

Advanced Building Services and Environmental Design

“Cardiff City Tower, Engineering Services”

ACBA6005



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(1.0) Introduction

The Welsh Government are highly invested in the development in a significant tower construction, which will be erected within Cardiff city centre, on the site of a retired office/retail structure. As a part of a multi-disciplinary project team, I am required to explore and critically evaluate the potential possibility of erecting this large new mixed-use tower block on the site, which links Westgate Street and St Mary's Street.

The requirement is to create flexible office accommodation, leisure and residential serviced apartments, with two storey retail units near ground level. the height above ground level will be 16 stories together with a 4 storey basement that will house building services, 3 floors of multi-storey car parking and a gym/spa. Floors 0 to 6 to be designed as offices, with serviced apartments above that can be rented.

The site is surrounded by many listed buildings and set within a conservation area. the application was submitted by a large UK based property developer, and I will be working as a part of their construction management team.

(2.0) Task 1

Utilising neat suitably annotated sketches and schematics, evaluate the options and make appropriate recommendations for the design and construction of the HVAC technologies and installation challenges facing at least two of the different uses that the building is to be divided into, as a multi-zone facility.

When looking at the various options available for the installation of a HVAC system, I shall be assessing the available options for use within the Cardiff city tower project, and evaluating the best fit for the project for installation.

Mitsubishi City Multi Range

The city multi range from Mitsubishi from their brochure states excellent seasonal energy efficiency, low running costs and reduced CO₂ emissions. Air and Water cooled, with heat recovery through branch controller, with this specific model able to utilise existing piping, wiring and power. Available heating pump and heat recovery, is viable with standard water systems or ground source systems, with small and quiet condensers situated indoors, and offers double heat recovery through refrigerant and water circuit.

This model that I have assessed and am recommending as the best fit for the Cardiff city tower project. As the basement level will be where the HVAC system is situated, the quiet nature of the system will not be disruptive to the ongoing of the building.

There is the 3 pipe capability which will be able to connect to multiple branch controllers and cassettes, which has the potential to effectively provide for the whole tower. Looking environmentally at the project, there is low carbon emissions which will be far better for the environment. The distribution of the heating ventilation and air conditioning will be provided through cassette ducts and wall mounted units throughout the tower, which will efficiently be able to provide the service in each area.

Below I have produced drawings in order to demonstrate the layout of all of HVAC system to show how it will work in practice.

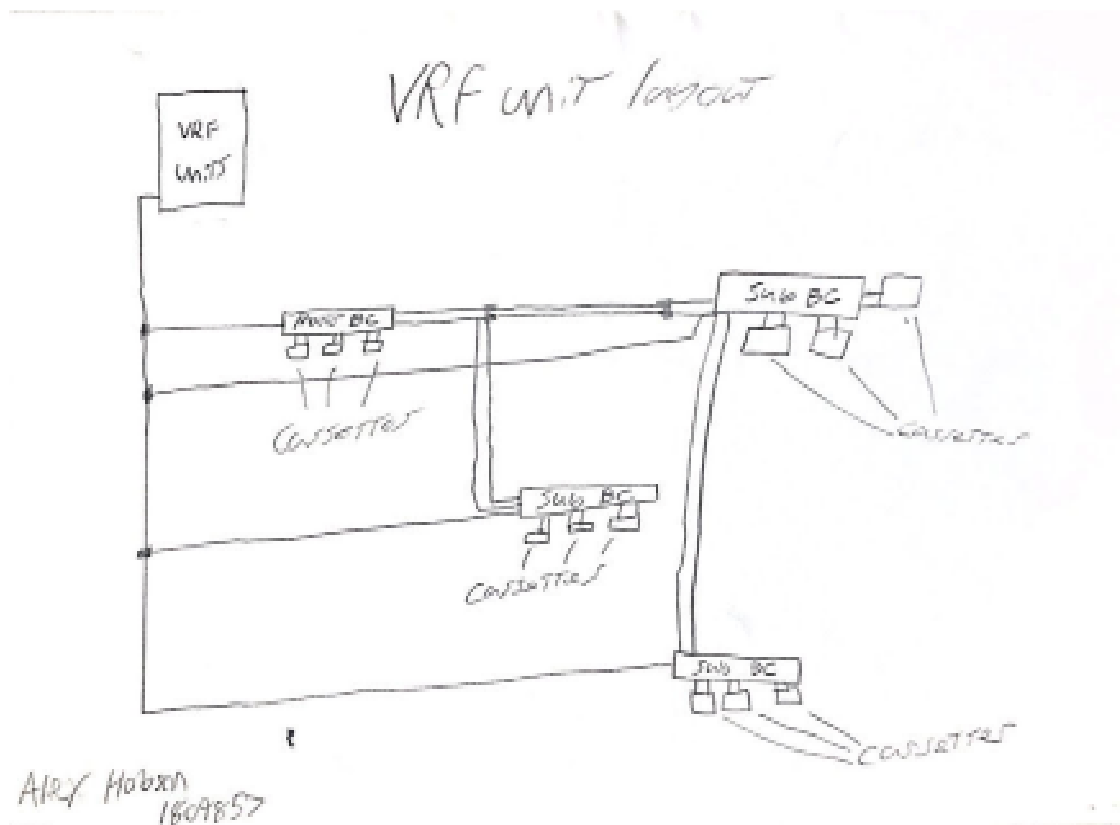


Figure 1: VRF Unit Layout; Alex Hobson.

