

# MECHANICAL AND ELECTRICAL TECHNICAL SPECIFICATION

For a

Domestic New Build

Prepared by

**MantaRay M&E Solutions Ltd**



**Manta Ray M&E Solutions Ltd** | Technical Specialists & Surveyors

Studio, Foxgloves Farm, Neyland, Milford Haven, Pembrokeshire, SA82 1TF

**T** 01326 379222 **E** 2326098@student.uwtsd.ac.uk **W** [www.MantaRayM&E.co.uk](http://www.MantaRayM&E.co.uk)

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## 1.0 Executive Summary

This report will detail the proposed mechanical and electrical design for a new build domestic building in Wales. The focus of this report will be centred on occupant health, fire safety and decarbonisation. For context, this approach will treat both the building fabric and the M&E services as one thermal being.

### 1.1 Assumptions and Justifications

The proposed designs will be to house type (HT 641), categorized as a 4 bed, 6 people dwelling with a measured surface area of 110m<sup>2</sup>. To establish a good baseline for accurate proposals, we are going to target 3.0m<sup>3</sup>/(hm<sup>2</sup>) at 50Pa, this threshold is to trigger the requirement for mechanical ventilation under approved document F to eliminate/reduce interstitial condensation and ensure high indoor air quality. It is assumed that the local electrical distribution network provides a single phase 100A supply to accommodate the additional loads built by the electric heating systems, vehicle charging etc. To ensure that the mechanical systems approach is appropriately sized for the HT 641 build, the design adopts a ‘fabric first’ approach with assumed U values of circa 0.15 W/m<sup>2</sup>K for the external walls which is consistent for the Welsh Government Approved Document Part L. This thermal performance justifies the Vaillant AroTHERM + 5kw ASHP as the reduced heat loss through the external envelope will ensure that a larger system with more capacity is not required.

Additionally, this design will target a water consumption limit of less than 110 L per person per day to adhere to the Welsh Government Building Regulations Part G for a 6-person dwelling. This influences the spec of the 210L cylinder which will ensure enough hot water provision all the while maintaining the homes overall low carbon threshold.

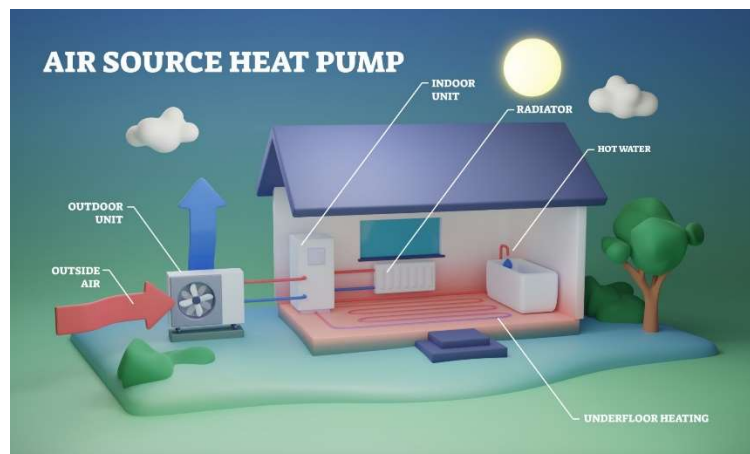
## 2.0 Mechanical Systems: Heating and Hot Water

### 2.1 Air Source Heat Pump (ASHP) Technology

In reference to the supplied plans for the house type (HT) 641, the mechanical design specifically specifies a 'Valiant aroTHERM plus 5kw' monobloc air source heat pump as the main heat source for the property, which aligns with the 'Planning Policy Wales (Edition 11)' which publicly favours electrical heating systems.

This system operates on the vapour compression cycle, where the efficiency is dictated by the coefficient of performance which is defined as the calculation below.

**COP (Coefficient of Performance) = Heat Output / Power (Electrical) Input.**



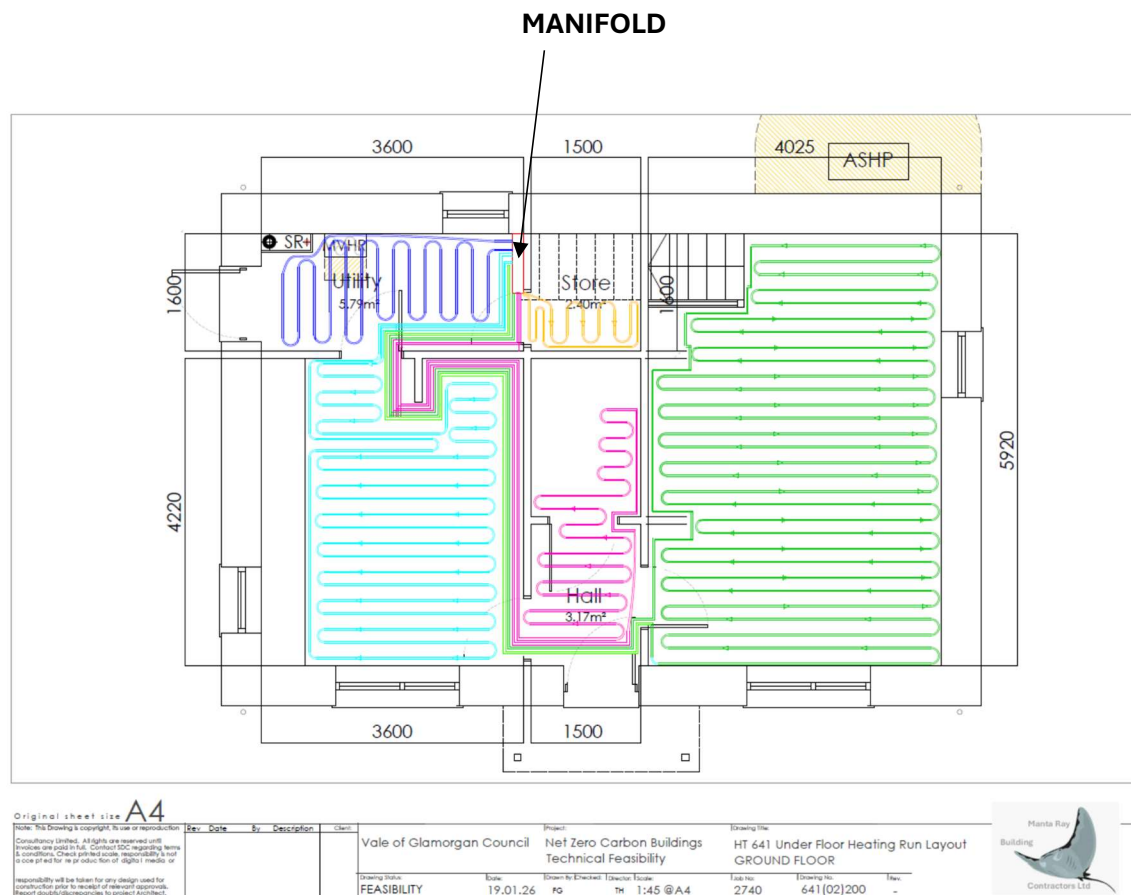
For this property, 5kw unit has been chosen due to the building being designed to keep the heat in so well that even a larger capacity system would not be necessary. Even when it is -3 degrees externally this system ensures that the house will stay warm while maintaining a high average efficiency (SCOP) of 4.01. From a 'whole life' perspective, even though the upfront costs of purchasing an ASHP is at first very expensive in comparison to a traditional GAS boiler, it will drastically save costs over time due to their being no fuel costs or standing charges taken by providers. GOV.WALES (2025)

