**ENEP20001**

**PROFESSIONAL ENGINEERING PROJECT REPORT**

**Student Name:**

**Student ID:**



**CENTRAL QUEENSLAND UNIVERSITY**

[Complete all sections shown below]

|  |  |
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Installation and Commissioning of 3 Pipe VRF System

# *Introduction*

As part of my degree – Masters in Engineering – it was mandatory for me to seek an internship in some organization that is involved in engineering related projects. Australian Airconditioning Services is one of leading HVAC companies in Australia that provides its services from design and installation of the HVAC systems to overall commissioning and maintenance of the existing projects. I was hired by Australian Airconditioning Services as an assistant design engineer for one of its projects with Lion Club International.

# ***Project Details***

As far as the project is concerned, it was all about the design, installation, and commissioning of 3 pipe VRF system and ventilation system. Australian Airconditioning Services had to work in collaboration with PACT construction, as the whole construction work was managed by PACT construction. The required equipment for the project was; Daikin Heat Recovery 3 Pipe VRF system. The timeline for the given project was 3 months following the completion of construction work. The project started in May 2019 and was concluded by the end of July 2019. The 3 months’ timeline of the project included the following phases:

1. Heat Load Calculations
2. Design of HVAC system
3. Preparation of working drawings of the system
4. Installation of the VRF system
5. Commissioning of the VRF system.

As an assistant design engineer, my task was to assist the project design engineer in the following tasks:

1. Heat Load Calculations
2. System Designing on the basis of calculations
3. Preparation of working drawings on AUTOCAD
4. Assisting erection team on site in installation works
5. Assisting project lead team in commissioning phase

# ***Application of Engineering Knowledge***

## *Nature of the Project*

The nature of the project was commercial, so that’s why the project was a lot more detail oriented, and all teams such as: sales, management, and engineering had to work in collaboration throughout the project. and solely an engineering project that required high-level skills in design engineering concerning HVAC. In addition, the project had to be completed within the given time frame of 90 days, so every task in the project needed to be managed in the given time frame. Being an assistant engineer, I was required to analyse every aspect of the conditioned space. This includes what it will be used for and what will happen when a failure occurs. Should redundancy be built-in or not, etc.

## *The objective of the Project*

The objectives of the project are to meet different cooling requirements in the different zone of Lion Club International. As it has been mentioned earlier that the project is based upon the design and erection of VRF system, there are three variants of VRF system available such as; heating only VRF system, cooling only VRF system, heating and cooling VRF system. The project was 3 pipe VRF system so the variant of VRF system used in the project was heating and cooling system. Save meeting different cooling requirements in different zones at Lion Club International, other two objectives were: cost-effectiveness and meeting more energy requirements. The aim of Australian Airconditioning Services was to design a system that was able to regulate the flow of refrigerant to multiple evaporators (Indoor Units), therefore enabling the use of many indoor units of various capacities and configuration connected to a single outdoor unit. Precisely, the objective was to control the indoor temperature by varying the flow of refrigerant to the indoor unit coupled with simultaneous heating and cooling. The advantages are as follows:

* Energy Saving
* Low maintenance cost
* Space-saving
* COP (Coefficient of performance) is high
* The versatility of the aesthetic requirements

## *Duties as an Asst. Design Engineer*

The very first task was to calculate all the heat loads of the building by taking into account the geography, weather, requirements, feasibility, and environmental aspects of the VRF system. The first task prior to carrying out the heating calculation was to collect the construction drawing of the building. Following the construction drawing, the space to air-conditioned area was visited so I could make sure that construction was carried out as per the construction drawings.

Following the site visit reading the construction drawing client – Lion Club International – was asked to provide all the requirements concerning heating, cooling, ventilation, and cleanliness. The next step was to calculate the heating and cooling load of the space. To proceed with Heat Load Calculation, we – I and project design Engineer – needed to understand or identify the sources of heat generation. There are four major components of heat gain:

1. External: Walls, roofs, windows, partitions, ceiling & floor
2. Internal: Lights, occupancy, appliances.
3. Infiltration: Air leakage, moisture migration.
4. System: Outside air, duct heat gain.

Again, heat gains are two types i.e. latent heat gain and sensible heat gain, and we had to calculate both heat gains depending upon the requirements of the space.

### *Heat Load Estimation*

We need to confirm the location, Orientation of the room and the desired inside the condition to get the below data for calculation.

### *Room sensible Heat*

1. Solar & Transmission Gain through walls (area X temp. difference X factor)
2. Solar & Transmission Gain through glass (area X temp. difference X U-factor)
3. Transmission Gain through internal partition walls, ceiling, floor, etc. (area X temp. difference)
4. Infiltration
5. Occupancy, power, light, etc.
6. Bypassed outside air.

