CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO HAZARD IDENTIFICATION, RISK ASSESSMENT AND RISK CONTROL (HIRARC)

With the country experiencing greater economic growth, it is imperative for the employer and the government to protect the life of their workers. The implementation and enforcement of the OSHA 1994 is viewed as a milestone development in the prevention of the occupational accidents and diseases in the country. The active role of the Ministry of Human Resources is implemented by governmental or non-governmental agencies. By looking at the country's Occupational Safety and Health performance through accident indicators, there is still place for improvement in order to achieve the standard as in the developed countries.

Many initiatives are needed by the government such as increasing the number of inspection among the factories especially in the small and medium sized industries which are accident prone. Other programs such as Occupational Safety and Health Week, National Safety Award and Occupational Safety and Health roadshows which have been carried out are applaudable. With all such efforts working at an increasing scale, it will help to improve Occupational Safety and Health status in Malaysia and increase productivity.

Environmental and Occupational Health and Safety aspects are the two main elements in the environmental health and safety field, in order to maintain a healthy and safe working environment, a friendly environment contributes to a safe working site. In effort at maintaining a sustainable environment, law enforcement, prevention and control techniques of the apparent hazard and continuous monitoring action should be applied by the employer for the benefit of employees, health and safety in the foundry.

The health aspects of the international workforce has gained an increasing concern for the last two decades. The globalization of the world economy and the rapid technological changes continue to change the nature of work and employment practices. Thus, it expose employees to new and serious health risks.

At present, safety, health and environmental issues have been one of the main concerns being raised by the public and the government. Similar to other industries, the steel foundry is facing increasing environmental pressures through the implementation of strict and high requirements of local regulations.

Most employers in this industries tend to underestimate and even trivialize risks, they perceive risk is an inherent part of the work activity therefore employers do not believe that their employees are in any significant danger (Homes et. al. 1996).

Some employers believe their safety management system is adequate simply because problems rarely occur. As a result, they do not ascribe much importance to safety prevention. Companies that have had bad experiences, for example being fined or license suspended or revoked should take into action occupational safety more seriously, but most of the condition appeared is they do not have a systematic approach and thus their choice of problems to be solved is based on the occurrence of accidents (Johansson et. al. 1997).

The production of metal casting foundry requires chemicals and machines to be utilized as part of the manufacturing process. Hence, the manufacturing processes at certain point may involve possibilities of hazard and risks at the workplace.

Some of the most common hazards and risks in the iron and steel industry include, unguarded machinery, skin contact with chemicals, contact with hot metal, fire and explosion, extreme temperatures and exposure to radiation.

Employers need to become the visionary leaders who adopt a proactive method, which consist of interdisciplinary and integrative system in the attempt at formulating and developing company policies. Such an boost action will facilitate employee participation, professional growth and team work.

These challenges are inescapable in any workplace, therefore it is crucial that employers examine how they can best fulfill their authoritative and leadership roles to protect and promote the health and well-being of their employees.

There are hazards and risks in all workplaces. Safety is possible only by knowing these risks and properly guarding procedures to minimize risks.

There are three steps used to manage health and safety at work:

1. Spot the hazard (Hazard Identification)
2. Assess the risk (Risk Assessment)
3. Make the changes (Risk Control)

The first step is to spot the hazard at the workplace, prior to that, evaluation of work practices and conditions must be undertook so that effective prevention and control measures can be implemented. This is considered as an integral part of the management’s responsibility.

Evaluation of the workplace environment addresses prevention and control measures in this instance. Environmental sampling and analysis are undertaken at regular intervals by qualified occupational health and safety professionals (Certified Safety Officer who registered with DOSH) in accordance with the methods recommended by the appropriate occupational health authority.

Assessing and monitoring are used as part of the evaluation of a hazard. This is also done to determine the effectiveness of control measures. The design and implementation of a monitoring program is carried out by certified personnel in the area of health and safety.

Every attempt should be made to keep the hazards below the safety exposure standards. Worker exposure to dusts, gases and vapours should be kept as low as possible. For example, the exposure standards represent airborne concentrations of individual chemical substances should neither impair the health of, nor cause undue discomfort to, nearly all workers. Additionally, the exposure standards are believed to guard against narcosis or irritation which could precipitate industrial accidents. However, if the situation where modified by consideration of excursion limits, exposure standards apply to long term exposure to a substance over an eight hour day for a normal working week, over an entire working life. In other words, the exposure standards do not represent 'no-effect' levels which guarantee protection to every worker.

Where there is a likelihood of worker exposure to foundry hazards, steps should be taken to minimize that exposure as far as possible. A thorough examination of work practices is essential. Procedures should be adopted to ensure that workers are not unnecessarily exposed to the hazard. Control measures include, but are not limited to, the following, which are ranked in priority of the effectiveness:

- Elimination/substitution and process modification
- Engineering controls

- Administrative control
- Use of personal protective equipment

Hazard identification, Risk Assessment and Risk Control (HIRARC) ensures that any potential risk to safety, health, environment and business aspects of any operation is minimized (Charles, 1998). Management commitment and employee involvement are fundamental to develope and implement any safety programs, but they are especially important when trying to prevent workplace accidents (Stephen and Mellissa, 1996).

Risk management is an aspect of the overall management function that determines and implements safety policy. The system emphasizes on identifying hazards as an early detection in the foundry and it subsequently plans appropriate health management system to eliminate or control the potential hazards in the workplace.

It also indicates management commitment towards health and safety management system at workplace. Survey on workers attitude towards health and safety management system is also used to investigate workers participation, opinion, knowledge, awareness and their readiness to adopt with the health and safety management system.

1.2 OBJECTIVES OF STUDY

The objectives of this study are to examine the issues in relation to health, safety, and environment aspects in the selected steel foundry.

The objectives of this study are:

- To identify the potential critical hazards which occur in the steel foundry to workers with regards to the manufacturing process.
- To evaluate the management risk assessment strategies and necessary methods of risk control by recommending elimination or minimizing the hazards identified in steel foundry.
- To determine the management commitment to control the hazards at the foundry and to explore the safety attitude of the workers towards risk and safety management system in foundry.

CHAPTER 2

LITERATURE REVIEW

2.1 THE OPERATIONAL SYSTEM OF STEEL FOUNDRY

A steel foundry is an industrial plant for the manufacture of steel. Steel is an alloy of iron and carbon. It is produced in a two-staged process. First, iron ore is reduced or smelted with coke and limestone in a blast furnace, producing molten iron which is either cast into pig iron or carried to the next stage as molten iron.

In the second stage, known as steelmaking, where impurities such as sulphur, phosphorus, and excess carbon are removed and alloying elements such as manganese, nickel, chromium and vanadium are added to produce the exact steel required. In the late 20th Century the world's largest steel foundry was located in Barrow-in-Furness, UK.

Places where employees engaged in high air temperatures operations, include, brick-firing and ceramic plants, glass products facilities, rubber products factories, electrical utilities, in particularly boiler rooms, bakeries, confectioneries, commercial kitchens, laundries, food canneries, chemical plants, mining sites, smelters, steam tunnels and iron and steel foundries. Steel foundry involve high air temperatures such as radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities which have a high potential for inducing heat stress.

The furnace and molten metal in a foundry create a hot working environment. Foundry worker experience a total heat load which is determined by the time spent at each workstation, for instance the intensity of work, the clothing worn and the immediate workstation environment, including air circulation contribute to a hot working atmosphere. If the heat load is sufficiently severe, it will affect employees' health and working performance as a decrease in concentration will lead to painful cramps, fainting, heat exhaustion and heatstroke. Nevertheless, the signs and symptoms require immediate medical attention.

In foundry, cast steel is typically melted in electric arc furnaces or coreless induction furnaces. However, there are several kinds of furnaces that are being utilized.

The cupola furnace is the common furnace used for cast iron melting and the oldest type of furnace used in foundries. The cupola process produces a significant amount of particulate emissions. Emission control systems typically require use of high energy wet scrubbers or dry baghouse (fabric filter) systems.

The Electric Arc Furnace (EAF) is a batching furnace often used in large steel foundries. Its use for cast iron production is less common.

Induction furnaces (IF) are used for melting ferrous and nonferrous metals. Melting is achieved through a strong magnetic field created by passing an alternating electric current through a coil wrapped around the furnace and consequently creating an electric current through the metal. The electric resistance of the metal produces heat, which melts the metal itself. These furnaces provide excellent metallurgical control and are relatively pollution free.

Reverberatory or hearth furnaces are used for batch melting of non-ferrous metals. It is a static furnace with direct heating. These furnaces are typically used for small-scale production as it is difficult to control emissions.

Crucible furnaces are used primarily to melt smaller amounts of non-ferrous metals whereas, rotary furnaces are used in non-ferrous melting for many years. The traditional oil-air burners of rotary furnaces can provide relatively low melting temperatures. Emissions control is often difficult. The development of oxygen-air burners has enabled the use of casting iron production.

Shaft furnaces are only used for non-ferrous metal melting, mainly for aluminum. It is a simple vertical furnace. Radiant roof furnaces are mainly used in non-ferrous (aluminum) pressure die-casting shops with centralized melting facilities.

A comparison has been made, between the pollution caused by the usage for melting iron of cupola furnace, arc furnace and induction furnace, on the basis of data compiled and processed by the commission for pollution control, the chemical composition and grain size distribution of solid emissions and the influencing factors. The comparison verifies without doubt that the induction furnace is the most favorable melting equipment with respect to pollution control (Horvath et al. 1984).

Concerning for workers' safety and health, which was once nonexistent in our country, now has become a major factor in foundries. This is because one of the hidden economic benefits of focusing on worker safety and health is a reduction in worker's compensation costs. For example, at Pennsylvania Steel Foundry & Machine Co., Hamburg, Pennsylvania, the company cut their worker's compensation losses from $615 000 in 1990 to less than $50 000 in 1991 through the implementation of a safety incentive program.

According to survey, most of the cost to business is seen in absenteeism, reduced productivity, compensation claims, health insurance and direct medical costs, which in United States, cost approximately $150 billion a year. In the UK, stress related absences are about ten time more costly than all industrial relations disputes put together, ranging from sickness absence, premature death and retirement due to alcoholism, which costs a staggering £2 billion a year. In future, the pressure on individual workers will increase as they will feel less in control and insecure in their work (Lawrence, 2000).