This ASHP is designed to allow for maintenance considerations in the proposal, a minimum of 600mm clear space surrounding the unit is required for unrestricted air flow and for servicing / potential repairs when required. The unit will be very easy to reach due to it being on a specific concrete pad adjacent to the property. CIBSE (no date)

## 2.2 Underfloor Heating Layout & Justification

For this new build, I will be proposing underfloor heating on the ground floor. This system will work well with the ASHP; by utilizing the large square meterage of the layout, the system will be able to operate on a considerably low flow temperature, (typically at 35C). This lower temperature is essential for the coefficient of performance and helps hit the seasonal coefficient of performance (SCOP) of 4.01.

Additionally, underfloor heating allows for a consistent radiant heat emitter. This eliminates cold spots which is a vital consideration for maintaining comfort levels in the larger open plan rooms such as the kitchen/diner & the living room. The floor screed which surrounds the UFH will also act as a good heat store, which further increases & stabilizes internal temperatures.

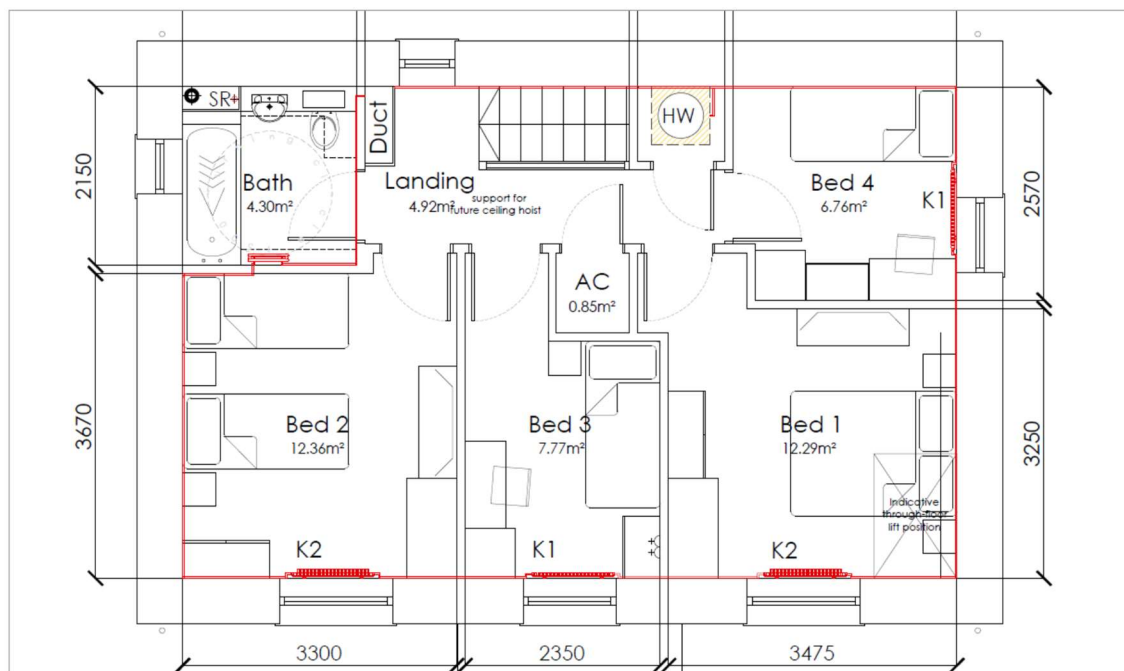


## 2.3 Radiator Schedule & Justification

Below is the floor plan showing where each radiator will go, below that is a table with more information regarding justification for individual sizes. The usage of radiators on the first floor is to provide a faster thermal response; this is generally considered essential for bedrooms where occupants typically prefer lower temperatures during the day and higher temperatures in the evening/overnight.

The ASHP compatibility, to maintain as SCOP of 4.01, the rads are oversized for their retrospective rooms, this is to be able to reach the desired temperature in the room by using a lower flow temperature of approximately 45C. The smaller radiators in the smaller bedrooms are purely for size benefits, the rooms are tight already, as we can use a thinner size than naturally that is the go-to.

