature is higher than 50˚C, then no gain can be had from the installed solar system or heat pump.

Features and Benefits Continued

Combined Heat and Power Units (CHP)

CHP can also benefit from low return temperatures.

CHP's are installed to produce electricity first and foremost.

Electricity is more expensive than gas and has the greater carbon footprint. The electricity supplied from power stations is generally around 38% efficient by the time it arrives at the building. It therefore makes sense to address the electricity demand within a building with CHP.

One of the reasons CHP's can be very efficient is that the resultant heat produced as a by-product of electricity production can be utilised in the building for the LTHW system.

However, if the CHP is unable to 'get rid' of its heat into the building, it will switch off and stop electricity production even if there is a high electrical demand within the building.

One of the ways to counter this is to use a heat dump radiator allowing the engine to dump its heat to atmosphere so that it can continue to run. However, this should be viewed as a worst case scenario as this will obviously dramatically reduce the efficiency of the CHP, the system as a whole and the CHP becomes little better than the remote power station.

The low return temperature from the instantaneous heat interface unit will allow the CHP to get rid of its heat easier and more reliably, maximising its run time and therefore allowing for longer periods of electricity production and greater performance.

Comparison Between Stored and Instantaneous Hot Water

There are advantages and disadvantages to both instantaneous hot water generation and the storage of domestic hot water however, this does not mean that the systems are similar or that there's no real benefit of one over the other.

Instantaneous hot water generation, in the large majority of instances, results in a more efficient system overall, providing the system is installed correctly and commissioned accordingly.

Whenever domestic water is stored, a potential Legionella risk is inherent. To combat this risk, the stored water needs to be kept above 60˚C to kill off the bacteria.

60˚C is a far higher temperature than that required at the terminal outlets (taps, showers, basins, baths etc.). Therefore, even though the actual required temperature of the DHW is circa 45 to 48˚C, additional energy needs to be taken from the primary system and the energy centre to lift the domestic water from the required 48˚C, to above 60˚C.

This is simply wasted energy that would not be used if instantaneous domestic water generation is utilised.

While instantaneous HIU's have a higher kW demand than a typical cylinder coil, it is important to note that the diversity that should be applied to each system is different. The instantaneous system has a higher degree of diversity to be applied, due to the lack of a cylinder reheat time.

On an additional note, the subsequent high temperature of the stored domestic water now also requires the installation of thermostatic mixing valves at the terminal units to ensure that the tenants cannot be scalded from this 'overheated' domestic water.

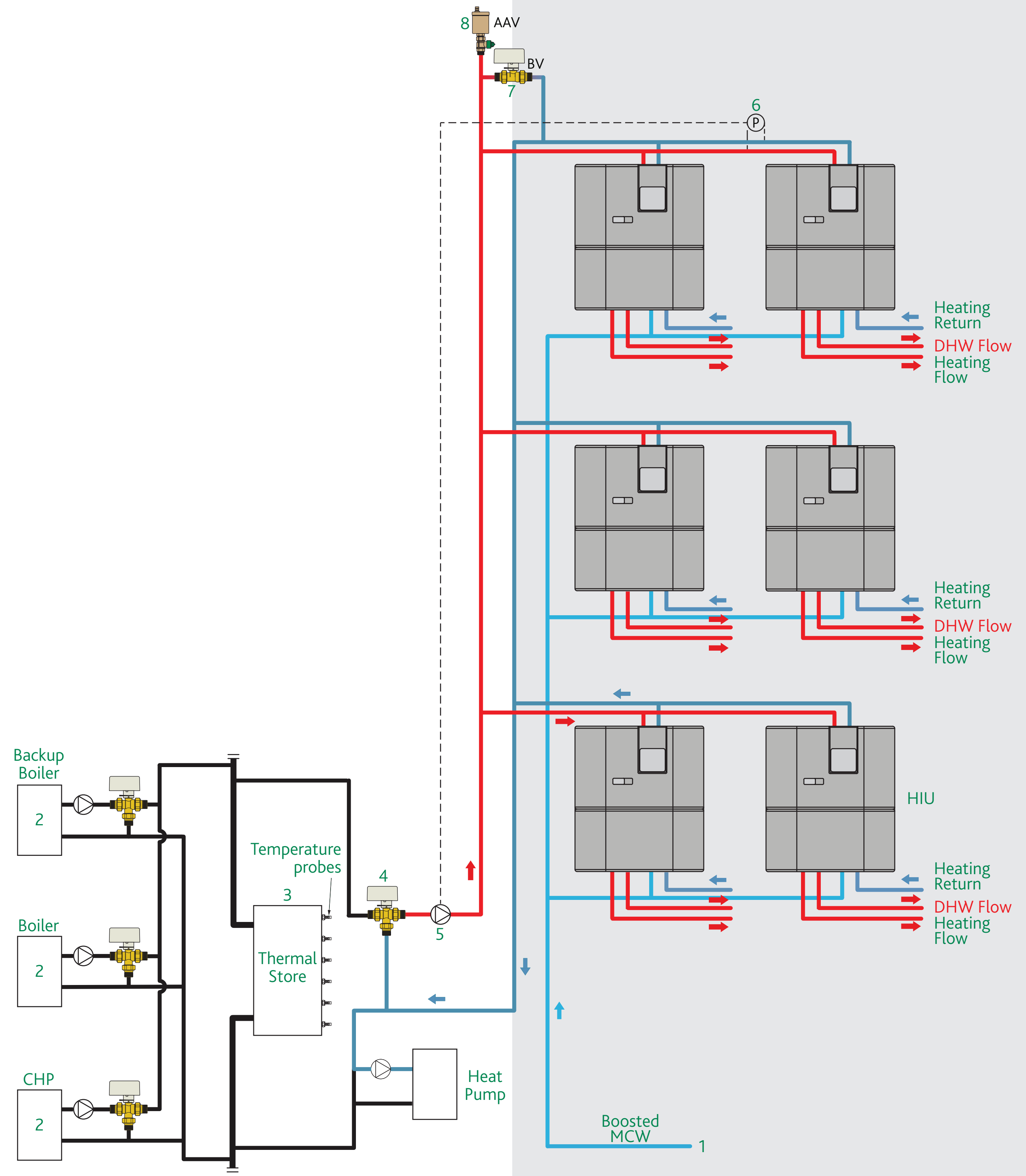
Storing the domestic hot water, just in case it may be required, also results in greater heat losses.

Typical System

The system below shows a complete heating and hot water system incorporating Altecnic HIUs, valves have been omitted for clarity.

