University of the West of England

Northavon House Heat Decarbonisation

Stage 3 Design Report

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Executive Summary

This heat decarbonisation report is to RIBA Stage 3 level of detail and proposes building interventions to first reduce the heating demand, and then replace the existing gas fired boilers with a low carbon heating solution.

Northavon House is located on the University's Frenchay Campus in Bristol and was constructed in 1991. It is an office building set over 4 floors with a total GIA of 2,281m^2. The building accommodation includes:

- Basement accommodating changing spaces and the electrical plantroom
- Levels 1 to 3 accommodates university staff offices, meeting rooms, server room and kitchenettes
- Roof plantrooms accommodating the main heating and ventilation plant

The building is not listed and there are no known planning constraints on the building.

Building fabric improvements

The existing building fabric performance is to 1990 UK building regulation standards and the existing façade has been assessed by a façade specialist. The existing and proposed fabric performance is summarised in Table 1

Table 1 Building fabric performance

Building Element	Existing W/m^2.K	Proposed W/m^2.K
Windows	2.8	1.3
Curtain walling	2.8	1.3
Roof	0.25	0.16
External walls	0.5	0.5 (no change)
Ground floor	0.7	0.7 (no change)

Heating system interventions

The existing space heating is generated by 3no gas fired boilers in the roof plantroom. The 2no lead boilers are original and exceed their design life by over 10 years. The third boiler is a backup boiler and was replaced in 2021.

The existing and proposed heating systems are summarised as follows:

Table 2 Heating system performance

System	System Size	Heat generator efficiency	System primary temperatures
Existing gas fired boilers	3 x 110kW	0.85	81 / 72ºC
Proposed ASHP	3 x 76kW	3.36 (SCOP)	55 / 50 ºC

The following systems are served by the heating system:

- Radiators. The existing radiators shall be replaced except in spaces where the radiator output at a reduced flow temperature is predicted to be sufficient to meet the predicted space heating loads.
- Fan coil units. The existing 4-pipe FCUs are to be replaced.
- Air handling unit heater batteries. The existing AHUs are to be replaced.

Ventilation system interventions

The existing central supply AHUs have no heat recovery and make a significant contribution to the heating demand. The AHUs and associated extract fans are proposed to be replaced with new centralised supply and extract AHUs with heat recovery.

The open plan offices are predominantly naturally ventilated and it is proposed to retain this approach due to the building constraints. An upgrade of the existing ventilation DX system and enhanced CO2 monitoring and control is proposed to enhance comfort in the space.

Electrical systems

Power is distributed from a floor standing LV switchboard panel within the basement plantroom. The electrical supply to the main electrical switchboard is derived from the utility cut-out and metering equipment located at the northern end of the building. This is fed exclusively from an external substation located at the east of the building.

The substation's existing spare load capacity (197 kVA) is sufficient for the electrification of the heating system and no upgrades are anticipated. The existing basement LV switchboard does not have sufficient outgoing ways with capacity to accommodate the power supplies for the new heating equipment. A new distribution panel is proposed between the existing utility intake and the existing LV switchboard to limit the disruption and minimise cost to existing installation. The resulting spare load capacity following the heating system replacement will be reduced to 57 kVA.

Energy, carbon and cost

Table 3 summarises the existing and proposed energy, carbon emissions, associated fuel costs, and a budget cost.

The heating decarbonisation works can potentially reduce the buildings carbon emissions by approximately 32% using 2023 carbon factors for gas and electricity. The carbon emissions will reduce further as the electrical grid is decarbonised.

Fuel costs are approximately the same due to the high unit cost of electricity versus gas, but are predicted to reduce as the unit cost of electricity reduces in the future.

The estimated budget cost for the heat decarbonisation project is £2.6million and is based on industry pricing books.

Table 3 Energy carbon and cost

Year	Electrical energy consumption		Fossil Fuel energy consumption		EUI	Carbon emissions	Carbon emissions saving	Operation Costs	Budget Costs
	kWh/ m2	MWh	kWh/ m2	MWh	kWh/ m2	Tonnes CO2e	Tonnes CO2e	£1,000s	£m
Existing	52	221,328	52.5	224,753	104	86	-	54	-
Proposed	61	261,141	0	0	61	54	33	50	2.6

Decarbonisation high level programme summary

The proposed decarbonisation programme is below.

- Year 0 apply for Salix funding. Stage 4 design.
- Year 1 Contractor Appointment. Fabric upgrades
- Year 2 Boiler replacement with ASHP. Installation and commissioning.
- Year 3 Decarbonisation review / monitoring / updates

1. Introduction

In February 2020 the University of the West of England (UWE) declared a Climate and Ecological Emergency and launched ‘Strategy 2030’ which commits to be carbon neutral by 2030. UWE Bristol commissioned a decarbonisation plan of its Estate and Northavon House was highlighted as falling outside of the Frenchay campus heat network decarbonisation work due to its location and relatively small heating load.

UWE has several campuses across Bristol including Frenchay, City, and Glenside. Northavon House is located on the Frenchay Campus and was constructed in 1991. It is an office building set over 4 floors including:

- Basement accommodating changing spaces and incoming electrical plant.
- Levels 1 to 3 accommodates university staff offices, meeting rooms, server room and kitchenettes.
- Roof plantrooms accommodating the primary heating and central ventilation plant.

This report proposes a heat decarbonisation solution for Northavon House to RIBA Stage 3 level of detail.

1.1 Energy consumption

The building’s existing energy consumption as reported in the Display Energy Certificates (DEC) over the past 5 years is in Table 4. The DEC certificates report the energy use from the previous year. Additionally, the available gas and electricity meter data has been evaluated to understand the existing energy use profiles and peak system loads. The DECs and meter data report can be found in Appendix A and Appendix B.

Table 4 DEC energy consumption and carbon emissions

DEC Year	Electrical energy consumption		Fossil fuel energy consumption		EUI	Carbon emissions
	kWh/m2	kWh	kWh/m2	kWh	kWh/m2	TonnesCO_2e
2020	61	261,141	49	209,769	110	92
2021	54.91	235,070	52.1	223,040	107	89
2022	50.26	215,163	88.78	380,067	139	113
2023	51.7	221,328	52.5	224,753	104	86
2024	45.5	194,786	27.71	118,627	73	62

Building GIA used in DECs is 4,281m^2

2022 DEC data discounted. Building in covid operation with higher than usual fossil fuel consumption.

2024 DEC data discounted. Low energy consumption impacted by internal fit out works.

2023 carbon emission factors from GHG conversion factors 2023 (0.18kgCO2/kWh gas; 0.2kgCO2/kWh elec)

1.2 Plans for the sites / key challenges

Northavon House is not a listed building and the University have advised that there are no known planning restrictions or planning guidance for this building.

There are no major refurbishment plans or change of use for the building. Any future improvements will need to meet UK building regulations as a minimum.

1.3 Reference information

The following information has been referenced as part of this report:

- DEC certificates (2019 – 2024).
- Incoming gas and electricity meter data between 2022 and 2024
- O&M information – Architectural and Structural record information (MEP information not available).
- SPONS 2024 pricing books

1.4 Heat decarbonisation approach

<u>Fabric first</u>

This project follows a fabric first approach to reduce energy consumption passively. This will reduce the heat loss from the buildings and reduce energy consumption for the remaining life of the building.

Improving the thermal performance of the building requires the replacement of windows and curtain walling. This will improve the overall buildings fabric but could impact the building character and aesthetic. The visual impact will need to be reviewed by the University alongside an appropriate Architect in the next design stage.

<u>Heat source</u>

The building is served by gas fired boilers. The proposal provides an electric based heat source to replace the existing fossil fuel system. These works would ideally take place outside of the heating season, be completed in a single phase, and follow with the fabric improvements and AHU replacement.

<u>Heat emitters</u>

The heat output of the existing heat emitters, i.e. radiators and FCUs, will be reduce at the lower flow temperatures. There will be instances, particularly on the ground floor and top floor, where radiators need to be replaced.

<u>Building electrical works</u>

The heating system electrification requires upgrades to the electrical distribution and additional supplies. The proposals are outlined in this report and describe the scale and extent of the works necessary to switch to an all-electric heating system.

<u>Electrical incoming infrastructure</u>

The University’s transition from fossil-fuel based heating systems to electricity-based systems will increase demand on the existing electrical supply infrastructure.

An electrical load assessment has been undertaken to identify the impact of the proposed system against the existing building systems. The Distribution Network Operator (DNO) has verified that the existing incoming electrical infrastructure arrangement has sufficient capacity to accommodate the anticipated increase in maximum electrical load demand. The DNO have noted that confirmation of the existing equipment is subject to a site inspection to ascertain the incoming fuse sizes, the incoming cable size from the substation need to be assessed to determine if further upgrades, with associated charges if required.

<u>Cost</u>

A high-level costing exercise has been carried for the proposed works using industry pricing guidance. The costing exercise provides the University with an indication of budget costs, and will require the input of a quantity surveyor during later design stages to verify these. A summary of the costs can be found in section 10.

1.5 Report contents

The contents of this report are as follows:

- Decarbonisation options appraisal
- Building analysis (Thermal model, fabric, mechanical, electrical, acoustics, structure and civils)
- Energy and carbon
- Costs and programme
- Discussion and next steps

2. Decarbonisation Options Appraisal

This section provides an appraisal of the various technologies that were considered for Northavon House. A brief introduction is given for each technology, as well as clarification as to why they may have been discounted, for either being impractical due to limitations of the site, or due to client preferences.

2.1 District heat network

A district heating scheme typically comprises of one or more energy centres used to generate heat, which is distributed around a piped network (normally buried), routed to each end user. Heat is transferred into individual properties and is then used in conventional heating systems. District heating schemes can vary widely in scale.

The Frenchay campus has an existing district heat network with heat generated by CHP engines and it serves several buildings on the campus. The addition of Northavon House onto the heat network has been considered as part of the wider UWE decarbonisation plan but has been discounted due to the distance from the existing heat network, the relatively low heat demand, and disruption created by laying pipework to the building. Additionally, the UWE decarbonisation plan reports that the pipework heat losses are prohibitively high and therefore **connection to the heat network has been discounted.**

2.2 Ground Source Heat Pump (GSHP)

The earth's mass and any water stored within it provides a consistent heat source that can be utilised to heat (and cool) buildings utilising heat pumps and pipework circuits.

A closed loop GSHP works by pumping a refrigerant (brine or glycol) around a network of pipes in contact with the earth. This heat from the earth is transferred to the fluid and is then used as the low-grade energy source for a heat pump. The system adds or removes heat from the water circuit before returning it to the ground.

GSHPs work most effectively when the approximate heating and cooling loads are similar, creating a balance between the amount of heat removed and put back into the surrounding ground. Typically, GSHPs have a higher SCOP than ASHPs.

Heat pumps typically operate with a lower flow temperature than a traditional gas fired boiler which can reduce the heat output of the emitters. This potentially requires installation of additional heat emitters and/or upgrade of the existing emitters to achieve the required space heating loads.

The GSHP heating plant is typically no larger than a floor standing boiler and can be accommodated in an internal plantroom. Noise is less of a concern than other types of heat pump types.

The reference service life of a GSHP, including boreholes and all ancillary components (including closed and open loop systems), is 20 years.

Heat pumps require a fuel input in the form of electricity and are considered a low-carbon technology.

2.2.1 High level GSHP desktop study

Using general guidance documentation, our experience on similar projects, and guidance from manufacturers, we can estimate the approximate space required to install GSHP as a heating source. This is a high-level study and a more detailed desktop study would be recommended to provide more detailed analysis and recommendations. The study is based on the predicted space heating load following the building fabric improvements excluding external wall insulation and using the following parameters:

Ground temperature: 10.6 °C

Ground conductivity: 2.2 W/mK (based on sandstone geology, assumed by GSHP manufacturer)

Vertical collector (bore hole) max power per unit length: 64 W/m

Bore hole depth: 235m

Spacing between bore holes 12m

12 boreholes are required to provide the heating demand for Northavon House GSHP which will cover the entire northern carpark - see Figure 1. A horizontal pipe arrangement has not been considered due to space limitations.

Figure 1: Estimated GSHP boreholes for Northavon House

A manufacturer GSHP cost estimates for Northavon House is in the order of £ 550,000 for vertical boreholes (based on manufacturer quotes). Additional costs such as inflation, incoming services, electrical upgrades, and particular site influences are not included within this figure. Obtaining specific costing advice prior to advancing a GSHP installation project is recommended.

GSHPs are considered a viable heating solution for the building, however the GSHP output is dependent on several factors influenced by the local situation and further detailed studies are recommended if pursuing this technology.

2.3 Air Source Heat Pump (ASHP)

ASHPs works in a similar manner to a GSHPs but ambient air is used as a heat source as opposed to the ground. The ambient air temperature varies far more than the ground temperature and the efficiencies are generally lower than a GSHP system. The overall system is typically cheaper to install than a GSHP as the costs associated with installing a ground loop or boreholes are not present.

ASHPs are available in many sizes and configurations and can operate at different flow temperatures, traditionally running most efficiently at lower flow temperatures. As with GSHPs, the lower flow temperature reduces the heat output of the emitters, potentially requires installation of additional heat emitters and/or upgrade of the existing emitters to achieve the required space heating loads.

ASHPs are located externally which can take up a significant amount of useful space at ground level. Structural interventions are usually required if ASHPs are accommodated on the roof.

Noise generation from ASHPs can be an issue in noise sensitive areas and often require acoustic treatment.

The reference service life of a ASHP is 15 years.

Heat pumps require a fuel input in the form of electricity and are considered a low-carbon technology.

ASHPs are considered a viable heating solution for the building.

2.4 Biomass boiler plant

Biomass boilers use wood as their primary fuel source. Biomass fuel source is carbon neutral as the fuel source is derived from plant material and/or animal waste. The carbon released in the burning of the fuel is offset as from the carbon absorbed from the atmosphere during its growth. It is important to note there is still a carbon emission involved with biomass, fuelling the delivery vehicles, processing wood into pellets etc.

Whilst it is not a statutory requirement, the biomass fuel should be sourced from a local supplier to ensure that the carbon emissions arising from the process are not undermined by large carbon emission from transporting the fuel to site. Although biomass offers a very effective solution to reducing carbon emissions, the operation of the plant is more complicated and labour-intensive than a conventional gas boiler system. Regular deliveries of fuel are also required dependant on the size of the store accommodated onsite.

The bio-fuel source must be stored onsite prior to being burnt; therefore, there is a compromise to be made over the area allocated for storage space. Biomass boiler flues often need to terminate a minimum of 3m above the highest point of the roof in order to comply with the clean air act.

Due to the large storage requirements, regular delivery of large quantities of fuel, increased NO_x emissions and the generation of dust and noise with deliveries, **biomass boiler technology has been discounted**. The explosion and fire hazards associated with biofuel storage also make it a less attractive option.

2.5 Combined Heat and Power (CHP)

Natural gas/biomass can be used in CHP plant for the generation of electricity with waste heat used for space heating, domestic hot water, cooling (using an absorption chiller), and humidification and dehumidification where required.

CHP is generally considered to be economically viable if there is a high simultaneous heating and electricity demand for more than 5,000 hours per year which is unlikely for this building. Thus, **CHP has been discounted as a solution for this project.**

In addition, for gas-fuelled CHP systems, the carbon dioxide emissions from the electricity grid will decrease as the national grid is de-carbonised, and so a solution that is based on consumption of electricity, would be expected to emit fewer carbon emissions in the long term. It is projected that condensing boilers will become more carbon efficient than CHP in the short term, and air source heat pumps are significantly less carbon intensive both now and in the future.

2.6 Solar thermal panels

Solar thermal panels absorb sunlight to heat hot water that can then be used within the building. Solar thermal panels are more efficient than PV panels and can significantly reduce domestic hot water loads when running at peak efficiency during the summer months.

The building has a very small domestic hot water load and the provision of **solar thermal panels has been discounted.**

2.7 Solar Photovoltaic (PV) Panels

Photovoltaic (PV) panels convert sunlight into electricity and therefore are most effectively mounted on an unobstructed south facing roof area, angled at an elevation of around 10-30 degrees from the horizontal axis.

For the southern part of UK, a PV array is typically able to provide a useful output of 90-110kWh per annum for every $1m^2$ of array.

The carbon reduction benefit from the installation of PV reduces overtime as the carbon factor associated with grid electricity reduces year on year. Despite this, PV is a mature technology which reduces grid electrical consumption and therefore PV is a viable technology.

2.7.1 High level PV desktop study

Using general guidance and information from manufacturers, we can estimate the approximate output from a roof mounted PV array. This is a high-level study and a more detailed desktop study is recommended by a specialist PV designer should this technology be chosen. The study is based on the available roof area indicated in Figure 2

An array covering the east and west roofs only can generate approximately 143MWh per annum which is approximately 57% of the buildings current electrical consumption.

Table 5 PV output information

Roof Area m2	Orientation	Angle	Peak output kW	Annual output MWh
430	E	35°	86	71
430	W	35°	86	73
			172	143

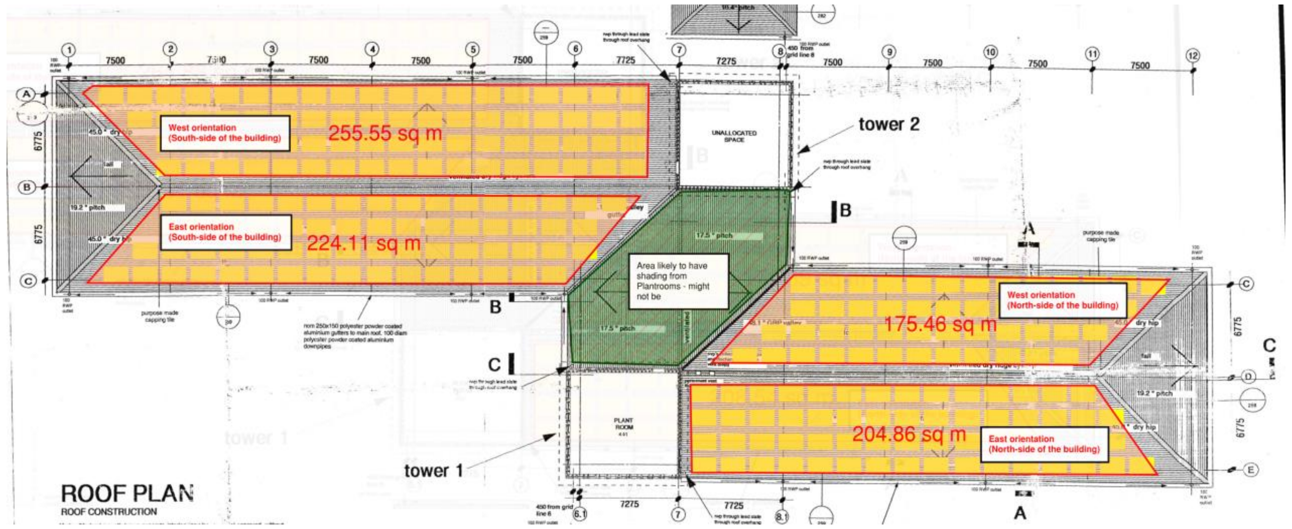


Figure 2 Outline of potential roof PV array. Geen zone indicates unsuitable area due to overshading from towers.

The peak PV generation is predicted between April and August and for a large portion of this time the building is unoccupied during the summer holiday period. Also, the building's peak electrical demand is expected in winter with a building with an all-electric heating system.

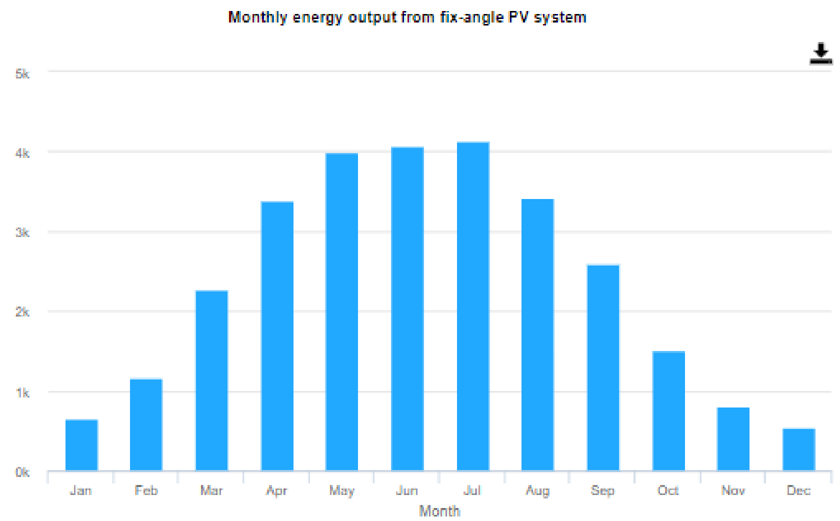


Figure 3 PV generation profile for typical PV array

There is limited opportunity for the building to share the energy generated with other buildings on Campus as Northavon house is on a separate electrical distribution circuit to the wider campus.

The University has also raised concerns regarding the maintenance of pitched roof PV systems due to issues with other building on campus and for this reason **PV has been discounted.**

2.8 Conclusion

A selection of LZC measures have been evaluated for their site suitability, carbon reduction potential and client needs. From this, it has been demonstrated that ASHPs are a suitable solution to provide a meaningful reduction in carbon emissions.

GSHPs offer slightly improved energy savings versus ASHPs, however ASHPs are preferred due to the smaller capital costs and reduced site disruption.

3. Thermal Modelling

A Dynamic Thermal Model has been built in IES Virtual Environment 2023 to assess the impact of the proposed building fabric interventions. Refer to Appendix C for thermal modelling report.

The building geometry was built in IES using the available architectural general arrangement layouts and sections. The dimensions were validated using approximate site measurements and information from a 3D Lidar scan of some spaces.

The IES model has been baselined against the 2023 DEC annual energy consumption and the available half hourly metering data to inform the existing peak building loads.

The proposed thermal model is based on improved fabric (windows, curtain walling and roof), AHUs with heat recovery, and a gas heating system with 85% efficiency (for comparison with the actual building performance). The peak thermal load is based on sensible heat load (discounting the boiler efficiency losses) to give the peak heating load required for sizing of the heat pumps.

A summary of the results in included in Table 6 below.

Table 6 IES heating results summary.

Scenario	Annual gas heating consumption kWh	IES Thermal model vs actual	Peak thermal load kWh	Comments
Actual building performance	221,328	-	170	Annual heating energy consumption based on DEC 2023 output for fossil fuels
IES Base model	233,505	-6%	185	IES result is within 10% of actual DEC 2023 data and therefore considered reliable.
IES Proposed model	154,623	-34%	143	Improved fabric and ventilation upgrades (10% management factor applied).

Figure 4 View of Northavon House from South East

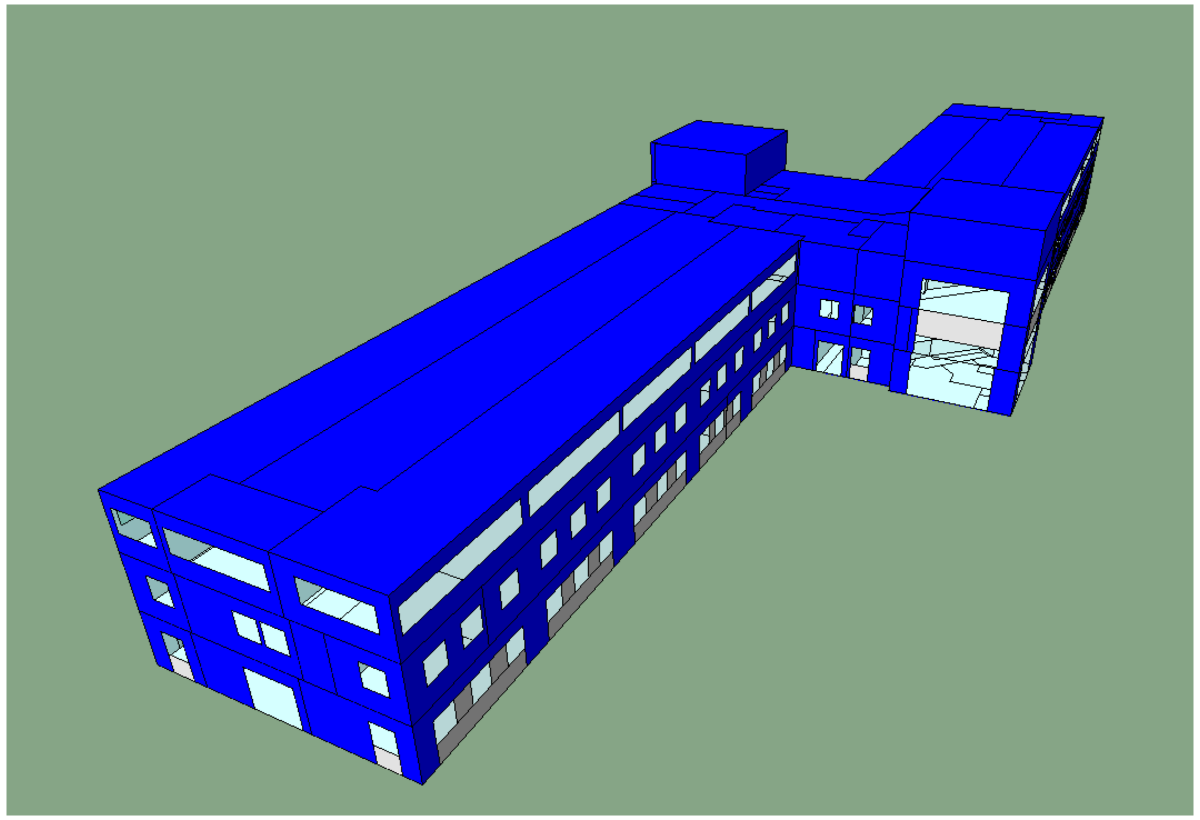


Figure 5 View of thermal model from South East

4. Building Fabric

The existing facade thermal performance of the walls, windows and curtain walling has been assessed by the Arup façade team and recommendations for the improving the building fabric are proposed. See Appendix D for façade reports.

The roof and ground floor U-values are, based on visual inspections and from record drawings, assumed to be to 1990 Building Regulation limiting U-values.

Two fabric upgrade options have been considered; a deep retrofit and a light retrofit. The deep retrofit option includes all the proposed retrofit targets outlined in Table 7. The light retrofit discounts the external wall overcladding but includes all other measures. The recommendations are discussed in the façade report.

A light retrofit is proposed for this building, i.e. windows, curtain walls, and roof insulation upgrade. The deep retrofit has been discounted due to the significant cost uplift and likely disruption for only a marginal improvement in the overall thermal performance.

A building air test should be completed following the façade upgrades to measure the building airtightness.

Additionally, the University should explore recycling options for salvaged materials to further the University's commitment to sustainable practices. Consideration should be given to include this as a question in the Contractor procurement process.

The façade report discusses the condition of the existing building fabric and recommends a list of actions:

- An intrusive survey is recommended to confirm the wall's build-up and if the insulation material is combustible.
- Investigate the extent of corrosion of lintels above window and curtain wall openings on ground and first floors.
- Undertake minor repointing for brickwork and mortar.
- Replace hardened silicone at movement joints.

  Clean and remove stains and organic growth from surfaces.

Table 7 Existing and proposed façade components and air infiltration rates

Façade component	Proposed retrofit options	Estimated existing thermal performance	Retrofit thermal performance target
Walls (deep retrofit not proposed)	• Reclad or overclad with additional external insulation: • Remove existing combustible insulation, if necessary. • Reclad with brickwork or alternative cladding, ensuring the lintels above all openings are installed in compliance with standard industry specifications. The above are included to illustrate the potential improvements	**0.5 W/m2K**	~~0.26 W/m2K deep retrofit~~
Windows	• Replace glazing system	3.1 W/m2K g-value 0.7	**1.3 W/m2K** **g-value 0.4**
Curtain wall	• Glazed area: Replace secondary components. • Opaque area: Replace opaque panel and blockwork with insulated opaque panels. Replacing the entire curtain wall system should be considered if the above works are insufficient in achieving the target thermal performance and has been allowed for in costing.	3.1 W/m2K g-value 0.7	**1.3 W/m2K**
Roof	Additional mineral wool insulation added to existing to achieve target u-value	0.25	**0.16**
Ground floor (ground contact)	N/A	0.7	N/A
Airtightness	Airtightness target based on proposed measures		**7.5 ACH light retrofit** ~~6 ACH deep retrofit~~

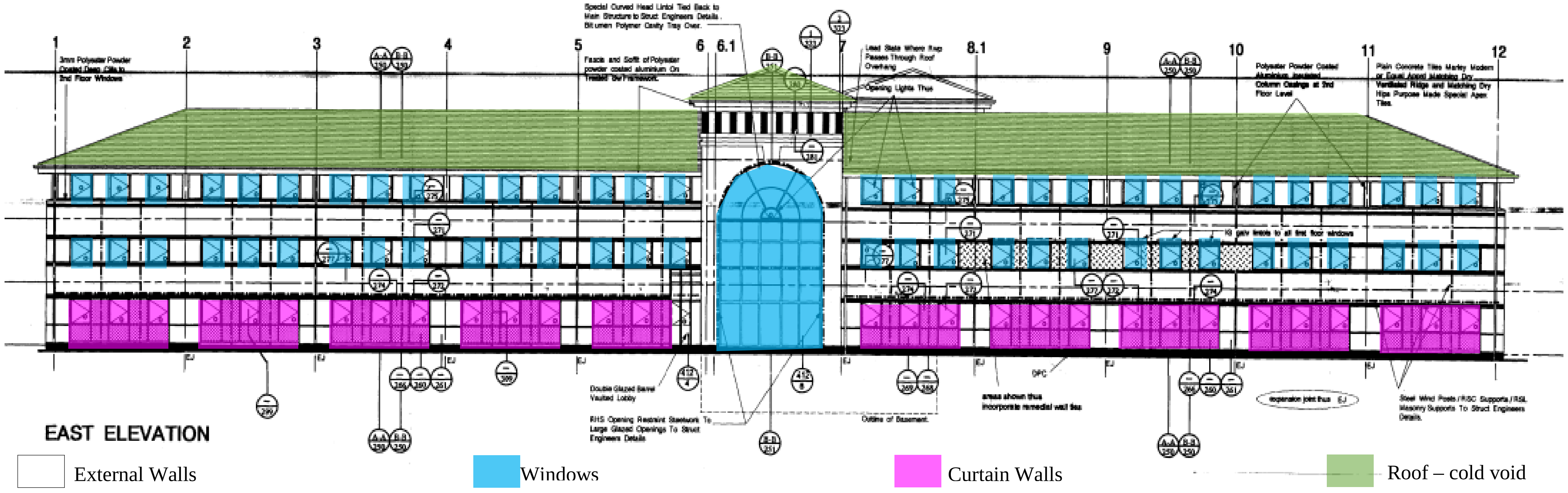


Figure 6 Elevation indicating building elements

5. Mechanical Services

5.1 Existing Mechanical Services

There is no available M&E O&M information. Our understanding of the existing system is from site walkarounds and discussions with site staff.

5.1.1 Existing heating

3no gas fired condensing boilers are located in the roof heating plantroom. See Appendix for boiler nameplate details.

- 2no original Strebel condensing boilers. Lead boilers installed 1991.Boilers past end of service life.
- 1no Strebel condensing boiler. Back-up only. Installed 2020.

The primary LTHW system includes a dirt/air separator and pressurisation unit with associated expansion vessels.

The secondary LTHW circulation systems are:

- LTHW VT circuit serving radiators. Twin head inverter driven pump in heating plantroom.
- LTHW CT circuit serving AHUs and FCUs. Twin head inverter driven pump in heating plantroom.

The LTHW pipework is distributed from the plantroom and through the roof void to a vertical riser where it drops to serve the lower levels. The LTHW VT pipework branches off the riser pipework at low level and runs within the floor voids. The LTWH CT pipework branches off the riser pipework at high level and runs within the ceiling voids.

The perimeter radiators are double panel type with fins and are located throughout the building.

4-pipe fan coil units are located within the ceiling voids of meeting rooms and offices in the core areas of the building only.

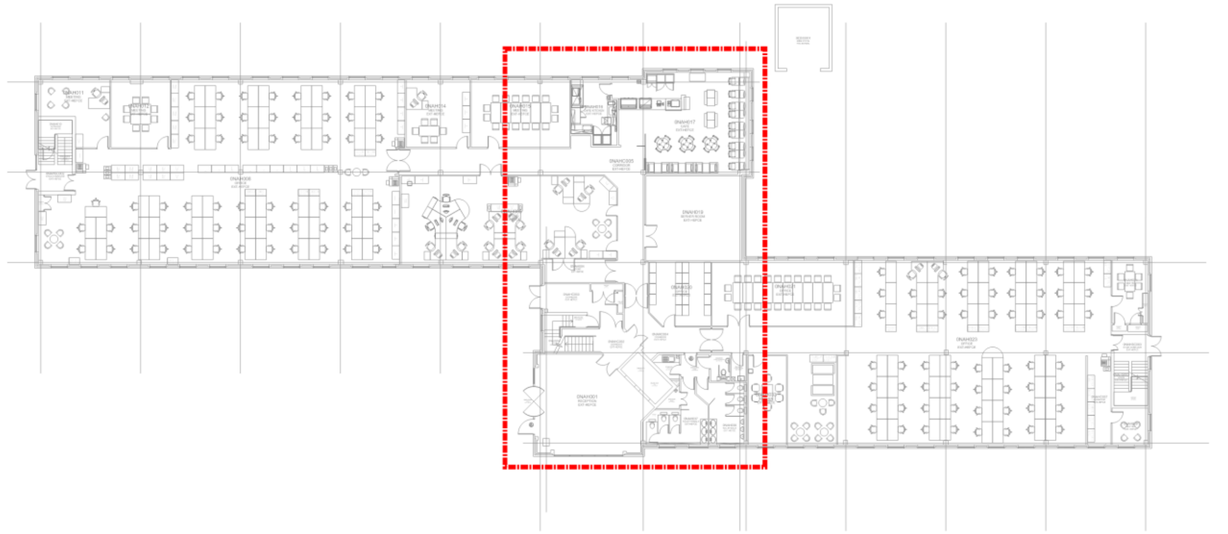


Figure 7 Red dashed line indicates building core areas. Offices/meeting rooms within core typically have 4-pipe FCUs.

The heating plant and distribution is original. Where visible, pipework is in steel and insulated along its length.

The lead boilers, pumps and controls exceed their design life and should be replaced. The original backup boiler recently failed and has been replaced. The external condition of the distribution system appears to be good, however water testing should be undertaken to confirm the overall pipework system condition.

Figure 8 Existing gas fired boilers in roof heating plantroom

Figure 9 Typical office double panel radiator with fins.

5.1.2 Existing cooling

A ducted air-cooled chiller is in the roof heating plantroom and is ducted to the roof.

The CHW serves the office supply AHU and the 4-pipe FCUs in the meeting rooms.

The chiller has integral circulation pumps and the CHW is distributed from the plantroom and through the roof void to a vertical riser where it drops to serve the fan coil units and the AHUs.

In addition to the chiller, there are multiple DX systems within the building providing heating and cooling.

- Server room on ground floor
- Open plan offices. 6no duct-mounted DX batteries on supply air ducts to offices (2no per level) to provide summer cooling only. The building primarily uses natural ventilation to reduce risk of overheating, with the cooling system operating only on the hottest days and when internal space temperatures in open plan offices exceeds 24ºC.