Health and safety aspects are apparently important in all workplace, as well as in foundry. Foundry work occurs in a very hot, noisy and potentially dangerous environment. Deafness, lung cancer and respiratory problems are just some of the serious health problems workers will face if they are regularly exposed to excessive heat, noise and hazardous substances. It is important that workers are protected with properly designed workplace health management.

2.2 OCCUPATIONAL SAFETY AND HEALTH IN MALAYSIA

In the early state of our country's development, the economic structure depended heavily on agricultural and mining based activities. The growth of these sectors introduced various hazards to workers. The Selangor Boiler Enactment in 1892 is the first legislation to address industrial safety issues.

In 1913, the Machinery Ordinance was enacted to ensure safety of machinery including boiler and internal combustion engines. The Machinery Ordinance 1913 is revised in 1932 (Machinery Enactment 1932) with additional provisions on registration and inspection of machinery installation.

The Machinery Ordinance of 1953 superceded all other previous legislation related to industrial safety, and was enforced in all the 11 states of Malaya under the jurisdiction of Machinery Department, Ministry of Labour.

In the early OSH legislation, the Federated Malay States Mining Enactment of 1926 and the Rump Labor Code of 1933 included public health provisions. Both these legislation required the provision of accommodation, sanitation, medical care and services, decent working conditions and livable wages for mine and estate workers.

In the following year, government implemented a policy to move towards industrialization. This resulted in an increasing number of workers in the manufacturing sector such as microelectronics, chemical and mineral based industries, and in later years in textile and automobile industries. In order to manage the safety and health problems associated with manufacturing, the Factories & Machinery Act 1967 (FMA) are enacted and enforced by the Factories and Machinery Department (previously known as Machinery Department).

Although the FMA was an improvement over earlier pieces of legislation, it had some important limitations. Among them was the fact that it only encompassed “factories” and hence covered only 23% of the workforce. It was prescriptive in nature, and based on traditional “checklist” system, whereby hazards were identified and measured to overcome the hazards were stipulated. It also depended on command and control approaches and improvement which are heavily dependent on the effectiveness of enforcement agencies.

However, this Act and the regulations was the cornerstone of Occupational, Safety and Health improvement for the next three decades before the introduction of the Occupational Safety and Health Act 1994.

In 1970, a number of regulations were introduced to strengthen the FMA 1967 (**Table 2.1**). These regulations except for the Safety, Health and Welfare Regulation 1970 are primarily targeted in addressing safety problems.

Table 2.1: List of Regulations Made under The FMA 1967

Regulations	Year
Certificate of Competency-Examination	1970
Electric Passenger and Good Lift	1970
Fencing of Machinery and Safety	1970
Notification of Fitness and Inspections	1970
Person-In-Charge	1970
Safety, Health & Welfare	1970
Steam Boiler & Unfired Pressure Vessel	1970
Administration	1970
Compounding of Offences	1978
Compoundable Offences	1978
Lead	1984
Asbestos Process	1986
Building Operations and Works of Engineering Construction (Safety)	1986
Noise Exposure	1989
Mineral Dust	1989

Source: Factory & Machinery Act, 1967.

Provisions of first aid and welfare facilities, for example, drinking water, toilets and washing facility are included in the Safety, Health and Welfare Regulation 1970.

From 1984 to 1989, four pieces of regulations addressing specific health hazards in the workplace which are lead, asbestos, noise and mineral dust were introduced. The regulations comprise provisions used for assessing exposure at the workplace, establishing permissible exposure level (PEL), control measures including medical and health surveillance provisions, competence and training program. However, the process of introducing regulations covering other health hazard is slow.

The Occupational Safety and Heath Act, 1994 was gazetted on 24 February 1994. The Act, which provides the legislative framework to promote, stimulate and encourage high standards of safety and health at work, is a practical tool superimposed over existing safety and health legislation, such as the Factories and Machinery Act, 1967.

The primary aim of the Act is to promote safety and health awareness and to instill a safety and health culture among all Malaysian workforces.

People spend more than one-third of each day at work. For this reason alone it should be clear that working conditions can have a major and direct impact on the health and well being of the workers (Giuffrida, Iunes and Savedoff , 2001A & 2001B).

The introduction of a comprehensive Occupational Safety and Health Act (OSHA) 1994 was in response to the need to cover a wider employee base and newer hazards introduced in the workplace. For instance, developed countries such as Japan had enacted such legislation in 1972, United Kingdom in 1974 (the Health and Safety at Work Act 1974), in the United State of America in 1970 (the Occupational Health & Safety Act 1970) and in Sweden and Norway, the Act was called Internal Control Regulation. The OSHA 1994 is enforced by the Department of Occupational Safety and Health (DOSH) (previously known as Factory and Machinery Department. The name is changed to reflect changes in coverage) under the Ministry of Human Resources.

The Act was derived from the philosophy of the Roben's Commission and Health & Safety at Work Act 1974 in the UK, emphasizing on self-regulation and duties of employer, employee and designer/manufacturer. The employer's duties include the provision of a safe system of work, training, maintenance of work environment and arrangement for minimizing the risks as low as reasonably practicable. In short, the responsibility on Occupational Safety and Health is made to rest on those who create the risks (employers) and those who work with risks (employees). This also includes designers, formulators, manufacturers, importers and suppliers in various fields.

It is hoped that the new Act will ensure that all parties concerned, particularly employers and workers, are more responsible and accountable in their efforts to provide and maintain a safe and healthy workplace. Therefore increased workers and participation at the company safety and health committee level is where Occupational Safety and Health is going to be strengthened in the future.

Institution also provides various Occupational Safety and Health services which could be the driving force to enhance the implementation of OSHA 1994. These institutions are DOSH, SOCSO, Workers and Environmental Health Unit, Ministry of Health, NIOSH, Universities, Society of Occupational and Environmental Medicine, Malaysia Medical Association (MMA), Malaysian Society for Occupational Safety and Health (MSOSH), Malaysian Occupational Health Nurses Association (MOHNA), OSH Department in Malaysian Trades Union Congress (MTUC), Various consumer and environmental groups such as Sahabat Alam Malaysia (SAM) and Consumer Association of Penang (CAP).

Provisions of the Occupational Safety and Health Act 1994 are based on self regulation approach with its primary responsibility's to ensure safety and health at work. It also lies with those who create risks and those who work with risks.

The concept of self-regulation encourages consultation, cooperation and participation of workers and management in the effort to upgrade the standards of safety and health at the workplace.

A series of regulations have been introduced under OSHA 1994. There are five regulations which are formed under the Act:

- Occupational Safety and Health (Control of Industrial Major Accident Hazard) Regulations 1996
- Occupational Safety and Health (Safety and Health Committee) Regulations 1996
- Occupational Safety and Health (Classification, Packaging and Labeling of Hazardous Chemicals) Regulations 1997
- Occupational Safety and Health (Safety and Health Officer) Regulations 1997
- Occupational Safety and Health (Safety and Health Officer) Order 1999

The emphasis of these regulations has been on establishing mechanism to implement Occupational Safety and Health in workplaces. Workplaces with five or more workers are required to formulate a Safety and Health Policy. The Safety and Health Committee Regulations 1996 requires establishments with 40 workers and above to establish a safety and health committee. The committee is required to meet at least once in every three months, with the functions to identify hazards at the workplace, institute control measures, and investigate incident and conducting audit.

Occupational health is an integral part of assuring environmental justice (George, 1999). In terms of representation in the committee, workplace with less than 100 workers will need to have at least two representatives each for workers and management respectively. However, workplaces with more than 100 workers will need to have a minimum of four representatives each for workers and management. The Safety and Health Officer Regulations provide for specific industries to have a Safety and Health Officer (SHO). A SHO is an individual who has attended training in National Institute of Occupational Safety and Health (NIOSH) or other accredited training bodies and has passed the examination conducted by NIOSH and registered with DOSH.

However, compliance to the enforcement law by the relevant companies or industries were strongly correlated with several key factors which include, perceived organizational commitment to safety, risk-taking personality, perception of risk, training in universal precautions (Gershon et al. 1995).

2.3 HAZARDS IN STEEL FOUNDRY

A hazard has the potential to cause harm which can result illness, injury to people, damage to property, plant, products or the environment and even cause loss of life. Hazards are everywhere, they include: chemical hazards, thermodynamic hazards, electrical & electromagnetic hazards, mechanical hazards, health hazards (Rosmani, 2006).

All workplace hazards (chemical, physical, etc.) can be controlled by a variety of methods. The goal of controlling hazards is to prevent workers from being exposed to occupational hazards. Some methods of hazard control are more efficient than others, but a combination of methods usually provides a safer workplace than relying on only one method. Some methods of control are cheaper than others but may not provide the most effective way to reduce exposures. The most effective method of controlling hazards is to control the source by eliminating hazard or by substituting a hazardous agent or work process with a less dangerous one (Rosskam, 1996).

The toxic properties and health effects of many environmental contaminants are originally discovered in workplace settings where workers are repeatedly exposed to high doses of such contaminants.

A major environmental hazard associated with integrated steel foundry is the air pollution produced during the manufacturing of coke, which is an essential intermediate product in the reduction of iron ore in a blast furnace.

For most iron-making, the essential features are coke ovens and the blast furnace, where coke is produced from coal and where iron ore is melted to produce pig iron, respectively. The purpose of steel-making operations is to refine the pig iron which contains large amounts of carbon and other impurities. As a first step, the carbon content being reduced, then the impurities are oxidized and removed.

Finally, the iron is converted into a highly elastic metal that can be forged and fabricated. Alloying agents may be added at this stage. Different types of melting furnace are used in this process.

Some steel is produced directly from scrap or other iron-containing materials, most often in electric arc furnaces, without the need for iron ore or coke. Operations in the iron and steel industry may expose workers to a wide range of hazards at workplace activities that could cause incidents, injury, death, ill health and diseases.

The most common occupational illnesses in smelters and foundries are: acoustic trauma (50%), industrial bronchitis (20%), siderosis (10%), chemical and physical conjunctivitis (5%), and miscellaneous illness such as poisonings (15%) (Alfredo, 1996).

Safety in the foundry is paramount to all other activities within the facility. When safety is given major priority, production and quality will be achieved to expected levels. No job is so urgent that it cannot be done in a safe and timely manner (Geng, 2004).