BSRIA and CIBSE Guides

BSRIA Guide BG 12/2011 'Energy efficient pumping systems' and CIBSE's KS7 'Variable flow pipework systems' gives advice on the design of variable flow systems.



System Components

1. Mains cold water supply

A minimum mains cold water supply of 0.5 bar is required for the Altecnic HIUs.

Hot water outlets such as thermostatic showers or outlets fitted with thermostatic mixing valves may require higher pressures to operate correctly.

In tall multi floor buildings the required cold water pressure will be achieved by a boosted main water supply with pressure reducing valves set to the required pressure on each floor branch.

2. Energy Sources

Boilers today must be as efficient as possible to reduce carbon emissions to a minimum.

Solar heating or heat pumps can improve the overall efficiency and reduce the size of the boiler required.

In the diagram, the heat pump is located in the return pipework from the system, upstream of the thermal store. In this way, the heat pump can only 'see' the lowest water possible on the network. This maximises its operation and therefore the benefits.

Typical boilers are gas condensing boilers, multi stage boilers, a combined heat and power (CHP) unit or a biomass boiler.

Low carbon heat sources such as solar heating, heat pumps or CHP units are more efficient when operated with low return water temperatures.

The correct design, sizing, valving (arrangement and type) and commissioning of the space heating emitters whether radiator or underfloor heating can help to reduce the return water temperature as much as possible.

To ensure optimum control of the flow rate through the radiator, Altecnic recommend a dynamic pre-settable radiator valve, such as the Altecnic Dynamical valve for all radiators. This is also a recommendation in CIBSE's CP1, Code of Practice for Heat Networks.

If domestic hot water is drawn off for baths, and showers, basins etc.then this will cause a drop in the overall return temperature back to the plant room.

3 . Thermal Store

A suitably sized thermal store should be at the centre of the plant-room philosophy.

The thermal store allows the low carbon sources, such as CHP, heat pumps etc. to run for longer periods of time, it also augments the energy sources by providing additional energy for the system to meet peak demand periods.

The thermal store reduces the number of times the system boilers are switching off and on and increases the resilience of the system. Without the thermal store, the energy sources may not be able to react with sufficient speed to meet the fluctuating demands of the system.

The thermal store must be designed to achieve stratification and therefore should have a large height to width ratio. The store should also utilise internal baffle plates to further reduce the mixing of the water and ensure stratification.

The store should, as a minimum, have at least four temperature measuring points located evenly up the side of the vessel.

3. Thermal Store

These should be connected to the BMS system. In operation, these measurement points allow the location, and crucially, the direction of travel, of the stratification layer to be ascertained.

An example of operation: At times of low demand, the stratification layer will be moving downwards in the store i.e. the store is filling up with high temperature water and pushing the cooler water back to the energy sources.

As the stratification layer gets lower in the store (energy centre output is greater than the demand on the network), the energy sources in operation are slowly switched off, in order of their carbon implication and cost.

In other words, the condensing boiler will be the first to be switched off, then the CHP etc. so that only the heat pump is in operation.

As the demand increases in the building, so the direction of travel of the stratification layer will change as the energy in the thermal store starts to be used.

As the stratification layer gets higher in the vessel (output is less than the demand on the network), the next available energy source will be utilised. So, if the heat pump was the only energy source, then the CHP will be next to be switched on.

If the stratification layer continues to move higher in the store, then the next available energy source will be switched on and so on. Once the stratification layer reverses and starts to move down the store, then the sources are again switched off, in reverse order.

In this way, the control of the whole plant-room is dictated by the temperature readings from the thermal store.

Individual hot water storage at the apartment level reduces the requirement for a plant-room based thermal store, but it should be noted that the thermal store can increase the operating time of the renewable sources even in a stored DHW building.

4. Three Port Valve

The purpose of the three-port valve allows the energy centre output temperature to be controlled to match the demands of the network.

For example, in the winter at times of high heating and DHW demand, the three-port valve will, in effect be wide open ensuring that the output temperature onto the network is high.

However, in the summer and at low DHW demand times, the three-port valve allows the water from the energy centre, which may be at 80 – 90˚C to be mixed down to say 65 – 70˚C before it is sent out onto the network.

In this way, the system has the flexibility to be weather/load compensated. The system is flexible to meet high demands, but can also 'throttle back' with lower temperatures at low demands, saving energy and reducing network losses.T

5. System Pump(s)

Pump speed should be controlled by an external pump sensor(s), located at the index point(s) within the network to ensure that the most remote HIU's have the minimum differential pressure they require for full DHW production.

The SATK20 and SATK30 ranges, require 35kPa and the SATK22 and SATK32 ranges require 45kPa at the least favoured HIUs.

It is important that the turndown ratio of this pump(s) is maximised.

The latest generation of pumps can operate at levels as low as 2 – 5% of their maximum flow. Reducing the system flow rates saves pump energy, increases system ΔT and reduces the chances of network overheating.

Consideration should also given to the potential of utilising 'jockey' pumps at times of low system demand.

This ensures that all the HIUs on the system, have as a minimum, the required differential pressure to operate correctly and that the system is operating at it's most efficient and reactive.

Whilst it is possible to control the pumps on differential pressure at other locations in the system, generally this will lead to inefficiencies with under/over pressure at the terminals.

6. Differential pressure sensor

A differential pressure sensor or sensors, must be installed across the flow and return pipes located immediately upstream of the HIU(s) located at the extremity or extremities of the network.

This sensor or sensors, should be wired back to the plant-room pumps.

During commissioning, the pumps should be set to hold differential pressure stable at this point(s) to meet the demands of the installed HIU at those points. (See section 5 above).

7. Bypass

A by-pass located at the top of the heating system riser will provide a route for flow under minimum load conditions i.e. when all radiator control valves are closed and there is no demand for hot water.

It is imperative that the flow around any network bypass is kept to an absolute minimum.

Excessive flows will reduce pump turndown, increased system losses and increase return temperatures. While there are different valve arrangements and methods that can be utilised, all need to be installed and commissioned carefully.

7. Bypass Continued

1. Reverse Acting Differential Pressure Control Valve (RADPCV).

A simple, low cost, single valve method.

The RADPCV is closed under normal system operation.

However, when the system is at a very low flow or 'dead head' condition, the valve opens, on rising DP and allows flow through the bypass.

This can be difficult to set and changes to the system, phasing etc. require the valve to be recommissioned.

Coupling the valve to an automatic balancing valve is recommended to allow a specific maximum flow rate to be set.

2. Differential pressure bypass valve.

This is similar to the reverse acting DPCV listed in '1'.