The cooling plant, FCUs, and CHW distribution is original and exceeds its design life. It is reported to be in good working order.

5.1.3 Existing ventilation

The open plan offices and meeting rooms are predominantly naturally ventilated using openable windows.

There are 3no balanced ventilation systems; 2no are in the roof AHU plantroom and 1no in the basement plantroom. The supply AHUs and extract fans are described as follows

- AHU1 serves WC core and is located in the roof AHU plantroom. A supply AHU and inline extract fan provides make up air and extract air to the WC areas. The AHU has a heater battery connected to the LTHW CT circuit.
- AHU2 serves offices and meeting rooms in the core area and is located in the roof AHU plantroom. A supply AHU and inline extract fan provide fresh air and extract air. The AHU has a heater battery connected to the LTHW CT circuit and a cooling coil on the chilled water circuit.
- AHU3 serves the basement changing area and is located in the basement plantroom. A supply AHU and inline extract fan provides make up air and extract air to the WC areas. The AHU has a heater battery connected to the LTHW CT circuit.

The open plan offices have a summer cooling system (6no in total) which comprises of a supply fan with DX cooling coil for cooling only. Oval ductwork in installed at high level within each open plan office with linear deflection grilles. The system is controlled to run on hot days and when the space temperature exceeds a setpoint of 24ºC as described earlier in this report.

The entrance foyer has a general extract system and a smoke extract system. The extract fans are located in the roof AHU plantroom.

There are several local wall mounted extract fans which serve kitchenettes, café and server room.

The ventilation plant and distribution is original and exceeds it's design life.

5.1.4 Existing cold water services

The incoming cold water enters the building in the basement and rises to a cold water storage tank in the heating plantroom. The cold water tank has been disconnected since the University is satisfied that the flowrate provided by the incoming mains water is suitable for the building.

The pipework distribution is original and within its design life.

5.1.5 Existing domestic hot water services

A 150 litre direct electric hot water cylinder is in the roof AHU plantroom and serves the WC core on ground,first floor and second floor. A circulation pump distributes the domestic hot water around the recirculation system.

Local electric point of use water heaters serve kitchenettes.

The pipework distribution is original and within its design life. The cylinder and circulation pumps have been replaced recently and are within their design life and appear to be in good condition.

Figure 10 Existing ducted chiller in roof heating plantroom

Figure 11 Existing AHU (left) and high level extract fans in the roof ventilation plantroom and the floor soft spot (right)

5.2 Proposed Mechanical Services

The proposed mechanical systems are:

- ASHPs to replace the existing gas fired boilers.
- AHUs with heat recovery to replace the existing central supply AHUs and associated extract fans.
- Upgrade open office summer cooling ventilation system.

These are described in more detail in this section.

5.2.1 Proposed Low Temperature Hot Water (LTHW) heating plant

The existing gas boilers and associated flues shall be removed. The existing primary circulation pipework and pumps shall be removed. The gas supply to the plantroom shall be capped at the entrance to the plantroom. The meter can be removed as gas shall no longer be consumed within the building.

3No. Mitsubishi MEHP-iS-G07 0102 ASHP units with 76kW capacity each shall be installed in an external ground floor plant enclosure. An integral pump shall be included with each ASHP. This allows the flow rate of the primary system to change in line with the ASHPs being brought online. A header pipe shall connect the ASHPs within the enclosure. Heating pipework shall rise up the outside of the building to the roof heating plantroom. The pipework will enter the building at low level in the plant room. A new drainage point local to the ASHP enclosure is required for ASHP condensate.

A plate heat exchanger (PHX) shall be installed within the roof level plant room to maintain separation from the existing system and to control the return temperature to the ASHP. Pipework connections shall be made from this PHX to the existing boiler circulation pipework. A flow and return low loss header shall be installed on the building side of the PHX and existing secondary heating pipework shall connect into them.

A buffer vessel shall be installed in the plantroom to achieve the minimum system water volume for the ASHPs. The total hydraulic content of the primary system required for the ASHPs is approximately 2,400 litres. The anticipated content of the primary LTHW pipework can be included from the hydraulic water content.

The VT and CT heating circuit pumps shall be replaced with twin-headed pump to suit the new system duty.

New plinths shall be installed for the PHX and the buffer vessels.

The proposed ASHP arrangement provides resilience for the heating systems and, should one ASHP be out of operation during the peak heating season, the remaining heat pumps can provide the building heating duty. i.e. N+1

See equipment selection in Appendix and drawings in Appendix

5.2.2 LTHW system

The existing LTHW system operates at 81/72 °C flow and return and this shall be reduced to 55/50°C to allow the ASHP to operate efficiently. The reduced flow temperature will require some heat emitters to be replaced due to a lower heating output and shall be investigated in the detail design stage. The reduction in flow and return temperatures of the LTHW system will reduce the emitter output by ~45% as the MWT reduces from 70 °C to 50 °C. A cost allowance has been made for replacing ground floor and top floor radiators if the existing output is not sufficient to meet the space heating load following the fabric improvements.

The existing supply only AHUs are to be replaced with efficient supply and extract AHUs with heat recovery and the AHU heating demand will reduce significantly. The CT circuit shall be recommissioned for the new pumps and new flowrates.

The existing FCUs are in the spaces with tempered fresh air supply from the central ventilation system It is proposed that the existing fan coil units are replaced as they are unlikely to achieve the required space heating duty at the lower flow temperatures and they also exceed their reference service life.

The Table 8 below summarises the existing and proposed primary heating plant conditions.

Table 8 Heating system summary

System	System Size	Heat generator efficiency	System primary temperatures
Existing gas fired boilers	3 x 110kW	0.85	81/72ºC
Proposed ASHP	3 x 76kW	3.36 (SCOP)	55/50ºC

5.2.3 Proposed ventilation – central ventilation systems

The existing supply AHUs and associated extract fans shall be removed along with AHU heater batteries (frost and space heating) and other accessories. The existing supply and extract distribution ductwork shall be retained.

3no supply and extract AHUs with heat recovery shall be installed in place of the roof and basement AHUs. Each AHU shall be complete with a supply fan, extract fan, thermal wheel, heater battery, motorised dampers and integral controls. Integrated heat pump units can also be considered and a cost benefit analysis should be conducted at the detail design stage.

Sectional AHUs are proposed to allow the AHU sections to be posted through the existing ventilation plantroom soft access spot in the floor of the plantroom (see Figure 11).

Figure 12 Sectional AHU with heat recovery (IV Produkt)

Each AHU is to be connected to the existing BMS system for control and monitoring.

Local ductwork modifications shall be required within the ventilation plantroom to accommodate the new AHUs and acoustic attenuators. Local room ductwork modifications are proposed (office AHU system) to provide local ventilation demand control based on room CO2 levels. Ventilation demand control on BMS.

5.2.4 Proposed Ventilation – Open plan offices

The 6no existing supply fans and associated accessories and oval ductwork shall be retained.

The existing cooling only DX system (ductwork DX coil and external DX unit) shall be replaced with a DX system capable of heating and cooling along a new DX coil shall replace of the existing coil. Ductwork modifications shall be required to suit new DX coils. External condenser to be located in the same location as existing and reuse existing power supply.

In addition, each supply fan shall be controlled using new room CO2 and temperature sensors. The CO2 sensors shall control the fan speed to run at a background speed (25% adjustable) when the space CO2 level rises above an adjustable setpoint, say 1000ppm, linearly to full speed at a CO2 level of 1500ppm (adjustable). The fan shall be off at all other times unless called upon for cooling when the fans shall operate as the existing control regime.

The BMS shall control and monitor the fans and sensors.

Installation of local MVHR units in the open plan offices to replace the existing supply fans has been appraised for the following options:

- Centralised AHU with heat recovery. AHU per open plan offices wing, i.e. north wing and south wing. Existing supply ductwork retained. New return air grille local to AHU. This is discounted due to the plantroom and riser space requirements and additional large opening in the façade for the louvres.
- Decentralised MVHR units. Single high level MVHR unit serving single floor on each wing. Existing supply ductwork retained. This has been discounted due to the space height limitations and the disruption caused by installation including new builderswork holes for louvres.
- Decentralised hybrid ventilation units. Multiple high level hybrid ventilation units serving single floor on each wing. Existing supply ductwork removed. Hybrid ventilation units temper incoming fresh air by mixing warm return air to prevent cold draughts in winter and are controlled on room CO2. This has been discounted due to the space height limitations and the disruption caused by installation including new builderswork holes for louvres.

5.2.5 Ventilation system summary

The table below summarises the existing and proposed primary ventilation plant.

Table 9 Ventilation system summary

System		Flowrate m^3/s	Heat recovery	Additional requirements
WC	Existing	1.2	n/a	
	Proposed	1.2	80%	
Meeting rooms	Existing	1.6	n/a	Demand control vent in each room using local CO2 monitoring in each space.
	Proposed	1.6	80%	
Basement	Existing	0.68	n/a	Volume reduced. Serves changing area only at 10ACH.
	Proposed	0.35	80%	
Open plan offices	Existing	n/a	n/a	Natural ventilation Supply fan connected to DX cooling coil for controlling peak space temperature on hot days.
	Proposed	n/a	n/a	Natural ventilation. Winter ventilation demand control based on CO2 in space. DX unit with heating and cooling coil in ductwork to help mitigate cold draughts in winter. Temperature control on hot days as existing.

5.3 Proposed Public Health Services

Pipework modifications shall be required to the local cold water and drainage system within the roof plantroom for the proposed pressurisation units.

Local external drainage shall be required for the new ASHP external enclosure for condensate waste.

5.4 Plantroom Access and Maintenance

Access to both roof plantrooms is via vertical ladders from the floor below. In addition, the ventilation roof plantroom has a soft spot within the floor for plant replacement. There is an accessible walkway is between the roof plantroom in the roof void.

A method statement and safe working procedure will be required for the plant replacement and work in plantrooms.

The basement plantroom is accessed via stairs and a lift from the ground floor.

5.5 BMS

The existing heating plant equipment is controlled by the main panel located in the roof heating plantroom. The basement ventilation plant is controlled by a MCP in the basement plantroom. See Figure 13.

The panels contains all contactors, overloads, relays and BMS outstations that control the local boiler plant, associated pumps and roof ventilation plant. The outstation connects to the existing site-wide University system.

Figure 13 Existing heating plantroom MCP (left) and basement plantroom MCP (right)

The controls package will include the necessary modifications to the existing panel sections associated with the removal of all redundant components associated with gas boiler system and roof ventilation plant and the addition of the new interface equipment to the controls and BMS sections for remote alarms and monitoring.

This will include, but not limited to all associated new electrical and control cabling, upgraded/replaced controllers, additional over-ride controls and switching, new sensors and switches, interfaces with pumps and metering.

Additionally, the BMS will monitor all sub-meters as part of an automatic monitoring system.

Submeters will include heat meters (ASHPs and heating circuits), mechanical plant (DHW, Ventilation, DX) and electrical distribution boards.

A detailed points list will be developed during the detailed design to include all appropriate points.

The panel currently powers, controls and provide interfaces for space heating and ventilation and consideration will be given to cost effectiveness of replacing the entire controls enclosure during the detail design stage.

A new user platform interface graphics will also be considered in detail stage to incorporate the ASHPs, new pumps and ventilation plant to show locally their operating status and the conditions within the system.

6. Electrical Services

6.1 Existing Electrical Services

6.1.1 Existing building main electrical intake and supply

The electrical supply is derived from a dedicated external package HV/LV substation located east of the building. A 400Amp rated TPN fused cut-out and metering equipment from the Utility is located within a cupboard on the north wing of the building which directly feeds the main Low Voltage (LV) switch panel in the basement.

The cable distribution route to the main switch panel in the basement plant is assumed to be on cable tray within the ceiling void and drops within a riser.

Figure 14 Electrical cut-out and metering equipment

6.1.2 Building electrical distribution

The existing main LV switch panel, located in the basement, is a floor standing front and rear access enclosure which has top and bottom cabling entry/exit and a 600 Amp rated incoming device protection. The switchboard comprises of HRC fuse switched outgoing protection devices. From visual observations, it is noted that subsequent additional outgoing feeds have been retrofitted on the rear side of the panel.

6.1.3 Electrical metering

The electrical power is metered via a local meter and display within the main incomer at the LV switchboard. It has been observed that the main electrical switchboard does not incorporate submetering for the various power distribution to sub-distribution boards, panel boards and loads.

Distribution boards are generally unmetered. Where DBs incorporate integral metering, they are not of a split load type and do not allow split metering of small power and lighting. The meters data is not recorded on an automatic monitoring system.

6.1.4 Lighting systems

The building is undergoing a lighting system replacement and switching to modern LED luminaires with automatic presence detection. This has been largely completed in the office areas with circulation and back of house areas still to be upgraded.

Figure 15 LV main swich panel (left) and image of additional outoing feed (right)

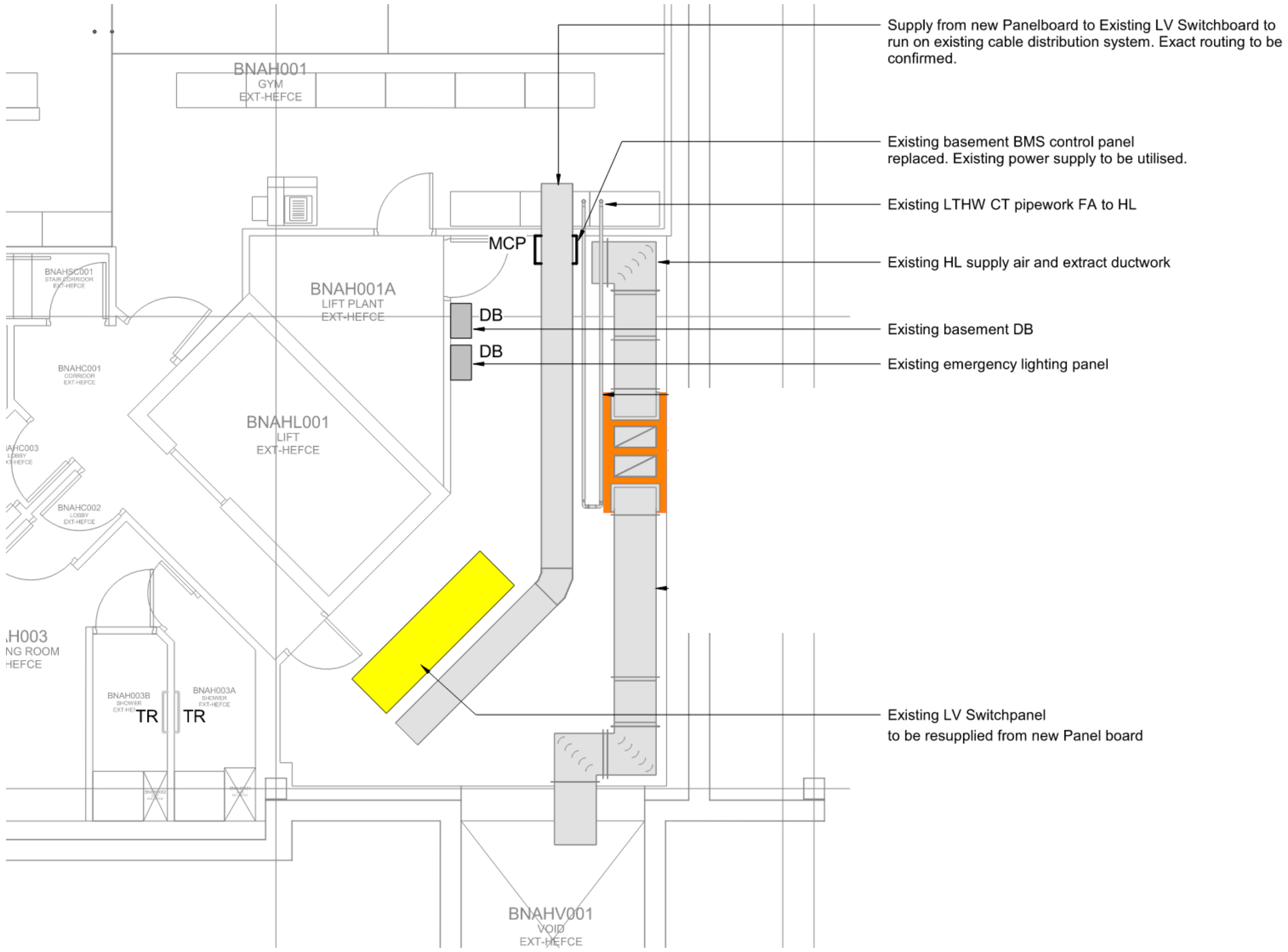


Figure 16 Layout of basement plantroom (LV switch panel in yellow)

6.2 Proposed Electrical Services

The electrical distribution will require upgrades to accommodate the increased electrical requirement. The existing LV panel can accommodate the estimated additional load and has 2no. 63Amp 3-phase spare outgoing ways (currently in the 'OFF' position) however these are not of the required capacity to accommodate the new ASHP power supplies.

A new MCCB panel board is proposed to be installed in the vicinity of the current utility LV intake equipment and shall serve as new source of electrical distribution for new equipment. The existing supply cabling from the LV intake and metering position supplying the main LV switch panel in the basement plantroom shall then be de-commissioned and existing panel be re-supplied from the proposed new panel board.

Additional outgoing ways on the new panel board shall supply a new external feeder pillar dedicated for the new heat pumps and external equipment. Spare ways shall be allowed for in the new panel board for potential future connections of a PV installation and EV charging points. Additional studies are required if EV charging and PV is to be considered for this building.

This is considered to be the most effective solution which minimises the impact and level of disruption to the existing systems.

During the detailed design stage, the equipment selections must consider power supply requirements and specific considerations in the mitigation of effects of potential distortions including harmonic distortion and neutral currents.

Sub-metering is to be installed to monitor and log electrical consumption of the key items of mechanical plant including, but not limited to, ASHPs, AHUs, pumps, DX condensers, DHW generation. A comprehensive metering strategy will be developed in the detailed design stage.

6.3 Electrical Infrastructure

6.3.1 Existing

The HV/LV substation located east of the building and is operated by the Distribution Network Operator (DNO) who is National grid. The transformer at the substation has a maximum rated capacity of 315kVA. The agreed capacity for the current electrical supply to the building is 210 kVA from the DNO .

The recorded maximum electrical load demand for the building has been observed to be 118kVA at the local meter display of the main LV switchboard and therefore the substation has a maximum spare load capacity of 197 kVA.

6.3.2 Proposed

A building maximum demand of 258 kVA has been estimated after the proposed electrification of the heating system. This is an increase in electrical maximum load demand (peak) of approximately 140 kVA (202 Amps) which exceeds the current agreed capacity with the DNO. The substation maximum spare load capacity would reduce to 57kVA.

National Grid has confirmed that the load allowance is available and agreed capacity can be increased to 258kVA to cater for additional loads without any upgrades. There is fee payable to the DNO of £82 to attend site to complete a short shutdown of power to ascertain the fuse size, replacing it if required, to cater for the 258kVA requirement.

The University need confirm the meter tail size on the existing arrangement is a minimum of 185mm² to be suitable for a larger load. If it proves that the existing tails require upgrading then a formal quotation will be required for National Grid to attend during the replacement to complete their element of the work.

and any future increase in the load required from the utility substation would require physical upgrades to the incoming supply cabling and equipment to the building.

It shall be noted that the 258kVA is a peak simultaneous demand. The gas meter information indicates that peak load demand associated with heating occurs in the earlier part of the day, while the existing electrical load daily demand typically peaks in the earlier afternoon and it is unlikely that both peaks will occur simultaneously. Therefore it is predicted that the maximum demand will be below the 258 kVA.

The load estimate calculation can be found in the Appendix .

Figure 17 Existing Package Substation Enclosure

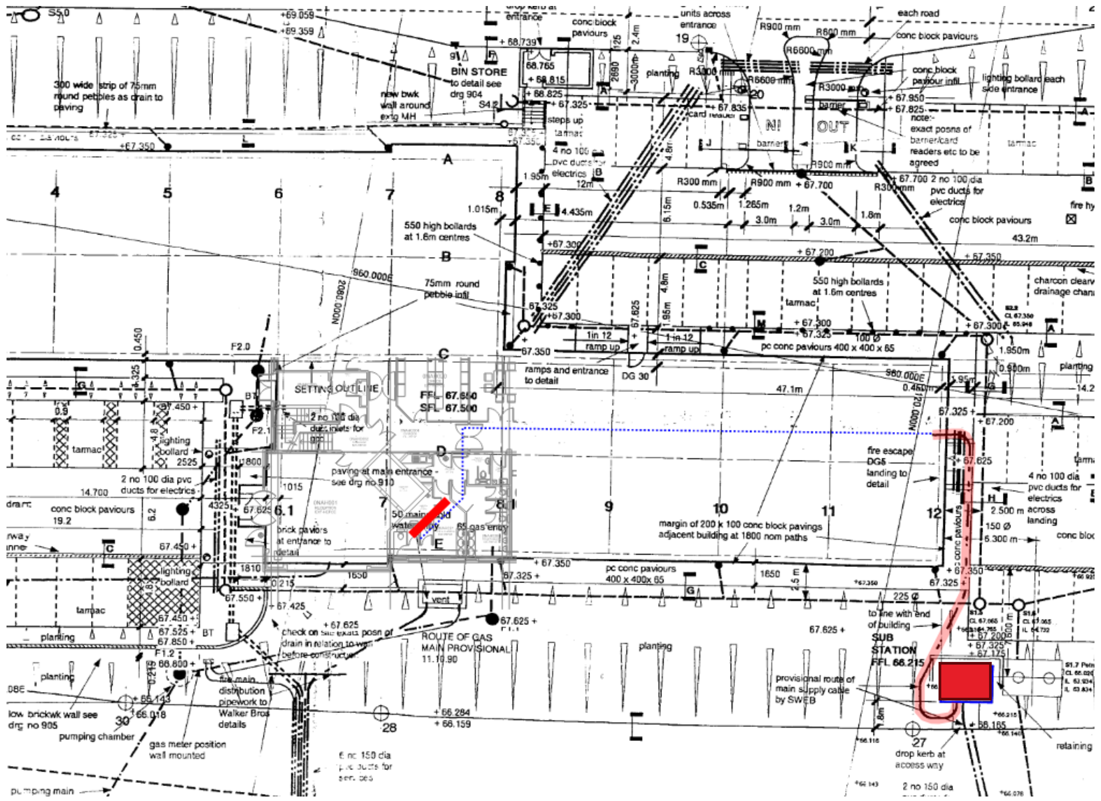


Figure 18 Existing Supply Source Substation location and Incoming Low Voltage Supply route

7. Acoustics

An acoustic survey of the site is required to assess the existing background noise and to inform the required acoustic treatment to the heat pump enclosure and any additional new plant. This will need to be completed as part of the detail design stage.

As a result of the acoustic survey, the inclusion of attenuator baffles may be necessary for the ASHPs. A cost allowance had been made for acoustic rated enclosure for the ASHPs.

8. Structures and Civils

8.1.1 Externals

The existing bike shelter in the north car park shall be demolished to make way for a new plant enclosure. The enclosure shall include a new base and acoustic rated screen will be installed in the approximate area to house the new ASHPs and associated plant. A drainage point is required for the ASHP condensate connection.

A new service duct route shall be trenched for the new ducts between the new plant enclosure and the new panel board on the north wing.

8.1.2 Plantrooms

The new internal heating plant and the replacement AHUs shall be supported on the new plinths within the roof plantrooms. The existing structural record drawings included with the O&M information confirm a plantroom live load of 7.5kN/m2.

9. Energy consumption and carbon emissions

The resulting energy use, carbon emissions, and running costs for the proposed building upgrades versus the building as existing are illustrated in Table 10.

The building Energy Use Itensity (EUI) of the existing building is 104 kWh/m^2. Following the proposed fabric and heating improvements the EUI is predicted to reduce to 61kWh/m^2.

The heating decarbonisation works can reduce the buildings carbon emissions by approximately 32% using 2023 carbon factors for gas and electricity. The carbon emissions will reduce further as the electrical grid is decarbonised.

Fuel costs are approximately the same due to the high unit cost of electricity versus gas, but are predicted to reduce as the unit cost of electricity reduces in the future.

Table 10 Energy, carbon and cost summary

Year	Electrical energy consumption		Fossil Fuel energy consumption		EUI	Carbon emissions	Carbon emission saving	Operation Costs	Capital Costs
	kWh/ m2	MWh	kWh/ m2	MWh	kWh/ m2	Tonnes CO2e	Tonnes CO2e	£	£
Existing Building	52	221,328	52.5	224,753	104	86	-	54	-
Proposed Building 2023	61	261,141	0	0	61	54	33	50	2.6
Proposed Building 2030	61	261,141	0	0	61	27	59	36	

Building area is 4,280

2023 gas and electricity costs based on BEIS retail prices for Commercial/public sector, central, Nov 2024. (5p/Wh; £0.19p/kWh elec)

2030 gas and electricity costs based on BEIS retail prices for Commercial/public sector, central, Nov 2024. (4p/kWh; 14p/kWh elec)

2023 carbon emission factors from GHG conversion factors 2023 (0.18kgCO2/kWh gas; 0.2kgCO2/kWh elec)

2030 carbon emission factors from FES 2023. Falling short scenario (0.18kgCO2/kWh gas; 0.1kgCO2/kWh elec)

10. Costs, Programme and Resources

10.1 Costing

The proposed measures have been costed using industry pricing books and is at an appropriate level of detail and accuracy for RIBA Stage 3. A summary of costs has been outlined in Table 11.

The assumptions and exclusions for this project can be found in the Appendix

Table 11 Cost summary for proposed interventions

Item	Budget Cost £m	Comments
Fabric Upgrades	0.21	
Heating upgrades	0.38	Manufacturer lead times to be considered. At time of report issue lead times were typcially 10-14 weeks.
AHU replacement	0.21	Manufacturer lead times to be considered
Office ventilation upgrade	0.080	Allowance for DX heating and cooling to office supply fan.
Radiator replacement	0.09	Allowance for ground and level 2 radiator replacement.
FCU replacement	0.07	Allowance for 10no FCU to be replaced.
AHU ventilation demand control	0.13	Central office AHU only
Contractor Prelims	0.52	Includes allowance for building scaffolding
Contractor OH&P	0.1	Contractor OH&Ps @ 10% to construction costs
Contingency	0.19	10% contingency of total construction cost
TOTAL	**2.0**	
Design Team fees	0.2	@10%
TOTAL exc VAT	2.2	
TOTAL inc VAT	**2.65**	

10.2 Delivery programme

The indicative programme in Figure 19 is based on a traditional single stage tender contractor procurement route. The University's intention is to apply for funding via the Salix Public Services Decarbonisation Scheme (PSDS) and the programme below has been developed to suit a 2-year funding period.

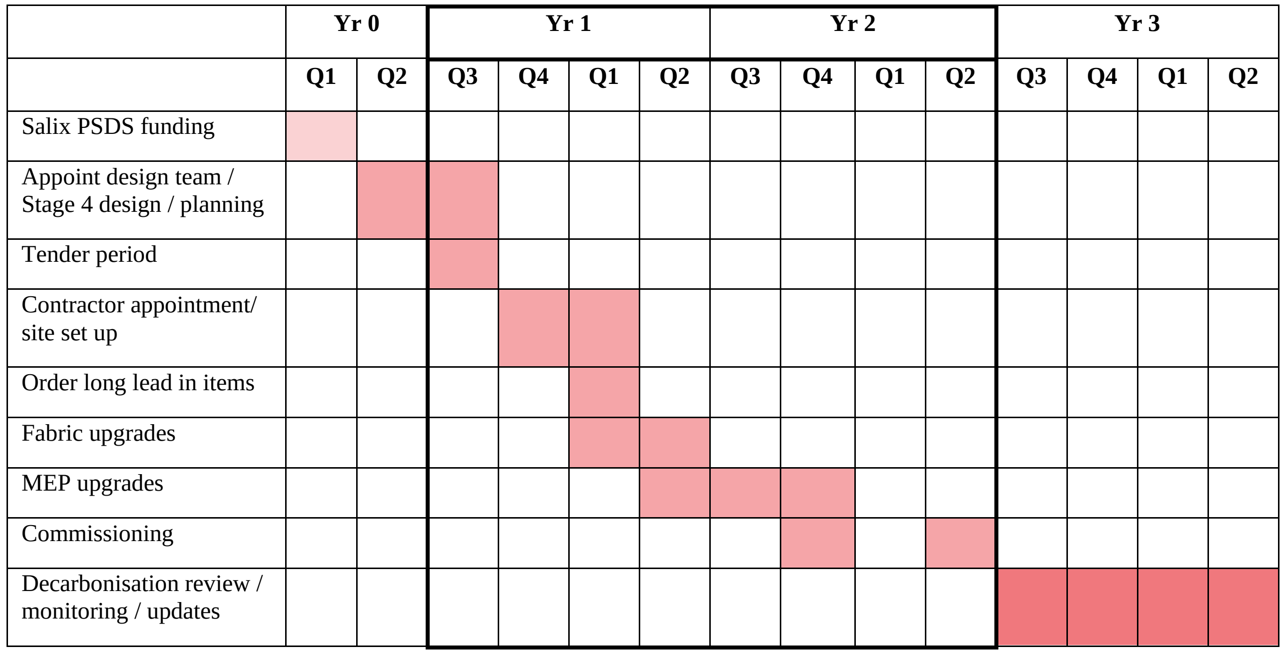


Figure 19 Indicative delivery programme

10.3 Resources

This section aims to provide context on the existing resources available and outline the future resources required to develop and deliver the heating decarbonisation.

10.3.1 Project Team

The project team will be responsible for preparation of the design and review of construction information and final commissioning information prior to building completion.

Table 12 Project team summary

Role	Design Stage	Responsibilities
Client / Project Manager	All	Interface between the Design Team and the Contractor. Assist in the appointment of the design team
Contract administrator	Stage 4 onwards	Plan and coordinate project team and monitor progress.
Architect	Stage 4 onwards	Design and review all matters related to the fabric upgrades including any changes to aesthetics of the building and planning preparation
MEP Engineers	Stage 3 onwards	Prepare matters relating to the mechanical and electrical engineering and energy analysis for the building. Assist client in preparation of the Salix funding application.
Facades Engineer	Stage 3 onwards	Review information related to upgrade of the existing fabric
Structural Engineer	Stage 4 onwards	Provide support and design related to new fabric upgrades and plant modifications.
Civil Engineer	Stage 4 onwards	Provide support and design related to external works
Acoustician	Stage 4 onwards	Prepare acoustic report and inform acoustic treatment required for proposals
QS	Stage 4 onwards	Prepare and review costs
CDM	Stage 3 onwards	
Contractor	Stage 4/5 onwards	The contractor will be appointed at an appropriate time to carry out the construction works. The Contractor will report through and the contract administrator at regular project team meetings.

10.4 Funding Opportunities

The Salix Public Sector Decarbonisation Scheme (PSDS) provides grants for public sector bodies to fund heat decarbonisation and energy efficiency measures.

Funding for the building heating decarbonisation should be available from

The last round of funding (PSDS Phase3c) closed in November 2023 and it is anticipated that there will be a new window opening for funding applications in 2024.

Salix funding in the previous application rounds has been based on the amount of fossil fuels energy displaced by a non-fossil fuel system. Based in the 2023 DEC information for fossil fuels energy consumption (224MWh), a potential Salix grant of £265,000 is available. This figure will need to be validated when the next PSDS application form is released.

11. Discussion

Fabric

The fabric first approach of improving the thermal performance of curtain walling, windows and roof can reduce annual energy consumption by approximately 17%. Installing external cladding to improve the wall U-value to from 0.5W/m^2.K to 0.26 will further enhance this saving however is not considered to be cost effective.

The facades survey highlights potential issues which should be investigated further such as possible flammable wall insulation and also the corrosion of the lintels above windows.

Minor repairs to other elements of the existing fabric are recommended prior to the façade upgrade works as discussed in the façade report.

Mechanical

ASHPs are proposed to replace the gas fired boilers and are considered to be the most cost-effective low carbon heating solution. GSHPs are slightly more efficient than ASHPs but the capital cost is much higher. A GSHP system uses less external plant space in the car park (once the boreholes have been completed) and, if GSHPs are preferred, an additional study can be undertaken.

The proposed lower flow temperature reduces the heating output of the existing radiators and FCUs and will require some heat emitters to be replaced due and shall be investigated in the detail design stage. The existing 4-pipe FCUs are proposed to be replaced due to their age and reduced output (although exact details for the FCUs are unknown).

New supply and extract AHUs with heat recovery can reduce peak heat demand significantly. Central plant heat demand can potentially be reduced further using AHUs with integral heat pumps and a cost-benefit analysis should be undertaken in the next design stage.

Plant replacement in the roof plantroom must be considered in more detail. Access is assumed to be available via the soft spot in the ventilation plant room floor. The University will need to confirm this access route is available. The alternative is to lift the plant through a temporary opening in the roof.

The proposed BMS modifications are significant and consideration will be given to cost effectiveness of replacing the entire controls enclosure during the detail design stage.

Electrical

The electrical substation's existing spare load capacity (197kVA) and is sufficient for the electrification of the heating system and no upgrades are anticipated. The National Grid have advised that a nominal fee is required to replace/upgrade the fuse in the substation. However, this assumes that the cable size if sufficient for the load and this should be confirmed by the University. If the cable size if smaller than the required size advised by National Grid then the cable will need to be upgraded at an additional cost.

Energy and Carbon

Carrying out the heating decarbonisation works can potentially reduce the buildings carbon emissions by approximately 32% using 2023 carbon factors for gas and electricity. The carbon emissions will reduce further as the electrical grid is decarbonised.

The fuel costs are approximately the same due to the high unit cost of electricity versus gas, but are predicted to reduce as the unit cost of electricity reduces in the future.

Funding Opportunities and Costs

The estimated budget cost for the heat decarbonisation project is £2.6million and is based on industry pricing books and Arup experience.

The Salix PSDS scheme is expected to announce funding for public sector decarbonisation in 2024 and this report should be the basis of an application. Further input will be required from Arup and the University to complete the application.

The programme of the works can be spread over 2 years to suit the Salix PSDS 2 year programme. In our experience, the 1 year Salix PSDS funding stream typically leads to the new heat source switchover in the heating season which can potentially cause disruption to the building users and lead to a shorter commissioning period.

As part of the PSDS application, we recommend that a Contractor is contacted to price the works. This is valuable for obtaining real costs and programme input.

12. Next steps

This RIBA Stage 3 report that should be reviewed in conjunction with the information within the appendices.

This report is suitable as the basis for an application for Salix funding through their Public Sector Decarbonisation Scheme (PSDS) when the next application window opens. Arup can work together closely with the University to prepare and submit the application. We recommend seeking input from a Contractor on the costs and programme prior to the Salix application window opening to provide a higher level of cost and programme certainty.

Further development of the design to RIBA Stage 4 is necessary ahead of a contractor developing their installation design for construction.

Prior to the work commencing, we recommend the University conducts the following surveys, investigations, and studies are completed.