### *Room Latent Heat*

1. Infiltration.
2. Occupancy.
3. Bypassed outside air.

### *Piping Design*

VRF systemstypically have line sets or line sizing dictated by the manufacturers, specific to lengths of piping, total piping connected, lift height from condenser to the highest evaporator. Generally, and as a practical matter, most contractors rely on the manufacturers. It saves both of them time and for the contractors, materials, and refrigerant. As far as the insulation is concerned, the local energy code, which may well be the IECC or International Energy Conservation Code, governed us in piping insulation. From IECC, piping 40 degrees F. and below would use 0.50 inches thickness (13mm) for less than an inch nominal pipe size and 1.00-inch thickness for larger pipes, up to sizes you probably are not using. Personally, the code is minimal and I would go with the 1.00-inch thickness AND a durable UV resistant jacket. That is for the suction gas line which is cold. If you are using a heat pipe, the hot gas should similarly be insulated both to protect people from accidental contact but also to maintain the heat value until it gets to the coil. Following are the considerations which we had to follow during piping size design.

* Refrigerant pipe sizing is specific to the type of refrigerant used. They operate at different pressures, temperatures, and ranges. Obvious but worth stating- just because a certain system worked with X size, another might use a different refrigerant.
* Pressure drops are relative to degrees F. at the evaporator and piping is sized traditionally for a maximum drop of 2 degrees F. (as a system capacity loss). Your mileage may vary.
* The lubricating oil for the compressor is highly miscible (mixes with) refrigerant, which is a solvent. The suspended oil has to make its way back to the compressor. Which brings me to the next point.
* Return piping can be the most problematic regarding oil return. If it is too large, there may be insufficient velocity to carry entrained oil back to the compressor, at low-load operation, which can damage it. If too small, the compressor might cavitate (rare) but will at least see a higher pressure drop than good design allows.
* If the lift of the refrigerant is above certain heights, double-suction risers and traps are often used to lift the oil in stages with the refrigerant. Each stage has a U-trap in the base of the larger line, which forces any oil to seal it from the flow. A smaller parallel riser then can achieve the higher velocities needed to suck the oil back to the compressor.
* The total system sizing and pressure drops have to include all accessories, such as filters, dryers, sight glasses, solenoid valves, capillary pressure drops, in addition to pipe lengths, elbows, and offsets.

## *Tools used for the VRF System Design*

VRF piping design software was used to design the whole piping system of the project. The diagram of the VRF piping design showed the following things:

* Model and Size of the outdoor unit.
* Size of piping from the outdoor unit to the indoor unit or branch selector.
* Lengths of pipe for each section
* Placement and size of the “y- joints”.
* Length of pipe for each section.

Following the design of piping tree VRF software provided us with BOM (Bill of Materials) for the complete project that included the following at a minimum:

* The capacity of the equipment
* Accessories such as; headers, branch selectors, Y-joints.
* Size and length of complete piping.
* Thermostatic controls

Following the BOM, the software provided us with the complete equipment schedule of the project. Equipment schedule was then used on the AUTOCAD drawings. The advantage of equipment schedule and placing it on AUTOCAD drawings was; it saved time and money. The specific software we use for the piping design was “VRV Xpress” as recommended by the DAIKIN.

## *Statement of Duties*

During the course of the whole project, I came across a number of difficulties and situations. The very first difficulty that I faced during the design phase was that the client asked us to oversize the system. However, it was never suitable to oversize the unit because the amount of freon in the evaporator must be completely used up before it reaches the compressor, or the liquid will destroy the compressor as it cannot compress liquid, it can only compress the gases containing the heat that it collected passing hot air through the coils, collected from the area being cooled. Thus, the last few passes through the evaporator must consume the final amount of liquid freon going through the system.

I was assigned by the design engineer to tell the client what could be the negative repercussions of an oversized unit. Moreover, the design engineer, whom I was assisting in the project, asked me to convince the client that an oversize system would not be feasible for the project and would work as per the client’s requirements.

The actions that I undertook to convince the client were; I provided him with reports of oversizing units with its negative implication for the system. I, as an assistant design engineer, informed him that Oversized systems may overachieve and cut off on meeting the design condition. If the return air temperature sensor is not functional, then the occupants may feel too cold. I do not think that they reduce comfort level.

The result of the meeting with the client was that I managed to convince him that oversize design is considered for the worst application. In addition, the oversized would also increase the initial cost of the system to manifolds. As far as learning is concerned, all the way through the project I learned a lot of things a few are as follows:

* How to engage with the client.
* How to mitigate the design complications concerning VRF system design.
* How to design the VRF system.
* How to engage with the stakeholders of the project.
* How to manage the project in a given time frame.
* How to work as a team and how to collaborate with different departments of the project.