CASE STUDY: A study have been done in Taiwan in the year of 1998 by a group of expertise concerning on the Prevalence of and Factors Related to Pneumoconiosis Among Foundry Workers in Central Taiwan. The group of expertise consist of H.W. Kuo, C.L. Chang and J.S. Lai from Institute of

Environmental Health, China Medical College, Hsueh Shin Road, Taichung, Taiwan, F.C. Lee and B.C. Chung from Provincial Feng-Yuan Hospital, Taiwan Provincial Health Department, Taichung, Taiwan, C.J. Chen from Institute of Occupational Safety and Health, Council of Labor Affairs, Executive Yuan, Taichung, Taiwan. The objective of the study was to investigate the prevalence and factors related to pneumoconiosis in foundry workers. Seven hundred and eighteen workers from 50 foundries in central Taiwan were interviewed using a constructed questionnaire. A full-sized PA chest radiograph was used to diagnose pneumoconiosis, according to ILO criteria. Overall, pneumoconiosis was found in 7.50% of the workers. The highest prevalence was found among furnace workers (15.90%) and molding workers (8.40%). All foundry workers except those in administrative positions had a significantly increased risk of developing pneumoconiosis. Using a multiple logistic regression, compared to administrative workers, furnace workers had the highest risk (10.63 times), followed by post-treatment workers (6.63 times), and molding workers (5.41 times). In conclusion, the prevalence of pneumoconiosis was significantly related to high concentrations of dust, especially with a high proportion of free silica, however, smoking and length of exposure were also contributing factors. (Kuo et al., 1998)

The choice and the implementation of specific measures for preventing workplace injury and ill health in the workforce of the iron and steel industry depend on the recognition of the principal hazards, in anticipating injuries, diseases and incidents.

Below are the most common causes of injuries and illnesses in the iron and steel industry:

- Slips, trips and falls on the same level
- Falls from height
- Unguarded machinery
- Falling objects
- Engulfment
- Working in confined spaces
- Moving machinery, on-site transport, forklifts and cranes
- Exposure to controlled and uncontrolled energy sources
- Exposure to asbestos
- Exposure to mineral wools and fibers
- Inhalable agents (gases, vapours, dusts and fumes)
- Skin contact with chemicals (irritants (acids, alkalis), solvents and sensitizers)
- Contact with hot metal
- Fire and explosion
- Extreme temperatures
- Radiation (non-ionizing, ionizing)
- Noise and vibration
- Electrical burns and electric shock
- Manual handling and repetitive work
- Exposure to pathogens (e.g. legionella)
- Failures due to automation
- Ergonomics
- Lack of OSH training
- Poor work organization

- Inadequate accident prevention and inspection
- Inadequate emergency first-aid and rescue facilities
- Lack of medical facilities and social protection.

The need for environmental protection and safety are major concerns in the metal casting industry. Breathing air that contains hazardous contaminants can cause health problems. Water that contains toxic pollutants can contaminate surface and ground water. Waste sand and other solid materials can adversely affect the environment when disposed of in landfills and may need to be cleaned or treated before disposal, or beneficially recycled or reused (Geng, 2004).

According to general survey, it is found that measures for cooperation should be taken relating to the elimination or control of hazards or risks to safety and health in the production of iron and steel. These measures include the responsibilities of employer. Employer act in discharging from their responsibilities, therefore it is crucial that they cooperate as closely as possible with their workers and representatives

The workers should cooperate as closely as possible with their fellow workers and their employers in the sanctioning by the employers of their responsibilities, they should comply with all prescribed procedures and practices.

Suppliers should provide employers with all necessary information as is available and required for the evaluation of any unusual hazards or risks to safety and health that might result from a particular hazardous factor in the production of iron and steel.

Generally, an employer is required to protect his or her employee from all possible risks in the workplace. At the same time, employees have a general duty to take reasonable care of their own health and safety, and that of others who may be affected, and to cooperate with the employer's efforts to make the workplace safe.

However, there is evidence that supportive supervision, where leaders demonstrate concern for subordinates' welfare and listen to safety suggestions, is related to improved safety compliance (Thompson et al., 1998).

Foundries are also very prone to hazards from noise which can result in industrial deafness and from vibration (in the fettling process) which can lead to hand arm vibration syndrome. Some of them suffer from poor standards of "housekeeping" with numerous trip hazards (Hobson, 2001).

CASE STUDY: A survey on Comparison of two methods of measuring personal noise exposure has been carried out by S. Shackleton and M. D. Piney, from Institute of Occupational Health, Birmingham University U.K., Department of Environmental and Occupational Health, University of Aston in Birmingham U.K. The survey assessed the accuracy with which hand-held Sound Level Meter (SLM) surveys could be used to measure the mean of noise exposure and subjects from 25 occupational categories in a steel foundry. The noise exposure of foundry personnel was measured by repeated noise dosimetry until each subject's mean daily exposure could be calculated within 95% confidence limits of approximately ±2 dB(A) Leq. (Shackleton & Piney, 1984).

According to Shackleton and Piney, this survey is a series of five l-day surveys, the same individuals' mean noise exposures were assessed by experienced noise surveyors using hand-held precision integrating SLMs. The results of the two measurement methods were compared. Allowance was made for the effects on measurement of a body-mounted microphone when using dosemeters. In seven cases the hand-held SLM surveys significantly underestimated the mean exposure measured by dosimetry by between 2.4 and 7.2 dB(A) Leq ($p<0.05$). A further seven subjects' noise exposures could not be assessed by SLM and in no cases did the SLM surveys indicate a higher average exposure than the dosemeters. The exposure of some 37% of the potentially noise-exposed population was either immeasurable or underestimated by the hand-held SLM survey method (Shackleton & Piney, 1984).

In the foundry industry people are subjected to a variety of noise sources. High noise levels from sources, such as vibrator systems to compact moulding sands in moulds, arc/air gouging and fettling activities and particularly those of short duration, such as impulse or impact noise, are present in many foundries and are capable of causing damage to hearing. Foundries form part of the metal fabrication industry. This industry is responsible for a large proportion of worker's compensation payouts for noise induced hearing loss of its workers.

Evaluation by occupational health and safety personnel of noise should be undertaken to identify areas where noise levels may be excessive. Surveys of foundries have shown that dressing, fettling, and shakeout operations could give rise to considerable noise levels, with potentially harmful effects on the hearing of exposed workers. In addition, workers who are immediately involved in these processes, people working in the vicinity may be exposed to noise levels well in excess of 85dB (A).

In foundries noise levels can be expected to range generally between about 80 and 110dB(A). Most common noise sources are from mould vibrators, shake outs, rumblers and shot blasting, arc gouging and fettling and dressing of castings, using angel grinders and hammering and banging on castings. Extraction fans, die-casting machines, core-making and shell-making equipment may also be sources of excessive noise. Some fettling workers have been shown to be exposed to levels of noise over 100dB (A), shakeout and knockout processes are typically associated with readings of 90-110dB (A). Mechanical sand mixing processes and forced draught furnaces may produce noise levels of 90-100dB (A), averaged over an eight hour shift.

The typical noise sources in the foundry industry at operator ear level are shown in **Table 2.2** as below.

Table 2.2: The Noise Sources and Its Level in Foundry Industry

Sources	Noise Level (dB)
Mould vibrators	85-114dB(A)
Inverter	83-116dB(A)
Arc/air gouging	82-107dB(A)
9 inch angle grinder	97-110dB(A)
Shot blasting	86-101dB(A)
Shake out	84-95dB(A)

Operator noise exposure levels from the above sources, of between 96-102dB(A), as average over the shift duration, are common in this industry. Noise sources may also be found from induction furnaces. The frequent use of compressed air systems to clean moulds or work benches, cause high noise levels consisting predominantly high pitched components. A variety of woodworking machines in the making of mould patterns also add to noise exposure. All of these noise sources create high ambient noise levels in foundries, hence the use of personal hearing protectors is required in most situations.

Generally where high levels of noise are present throughout the work shifts, workers tend to wear personal hearing protectors most of the time. However, with short duration noises, for example, a few belts with a hammer on a metal casting or using compressed air to clean a mould or work bench, the use of hearing protectors is often ignored or simply not even thought of. These relatively short duration exposures however, happen many times per shift and add to the overall exposure.

Emissions of particulate matter (PM) from the melting and treatment of molten metal, as well as from mold manufacture, shakeout, cleaning and after-treatment, is generally of greatest concern. Toxic metals tend to attach on the surface of PM. Oil mists are released from the lubrication of metals. Odor and alcohol vapor (from surface treatment of alcohol-based blacking) and emissions of other volatile organic compounds (VOCs) is also of concern. Care must be exercised when handling halogenated organics, including aluminum scrap contaminated with chlorinated organics, polyvinyl chloride (PVC) scrap and turnings with chlorinated cutting oil, it is because dioxins may be emitted during melting operations.

CASE STUDY: A study concerning on the long-term behavior of stabilized steel foundry dust (SFD) wastes, has been carried out by A. Andres, I. Ortiz, J. R. Viguri and A. Irabien from the Spain University. It was a study of the long-term behavior of stabilized steel foundry dust (SFD) wastes, which has been performed using a dynamic leaching test (DLT). Two stabilized/solidified forms were produced by solidifying the SFD (containing Pb, Cr, Cd and Zn) using either cement or cement and anhydrite (waste material) as binders. (Andres et al., 1995)

Based on Andres' survey, the results of the dynamic leaching test were fitted to a semi-empirical mathematical model based on simple leaching rate mechanisms, which permitted the evaluation of an apparent diffusion coefficient and a leachability index, thus providing a measure of the contaminants' mobility in the solidified waste. In the case of Pb and Zn, the rate of leaching was controlled by either an initial resistance or an initial wash off, followed by diffusion of the metallic contaminants. The leaching indexes obtained in both cases were higher than 12, suggesting that both solidification/stabilization processes are acceptable (Andres et al., 1995).

Raw materials used during the process of iron and steelmaking may also pose danger to those exposed to them. These materials include:

- Coal: may decrease lung function and is combustible
- Coke: may irritate respiratory tract in large doses, and cause eye irritations
- Iron fines: may cause and exacerbate respiratory diseases due to its small particle size
- Silica: known carcinogen in quartz and cristobalite form, if inhaled
- Limestone: may contain silica particles, a known carcinogen, and affect respiratory tract if dust is inhaled in large amounts
- Dolomite: may contain silica particles, a known carcinogen

Chemical monitoring is one of the ways to ensure adequate prevention and protection at workplace. The Material Safety Data Sheets (MSDS) utilized during monitoring process provide advices on the safe handling of any chemical being utilized or exposed at work.