- Full MEP survey of the building to ascertain equipment details and services distribution. Survey to include layout drawings with sizes, schematics, condition assessment of plant.
- Detailed above and below ground survey of external landscape to determine any buried services.
- Trial lower space heating flow temperatures, e.g. reducing the flow temp to 55°C flow and 45°C return prior to the ASHP installation to reduce energy costs and test building performance for installation of ASHP. Study to take place before and after fabric upgrades.
- Monitoring existing CO2 levels and space temperatures in key occupied spaces, e.g. open plan offices, meeting rooms.
- Establish if EV charging points in the car park are anticipated in the future.
- Confirm tail size of existing utility incoming power cable. A minimum size of 185mm2 is required for the proposed load.
- An intrusive survey of external wall buildup. This will inform wall's actual build-up and performance and confirm the type of insulation material and its flammability.
- Further investigation is required to confirm the extent of corrosion in lintels at window and curtain wall openings on both the ground and first floor.
- Gas and electricity unit costs paid by UWE to provide more accurate payback analysis.
- Detailed radiator survey and output check across the whole building.

Appendix A

Building Display Energy Certificates

DEC 2020

NORTHAVON HOUSE
University of the West of England
Frenchay Campus, Coldharbour Lane
BRISTOL
BS16 1QY

Operational rating

C

Certificate number:	2496-1027-0500-1805-9391
Valid until:	30 October 2020
Total useful floor area:	4,281 square metres

Energy performance operational rating

The building's energy performance operational rating is based on its carbon dioxide (CO2) emissions for the last year.

It is given a score and an operational rating on a scale from A (lowest emissions) to G (highest emissions).

The typical score for a public building is 100. This typical score gives an operational rating of D.

Score	Operational rating	This building	Typical
0-25	A		
26-50	B		
51-75	C	58 C	
76-100	D		100
101-125	E		
126-150	F		
150+	G		

Previous operational ratings

Date	Operational rating
October 2019	58 C
October 2018	52 C

Total carbon dioxide (CO2) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO2.

Date	Electricity	Heating	Renewables
October 2019	143	40	0
October 2018	153	44	0

Assessment details

Assessor's name	Ian Shellard
Employer/Trading name	ESOS Energy
Employer/Trading address	2nd Floor, Tower House, Fairfax Street, BS1 3BN

https://find-energy-certificate.service.gov.uk/energy-certificate/2496-1027-0500-1805-9391?print=true 1/2

15/11/2023, 09:35 Display energy certificate (DEC) – Find an energy certificate – GOV.UK

This building's energy use

Energy use	Electricity	Other fuels
Annual energy use (kWh/m2/year)	61	49
Typical energy use (kWh/m2/year)	95	115
Energy from renewables	0%	0%

Assessor's declaration	Contractor to the occupier for EPBD services only.
Accreditation scheme	Stroma Certification Ltd
Issue date	16 June 2020
Nominated date	31 October 2019

DEC 2021

Northavon House
University of the West of England
Frenchay Campus, Coldharbour Lane
BRISTOL
BS16 1QY

Operational rating

C

Certificate number:	2417-1116-2897-9102-8721
Valid until:	30 October 2021
Total useful floor area:	4,281 square metres

Energy performance operational rating

The building's energy performance operational rating is based on its carbon dioxide (CO2) emissions for the last year.

It is given a score and an operational rating on a scale from A (lowest emissions) to G (highest emissions).

The typical score for a public building is 100. This typical score gives an operational rating of D.

Score	Operational rating	This building	Typical
0-25	A		
26-50	B		
51-75	C	55 C	
76-100	D		100
101-125	E		
126-150	F		
150+	G		

Previous operational ratings

Date	Operational rating
October 2020	55 C
October 2019	58 C
October 2018	52 C

Total carbon dioxide (CO2) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO2.

Date	Electricity	Heating	Renewables
October 2020	129	43	0
October 2019	143	40	0
October 2018	153	44	0

Assessment details

Assessor's name	Ian Shellard

https://find-energy-certificate.service.gov.uk/energy-certificate/2417-1116-2897-9102-8721?print=true 1/2

15/11/2023, 09:34 Display energy certificate (DEC) – Find an energy certificate – GOV.UK

This building's energy use

Energy use	Electricity	Other fuels
Annual energy use (kWh/m2/year)	54.91	52.10
Typical energy use (kWh/m2/year)	95	111.60
Energy from renewables	0%	0%

Employer/Trading name	ESOS Energy
Employer/Trading address	2nd Floor Tower House, Fairfax Street, Bristol, BS1 3BN
Assessor's declaration	Contractor to the occupier for EPBD services only.
Accreditation scheme	Stroma Certification Ltd
Issue date	3 September 2021
Nominated date	31 October 2020

DEC 2022

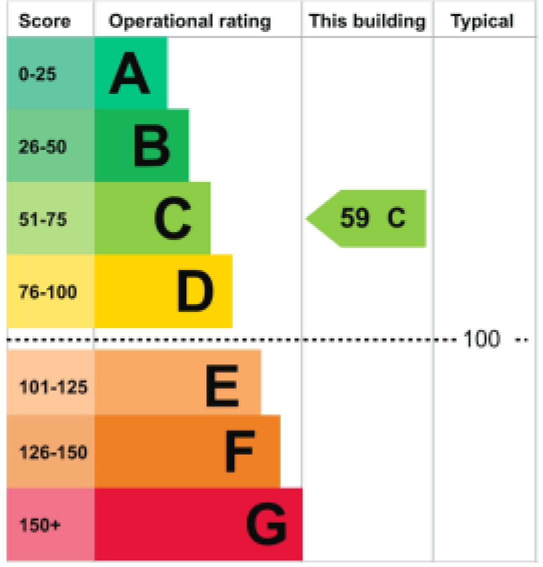
Northavon House University of the West of England Frenchay Campus, Coldharbour Lane BRISTOL BS16 1QY	Operational rating **C**	Certificate number: 4923-9792-6018-3293-0983 Valid until: 30 October 2022 Total useful floor area: 4,281 square metres

Energy performance operational rating

The building's energy performance operational rating is based on its carbon dioxide (CO2) emissions for the last year.

It is given a score and an operational rating on a scale from A (lowest emissions) to G (highest emissions).

The typical score for a public building is 100. This typical score gives an operational rating of D.



Previous operational ratings

Date	Operational rating
October 2021	59 C
October 2020	55 C
October 2019	58 C

Total carbon dioxide (CO2) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO2.

Date	Electricity	Heating	Renewables
October 2021	118	74	0
October 2020	129	43	0
October 2019	143	40	0

Assessment details

Assessor's name	Adrian Newton

https://find-energy-certificate.service.gov.uk/energy-certificate/4923-9792-6018-3293-0983?print=true 1/2

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This building's energy use

Energy use	Electricity	Other fuels
Annual energy use (kWh/m2/year)	50.26	88.78
Typical energy use (kWh/m2/year)	95	122.68
Energy from renewables	0%	0%

Employer/Trading name	ESOS Energy Ltd
Employer/Trading address	2nd Floor Tower House, Fairfax Street, Bristol, BS1 3BN
Assessor's declaration	Contractor to the occupier for EPBD services only.
Accreditation scheme	CIBSE Certification Limited
Issue date	25 April 2022
Nominated date	31 October 2021

DEC 2023

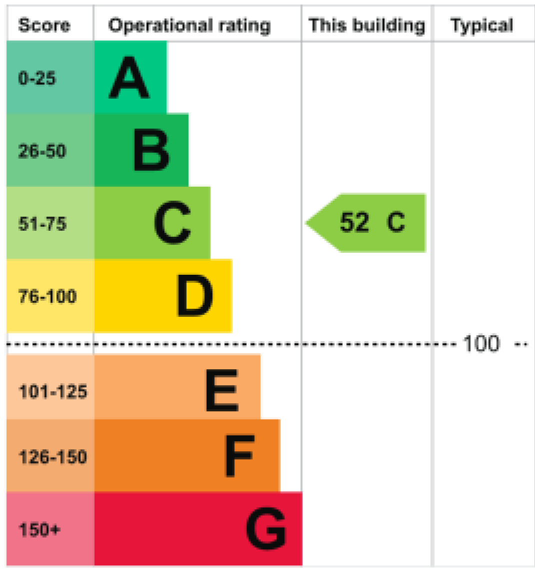
NORTHAVON HOUSE University of the West of England Frenchay Campus, Coldharbour Lane BRISTOL BS16 1QY	Operational rating **C**	Certificate number: 2942-1401-7926-8208-9221 Valid until: 29 October 2023 Total useful floor area: 4,281 square metres

Energy performance operational rating

The building's energy performance operational rating is based on its carbon dioxide (CO2) emissions for the last year.

It is given a score and an operational rating on a scale from A (lowest emissions) to G (highest emissions).

The typical score for a public building is 100. This typical score gives an operational rating of D.



Previous operational ratings

Date	Operational rating
October 2022	52 C
October 2021	59 C
October 2020	55 C

Total carbon dioxide (CO2) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO2.

Date	Electricity	Heating	Renewables
October 2022	122	44	0
October 2021	118	74	0
October 2020	129	43	0

Assessment details

Assessor's name	Adrian Newton

https://find-energy-certificate.service.gov.uk/energy-certificate/2942-1401-7926-8208-9221?print=true 1/2

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This building's energy use

Energy use	Electricity	Other fuels
Annual energy use (kWh/m2/year)	51.70	52.50
Typical energy use (kWh/m2/year)	95	112.73
Energy from renewables	0%	0%

Employer/Trading name	Esos Energy
Employer/Trading address	5th Floor, Castlemead tower, Lower, Bristol, BS1 3BN
Assessor's declaration	Contractor to the occupier for EPBD services only.
Accreditation scheme	CIBSE Certification Limited
Issue date	21 September 2022
Nominated date	30 October 2022

Appendix B

Meter Data Report

Subject	University of the West of England Northavon House Meter Review
Job No/Ref	297699-00
Date	24 October 2023

ARUP

1. Introduction

The purpose of this document is to report on Arup’s findings from the metering information provided by the University of the West of England for Northavon House. The data will be used to assess building heat loads and inform provisional plant selections.

2. Metering information

A summary table of the half hourly meters is in Table 1.

The meters are on the incoming supply and serve Northavon House solely, as a result no manipulation or assumptions of utility usage was required.

Table 1 DH1 heat meter summary

Meter Ref	University Meter Ref	Meter Location	Service	Meter Resolution	Notes
				kWh	
Elec	Northavon Gas {EA data} (kWh)	Northaven Plantroom	Electricity	10	Electrical usage of whole building. Not limited to space heating.
Gas	Northavon Main Elec {Stark} (kWh)	Northaven Plantroom	Gas	100	Gas usage for existing gas boiler.

3. Metering Analysis

We have reviewed the metering data to assess the building's gas and electricity profile and to estimate the peak gas usage and electrical load. The outputs from the meter analysis will be used inform the building thermal model loads and profiles.

A summary table for the meters is below. Metering data graphs for each of the meters are included in Appendix A.

Table 2 DH1 heat meter analysis

Meter Ref	Location	Equipment Installed Load kW	Peak Load / meter kW	Notes	Heat Meter Output Data Quality
Elec	Northaven Plantroom	-	84kW peak (48kW avg. daily)	• The readings were consistent and showed a repeated occupancy profile throughout the year. This aligns with the building type and hours of operation. • Electrical meter data is on the incoming supply and includes both regulated and unregulated energy use.	Good
Gas	Northaven Plantroom	-	320kW warm up peak load 200kW daytime operation heat load.	• Consistent spike in the gas load is observed in early morning throughout the year (typically around 5 a.m.), suggesting a pre-heat period to bring the building up to set-point after losing heat over night. • Pre-heat stops at around 6:30 a.m., leading to a relatively consistent load throughout the day. • The building heating profile drops off at 5pm on most evenings suggesting heating is turned off at this time. • A longer pre-heat period can reduce the spike and reduce the peak load.	Good

4. Summary

The metering data quality appears to be good and provides a useful insight into the building operational loads and profiles that can be used to inform the next phase of work.

Some key observations are below:

- The meter data period is between 1st October 2021 through to 30th September 2023 for both meters.
- Electrically, it is evident that usage is much greater during the week (Monday to Friday) than the weekends. Consistently, electrical usage starts rising at round 7am for an hour. After that, the usage level stays steady between 8am to 4pm before slowly dropping as occupancy reduces into the evening. This is consistent with the assumed building type and its expected profiles.
- The electrical metering data is for the incoming electric to the building as a whole and is not broken down by end use, e.g. small power, lighting, ventilation, hot water, cooling.
- As expected, gas usage was low in the summer months (June to August) since there is minimal heating demand and the domestic hot water is all electric.
- A short pre-heat period was observed most mornings, with a spike in gas usage during a 1-2 hour preheat time from around 5am. The heating returns to a steady heating input rate from approx. 7am until 5pm when the heating usage drops. This aligns with feedback from the university.

5. Recommendations

We have the following recommendations from the Northavon House metering review.

- Existing metering data appears to be good. The meters should be well maintained and replaced periodically to ensure the maintain their accuracy.
- Additional meters are required to provide a breakdown of energy use by end use as recommended in CIBSE TM39., e.g., small power, lighting, heating, cooling, domestic hot water, Server, Lifts, etc. This allows a more in depth energy analysis and can be used to find faults in the operation and performance of the building systems.

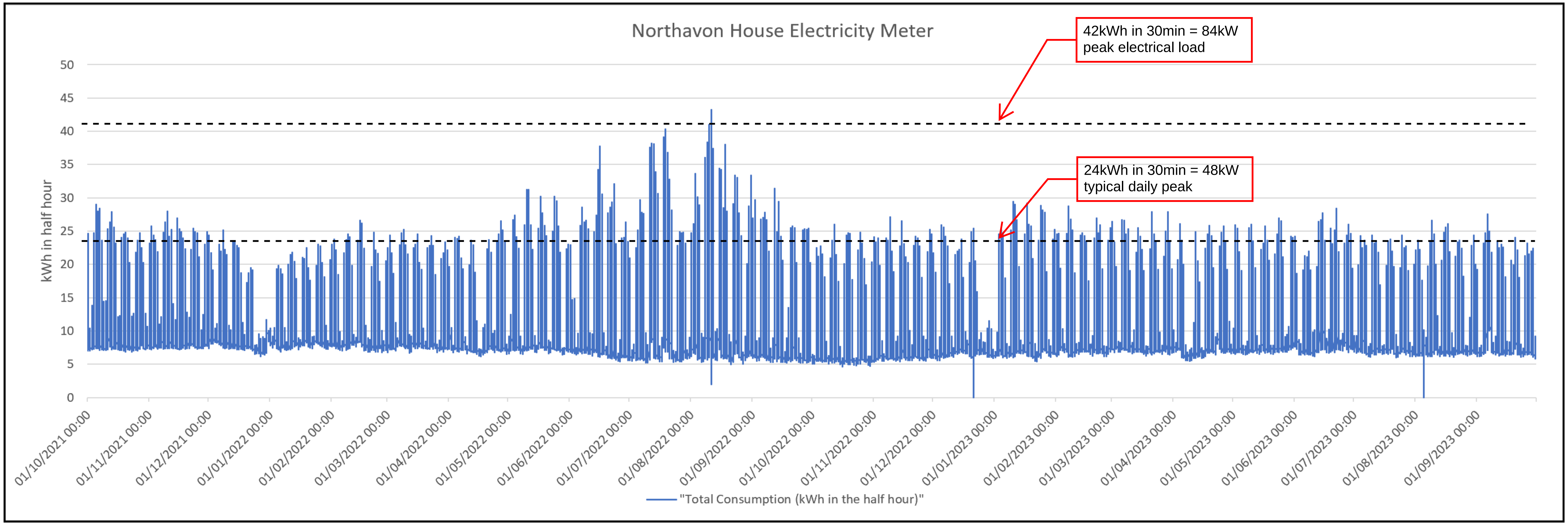
6. Next Steps

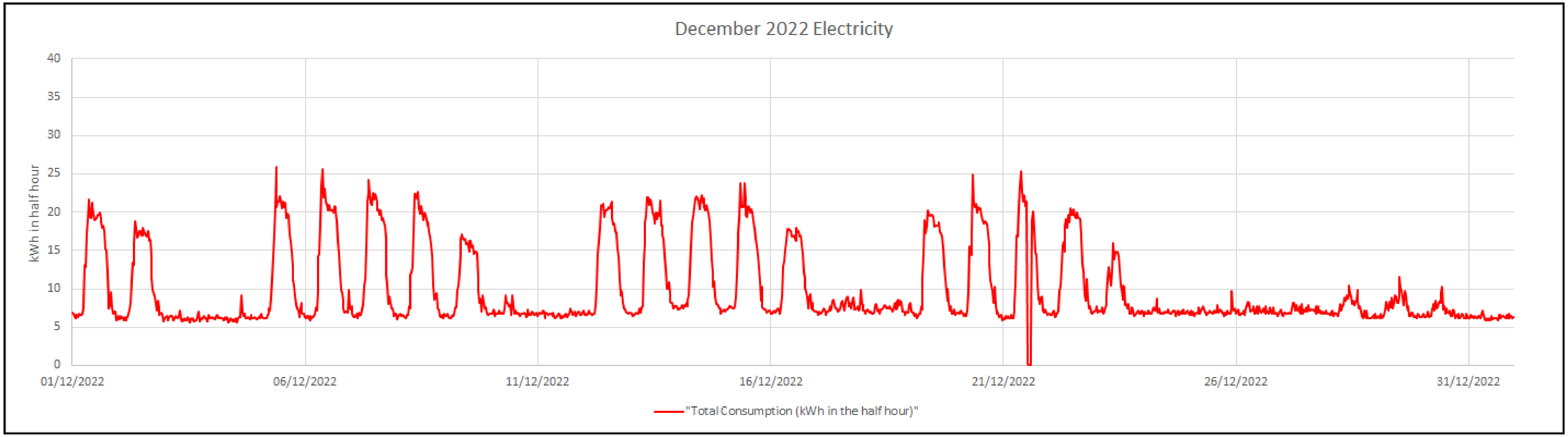
The estimated peak load information in Table 2 will be used to inform base case thermal modelling and this will feed into the Northavon House Decarbonisation Study

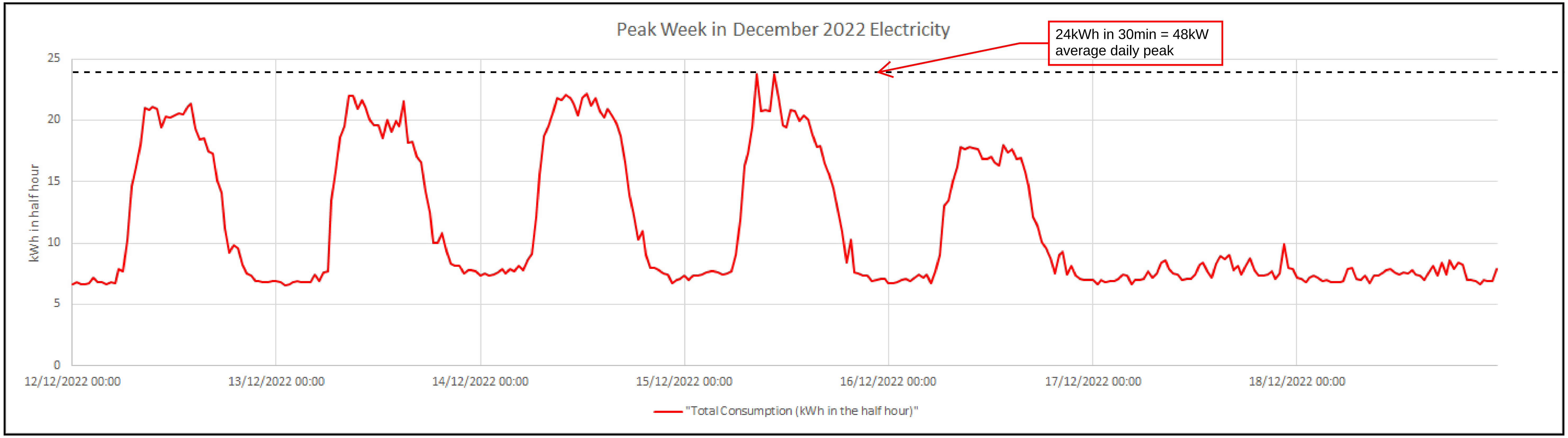
Appendix A

Heat Meter Analysis

University of the West of England Decarbonisation
Northavon House Electrical Meter

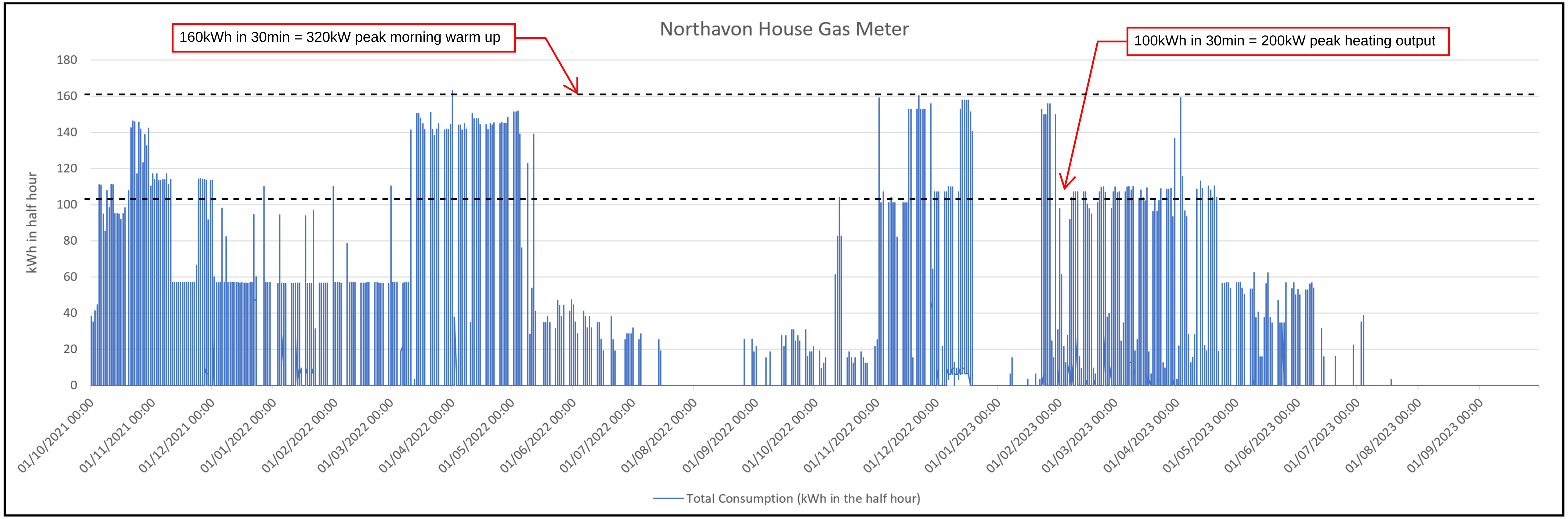


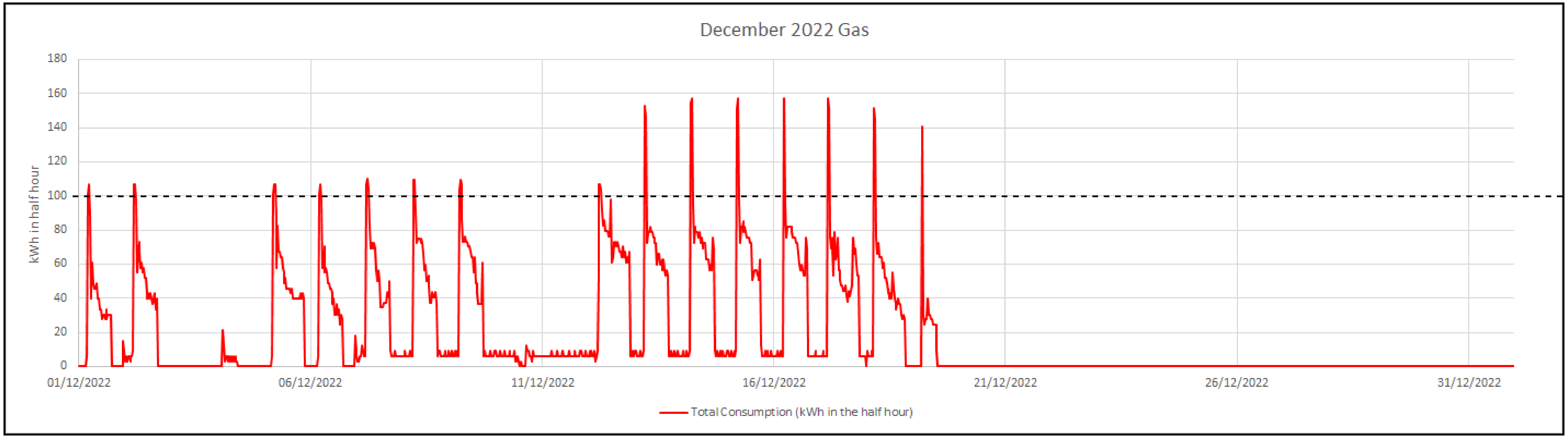

December 2022 Electricity
kWh in half hour
40
35
30
25
20
15
10
5
0
01/12/2022
06/12/2022
11/12/2022
16/12/2022
21/12/2022
26/12/2022
31/12/2022
"Total Consumption (kWh in the half hour)"

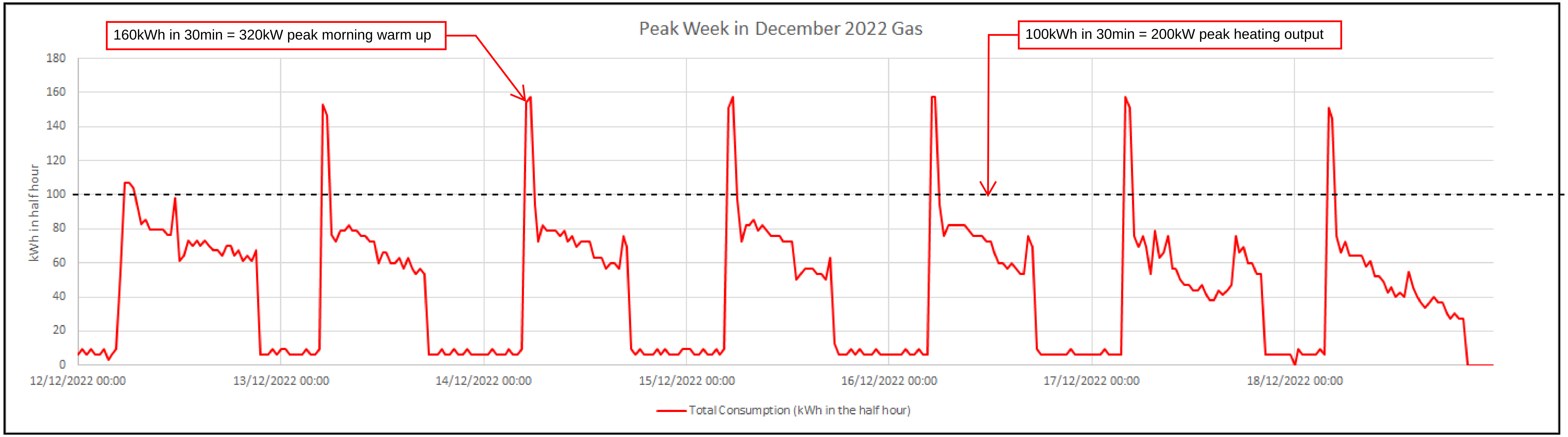

Peak Week in December 2022 Electricity
24kWh in 30min = 48kW average daily peak
kWh in half hour
25
20
15
10
5
0
12/12/2022 00:00
13/12/2022 00:00
14/12/2022 00:00
15/12/2022 00:00
16/12/2022 00:00
17/12/2022 00:00
18/12/2022 00:00
"Total Consumption (kWh in the half hour)"

University of the West of England Decarbonisation
Northavon House Gas Meter

ARUP




December 2022 Gas
kWh in half hour
180
160
140
120
100
80
60
40
20
0
01/12/2022
06/12/2022
11/12/2022
16/12/2022
21/12/2022
26/12/2022
31/12/2022
Total Consumption (kWh in the half hour)


Peak Week in December 2022 Gas
160kWh in 30min = 320kW peak morning warm up
100kWh in 30min = 200kW peak heating output
kWh in half hour
180
160
140
120
100
80
60
40
20
0
12/12/2022 00:00
13/12/2022 00:00
14/12/2022 00:00
15/12/2022 00:00
16/12/2022 00:00
17/12/2022 00:00
18/12/2022 00:00
Total Consumption (kWh in the half hour)

Appendix C

Thermal Modelling Design Note

ARUP

Subject	UWE NAH Thermal Modelling Design Note
Job Number	297699-00
Date	22 December 2023

1. Introduction

A digital twin of Northavon House has been created in IES to assess the impact of the proposed building interventions. The IES thermal model heating consumption and heating profiles have been correlated with the building DEC and building meter data to verify the assumptions and baseline the thermal model.

The building geometry was built in IES using the available architectural general arrangement layouts and sections. The dimensions were validated using approximate site measurements and information from a 3D Lidar scan of some spaces.

Dynamic thermal modelling of the building was carried out using IES Virtual Environment software IESVE 2023.

1.1 Key Uncertainties and Assumptions

This analysis is based on available O&M information, client workshops and a study into the existing façade. Where information was not available and assumption are required, this has been highlighted in this design note. Surrounding buildings and tree have not been modelled.

2. Model inputs

2.1 Building Geometry

The building geometry has been measured or referenced from the existing pdf drawings and HEFCE Building - Frenchay New Office Building - Building Manual provided by UWE Bristol. The heated envelope of the building of the modelled and this does not include the pitched roof as it is a cold void.

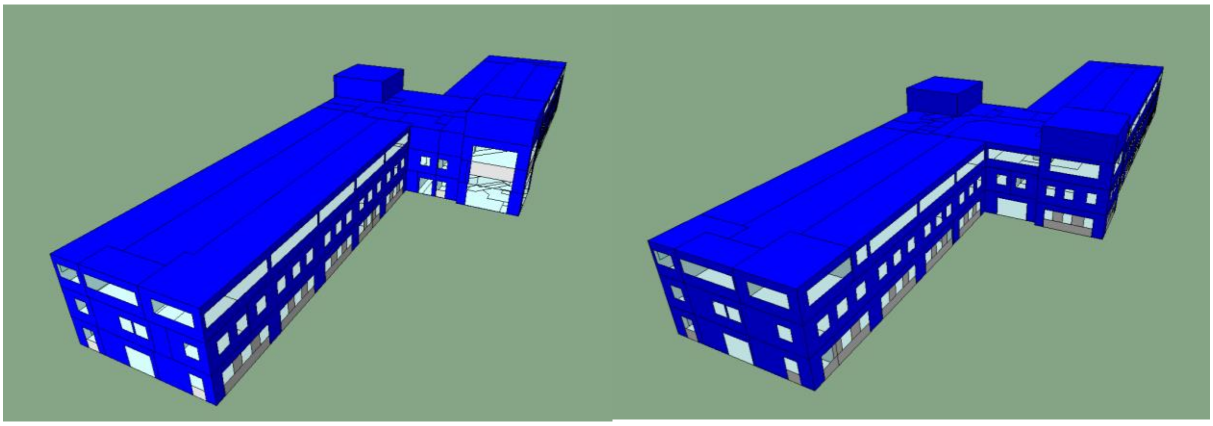


Figure 1 3D Model views in IESVE 2023

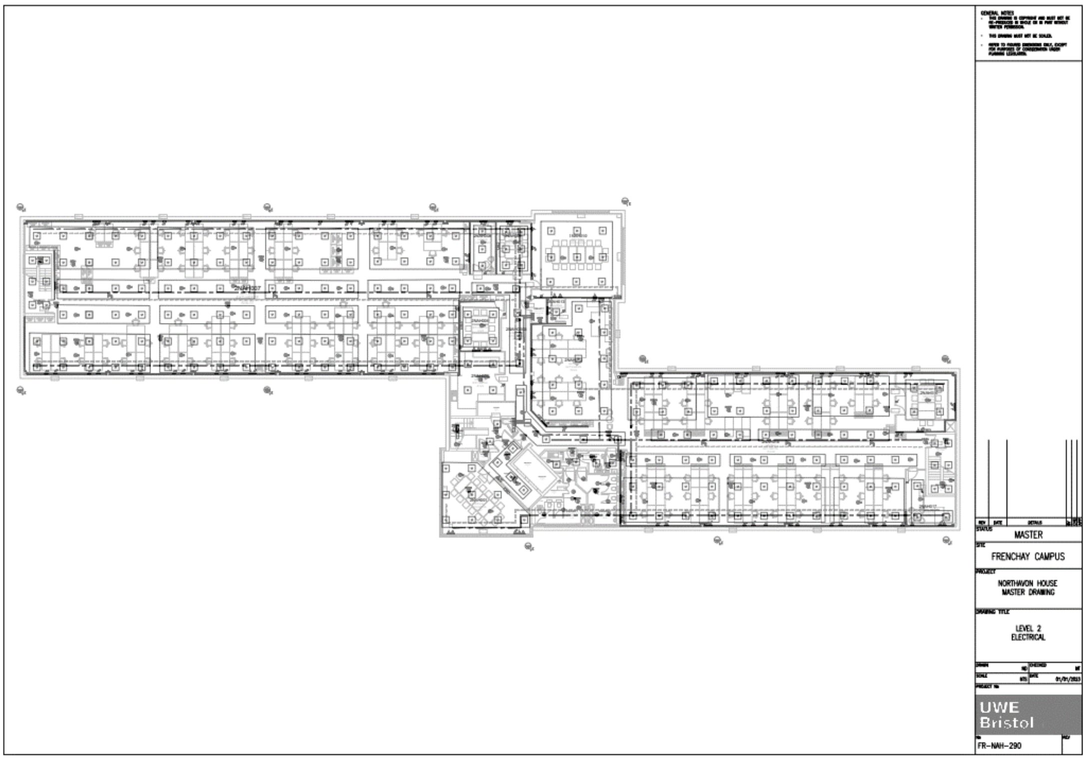


Figure 2 Layout plans from existing drawings

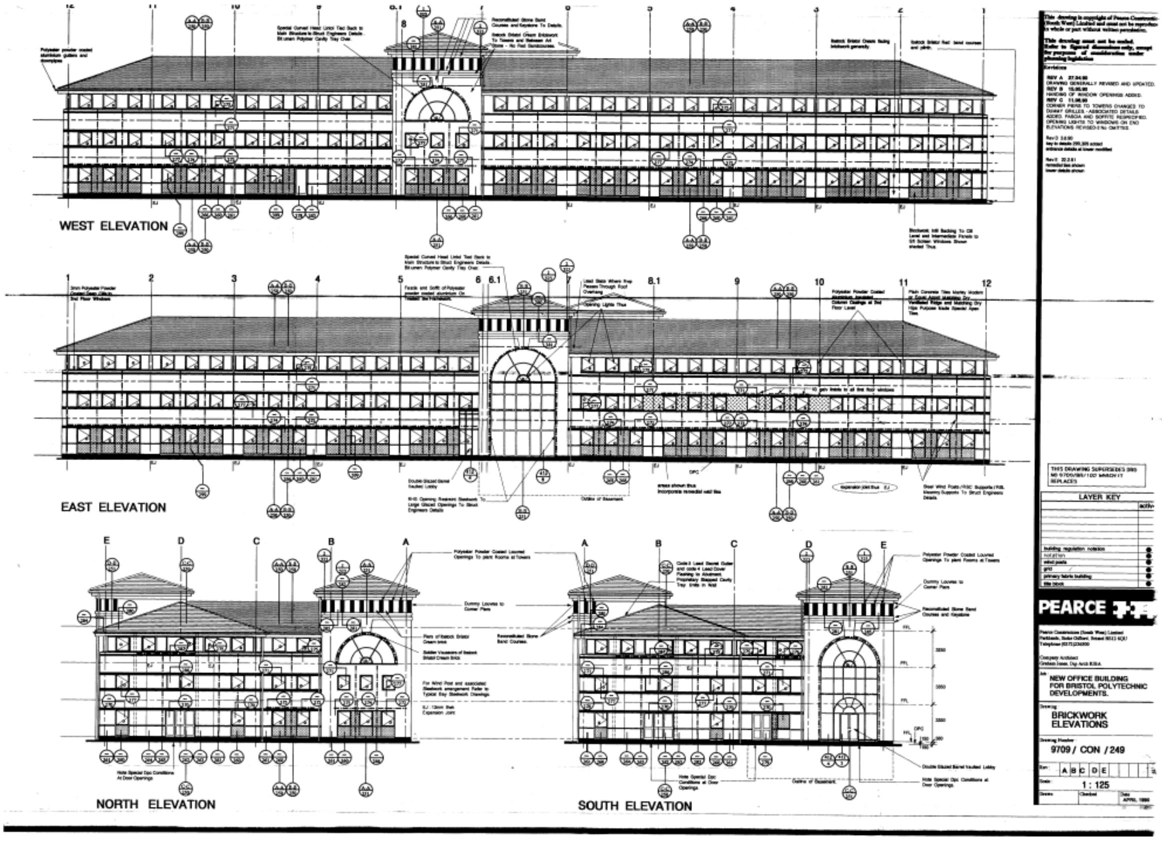
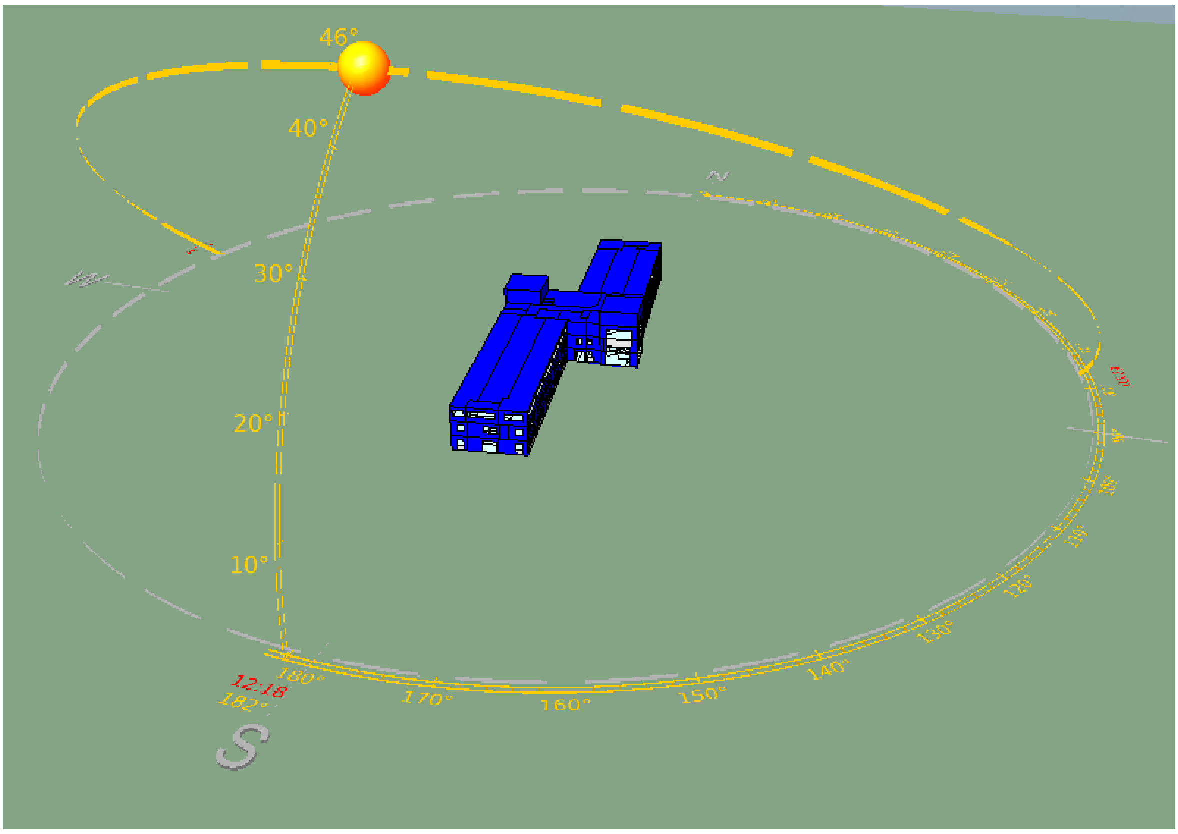