An adjustable differential pressure bypass valve, once commissioned correctly, should remain closed under normal system operation and only open on rising differential pressure as the system demand drops to an almost 'dead head' situation.

This is a simple method and therefore low cost. However, the correct setting of this valve can be difficult to achieve and may, on some systems (depending on valve location, riser location, pump sensor location be almost impossible to achieve.

On phased builds, the valve will need to be recommissioned each time additional apartments are brought on stream. We would recommend that the bypass valve is close coupled to an automatic balancing valve (ABV) set to hold a flow rate equivalent to the maximum pump turndown flow rate.

The ABV ensures that the flow rate through the bypass is always kept under control and in line with the minimum pump flow rate.

Even if the setting of the bypass valve is incorrect and the valve is constantly open, the ABV will ensure that the flow rate through the bypass remains under control. In a similar way, if additional apartments are brought on stream, and the bypass valve hasn't been recommissioned, the ABV maintains the low flow rate.

The Altecnic network bypass module is an example of this combination valve approach.

7. Bypass Continued

3. Temperature Regulator

A relatively new method of control.

The temperature regulator is a mechanical valve that can be set to hold a specific return temperature. These types of valve were originally designed for domestic hot water return systems, but have been increasingly utilised on district heating schemes.

Once set, the valve will modulate the flow through the valve to ensure the set point temperature downstream of the valve.

In this way, a low return temperature back to the plant-room can be guaranteed when the system is under low load.

The valve will of course also let the low flow/return through the valve even when the system is in high demand. The Altecnic 116 series is an example if this type of valve with a return temperature setting range of 35 – 60˚C.

4. Motorised, 230V valve with temperature probe

In some ways, this valve operates in a similar way to the one in ‘3’ above.

The temperature probe is placed in the return pipework and the required temperature set on the valve.

In operation, the valve will open to maintain the set temperature at the probe insertion point.

The location of the insertion point can be problematic to determine to get the correct method of operation.

As this is a motorised valve an electricity supply is required, as is an access hatch for maintenance.

8. Automatic Air Vent

Automatic air vents should be fitted at the top of risers where air may collect in pockets and short dead legs. The removal of air will improve the efficiency of the system.

Flushing and commissioning provisions

The features shown are as recommended in BSRIA Application Guide AG 1/2001.1 Pre-commission Cleaning of Pipework Systems.

Following the principles set out in the BSRIA Guide AG 1/2001.1 Pre-commission Cleaning of Pipework Systems, each type of HIU should be treated as a terminal unit fed from the main heating system pipework.

The guidance document states that as the HIU is a terminal unit, it should be valve and flushed accordingly. Therefore, each HIU should have a flushing bypass installed on the primary flow and return ahead of the HIU.

This can be simply a pipe across the flow and return with an integral isolation valve. However, as this valve will be located within the apartment, it should be ensured that the valve cannot be easily operated. Either by removing the handle/lever, or by utilising a lock-shield valve.

Alternatively, Altecnic HIU’s are available with a flushing bypass as an optional accessory. This bypass mounts on top of the HIU isolation valves and includes an integral isolation valve that requires tools to operate.

It is possible that some debris could be carried into the hot water side of the plate heat exchanger with the incoming mains cold water supply.

It is recommended that a strainer is installed on the mains cold water supply to the domestic hot water heat exchanger to collect any debris which may be present.

Pressure test points are required to verify the differential pressure.

Each HIU requires a minimum differential pressure in order to function correctly.

The SATK20 and SATK30 HIU’s are supplied with primary isolation ball valves that contain blank plugs to facilitate the installation of binder test points.

The SATK22 and SATK32 HIU’s have blank points integral to the HIU that facilitate the installation of binder test points.

The pressure test points allow the differential pressure immediately upstream of an individual HIU to be checked.

The SATK20 and SATK30 HIU’s require 35kPa as a minimum, the SATK22 and SATK32 require 45 kPa as a minimum.

System Sizing

HIU Selection

The first point of selection would be to determine whether instantaneous DHW or stored DHW is required.

Stored DHW HIU's either have an integral DHW cylinder/calorifier or are designed to be connected to an indirect cylinder or calorifier.

In recent years, the number of stored DHW installation have reduced.

The reason is generally down to efficiency and space. The storage cylinder takes up a lot of space in an apartment that could be used for other things.

From an efficiency point of view, stored DHW systems generally have a higher primary system return temperature and therefore lower Δ T.

The DHW within the tank needs to be either kept above 60˚C to stop the multiplication of Legionella or it has to be pasteurised on a regular basis. This high temperature will of course require greater input energy to achieve.

The 60˚C water will then require the installation of Thermostatic Mixing Valves (TMV's) to ensure that the tenants cannot be scalded.

Once the cylinder is empty, it may be 30 minutes or more before the store is back to temperature.

The storage system does not require pre-heat within the HIU and this can be an efficiency benefit. However, we shall see in later paragraphs, that preheat is something that could, and indeed should, be engineered out of the network.

The perception can be that the central plant and primary system will be smaller for a stored system.

The calculation is as follows: Cylinder coil (kW) multiplied by the number of apartments multiplied by diversity.

A typical cylinder coil may have a kW capacity of 12kW compared to an instantaneous HIU's capacity of 45kW.

Therefore surely the required energy centre is larger for an instantaneous system?

This is only correct if the diversity applied in both calculations is the same. However, this is not the case.

Due to the reheat time on the cylinder, the diversity on a stored system is lower than that of an instantaneous system.

Using typical diversity figures, for 100 apartments, we would see that a stored DHW system would have circa 25% diversity, whereas an instantaneous system would have a diversity around 7-8%. In general, the calculated figures for the energy centre size, tend to be similar.

When we come to calculating flow rates, we see something similar. Again the diversity that should be applied is different for stored than it is for instantaneous but crucially, the typical ΔT's are also different.

The stored system will give a ΔT that wildly varies depending on the temperature of the water within the storage cylinder.

System Sizing Continued

HIU Selection Continued

Once the cylinder is within 10˚ C of its set point, the Δ T on the network will be minimal.

With an instantaneous HIU, when on DHW production, the ΔT may be as high as 55 to 60˚C, i.e. a return temperature as low as 20 to 25˚C.

Therefore a typical instantaneous system will have a lower return temperature than a stored DHW system for the majority of the time. An additional benefit of course is that the lower return temperature, the lower the heat losses from the return pipe-work.

Next, we need to determine whether direct or indirect HIU's are required.

Direct HIU's

The term direct and indirect refers to the heating circuit of the HIU.

