



**INTEGRITY ASSESMENT OF HVAC AND SYSTEM SUPPORT  
USE IN COMMERCIAL BUILDING AND OFFSHORE PLATFORM**



**BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY  
(MAINTENANCE TECHNOLOGY) WITH HONOURS**

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**Faculty of Mechanical and Manufacturing Engineering  
Technology**



**INTEGRITY ASSESMENT OF HVAC AND SYSTEM SUPPORT USE  
IN COMMERCIAL BUILDING AND OFFSHORE PLATFORM**

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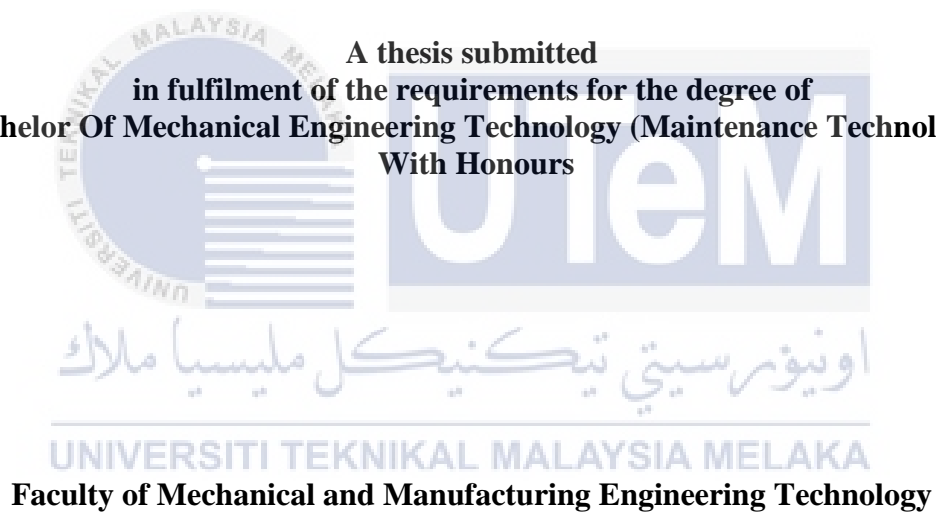
**Bachelor Of Mechanical Engineering Technology (Maintenance Technology) With  
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**2021**

**INTEGRITY ASSESMENT OF HVAC AND SYSTEM SUPPORT USE IN  
COMMERCIAL BUILDING AND OFFSHORE PLATFORM**

**KHAIRUNNISA BINTI BADRUL HISHAM**

**A thesis submitted  
in fulfilment of the requirements for the degree of  
Bachelor Of Mechanical Engineering Technology (Maintenance Technology)  
With Honours**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2021**

## DECLARATION

I declare that this thesis entitled Integrity Assesment of Hvac and System Support Used In Commercial Building and Offshore Platform is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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## APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours.

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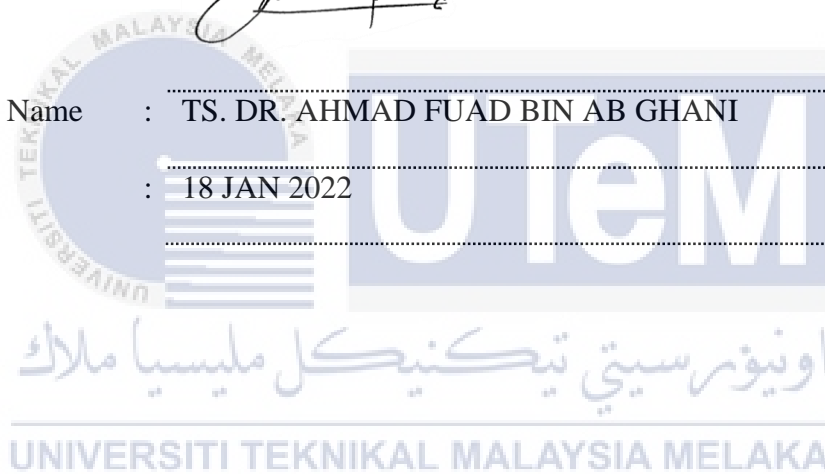