Figure 3 Elevation from the building manual

2.2 Location and Weather

The analysis uses the Cardiff Test Reference Year (TRY) weather set published by CIBSE (2016. Cardiff_TRY.epw). The Cardiff TRY has been chosen as a Bristol TRY is not available and Cardiff is the geologically closest TRY to Bristol. The corresponding sun path diagram and external weather data are as shown below. Ground Temperature is set to be steady 10°C.



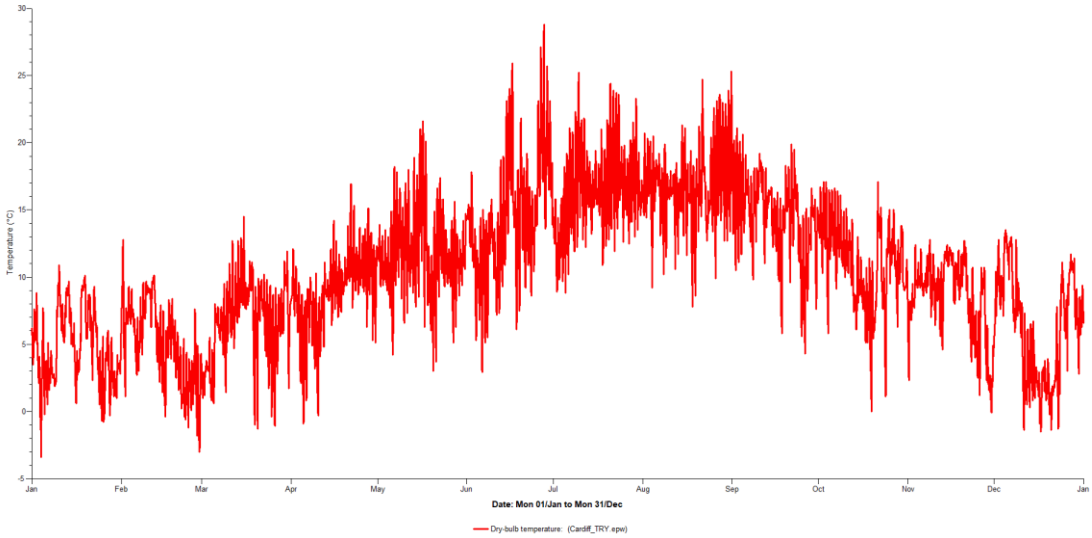


Figure 4 Sunpath diagram and external weather data extracted from Cardiff_TRY.epw

2.3 Building fabric and construction data

The table indicates the thermal performance of the building and the sources for the data.

Table 1 Existing building fabric thermal performance

Building Elements	U – value (W/m^2 K)	Source
External Walls	0.5	Based on Façade report
Roof	0.25	Minimum Part L regulations (1990)
Windows	2.8	Based on Façade report
Curtain walls	2.8	Based on Façade report
Internal Walls	1.79	Assumed - IES Default
Internal Floor	1.08	Assumed - IES Default
Ground Contract Walls	1.76	Based on existing building details
Ground Contact Floor (Ground Level)	0.72	Based on existing building details
Ground Contact Floor (Basement Level)	1.91	Based on existing building details

2.4 Building Heating systems

The building space heating is provided by 3no gas fired condensing boilers with an efficiency of 85%. The space heating is provided by radiators, fan coil units, and AHUs and is summarised below.

Table 2 Space heating systems

Emitter type	LTHW system	Location served	Comments
Radiators	VT	All areas	Single panel radiators
FCUs	CT	Core offices and core meeting rooms only.	4 pipe FCUs. Space heating topped up by rads.
AHUs	CT	Core offices and core meeting rooms, WCs, basement changing area.	Heater batteries on supply only AHUs. See section 2.7

2.5 Occupancy profiles

The building is occupied between 7am to 7pm Monday to Friday and closed on weekends. The building is closed over Summer and Christmas holiday periods.

The general occupancy profile used for each of the space referred to the default NCM profiles as indicated in Table 3 as these profiles reflect the actual occupied daily usage of the building.

Table 3 Apache template summary

Space Type	NCM template assigned
Office	NCM B1 Office or Workshop (Office) : Office Open
Meeting Room	NCM B1 Office or Workshop (Office) : Office (Office : Meeting)
Café	NCM B1 Office or Workshop (Office) : Food preparation area
Changing Room	NCM B1 Office or Workshop (Office) : Changing facilities
Toilet	NCM B1 Office or Workshop (Office) : Toilet

2.6 Heating profiles

The heating is on between 7am and 7pm on weekdays and set back to 12°C on evenings and weekends.

The heating profile used for the building is as the profile in Figure 5 and represents the heating optimised on this building.

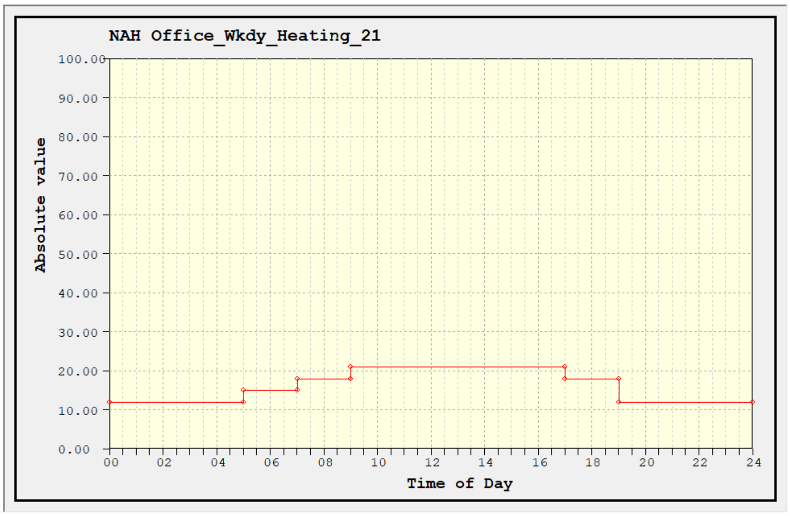


Figure 5 IES daily heating profile

2.7 Air infiltration and ventilation

An air permeability of 10m3/m^2.hr @ 50Pa has been used for the existing buildings which is typical for a building of this age and construction and is advised by the Façade engineer. This equates to an estimated air infiltration of 0.5ACH at normal atmospheric pressure.

Natural ventilation has been modelled in the building using IES Macroflo profiles which models the effects of window opening according to time, internal temperature, and external temperature. The profile is as below.

The profile allows the window open gradually from indoor room temperature(ta) from 23 to 25 °C, as long as the outdoor air temperature(to) is greater than 16 °C. For example, given to = 17 °C, ta= 24 °C, the opening percentage of the window will be 50%.

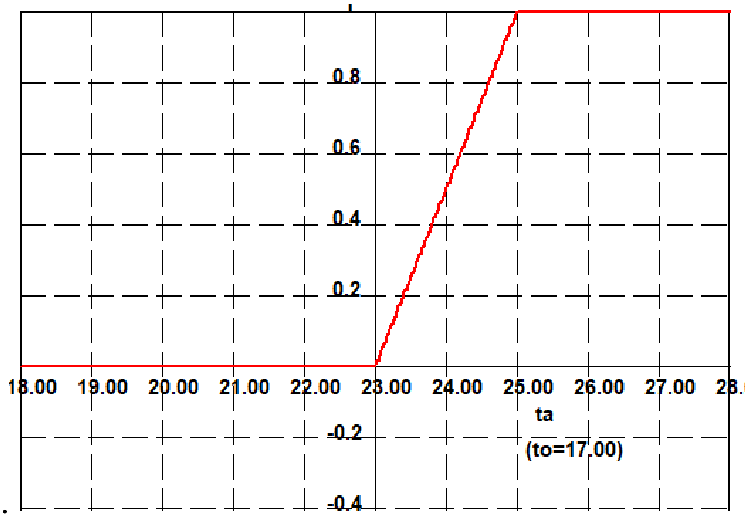


Figure 6 MarcoFlo ventilationProfile

Mechanical ventilation is provided to the WC core, basement changing area and some meeting rooms in the central core area. For the base case, the flowrates for each of the systems is as NCM profiles for these areas and had been modelled as Table 4 and represents the AHU duty indicated on the AHU nameplate.

For the proposed case, 80% heat recovery has been applied to these systems.

Table 4 Mechanical ventilation flowrate in different systems

System	LTHW system	Ventilation Supply AHU flowrate (l/s)	Heat recovery (Yes/No)	Comments
WC core	CT	1190	No	
Basement	CT	348	No	Reduced flowrate. Serving changing only.
Core meeting rooms	CT	1616	No	

2.8 Internal gains

The internal gains for the building space types are summarised in Table 5 Internal gains in different space types

Table 5 Internal gains in different space types

Space type	Lighting Power Density (W/m²)	Small Power (W/m2)	Occupancy (m²/person)
Office	6	5	5 (based on average seat count on the layout)
Meeting Room	6	5	5
Café	6	5	5
Changing Room(showers)	6	5	Assuming 8 people taking showers per day

Space type	Lighting Power Density (W/m²)	Small Power (W/m2)	Occupancy (m²/person)
Toilet	6	5	Based on occupancy from other occupied spaces

2.9 Hot Water System

The hot water is provided by an electric calorifier and POU electric water heaters and is outside of the scope of the thermal modelling.

3. Proposed building interventions

The following changes were made to the thermal model for the proposed building interventions. All other parameters in the base IES model remained the same.

Table 6 Proposed constructions and infiltration

Building Elements	Base case U-Value (W/m^2 K)	Proposed U-Value (W/m^2 K)	Comments
External Walls	0.5	0.5	No improvement
Roof	0.25	0.16	Minimum building regs
Windows	2.8	1.3	Proposed
Curtain walls	2.8	1.3	Proposed
Ventilation and Infiltration	**Base Case**	**Proposed**	**Comments**
Air permeability @ 50Pa	10 m3/m2.hr	7.5 m3/m2.hr	
Ventilation heat recovery	No	80%	

4. Results

The results for the base case and the proposed model are in the table below.

Table 7 Heating results comparison

Scenario	Annual gas energy kWh	% difference vs. base case	Peak gas heating load kW	% difference vs. base case	Comments
Existing recorded data	221,328	-	200	-	Annual heating energy consumption based on DEC 2023 output for fossil fuels. 200kW peak gas input equates to
IES Base case	233,505	-6%	190	-	IES result is within 10% of actual DEC 2023 data.
IES Proposed	140,566	36%	160	-42%	Improved fabric and ventilation upgrades.
IES Proposed (inc management factor)	154,623	30%		-36%	10% management factor applied

A comparison of the gas consumption profiles for the metered data and the IES profiles are illustrated in Figure 8 and Figure 9 on the following page.

Figure 10 and Figure 11 illustrate the peak weekly heating sensible load for the base model and proposed model.

The peak profile from the metered gas data is in Figure 7. The peak morning warm up spike occurs in the morning when the building calls for heat and quickly settles to the peak building heating output. The peak heating output is the most appropriate value to base the building heating load. In practice, the spike can be minimised by further optimising the heating morning warm-up.

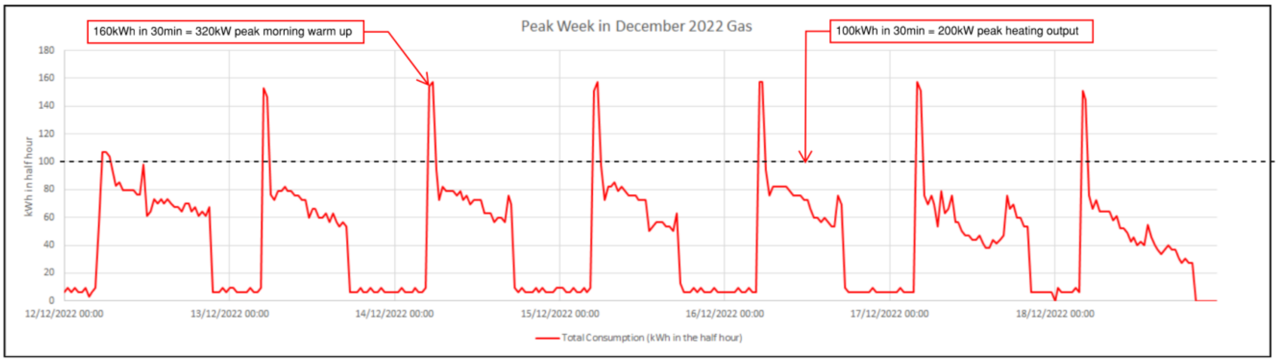


Figure 7 Peak gas meter profile indicating peak morning warm up and peak heating ouput

4.1 Management factor

A 10% factor has been applied to the overall estimated consumption with the improved fabric to account for thermal bridging and the non-optimum running of systems. This is intended to account for the difficulty in modelling the operation of existing buildings with varied operating schedules and predominantly natural ventilation.

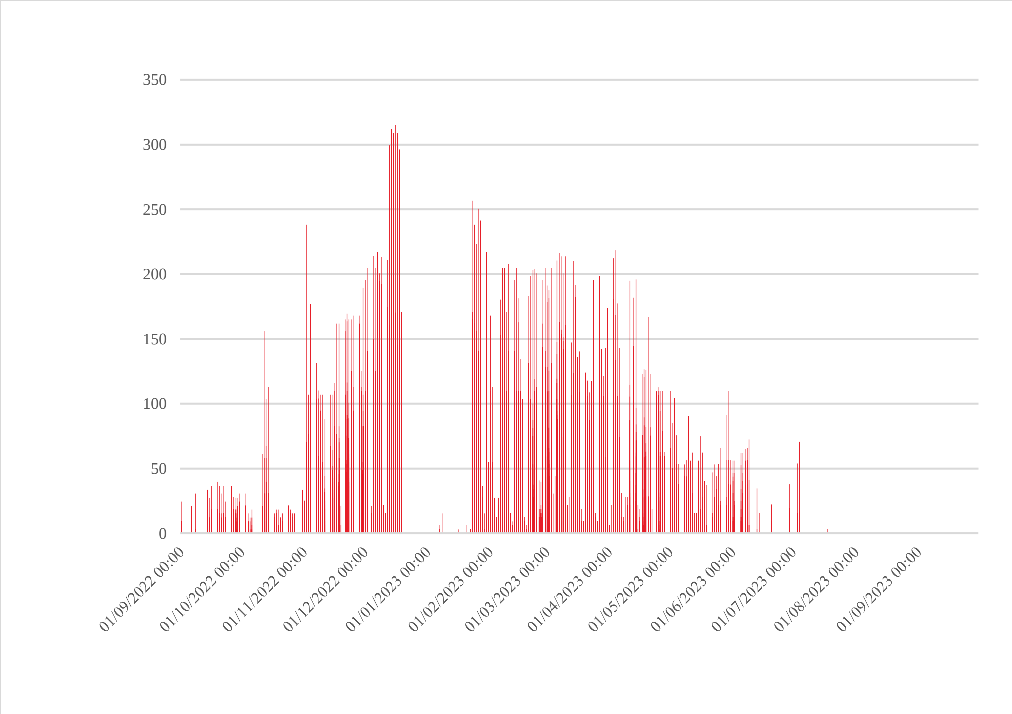


Figure 8 Annual gas consumption based on meter data (Sep 2022 – Aug 2023), hourly data

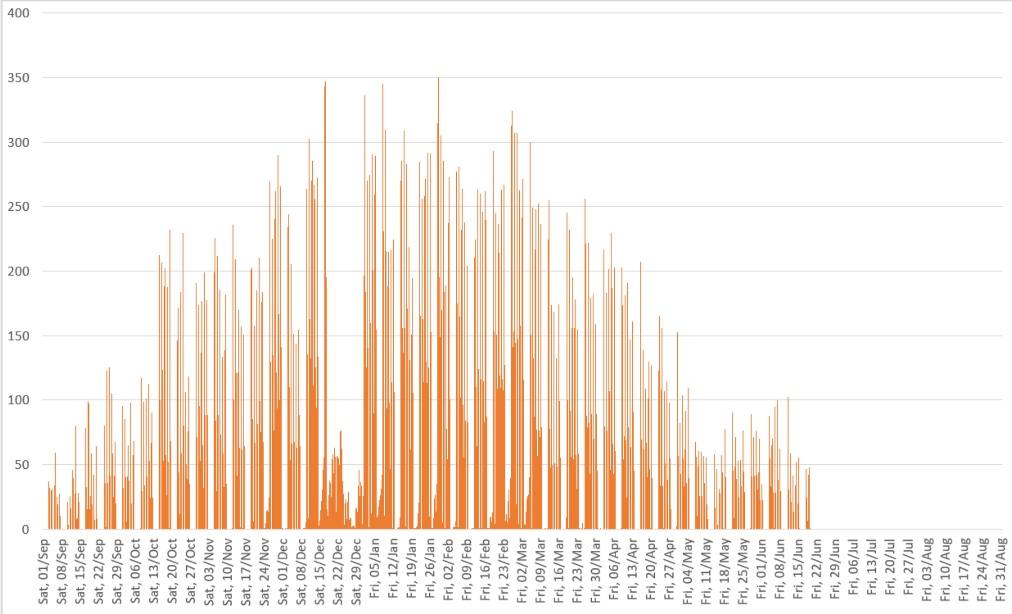


Figure 9 Annual gas consumption based on IES simulation, hourly data. Base case.

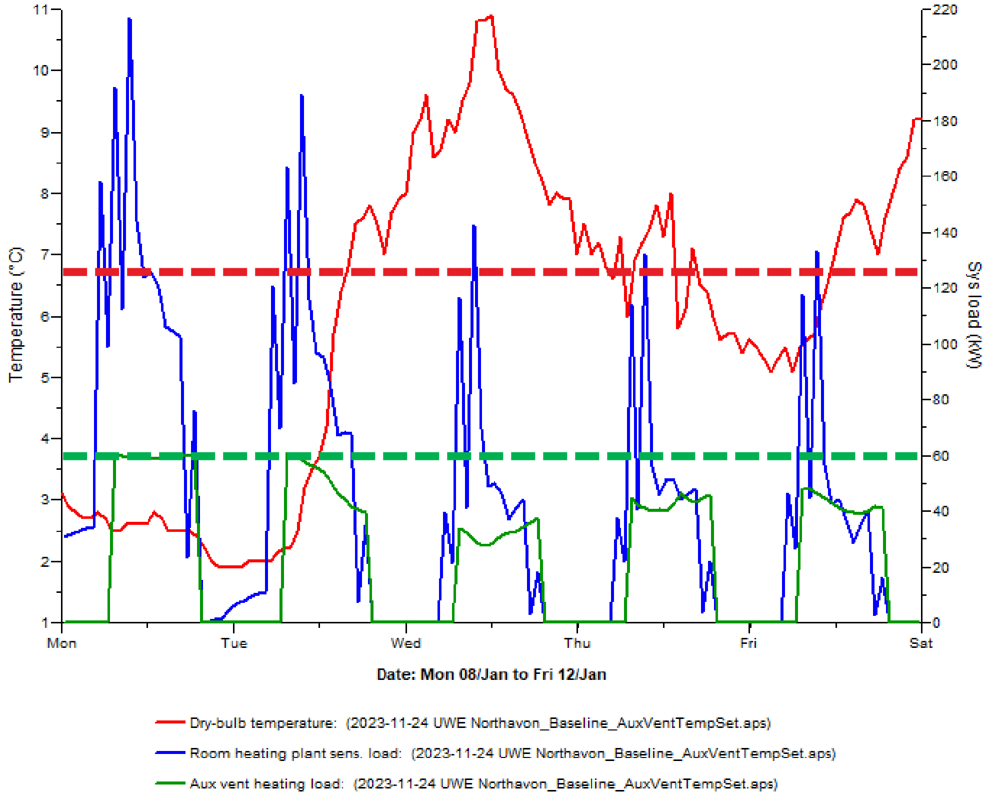


Figure 10 Space heating and ventilation heating load for base model.

Figure 10 illustrates the base model IES heating profiles for the peak week heating sensible loads for the space heating and ventilation heating loads.

The dashed red line indicates the typical peak space heating load and discounts the spikes. The spikes can be mitigated through further optimisation control of the morning warm up.

The green dashed line indicates the ventilation heating load profile.

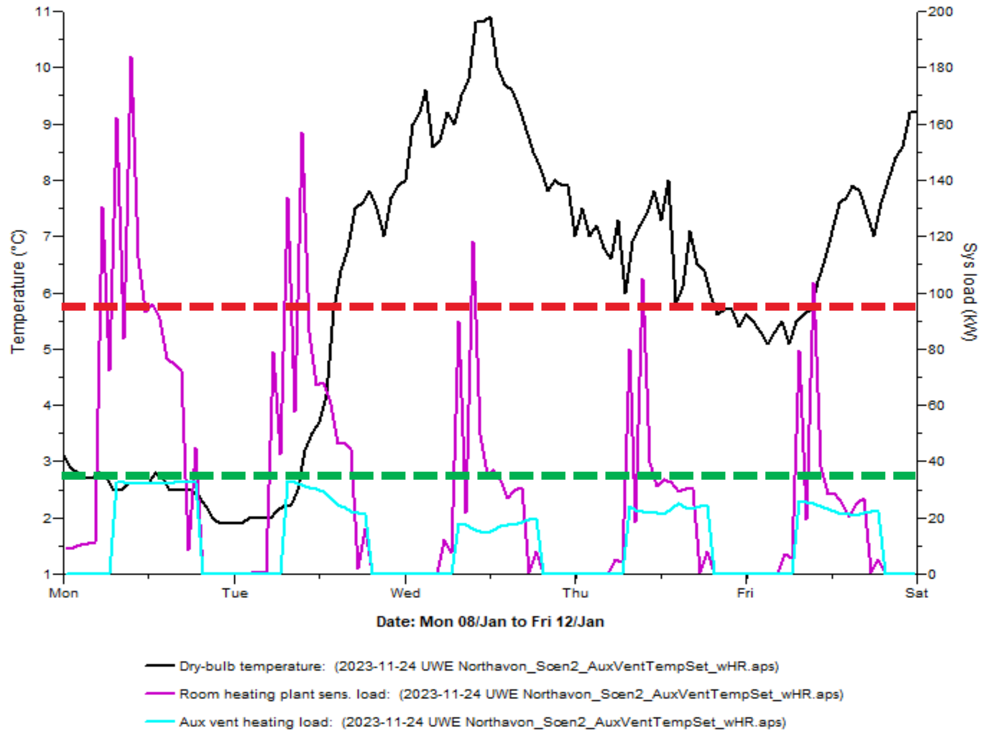


Figure 11 Space heating and ventilation heating load for proposed model.

Figure 11 illustrates the proposed model IES heating profiles for the peak week heating sensible loads for the space heating and ventilation heating loads.

The dashed red line indicates the typical peak space heating load and discounts the spikes. The spikes can be mitigated through further optimisation control of the morning warm up.

The green dashed line indicates the ventilation heating load profile.

4.2 Discussion

The IES base model result shows a 9% difference for gas consumption (space heating) and 11% and peak heating load and is considered a close match. Therefore, the base- case IES model is an appropriate digital twin of the existing building.

For the proposed simulated results, IES provide an estimated heat load for the building with the proposed fabric improvements and ventilation heat recovery and is suitable to inform the sizing of the heat source.

Appendix D

Fabric Performance Audit

University of the West of England

Northavon House Decarbonisation

Fabric performance audit

Reference: 5.5

P01 | 24 October 2023

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 297699-00

Ove Arup & Partners Limited
63 St Thomas Street
Bristol
BS1 6JZ
United Kingdom
arup.com

Document Verification

Project title	Northavon House Decarbonisation
Document title	Fabric performance audit
Job number	297699-00
Document ref	
File reference	

Revision	**Date**	**Filename**	UWE NAH Fabric Performance Audit P01		
P01	24/10/2023	**Description**	First issue for comment		
			Prepared by	**Checked by**	**Approved by**
		Name	Jolie Lau	Innes Ross	Matt Williams
		Signature			
		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

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Figures

Drawings

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Pictures

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Photographs

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Attachments

No table of figures entries found.

Appendices

No table of contents entries found.

1. Introduction

Arup Façade have been instructed to produce a report relating to aspects of the external wall systems to Northavon House, at The University of the West of England, which was opened in 1991.

This document examines the thermal performance and general state of repair of the building fabric based on a non-intrusive survey conducted on 11th October 2023, and subsequent desktop reviews by the Arup Facades team. This is a supplementary piece to the comprehensive Stage 1 Arup report, which reviews the University's carbon reduction goals, energy and carbon audits, and the existing systems.

The content herein offers insights into the primary fabric types identified during the site visit, detailing the:

- Presumed build-up/construction,
- Any health and safety concerns,
- Estimated thermal performance, and
- Current conditions.

Common themes are highlighted by photographs. The report is not intended to be a line-by-line record of all items/ issues identified or their specific locations. Further information can be provided on specific items, should any further clarifications be required. The objectives of this report are to:

- Highlight crucial items that need attention before considering façade interventions.
- Identify opportunities in enhancing the thermal efficiency of the façades.
- Determine any further surveys, including those that might be intrusive, that are deemed essential.

1.1 Documents reviewed

The following documents relating to the façade have been reviewed and helped inform part of this study:

- "New Office Building Bristol Polytechnic: Volume No 1"
- "New Office Building Bristol Polytechnic: Volume No 2"

1.2 Inspection details

The condition survey of the building façade was carried out over the course of 1 day.

Date	Temperature	Precipitation	Wind
11th October 2023	16-19 C	None	8 mph S

2. Visual appraisal

2.1 Brickwork/ Opaque Façade Elements

Figure 1, External view of brick wall

2.1.1 General description

The typical wall-build up consists of 103mm brick, a cavity filled with 35mm Celotex insulation, and an inner layer of 100mm concrete blockwork, as depicted in Figure 2.

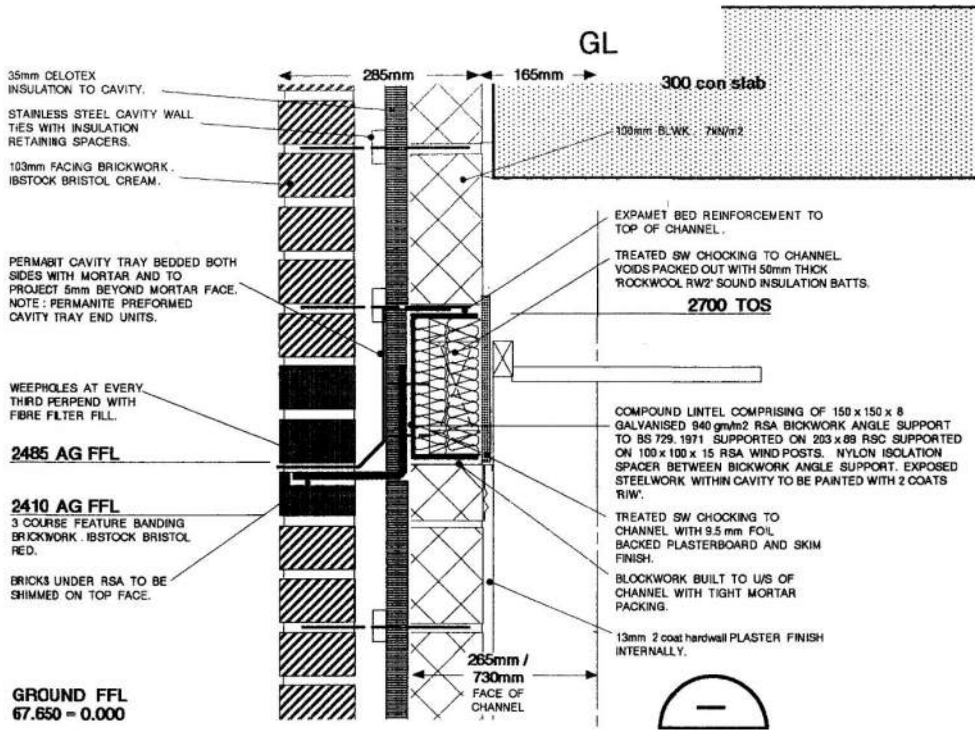

Figure 2, build-up of wall at first floor slab.

As-built details in Figure 3 illustrates the DPC positioned 150mm above ground level, with a full-brick feature banding below it. The actual execution appears inconsistent with this depiction. Further details are provided in Section 2.1.4.

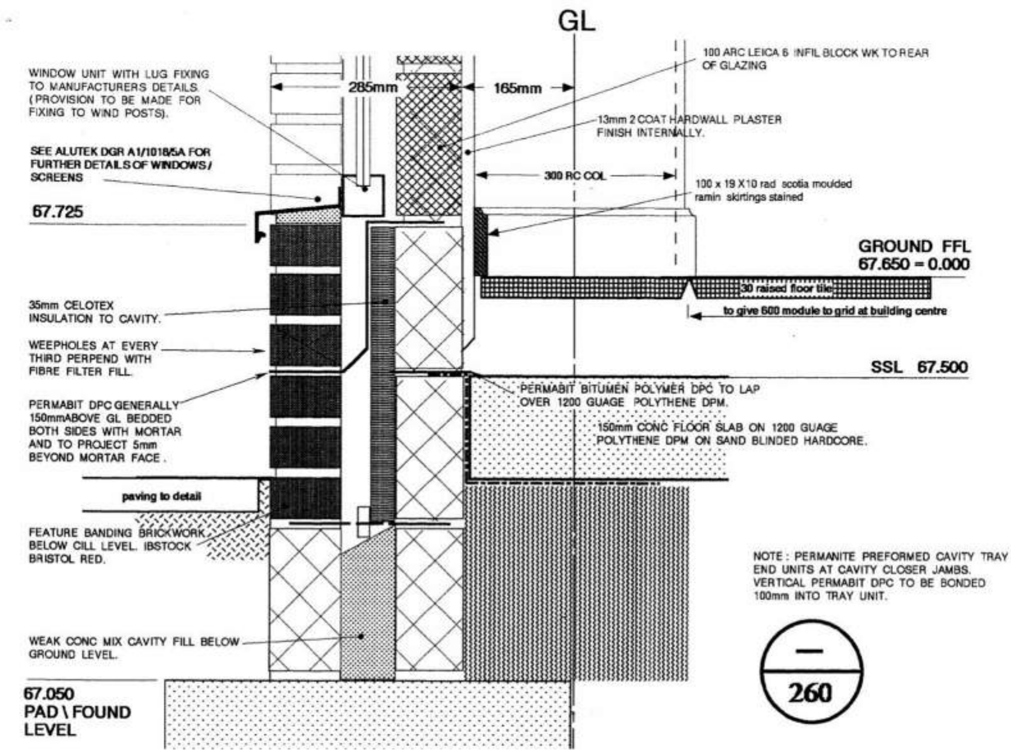

Figure 3, detail of brickwork at ground level.