In a direct HIU, there is no hydraulic separation between the primary system and an apartments space heating circuit.

The water that circulates through the centralised energy centre is the same water that circulates around the radiators or under-floor heating system. The HIU is simpler and therefore they are generally more cost effective.

The network as a whole will be more efficient as, the lack of any heating plate heat exchangers reduces efficiency losses.

The lack of an apartment space heating pump also reduces the electricity cost for each tenant and energy use of the system as a whole.

The concern can be that should a leak occur within an apartment heating circuit, potentially the primary system water can be emptied into the apartment and the whole network is lost. The reality appears to be that this is a very rare occurrence.

Indirect HIU's

These are the most common HIU installed in the UK.

The HIU will typically have two plate heat exchangers, one for DHW production and one to hydraulically separate the apartment space heating circuit.

They are more costly than a direct HIU and the cost difference can be significant.

The reason for this is, as soon as you hydraulically separate the two circuits, you need an additional pump, safety valve, strainer, filling loop and expansion vessel not to mention the pump and plate heat exchanger.

The benefit of course is that should an apartment leak occur, it affects only that apartment, the system remains operational for the other tenants and the amount of water that can be lost into the apartment is limited only to the volume of water in the single apartments heating circuit.

System Sizing Continued

HIU Selection Continued

Next, we need to select the HIU outputs

HIU kW Outputs - DHW

Historically we have tended to overestimate the typical apartment demands for domestic hot water.

On a heat network this can have grave results. When sizing the network, the calculation has to start at the apartment level and work backwards towards the plant-room. Therefore over sizing at the apartment level and then multiplying that figure through the calculations back to the plant-room can lead to a seriously oversized energy centre.

Data gathered from existing networks, seems to suggest the following typical demands:

- single bathroom/1 bedroom – 30kW
- single bathroom/2 bedroom – 35kW
- bathroom and en-suite/2,3 bedrooms – 45kW
- 3 bed+/luxury fittings – 50kW

These are typical demands and depending on fittings and the variances of a particular project, the actual values may be different.

HIU kW Outputs - Heating

The increase in air tightness, insulation/'U' values etc. of today's new build apartments typically mean that single/two bedroom apartments have a 2-3kW heating demand and it's very rare to see heating demands greater than 6kW on even large apartments.

These low energy demands, coupled with desire to widen the ΔT as much as possible (a small Δ T on the space heating circuit equates to an even smaller Δ T on the primary circuit), reduce space heating flow rates to a very small value.

It therefore can be very difficult to balance these low flow rates via the radiator valves. It is for this reason that we would recommend the utilisation of pre-settable radiator valves (Altecnic Dynamical) and better still to combine these valves with a HIU that has Return Temperature Limitation (RTL), such as the Altecnic SATK22/32.

Lastly, we need to look at output temperatures

HIU Output Temperature - DHW

As mentioned previously, with an instantaneous HIU, the likelihood of Legionella growth is greatly reduced.

Unlike a stored DHW system, there is no hot water until the hot tap is opened and only then is the DHW created by the HIU.

This minimises the likelihood of Legionella growth. If Legionella is still thought to be an issue, the Altecnic SATK22 and SATK32 can run an automatic pasteurisation function if required. It is therefore common for the output temperature from the HIU to be set at 50C or even lower. The lower the DHW set point temperature, the more efficient the network will be and the

System Sizing Continued

HIU Selection Continued

HIU output temperature - DHW

The importance of approach temperatures should also be noted. Approach temperature is the difference between the secondary output temperature and the primary flow temperature.

The smaller this ΔT, the less efficient the system will be.

This has never typically been an issue, with regards to DHW, but today's low temperature and heat pump led networks can create problems when high DHW set point temperatures are utilised.

If a heat pump network is operating at 65˚C, and the hot water set point is high at 60˚C, then the approach temperature is just 5˚C.

The result is the maximum output from the HIU will be greatly reduced, the network return temperature will be high as will the primary flow rate. In this scenario, if the primary flow temperature is 65˚C, then we would recommend a maximum DHW setting of 50˚C with 45˚C being preferable.

It should also be noted that all of today's common detergents are tested at 45˚C, not higher. The objection of "I need higher temperatures at the sink to cut through grease" is no longer valid.

HIU Output Temperature - Heating

The same comments regarding approach temperatures, mentioned above, also apply here. The flow temperature on the space heating circuit should be at least 8˚C (10˚C or greater preferred), below that of the primary flow temperature.

Again, smaller approach temperatures will lead to higher return temperatures, increased primary flow rates etc.

It is also important to note that, if it is intended that the primary flow temperature is lowered during the summer months, the secondary output temperatures from the HIU may also require lowering.

As an example, let's look at a system with a primary flow temperature of 70˚C in winter and the HIU is set at 65˚C flow onto the space heating circuit and 60˚C DHW temperature.

If the primary flow is reduced to 65˚C immediately, all of the space heating control valves within the HIU will open fully if the heating is switched on.

The same happens of course if the primary flow temperature is lowered to 60˚C, but now, the DHW also becomes a problem.

Whenever there is a DHW demand, the control valve within the HIU will be wide open and taking the maximum flow rate it can from the primary system. In both cases, the network will probably fail.

System Sizing Continued

HIU Selection Continued

HIU Output Temperature - Heating

In these scenarios, the HIU's will have to have their set points changed as/when the primary system temperatures are changed.

Typically, this is deemed to be too onerous, as it would require access to every apartment on the network and the system is left as it is all year round. The potential benefits of lowering the primary flow temperature are ignored.

However, if the Altecnic SATK22/32 are utilised then the Modbus control can be utilised. It would then be a simple task of remotely changing the values for the HIU's on the network via the BMS or stand-alone Modbus system.

Pipe Sizing from the Central Boiler Plant

Pipe diameters from the central boiler plant to each HIU must be sized to accommodate the maximum heating and diversified hot water demands served by that pipe.

The maximum heating demand is relatively predictable, this being the summation of the calculated heating loads for each of the apartments.

In general diversity is not applied to the heating circuit.

However, it has been shown that on larger systems, it is possible to apply diversity to the heating calculation. While not advocating diversity here, it should be noted that some systems are operating perfectly well with diversity applied and figures of 80% or lower have been utilised on some networks.

The estimation of maximum hot water demand is less obvious. It is extremely unlikely that all of the hot water taps in all of the apartments will be open simultaneously therefore allowance for the diversity in usage is required.

Simultaneous demand is only predictable when the pattern of usage in each apartment might reasonably be expected to be identical, such as in a hall of residence where the occupants are expected to get up at exactly the same time and return in the evening at exactly the same time.