The use of radiators on the first floor is also due to the zones; each bedroom will have their own control valves. This will allow for the heating in the ‘quieter’ areas of the building can be set at a much lower temperature than the habitable rooms.



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| Project                                                                         | Drawing Title                         |
|---------------------------------------------------------------------------------|---------------------------------------|
| Vale of Glamorgan Council<br>Net Zero Carbon Buildings<br>Technical Feasibility | HT 641 RADIATOR LAYOUT<br>FIRST FLOOR |

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| Room            | M <sup>2</sup> | Rad Type          | Size of Rad | Reasoning                                                                                         |
|-----------------|----------------|-------------------|-------------|---------------------------------------------------------------------------------------------------|
| <b>BED 1</b>    | 12.5           | K2                | 600 x 1000  | Requires the most heat, K2 type provides maximum surface area to compensate for the 45C ASHP flow |
| <b>BED 2</b>    | 12.4           | K2                | 600 x 1000  | Large external wall area increases heat loss, necessitating a higher output emitter.              |
| <b>BED 3</b>    | 7.3            | K1                | 600 x 700   | Smaller volume allows for a smaller K1 rad whilst still meeting comfort levels                    |
| <b>BED 4</b>    | 6.3            | K1                | 600 x 700   | Compact sizing reflects the smaller heat demand of the smallest bedroom                           |
| <b>BATHROOM</b> | 4.3            | Heated Towel Rail | 1200 x 500  | Focussing on moisture control & towel drying.                                                     |

## 2.4 Domestic Hot Water (DHW)

The ASHP will be located externally, likely on a level concrete platform adjacent to where the cylinder will be placed internally. As per the ground floor plan, the location of the ASHP will meet manufacturer requirements of 765 x 1100 x 490mm and will be designed for both airflow and maintenance requirements.

Hot water supply to the property, the design specifies a 'Mixergy 210L cylinder', which is located in the first-floor airing cupboard. This design has been chosen in turn to meet the demands of the 4-bedroom new build plans.

Operating as per the AECB Carbon Lite threshold, the system targets a high SCOP of 4.01 per season. To guarantee safety along with performance, the unvented stainless cylinder must include a temperature and pressure relief valve (TPRV) in accordance with Approved Document G. Additionally, the cylinder will be designed to maximise efficiency by utilizing a larger surface area internal coil, smaller than 2.5sqm, ensuring the effective heat transfer even at the lower flow temperature which is typical of heat pump systems. (CIBSE, 2021) (Welsh Government, 2022)