2.1.2 Health and safety concern

Although the type of Celotex was not specified, it is presumed to be made of PIR insulation. PIR insulation is combustible and, if ignited, can emit hazardous amounts of smoke containing toxins such as cyanide and carbon monoxide. There is no legal mandate to remove this insulation due to the building's non-residential status, but the removal of this hazardous material should be considered.

An intrusive investigation of the wall is recommended to confirm the exact wall build-up and insulation type.

2.1.3 Estimated thermal performance

The overall U-value of the brick wall is estimated to be within the range of 0.5-0.6W/m^{2}K, considering the following components:

- Centre pane U-value of the opaque wall
- Repeating point thermal bridges from the brick ties.

A summary of the calculations can be found at the end of this report in Section 5.1.

2.1.4 Current condition

Figure 4, Isolated damage to brickwork.

Damage to the brickwork and pointing was apparent in isolated locations. This requires further investigation to determine the underlying cause and subsequent repair.

Figure 5, Hairline crack following a stepped pattern in the mortar.

Damage to the brickwork and pointing was apparent in isolated locations. This requires further investigation to determine the underlying cause and subsequent repair.

Interior

Exterior

Figure 6, Evidence of water damage.

Internal and external view of the east wall at the reception shows signs of previous water damage. A visual check of the same location outside suggests the damage was likely caused by plant equipment penetration that has since been removed.

Figure 7, Localised stains.

There is notable staining above the feature brick boxes concealing M&E equipment. It is unclear whether the stains are due to moisture accumulation inside the facades or from previous long-term obstructions. Further investigation is necessary.

Figure 8, Inconsistent DPC location.

The DPC location on the east elevation is inconsistent and not continuous, deviating form the as-built condition shown in Figure 3. Further investigation is necessary to determine whether this inconsistency has led to moisture penetration into the main building.

Figure 9, Evidence of consistent DPC location elsewhere.

The DPC location aligns consistently with the as-built details on other elevations. Notably, a step-up was observed on the south elevation to ensure this consistency.

Figure 10, Missing mortar below DPC.

Below the DPC, mortar is notably missing or loose.

Figure 11, Damaged half-brick below DPC.

Many bricks are damaged below the DPC. A broken brick revealed that the feature banding beneath te DPC consists of half-bricks, deviating from the as-built depiction.

Figure 12, Hardened silicone joint.

The silicone movement joint has hardened over time due to exposure to the environments, risking water infiltration into the facades. It should be removed and reapplied for optimal functionality.

Figure 13, Organic growth on surface of bricks.

A significant amount of staining and organic growth is apparent on the brick surface on the east elevation feature banding beneath the curtain walls. Maintenance is necessary to prevent further deterioration.

2.2 Typical curtain wall condition

Figure 14, External view of the curtain wall at reception

Figure 15, External view of a typical curtain wall.

2.2.1 General description

The glazing at the reception features a double-story vaulted curtain wall entrance with manually operable windows and shades atop that are in working order. The remaining curtain wall throughout the building spans one story with infill panels staggered with glazed openings. The systems are Kawneer thermally broken stick curtain walling, featuring toughened double-glazed units with an external tint and internal low 'E' glass. Infill areas are backed up with ARC Leca 6 insulating blockwork at sills and piers, as depicted in Figure 16. Lintels are galvanised mild steel supporting the brickwork above the opening, as depicted in Figure 17. These lintels penetrate through cavity insulation and are exposed to the exterior. Investigation should be conducted to understand the impact of this thermal bridging on the performance building.

Although the system has undergone regular maintenance, the glazing is at the end of its service life (*Typically 30-years*) and should be replaced to enhance thermal performance (*See Section 5 relating to Design Life & Performance Issues*).

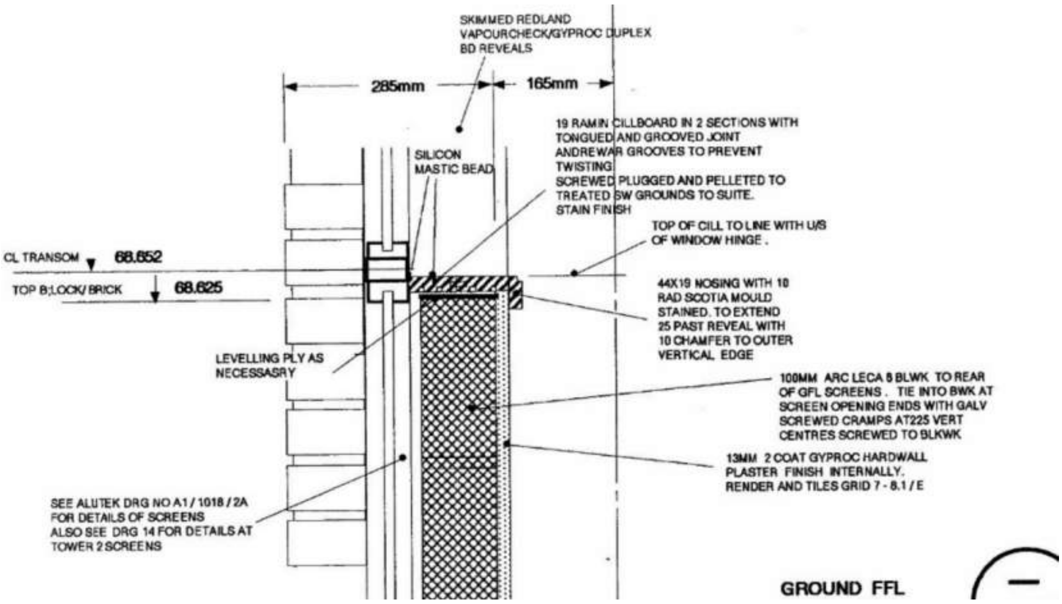

Figure 16, typical curtain wall sill detail.

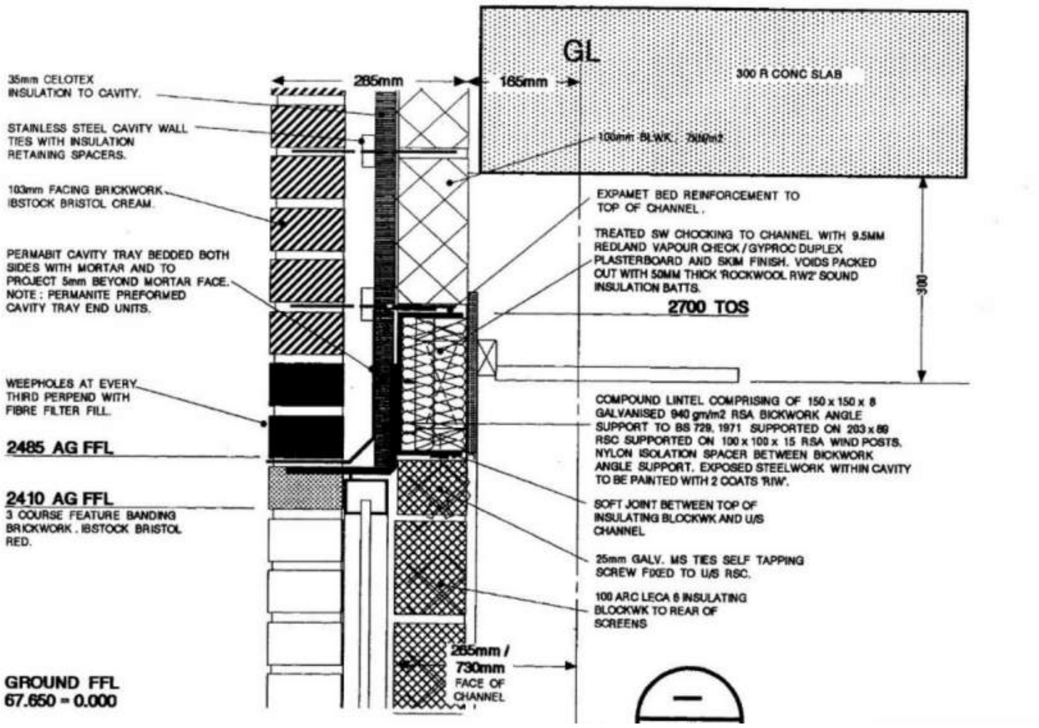

Figure 17, Lintel condition above curtain wall.

2.2.2 Health and safety concern

Many of the lintels show evidence of corrosion, with their galvanic coating showing signs of deterioration. If this corrosion is not addressed, the steel will continue to degrade. This could compromise its ability to bear the loads it was engineered to support, thereby increasing the risk of structural failure. The corrosion may also create pathways for water ingress, leading to a risk of mould growth and further corrosion issues.

Further investigation is required to confirm the extent of corrosion.

2.2.3 Estimated thermal performance

The system's thermal performance is dependent on the glass build up, the presence of insulating gas, the material of the glass spacer, the mullion and transom frame construction, and the interaction between these elements. The Building Manuals lack detailed specifications and drawings for these systems, offering only warranty information.

The system's U-value will be approximated using the "Refurbishment of non-domestic buildings" (TM53), a CIBSE-published industry standard. It outlines a typical U-value range for windows in 1990, the year the building was constructed. While the opaque infill area is expected to slightly outperform the glazed area due to lack of insulation, the absence of glazing details hinders precise area-weighting calculations for the overall U-value.

The U-value of this system is estimated to be within the range of 2.8-3.4 W/m^2K. Further investigation can be conducted to determine the estimated U-value of individual curtain walling systems.

2.2.4 Current condition

Figure 18, Lintel corrosion at the head of opening.

Most lintels display signs of corrosion. Their galvanic coating has deteriorated. Prolonged exposure could threaten its structural integrity.

Figure 19, Loose gasket.

Gasket misalignment/shrinkage was observed at multiple locations, indicating the system has reached the end of its service life. Loose gaskets can cause drafts, discomfort, and a reduced thermal efficiency.

Figure 20, Membrane below curtain wall sill

The membrane at the sill is not adhered to surfaces, posing a risk of insect intrusion, accumulation of dirt and debris and a source of water ingress.

Figure 21, Curtain wall at computer room

The curtain wall in the computer room consists solely of glass, with a dark film applied, likely to reduce glare for computer usage.

Figure 22, Kite mark.

Glass marking appears to indicate BS 12150, which is the British Standard used for classification of 'Toughened safety glass'.

Figure 23, sealant around glazing.

The sealant around the glazing appears to be in poor condition in some areas. This may impact air-tightness of the façade and impact thermal performance/ comfort.

2.3 Typical windows on the upper floors

Figure 24, External view of punch windows and ribbon windows on level 1 and 2.

2.3.1 General description

Level 1 is characterised by punch windows, whereas level 2 displays a row of ribbon windows. Both levels use glass similar to the curtain wall: toughened double-glazed units with an outer tint and inner low 'E' glass. While they have comparable sill details, the ribbon windows on level 2 have an added inner blockwork layer, refer to Figure 25.

The proprietary insulated lintels on level 1 are made of galvanised steel, with an exposed exterior similar to the curtain wall's top configuration, as shown in Figure 26. These lintels also penetrate through cavity insulation, and investigation should be conducted to understand the impact of this thermal bridging on the performance building.

For level 2, windows are fixed to a reinforced concrete beam, depicted in Figure 27. Although the system has undergone regular maintenance, the glass is at the end of its design life span and should be replaced to enhance thermal performance (*See Section 5 relating to Design Life & Performance Issues*).

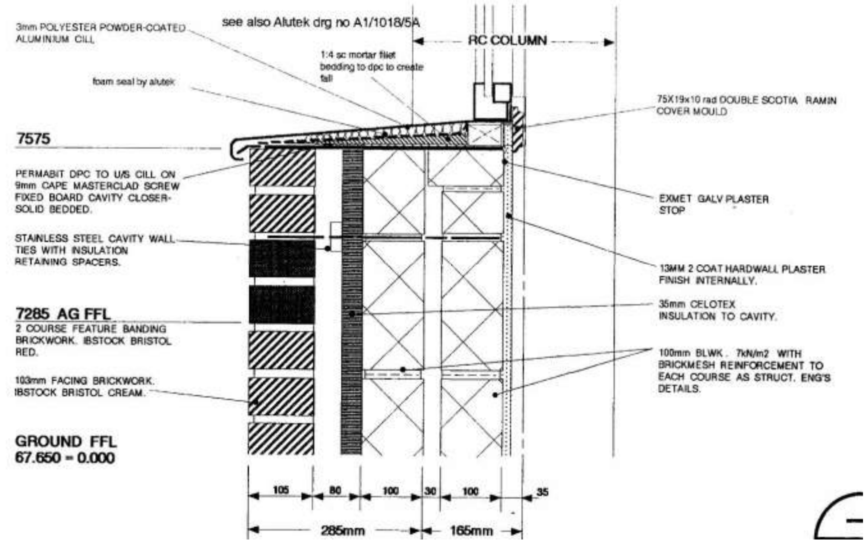

Figure 25, sill detail of ribbon window on level 2.

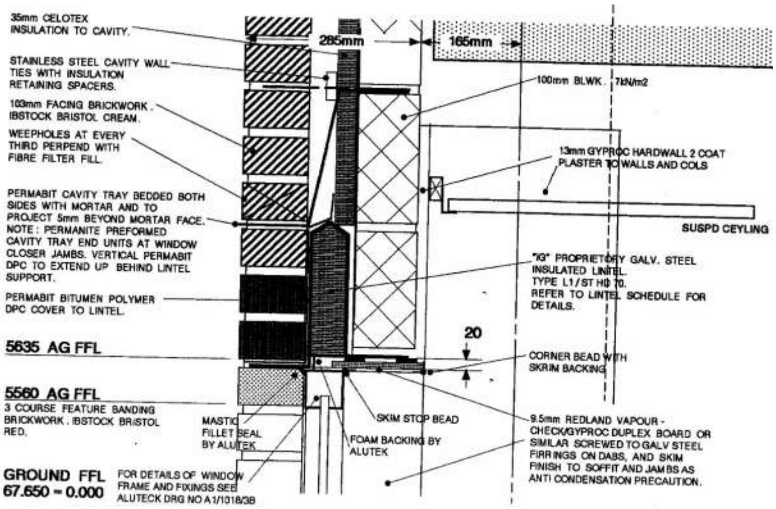

Figure 26, lintel condition at punch window on level 1.

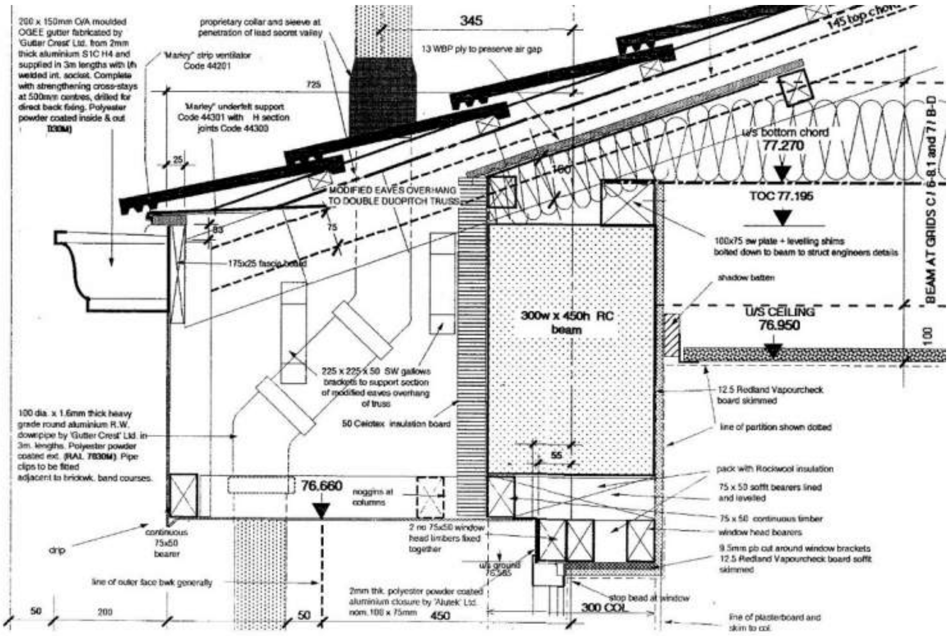

Figure 27, head condition at ribbon window on level 2.

2.3.2 Health and safety concern

While determining the corrosion state of the first-floor lintels was challenging during the site visit, corrosion is probable. Similar to the lintels at the curtain wall openings, if this corrosion is not addressed, the steel will continue to degrade. This could compromise its ability to bear the loads it was engineered to support, thereby increasing the risk of structural failure. The corrosion may also create pathways for water ingress, leading to a risk of mould growth and further corrosion issues.

Further investigation is required to confirm the extent of corrosion at the first-floor openings.

Windows on the second floor has no steel lintel, thus have no corrosion concerns.

2.3.3 Estimated thermal performance

Similar to the curtain wall, there is no information on the frame composition and details of the windows themselves. TM53 has been used to approximate the U-value of the glazed system.

The double-glazed windows are estimated to have a U-value within the range of 2.8-3.4/m^{2}K. Further investigation can be conducted to determine the estimated U-value of individual curtain walling systems.

2.3.4 Current condition

Figure 28, gasket peeling from level 1 window

Gasket peeling is observed at multiple locations. Loose gaskets should be replaced or repaired to reduce drafts, discomfort, and poor thermal efficiency..

Figure 29, lintel corrosion.

Though not easily discernible in photos, the window lintels on level 1 seem to exhibit corrosion signs, similar to the condition of the curtain wall lintels on the ground floor.

Figure 30, Glass marking on the internal face of windows

Glass marking appears to indicate BS 14449, which is the British Standard used for classification of 'Laminated safety glass. This was not specified in the building manual.

3. Design life and performance issues

Based on the elements of interest in the building being completed in 1990 and being 33+ years old at the time of reporting the following commentary is made.

The curtain wall and windows comprise individual components which have been assembled to form an external wall system. In the table below, reference has been made to anticipated individual component *design life*[1]. Whilst individual components may continue to function after their *design life* has been reached, the performance provided from each component or system is anticipated to deteriorate. The rate of deterioration is not anticipated to occur in a uniform manner. It will be influenced by various factors including and not limited to component, assembly or system orientation, exposure to UV degradation and pollution, mechanical damage including abrasion, protection offered by surrounding structures, the nature and frequency of cleaning undertaken, and loads applied to the system during the service life of the external wall system.

Observations during the survey identified that some components require investigations and/or remedial works in the near future to permit them to provide ongoing functions.

Should a lower standard of operational performance be accepted by the building owner after the design life has been reached, the remaining life of the systems may be permitted to extend for agreed periods of time. Revised acceptance criteria would need to be agreed following discussion with various parties.

The table below identifies stick component types(s), category of component (primary & secondary[2]), anticipated design life, and anticipated remaining design life based on current age. The table relates to the anticipated life and does not consider localised, random or outlier component failures.

#	Component type	Primary/ secondary component	Current age (years)	Design life (Anticipated)	Remaining design life (Anticipated)
1	Framing brackets	Primary	~33	50	17
2	Bracket fixings	Primary	~33	50	17
3	Curtain wall or window frames	Primary	~33	50	17
4	Coating to frames (internal)	Secondary	~33	20 to 30	-13 to -3
5	Glazing units	Secondary	~33	15 to 30	-18 to -3
6	External gaskets	Secondary	~33	15 to 25	-18 to -8
7	Internal gaskets/ air seals	Secondary	~33	15 to 30	-18 to -3
8	Thermal break	Primary	~33	15 to 30	-18 to -3
11	Fire stop	Primary	~33	40 to 50	7 to 17

[1] Design life is defined as the *anticipated period of time during which a component, assembly or system will either meet or exceed its performance criteria requirements as intended by designer. Refer to ISO 15686-1 2011 for details.* Note, design life is anticipated to be longer than a warranty period offered by the supplier or contractor.

[2] Primary components are those defined as anticipated to reach the end of the system design life without replacement. Secondary components are defined as components which are anticipated to require replacement before the system design life has been reached.

4. Conclusions and recommendations

A survey of the external wall systems of the building was undertaken.

Further discussions with the University are necessary to determine the required level of intervention. However, the survey highlighted health and safety concerns, the need for general maintenance and repairs, and opportunities to enhance the facades' thermal efficiency. The key findings are summarized below:

Health and safety concerns:

- According to the as-built drawings, combustible cavity insulation may have been used. To confirm the wall's build-up and type of insulation material, an intrusive survey is recommended.
- Corrosion observed in lintels at window and curtain wall openings on both the ground and first floor. This poses a potential threat to their structural integrity. Further investigation is required to confirm the extent of corrosion.

General maintenance and repair recommended:

- Replace secondary components (i.e., Gaskets, insulated glass units, etc.) within the curtain wall and window systems that have reached the end of their design life.
- Undertake minor repointing for brickwork and mortar.
- Replace hardened silicone at movement joints.
- Clean and remove stains and organic growth from surfaces.

Opportunities in enhancing the thermal efficiency of the facades:

- Address thermal bridging by insulating lintels, which can also prevent further corrosion.
- Consider upgrading to higher performance double-glazed insulated glass units. Prioritise material circularity by recycling the existing glass.
- Install insulation at infill panels of curtain walls.
- Enhance the wall U-values either by overcladding or adding internal insulation. The approach will depend on the intended treatment of the existing combustible insulation and the University's sustainability objectives.

We recommend the following next steps to further elaborate on the points mentioned above:

- The University should evaluate the suitability of retaining this insulation, given the building's function and potential insurance implications.
- Investigate the sources of localised stains on brickwork.
- Examine potential moisture penetration linked to inconsistent DPC placement.
- Assess thermal bridging specifically at lintels situated above openings.

5. Supplementary information: Thermal calculations

The U-value of the existing system is calculated according to BS EN ISO 6946.

5.1 Brickwork/ opaque façade elements

The centre pane U-value is estimated to be 0.48 W/m2K, as detailed in the table below.

Table 1, Centre pane U-value calculation of brick wall.

	λ	d	R
	W / mK	m	m2K / W
External surface resistance			0.04
Brick: outer leaf	0.77	0.103	0.13
Air cavity		0.047	0.18
Celotex	0.023	0.035	1.52
Blockwork: inner leaf	1.31	0.1	0.08
Internal surface resistance			0.13
R_{tot} (m^2K/W)			2.08
Centre pane U-value (W/m2K)			**0.48**

The point thermal transmittance of brick ties was calculated using TRISCO thermal model, as demonstrated in the image below:

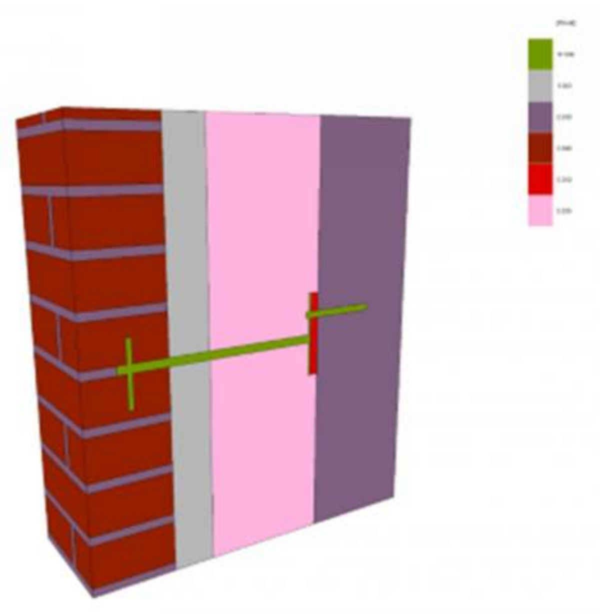

Figure 31, TRISCO model of brick ties.

The overall U-value is calculated to be 0.5W/m2K, as detailed in the table below.

	U-value	Area	X-value	Quantity	Heat Loss
Component	W/m^2K	m^2	W/K	QTY	W/K
Wall centre pane	0.48	2.12			1.02
Brick ties			0.004	8	0.03
				Total heat loss (W/K)	1.05
				Overall U-value – lower bound (W/m^2K)	**0.50**
				Overall U-value – upper bound (W/m^2K)	**0.60**

Fabric Interventions Assessment

University of the West of England

Northavon House Decarbonisation

Fabric Interventions Assessment

Reference: 5.5

P01 | 22 December 2023

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 297699-00

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Document Verification

Project title	Northavon House Decarbonisation
Document title	Fabric Interventions Assessment
Job number	297699-00
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Revision	**Date**	**Filename**	Fabric Interventions Assessment		
P01	22/12/2023	**Description**	Fabric Interventions Assessment		
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		Name	Jolie Lau	Maela Allegretti	Maela Allegretti
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		Filename			
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		Signature			
		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

1. Introduction

Arup Façade have been tasked with conducting assessments necessary to inform the building fabric interventions of Northavon House at the University of the West of England. This follows our initial non-intrusive survey of the building's thermal performance and overall condition, as detailed in the Stage 1 fabric report *'Northavon House Decarbonisation: Fabric performance audit'*.

This document serves as a supplementary piece to the comprehensive Stage 2 Arup report. The insights gathered from Stage 1, and the fabric intervention options as outlined in this report, will be used to create a thermal model of the building to estimate the building heat loss and inform the HVAC system design.

The following report will:

- Further examine the crucial items that needed attention before considering façade interventions.
- Explore the opportunities in enhancing the thermal efficiency of the facades.
- Determine next steps.

2. Assessing health and safety concerns

In our initial Stage 1 report, we identified key health and safety concerns that require further examination. These include:

1. The potential use of combustible cavity insulation
2. Visible corrosion on lintels at window and curtain wall openings, particularly on the ground and first floors, possibly compromising their structural integrity.

In the subsequent sections, a desktop examination of these identified concerns will be conducted. This analysis aims to ensure that proposed strategies for enhancing the building's thermal efficiency are informed by these health and safety considerations.

2.1 Evaluation

2.1.1 Combustible cavity insulation

As noted in the Facades Stage 1 report, the as-built drawings indicated a cavity filled with 35mm Celotex insulation, as depicted in the figure below.

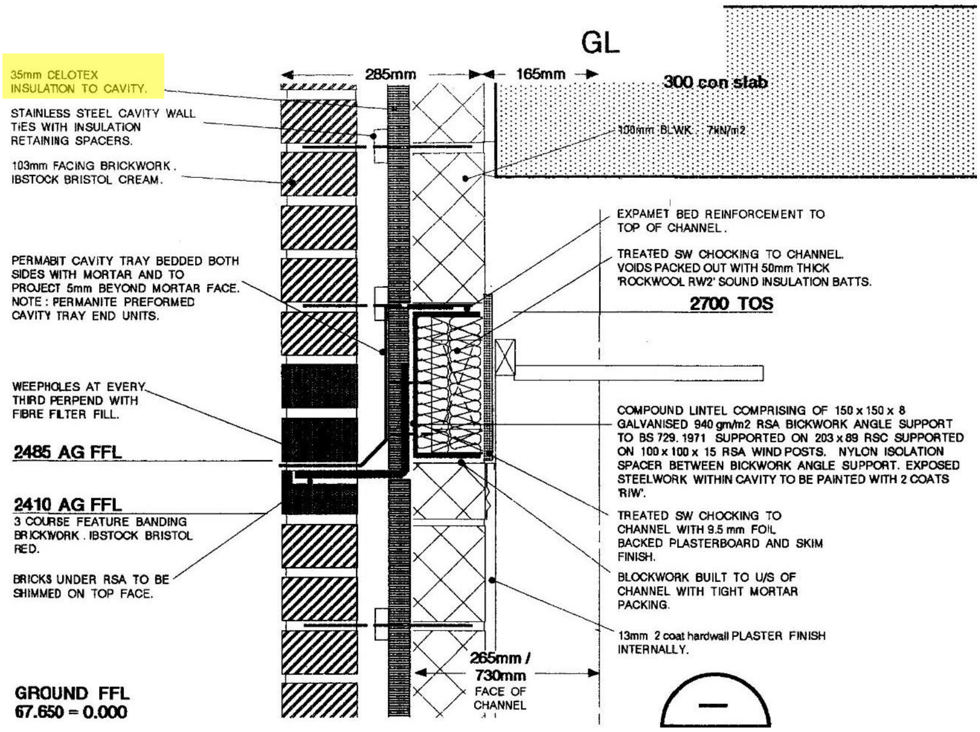


Figure 1, build-up of wall at first floor slab.

Although the type of Celotex was not specified, it is presumed to be made of PIR insulation. PIR insulation is combustible. Currently, there is no scope mandate to remove this insulation due to the following reasons:

- The insulation sits within a masonry cavity wall and meets the provisions set out in Approved Document B Table 9.1.
- The building has no residential purpose.

However, the removal of this hazardous material should be considered. This will be further explored in the next Section.

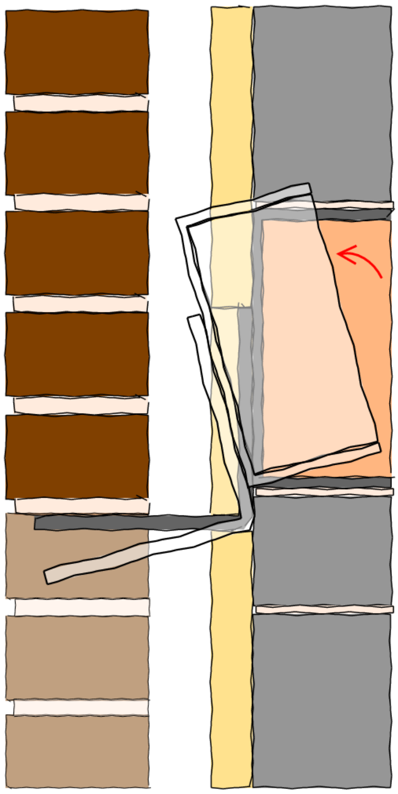
2.1.2 Lintels condition

The Facades Stage 1 report observed signs of corrosion in the lintels above the curtain wall openings and the first-floor window openings. This corrosion was suggested by the detachment of the lintels from the brickwork above, potentially due to the accumulation of zinc salt. We suspected that this by-product of corrosion progressively increased in volume, exacerbating the separation.

Figure 2, lintel separation from brickwork above at the head of opening.

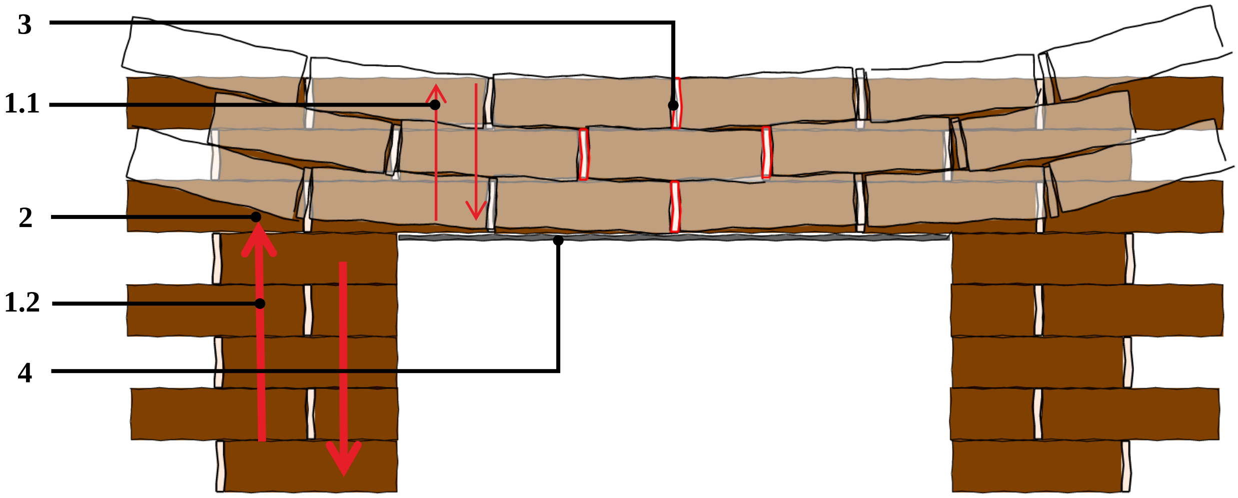
In subsequent consultation with our steel specialist, it was concluded that the specified galvanic coating of 940 gm/m^2 (as indicated in the as-built detail) on the steel provided adequate protection. Considering the building's age, the likelihood of the coating to have completely worn off (resulting in corrosion) is minimal. This is supported by the absence of noticeable zinc salt build-up, which would be expected to fully occupy the gap where separation was noted. Consequently, the observed detachment of the lintel from the brickwork is likely not due to corrosion.

In standard lintel configuration, the steel lintel is expected to extend beyond the sides of the opening to ensure proper load distribution. The lintel's end falls short of this standard on all openings on the ground and first floor. Based on this observation and information from the as-built drawings, two potential causes for this separation were considered. It is believed that these factors interacted and intensified the separation.



Hypothesis 1: Lintel-brickwork separation is caused by the buckling of steel bracket.

The lintel angle is anchored to the slab connection. It is possible that thermal expansion or movement from the slab connection caused buckling. This might have resulted in a slight rotation of the lintel, as shown in the exaggerated wall section illustration above.



Hypothesis 2: Lintel-brickwork separation is caused by the differential thermal movement of brickwork at different locations.

The thermal expansion rate of the brickwork above the lintel (1.1) is slower compared to that of the brickwork on either side of the opening (1.2). This discrepancy in expansion rates may have caused the more rapidly expanding side brickwork to lift the bricks above the lintels from the sides (2). The uplift on the sides led to a weak point at the centre of the lintel span (3). The steel lintel that is anchored to the inner leaf wall remained in place while the brickwork is lifted (4). This phenomenon is depicted in the exaggerated illustration above and reinforced by the hairline crack observed at the centre of the brickwork above one of the window openings, as shown in the image below.

Figure 3, Hairline crack observed in mortar above opening.

An intrusive investigation focusing on the area exhibiting the most severe separation and mortar cracking is recommended. This investigation shall involve opening-up the affected area to assess the cause of the lintel detachment and cracks. If the potential explanations provided in this report are confirmed, Arup believes that this atypical lintel condition has already manifested its most significant deformation and is unlikely to worsen. Consequently, the risk of lintel detaching or falling is unlikely. The gap between the lintel and the brickwork could be filled to prevent water ingress, and further interventions might not be necessary.

2.2 Consideration

Combustible cavity insulation

The removal of the combustible insulation can be considered especially for the following reasons:

- Minimising fire spread risk, which could lead to lower insurance premiums.
- Futureproofing against potential updates in the building’s functionality, or Approved Document B mandates regarding combustible materials. Although current regulations exempt non-residential building with masonry wall cavity insulation from removing combustible materials, proactive elimination of the insulation could prepare the building for such potential eventualities.

Lintel condition

If the opening-up work confirms that the atypical lintel condition has already undergone its most significant deformation, then the risk of lintel detachment or fall is unlikely. Consequently, any proposed fabric interventions will not necessitate substantial consideration of the lintel's condition, except for cosmetic improvements to address the gap between the lintel and the brickwork.