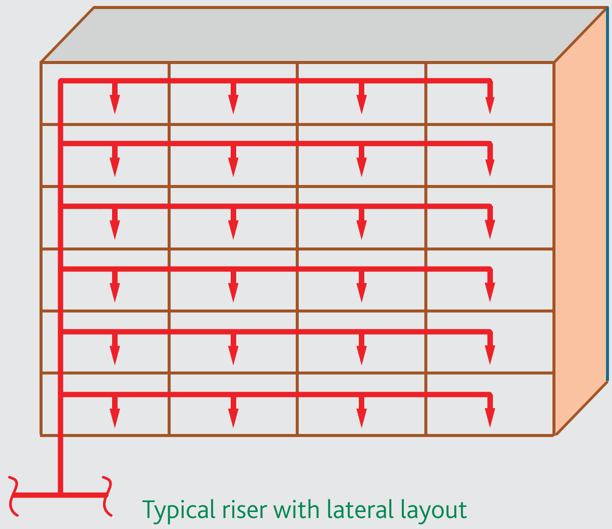
For groups of apartments occupied by families with different occupations and lifestyles, the load pattern is likely to be very different.

In such cases, peak demand periods in each apartment are unlikely to occur simultaneously for the simple reason that people will get up at different times in the morning and come in from work at different times in the evening, hence the expected peak simultaneous hot water demand will be lower.

This explains why surveys of hot water consumption for multiple apartments often show peak simultaneous demand values significantly less than might be expected.

The design standards in some European countries where district heating is more established reflect this within their respective diversity factors for example, the Danish Standard DS439 or Swedish F101.

Optimisation of Network Pipework



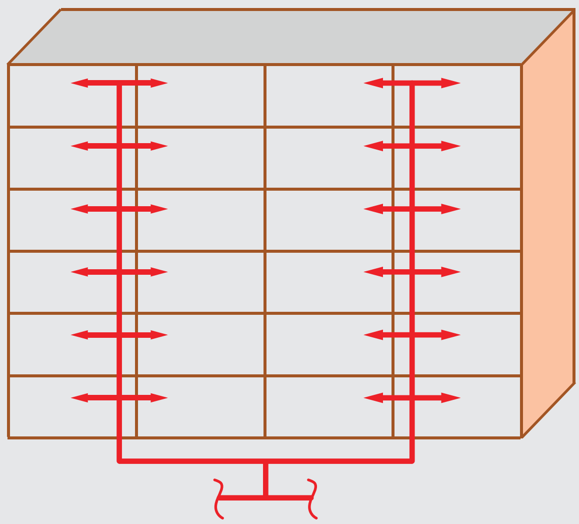
Typical riser with lateral layout

Sub-optimal layout.

Single riser, long laterals. The long lateral pipe-work increases the network losses and can lead to corridor overheating.

This type of layout either requires bypasses at the end of the laterals (not to be recommended), or the HIU's have to have preheat enabled.

In this scenario, with the HIU preheat enabled, it is extremely doubtful that the network losses will be kept within the guidelines of CIBSE's CP1, code of practice (15%, with 10% best practice).



Preferred riser and lateral layout

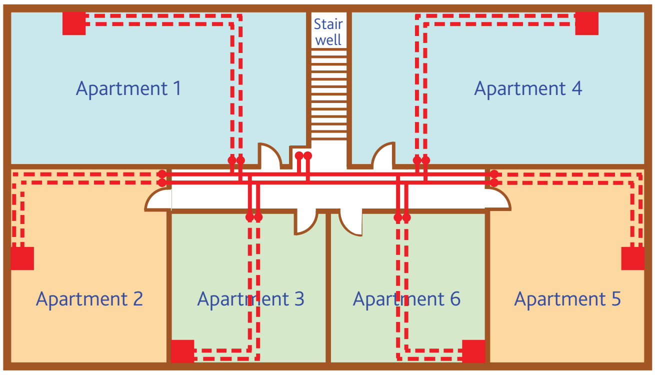
Optimal layout.

Optimal layout. Multiple risers, short laterals. The shorter laterals reduce the losses on the network, reduces the chances of corridor overheating and should allow the HIU's to have preheat disabled.

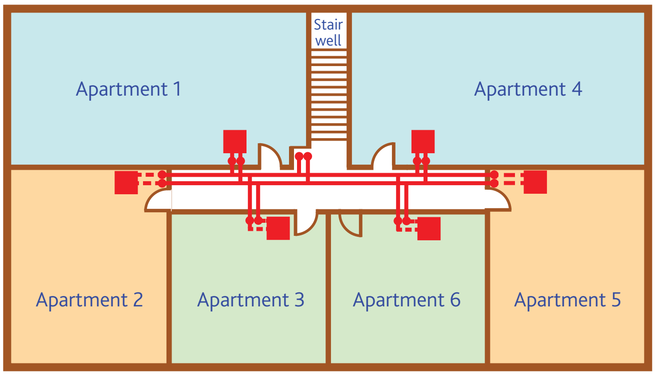
The response time (the time taken for DHW to arrive at the tap), should be within an acceptable limit.

Optimisation of Network Pipework Continued

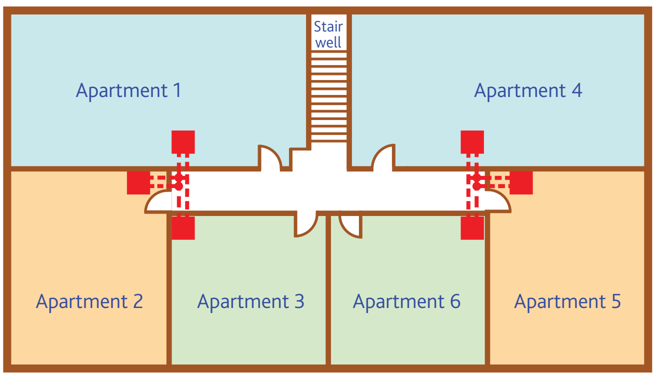
Network pipework viewed from above



Poor Layout: Single riser, very long laterals, HIU's located far into the apartment, long response times, corridor overheating, reliance on preheat.



Better Layout: Single riser, shorter laterals, slightly reduced response times, but still the probability of corridor overheating, may require HIU preheat.



Best Layout: Multiple risers, shortest laterals, fastest response times, lowest heat losses, least reliance on preheat.

To further reduce response times, a number of other factors need to be taken into account.