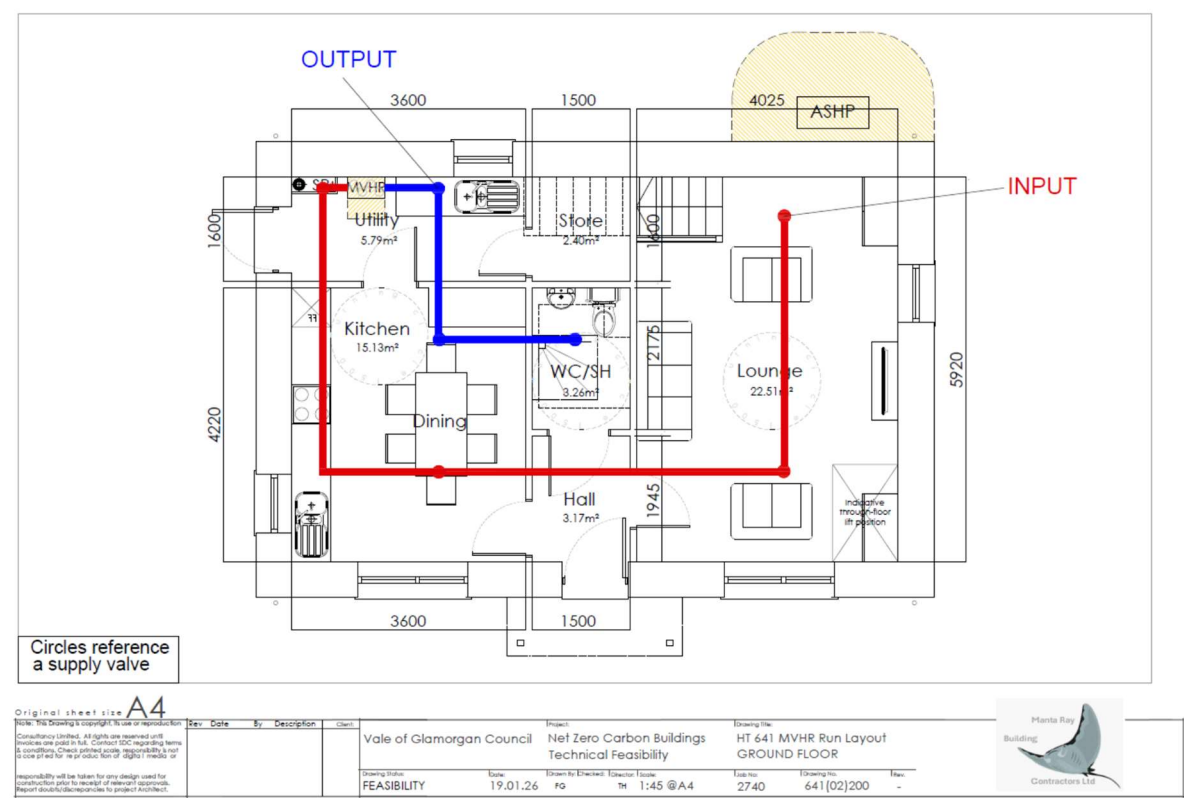
## 3.0 Ventilation: Part F Compliance

### 3.1 MVHR (Mechanical Ventilation with Heat Recovery)

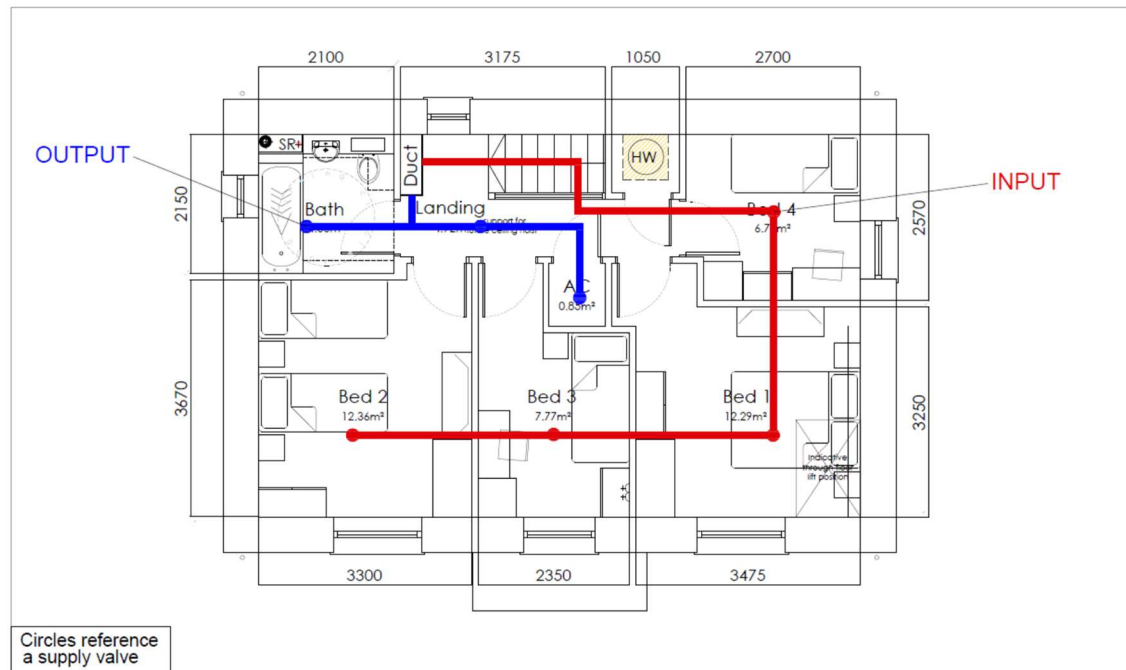
To maintain the high airtightness standards of the building, this ventilation strategy will discard natural methods in favour of the 'build tight, ventilate right' slogan, utilizing an 'EnviroVent energiSava 200' mechanical ventilation with heat recovery (MVHR) system. This will be situated in the ground floor utility room central to the plan. Due to the location and specs, the system will achieve a heat recovery efficiency of 89%, benefitting from a counter-flow heat exchanger to significantly reduce the 'volume heat loss' component of the buildings total thermal requirements. The system provides a volume flow of 40 to 45 M<sup>3</sup>/h with 0.79 W/1/s of fan power and is connected with semi-rigid aluminium radial ducting, to prevent any thermal loss and risk of condensation, it will be 50mm closed-cell Armaflex insulation is applied to both the inlet and outlet exhaust cans. Additionally, to prevent any excess noise and ensure maximum acoustic comfort, the ducting is sized to maintain air velocity to below 2.5m/s in branches and 4 m/s in main headers in accordance with CIBSE Guide B4 (BSRIA, 2013, Welsh Government, 2022).

Access for maintenance is a large factor in the design consideration for the MVHR. Located in the ground floor utility room, a 600mm maintenance area in front of the unit to allow for interval cleaning, servicing and repairs. These are all requirements for sufficient heat recovery efficiency. *WELSH GOVERNMENT (2022)*

3.2 Ground Floor MVHR Layout



### 3.3 First Floor MVHR Layout



|                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |                           |  |                                                 |             |                                    |         |               |           |              |      |
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## 4.0 Electrical Design: Power and Lighting

### 4.1 Small Power and EV Charging

All electrical design for this new build must be fully compliant with BS7671 (IET Wiring regulations) to maximise the potential safety over the building's life cycle. For circuit protection, we recommend installing an arc fault detection device (AFDD) for ring main circuits serving 4 or more bedrooms on the first floor to reduce risks of overcharging and any fires caused by faulty electrical connections. *BS 7671 - 18th Edition (no date)*

To comply with Part S in Wales, the installation of a 7kW electrical vehicle (EV) charger is a mandatory requirement. To support this addition, the system will use a dedicated circuit connected to the mains 100A single phase supply, which will be accompanied with a load management system. This system monitors energy use and prevents high demand from the EV charger and the ASHP from overloading any fuses within the building. *Welsh Government (2025)*

Maintenance is a critical part of the design consideration, all primary electrical components such as the consumer unit and the load management system. Both must be installed with a minimum clearance 'Maintenance Zone' of 0.6m to allow for adequate access for testing, inspection, servicing and future repair needs.

For the EV charger, specifically, the unit will have to be mounted at a height which is accessible on an external wall with surface mounted cable runs and sufficient clearance for cable management and replacements.