The objective of chemical monitoring is to analyse workers exposure to chemical hazardous to health from different areas in order to comply with Occupational Safety and Health, Use and Standard of Exposure of Chemicals Hazardous to Health (USECHH) Regulations 2000.

Material Safety Data Sheets is a comprehensive collection of material safety data sheets on more than 54,512 chemicals, including pure substances and mixtures. The data sheets are prepared and formatted in accordance with the ANSI Z400.1 standard, which is a 16 section format that has been adopted by the

Chemical Manufacturers Association (CMA), the International Labor Organization, and other major organizations. The data sheets help organizations satisfy regulatory and safety laws, it provide employees the right-to-know information, respond to chemical emergencies, and have the information available to safely handle hazardous waste.

Material Safety Data Sheets contain the 16 section titles and sequence from the ANSI Z400.1 standard, include:

1. Chemical Product and Company Identification
2. Composition, Information on Ingredients
3. Hazards Identification
4. First Aid Measures
5. Fire Fighting Measures
6. Accidental Release Measures
7. Handling and Storage
8. Exposure Controls, Personal Protection
9. Physical and Chemical Properties
10. Stability and Reactivity
11. Toxicological Information
12. Ecological Information
13. Disposal Considerations
14. Transport Information
15. Regulatory Information
16. Other Information

The data sheets are written in English and contain the name of the chemical (same as on the label), the chemical and common names of the substance, a listing of the ingredients, a statement of the ingredients that are known carcinogens or that present other known hazards or any specific hazards. These data sheets play significant roles in several recordkeeping requirements, and created and distributed as a part of comprehensive hazard communication program. They are required as a part of any compliance obligation to be available and displayed prominently in the workplace. The public has the right to view MSDS data upon request.

Material Safety Data Sheets prepared by an experienced staff of safety and health professionals, independent of chemical manufacturer, for example chemical scientist. This creates MSDSs that report independently researched information objectively and without bias. All those concerned with the storage and handling of chemicals, and with general housekeeping are trained to adopt a safe system of work at all times (The Globally Harmonized System of Classification and Labelling of Chemicals,United Nations, 2003).

The use of specialized equipment and procedures to insure the protection of workers and the public is a necessary and mandatory part of foundry operations (Geng, 2004).

Hence, identifying hazard and assessing risks are important to reduce the probability of accidents and therefore it should be seen as a bigger issue (Roger, 1996).

2.4 RISK ASSESSMENT IN STEEL FOUNDRY

A strategy is suggested for employers to deal with the multifaceted workplace pressures and health impacts on employees, for example, implementing an integrative holistic model of workplace health management. Workplace health management is an approach to workplace health that includes health promotion, disease prevention, organizational development, safety management and risk management. Workplace health management has emerged from the latest developments in the settings approach to workplace health promotion. Besides, promoting the 3Rs system of Reduce-Reuse-Recycle is an effective way to reduce pollution during manufacturing processes.

Risk management is the concept involving the planned and systematic attempt to reduce the risk of work-related injury and disease from the workplace. This approach to occupational health and safety issues primarily comprises three stages, which involve the identification, the assessment and the control of risk factors or agents.

Where a risk to health and safety has been identified, controls must be introduced to eliminate or minimize it. All employees and supervisors must be trained in safety awareness and practices to curb risks (Robotham, 1998).

This training will not only make employees more self-observing, it will also encourage and enable them to encourage others to consider safer methods of working (LaBar, 1996).

However, employees who are unaware of safer ways of working have no option but to continue with unsafe practices. This has obvious links to the level of management commitment to safety demonstrated (Robbins, 1994). It is importance that the accident investigations and safety inspections tailored to specific situations in which they are conducted and actioned directly after recommendations are made (Robotham, 1998).

It is clear from investigations relating to shift-work that range from modifying factors are likely to influence the level and nature of health and performance outcomes. These include the attitudes and motivation of the people concerned towards the job requirements, and other aspects of the organizational and cultural climate. It is concluded that there is currently sufficient evidence to raise concerns about the risks to health and safety of long working hours (Spurgeon et al., 1997).

Effective risk-management measures concerning the health, legislative and financial implications of environmental risk rely fundamentally on a robust risk assessment and risk control (Pollard et al., 1995).

There are four major areas of environmental and safety control in the metal casting industry. They are emissions, water pollutions, solid waste and safety (Geng, 2004).

The first critical factor is that commitment by management to the safety program must be demonstrated and highly visible (Robotham, 1998). It is not enough for management to claim that they are committed to safety; they must visibly demonstrate this commitment through overt actions in order for organisational culture to espouse a high degree of commitment to the program (Robotham, 1998). Regardless of the values stated on the mission statement, employees will judge management's commitment by what they actually observe (LaBar, 1996). Similarly, without management modeling, expected behaviors and values, employees will become cynical and distrustful toward the programs that are implemented (Hawkins & Hudson, 1998).

All communication, whether it is face-to-face, via newsletters or safety committee meetings, needs to stress safety as the number one priority maintained at all times. Meetings need to be held at regular intervals. All employees should be involved in the communication to ensure that employees are receiving the right information, thus, leaving no room for inconsistencies, confusion or resentment to arise (Fisher, 1997).

Mechanisms, including training and incentives, may be useful in rewarding and reinforcing the organization's commitment to safety. Linking these Human Resource practices to safety performance will also help make safety become intrinsic to the job, rather than an extra consideration at work (Cacioppe, 1988).

Risk management disciplines stress substance and policy content, treat risk as a malleable commodity that can be managed but not necessarily eradicated, and offer concrete strategies for measuring and controlling risk (Glendon et. al., 2006).

Effective tools to the risk management in the foundry include designing, preplanning, training, management commitment and the development of a safety culture. The introduction and operation of effective safety management systems represents a viable way forwards, but these systems are all too rarely implemented (Steve, 2004).

Environment protection at workplace affects different dimensions of the working and protection process. **Figure 2.1** shows the relationship between work and health protection in the workplace and the external environment.

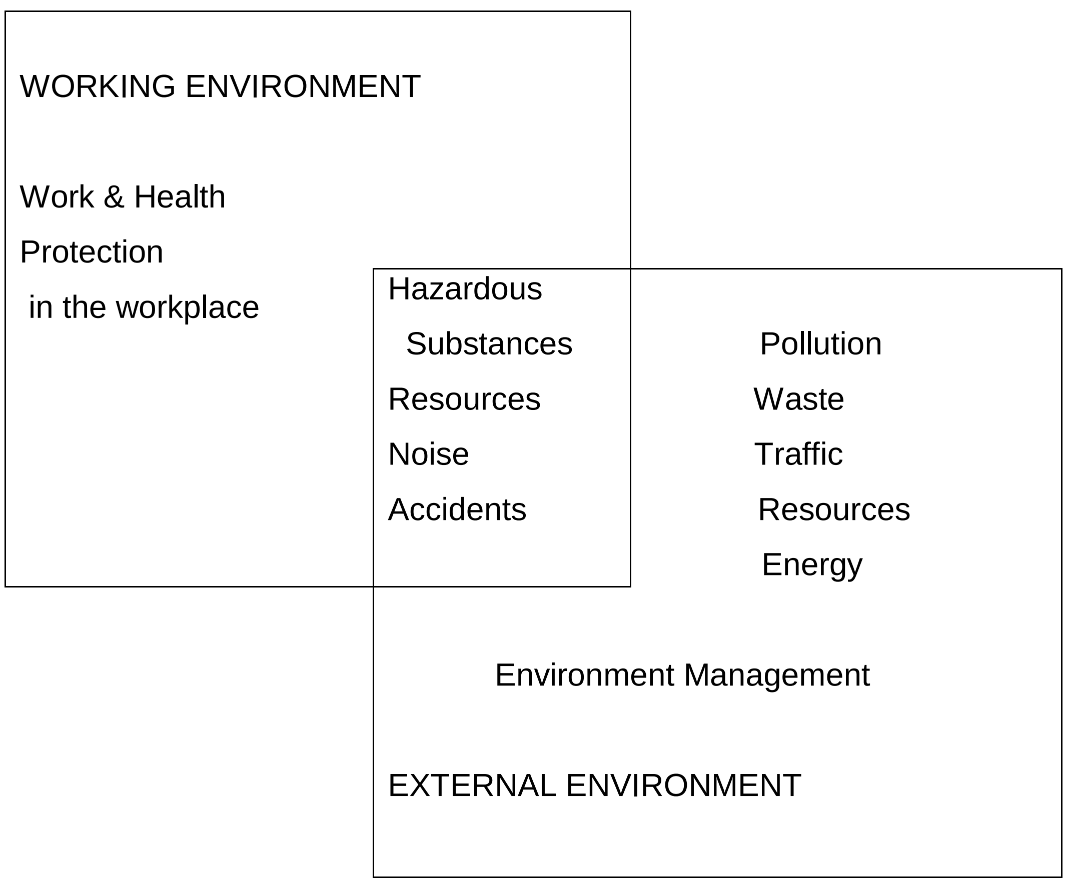

Figure 2.1: Environment Protection at Workplace

The intersection between the internal and external environmental protection creates a segment that is particularly important which include the hazardous substances, resource consumption, noise effects and the risk of accidents (Eckart and Eberhard, 1994). These are the aspects that employer need to put in extra mile in order to build a safety and accident free working environment at the workplace.

CHAPTER 3

BACKGROUND INFORMATION

3.1 PROFILE OF THE SELECTED FOUNDRY FOR THIS STUDY

The selected foundry is a steel casting company located in Ipoh and a bigger branch in Pengkalan, Perak. The ownership of this company is owned 100% by Malaysian and it was established in 1972. The main products of this company are alloy steel, iron casting and others. 15% of the products are for local use while 85% is exported to foreign countries like Japan, Canada, USA, Singapore, Indonesia, West Africa, UK, Australia, Hong Kong, Sri Lanka and Germany.

The company is an intergrated steel manufacturing foundry. They used 75% of recycle scrap steel for melting. Materials used for the products are carbon & alloy steel, wear resistant & iron, heat-resistant steel & iron, stainless steel, corrosion resistant iron. The main production processes are electric melting of scrap, casting of molten metal into sand moulds, heat treatment and machining. The company is equipped with electric melting (induction furnaces) (13 units), heat treatment furnaces (11 units), pattern shop and 2 comprehensive machine shops. The foundry comprises about 620 employees.