3. Opportunities in improving fabric thermal efficiency

Two fabric improvement options are proposed. The first, a 'light retrofit' approach, focuses on maximizing cost-to-energy savings. The second, a 'deep retrofit', aims to thoroughly address previous chapter issues and targets the highest total energy savings. The following sections elaborate each option in detail and provide the improved thermal performance targets for the respective fabric components.

3.1 Light retrofit

The proposed light retrofit option is based on the site observations that the existing fabric is in generally good condition, requiring only minor maintenance and repairs as outlined in the Stage 1 report. From our experience, this approach is likely to maximise cost-to-energy savings and will also address general maintenance and repairs needed due to the age of some components.

The recommended improvements and the associated improved thermal performance are detailed in the table below:

Façade component	Proposed works for light retrofit option	Light retrofit thermal performance target	Estimated existing thermal performance
Walls	• No works	N/A	0.5 W/m²K
Windows	• Replace secondary components. • Replace entire system only if the above work is insufficient in achieving the target thermal performance.	1.3 W/m²K g-value 0.4	3.1 W/m²K g-value 0.7
Curtain wall	• Glazed area: Replace secondary components. • Opaque area: Replace opaque panel and blockwork with insulated opaque panels. • Replace entire curtain wall system only if the above works are insufficient in achieving the target thermal performance.	1.3 W/m²K g-value 0.4	3.1 W/m²K g-value 0.7

Upgrading the existing windows and curtain walls will significantly improve thermal energy performance, especially when the non-insulated areas of the curtain walls are replaced with insulated opaque panels.

As per the Stage 1 Facades report, the secondary components (such as glazing units, frame coatings, gaskets, air seals, and the thermal breaks) in these systems are 3 to 18 years past their design life as of 2023. The failure of these components would lead to reduction in thermal performance, and air and water leaks. On the other hand, the primary components (such as frames and fixings) still have 17 years of expected life remaining.

Improving the thermal performance of the glazed systems can vary from full system replacement (of primary and secondary components) to just replacement of the secondary components. However, to minimize upfront embodied carbon emissions, a full system replacement shall only be considered if the replacement of secondary components alone will not allow the systems to achieve their target thermal performance.

Since there are no as-built details available for the glazing system at this stage of the study, we recommend conducting an intrusive survey of the system frames in the next stage. This will help estimate the thermal performance of the frame and the feasibility of the proposed approach.

This solution is proposed under the assumption that both the combustible insulation and the lintel conditions will remain unchanged. Nevertheless, to guarantee that the atypical lintel condition do not present a structural risk, an intrusive investigation is still advised.

3.2 Deep retrofit

The proposed deep retrofit option is a more comprehensive approach that incorporates an overclad alongside the interventions outlined in the light retrofit option. This strategy not only offers the greatest total energy savings but also enhances the building's thermal efficiency, appearance, and provides an opportunity to replace the existing combustible insulation, as highlighted in the previous Section of the report.

In exploring options for external wall interventions, it is important to understand the alternatives and their implications. The thermal performance of the external walls can be enhanced through internal insulation, cavity insulation, or overclad insulation. Each method has its merits and challenges. Cavity wall insulation preserves the appearance on both the interior and exterior sides of the facade and ensures no reduction in floor area. However, it can increase rainwater retention, compromising structural integrity and heightening freeze-thaw dangers. On the other hand, internal insulation maintains the exterior facade's appearance, but can decrease net internal area, alter room layouts, and requires careful consideration to avoid risk of condensation. Neither method completely prevents thermal bridging, which can result in localized heat loss, and internal insulation might also limit access to in-wall services such as electrical wiring and plumbing. Given these complexities, overcladding with additional external insulation is proposed for this project.

The recommended improvements and the associated improved thermal performance are detailed in the table below:

Façade component	Proposed works for deep retrofit option	Deep retrofit thermal performance target	Estimated existing thermal performance
Walls	• Reclad with brick or alternative cladding material: – Remove existing combustible insulation if necessary. – Install additional external insulation to meet target thermal performance. – Ensure the lintels above all openings are installed in compliance with standard industry specifications.	0.26 W/m^{2}K	0.5 W/m^{2}K
Windows	• Replace secondary components. • Replace entire system only if the above work is insufficient in achieving the target thermal performance.	1.3 W/m^{2}K g-value 0.4	3.1 W/m^{2}K g-value 0.7
Curtain wall	• Glazed area: Replace secondary components. • Opaque area: Replace opaque panel and blockwork with insulated opaque panels. • Replace entire curtain wall system only if the above works are insufficient in achieving the target thermal performance.	1.3 W/m^{2}K g-value 0.4	3.1 W/m^{2}K g-value 0.7

3.3 Embodied carbon and circular economy

This project presents several opportunities to reduce the whole life carbon of the facades while embracing circular economy principles.

The proposed façade interventions will lower the operational carbon of the building, but the upfront embodied carbon of new components is a crucial consideration. Section 3.1 of the report suggests that replacing primary components of the glazed systems should only be a last resort if upgrading secondary components fails to meet the targeted thermal performance. Reusing existing primary components such as frames and brackets can save up to 25% of embodied carbon, as indicated by the graph below.

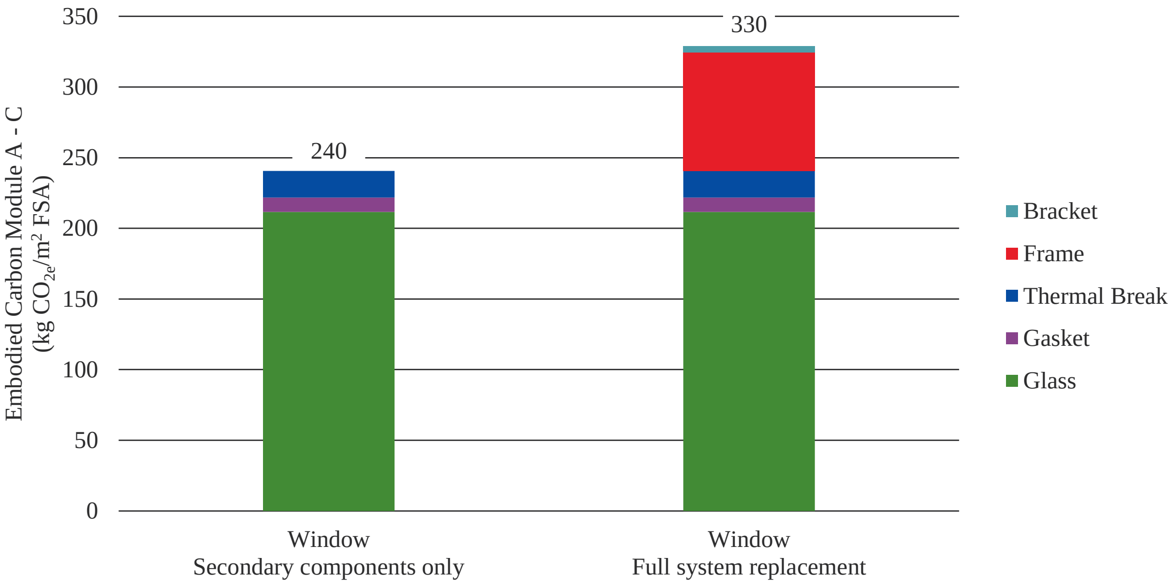


Figure 4, Embodied carbon (Module A-C), in kg CO_{2e}/m^2 of façade area (FSA), of window replacement

Up to 65% of the system's embodied carbon emissions can come from glass and 25% from frames, making their replacement a significant environmental decision. If replacement is necessary, recycling the existing materials is crucial to mitigate whole life carbon emissions. This approach considerably reduces refurbishment waste, minimising the whole life carbon impact of the building interventions, not just its operational carbon impacts. A circular economy approach to refurbishment should be explored in the next project phases, separate from this study.

Although a retrofit project generally has a lower embodied carbon footprint than a new build, the difference in embodied carbon between light and deep retrofit options is nearly double. The graph below illustrates the Module A to Module C embodied carbon emissions for both light and deep retrofit options, considering scenarios of replacing only secondary components or a full system replacement. The significant variation is attributed to the large amount of wall areas in the building, leading to the deep retrofit incurring more embodied carbon per square meter of façade area. Opting for the light retrofit approach with secondary component replacement over a full system replacement in a deep retrofit can result in saving of over 150% in embodied carbon emissions.

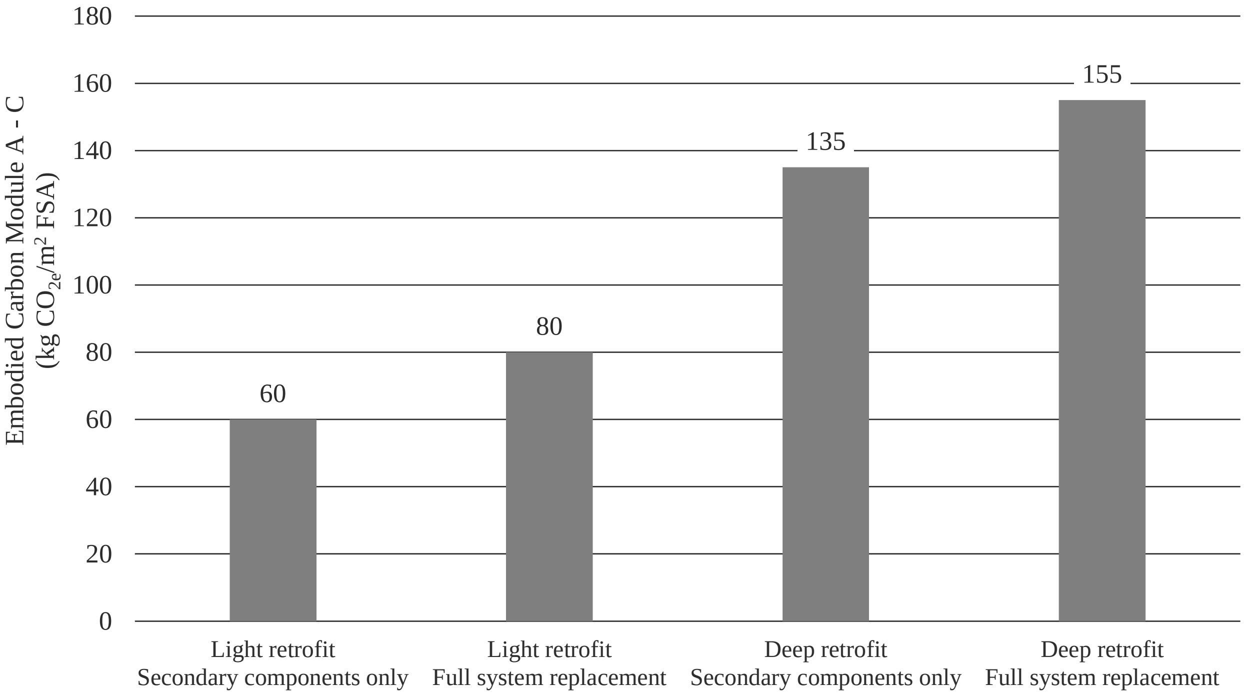


Figure 5, Embodied carbon (Module A-C) in kg CO_{2e}/m^2 of building facade area (FSA) for the proposed options.

4. Conclusions and recommendations

This report concludes our feasibility study on the decarbonisation opportunities for the façade of Northavon House. Following the Stage 1 report, which was based on an initial non-intrusive survey assessing the general state of repair of the façade, this report represents Stage 2 of our study. It investigated the risks posed by maintaining the combustible insulation within wall cavities and examined the causes of the lintel-brick separation at window and curtain wall openings. These findings helped inform our subsequent recommendations at façade improvements.

To enhance the thermal efficiency of the façades, we recommend two approaches: a light retrofit, involving replacement of only the glazed systems, and a deep retrofit, encompassing improvements to both glazed systems and opaque walls. Both options consider replacing only secondary components of the glazed systems to minimize embodied carbon and support circular economy principles.

Moving forward, the project should focus on selecting the most suitable façade intervention. We recommend the following steps to aid this decision:

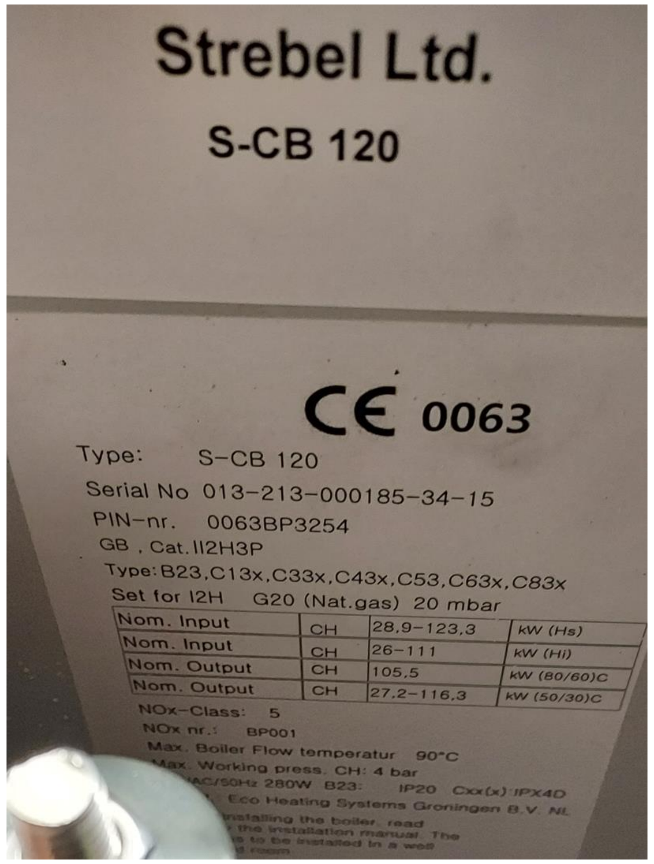
- Conduct opening-up works to verify the lintel-brick separation hypothesis as theorized in Section 2.1.2.
- Obtain as-built details of windows and curtain walls from the façade contractor (referenced *in 'HEFCE Building – Frenchay New Office Building – Building Manual Vol 1 & 2'* as drawings *'ALUTEK A1/1018'*). This will enable an accurate assessment of current thermal performance and feasibility for partial system replacement.
- Explore recycling options for salvaged materials, particularly glass and aluminium, to further the University's commitment to sustainable practices.

Additionally, the following general maintenance and repair works are recommended, as detailed in the Stage 1 façade report:

- Undertake minor repointing for brickwork and mortar.
- Replace hardened silicone at movement joints.
- Clean and remove stains and organic growth from surfaces.

Appendix E

Boiler Nameplate Information

<table>
<tr><th>Boiler B1</th><th>Boiler B2</th><th>Boiler B3</th></tr>
<tr>
<td>
</td>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>Clyde Combustion
Ambassador 120 CG Boiler
Output 109.1kW
Installed 1991</td>
<td>Strebel Ltd
S-SC 120
Output 105.5kW
Installed 2020</td>
<td>Clyde Combustion
Ambassador 120 CG Boiler
Output 109.1 kW
Installed 1991</td>
</tr>
</table>

Appendix F

Equipment Selection

TECHNICAL SELECTION
Software version: ELCA World v. 1.8.2.0
User: Scott Evemy
Database version: 1.9.2.0
Print data:06/12/2023 13:16

HEATING
COOLING

TECHNICAL SELECTION

MEHP-iS-G07 0102
Reversible unit, air source for outdoor installation

SCROLL

Code		MEHP-iS-G07 0102
Version		-
Size		0102
Power supply	V/ph/Hz	400/3/50

MITSUBISHI ELECTRIC
Changes for the Better

INDEX

1.1 PERFORMANCE AT DESIGN CONDITIONS

RUNNING CONDITIONS		
COOLING		
HEAT EXCHANGER USER SIDE		
Fluid type		WATER
Glycol	%	0
Fouling factor	m²K/kW	0.000
Fluid inlet temperature (cooling mode)	°C	12.00
Fluid outlet temperature (cooling mode)	°C	7.00
Water flow	l/s	4.112
Pressure drop at the heat exchanger	kPa	20.8
Available unit head	kPa	139
OUTDOOR CONDITION		
Air temperature (cooling mode)	°C	35.0
HEATING		
HEAT EXCHANGER USER SIDE		
Fluid type		WATER
Glycol	%	0
Fouling factor	m²K/kW	0.000
Fluid inlet temperature (heating mode)	°C	45.00
Fluid outlet temperature (heating mode)	°C	50.00
Water flow	l/s	3.681
Pressure drop at the heat exchanger	kPa	16.7
Available unit head	kPa	150
OUTDOOR CONDITION		
Air temperature (heating mode)	°C	-5.0

COOLING (Gross value)		
Cooling capacity	kW	85.99
Compressor power input	kW	29.98
Fans power input (cooling mode)	kW	1.88
Total power input	kW	31.86
EER	kW/kW	2.696
ESEER CALCULATED	kW/kW	4.710

HEATING		
Total heating capacity	kW	76.12
Compressors power input (heating mode)	kW	28.33
Fan power input (heating mode)	kW	2.08
Total power input	kW	30.41
COP	kW/kW	2.503

SCOP

The performance shown are obtained from theoretical calculations and tolerances will apply.Rpt.version:1.0.6.0

SCOP Official (Reg. 813/2013 EU)		
MEDIUM TEMPERATURE		
Type climate		Average
Temperature application	°C	55
Type flow		Variable
Type Temperature		Variable
Bivalent temperature	°C	-7.0
PDesign	kW	81.8
Qhe	kWh	50262
SCOP		3.36
Performance ηs	%	132
Seasonal efficiency class		-

1.2 PART LOAD DATA

COOLING PARTIAL LOADS											
Load	%	100.0	90.0	80.0	70.0	60.0	50.0	40.0	30.0	*20.0*	*10.0*
Outdoor air temperature	°C	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	*35.0*	*35.0*
Cooling load	kWh	86	77	69	60	52	43	34	26	*17*	*9*
Fans power input (cooling mode)	kW	1.88	1.88	1.88	1.88	1.58	1.18	0.79	0.54	*0.35*	*0.20*
Total power input	kW	31.90	27.80	23.70	19.60	15.80	12.30	8.740	6.510	*4.460*	*2.510*
Temp. evaporator inlet	°C	12.00	11.50	11.00	10.50	10.00	9.50	9.00	8.50	*8.29*	*8.29*
Temp. evaporator outlet	°C	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	*7.00*	*7.00*
Evaporator water flow	l/s	4.113	4.112	4.112	4.112	4.112	4.113	4.113	4.111	*4.111*	*4.111*
EER	kW/kW	2.700	2.790	2.910	3.080	3.260	3.510	3.940	3.960	*3.860*	*3.430*
Note		Note: italics texts mean integrated values under minimum step									

HEATING PART LOAD											
Load	%	100.0	90.0	80.0	70.0	60.0	50.0	40.0	30.0	*20.0*	*10.0*
Outdoor air temp.	°C	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	*-5.0*	*-5.0*
Heating load	kWh	76	69	61	53	46	38	30	23	*15*	*8*
Total power input	kW	30.40	27.40	24.40	21.40	18.40	15.50	12.50	9.070	*6.300*	*3.590*
Condenser input temperature	°C	45.00	45.50	46.00	46.50	47.00	47.50	48.00	48.50	*48.53*	*48.53*
Condenser output temperature	°C	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	*50.00*	*50.00*
Condenser fluid flow	l/s	3.681	3.681	3.682	3.682	3.682	3.681	3.680	3.681	*3.681*	*3.681*
COP	kW/kW	2.500	2.500	2.500	2.490	2.480	2.470	2.440	2.520	*2.410*	*2.120*
Note		Note: italics texts mean integrated values under minimum step									

1.3 EXCHANGERS

HEAT EXCHANGER USER SIDE		
Typology		PLATE
Quantity	N°	1
Type of connections		[E1] - Female threaded pipe (UNI ISO 228/1 - G)
Diameter of connections		2"1/2
Min flow	l/s	2.778
Max flow	l/s	8.889
Heat exchanger water content	l	8.10
Minimum water content admitted in the plant	l	800

1.4 FANS

Fans type		AXIAL EC
Quantity	N°	4
Total fans power input	kW	1.88
F.L.I.	kW	4x0.92
F.L.A.	A	4x2.5

COOLING		
Total fans power input	kW	1.88
Air flow	m³/s	11.77
Available static pressure	Pa	0

HEATING		
Total fans power input	kW	2.08
Air flow	m³/s	13.72
Fan available static pressure	Pa	0

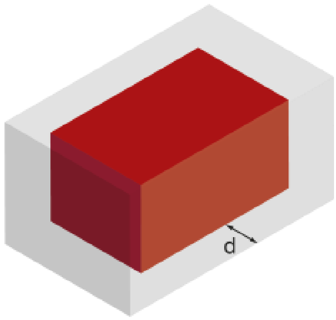
1.5 COMPRESSORS

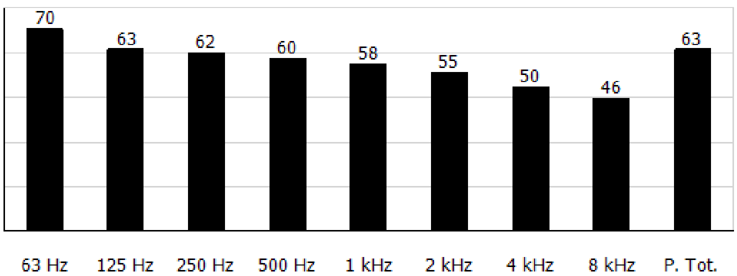
COMPRESSORS		
Compressor type		SCROLL
Compressors nr.	N°	2
No. Circuits	N°	1
Number of capacity steps	N°	0
Min. capacity step	%	20
Regulation		Stepless
Oil charge	kg	7.00
F.L.I. - Max absorbed power	kW	1x32.6+1x15.9
F.L.A. - Max absorbed current	A	1x55.3+1x27.2
L.R.A. - Locked rotor amperes for single compressor	A	1x0+1x132

REFRIGERANT		
Refrigerant		R32
Theoretical refrigerant charge	kg	21.5
GWP100 value (from IPCC AR5)		677
CO2 equivalent	t	14.6

1.6 NOISE DATA

SOUND DATA COLD									
Frequencies	Hz	63	125	250	500	1000	2000	4000	8000
Sound power (spectrum)	dB	89	82	81	79	77	74	69	65
Total sound power level in cooling	dB(A)				82				
Sound pressure level (spectrum)	dB	70	63	62	60	58	55	50	46
Total sound Pressure	dB(A)				63				



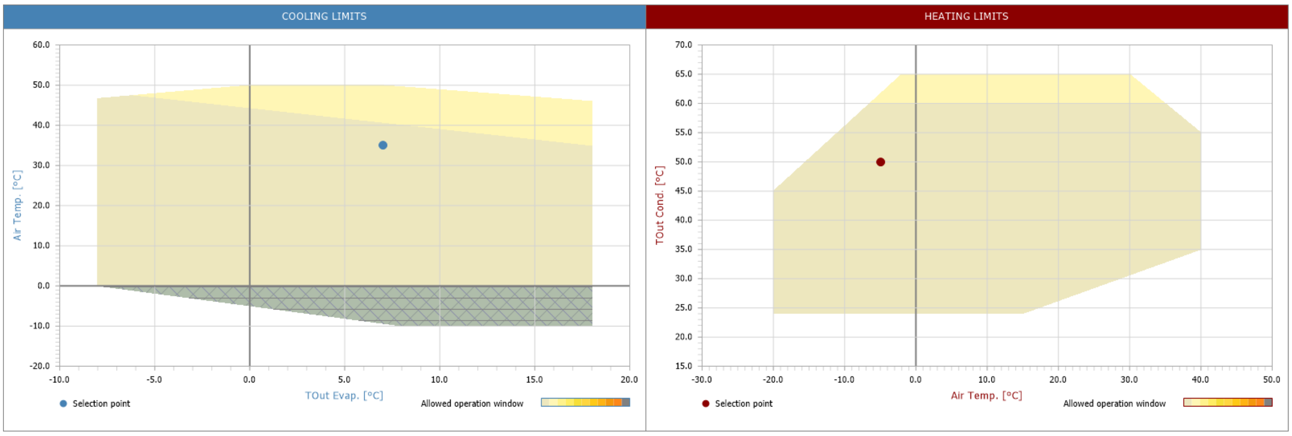


SOUND DATA OUTDOOR HOT		
Total sound power level in heating	dB(A)	82

The performance shown are obtained from theoretical calculations and tolerances will apply.Rpt.version:1.0.6.0

Note		
Distance	m	1
Note		Average sound pressure level at 1 m distance, unit in a free field on a reflective surface; non-binding value calculated from the sound power level. Sound power on the basis of measurements taken in compliance with ISO 9614.

1.7 OPERATING LIMITS



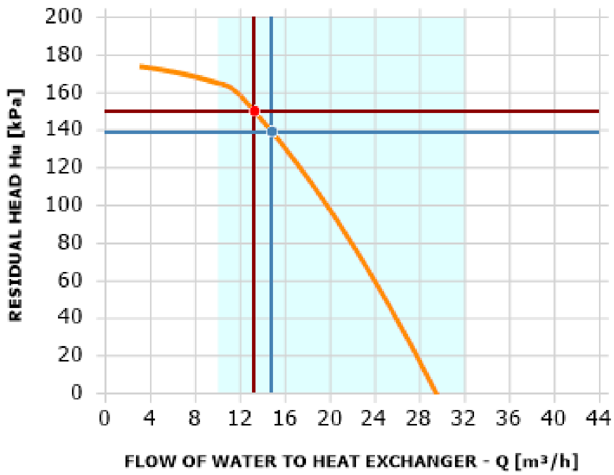
COOLING LIMITS	HEATING LIMITS
2432-ANTIFREEZE PIPING, PUMPS	
2433-ANTIFREEZE PIPING, PUMPS, TANK	
2431-ANTIFREEZE PIPING	

1.8 ELECTRICAL DATA

Power supply	V/ph/Hz	400/3/50
F.L.I. - Max absorbed power	kW	53.30
F.L.A. - Max absorbed current	A	95
S.A. - Inrush current	A	197.3

1.9 ACCESSORIES

HYDRONIC GROUPS		
HEAT EXCHANGER USER SIDE		
Accessory code		4752
Accessory description		U - 2 PUMPS 2P LH (VAR SPEED)
Min flow	l/s	2.778
Max flow	l/s	8.889
COOLING		
Water flow	l/s	4.112
Available unit head	kPa	139
HEATING		
Water flow	l/s	3.681
Available unit head	kPa	150
GRAPH OF RESIDUAL PRESSURE HEAD		



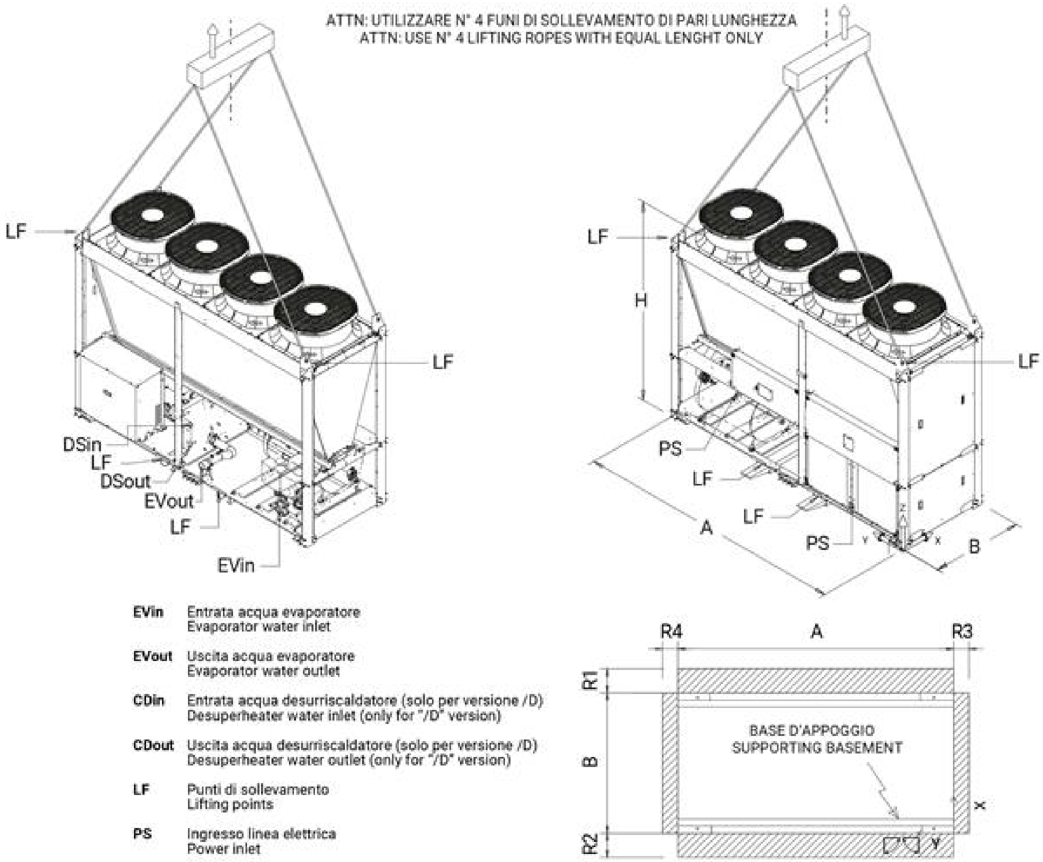
BUFFER TANK		
HEAT EXCHANGER USER SIDE		
Accessory code		4942
Accessory description		U - WITH BUFFER TANK

DIMENSION AND ELECTRIC DATA VARIATION

FLA hydronic group	A	2
FLI hydronic group	kW	1.100
Additional weight	kg	400
Additional length	mm	0
Additional width	mm	0
Additional height	mm	0
Additional Sound pwr.	dB(A)	1.0
Buffer tank	l	220

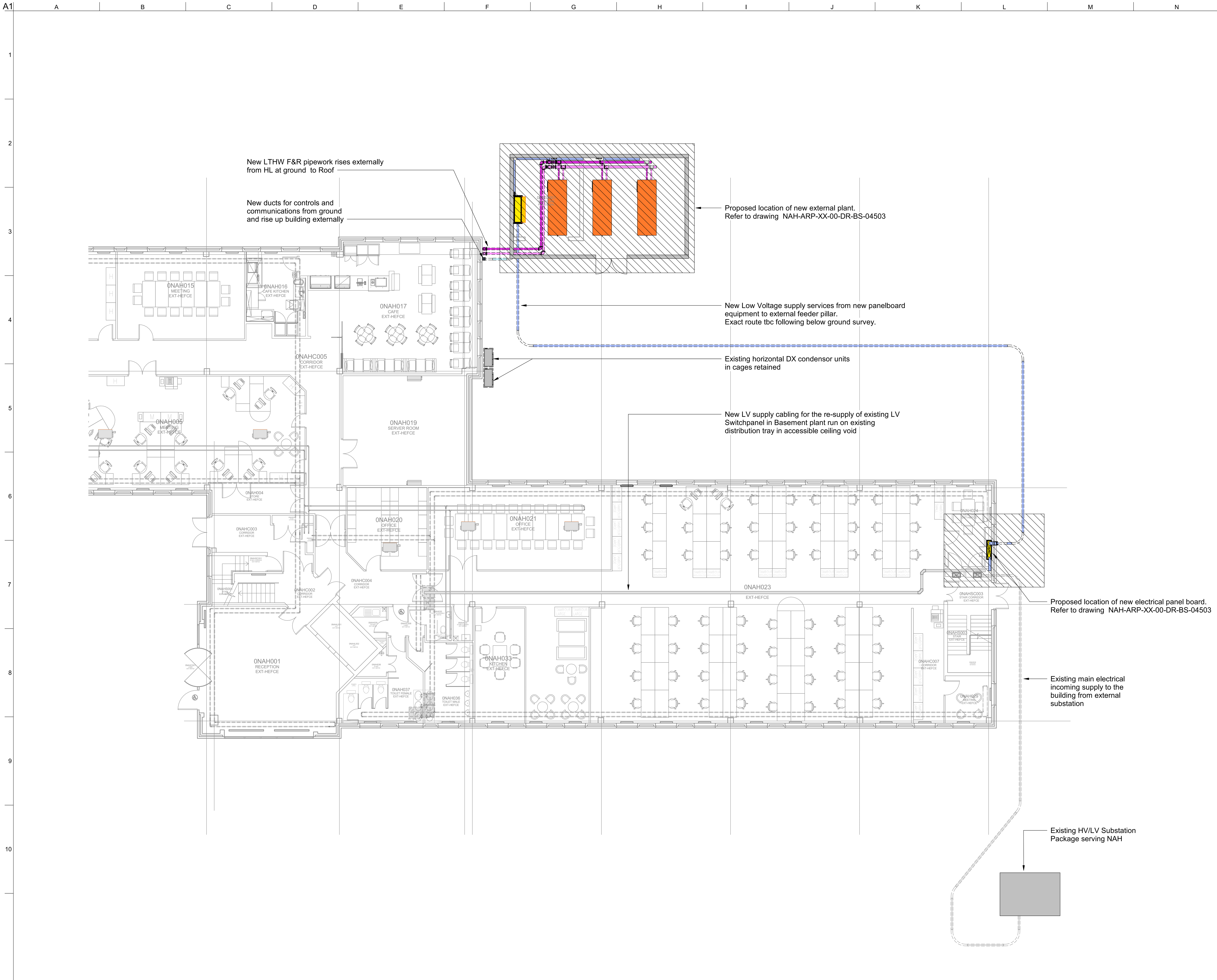
1.10 WEIGHT & DIMENSIONS

A	mm	3225
B	mm	1100
H	mm	2400
Operating weight	kg	1485
R1	mm	1000
R2	mm	1000
R3	mm	400
R4	mm	400



Appendix G

Drawings



Notes:

1. This is not an installation drawing.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with all Architectural, Mechanical, Electrical, Structural and Civil engineering drawings, schematics and all specification documents.
4. Drawing has been produced based on information presented in O&M manual drawings and visual observations on site.
5. This drawing is indicative and illustrates the design intent for the primary services routes. It is subject to design development and coordination with other disciplines during the next stages of design.
6. Drawing elements shown as grey/halftone represent existing installation. The full extent of the existing services are not indicated for clarity.
7. Sizes of containment and pipework at this stage are indicative and for primary coordination purposes only.
8. Final connections to equipment not shown for clarity.