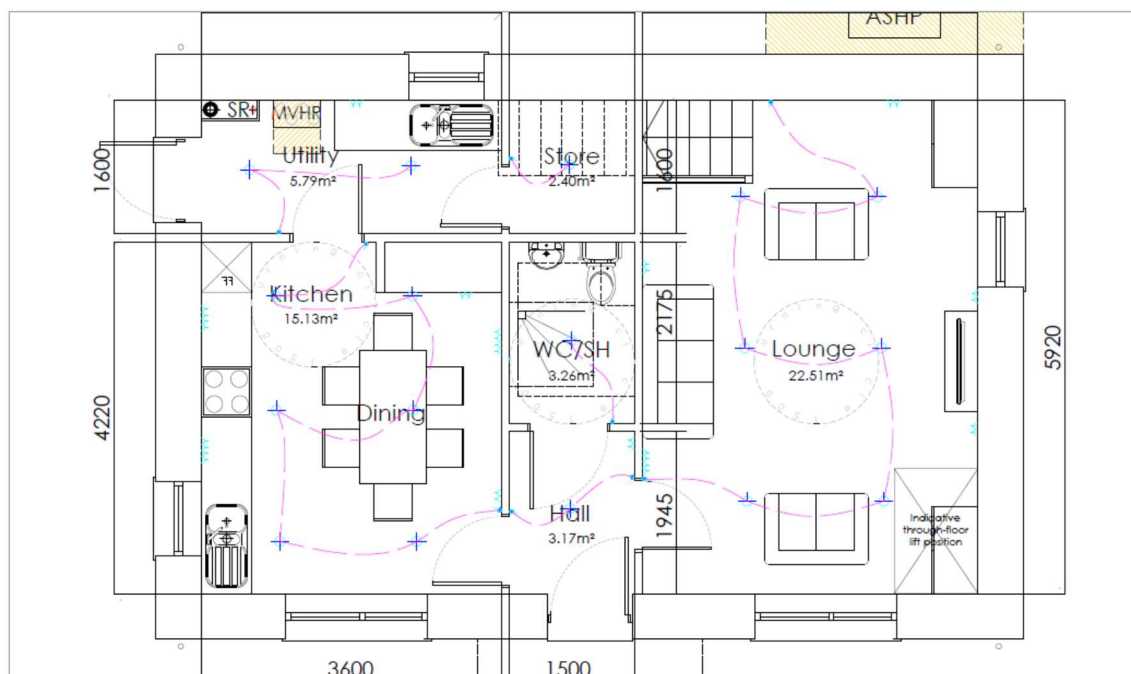
## 4.2 Lighting and Telecoms

The lighting and telecommunications will be designed to meet both regulatory and practical requirements. All internal lighting will be designed to achieve a minimum efficiency of 75 lm/W, ensuring compliance with Approved Document L in Wales for the conservation of fuel and power. In regard to the building's digital infrastructure, a specific layout will be used for data cabling to all feed back to a more centralized hub.

The lighting design utilizes 100% efficiency LED fittings, incorporating IP65 rated moisture resistant LEDs for the bathroom and ground floor WC/SH zones to ensure maximum safety and longevity in more humid environments. (*Office Lighting, 2023*)

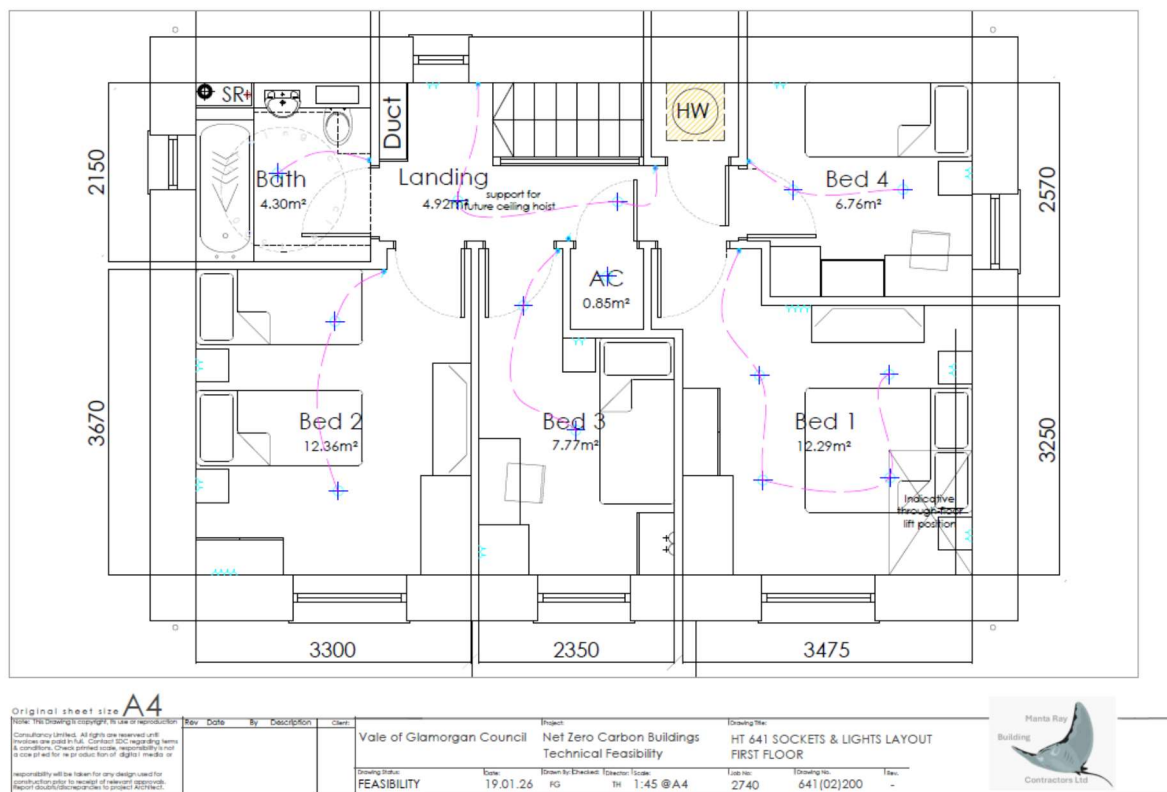
Location of Ethernet points will be down to the contractor, ideally located in living room and the bedrooms.