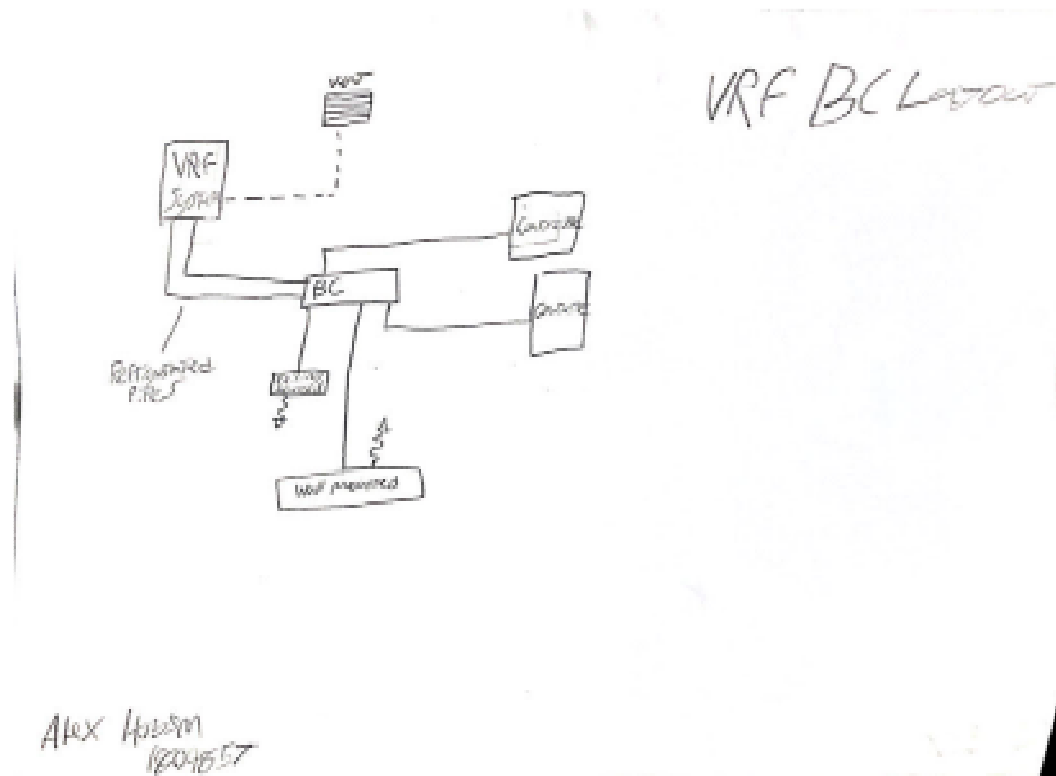


Figure 2: VRF BC Layout; Alex Hobson.