Electrical Legend:

- Control Panel
- Electrical Distribution Board
- Industrial Socket Outlet
  'N' denotes Rating (A)
  'X' denotes No. of Phases
  'WP' denotes Weather Proof
- Disconnector / Isolator
  'N' denotes Rating (A)
  'X' denotes No. of Phases
  'WP' denotes Weather Proof
- Low Voltage Tray / below ground duct
- ELV Cable / below ground duct

Mechanical Legend:

- Mechanical Equipment
- LTHW Flow
- LTHW Return

Issue	Date	
P01	12/01/2024	Stage 3 Issue

ARUP

63 St Thomas Street
Bristol BS1 6JZ
Tel +44(0)117 976 5432 Fax +44(0)117 976 5433
www.arup.com

Client
University of the West of England

UWE Bristol University of the West of England

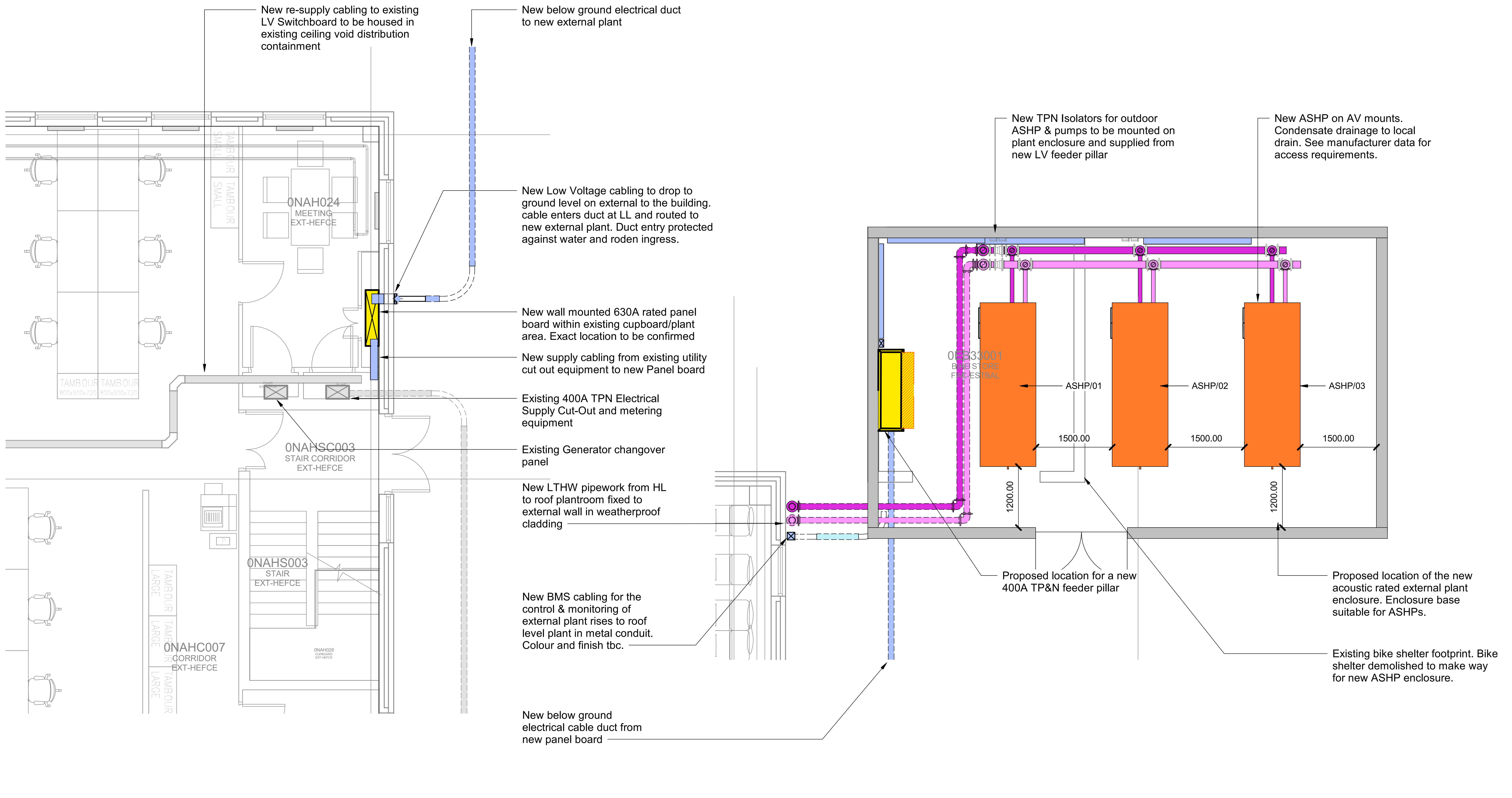
Project Title
Northavon House

Drawing Title
Combined Services
Ground Level & External Layout

Scale at A1	1 : 100	Dsg/Drw/Chkd/Ap IR/AM/IR/RJ
Role	Combined MEP	
Status	S2 - Suitable for Information	
Arup Job No	297699-00	Rev P01
ID	NAH-ARP-XX-00-DR-BS-01501	

10/01/2024 12:37:19

Do not scale



2 North Wing Ground Floor Plan
1 : 50

1 External Plant Enclosure Plan
1 : 50

Notes:

1. This is not an installation drawing.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with all Architectural, Mechanical, Electrical, Structural and Civil engineering drawings, schematics and all specification documents.
4. Drawing has been produced based on information presented in O&M manual drawings and visual observations on site.
5. Lighting local to new external plant enclosure to be provided and supplied from new external feeder pillar.
6. This drawing is indicative and illustrates the design intent for the primary services routes. It is subject to design development and coordination with other disciplines during the next stages of design.
7. Drawing elements shown as grey/halftone represent existing installation. The full extent of the existing services are not indicated for clarity.
8. Sizes of containment and pipework at this stage are indicative and for primary coordination purposes only.
9. Final connections to equipment not shown for clarity.
10. Existing below ground services to be surveyed prior to ground works

Electrical Legend:

- Control Panel
- Electrical Distribution Board
- Industrial Socket Outlet 'N' denotes Rating (A) 'X' denotes No. of Phases 'WP' denotes Weather Proof
- Disconnector / Isolator 'N' denotes Rating (A) 'X' denotes No. of Phases 'WP' denotes Weather Proof
- Low Voltage Tray / below ground duct
- ELV Cable / below ground duct

Mechanical Legend:

- Mechanical Equipment
- LTHW Flow
- LTHW Return

Issue	Date	
P01	12/01/2024	Stage 3 Issue

ARUP

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www.arup.com

Client
University of the West of England

UWE Bristol University of the West of England

Project Title
Northavon House

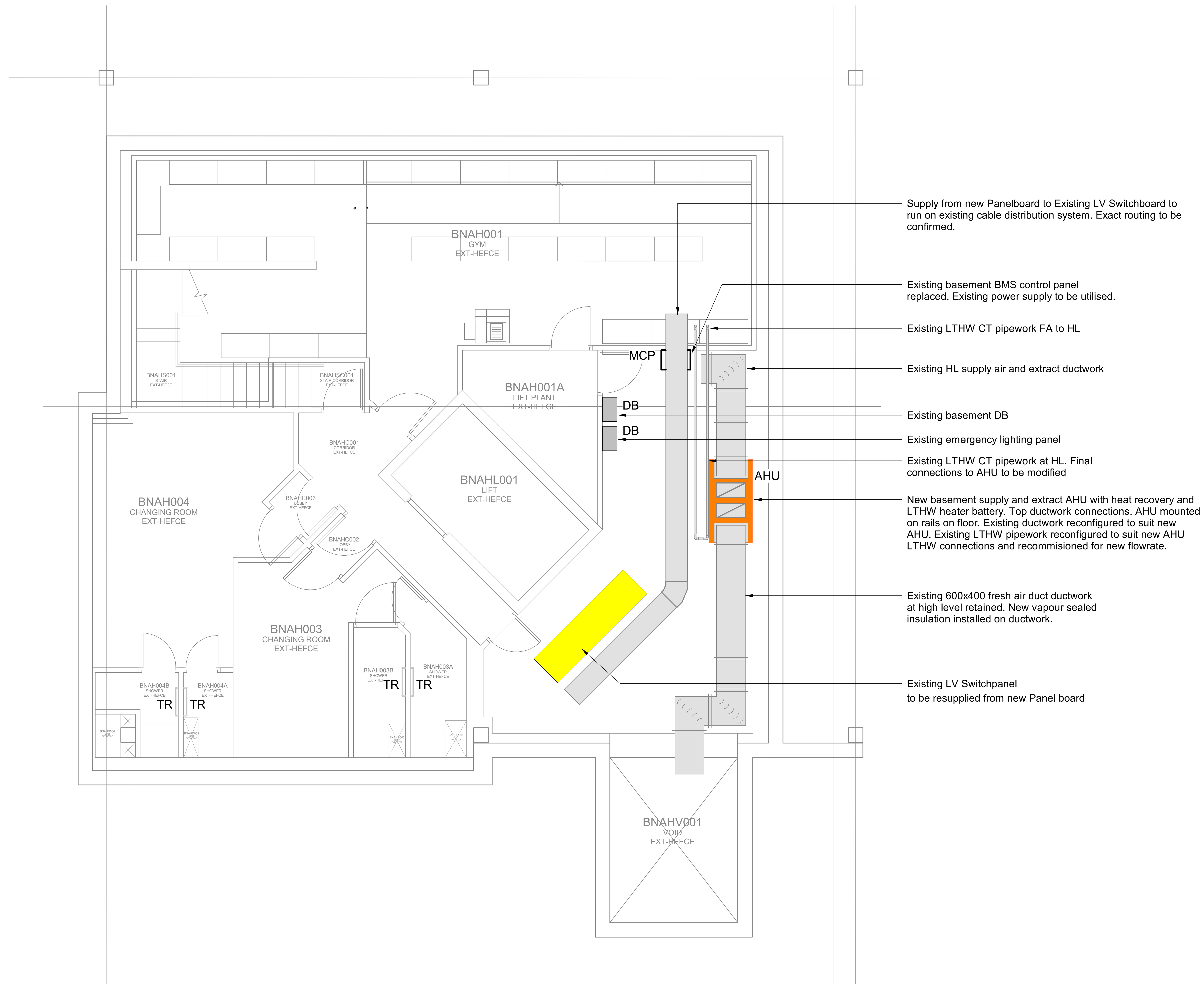
Drawing Title
Combined Services
Ground Level plant Layout

Scale at A1	1:50
Dsg/Drw/Chkd/Ap	MB/IR/AM/IR/RJ/RJ
Role	Combined Services
Status	S2 - Suitable for Information
Arup Job No	297699-00
Rev	P01
ID	NAH-ARP-XX-00-DR-BS-01502

10/01/2024 12:37:21

Do not scale

A1



Notes:

1. This is not an installation drawing.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with all Architectural, Mechanical, Electrical, Structural and Civil engineering drawings, schematics and all specification documents.
4. Drawing has been produced based on information presented in O&M manual drawings and visual observations on site.
5. This drawing is indicative and illustrates the design intent for the primary services routes. It is subject to design development and coordination with other disciplines during the next stages of design.
6. Drawing elements shown as grey/halftone represent existing installation. The full extent of the existing services are not indicated for clarity.
7. Sizes of containment and pipework at this stage are indicative and for primary coordination purposes only.
8. Final connections to equipment not shown for clarity.

10/01/2024 12:37:17

Electrical Legend:

- Control Panel
- Electrical Distribution Board
- Industrial Socket Outlet 'N' denotes Rating (A) 'X' denotes No. of Phases 'WP' denotes Weather Proof
- Disconnector / Isolator 'N' denotes Rating (A) 'X' denotes No. of Phases 'WP' denotes Weather Proof
- Low Voltage Tray / below ground duct
- ELV Cable / below ground duct

Mechanical Legend:

- Mechanical Equipment
- LTHW Flow
- LTHW Return

Issue	Date	
P01	12/01/2024	Stage 3 Issue

ARUP

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Tel +44(0)117 976 5432 Fax +44(0)117 976 5433
www.arup.com

Client
University of the West of England

UWE Bristol University of the West of England

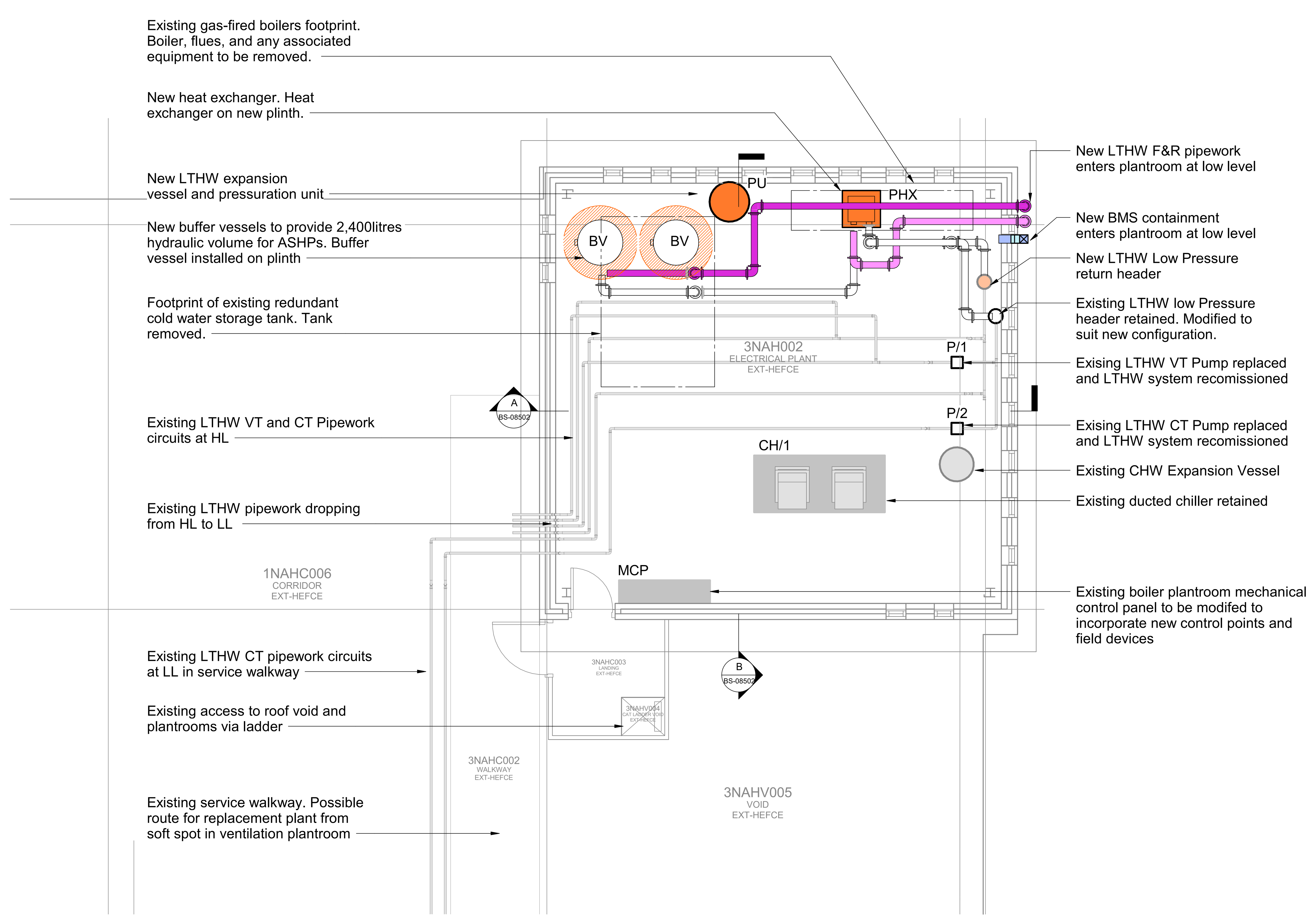
Project Title
Northavon House

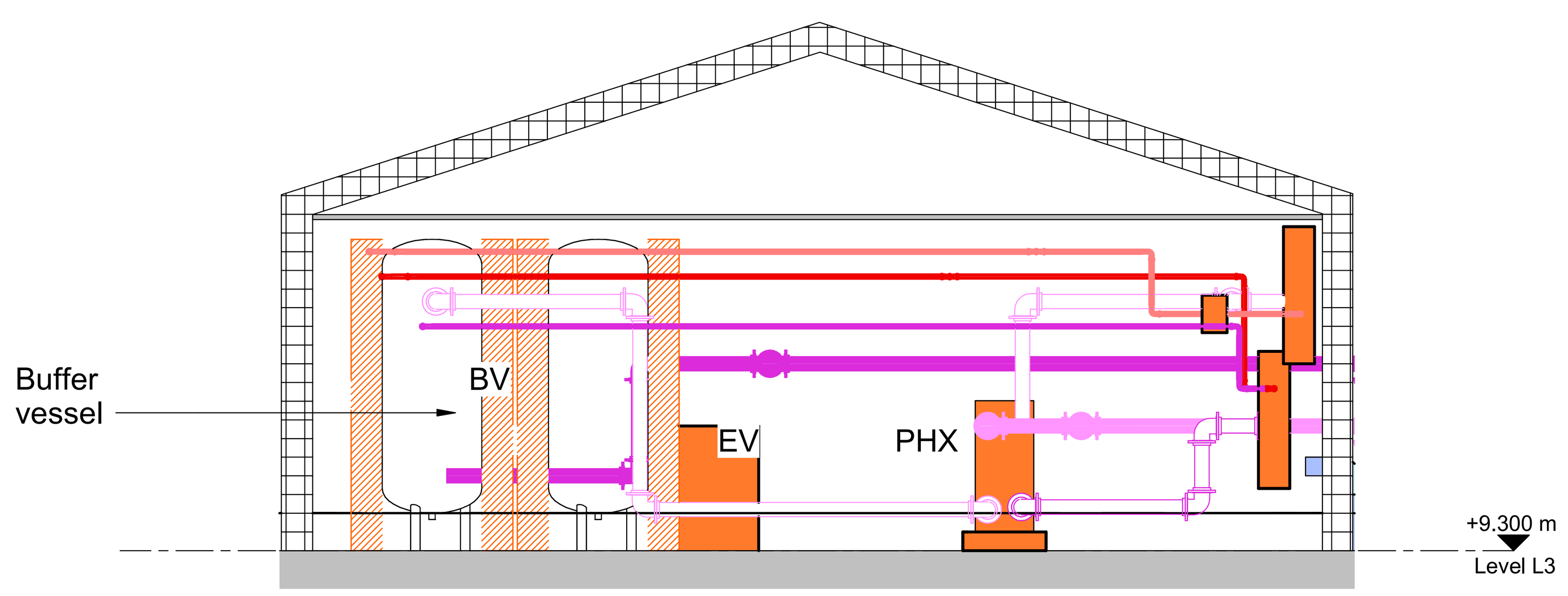
Drawing Title
Combined Services
Basement Plantroom Layout

Scale at A1	As indicated	Dsg/Drw/Chkd/Ap	IR/ACS/IR/RJ
Role	Combined Services		
Status	S2 - Suitable for Information		
Arup Job No	297699-00	Rev	P01
ID	NAH-ARP-XX-B0-DR-BS-08501		

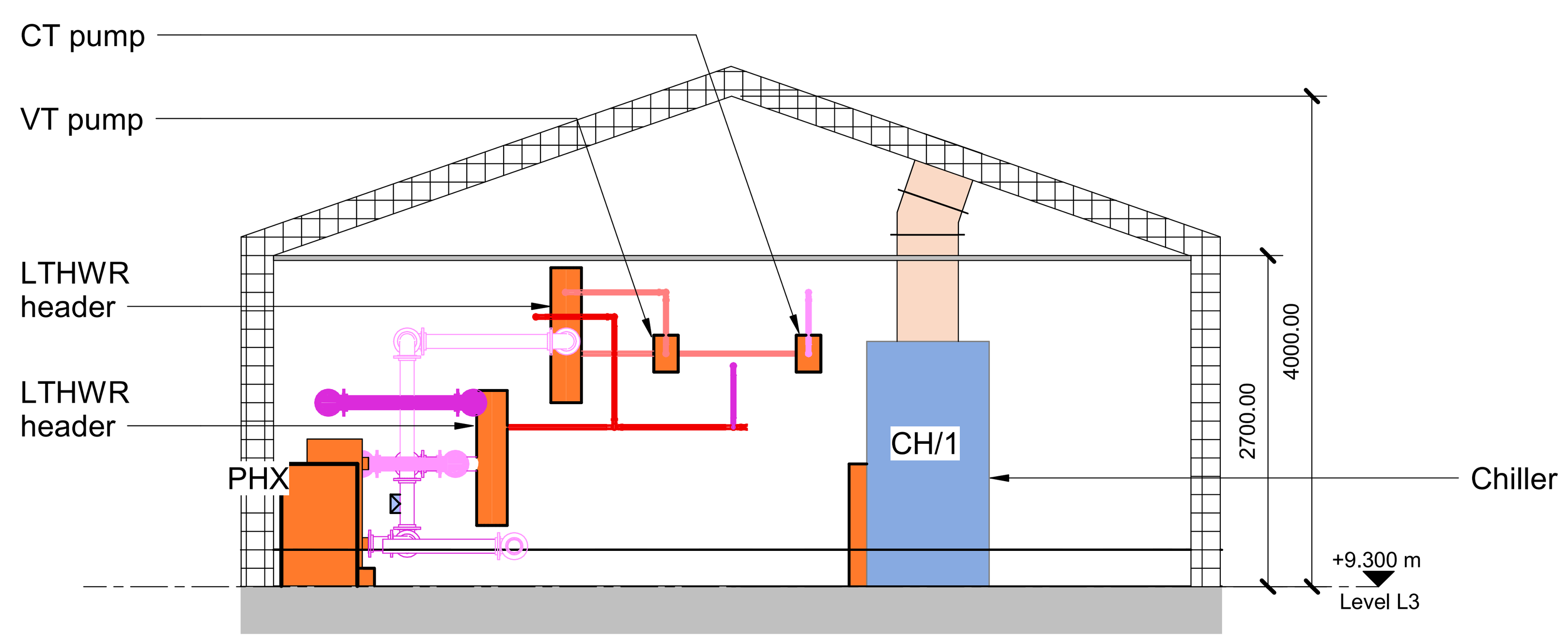
Do not scale

A B C D E F G H I J K L M N





A Section A - Heating and Cooling Plantroom
1 : 50



B Section B - Heating and Cooling Plantroom
1 : 50

Notes:

1. This is not an installation drawing.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with all Architectural, Mechanical, Electrical, Structural and Civil engineering drawings, schematics and all specification documents.
4. Drawing has been produced based on information presented in O&M manual drawings and visual observations on site.
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6. Drawing elements shown as grey/halftone represent existing installation. The full extent of the existing services are not indicated for clarity.
7. Sizes of containment and pipework at this stage are indicative and for primary coordination purposes only.
8. Final connections to equipment not shown for clarity.

10/01/2024 12:37:22

Electrical Legend:

Control Panel

Electrical Distribution Board

Industrial Socket Outlet
'N' denotes Rating (A)
'X' denotes No. of Phases
'WP' denotes Weather Proof

Disconnector / Isolator
'N' denotes Rating (A)
'X' denotes No. of Phases
'WP' denotes Weather Proof

Low Voltage Tray / below ground duct

ELV Cable / below ground duct

Mechanical Legend:

Mechanical Equipment

LTHW Flow

LTHW Return

P01	12/01/2024	Stage 3 Issue
Issue	Date	

ARUP

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Client
University of the West of England

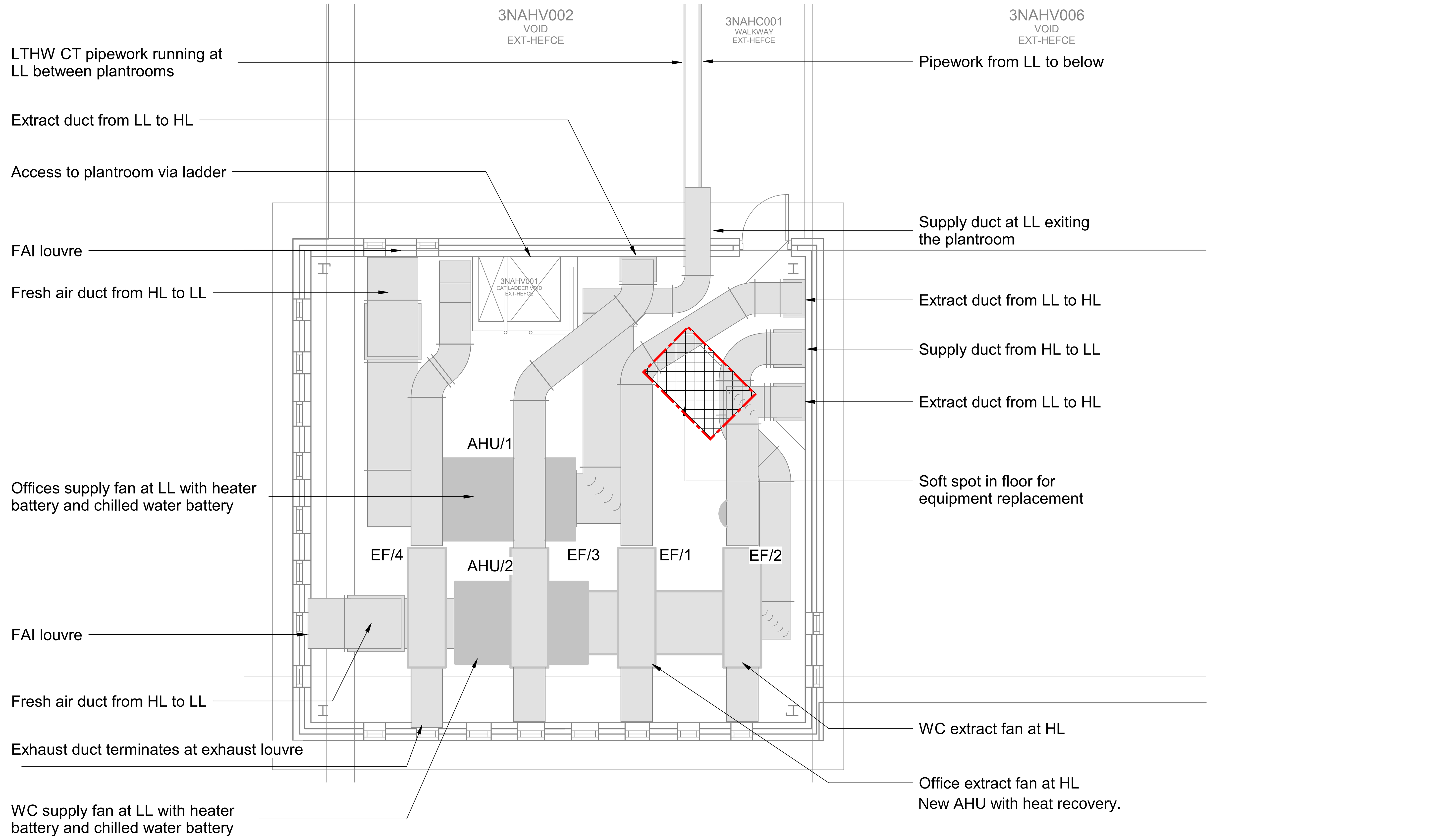
UWE Bristol University of the West of England

Project Title
Northavon House

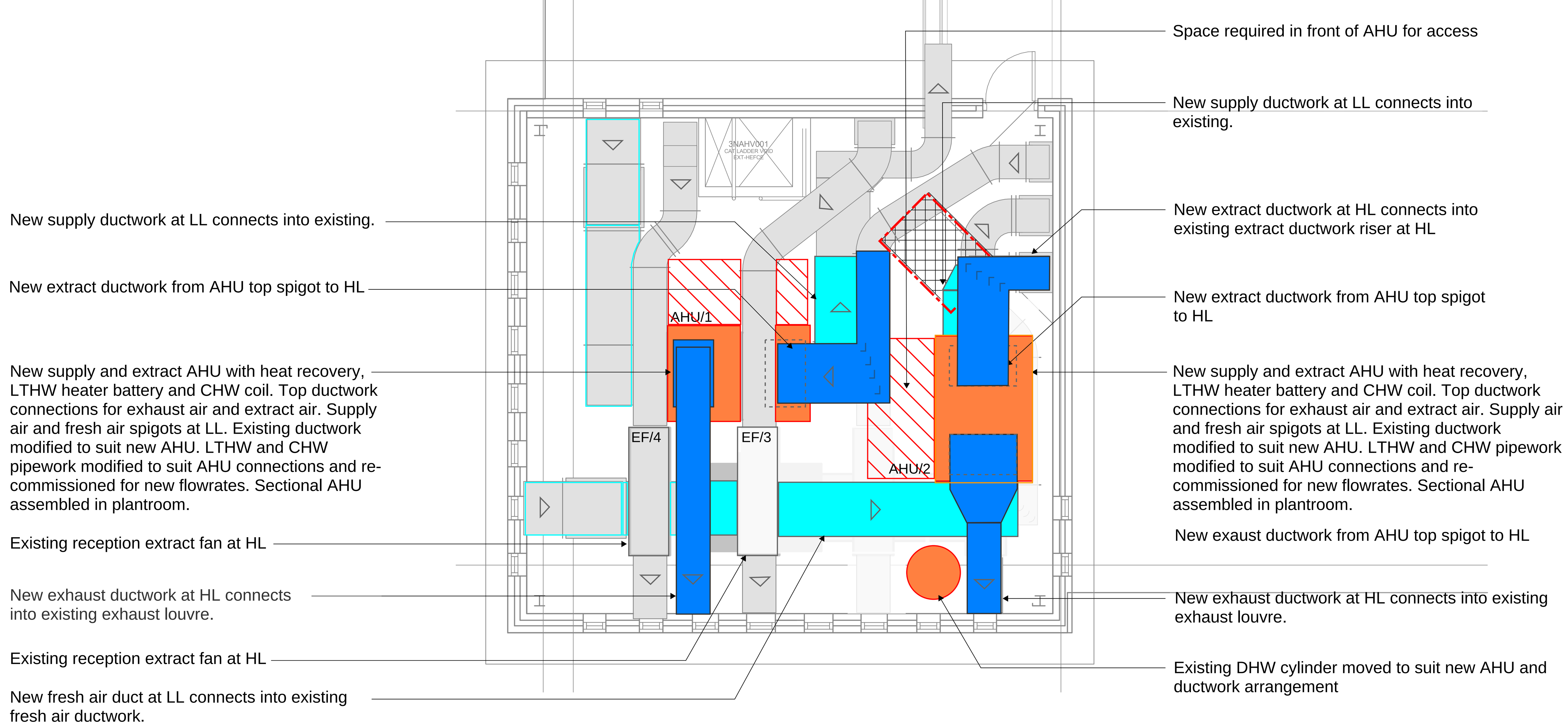
Drawing Title
Combined Services
Level 4 Heating and Cooling
Plantroom Layout and Sections

Scale at A1	As indicated	Dsg/Drw/Chkd/Ap ACS/ACS/IR/Approver
Role	Combined Services	
Status	S2 - Suitable for Information	
Arup Job No	297699-00	Rev P01
ID	NAH-ARP-XX-L4-DR-BS-08502	

Do not scale



1 Existing Ventilation Roof Plantroom
1 : 50



2 Proposed Ventilation Roof Plantroom
1 : 50

Notes:

1. This is not an installation drawing.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with all Architectural, Mechanical, Electrical, Structural and Civil engineering drawings, schematics and all specification documents.
4. Drawing has been produced based on information presented in O&M manual drawings and visual observations on site.
5. This drawing is indicative and illustrates the design intent for the primary services routes. It is subject to design development and coordination with other disciplines during the next stages of design.
6. Parts of the drawing shown as grey/halftone represent existing installation, electrical infrastructure and equipment. The full extend of the existing services might not be represented.
7. Sizes of containment and pipework at this stage are indicative and for primary coordination purposes only.
8. Final connections to equipment not shown for clarity.

P01	12/01/2024	Stage 3 Issue
Issue	Date	

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Client
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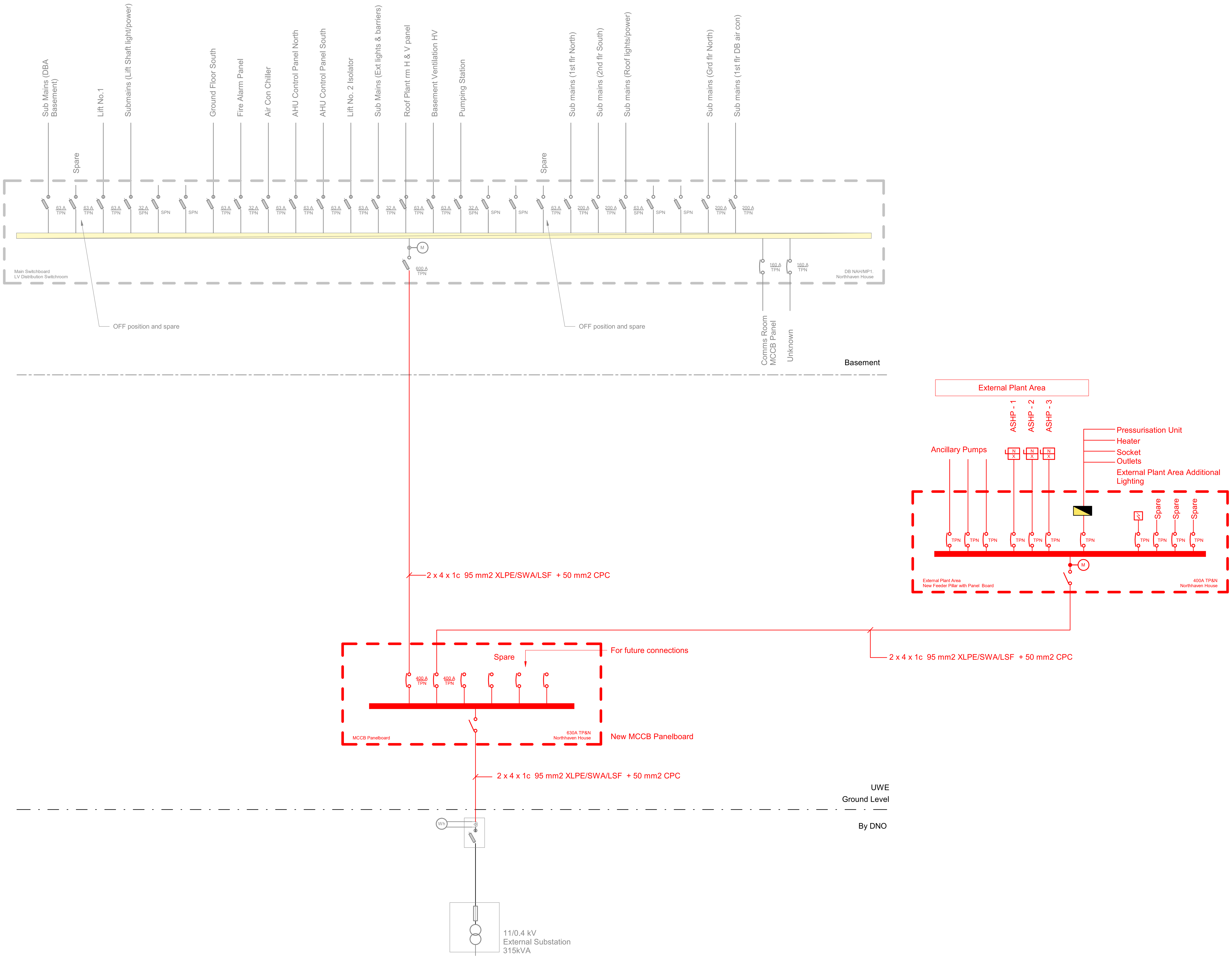
Project Title
Northavon House

Drawing Title
Combined Services Level 4 Ventilation Plantroom Layout

Scale at A1: As indicated
Dsg/Drw/Chkd/Ap: IR/ACS/RJ/RJ
Role
Status
Arup Job No: 297699-00
Rev
ID: NAH-ARP-XX-L4-DR-BS-08503



Notes:

1. This is not an installation drawing
2. Drawing elements shown as grey/halftone represent existing installation. The full extent of the existing electrical distribution might not be represented.
3. Red linework represents proposed new electrical installation/equipment.
4. Feeder Pillars to be provided with anti-condensation heater, internal lamp and 13A socket outlet with RCD protection.
5. LV feeder pillars shall be supplied to Form 4 type 6 assemblies.
6. Drawing has been produced based on information from visual survey only. Electrical distribution to be fully surveyed on site to confirm details.