## 4.3 Floor Plans (Small Power & Lighting)



|                                                              |  |  |  |                           |  |  |  |                                |  |  |  |
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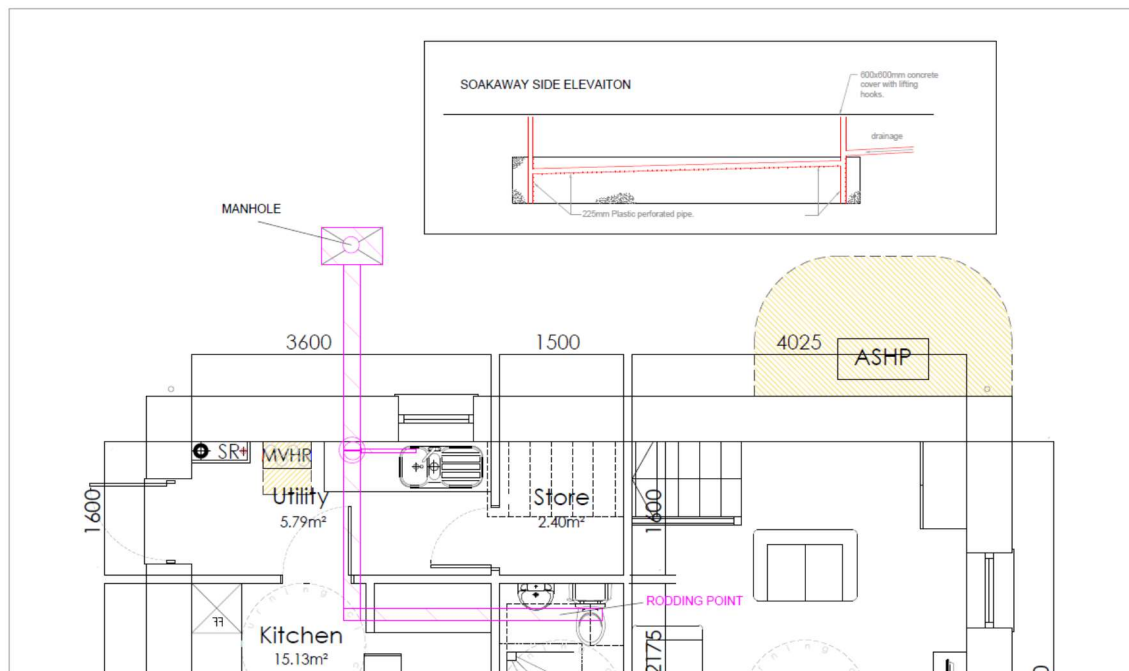


## 5.0 Public Health and Fire Safety

## 5.1 Drainage (Above and Below Ground)

The plumbing and drainage strategy for this proposal is designed to be as efficient as possible and be sufficiently weather resistant for all UK weather conditions. For the above ground drainage system, a single stack system will be used, which will in simple terms keep all waste pipework inside the building to prevent any freezing in the colder months. It will also remove the unsightly vent pipes on the exterior of the building. To account for thermal movement from the materials, expansion joints are included every 3 metres along the internal pipework. GOV.WALES (2025)

In regard to below ground drainage layout, the new build will have to comply with the Flood & Water Management Act 2010, which demands all new builds in Wales to include SUDS (Sustainable drainage systems). To direct rainfall efficiently, a retention area which soaks up all water such as a soakaway is very effective, the garden in these plans will have a layer of clean stone to absorb the water and seep down into the ground, these systems drastically help local flooding issues. In reference to SUDS approval body, SAB, in Wales you cannot just drain to a soakaway without SAB approval.