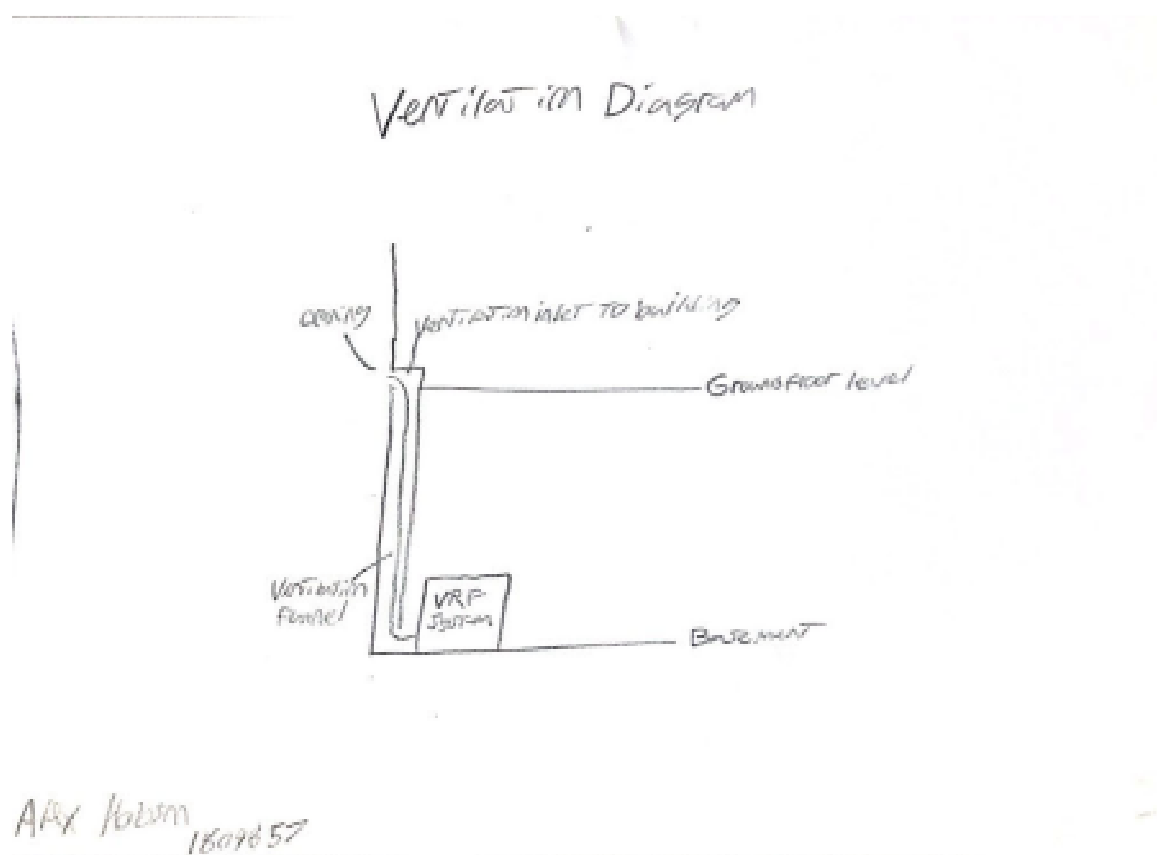


Figure 3: Ventilation Diagram; Alex Hobson.

(3.0) Task 2

Critically evaluate Natural, Artificial, and Emergency Lighting and power systems.

Natural

For maintaining comfort levels within the building regarding natural lighting, on the windows in the West, South, and East facing windows will be fitted with solar shading devices, in order to combat the morning sun to the setting of the sun during the evening. Solar shading devices are implemented in order to maintain the solar gains within the building, but also to eliminate potential glare from the windows, they also come included with overhangs and blinds, to further maintain natural light at a comfortable balance. (Maria Mandalaki, 2019)

The principles of solar shading stem from the need to be able to reduce heat/solar gains, reduce cooling loads, meaning the amount of heat required to move, the requirement for less energy consumption, which can remove the need for artificial lighting and due to the process of solar shading being completely natural, the energy consumption is extremely low. Another benefit of solar shading is that there is improved natural lighting quality, as there will be reduced glare and reduce the contrast ratios. (Levermore, 2000)

Installing solar shading systems will also allow the building to safely look at the exterior views of the structure, with added solar protection.

My recommendation for the installation of solar shading within the building would be to implement louvres onto the windows, this will allow for optimum amounts of natural light to be able to enter the building, but will eliminate glare and will keep the rooms at a comfort level suitable for people to exist within.

Artificial

The principles of artificial lighting is by using man made lamps (light) to be able to illuminate a room. Artificial light is easily manipulated in order to achieve the correct level of comfort within a room, through increasing or decreasing the volume of light, having the light be directed, focused or change colour, in order to meet the requirements of the space.

There are three types of artificial lighting that are available for use, Incandescent, which is the traditional bulb type of lamp that has a glowing filament, and generally seen in common use within residential buildings, Fluorescent lighting is available in various sizes and fittings, and considerably more efficient than incandescent bulbs, these kind of lights are seen in floodlights. The last type is known as a light-emitting diode (LED), and this is one of the most efficient energy using lamps available on the market. Comparing the incandescent lamps, it is seen that there is a 75% energy saving and generally last around 25 times longer than incandescent bulbs. (Hou, 2018)

My recommendation for the installation of artificial lighting would be to have LED lamps installed within all the rooms. The energy efficiency will make running costs cheaper and more effective as the brightness from the bulbs are very bright, and you can have sensors to be able to allow the bulbs to turn on based on movement, in turn saving mass amounts of energy. The kind of LED lighting that will be fitted will be to have strip lighting with sensors within hallways and within rooms to have LED bulbs with fitted sensors.

Emergency Lighting

When looking at implementing emergency lighting, there are only two kinds from the British and European standard BS EN 1838, which are emergency escape lighting, and standby lighting.

