

Technical Note			TN-010
Test: General			Test no.:
Assumption: Reference Building			
Rev: 04	Date: 11/05/2021	Author: Josu Aurrekoetxea	Checked: Tom Naughton

1. Introduction

There is a wide range of Communal Heating Networks (CHN) in the UK with very different characteristics depending on the specific site requirements and the selected design parameters.

The Technical subcommittee agreed that two reference systems (dwelling and buildings) should be developed, with their corresponding size and characteristic parameters well defined, as part of the test regime.

These reference systems will be used as a benchmark to compare the impact of the selection of different HIUs on the same CHN. This technical note will present a proposal agreed by Tom Naughton and Josu Aurrekoetxea. The design of the system follows CIBSE CP1 2020 guidelines and does not necessarily represent the opinion of the authors

It should be noted that due to the disparity of the CHN it is not possible to produce a generalised model that predicts the actual effect of an HIU on any given CHN.

2. Heat network layout

The CHN type considered as a reference system will be based on a typical new built London area multi-residential development as the majority of HIUs installed in the UK are installed in this type of development.

There are many different sizes, shapes and technical variables in CHN developments and therefore, this reference system won't necessarily represent all new build developments. The goal of the system is to allow the comparison of different HIUs within the same system context. For this reason, a series of arbitrary decisions have been taken to define the building:

The CHN starts in a plantroom that could be either an Energy Centre or a substation connected to a bigger district heating network. There will be a distribution circuit at ground floor through a car park reaching the different cores of the development. There will be 2 different cases from car park distribution.

1. The first case will have one riser per core with corridor distribution to all the apartment. This is currently the most common solution in most existing developments.
2. The second case will have a multi-riser solution with the HIUs installed outside the apartment next to the riser. This solution reduces the amount of pipe and it is an example of the most efficient distribution solution.

Old building retrofit systems are not represented by this reference system because they will potentially have higher demands and temperatures.

3. Heat network typology

Based on analysis of 15 existing London residential heat networks, the mean average number of apartments in a London heat network is 204. Within the building, the mean average number of floors is 9.5 and the mean average number of apartments per riser/floor is 5.06.

Based on this data, the reference building was defined as follows:

- 200 apartments
- 4 cores of 10 floors (50 apartments per core)
- 5 apartments per floor

It should be noted that there are significant differences between the heat networks reviewed as shown in the table below.

In order to select an indicative pipe distribution eight sites were analysed. The results were as follows:

Dwellings	Total Lateral Length	Total Terminal Run Length	Laterals per Dwelling (m)	Terminals per dwelling (m)
74	303	444	4.09	6
77	592	486	7.69	6.31
791	2512	5090	3.18	6.43
86	236	587	2.74	6.83
255	882	1108	3.46	4.35
194	467	485	2.41	2.50
308	960	3106	3.12	10.08
182	416	867	2.29	4.76
			Avg	Avg
		Single pipe	3.62	5.91
		Double Pipe	7.24	11.82

In the corridor (lateral), the average distance between branches feeding single apartments was 3.62m, and the average distance between corridor pipe and HIUs was 5.91m. It was assumed that the average floor height was 3.00m. Since the pipe system will include flow and return, the numbers used for the reference building will be:

- 6 m of riser pipe per floor (including F&R)
- 7 m laterals between branches feeding single apartments (including F&R)
- 12 m terminal runs from HIU to the corridor (including F&R)

The selected distance between cores is 25 m (50m including F&R). This distance is arbitrary but it was felt that this represented a realistic distance between cores. It should be noted that this pipework had a minimal impact on site performance and overall heat losses.

On the efficient multi-riser distribution, the HIUs are next to the riser with assumed terminal runs of 2 m length (including F&R) and the car park distribution is assumed to have slightly longer pipework to show a more complex distribution at ground level to simplify the riser distribution.

With these parameters, the standard solution would have 4,255 m of pipe while the efficient distribution would only have 1,495 m pipe.

4. Temperature profile

The two designs put forward in the technical note are modelled with a high temperature profile and a low temperature profile.

The primary flow temperature for the high temperature design is 70 °C.

The primary flow temperature for the low temperature design is 55 °C.

It should be noted that all parameters are the same across the two designs apart from the primary flow and return temperatures and the space heating profiles. A summary of these parameters has been included at the end of the document.

5. Apartment standard demand

The DHW set point has been minimised as far as practicable to 50 °C in line with HSE guidance.