1. Reduce the lateral pipework diameter.
2. Utilise a HIU that can boost the control valve based on temperature of the primary water.
3. Reduce the apartment DHW pipe diameters.

Optimisation of Network Pipework Continued

1. Typically, the UK has sized pipework based on 250 – 300 Pascals/metre.

   So, where did these values come from?

   Typically, they date back to guidance documents from the days of constant volume systems.

   The concern with utilising higher values was the increase in velocity that would lead to erosion and noise. However, as we were calculating pipe diameters for constant speed systems, the velocities would occur for 24 hours a day, 365 days a year.

   On a heat network, the calculated flow rate is a peak flow rate and the peak occurs for just 10 – 15 minutes a day.

   Therefore erosion would be massively reduced. As for noise, well, the peak flow rate only occurs at times of high DHW use., say when the tenant is running a bath etc.

   The noise 'issue' therefore is not really an issue. Therefore, if we can reduce the size of the lateral pipe-work, we reduce the losses from this pipe, but crucially, we also reduce the volume of water.

   With the reduced volume, the laterals can be left to go cool. The volume of cool water, in these short and small diameter laterals, can be easily and quickly purged through the HIU and the response time in the apartment is not adversely affected. Therefore, for the lateral pipework, values of 500-600 Pascals/metre or even higher are to be encouraged.

2. It was demonstrated in recent testing carried out at the Swedish Technical Institute (RISE) that proportional mechanical control valves in HIU's can increase the time it takes to get DHW from a tap.

   This puts more reliance on the HIU's preheat, but we also know that this wastes energy and can lead to greater system losses/corridor overheating.

   The control valves in all Altecnic HIU's are controlled electronically. This allows their position to be changed based on multiple different parameters rather than just one.

   The Altecnic HIU monitors the temperature of the primary flow and if it detects that the temperature is low, it will open the control valves wide to purge the cooler water through the HIU, as fast as possible, and then drop down to their control positions, once the primary water is up to temperature. This dramatically reduces response times.

3. In a similar way to the primary pipework, the volume of water in the DHW pipework within the apartment affects the response time at the taps.

   This cool water needs to be purged before the hot water reaches the outlet.

   The diameter of this pipework therefore needs to be minimised. In the vast majority of apartments 15mm DHW pipework should be fine.

Diversity Factor

The degree of diversity for multiple dwellings is expressed as a "coincidence factor" and is defined as:

$$F = \frac{DFR}{MFR}$$

Where

F = coincidence or diversity factor

DFR = design flow rate for hot water outlets - l/s

MFR = max. possible flow rate for hot water outlets - l/s

Typical Diversity Factors

No of HIUs	Diversity
1	1
2	0.6194
3	0.4765
4	0.3988
5	0.3490
6	0.3139
7	0.2876
8	0.2670
9	0.2504
10	0.2366
11	0.2250
12	0.2151
13	0.2064
14	0.1988
15	0.1920
16	0.1860
17	0.1805
18	0.1756
19	0.1710
20	0.1670
21	0.1631
22	0.1596
23	0.1563
24	0.1533
25	0.1504
26	0.1478
27	0.1453
28	0.1429
29	0.1407
30	0.1386

No of HIUs	Diversity
31	0.1366
32	0.1347
33	0.1329
34	0.1312
35	0.1296
36	0.1280
37	0.1265
38	0.1251
39	0.1238
40	0.1224
41	0.1212
42	0.1200
43	0.1188
44	0.1177
45	0.1166
46	0.1156
47	0.1148
48	0.1136
49	0.1127
50	0.1118
51	0.1109
52	0.1100
53	0.1092
54	0.1084
55	0.1076
56	0.1069
57	0.1061
58	0.1054
59	0.1047
60	0.1040

No of HIUs	Diversity
61	0.1034
62	0.1027
64	0.1015
65	0.1009
67	0.0998
68	0.0992
69	0.0987
70	0.0981
71	0.0976
72	0.0971
73	0.0966
74	0.0961
75	0.0956
76	0.0952
77	0.0946
78	0.0942
79	0.0939
80	0.0934
81	0.0930
82	0.0926
83	0.0922
84	0.0918
85	0.0914
86	0.0910
87	0.0907
88	0.0903
89	0.0899
90	0.0896
91	0.0892
92	0.0889
93	0.0886
94	0.0882
95	0.0879
96	0.0876
97	0.0872
98	0.0870
99	0.0867
100	0.0864

Factors based on DS 439

Effect of Diversity Factors

The simple system illustrates the effects for diversity.

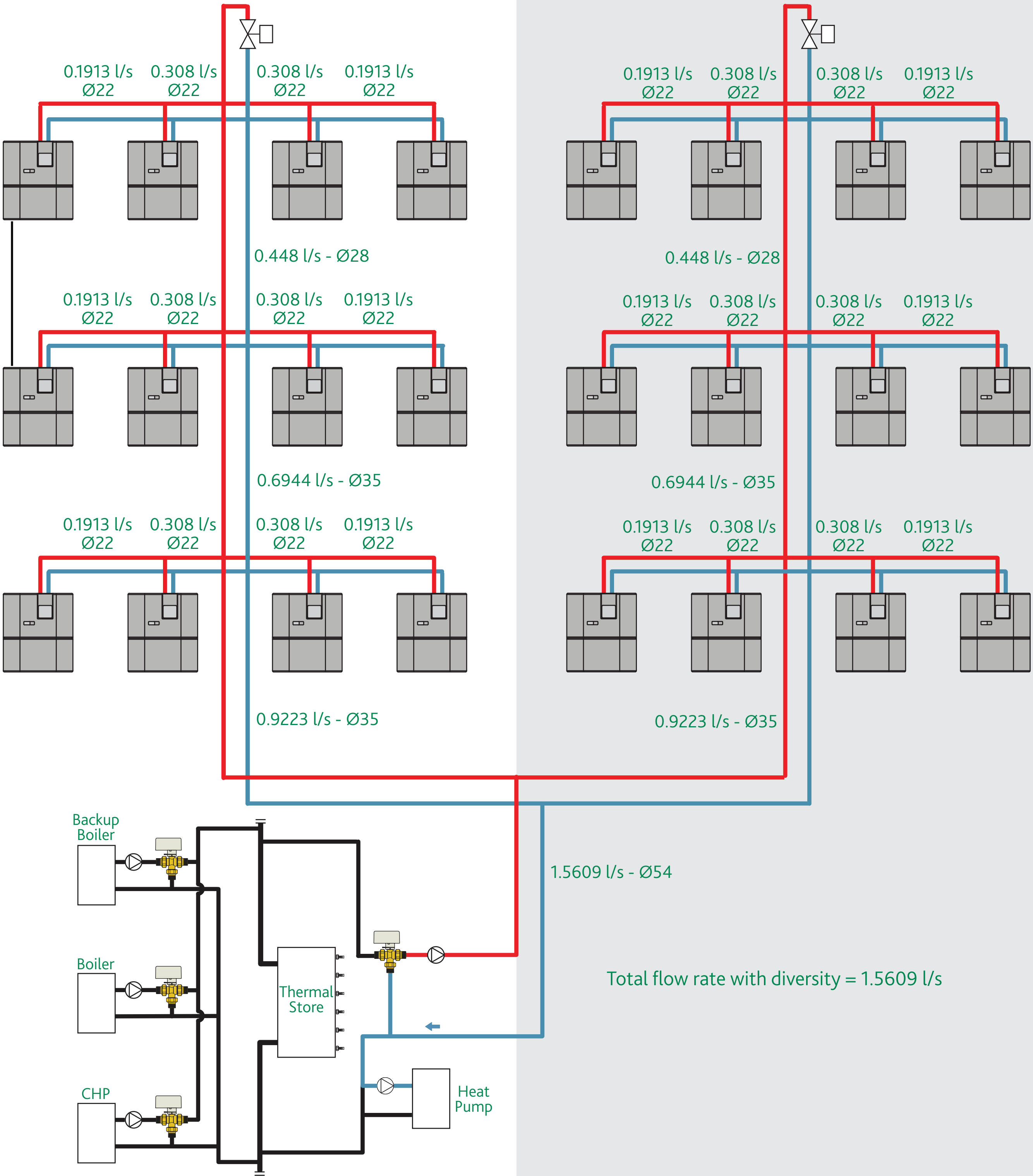
It assumes that each apartment is identical with a