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## DEDICATION

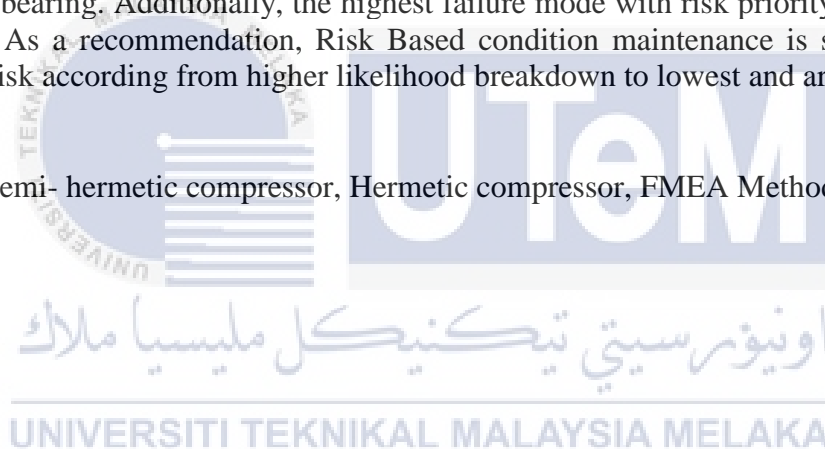
I am dedicating this thesis to my parents Hayati binti Mohamad Nazir and Badrul Hisham bin Mohamed Ramli who give their full support through my ups and down and also to my siblings Danial Haqim bin Badrul Hisham, Danial Haiqal bin Badrul Hisham that always there help builds my motivation up and cheer me up when i felt lost. Also, a big thanks to my project supervisor Ts. Dr. Ahmad Fuad bin Ab. Ghani and Ir. Mohd Azhar bin Shah Rizam for the guidance throughout completing this thesis and to all other UTeM lecturers. Without their dedication in teaching, I wouldn't reach until this far. Lastly, to my all good friends, classmates and teammates through bittersweet four years' journey. Thank you I appreciate all the support and good vibe through the process.



## ABSTRACT

Heating, Ventilation, Air Conditioning (HVAC) is a system keeps people healthy by filtering clean indoor air that and maintained the humidity levels at optimal comfort levels. The failure of the compressor results in the breakdown of the entire system. Multi criteria decision making (MCDM) focused with constructing and addressing multi criteria decisions and planning issues on to failure that occur on the compressor. In this reports, Failure Mode Effect Analysis (FMEA) was applied in order to identify the most significant failure mode using the Risk Priority Number (RPN) score. Then, the highest risk priority number score was compared between the compressor used in oil and gas platform in Terengganu with other failure occur in other wide industry application. The information identified of compressor was gathered on the maintenance reports HVAC Experts Sdn. Bhd. The highest failure modes occur in offshore analysis is crankshaft with 17% due to chlorine from the sea water caused a moderately acidic at the base component while other application was the pistons and bearing. Additionally, the highest failure mode with risk priority number score above 120. As a recommendation, Risk Based condition maintenance is suggested as it reduce the risk according from higher likelihood breakdown to lowest and are cost-saving.

Keyword: Semi- hermetic compressor, Hermetic compressor, FMEA Method, RPN score



## **ABSTRAK**

Pemanasan, Pengudaraan, Penyaman Udara (HVAC) ialah sistem memastikan orang ramai sihat dengan menapis udara dalaman yang bersih dan mengekalkan tahap kelembapan pada tahap penyelesaian optimum. Kegagalan pemampat mengakibatkan kerosakan keseluruhan sistem. Pembuatan keputusan pelbagai kriteria (MCDM) tertumpu dengan membina dan menangani keputusan pelbagai kriteria dan merancang isu kepada kegagalan yang berlaku pada pemampat. Dalam laporan ini, Analisis Kesan Mod Kegagalan (FMEA) telah digunakan untuk mengenal pasti mod kegagalan yang paling ketara menggunakan skor Nombor Keutamaan Risiko (RPN). Kemudian, skor nombor keutamaan risiko tertinggi dibandingkan antara pemampat yang digunakan dalam platform minyak dan gas di Terengganu dengan kegagalan lain berlaku dalam aplikasi industri yang luas. Maklumat yang dikenal pasti mengenai pemampat telah dikumpul pada laporan penyelenggaraan HVAC Experts Sdn. Bhd. Mod kegagalan yang paling tinggi berlaku dalam analisis luar pesisir ialah aci engkol dengan 17% disebabkan oleh klorin dari air laut menyebabkan komponen asas berasid sederhana manakala aplikasi lain adalah ombok dan galas. Selain itu, mod kegagalan tertinggi dengan skor nombor keutamaan risiko melebihi 120. Sebagai cadangan, penyelenggaraan keadaan Berdasarkan Risiko dicadangkan kerana ia mengurangkan risiko mengikut pecahan kemungkinan lebih tinggi kepada terendah dan menjimatkan kos.