An annual output of about 50,000 tonnes of iron and steel castings are supplied to industries such as cement, quarry, tin-mining, civil construction, oil palm, petroleum, railway, shipbuilding and general engineering. The range of materials offered is extensive which includes carbon steel, low alloy steel, high allow steel, stainless, high-resisting, corrosion-resisting, wear-resisting steels and irons to BS (British Standards), ASTM (American Standard for Testing of Materials), DIN (German Standard) and JIS (Japanese Standards) specifications or to the customers' individual requirements.

3.2 FOUNDRY'S MANUFACTURING PROCESS DESCRIPTION

Foundry work is the process of making a metal casting of an object by pouring molten metal into a mould. The mould is made by using a pattern of the article required.

Steel foundries produce iron and steel castings. Founding, or casting, involves pouring of molten metal into a mould made to the external shape of the article to be cast. The mould may contain a refractory core which determines the dimensions of any internal cavity or hollow. Molten metal is introduced into the mould. After cooling has taken place, the mould is subjected to a 'shakeout' procedure which releases the casting and removes the core. The casting is then cleaned and any extraneous metal is removed from it.

In the selected foundry, the production starts at the pattern shop as the foundry receives orders or drawings from clients, it will be sent to the Pattern Shop for wood pattern making. After that, the pattern will be sent to the Moulding Department to produce the sand mould in quantities needed according to the request of the client. Besides that, cores of the moulds are also produced here. Moulds which are ready will be set up with sprue for the pouring session. Before carrying out the pouring session, scrap metal are melted to produce the molten metal which is heated to a temperature around 1500°C. Molten metal are then poured into the cavity of the mould through the sprue. After leaving the casting for around 24 hours to cool down and recrystallize, it is sent to shake-out and fettling to remove the sand, riser and gating system. For the next procedure, the casting will undergo the heat treatment process. Depending on the material of the casting, it will go through several treatments to meet the mechanical properties of the client's requirement. It will be then send to the Machine Shop to machine out as shown by the dimensions in **Figure 3.1**. After that, Quality Control Department will make sure the products meet the requirement of the client in mechanical properties and the dimensions. The products will be dispatched after this procedure.

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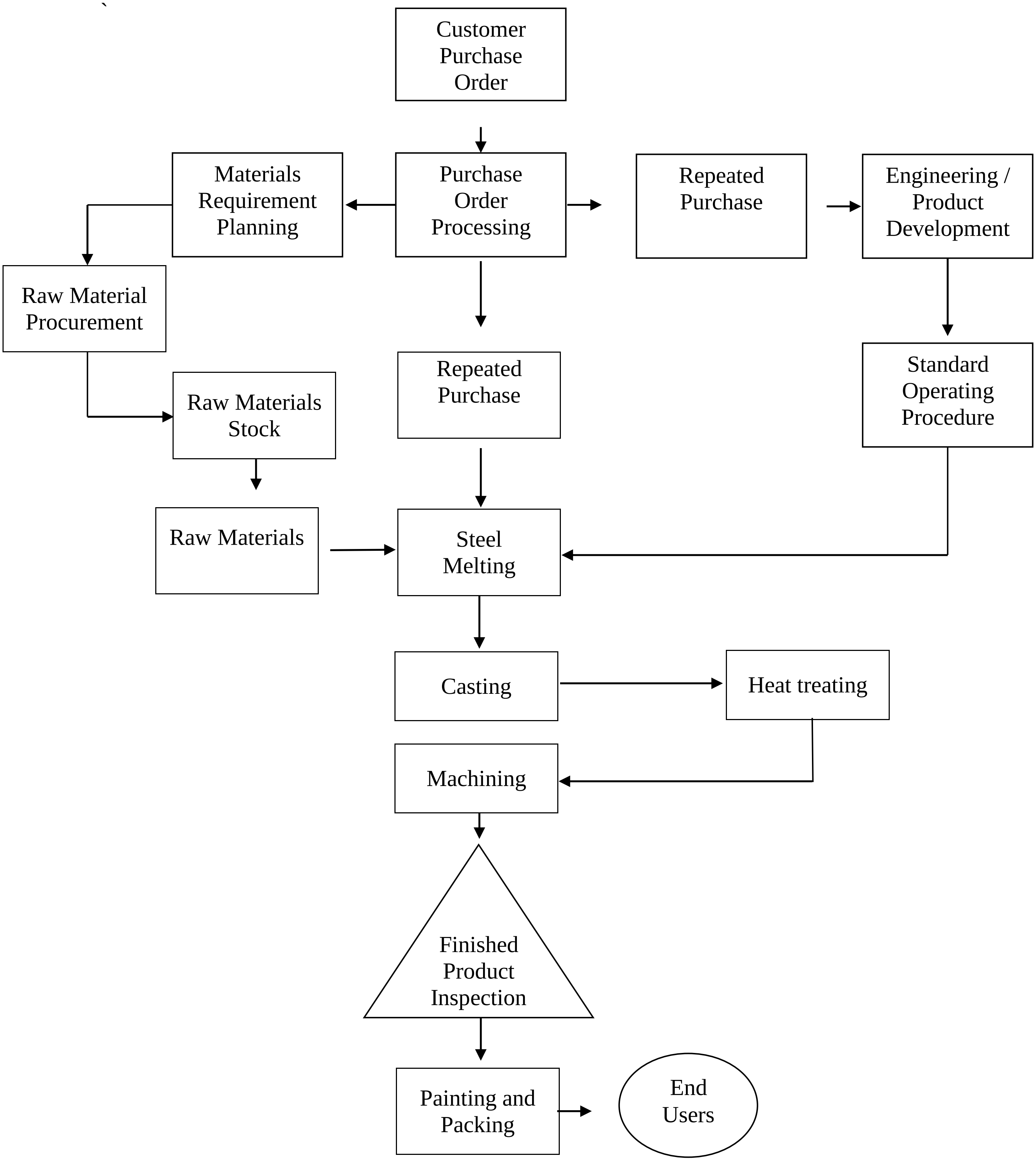


Figure 3.1: Process Flow Chart of The Selected Foundry

In order to further understand the manufacturing process of the steel foundry, the above **Figure 3.1** shows the Selected Foundry's Process Flow Chart.

Generally, foundry works involve numerous processes, including, moulding and pattern making, core making, melting and pouring, shakeout, dressing and cleaning.

3.2.1 Moulding and pattern making

Sand moulds are commonly used for ferrous founding. To produce the depression in the sand into which the metal is poured, a pattern of the object to be cast is formed. Hardwoods, metals or resins are used by pattern makers in this forming process.

The majority of ferrous castings are produced by 'green' sand moulds. The moulding mix usually contains silica sand, coal dust, and organic binders such as dextrine and carbon oil. The moulding sand may also contain metal fragments from previous pourings as the sand is recycled. Water and binder are normally added to the sand before it is re-used. Synthetic resins are sometimes used in mould making.

The casting of non-ferrous metals often utilizes graphic or metal dies in the moulding operation. The use of such metal dies requires specific procedures and safety precautions.

3.2.2 Coremaking

Cores are traditionally formed from sand, with an organic binding agent added. The processing of these traditional cores involves oven curing, which releases acrolein. However, if oils are used, it produces a disagreeable and choking odour.

Several new binding systems contain various synthetic resins such as phenol formaldehyde, urea formaldehyde, furfuryl alcohol (furan), polyurethanes and various amines. The curing of these resins are achieved by chemical reaction or heating. Gases may be used as catalysts for these reactions.

The mixing of sodium silicate with sand, and the passing of carbon dioxide through the mixed core, is also utilized. Silica gel and sodium carbonate are formed through this process which forms a rigid core.

The completed, cured cores are sprayed with a coating material prior to pouring. This may involve a combination of alcohol and graphite.

3.2.3 Melting and pouring

A variety of furnaces are used for melting metals prior to casting. Electrically powered induction furnaces are used to process higher grades of cast iron and steel. These furnaces are almost noise free and generate little nuisance heat.

The cupola furnaces are fuelled by coke, and compressed air is introduced to enhance the combustion. If the air is pre-heated, to about 300° C, the furnace is known as a ‘hot-blast’ cupola. Large amounts of carbon monoxide are generated during cupola operations.

Non-ferrous operations utilize electric furnaces, simple blast furnaces or, more commonly reverberatory-type furnaces. Fume and dust collectors are incorporated into non-ferrous furnaces. Roasting ovens are used, in addition to furnaces, for refining copper and zinc.

Electric holding furnaces are also used in foundries, to maintain the metals in the molten state prior to pouring.

The molten metal is poured from the furnace by tilting or tapping the furnace, and the metal is then passed to the moulds. In old or small foundries, the pouring of metal into moulds is carried out manually, while larger foundries used mechanized systems.

3.2.4 Shakeout (knockout)

The removal of the cooled casting from the mould is termed ‘shakeout’. The moulding sand is dry and friable at this stage. It must also be noted that particles of metal, sand and core material can become airborne during this process. While new foundries may have automated shakeout facilities, many smaller foundries do not, as the shakeout is performed manually. When the technique of ‘jobbing’ moulding is utilized, the moulds are knocked out by hand, usually with a hammer.

If coal dust is incorporated into a sand mould, carbon monoxide will be generated during cooling and shakeout.

3.2.5 Dressing and cleaning

Following the shakeout or knockout procedure, the formed castings are cleaned and dressed to remove any extraneous metal, sand or other material left from the moulding process. The castings are often sent to an allied machine shop at this stage for buffing and polishing. Various methods are employed in dressing and cleaning.

Tumble blasting is now used extensively. In this process, the castings are mechanically tumbled with metallic abrasives in an enclosed drum. Abrasive blasting techniques are still utilized. A variety of non-metallic (corn husks, pecan shells, glass beads, silicon carbide and aluminum oxide) and metallic (steel grit of shot) abrasives are used. Water of air under pressure is used to deliver the abrasive to the surface of the casting. A great deal of dust is generated by this blasting, and it is usually carried out in an enclosure equipped with special ventilation and particle recycling facilities.

Pneumatic grinding and chipping tools may be used for cleaning castings. Hydraulic blasting or vibration processes may be employed to remove cores from the castings. An additional grinding, polishing and buffing operations are carried out to develop a smooth and polished surface on the metal. After this stage, the metal product is produced with the final work of painting and packing.