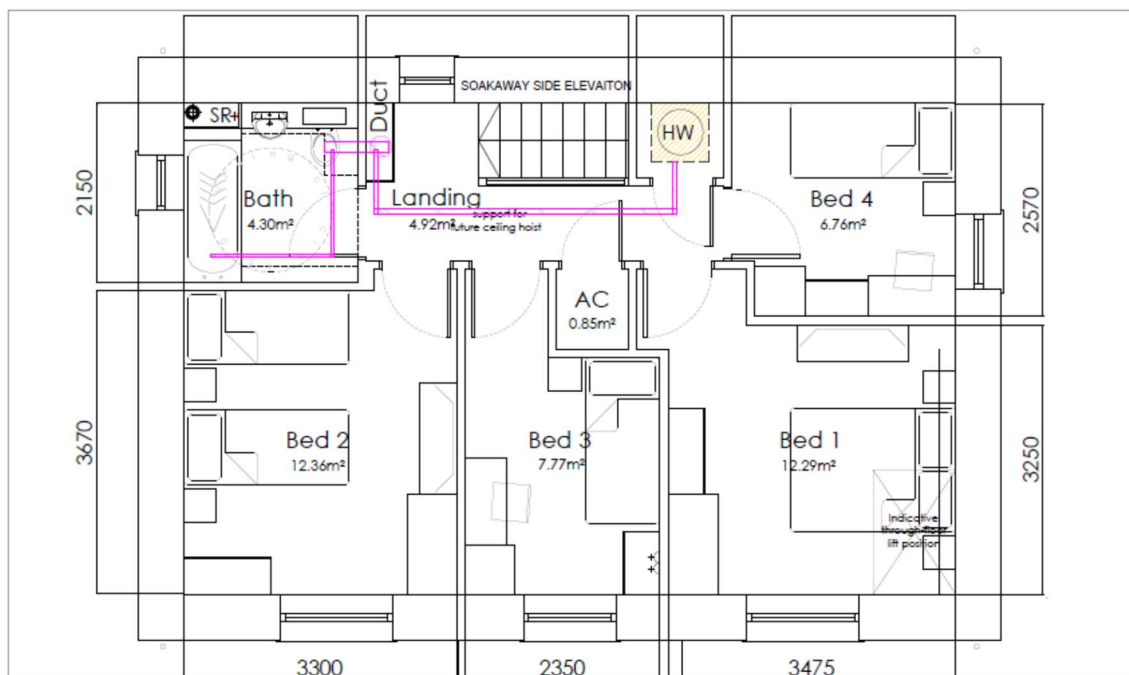
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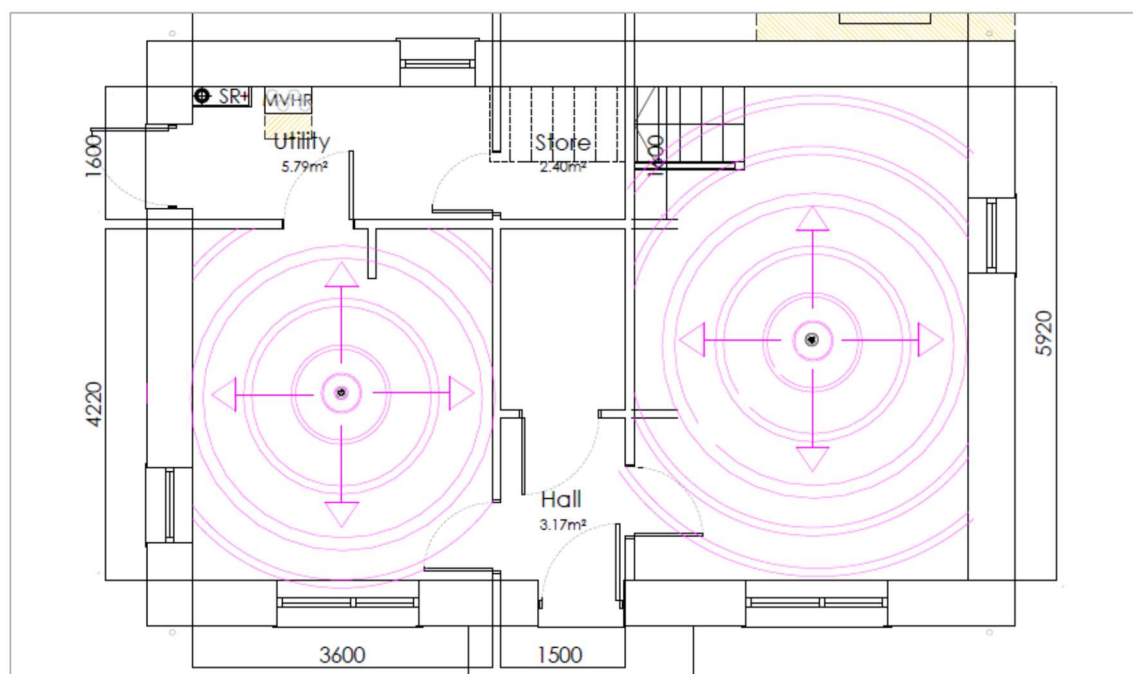
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## 5.2 Mandatory Sprinkler Systems

Within Wales, fire safety parameters are unique, all new homes must be fitted with fire sprinklers as per Regulation 37A. To adhere to this, this water system must be fully BS9251:2021 compliant. This will have a large impact on this proposal due to the installation/requirement of a 32mm alkaline water main to guarantee a flow rate of roughly 84l a minute. This is needed to simultaneously support the operation of two sprinkler heads. (Welsh Government, 2016) (BS 9251:2021). Compared to non-sprinklered homes, which generally have 25mm main, the larger diameter of pipe allows for reduced friction loss and be consistent in maintaining pressure.

The incoming mains pressure must be verified as sufficient to meet the sprinkler systems hydraulic calculations – if the local authority cannot guarantee a consistent minimum pressure which is typically around 1.5-2 bar, a pump and tank system must be installed to allow for supply to the property in the event of an uncontrolled fire. *Sprinklers Direct Ltd (2025)*