Kata kunci: Pemampat separa hermetik, Pemampat hermetik, analisis FMEA, skor RPN

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## LIST OF SYMBOLS AND ABBREVIATIONS

HVAC	-	Heating Ventilation and Air Conditioning
FMEA	-	Failure Mode Effect Analysis
Sdn. Bhd	-	Sendirian Berhad (Company)



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# CHAPTER 1

## INTRODUCTION

### 1.1 Background

HVAC stand for Heating Ventilation and Air Conditioning or in the simple way system that are used to make people feel cosy warm and cool in any residential and commercial buildings. It is called heating ventilation and air conditioning, which it keeps cooling and cosy to people like Malaysia country which is the weather mostly hot and humid. Because of the systems used air particle moving freely in both residential and commercial buildings, the system also keeps people healthy by filtering clean indoor air that and maintained the humidity levels at optimal comfort levels. One of the most intricate and comprehensive system in building is heating and air conditioning system, if one part in the system broken it can affect the whole system (Brennan Heating & Air Conditioning, 2019). As the air conditioning main role is to reduce adverse temperature. It also to increase the comforts to the environment indoor, there a process of removing heat and moisture from interior of closed room. Moreover, there is a process called ventilation it takes source from fresh outside air intake then exchange it to replenish oxygen and remove the unwanted such as bad odours, carbon dioxide and excessive moisture. There are several part in the system that keep the system working, the air returns for ventilation, ducting, electrical elements, compressor, condenser, expansion valve, outdoor unit and blower.

Before, there are many gaps between the ventilation process into the building caused from the open and closed door system. But nowadays, the modern construction tightly focused on the sealed so ventilation process can be improving. After the outdoor air is

brought in the HVAC system itself will work to filter the air, remove dirt, excessive moisture, dust and other particles to keep people inside breathing clean air. When the process is done, the air will direct into the space provided such as home living rooms, cars, classes, laboratory and factories. So taking care from the earlier stage is crucial and support as mentioned by researchers (Haberschill et al., n.d.) in designing the system, it is crucial to study and investigate the performance of each component as there are wide variety of operating circumstances also the interactions between the component in the system. It is to prevent excessive failure, experimenting to determine performance may be costly and be time-consuming.

An air conditioning system inspection is important to improve efficiency, reduce energy consumption, operating costs and the carbon emissions of its system. Person in charge to taking control of the whole operation of the system, such as building owner, operator, engineer, manager and other has legislative requirement and care duties in the operation and maintenance of air conditioning systems. The system's capacity to create healthy and comfortable settings must be checked and maintained on regular basis. The ability of the system to provide healthy and comfortable conditions for building occupants in the same time minimising refrigerant gas leakage must be emphasis of the inspection and maintenance routine.

Compressor is like the heart to the HVAC system. The failure of the compressor results in the breakdown of the entire system. Usually it is the source of many system problems. The primary component of the system was identified based on the maintenance report Hvac Experts Sdn. Bhd and Failure Mode Effect Analysis (FMEA) was applied in order to identify the most significant failure mode influencing parameter first. The FMEA examine various failure modes and their impacts on the system, then ranks the degree of

severity based on failure rate and occurrence of failure effect (Jomde et al., 2017). The analysis information should be updated it will benefit to the system in long term. By overcome the failure through analysis it will results in lower total cost to run and maintain the facility as well as improved the system performance. The FMEA method are chosen according to standard by American Bureau of Shipping (ABS), Incorporated by Act of Legislature of the State of New York 1862 updated version in 2015.