Heat load	3 kW
DHW load	45 kW
Heating ΔT	20˚C
DHW primary ΔT	56˚C

Copper tube

Pipe diameter based on:

Pressure loss per meter length for risers	300 Pa/m
Pressure loss per meter length for laterals	600 Pa/m



Flow Rate Calculation

Using the diversity factor from the chart, the maximum design flow rate for each section of heating pipe can be determined.

The flow rate through each pipe must be capable of delivering the peak heating demand for the apartment being served plus the peak simultaneous diversified demand for domestic hot water.

The pipework serving the HIU's at the end of each lateral can be sized using only the DHW calculation.

For all other HIU's on the network with other HIU's downstream of their location, the following formula applies.

$$Q_T = (F * \text{DHW kW} \div (4.2 * \Delta T_{DHW})) + \text{Heat kW} \div (4.2 * \Delta T_{Heat})$$

Where

F = coincidence or diversity factor

Q_T = total design flow rate - l/s

DHW kW = Apartment kW demand for DHW

ΔT_{DHW} = Delta T derived from HIU when in DHW demand

Heat kW = Apartment kW demand for space heating

ΔT_{HEAT} = Apartment space heating Delta T

The quantity of hot water to heat the domestic hot water DHW kW can be calculated from the equation:

$$\text{DHW kW} = \frac{P_{DHW}}{4.2 * \Delta T_{DHW}}$$

Where

P_{DHW} = energy required in kW for all HIU domestic hot water

ΔT_{DHW} = design temperature drop across the central boiler plant side of the heat exchanger during hot water production - typically 50 °C - 75°C flow, 25°C return.

4.2 = specific heat factor - kJ / kg°K

The quantity of hot water for space heating Heat kW can be calculated from the equation:

$$\text{Heat kW} = \frac{P_{HTG}}{4.2 * \Delta T_{HTG}}$$

Where

P_{HTG} = energy required in kW for all apartments - typically 3 to 10 kW each

ΔT_{HEAT} = design temperature drop across the central boiler plant side - typically 30 °C - 75°C flow, 45°C return.

Sizing the Central Boiler Plant

The energy output of the central boiler plant does not need to match the calculated peak heating and domestic hot water demand as the HIU has hot water priority.

Peak demand should only occur for a relatively short time period during peak domestic hot water consumption, which is unlikely to be sustained for a prolonged period.

Sizing the Central Boiler Plant

There are several factors which enable the energy source to be reduced:

- When domestic hot water is being consumed, each HIU prioritises the domestic hot water circuit temporarily stopping the flow of water to the space heating circuit. This does not affect the space heating temperature within the apartment since domestic hot water is only consumed for a short period of time.
- The plant-room thermal store augments the boiler output to meet peak DHW demand.
- A thermal store enable the system to supply a large amount of energy for a short period of time, to match peak demand times.
- The thermal store also stops the boiler from cycling on and off continuously and builds resilience into the network. In many cases, the thermal store can also allow the integrated renewable sources to operate for extended periods of time, even during low network demand periods.

  The thermal store cools during peak demand and return to the design temperature when the peak demand has passed.

The Altecnic SATK40 with a storage cylinder in each apartment acts in a similar manner as a buffer vessel for the domestic hot water dealing with peak demand and reheating within short time period.

Energy Required to Heat Thermal Store

The quantity of hot water to heat the contents of the buffer vessel within one hour can be calculated from the equation:

$$P_{BUFFER} = \frac{V * 4.2 * \Delta T_{DHW}}{3{,}600}$$

Where

V = volume of thermal store - litre

For a duration less than one hour substitute the number of seconds for 3,600.

Thermal Store Sizing

The thermal store should be sized to deal with the peak domestic hot water demand for a minimum of 10 minutes/600 seconds (DS439).

It is good practice to ensure that the thermal store is never allowed to be completely filled with cool water during network operation. In the majority of cases therefore, the stratification layer would not be allowed to go above the last temperature measuring point on the vessel.

Therefore, any calculation of the vessel size, should add this additional capacity to the vessel.

Commissioning

Please refer to the Altecnic Installation, Operation and Maintenance manual for the respective HIUs.

Pre-commissioning check

Before commissioning commences check that:

- The pipework installation has been completed, all components are positioned and installed correctly, easily accessible for commissioning and future maintenance and identified correctly.

  Please refer to CIBSE Commissioning Guide Code W 'Water Distribution Systems'.
- The system has been filled, thoroughly vented and pressure tested
- The system has been flushed and chemically cleaned in accordance with BSRIA Guide BG29/2012 'Pre-commission Cleaning of Pipework'
- The pumps and associated variable speed drives are installed, inspected and tested in accordance with the manufacturer's instructions and are ready to operate.
- A closed head pump test has been carried out on each pump and the results plotted on the manufacturer's pump performance graph.