CHAPTER 4

METHODOLOGY

The methodology of this study is divided into two sections, in order to inspect compliance of the foundry health and safety management system with Occupational Safety and Health Act (OSHA), 1994 and its regulations.

The first section features the methods of hazard identification to identify and to quantify possible health and safety hazards occur in the workplace with regards to manufacturing activities.

The second section explores the methods of risk assessment of the foundry and inspects the management commitment and the safety attitude of the workers towards health and safety management system.

4.1 METHODS OF HAZARD IDENTIFICATION

Hazard identification is the process used to identify all the possible situations in the workplace where people may be exposed to injury, illness or disease.

The process of hazard identification also helps in indicating any environmental factors such as poor lighting that may contribute to an accident and help to determine methods and training programmes for ongoing monitoring to achieve optimum Occupational Health and Safety standards.

The first step to be taken in a preventive program in occupational health is to identify or recognize any potential health hazards. In general, to identify health and safety problems at the workplace, include, observe the workplace, investigate complaints from workers, examine accident and near-miss records, examine sickness figures, use simple surveys to ask co-workers about their health and safety concerns, use check-lists to help inspect the workplace, learn the results of inspections that are done by the employer, read reports or other information about the workplace, utilise material safety data sheets (MSDS).

In this study, to examine the health and safety analysis in the selected steel foundry, the following methods are utilized to identify the health and safety aspects at the workplace:

4.1.1 Observation and interview session

4.1.2 Safety Audit Checklist

4.1.3 Survey Form- Workplace Health Survey Form

4.1.4 Accident Reports and Investigations

The following sections discuss the details of each method.

4.1.1 Observation and interview session

A visit was conducted to the foundry as a walk through inspection, survey and observation to obtain information on the company's background, manufacturing process, health and safety documentation and approaches undertaken by the foundry. In the meantime, an interview session **(Appendix I)** is successfully held with the Foundry General Manager.

4.1.2 Safety Audit Checklist

Safety Audit Checklist **(Appendix II)** is used and carried out by the secretary of the Health and Safety committee to inspect the general safety aspect in the foundry. The checklist comprises of eight session including: general cleanliness, machine guards, local exhaust ventilation, personal protective equipment, personal hygiene, first-aid, fire-fighting equipment, methods of control, labeling information and emergency measures.

The checklist focus on assessing the documentation on safety auditing which are carried out in the foundry as a procedure once in six or twelve months for workplace safety inspection.

4.1.3 Survey Form

A Survey Form **(Appendix III)** consists of 33 general descriptions of the general health and safety aspects in the foundry and are distributed among 300 operators in the manufacturing department to assess the safety conditions at their workplace. The survey form is to assess the general safety aspects in the selected foundry.

4.1.4 Accident reports and Investigations

. The foundry is committed to the health and safety regulation of the county, whenever there is any accident occurred, proper procedures are followed by the safety personnel by submitting the JKKP form to the Department of Safety and Health (DOSH).

Besides, internal investigation is carried out to examine and report the work procedure deviation from the correct routine. In this study, a summary has made to assess the safety aspect in the foundry based on the data given by the management of the foundry, include accident report done by the health and safety committee and copies of JKKP form submitted by the foundry to DOSH **(JKKP Forms- Appendix IV)**.

4.2 METHOD OF RISK ASSESSMENT

Once a hazard has been recognized, proper measures to correct the problem most effectively can be determined. Generally, there are five major categories of control measures, which include elimination, substitution, engineering control, administrative control, personal protective equipment.

The primary consideration is elimination, which is to eliminate a hazard or remove it completely. However if the elimination measures is not ideal, substitution is taking place which replaces one hazardous agent or work proves with a less dangerous one.

An engineering control may also apply, mean changing a piece of machinery or a work process to reduce exposure to a hazard.

The final control is applying administrative controls, for example working a limited number of hours in a hazardous area, followed by a supplement of Personal Protective Equipment (PPE), PPE includes ear and eye protection, respirators and protective clothing to protect the health and safety aspects of worker at workplace.

The risk assessment methods which utilized to analyze the manufacturing process in the selected foundry include:

4.2.1 Job Safety Analysis- Hazard Assessment Form

4.2.2 Fault Tree Analysis (FTA)

4.2.3 Risk Matrix Ranking

The details of each method are further discussed in the following sections.

4.2.1 Job Safety Analysis- Hazard Assessment Form

A Hazard Assessment Form is used to identify the hazard in the workplace, assess the activities and proposed the control measures.

In this study, a hazard assessment form **(refer Table 5.3)** is utilized to inspect the health and safety aspect of the manufacturing process in the foundry.

4.2.2 Fault Tree Analysis (FTA)

Fault tree are a deductive method for identifying ways in which hazards can lead to accidents. The approach starts with a well-defined accident or top event and works backward towards the various scenarios that can cause accident.

Analysis is restricted to identifying system elements and events that can lead to the specified accident. By using the probabilistic risk assessment technique, probabilities of events occurring can be calculated. The 'AND' gates are used when the existence of all conditions or events indicated must occur for the tip event to occur. The 'OR' gates indicate that any one of the conditions or events indicated that can lead to the top events.

4.2.3 Risk Matrix Ranking

Risk assessment is the process used to determine the likelihood that people may be exposed to injury, illness or disease in the workplace arising from any situations which are identified during the hazard identification process.

Table 4.1 shows the analysis of risks by determining the consequences or severity of risk that may be induced to a worker and the likelihood of each risk that happen in a workplace.

Table 4.1: The Levels of Consequences and Likelihood of Risks

Consequences		**Likelihood**	
Level	Descriptor	Level	Descriptor
1	Negligible	A	Almost certain
2	Minor	B	Likely
3	Critical	C	Possible
4	Catastrophic	D	Unlikely

The level of catastrophic indicate the condition that is most likely to cause death or loss of facility whereas level critical refer to the severe injury, severe occupational illness or major property damage. Level minor means could cause minor injury or minor occupational illness resulting in lost work for days or minor property damage. Negligible level indicates the hazards may probably not affect Safety & Health of the workers.

The ranking of the likelihood indicates the probability of each risk occurred. Level A means the risk very likely to occur immediately when exposed which could happen frequently. Level B means could occasionally occur in time or a short period. Level C means probably will occur in time. Level D means unlikely to occur.

Once the likelihood and consequence of each hazardous event or situation has been decided, the risk are rated using the following table. The grid shows in **Table 4.2** is use to evaluate and identify the levels of risks.

Table 4.2: Semi-quantitative Risk Matrix

	Consequences			
Likelihood	Negligible- 1	Minor- 2	Critical- 3	Catastrophic- 4
A-almost certain	Medium	High	High	High
B-likely	Medium	Medium	High	High
C-possible	Low	Medium	Medium	High
D-unlikely	Low	Low	Medium	Medium

Table 4.2 above gives a clear view in determining the importance of risk level at the identified hazardous workplace. The information in the table above is used for all risk assessment. The system gives a simple way to determine the relative importance of risks. It takes into account the consequence (severity) and the likelihood (probability) of the event occurring. The selected foundry has increased the categories of the account of numbers exposed to the hazard as well as the duration of exposure. However, the more precise the definitions, the more it will be necessary to process accurate predictive data.

CHAPTER 5

RESULTS AND DISCUSSION

In general, workplace hazards can be divided into six groups. They are physical hazards, chemical hazards, ergonomic hazards, radiation hazards, psychological hazards, biological hazards and plant hazards.

Hazard is the potential to cause harm to a person or to the natural environment. Hazards may arise from the working environment, the plant or surrounding equipment, substances, and the work systems.

Based on the results of the study conducted, the safety and health aspects (HIRARC) of the selected steel foundry are determined.

The company has shown an initiative commitment to the Environmental Health and Safety (EHS) performance. A tour visit is conducted to the company as a walk through survey. The company has it own Environmental Health & Safety committee, continuously enhances the health and safety issues in the foundry.

5.1 HAZARD IDENTIFICATION

The process of hazard identification can also assist in, revealing hazards which were overlooked in the original design, and also assist in the installation of plant, equipment, operating procedures and setting-up of associated work systems. Besides that, it can also detect hazards which have developed after the plant, equipment, other resources or work system has been established and highlighted any ergonomic problems associated with the operating procedures.

The results of the analysis method are as following:

5.1.1 Observation and Interview

A comprehensive observation has been conducted in the foundry. During the research period being carried out in the foundry, an interview session has been successfully conducted with the Foundry General Manager.

Initially, the workplace looked clean and well organized. The employees were dressed neatly and they wear proper personal protective clothing while they are performing their work such as the heat protective suits, protective face shield and gloves.

They were prohibited to eat, drink and smoke during working time. A rest room was prepared for the workers to take a break. They have to remove their protective clothing and wash their hands, before leaving their workplace for lunch or break.

In the selected foundry, the washing facilities were conveniently accessible and not exposed to contamination from the workplace, and safe drinking water was provided and readily accessible for all workers.

Besides, the working environment was well equipped and structured. Each worker occupied their own space. The ventilation systems were also effective, as along the visit, there awere no any pungent or unpleasant odors. By observation, the workplace was clean and safe overall.

However, it was observed that, safety signs were not being posted at the workplace as a post of reminder and warning about possible dangers to the workers. Besides, it was noticed that there were insufficient sign board inside the foundry as well.

An interview session has been successfully conducted with the Foundry General Manager. According to the manager, the foundry has its own Health & Safety Committee. Besides, the foundry also ensured that all activities were performed in a manner that considers the health and safety of employees, contractors and the general public with no adverse impact on the environment.

The company continued to comply with all applicable laws and regulations relating to the environment occupational safety and health. The company is committed to:

- Provide healthy and safe work areas, certified equipment and work procedures for employees and contractors.
- Provide adequate training to all employees and contractors in environment, health and safety issues relating to their work.
- Regularly review work areas and practices to improve environment, health and safety.

The General Manager managed the foundry and he is assisted by the Administration Manager. The general manager is immediately responsible to the Foundry board of Directors in all aspect of business including safety and health. A dedicated management organization governed the foundry's day to day operations. **(Organization Chart- Appendix VII)** The main stream business effectiveness is closely monitored by the operations and production manager, who ensuring a close relationship between management and the Executive Directors.