As continuation in this report, the performance of maintenance report of HVAC support system produced by HVAC experts Sdn.Bhd such as blower, compressor, refrigerant data in industrial facilities has been compiled into this report to be studied the failure mode through Failure Mode Effect Analysis (FMEA) analysis. The file database compiled are gathered from year 2015 to the latest year 2020 are used to identify probable failure mechanism and undesirable conditions that might result affecting the system. Due to that, as a response maintenance of each component over the system is required throughout its lifecycle. Significantly, due to compliance with safety regulations and the standard followed the cost of new HVAC system is rather expensive compared to the existing HVAC system. The HVAC system on the oil and gas platform was scheduled for maintenance in accordance with standard procedure (Preventive maintenance, Corrective maintenance, and Risk-based inspection). These would be common options for the maintenance department while running a maintenance programme.

## 1.2 Problem Statement

Semi hermetic compressor are known as sealed type compressor. Marine refrigeration, residential buildings, petrochemical, pharmaceutical and chemical processes, industrial refrigeration, high temperature ammonia heat pumps are the examples of common application that uses semi hermetic screw compressor type. Oil and gas failures may have a wide range of consequences, affecting both business and safety. As a result, it's critical to evaluate failures in order to avoid them from happening again. most compressors fail as a result of system flaws, which must be addressed to avoid recurrence failures. Symptoms of system faults are frequently revealed during a field inspection of a failed compressor. The inspection and maintenance routine should focus on the system's capacity to provide healthy and comfortable conditions for building occupants while reducing

In this research, an assessment for HVAC support system approached for failure mode of compressor. As compressor are one of the component that keeps the HVAC system running. According to Jomde et al. 2017, when the compressor fails, the entire system fails. Current type of maintenance widely applied is the corrective maintenance and preventive maintenance. It is requiring high cost. Semi hermetic and hermetic compressor is widely used in wide application; it aims for maintenance that are cost- effective at the same time keeps the compressor in maximum performance.

### 1.3 Research Objective

The main aim of this research is to find integrity assessment to be applied of HVAC support system. Specifically, the objectives are as follows:

- a) To study and listed several type of integrity assesment in optimize HVAC component maintenace selections for HVAC support systems.
- b) To apply the Failure Mode and Effect Analysis (FMEA) to the actual maintenance report case study by listing the severity to the failure modes occur in the system.
- c) To analyze and provide a defined method for identiofy potential dangerous situations, adressing gaps and improving safety, environmental performance and operational downtime of HVAC system.

### 1.4 Scope of Research

The scope of this research are as follows:

- Mainly focused on the brainstorming to FMEA method to be applied to the case study maintenance report by Hvac Experts Sdn.Bhd.
- The analysis to ensure that the maintenace sugestion suitable with the occurs failure mode in the case study to the other jurnal follow Standard International Maritime Organizational .
- To compared type integrity assesment for HVAC system using FMEA method examined preventive maintenance, corrective maintenance, risk-based maintenance and replacement to determine which option the most effective for specified HVAC maintenance type and dependability.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

In today's modern society, energy efficiency is identified as key strategies to address growing issues in increasing electricity cost, utility cost, unexpected and high cost of equipment repairs, climate change and energy crisis without commissioning and good installation it can harm and give impacts on the building management. Due to increasing in the energy bill by unexpected costs through years it forced many company throughout the worlds towards energy saving in building so that the operating cost can be reduced also lead to green company as many existing commercial buildings are built with low carbon emission features. It is because with the features it helps enhanced the building environmental performance. But it is different now days, energy efficiency in commercial buildings can be achieved throughout redevelopment of energy efficiency of buildings heating, ventilation and air conditioning (HVAC) system.