Balancing the radiator circuits

The space heating circuit in each apartment will need to be balanced to ensure a comfortable environment for the occupants.

If the apartment is heated by radiators the flows between radiators will need to be balanced by means of a "temperature balance" whereby the lockshield valves are regulated until the return temperature from each radiator is at approximately the same temperature or at the specified room temperature.

As stated previously, the reduction of apartment kW loads and the increase in system Δ T's has reduced the required apartment flow rates to a small value.

This low flow rate can be very difficult to balance and often the radiator lock shield valve is unsuitable for these low flow rates. It is for that reason that we recommend utilising pre-settable TRV's such as Altecnic Dynamical.

These types of valve allow the correct radiator flow rate to be pre-set on the valve prior to installation. Changes in differential pressure on the space heating circuit will not affect the flow rate through the valve and therefore the radiator remains balanced.

The small capillaries associated with these types of valve make it imperative that the space heating circuit is clean of all dirt, debris and magnetite and that is has been chemically treated as per sound engineering practice.

The installation of a magnetic, dirt and air separator on the space heating circuit should be considered, such as the Altecnic Dirtmag range.

Return Temperature Limitation (RTL) within the HIU is very much to be recommended and it should be noted that RTL functionality will also protect the network from inefficiency should a tenant decide to install radiator covers, block the radiators with chairs or use them for drying washing etc.

Balancing the radiator circuits continued

Individual room temperature control will be achieved by fitting thermostatic heads to the pre-settable TRVs.

The only other item that requires commissioning is the by-pass valve(s) on the network bypass(s) illustrated on the system diagram, item 7.

The commissioning procedure for this bypass valve will depend on the bypass methodology and valving selected. However, it is crucial for network efficiency that the flow around these bypasses is kept to a minimum.

The actual flow rate should be as low as possible, but enough to protect the pump from 'dead heading' and be sufficient to maintain network flow temperatures.

If utilising temperature control methods, the set point temperature should again be enough to maintain primary flow temperatures and low primary return temperatures. It is important to ensure that the subsequent flow rate around the system post commissioning of the bypass set point temperature is sufficient to protect the pump.

It should also be realised that in a phased building approach where tenants may move in while work is occurring on other parts of the network, that the bypasses may need recommissioning as additional phases are brought on stream.

This can be set by adjusting its flow rate to a value in the range 2-5% of the maximum load flow rate, as recommended by the pump supplier.

Domestic hot water capacity testing

Having confirmed the temperature, flow and pressure conditions in the main heating system, the hot water output from individual HIUs can be adjusted and tested as required:

- Set the pressure reducing valves on the boosted mains water supply branches to the required value for each apartment, i.e. typically 0.5 bar minimum, such that there is sufficient pressure available for each HIU and downstream hot water outlets.
- In the index apartment open the number of taps specified by BS6700, check the domestic hot water temperatures.
- Check the differential pressure at the index HIU(s). The reading achieved should be between 35 and 45kPa depending on the Altecnic HIU installed."
- Open the taps in additional apartments at various points in the building up to the predicted diversified maximum, check the domestic hot water temperatures at all outlets.
- Check the differential pressure at the index HIU(S). The reading achieved should be between 35 and 45kPa depending on the Altecnic HIU installed."

Balancing the heating system

It should be possible to establish maximum and minimum load operating conditions when setting the pump. This test should demonstrate a significant reduction in pump speed at minimum load conditions.

Balancing the heating system continued

With the system operating at its design temperature, the procedure for carrying out these tests is as follows:

- Ensure that all radiator circuits are set to full flow i.e. all zone control valves, radiator valves are fully open and the thermostatic heads are removed from thermostatic radiator valves.
- Check the differential pressure at the index apartment(s). The reading achieved should be between 35 and 45kPa depending on the Altecnic HIU installed.
- Open a sufficient number of tap outlets, starting with the most least favoured remote outlets work back towards the most favoured towards the pump, until the measured flow rate through the pump is equal to the calculated maximum load flow rate for the system.

  Q_T = total design flow rate for the system
- Check the differential pressure at the index apartment(s). The reading achieved should be between 35 and 45kPa depending on the Altecnic HIU installed."
- Measure the differential pressure being generated by the pump by reference to inlet and outlet pressure gauges.

  Confirm and record the total flow rate leaving the pump using the flow measurement device installed on the secondary circuit main return pipe.
- Record how long it takes to empty the hot water in the buffer vessel at this condition, this should be a minimum of 10 minutes.
- Close all tap outlets. Override the controls to force all 2 port heating zone control valves into their fully closed positions.
- Measure the differential pressure being generated by the pump is the previous value and re-measure the total flow rate leaving the pump. If the pump is being controlled correctly the pump pressure value should be close to the controlled value at the differential pressure sensor.
- Check the differential pressure at the index apartment(s). The reading achieved should be between 35 and 45kPa depending on the Altecnic HIU installed."
- This flow rate should be close to the flow rate passing through the by-pass at the top of the riser.

Notes on commissioning the network

- It should be remembered that a Heat Network is a variable volume, variable pump speed, dynamic system. As such the differential pressure and pump speed will change as the system reacts to changes in demand.
- It is for this reason that manual balancing valves, such as DRV's and Commissioning Sets are not recommended on these types of network.
- The flow rate through these manual balancing valves can only be set/held under a single set of pump conditions. If the pump changes speed, the flow rate through the manual valve will also change. The manual balancing valve will not achieve anything.

Notes on commissioning the network continued

- It is for this reason that they are also not recommended to be installed on any system bypasses.
- There is also another reason as to why manual balancing valves are not to be recommended on a heat network. The HIU on the network will control, the primary flow rate through the unit to achieve the DHW set point temperature.
- If the manual valve has been commissioned to provide a certain flow rate and the HIU needs a greater flow rate, the HIU will be starved of energy and the DHW temperature will go down.
- The manual balancing valve is taking the valve authority away from the HIU control valve. The only answer therefore to the question of what to set the manual balancing valve to, would be "wide open".

Note:

Altecnic have a number of engineers who are CIBSE accredited Heat Network Consultants.

As per CIBSE's CP1, Heat Network Code of Practice, we would also recommend that an accredited Heat Network Consultant is involved in any heat network project at the earliest possible moment.

The consultant can give advice and recommendations to enable a low cost, efficient heat network that meets the needs of its stakeholders and avoids any potential pitfalls and problems.

Altecnic have a number of heat network CPD presentations that are CIBSE approved. Please contact the office if you'd like to arrange for a presentation to be conducted at your premises.

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