As for safety and health, an in-house safety and health committee is formed. The committee worked independently and reported directly to the General Manager. Its main roles were to control and evaluate major hazards identification.

As being the highest ranking personnel of the Foundry, the general manager lead the foundry matters in compliance with the Safety and Health legal matters, (CIMAH reg.5.sub.reg. (1) OSHA ACT 1994 Obligation of Manufacturer).

In compliance to Section 30 OSHA Act 1994, Establishment of Safety and Health Committee, the general manager himself chaired the bi-monthly Safety and Health meetings held to control and evaluate matters related to Occupational Health and Safety hazards arising at the workplace.

5.1.2 Safety Audit Checklist

Safety auditing is a structured process of collecting independent information on the efficiency, effectiveness and reliability of the total health and safety management system and drawing up plans for corrective action.

The main objectives and purpose of the Safety Audit are:

- To maintain a safe and healthy work environment through hazards recognition and removal.
- To ensure that employees are following proper safety and health procedures while at work.
- To determine which operations meet or exceed acceptable safety and healthy standards.
- To maintain product quality and operational profitability.

The audit process involves the process of collecting information about the health and safety management system and making judgements about its adequacy and performance.

In the selected foundry, a defined report from the audit team namely, summary of audit **(Appendix V)** on the findings of the audit is submitted on completion of each audit to the health and safety committee of the foundry. The report highlighted areas where compliance were being achieved, and offering praise where necessary.

Safety and Health audit or inspection in the foundry is carried out not only by the Safety and Health Committee members but also by management and supervisory staffs. Auditing is a formal preparation, hence documentation is carried out as a procedure once in six or twelve months. According to the general manager, who is the general manager of foundry, this new concept will be a continuous event conducted by the operators in every department in the foundry.

In this study, a safety audit checklist is utilized to inspect the health and safety aspect in the foundry. The result of the checklist which was carried out in the selected foundry is given in **Table 5.1** as below.

Table 5.1: Result of Safety Audit Checklist carried out in The Selected Foundry

DESCRIPTION	YES	NO	REMARK
GENERAL CLEANLINESS			
1. Is the layout designed to facilitate order and cleanliness?	X		
2. Are aisles, passageways, transport areas and exits clearly marked and free of obstacles?	X		
3. Are special areas set aside for storage of raw materials, finished products, tools and accessories?	X		
4. Are there racks for hand tools or other necessary items above work tables?		X	
5. Are there under bench slots or other spaces for storage of small personal belongings?	X		
6. Are receptacles for waste and debris in convenient locations?	X		
7. Are floor-covering materials suitable for the work and for cleaning?	X		
8. Are there screens or simple devices to prevent deposits of oil, liquid wastes or water on the floors?	X		
9. Are there drainage channels for waste water?	X		
10. Are there special groups of people to carry out day-to-day cleaning and weekly or monthly cleaning?	X		
11. Have arrangements been made to remove finished goods and wastes?	X		
12. Is there a clear assignment of duties for maintenance and repair of work premises, particularly stairs, walkways, walls, lights and toilet/washing facilities?	X		
MACHINE GUARDS			
1. Are the operators' hands, fingers and bodies kept safely away from the danger areas when a machine is being operated?	X		
2. Are starting and stopping controls within easy reach of the operator?	X		

3. If operators are not within sight or hearing distance or other workers, is an alarm device provided in case of an accident?	X		
4. Is there an effective system for disconnecting and locking out the machine from its power sources when guards are removed during maintenance?	X		
5. Is the company following all local or national requirements for machine guarding and any special rules for guarding of hand and portable powered tools?	X		
6. Are there proper guards or safety devices attached to dangerous moving pats of machines and power transmission equipment?	X		
7. Are guards installed without interfering with visibility, production or maintenance?	X		
8. Are machines well maintained?	X		
LOCAL EXHAUST VENTILATION			
1. Any chemical odors or see dust building up near the hood or machines?		X	
2. Is the hood close enough to the place where air contaminants are being released?			NA
3. Does the hood pull contaminants in the proper direction away from the worker's face rather than past it?			NA
4. Does the amount of clean air brought into the system equal the amount exhausted?			NA
5. Are clear passageways provided and marked?	X		
PERSONAL PROTECTIVE EQUIPMENT			
1. Has all protective clothing (masks, helmets, gloves, eye protectors, overalls, boots, aprons, etc.) been personally fitted and issued?	X		
2. Are protective clothing items immediately replaced when damaged or lost?	X		
3. Are protective clothing and equipment of good quality and the correct type for the job being done?	X		

4. Are respirators handled carefully? Is the type of respirator correct for the conditions?	X		
5. Have workers been properly trained in the use of PPE?	X		
6. Is all PPE provided to workers free of charge?	X		
7. Is protective clothing only worn for limited periods of time?		X	
8. Is PPE inspected, cleaned and maintained by management?	X		
9. Are workers expected to take contaminated clothing home?		X	
10. Does the use of PPE create other risks? (reduction vision, mobility or hearing)		X	
11. Are respirators approved by recognized standard-setting institutions?	X		
PERSONAL HYGIENE			
1. Eat in locker rooms, working areas, washrooms or where dangerous materials are used?		X	
2. Wash hands and the exposed parts of body regularly and take daily baths or showers?	X		
3. Wear proper clothing and footwear?	X		
4. Clean working clothes, towels etc. with the help of special laundry?		X	
5. Is there an adequate supply of safe drinking water in workplace?	X		
6. Are there clean sanitary facilities for washing and separate toilets for women?	X		
FIRST-AID AND FIRE-FIGHTING EQUIPMENT			
1. Is adequate first-aid equipment provided and checked regularly?	X		
2. Are trained and adequate first-aid personnel present during all shifts?			NA

3. Is adequate fire-fighting equipment provided?	X		
4. Is fire-fighting equipment maintained in a usable condition?	X		
5. Are locations of fire-fighting equipment posted?	X		
6. Have workers been trained in the use of fire-extinguishing equipment?	X		
7. Are emergency telephone numbers posted?	X		
LABELLING, INFORMATION AND EMERGENCY MEASURES			
1. Are containers with chemicals in them labeled indicating the contents and warning of the hazard?	X		
2. Is necessary information on safe handling and first-aid measures given on the label or as written instructions?	X		
3. Have workers been trained on health risks and safe handling of hazardous chemicals?	X		
4. Does training include information on safe storage and transportation of chemicals?	X		
5. Are emergency showers and eye-wash stations available at the worksite?	X		
METHODS OF CONTROL			
1. Does it adequately control the hazard?	X		
2. Does it allow workers to do their job comfortably without creating new hazards?	X		
3. Does it protect every worker who may be at risk of exposure to the hazard?	X		
4. Does it eliminate the hazard from the general environment as well as the workplace?	X		
5. Are less toxic chemicals used whenever possible?	X		
6. Are works processes used which minimize the release of gases, vapors, dusts or fumes?	X		
7. Are the sources of the release of gases or vapors completely enclosed?	X		

8. Are workstation locations chosen so that exposure to gases, vapors, dusts or fumes is minimal?	X		
9. is there a proper procedure storage and for disposal of hazardous waste?	X		

Based on the checklist, the company has provided a clean and well maintained environment to the employee. The checklist comprised of eight aspects including: general cleanliness, machine guards, local exhaust ventilation, personal protective equipment, personal hygiene, first-aid and fire-fighting equipment, labeling information and emergency measures. Methods of control are satisfactory as it is ideal to promote and enhance a safe working environment. The following discussion will further discuss the details of each aspect in the foundry.

5.1.2.1 Personal Protective Equipment

Personal Protective Equipment (PPE) is only essential as a supplementary protection against exposure to hazardous conditions in the production of iron and steel. Personal protective equipment only being use where the safety of workers cannot be ensured by other means, such as eliminating the hazard, controlling the risk at source or minimizing the risk.

In the selected foundry, the employer determined the type of PPE used bye the workers, depending on the type work and risks. This was done in consultation with the workers and their representatives. The equipments were provided and maintained by the employer, without cost to the workers.

To continuously improve the system, more safety equipment and PPE such as face shield, goggles, safety spectacles, respirators and hand gloves are frequently purchased and supplied to the staff at free of charge. Also more safety signs have been put up, while fume cupboards and solvent storage are also being upgraded.

From the survey, it was found that, the PPE were selected based on the characteristics of the wearer and additional physiological load or other harmful effects caused by the PPE. It is used, maintained, stored and replaced in accordance with the standards or guidance for each hazard identified at the facility and according to the information given by the manufacturer. Different PPE and their components are compatible with each other when they are worn together. Items of special PPE are used in foundry, proximity to molten metal, to protect the wearer from heat and withstand splashes of molten metal.

The foundry regularly checks and maintains the PPE to ensure workers protection. Personal protective equipment is appropriately selected, individually fitted and workers trained in their correct use and maintenance.

The selected foundry provided the items of PPE which comply with the relevant national standards and criteria, they also approved and recognized by the competent authority, to be free from any hazardous substances, such as asbestos.

Before reissuing the clothing or equipment, the foundry provided for the laundering, cleaning, disinfecting and examination of protective clothing or equipment which has been used and which are hazardous to health. Protective equipment that may be contaminated by materials hazardous to health is laundered, cleaned or kept at the workplaces, at no cost to the worker. Furthermore, workers were not required taking the contaminated clothing home.

In certain circumstances, personal protection of the individual may be required as a supplement to other preventive action. It is not regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures.

5.1.2.2 Health Assessment

In the selected foundry, health assessment form part of a comprehensive occupational health and safety strategy. The new recruited employees need to undergo a health assessment. And the employees' medical records are kept confidential. It is particularly valuable to be able to relate to employees' health and illness data to examine the exposure levels in the workplace.

5.1.2.3 Working Hours

Daily and weekly working hours is arranged to provide adequate periods of rest, as prescribed by the national laws and regulations which include:

- short breaks during working hours, especially when the work is strenuous, dangerous or monotonous, to enable workers to recover their vigilance and physical fitness

- sufficient breaks for meals
- daily or nightly rest
- weekly rest.

Besides, extended workdays (above eight hours) are contemplated only if the nature of the work and the workload permit or the shift system is designed to minimize the accumulation of fatigue.

The foundry production operated from 0800 to 1700, inclusive of two hours of overtime which is optional. The daily office staff commenced work regularly at 0815 and finished at 1715 with Saturdays being half-a-day. And with one hour of lunch break.