Electrical Legend

- Switch disconnector
- Digital Multifunction Meter Unit
- Moulded Case Circuit Breaker, MCCB
- Disconnector Switch-Fused
- Isolator
- Surge Protection
- MCB Distribution Board

Issue	Date	
P01	12/01/2024	Stage 3 Issue

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Project Title
Northavon House

Drawing Title
Proposed Low Voltage Electrical Schematic

Scale at A1: 1 : 100
Dsg/Drw/Chkd/Ap: AM/AM/IR/RJ
Role: Electrical
Status: S2 - Suitable for Information
Arup Job No: 297699-00
Rev: P01
ID: NAH-ARP-XX-ZZ-DR-EE-01301

Do not scale

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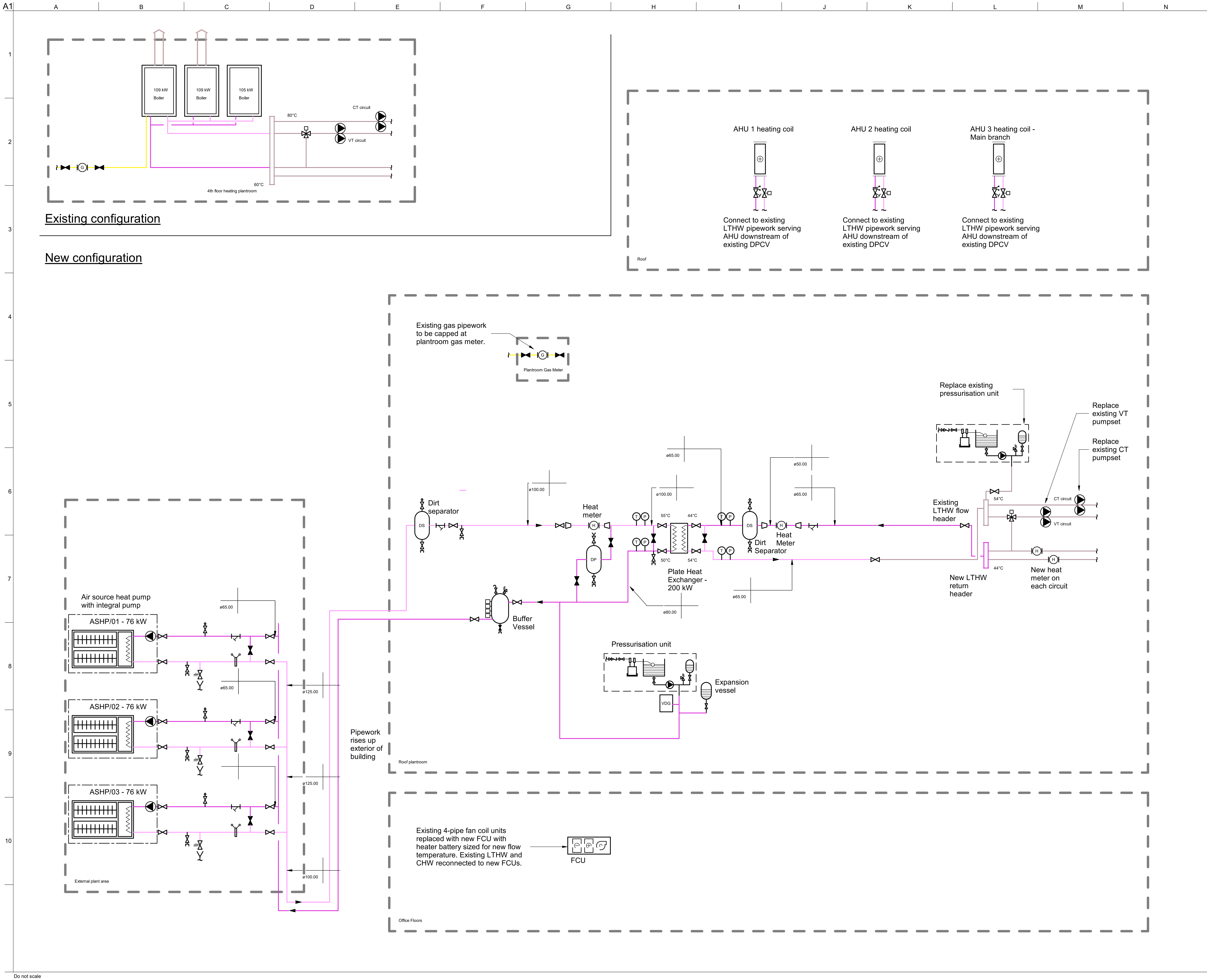

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Notes:

1. This is not an installation drawing
2. Drawing elements shown in grey/halftone represent existing installation.
3. Drawing elements indicated in red pen are proposed.

Legend

- Pipework - LTHW - Flow
- Pipework - LTHW - Return
- Pipework - LTHW CT - Flow
- Pipework - LTHW CT - Return
- Pipework - LTHW VT - Flow
- Pipework - LTHW VT - Return
- Pipework - Existing

P01	12/01/2024	Stage 3 Issue
Issue	Date	

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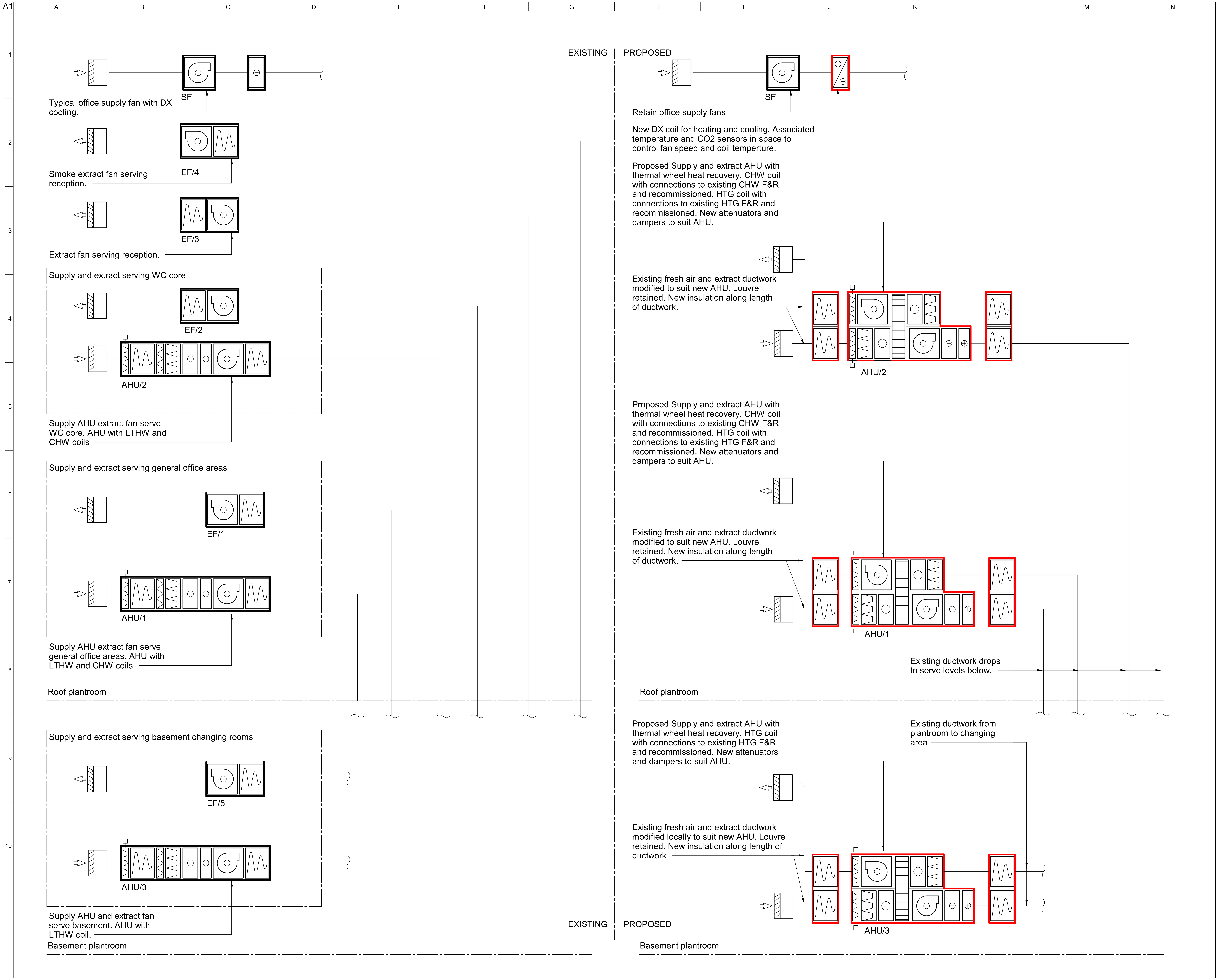
Project Title
Northavon House

Drawing Title
Heating Schematic

Scale at A1	NTS	Dsg/Drw/Chkd/Ap IR/ACS/IR/RJ
Role	Mechanical	
Status	S2 - Suitable for Information	
Arup Job No 297699-00		Rev P01

ID
NAH-ARP-XX-ZZ-DR-ME-01301



Notes:

1. This is not an installation drawing
2. Drawing elements shown in grey/halftone represent existing installation.
3. Drawing elements indicated in red pen are proposed.

10/01/2024 13:04:11

P01	12/01/2024	Stage 3 Issue
Issue	Date	

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Project Title
Northavon House

Drawing Title
Ventilation Schematic

Scale at A1	NTS	Dsg/Drw/Chkd/Ap	IR/IR/RJ/RJ
Role	Mechanical		
Status	S2 - Suitable for Information		
Arup Job No	297699-00	Rev	P01
ID	NAH-ARP-XX-ZZ-DR-ME-04301		

Do not scale

Cooling

- Chilled Water Flow
- Chilled Water Return
- Condenser Water Flow
- Condenser Water Return
- Cooling Ground Source Flow
- Cooling Ground Source Return
- Refrigerant Flow
- Refrigerant Return
- Refrigerant Gas
- Refrigerant Liquid

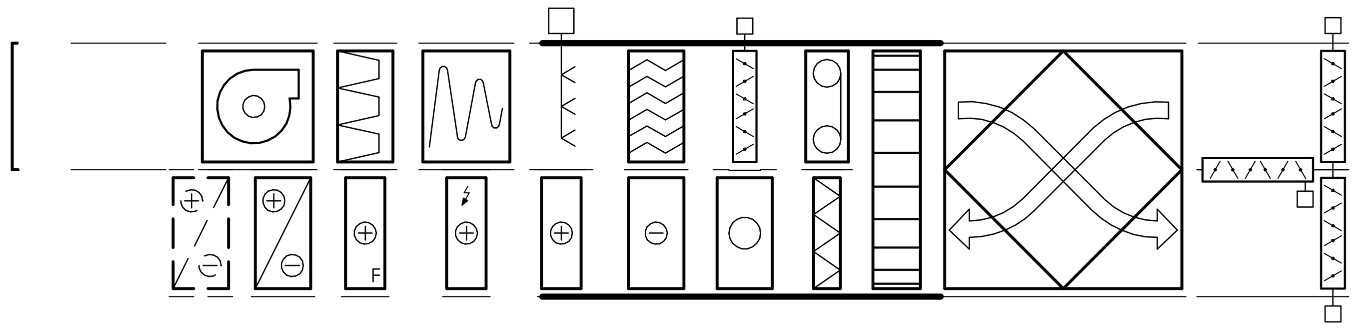
Heating

- HTHW Flow
- HTHW Return
- LTHW Flow
- LTHW Return
- LTHW CT Flow
- LTHW CT Return
- LTHW VT Flow
- LTHW VT Return
- MTHW Flow
- MTHW Return
- Steam High Pressure
- Steam Low Pressure
- Steam Medium Pressure
- Condensate Low Pressure
- Condensate Medium Pressure
- Condensate High Pressure
- Fuel Oil - Flow
- Fuel Oil - Return

Ventilation

- Exhaust Air - Clean
- Exhaust Air - Flue
- Exhaust Air - General
- Exhaust Air - Kitchen
- Exhaust Air - Grease Waste
- Exhaust Air - Food and Beverage
- Exhaust Air - Smoke
- Exhaust Air - Toilet
- Exhaust Air - Car Park
- Exhaust Air - Process
- Exhaust Air - Hazardous
- Outside Air - General
- Return Air - Clean
- Return Air - General
- Transfer Air
- Supply Air - Clean
- Supply Air - General
- Supply Air - Makeup
- Supply Air - Stair Pressurisation
- Supply Air - Mixed
- Supply Air - Kitchen

Air Handling Unit



Mechanical Equipment - Fans

- Axial Fan
- Axial Fan - Twin
- Bifurcated Fan
- Centrifugal Fan
- Centrifugal Fan - Twin
- Attenuator
- Wall Mounted Fan

Duct Mounted Devices

- Attenuator
- Attenuator - Crosstalk
- Cooling Coil
- Heating Coil

Dampers

- Fire Damper
- Motorised Control Damper
- Motorised Control Damper - Pneumatic
- Non Return Damper
- Smoke Damper
- Volume Control Damper

Ductwork Measuring Devices

- C02 Sensor
- Humidity Sensor
- Smoke Sensor
- Temperature Sensor

Natural Ventilation

- Motorised Opening
- Openable Window
- C02 Sensor
- Roof Cowl
- Roof Opening
- Trickle Vent
- Trickle Vent - Motorised
- Wind Sensor

Louvres

- Exhaust Louvre
- Exhaust Louvre - with Plenum
- Fresh Air Louvre
- Fresh Air Louvre - with Plenum
- Fresh Air Louvre - Sloped

Heat Exchangers

- Plate Heat Exchanger
- Tube Heat Exchanger

Grilles

- Acoustic Transfer Grille
- Air Extract Luminaire
- Bell Mouth - Extract
- Bell Mouth - Supply
- Ceiling Grille - Extract
- Ceiling Grille - Supply
- Displacement Drum
- Extract Grille
- Flexible Duct
- Flexible Duct (Single Line)
- Floor Swirl Diffuser
- Jet Nozzle Diffuser
- Jet Nozzle Diffuser - Motorised
- Linear Extract Grille
- Linear Extract Sidewall
- Linear Supply Grille
- Linear Supply Sidewall
- Perforated Floor Tile
- Rectangular Grille
- Rectangular Grille - Extract
- Rectangular Grille - Supply
- Sidewall Grille
- Sidewall Grille - Extract
- Sidewall Grille - Supply
- Supply Grille
- Transfer Grille
- Transfer Grille with Fire Damper
- Transfer Grille with Smoke Damper

Louvres

- Active Chilled Beam - Cooling
- Active Chilled Beam - Heating
- Active Chilled Beam - Heating & Cooling
- Cassette Unit - Cooling
- Cassette Unit - Heating & Cooling
- Cassette Unit - Heating & Cooling (DX)
- Chilled Ceiling
- Door Air Curtain
- FCU - Cooling
- FCU - Heating & Cooling
- FCU - Heating
- FCU - Wall Mounted - DX
- FCU - Wall Mounted - Heating & Cooling
- Gas Fired Radiant Heater
- Radiator
- Room AC Unit
- Trench Heater - Fan Assisted
- Trench Heater - Natural Convection
- Unit Heater
- VAV - Electric
- VAV - Cooling
- VAV - Heating

Mechanical Equipment

- Air Source Chiller
- Boiler
- Condensing Boiler
- Calorifier
- Condensor Unit
- Cooling Tower - Force Draft
- Cooling Tower - Force Draft w/ attenuation
- Cooling Tower - Induction Closed
- Cooling Tower - Induction Open
- Dry Cooler
- HWS - Gas Fired
- Hydrobox
- Water Source Chiller
- Cold Water Storage Tank
- DA - Dirt Aerator
- DS - Dirt Separator
- DP - Dosing Pot
- Duplex Filter
- Expansion Vessel
- Manifold
- Pressurisation Unit
- Pressurisation Unit w/ Glycol
- Sidestream Filtration
- Vacuum Degasser

Pipework Equipment

- Buffer Vessel

Pipework Equipment - Pumps

- Pump Running
- Pump Variable Speed Running
- Pump Twin
- Pump standby
- Pump Variable Speed Standby
- Compressor

Valves

- 2 Port Valve Motorised
- 2 Port Valve Pneumatic
- 3 Port Valve Motorised
- 3 Port Valve Pneumatic
- 3 Port Valve
- 4 Port Valve Motorised
- Air Vent Automatic
- Air Vent Manual
- Anti Vacuum Valve
- Air Admitance Valve
- Ball Valve Delayed Action
- Ball Valve Float Operated
- Commissioning Set
- Differential Pressure Control Valve
- Direct Acting Sensor
- Direct Acting Valve
- Double Check Valve
- Double Regulating Valve
- Thermal Balancing Valve
- Drain Cock
- Expansion Valve
- Gas Governor
- Gas Solenoid Valve
- Gravity Operated Valve
- Valve with Hose Union
- Bib Tap
- Isolating Valve Angled
- Isolating Valve Closed
- Isolating Valve
- Lockshield Valve
- Non Return / Check Valve
- Open Vent
- Pressure Independent Control Valve
- Pressure Reducing Valve with Gauge
- Pressure Reducing Valve
- Regulating Valve
- Relief Valve
- Angled Safety Valve
- Safety Valve
- Stop Cock
- Solenoid Shut Off Valve

Pipework Measuring Devices

- Content Gauge
- Differential Pressure Sensor
- Float Trap
- Flow Sensor
- Flow Switch
- Gas Meter
- Heat Meter
- Orifice Plate
- Pressure Gauge
- Pressure Sensor
- Pressure Tapping
- Sight Glass
- Temperature Gauge
- Temperature Sensor
- Test Point
- Thermometer
- Thermostat
- Vacuum Gauge
- Venturi Meter
- Water Meter

Pipework Fittings

- Anti vibration Coupling
- End Cap
- Expansion Bellows
- Flange Joint
- Flexible Connection
- Quick Fill Connection
- Trapped Tundish
- Tundish
- Union
- Pocket

Abbreviations

TB	To Below
TA	To Above
FA	From Above
FB	From Below
FA to HL	From Above to High Level
FA to LL	From Above to Low Level
FB to HL	From Below to High Level
FB to LL	From Below to Low Level
HL TB	High Level to Below
HL TA	High Level to Above
LL TB	Low Level to Below
LL TA	Low Level to Above
HL	High Level
LL	Low Level
RFB	Rise From Below
RTA	Rise To Above
DFA	Drop From Above
DTB	Drop To Below
DT LL	Drop To Low Level
DFA HL	Drop From Above To High Level
ø or Dia	Diameter
F	Flow
R	Return
NRV	Non Return Valve
AAV	Automatic Air Valve
CS	Commissioning Set
OP	Orifice Plate
FOP	Fixed Orifice Plate
PRV	Pressure Reducing Valve
N/C	Normally Closed
C/W	Complete with
LSV	Lock Shield Valve
MV	Motorised Valve
GC	Gas Cock
CT	Constant Temperature
VT	Variable Temperature
HTG	Heating
LTHW	Low Temperature Hot Water
P	Pump
DPS	Differential Pressure Switch
IV	Isolating Valve
DRV	Double Regulating Valve

General Schematic Items

- Level 01 — Building Level
- Space_Name Space_Number — Schematic Room
- Flow Rate (kg/s or l/s), Velocity, 0.26 kg/s, 0.37 m/s, 44 Pa/m, 400x400, Size, Pressure Drop — Ductwork Commission Data
- Flow Rate (kg/s or l/s), Velocity, 0.26 kg/s, 0.37 m/s, 46 Pa/m, ø100, Size, Pressure Drop — Pipework Commission Data

Issue	Date	
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Project Title
Northavon House

Drawing Title
Mechanical Legend

Scale at A1	NTS	Dsg/Drw/Chkd/Ap AMM/AMM/IR/RJ
Role	Mechanical	
Status	S2 - Suitable for Information	
Arup Job No	297699-00	Rev P01
ID	NAH-ARP-XX-XX-DR-ME-00901	

Do not scale

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Appendix H

Electrical Calculations

ARUP

Maximum Electrical Load Assessment JOB NAME: Northaven House | JOB NUMBER : 297699 | STATUS: For Information | REVISION : S1 | DATE: AMA 06-12-23

Building Profile

Building Area	*Typical Benchmark density*		
4281 m2	43 *w/m2*	100% *Capacity threshold.*	
	0.95 *Power Factor*		

Green	A 'green' highlighted cell indicates the current supply capacity threshold is likely to not be exceeded.
Yellow	A 'yellow' highlighted cell indicates the current supply capacity threshold may be exceeded and/or requires further investigation.
Red	A 'red' highlighted cell indicates the current supply maximum capacity will likely be exceeded

					Currently (Baseline)					Proposed System				
Primary Source	Incoming Supply Rating Size (A)	Source	Building Incoming Supply Size (A)	PF	Max Load Demand Estimate (kVA)	Max Load Demand (Actual) kVA (see note 1)	Building Supply Capacity (kVA)	Building Supply Spare Available Capacity (kVA)	Existing Main Supply Cable Details	Max Load Demand Estimate (kVA)	Spare Capacity (A)	I Amps	Maximum Cable Current Capacity	Associated Main LV Switchgear Rating (A)
External Substation (315 kVA Transformer)			454		193.8	118.0	314.5	196.5	Unknown	258.5	81.0	373		Existing 600A rated
				TOTALS	193.8	**118.0**				**258.5**				
								197.0						

Equipment	Qty.	P.Rating kW	W/m2	PF	Diversity	kW	kVA	Amp	Comments
Existing									
Totals									
Interventions									
AHSP 1	1	53.3		0.81	1	53.3	65.8	95.0	
AHSP 2	1	53.3		0.81	1	53.3	65.8	95.0	
AHSP 3	1	53.3		0.81	0	0.0	0.0	0.0	(N+1 Arrangement)
Pump Future Provision	1	2.2		0.8	1	2.2	2.8		
Pump Future Provision	1	2.2		0.8	1	2.2	2.8		
Pump Future Provision	1	2.2		0.8	1	2.2	2.8		
Pressurisation unit	1	0.42		0.7	1	0.42	0.6		
Totals							140.45	202.7	

Notes

1) Extracted from Display Meter at Building Main LV Switchpanel at Basement Plant

Appendix I

Costing Assumption and Exclusions

ASSUMPTIONS AND EXCLUSIONS

1 Assumptions

The following assumptions have been allowed for within this cost plan:

1. All relevant systems will be shut-off prior to any work being completed on that system.
2. Protection to works areas, plant and equipment being retained, will be required.
3. There is no requirement for any extraordinary site investigations.
4. The contractor's preliminaries reflect a single phase programme and unrestricted working.
5. The contractor's overheads and profit is based on the likely cost of the main contractor's head office setup, administration proportioned to each contract and reasonable profit.
6. If necessary, any relocation or decant of personnel from the surrounding work areas will be funded and facilitated by the client's team.
7. The availability, capacity, condition and location of existing services are reasonable to facilitate the contract works to be undertaken.
8. Allowance has been made within estimates for some builder's work in connection with services, such as forming holes, pipe sleeves, fire resistant stopping and making good.
9. The estimates make no provisions for structural alterations to facilitate the installation of the new heat pumps
10. Allowance has been made within estimates for offloading and positioning of central plant and equipment. These costs have been benchmarked for undertaking works of a similar nature.
11. All costs are in GBP (£).
12. Costs and rates have been obtained from industry price books, previous project information, historic market information and professional experience and judgement.
13. Costs have been calculated on the basis of market conditions returning to pre-pandemic levels and no allowance for additional COVID-19 disruption has been made.
14. The estimates allow for testing and commissioning of mechanical and electrical services, for items such as: testing equipment and consumables, calibration, site installation tests, static and performance testing including records, commissioning including preliminary checks, and the like.
15. An allowance is included for project/ design team professional fees, for fees associated with the project/design team and other specialist consultants required for the building project (i.e. consultants' fees). In addition to, main contractor's pre-construction fees. No consideration has been given to the client procurement or tendering method at this stage, which could influence these costs.
16. The costs contained within this report should be considered indicative only and be used as a guide for future discussions surrounding the design development of these elements in relation to achieving the desired solutions. These costs should not be used during procurement or tendering activities or to determine project or business commercial targets.

ASSUMPTIONS AND EXCLUSIONS

2 Exclusions

The following items are excluded from this cost plan:

1 No allowance for tender or construction inflation.
2 Specific risk items that maybe associated with the design changes.
3 No allowance for utility upgrades, except where specifically noted - assumed existing electrical, fibre, water, drainage, etc. infrastructure has adequate capacity to service the new equipment.
4 Allowances for abnormal site surveys / investigations.
5 Allowance for *Other Development / Project Costs.*
6 Allowances for general or special planning conditions, if required.
7 Any attempt to estimate the client's procurement and tendering methods.
8 Costs for decanting personnel for any reason associated with the delivery of the project works.
9 No contamination / remediation strategy report is present at the time of producing this order of cost estimate, an allowance has not been included for the removal and disposal of asbestos contaminated materials / substances.
10 No allowance has been made for contaminated / hazardous ground
11 Site specific limitations arising from listed building status, or other statutory building requirements.
12 Any archaeological investigations, wildlife mitigation measures and other extraordinary site investigation works, and the like.
13 Does not include for physical restrictions or limitations in accessing site.
14 All works will be undertaken during normal working hours, no allowance has been made for premium time working/ out of hours working.
15 No allowance has been made for the replacement of existing calorifiers. It is assumed the capacity and condition of existing calorifiers is reasonable to facilitate these work being undertaken.
16 VAT and any other levies have been excluded

Intervention	Basis of costs	Comments	Cost (£)
A.1 - Air Source Heat Pump (ASHP)			
3no 75kW ASHPs	Cost allowances shall include for the decommissioning and removal of existing central plant equipment. Heat pump installation costs shall include for new plate heat exchanger, secondary hydraulic pumps, pressurisation unit, buffer vessel and dirt separator to provide sufficient LTHW management reflective of heat pump capacity. To support the increased electrical load demands, new additional LV switchgear and associated cabling to be included for. Costs shall include for new pipework to connect heat pumps to ancillary plant room and distribution plant and equipment. ASHP's shall be costed to be installed at ground level and assume sufficient space is available within a location suitable for efficient ASHP running. Louvered acoustic screening of 3m high to a 20m perimeter of the ASHP shall be allowed for. Assume 10nr BMS connections to the new plant and equipment and modification to BMS software / interface to incorporate new plant and equipment.	Mechanical Services	£277,101
		Electrical services	£57,059
		External work / BWIC	£48,373
		Main Contractor OH&Ps @ 10%	£38,253
		Main Contractor Preliminaries	£97,177
		Contingency	£51,796
		TOTAL construction cost	**£569,759**
		Design Fees @10%	£56,976
		TOTAL exc VAT	£626,735
		TOTAL inc VAT	£752,082
A.2 - AHU Replacement			
AHUs replacement	Cost allowance to include the decommissioning and removal of existing supply AHU equipment and assoicated extract fans. AHU installation cost shall allow for new AHU complete with direct drive EC fans and heat recovery. An allowance shall be included for enabling works within plantrooms, including plinths and builders work openings. An allowance shall be made for local modifications to the supporting LTHW and CHW piped services. Assume 5nr BMS connections to the new plant and equipment and modification to BMS software / interface to incorporate new plant and equipment.	Mechanical Services	£179,890
		Electrical services	£24,169
		External work / BWIC	£9,693
		Main Contractor OH&Ps @ 10%	£21,375
		Main Contractor Preliminaries	£68,653
		Contingency	£30,378
		TOTAL construction cost	**£334,158**
		Design Fees @10%	£33,416
		TOTAL exc VAT	£367,573
		TOTAL inc VAT	£441,088

A.3 - Office ventilation heating and cooling upgrade			
Replace supply fan DX coil and introduce additional room sensors	Allowance for 6no units associaited with the 6no supply fans. Cost allowance to include the decommissioning and removal of existing ductwork DX coil. DX installation cost shall allow for new ductwork coil and external condenser (Low GWP refrigerant). An allowance shall be included for enabling works including plinths and builders work openings. An allowance shall be made for local modifications to the ductwork. Assume 10nr BMS connections to the new plant and equipment and modification to BMS software / interface to incorporate new plant and equipment.	Mechanical Services	£27,242
		Electrical services	£48,372
		External work / BWIC	£4,356
		Main Contractor OH&Ps @ 10%	£7,921
		Main Contractor Preliminaries	£4,356
		Contingency	£22,084
		TOTAL construction cost	**£114,331**
		Design Fees @10%	£11,433
		TOTAL exc VAT	£125,764
		TOTAL inc VAT	£150,917

A.4 - Heating system upgrade			
Radiator replacement	Rate shall include for the removal of existing radiators on replacement like for like with new radiators (ground floor and 2nd floor). Works to the pipework are for making good only, the existing pipework is assumed to be in sufficient condition to be maintained.	Mechanical Services	£91,710
		Electrical services	inc
		External work / BWIC	£4,356
		Main Contractor OH&Ps @ 10%	£9,607
		Main Contractor Preliminaries	£26,465
		Contingency	£13,742
		TOTAL construction cost	**£145,881**
		Design Fees @10%	£14,588
		TOTAL exc VAT	£160,469
		TOTAL inc VAT	£192,562

A.5 - Heating system upgrade			
Replacement FCU allowance	Rate shall include for the removal of existing 4-pipe FCUs (allowance for 10no) and replacement like for like with FCUs. Works to the pipework are for making good only, the existing pipework is assumed to be in sufficient condition to be maintained. Allowance for new BMS point per FCU, room sensors, and wiring.	Mechanical Services	£34,813
		Electrical services	£30,840
		External work / BWIC	£1,654
		Main Contractor OH&Ps @ 10%	£3,647
		Main Contractor Preliminaries	£10,977
		Contingency	£5,310
		TOTAL construction cost	**£87,239**
		Design Fees @10%	£8,724
		TOTAL exc VAT	£95,963
		TOTAL inc VAT	£115,156

A.6 - Ventilation system upgrade			
Office ventilation demand control	Allowance for 5no rooms with DCV on hte general office vent system. Cost to include for demounting of ceiling and installation of ceiling panels following completion of ductwork modifcations (allowance is for 5no rooms) Sensors will include controls cabling, air sampling tubes, wall probes, outside air sensors, duct probes and vacuum pumps. The installation will also require retrofit of ductwork mounted VAV boxes (supply and extract duct), controls cabling and additional access hatches. The BMS will need to be reconfigured to suit the new controls system, with additional points & a new sequence of operation.	Mechanical Services	£74,343
		Electrical services	£45,863
		External work / BWIC	£5,152
		Main Contractor OH&Ps @ 10%	£12,536
		Main Contractor Preliminaries	£35,077
		Contingency	£17,987
		TOTAL construction cost	**£190,957**
		Design Fees @10%	£19,096
		TOTAL exc VAT	£210,053
		TOTAL inc VAT	£252,064

Intervention	Basis of costs	Comments	Cost (£)
A.4 - DGU Windows and spandral panels	New off-the-shelf system; to be thermally broken. Allow for openable vents where existing ones were installed. Allow for making good works once new windows are installed. Preliminaries allow for scaffold.		£134,663
A.5 - Loft insulation	Adding insulation materials, such as mineral wool, over the loft floor.		£91,700
		Main Contractor OH&Ps @ 10%	£13,466
		Main Contractor Preliminaries	£281,156
		Contingency	£50,760
		TOTAL construction cost	**£571,745**
		Design Fees @10%	£57,174
		TOTAL exc VAT	£628,919
		TOTAL inc VAT	£754,703

Appendix J

Designer Risk Register

Designer Risk Register

ARUP

Register reference

Project	UWE NAH heating decarbonisation	**Job number**	297699-00
Package/ topic	MEP	**Design stage**	RIBA Stage 3

Remember: Avoid – Reduce – Control and communicate relevant information to others

Date (+ initials)	Area/location of risk exposure	Description of hazard and risk exposure	Mitigation of risk (potential or achieved)	A	R	C	Further action	By	Status Active/closed
21/12/2023 (IR)	Northavon House	Presence of Asbestos	UWE to provide Asbestos risk register to Contractor.			C		UWE	Active
21/12/2023 (IR)	Existing Services	Presence of existing services that may not be recorded on as-installed drawings or recorded inaccurately.	Contractor to undertake scan of ground prior to works or hand dig trial trench. Review existing record information and be vigilant.		✓	✓	Contractor to update relevant O&M information.	Contra ctor	Active
21/12/2023 (IR)	Electrical intake and panel boards	Exposure to LV electrical equipment during construction, testing and thereafter	Competent Contractor aware of risks	✓	✓	✓		Contra ctor	Active
21/12/2023 (IR)	Site - Public	Large numbers of students in the surrounding areas to the site. Potential for site related accidents and injuries (e.g. moving vehicles).	Contractor to manage access routes and design temporary barriers to prevent access from pavement to road along heavily populated areas. Banksmen may be required to walk vehicles down entire access route. Divert pedestrians away from vehicles wherever possible	✓	✓	✓	Identify main access routes and work/delivery times and design temporary barriers/signage to prevent access into site areas.	Contra ctor	Active

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Date (+ initials)	Area/location of risk exposure	Description of hazard and risk exposure	Mitigation of risk (potential or achieved)	A	R	C	Further action	By	Status Active/closed
21/12/2023 (IR)	Building - Public	Potential for unauthorised people accessing the site and subsequent site related injuries occurring.	Project boundaries to work areas, access and protection measures to be clearly defined. Measures to exclude unauthorised personnel to include appropriate barriers, signage and publicity.	✓	✓	✓	Identify working zones and work times and design temporary barriers/signage to prevent access into work areas.	Contractor	Active
21/12/2023 (IR)	External noise	Noise survey information insufficient to design enclosure to mitigate noise	Noise survey to indicate if additional measures are required.		✓	✓	Noise survey to be undertaken	Arup	Active
21/12/2023 (IR)	Internal noise	Noise disturbance	Communication with client to minimise disturbance.	✓	✓	✓	Communication between University and Contractor	Contractor/ UWE	Active
21/12/2023 (IR)	Plant areas, risers and ceiling voids	Manual handling of large / bulky items of plant	Identify and maintain clear designated routes for access to and removal of plant and equipment. Consider ‘flat-pack’ plant and plant that can be broken down into smaller components to facilitate ease of installation and removal.	✓	✓	✓	Identify and maintain clear designated routes for access to and removal of plant	Contractor	Active

Designer Risk Register

ARUP

Register reference

Project	UWE NAH heating decarbonisation	**Job number**	297699-00
Package/ topic	MEP	**Design stage**	RIBA Stage 3

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Date (+ initials)	Area/location of risk exposure	Description of hazard and risk exposure	Mitigation of risk (potential or achieved)	A	R	C	Further action	By	Status Active/closed
21/12/2023 (IR)	Site	Hot works - risk of fire and burns	Estates team to provide permits to work and fire marshall			C			Active
21/12/2023 (IR)	Roof plantrooms / roof void	Risk of maintenance personnel being unaware of a major fire incident while undergoing maintenance work on flat roof areas.	Fire alarm flashing beacons and sounders at suitable locations at roof level.		✓	✓	Workers undertaking maintenance work on roof to receive induction on safety measures. Permit to work suggested to access roof areas.	Contractor / University	Active