The average apartment selected will include a bathroom with a bath and another bathroom with a shower. According to the latest NHBC standard the DHW required on this kind of apartment will be 9 l/min on the bath (at 48 °C) and 8 l/min on the shower (at 40 °C).

The kitchen outlet has been set to 6 l/min in accordance with Table 2.2 of the Part G Building Regulations.

This is calculated as 41.4 kW for the DHW demand following DS 439 flow rate DHW diversity methodology.

The average heating demand has been selected as 3 kW which is considered conservative and based on experience from the authors.

These parameters are only used to size the system pipework.

6. Space heating profile

For the high temperature model, the average apartment selected will include radiators with a space heating profile of 60 °C and 40 °C for the flow and return.

For the low temperature model, the average apartment selected will include under floor heating with a space heating profile of 45 °C and 35 °C for the flow and return.

7. System dimension criteria.

System load diversity will be applied on both heating and DHW in line with the diversity criterion recommended in CP1 (2020):

- For DHW the DS 439 flow rate diversity has been applied
- For space heating the Danish space heating diversity (up to 62%) has been applied

Velocities below 1.5 m/s in terminals, laterals and risers and pressures below 300 Pa/m in supply distribution.

Pipe insulation

The proposed system follows CP1 (2020) insulation requirements. Insulation material will be phenolic foam (0.025W/m·k). According to *Table 8: Minimum insulation thicknesses for pipework in internal and external spaces* all insulation is 50 mm thick. However, an exception has been made on the HIU drop down pipe because the narrow distance between connections doesn't generally allow the installation of 50 mm insulation.

The insulation will be as follows:

- Supply 50mm
- Risers 50 mm
- Laterals 50 mm
- Terminal runs 50 mm
- HIU drop down 30 mm

These values are not recommended and are just proposed for the purpose of providing reference building heat loss calculations.

8. Results summary

Heat Loss model

Heat losses	High temperature		Low temperature	
	Conventional	Multi-riser	Conventional	Multi – riser
Supply (kW)	1.28	1.99	1.28	1.96
Riser (kW)	0.71	1.91	0.62	1.58
Lateral (kW)	3.28	0.00	2.72	0.00
Terminal drop (kW)	1.19	1.19	0.90	0.90
Terminal run (kW)	4.69	0.00	3.54	0.00
Riser Feed (kW)	0.05	0.16	0.05	0.13
Total losses (kW)	11.20	5.25	9.10	4.57
W/dwelling	56.0	26.3	45.5	22.9
Total pipe length (m)	4255	1495	4255	1495

Table 1: Heat loss model summary of results

System Volumes

Conventional	High temperature		Low temperature	
	m ³	litres	m ³	litres
Vol. of system	2.477	2477.3	3.546	3546.3
Vol. /dwelling	0.012	12.4	0.018	17.7
Vol. of terminals	0.912	912.3	0.912	912.3
Terminal vol. / dwelling	0.005	4.6	0.005	4.6

Table 2: Summary of system volume for the conventional model

Multi-riser	High temperature		Low temperature	
	m ³	litres	m ³	litres
Vol. of system	1.803	1803.3	2.848	2848.1
Vol. /dwelling	0.009	9.0	0.014	14.2
Vol. of terminals	0.152	152.1	0.152	152.1
Terminal vol. / dwelling	0.001	0.8	0.001	0.8