# *Engineering Computational Activities*

During the course of the project, I was involved in a number of computational activities such as; problem-solving, engaging with all the stakeholders, managing documentation of the project, analysis of the different problems that we came across during the project. Following the analysis of the problem I, in the supervision of design engineer, evaluated and executed solutions.

# *Engineering tool*

Engineering tools used for the design of VRF system design project were:

* VRF piping design software, which in our case was “VRV Xpress”. We used “VRV Xpress” because the client was interested to install DAIKIN units, so “VRV Xpress” is the software that was most suitable and compatible with DAIKIN.
* AUTOCAD was used to make the layout of indoor and outdoor units on the spaces to be cooled or heated.
* HAP software was to calculate the heating load of the space.

# *Technical Knowledge in Problem Solving and Decision Making*

The project required a lot of expertise ranging from technical to management skills. As far as the technical knowledge is concerned, this project could not have been designed without the prior knowledge and understanding of heating ventilation and air conditioning. In addition, the specifications of VRF system varies from manufacturer to manufacturer, so it was really important to read through the specifications of all the VRF indoor and outdoor units manufactured by DAIKIN. Without evaluating DIAKIN’s units and their specifications, the design could either have been oversize or undersized.

# *Codes and Standards*

The most important thing to take care of while designing the VRF system was to follow all the codes and standard of ASHRAE (American Society of Heating Refrigeration and Air Conditioning Engineers). Apart from ASHRAE, we also had to follow the code and rules delineated by BCA (Building Code of Australia).

# *Health Safety and Environment*

Heating ventilation and air conditioning design are not about keeping the space heated or cooled or maintaining the temperature of the space to be air-conditioned. Cleanliness of another area that is being dealt by HVAC design. Clean air supply for the occupants is a factor that can never be downplayed while designing any HVAC facility. Besides, environmental safety must also be considered while designing the facility i.e. such material must not be used that pose threat to environmental cleanliness. Neither should the materials used that are responsible for the ozone depletion such as; CFCs (Chloroflouro Carbons).

# *Engineering Australia: Code of Ethics*

Before working on the preliminary design of the VRF system the design engineer asked to read through code of ethics. After reading through the code of ethics I came to know that during the course of this project I would need to maintain and develop knowledge and skills and represent the areas of competency objectively. Besides, sustainability promotion was another area I had to take care of during the course of the project. According to the code of ethics, I had to engage with all the stakeholders and balance the needs of the project.

# *Communication*

No project can be turned into reality if there is a communication gap between the stakeholders. Being a design engineer, it was imperative for us to take care of the inventory of the material inventory and assist the erection team. In addition, engaging with PACT construction and its staff was another important thing we had to take care of. If we had not collaborated or engaged with PACT construction then our design and actual space to be conditioned would have not have aligned with each other.

# *Personal Development and Achievements.*

The most important thing that I learned during the course of my internship was the importance of teamwork. Besides, the project rendered my technical skill concerning the design of HVAC systems. Another most important thing that I learned there was; without having adequate knowledge and skills it is impossible to design any system. The project gave me an opportunity to go through the ASHRAE standards for HVAC design. As far as professional development is concerned; the project taught me how to engage with different stakeholders of the project and how to present your idea to them. Besides, the project taught me how to lead the junior technical staff that worked under my supervision.

# *Time Management Skills and Organisational Capabilities*

The importance of time management can never be downplayed during any project. This particular project had to be delivered in due time by using the available resources. I learned how to multitask and use the resources effectively and efficiently. Organizational capabilities must be used at the full capacity in order to complete the project within the given deadline.

# DECLARATION

I <Name of Intern> hereby, certify that the information provided in this report is presented to the supervising officer <Name of supervising officer at the host organization> at <Name of the host organization>. This report will be submitted for assessment under the unit ENEP20001: Internship Work Experience at Central Queensland University and will not be published/submitted elsewhere.

**Date**

**Signature of Intern**

**HOST ORGANISATION RESPONSE\***

I <Name and position of supervising officer at the host organization> am aware/checked the information provided in the report by <Name of Intern> . I grant him/her approval to submit the report for assessment under the unit ENEP20001: Internship Work Experience at Central Queensland University. I also certify that:

|  |  |
| --- | --- |
| The report contains confidential information\*\* | Yes  No |
| The intern worked during the agreed/required work hours under the host organization | Yes  No |

**Date**

**Signature of Supervisor**

[\*Print this form in the institutional letterhead of the host organization.

\*\*This report is solely for the assessment of the intern’s performance. All information provided will be treated with strict confidentiality as per the CQUniversity Privacy Policy and will not be published to the public or any other sources.]