Emergency escape lighting can be broken down into different areas in which the lighting will be used. The first would be emergency route lighting, this will allow building occupants to effectively and rapidly find the optimal pathway to find the emergency exit, this is done by illuminating the escape door, and corridors and stairways, and including firefighting equipment such as fire extinguishers. Another area to consider would be open area & anti panic area lighting. For areas that would have large amounts of occupants, there will be anti panic lighting implemented to aid the evacuation of the building and guide mass amounts of people away from danger and to the exit. The final area to be considered by emergency escape lighting would be high risk task area lighting. This is implemented to combat anyone working in dangerous situations getting hurt when exiting their environment, and would need requisite shut down procedures implemented. (British Standards Institution, 2020)

Emergency escape lighting will be essential by every escape door, escape routes, intersection of corridors, escape signage, stairways, floor levels, fire equipment, alarm points, lifts, and areas larger than 60m². (British Standards Institution, 2020)

Emergency standby lighting is defined as the lighting that will allow normal activities to resume in case of a failure to the standard power supply.

Installation of these emergency measures must be fitted in all stated areas, with ample signage and clear visual layout of lighting and signage for all building occupants to safely exit the building. Emergency route lighting requirements are absolutely needed for our building as all occupants will be within rooms and needing to be evacuated this way, however we will not be spacing large amounts of people in once specific room, however the high risk work area will need to be implemented to ensure any service workers do not get hurt during an evacuation.

(4.0) Task 3

Critically appraise the building fabric and potential equipment choices for the design and installation practice within the context of sustainable futures, low carbon/low energy cost savings.

When looking potential equipment choices that will be implement the building, there are a few factors to consider when looking at the sustainability of the building in the future, and maintaining low carbon and energy savings.

One of the ways that can be explored to implement into the building will be passive solutions, such as implementing passive ventilation methods into the building, which will be able to moderate the internal temperatures within the building and could remove the need to use mechanical solutions to adjust temperature. Some of these mearuements that can help with this can be trickle ventilation, which can be installed into the framework of a window and allow air to freely flow out naturally and can be closed if needed (HM Government, 2010).

Another passive system to consider is night cooling, which is known to be a passive cooling method, powered by the natural forces of the wind or thermally generated pressures, where the heat absorbed by a building's thermal mass during the day and will be released to the interior air during the nighttime, after on it will need to be removed by night ventilation. External fresh air cools down the thermal mass, and then acts as a heat sink for the following day. The removal of the mass during the night requires operable windows or louvres being opened for a set period of time over night, allowing natural air flow throughout the building (Etheridge, 2011).

Passive ventilation systems are all designed on harnessing natural forces, which will mean that you will save considerably on building's energy consumption and therefore there will be substantial savings on your energy bills. Passive ventilation doesn't demand cost heavy maintenance, which will reduce cost, while also saving you time and effort in regards to mechanical ventilation methods.

Passive ventilation systems will maintain clean air consistently flowing throughout your building at all times within the day, which can improve the air quality which will improve the health of the occupants within the structure, and in turn will increase productivity and concentration levels, and general human comfort.

Passive ventilation can make sure that each room is supplied with ample amounts of both cool and warm air, which can be regulated at any time to maintain a pleasant temperature level. As well, the implementation of a passive ventilation system within your building will be providing a massive environmental benefit and lower the carbon/energy being used within the building. Implementing the ventilation inlets facing primarily towards the west gate street will be most beneficial for maximum wind flow benefit.

When looking at the different means in order to control all of these elements of the building and regulate all the different aspects, the Internet of Things (IoT) is referred as a term relating all objects that are able to transfer information between themselves without human intervention. Examples of this can all be linked to many factors, from security of the building, to being able to regulate the temperature within the building by communicating with different objects such as the louvres, windows and thermostat and manually detect if the temperature dips above or below the defined parameters, and will automatically operate and adjust (Greengard, 2015).

As far as security in the building is concerned, the IoT will be able to implement, is through being able to having door lock sensors, which will be able to link to an administrators computer and tell that computer that the door is locked or open, and be able to tell you what time that door was opened, in order to combat theft by knowing exact times and causes of entry, furthermore, it can also trigger security cameras to record specifically at points of entry (Russell, 2018).

Looking at how piping will be able to run through the building effectively, I will be suggesting implementing suspended ceiling systems. Suspended ceilings are a non-structural element installed commonly within commercial buildings, and they are implemented as a cosmetic overlay over the electrical, mechanical and piping systems. The ceiling grid will be suspended from the structural floor above. The grid system of a suspended ceiling system consists of inverted main tee beams and inverted cross tee beams, made of light steel, that interlock at intersections and sit on light gauged L-shaped wall moulding at the perimeter and is screwed to partition walls. Acoustic ceiling tiles will be manufactured from a compressed high-density mineral fibre material. Tile geometry is a 2ft. x 2ft. square with a thickness of 3in. The acoustic tiles are placed within the tee beam grid system, resting on the flange of each tee beam (Siavash Soroushian, 2015)

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