Table 3: Summary of system volume for the multi-riser model

9. Summary of parameters

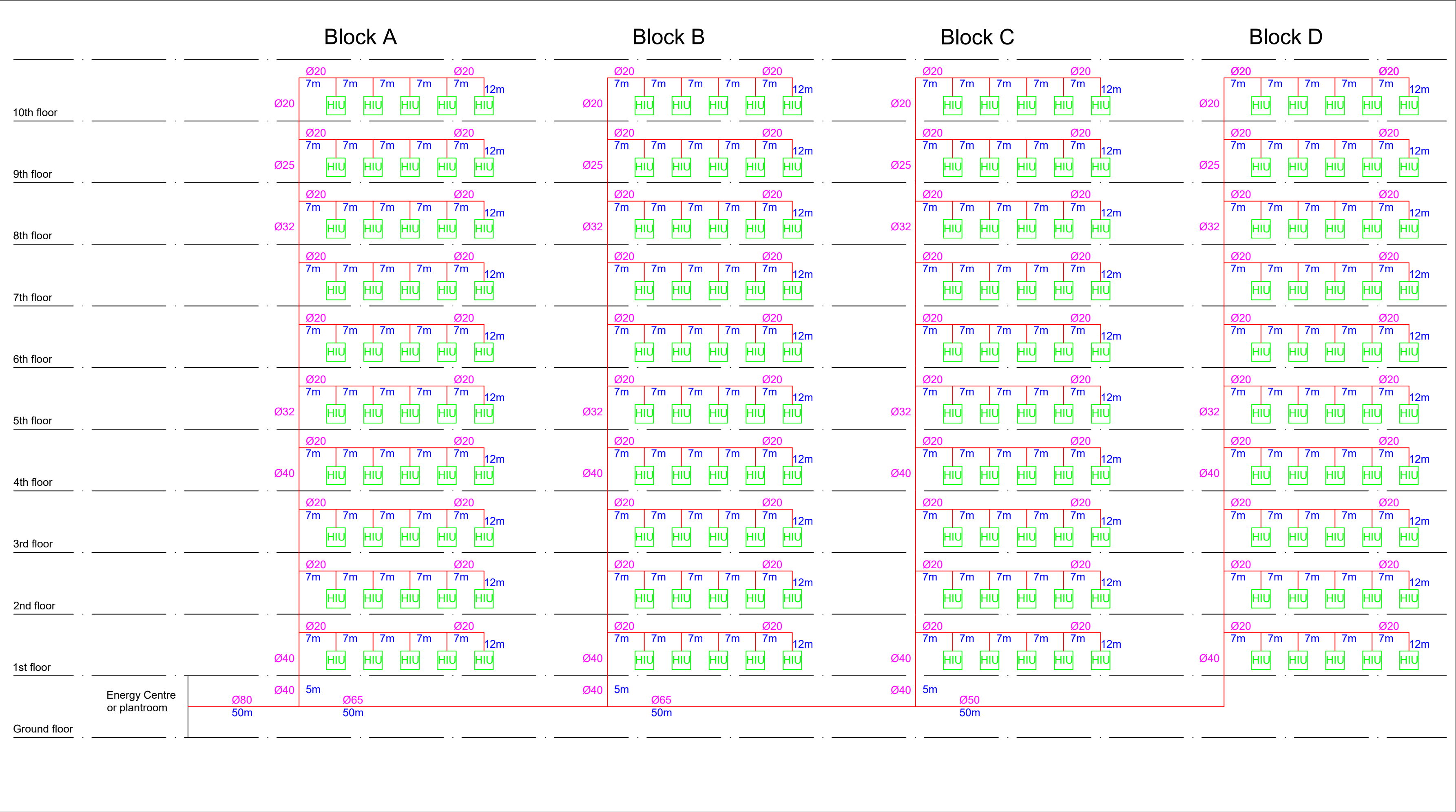
The following table lists the parameters used to calculate the pipe sizes in both reference models.

	High temperature	Low temperature
Primary flow (°C)	70	55
Primary return (°C)	30	33
DHW Set point (°C)	50	
DHW return (°C)	25	30
Space heating return (°C)	43	38
DHW demand in each dwelling (kW)	41.4	
Bath outlet flowrate (l/min)	9.0	
Shower outlet flowrate (l/min)	8.0	
Kitchen outlet flowrate (l/min)	6.0	
Bath outlet temperature (°C)	48.0	
Shower outlet flow temperature (°C)	40.0	
Space heating profile (°C/°C)	60/40	45/35
Space heating demand (kW)	3	
DHW diversity	DS 439	
Space heating diversity (kW)	Danish diversity (up to 62%)	
Ambient: terminals, laterals, risers (°C)	25	
Ambient: Supply (°C)	12	

Table 4: Summary of system parameters for high temperature and low temperature approach

10. Appendix

- Ref Building Conventional HT Schematic Rev01.pdf
- Ref Building Conventional LT Schematic Rev01.pdf
- Ref Building Multiriser HT Schematic Rev01.pdf
- Ref Building Multiriser LT Schematic Rev01.pdf



LTHW PIPE F&R

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PIPE DIAMETER IN MILLIMETRES

XXm

PIPE LENGTH SUM OF FLOW AND RETURN IN METRES

CONVENTIONAL DISTRIBUTION HIGH TEMPERATURE

Rev01

20/04/2021



LTHW PIPE F&R

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PIPE DIAMETER IN MILLIMETRES

XXm

PIPE LENGTH SUM OF FLOW AND RETURN IN METRES

CONVENTIONAL DISTRIBUTION LOW TEMPERATURE

Rev01

20/04/2021



LTHW PIPE F&R

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PIPE DIAMETER IN MILLIMETRES