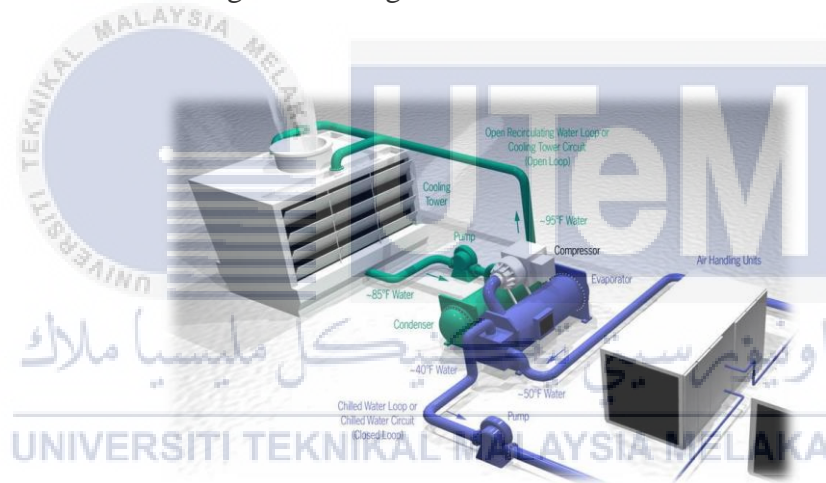
One of the support system in HVAC/R is compressor. Also in basic system of HVAC there are compressor, condenser, expansion valve and evaporator. In industry there are many listed type of compressor. One widely used type compressor is semi-hermetic refrigeration compressor due to their benefits which is has stable operation, reliability, has high efficiency also compact structure.

## 2.2 Background of HVAC system

HVAC are stand for Heating Ventilation and Air Conditioning. Refrigeration "R" is sometimes added, resulting in "HVACR." HVAC refers to the process of controlling the temperature of a restricted place in order to meet the needs of the people or items there. HVAC systems are responsible for not just heating and cooling air, but also for managing interior air quality (IAQ). In the winter, heating the air is done, and in the summer, cooling the air is done. Thermodynamics, fluid mechanics, and heat transfer are all used in HVAC systems. All of these fields are used in various HVAC components. IAQ (Indoor Air Quality) Indoor air quality refers to the air quality inside a building or structure as it relates to the health and safety of its occupants. Inclusion or contamination with gases, as well as uncontrolled mass and energy transfer, alter IAQ. HVAC systems are utilized for heating, cooling, and air conditioning in a variety of applications, including homes, buildings, industry, cars, aquariums, and more. HVAC applications are growing in popularity, and more research is being conducted in this space. The HVAC industry is growing at the same time that the field of application is expanding. A heating and cooling system, as well as indoor climate control, is essentially an assemblage of many types of equipment connected together. Mechanical and electrical components are used in HVAC systems to give comfort to building/space occupants or to maintain goods, products, or anything placed in space.

Depending on the HVAC architecture, HVAC cooling systems can be combined with HVAC heating systems or installed independently. On an industrial scale, HVAC systems keep machines working by maintaining the temperature of the space/hall/room where they are installed. For a variety of reasons, HVAC water chillers have become indispensable in any sector. A HVAC water chiller creates chilled water in the background of the HVAC system, which is then circulated throughout the building or area up to cooling coils in air

handling units. Blowers move air across cooling coils, which is subsequently distributed throughout the room or building for comfort or to preserve goods/items according to HVAC design. Air is delivered by supply ducts, while return air is collected via return ducts in air handling systems. Energy is provided by chilled water and cooling water pumps to keep the chilled and cooling water circulating. HVAC Valves are also put at various points in pipe to make HVAC system maintenance easier or to manage the system. Heating the air can be accomplished using an HVAC heat pump, a hot water generator, or a furnace. During the winter, certain industrial chillers can also be used as heaters. In the heating mode, heated coils take the place of cooling coils. The cost of an HVAC system varies depending on the use, as does the cost of heating and cooling an area or environment.



**Figure 2-1 Basic System of HVAC**

There are 4 types of HVAC system which is heating and air conditioning split system, Hybrid, Ductless mini split, and Packaged System. HVAC systems rely on the distribution system to supply the necessary volume of air while maintaining the ideal environmental conditions. The distribution system differs mostly according on the refrigerant type and the manner of delivery, such as air handling equipment, fan coils, air ducts, and water pipes.