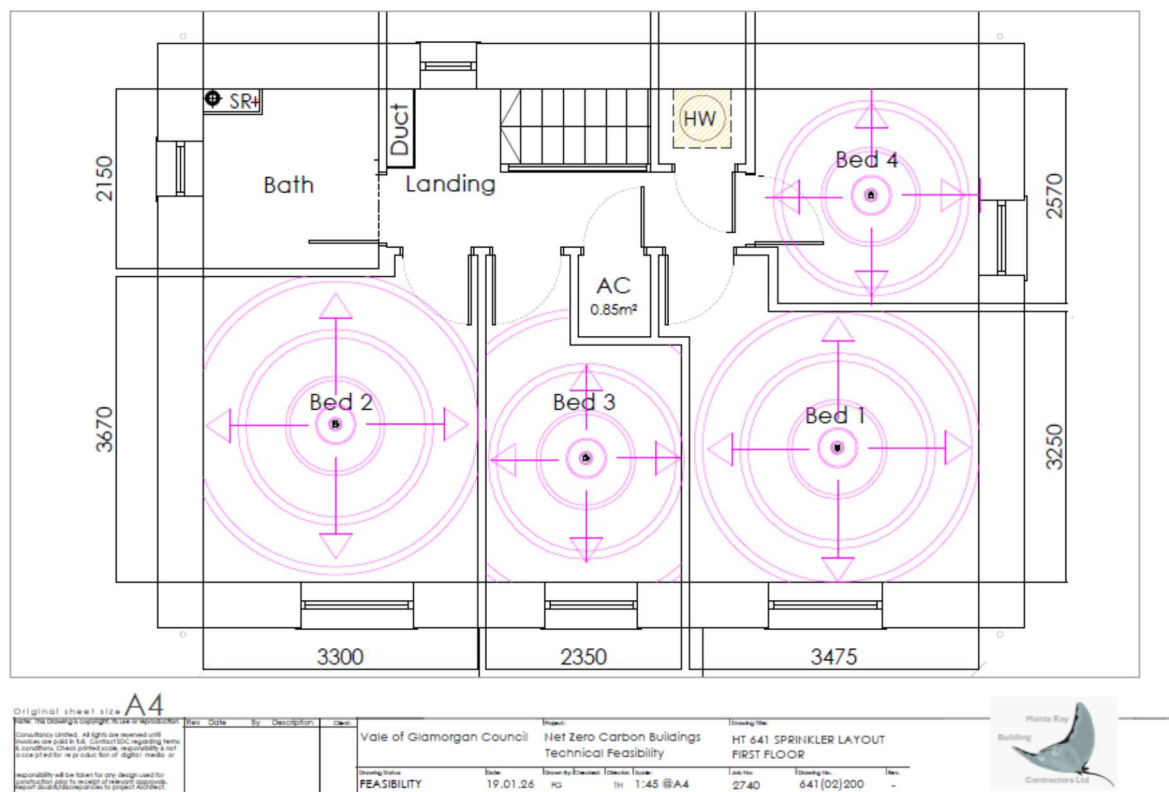


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These sprinklers shown in the plans and proposal have a max reach of 6m.



## 6.0 Whole Life Implications and Maintenance

We are working towards a 'whole life' approach in accordance with ISO 15686. This is essential for managing the total cost of owning the property and ensuring the long-term sustainability of the dwelling with the proposed adaptations.

For maintenance accessibility, there will be a 600mm gap around the MVHR unit and the hot water cylinder to allow for safe servicing for the remainder of its lifecycle. To support the buildings suspected life span, there will be easily removable panels around all of the new equipment for ease of access to update in 40 to 50 years.

To address the potential performance gap which is often found in low-energy builds, this proposal will include metering the ASHP and solar panels which will allow the tenants to monitor their energy use against what would have the original estimate.

To bridge the performance gap as previously mentioned, a simple smart home interface such as a 'Vaillant sensoCOMFORT' controller will drastically help any potential tenants easily adjust to suit their unique circumstances.

Carbon analysis, for information, operational carbon is the energy used to run the house whereas embodied carbon is the carbon in the bricks and insulation. *ISO (2017)*

## 7.0 Conclusion and Recommendations

The M&E proposal for this dwelling represent a shift towards electrical generation of heat rather traditional fossil fuels to align with modern decarbonization targets. By integrating Vaillant 5kw Air Source Heat Pump with mandatory regulation 37A fire suppression and high efficiency

EnviroVent ventilation, this design now creates a resilient, low carbon usage home that will balance safety precautions with the environmental performance.

## 7.1 Heat Loss Analysis

| Room           | Area (M <sup>2</sup> ) | Estimated heat loss (Watts) | Heat Emitter type                   | Reasoning                                                                        |
|----------------|------------------------|-----------------------------|-------------------------------------|----------------------------------------------------------------------------------|
| Lounge         | 22.31                  | 890 W                       | Underfloor Heating                  | Large floor area allows for low floor temp (35C) to maximise the ASHP efficiency |
| Kitchen/Dining | 18.13                  | 725 W                       | Underfloor Heating                  | Consistent with open plan ground floor thermal mass strategy                     |
| Utility/Hall   | 11.87                  | 475 W                       | Underfloor Heating                  | Serves as the hub for the MVHR                                                   |
| Bed 1          | 12.31                  | 490 W                       | K2 Radiator                         | Low temp rad sized for 45C                                                       |
| Bed 2          | 12.38                  | 495 W                       | K2 Radiator                         | Low temp rad sized for 45C                                                       |
| Bed 3          | 7.27                   | 290 W                       | K1 Radiator                         | Smaller load requires less surface area; K1 type minimizes space impact.         |
| Bed 4          | 6.24                   | 250 W                       | K1 Radiator                         | Sized to meet AECB CarbonLite demand-based performance                           |
| Bathroom       | 4.3                    | 175 W                       | Towel Radiator & Underfloor heating | IP65 zones require specific electrical safety specs for 'wet' areas.             |

## 8.0 References

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## 9.0 Product Specifications

| Category      | Component  | Specification / Model           | Justification & Compliance                                |
|---------------|------------|---------------------------------|-----------------------------------------------------------|
| Heating       | ASHP       | Vaillant aroTHERM plus 5 kW     | Targeted SCOP of 4.01; sized for HT 641 fabric            |
| Heating       | Controls   | Vaillant sensoCOMFORT           | Smart interface to bridge the 'Performance Gap'           |
| Hot Water     | Cylinder   | Mixergy 210L Unvented           | 210L for 6-person occupancy; includes TPRV per Part G     |
| Ventilation   | MVHR Unit  | EnviroVent energiSava 200       | 89% heat recovery - 0.79 W/l/s specific fan power         |
| Ventilation   | Ducting    | Semi-rigid Radial with Armaflex | 50mm insulation on intake/exhaust to prevent condensation |
| Electrical    | EV Charger | 7kW Mode 3 Smart Charger        | Mandatory for Wales Part S, includes load management      |
| Electrical    | Protection | 18th Ed. Board w/ AFDDs         | AFDDs recommended for bedroom circuits (BS 7671)          |
| Electrical    | Lighting   | LED (>75 lm/W) / IP65           | Compliance with Part L and safety in wet zones            |
| Electrical    | Telecoms   | Cat6a Data Cabling              | Star topography for high-speed home connection            |
| Fire Safety   | Sprinklers | BS 9251:2021 Compliant System   | Reg 37A - Mandatory in Wales                              |
| Public Health | Drainage   | Internal Single Stack System    | Smaller external pipe system                              |
| Public Health | SuDS       | Bio-retention / Clean Stone     | Complies with Flood & Water Management Act 2010           |