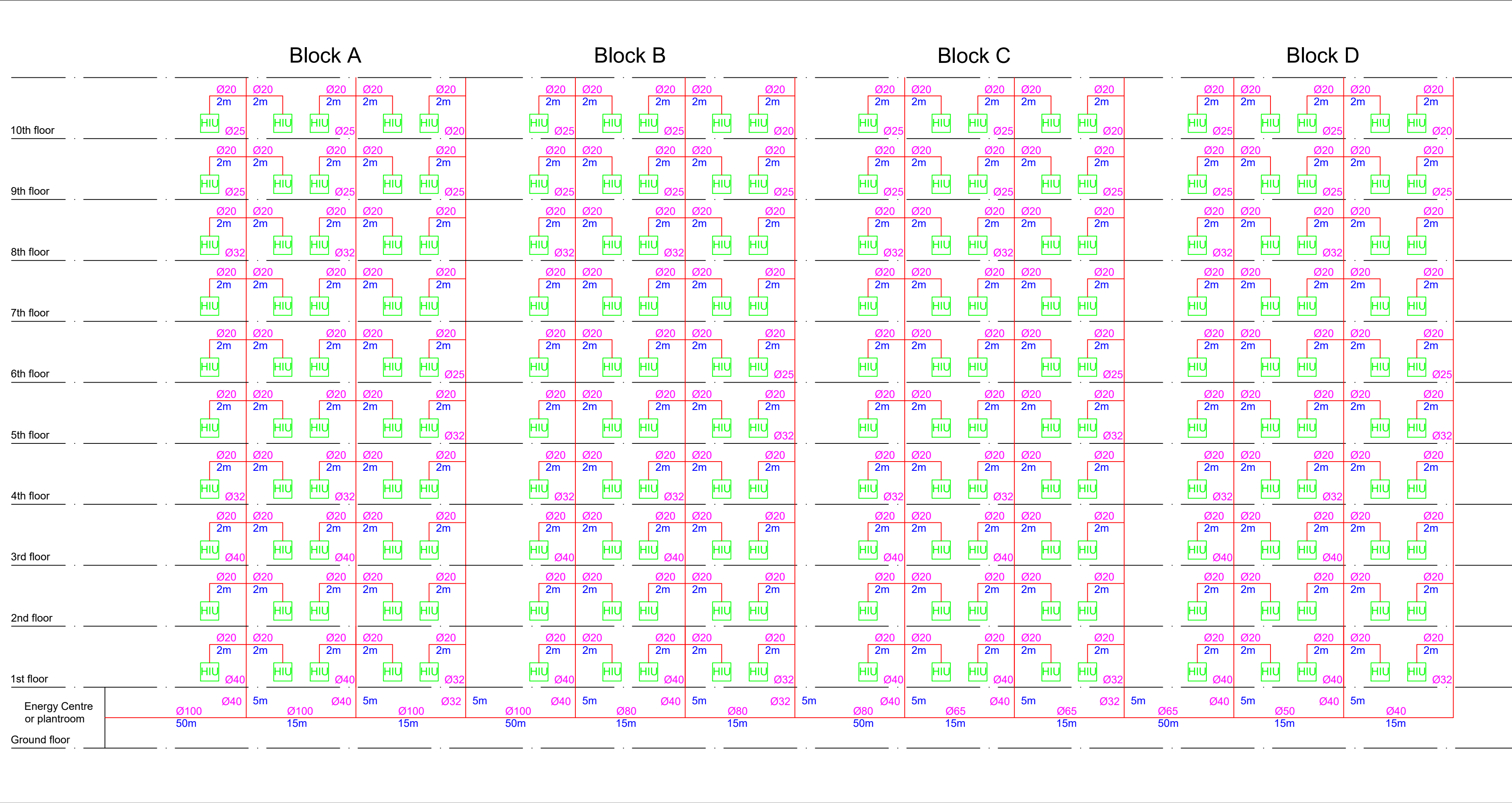
XXm

PIPE LENGTH SUM OF FLOW AND RETURN IN METRES

MULTIRISER DISTRIBUTION HIGH TEMPERATURE

Rev01

20/04/2021



LTHW PIPE F&R

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PIPE DIAMETER IN MILLIMETRES

XXm

PIPE LENGTH SUM OF FLOW AND RETURN IN METRES

MULTIRISER DISTRIBUTION LOW TEMPERATURE

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