5.1.2.4 Smoking at Work

A smoke-free workplace policy is established in the selected foundry, in consultation with workers and their representatives, for the enclosed area of the facility.

This policy is implemented and enforced by the employer since 2006 to reduce unwanted accidents in the foundry in compliance to laws and regulations.

These policies also specify where smoking may be permitted during agreed rest breaks without creating hazards for other workers or additional hazards in the external areas of the facility.

5.1.2.5 Social Protection

In accordance with national laws and regulations workers should be covered by an employment contract, entitled to adequate workers' compensation in the event of an occupational injury or disease and be entitled to survivors' and dependants' benefits, and have access to appropriate services for rehabilitation and return to work.

The selected foundry is in compliance with the Malaysian Labor Laws and Regulations, (Employees' Social Security Act, 1969 and the Employees' Social Security (General) Regulations 1971, Employees Provident Fund Act 1991), performing their part by providing SOCSO and EPF for their workers.

5.1.2.6 First Aid

Due to the nature of foundry work, medical emergencies such as burns, heat stroke, eye injury or carbon monoxide poisoning are sufficiently probable to warrant the development of special procedures and the provision of emergency equipment.

The first-aid boxes are provided by the selected foundry. The content of the first-aid boxes consists of medicine and equipments which is appropriate to the risks of the workers. A written instruction on the first aid procedure and the personnel in charge **(Figure 5.1)** of the selected foundry is well organized and stated.

Beside, the emergency response procedures for fire-fighting are documented. The company provides equipment such as emergency eyewash station, chemical emergency escape hood, chemical spill response kit and portable resuscitator for use during chemical emergencies. The first aid box supplies are checked as in the monthly and annual inspection checklists. Antidotes for accidental poisoning by chemicals are also prepared. The refresher courses on a quarterly basis are arranged for first aiders who had completed their training in first aid.

The fire extinguishers are inspected every six months while the maintenance services are carried out by a private company once in every two years.

5.1.2.7 Escape and Rescue

An appropriate escape and rescue plan is prepared in foundry. There are adequate numbers of emergency exits in the foundry. The routes to the emergency exits are free of any materials.

The emergency exit sign is visible in the nearest pathway of every post. Rescue equipment include items such as, protective clothing, blankets for fire-fighting, fire extinguishers, ropes, harnesses and specialized stretchers to move the victim are prepared as part of the rescue aids.

An Emergency Response Plan (ERP) is prepared by the selected foundry to minimize the effect of an accident, includes:

- Protection of workers and plant property during an emergency
- Emergency shutdown and evacuation procedures
- Containment or minimization of effect of the accident on the environment
- Roles of the response team
- Interaction with community services (Police, Bomba, DOE etc) to develop a full emergency planning; and
- Regular drills.

The foundry provides necessary and most recent information, as well as internal communication and coordination, to protect workers in the event of an emergency at the worksite.

Alarms are installed and capable of being seen and heard by everyone, periodic emergency drills is performed from time to time.

5.1.3 Survey Form

To further inspect the workplace health and safety aspects of the foundry, the discussion is based on the overall result of the survey form gathered from the feed back of the workers of the selected foundry.

A Workplace Health Survey Form consists of 33 general descriptions of the general health and safety aspects in the foundry. This survey form is utilized to assess the safety aspects in the workplace. It was distributed to workers in the selected foundry. The total of 300 workers took part in accessing their general workplace.

The discussion focuses on the summary of responses which based on the 50% of the operator's total feedback. Most of the workers agree that the company has provided a good and safe workplace area with adequate welfare facilities. Besides, they also agreed that the management level is putting effort to upgrade their workplace by minimizing the potential risk of hazards, such as the introduction of the automation process.

Based on the feed back of the survey, the company is striving to continuously maintain a safe workplace for the employees by giving them training and information to cope with any possible hazards at the workplace.

The company also implemented skill training such as EHS management system training and internal audit training.

5.1.4 Accident Report and Investigations

As a starting point for any accident investigation, we must first examine the work procedure deviation from the correct routine. In the selected foundry, factors causing such deviations include elements, such as, incorrect work procedures, blocked aisles or passages, and chemical spillage and not to mention the disorder at the workplace.

To further inspect the safety at the workplace of the selected foundry, the seven main manufacturing process lines are audited. **Table 5.2** shows the results of major accidents reported in each process line in the foundry (for the year of 2008).

Table 5.2: Report of Potential Major Accidents identified in the process lines of The Selected Foundry

No.	Process Line	Hazard Description	Potential Hazard	Hazard Category
1	Raw Material Procurement	High temperature exposure Thick dust inhalation Injury to body	Scrap cutting machine Scrap cutting machine Crane movement	Safety Health Safety
2	Steel Melting	High temperature exposure Thick dust inhalation Injury through physical Injury to eye	Induction furnace Induction furnace Induction furnace Induction furnace	Safety Health Safety Safety
3	Casting	Inhalation of dust Contact through skin Injury through physical Injury to eye	Mould machine Mould machine Crane movement Mould machine	Health Health Safety Safety
4	Machining	Hearing loss Head injury Injury to eye	Boring machine Crane movement Welding	Safety Safety Safety
5	Heat Treatment	High temperature exposure Dust inhalation Contact through skin	Burner machine Treatment machine Burner machine	Safety Health Health
6	Product Inspection	Injury through physical Falling objects Dust inhalation	Crane movement Stacked products Lorry movement	Safety Safety Health
7	Painting & Packing	Vapour inhalation Contact through skin Falling objects	Painted product Dust of mineral Stacked packing	Health Health Safety

For an effective accident investigation to be carried out, the various deviations need to be indicated first. Three main contributing factors will be: lack or faulty designed equipment leading to sequence of unexpected result in an accident; working conditions influences indirectly through noise, temperature, ventilation and lighting; and people.

In the selected foundry, the management found a committee and appointed a group of staff to inspect the occurrence of accidents in the foundry. This committee is lead by two leader, one from the management representative and the other one from the worker representative. The leaders is responsible to ensure all accidents are reported and investigated, ensure all documentations are in order and ensure all corrective actions are taken. All occurrences of accidents and action taken were reported to the leaders by the supervisors. **Figure 5.1** shows the flow and responsibility in an accident report and investigation carried out in the selected company.

Flow	Responsibility
Injury to report to supervisor	Victim or witness
↓	
Medical treatment for the injured person	First aider
↓	
Interview the injured / reporting person	1st Supervisor 2nd Safety & Health Officer
↓	
Site visit	Accident sub committee
↓	
Fill up Investigation Form & JKKP Form	Management Officer
↓	
Report verification	Safety and Health Committee
↓	
Carried out corrective action	Department Head
↓	
Return to Admin Office	Management Officer
↓	
Register accident in JKKP 8	Management Officer
↓	
Submit JKKP 6 and JKKP 8 to DOSH	Management Officer

Figure 5.1: Accident Report and Investigation Flow Chart of The Selected Foundry

5.2 RISK ASSESSMENT

"Risk" means a combination of the severity and likelihood of harm arising from a hazard. The risks arising from the hazards are assessed and rated by using the following factors. Records and other data collected during the hazard identification process shall assist this process.

5.2.1 Job Safety Analysis

Job safety analysis is to inspect and analyze the health and safety aspect of workplace and identify the hazards in each work area during the walk-through survey. Hazard Assessment form is utilized to perform the job safety analysis in the selected foundry.

In this study, the manufacturing process of the selected foundry consist of 7 main tasks (which include raw material procurement, steel melting, casting, machining, heat treatment, product inspection, painting & packing). Each work flow is analyzed to identify the cause and type of major hazard that incurred during the manufacturing process to the workers, additionally, the hazard control measure is assigned as well.

A hazard analysis was performed based on the summary of the hazard assessment form after completed the assessment. Analysis focus on the level of risk for each hazard category based on the observation and the results of the hazard assessment form and will identify the appropriate control measures, in order to enhance the significance level of workplace safety. The following **Table 5.3** shows the Hazard Assessment Form completed in the selected foundry.

Table 5.3: Hazard Assessment Form

TASK	IDENTIFIED HAZARDS	HAZARD CONTROL MEASURES
1. Raw Material Procurement (Hazardous substances and dangerous goods)	o Hazardous substances can enter the body through inhalation, skin contact or by mouth. o Dangerous goods that are not stored and handled properly have the potential to cause fire, explosion, corrosion, radioactivity, toxicity, asphyxiation or environmental harm.	• Ready-cut and sized from material to avoid dust production from cutting material on site. • Less hazardous substances, forms or processes, for example using granular form instead of powder. • A separate restricted access room for the mixing and use of epoxy resins in pattern making. • Exclusion zones around work areas to restrict access. • Local exhaust ventilation to remove contaminated air directly from the source. • Shift or work rotation, safe storage and disposal of hazardous substances, strict personal hygiene practices, proper washing facilities and regular maintenance of ventilation and exhaust systems. • Personal protective equipment where exposure to

		hazardous substances cannot be prevented or reduced by any other way. • Identification of dangerous goods and site classification. • Provision of information, training and supervision. • Control of ignition sources where flammable atmospheres may exist. • Segregation of incompatible goods. • Separation of dangerous goods from ‘protected places’. • Spills management. • Provision of safety equipment and personal protective equipment • Use of documented safety management systems. • Store two incompatible goods at least 3m apart. • Where the goods could react violently, store them at least 5m apart or • Use fire rated, vapour proof, task-specific physical barriers.
2. Steel Melting (Molten metal)	○ Workers who work with or near molten metal could come into contact with metal splashes and electromagnetic radiation. ○ Splashes, sparks,	• Barriers and other suitable shields are used or installed to protect workers against molten metal splashes and electromagnetic radiation.

	radiant heat and radiation from molten metal can result in serious burns and eye damage, including cataracts.	
3. Casting (Noise and vibration)	○ High noise levels from vibrator systems to compact moulding sands in moulds, arc/air gouging and fettling activities and particularly those of short duration, such as impulse or impact noise, are present in many foundries and are capable of causing damage to hearing. ○ The health effects of vibration include blood pressure and heart problems, nervous disorders, and blanching and numbness in the fingers.	noise control: • Introducing a 'buy quiet' policy • Training workers, for example fettlers, about noise issues • Sign-posting noisy areas • Maintaining equipment • Reducing the amount of time operators spend in noisy areas through job rotating to reduce and control individual exposures from noisy work, for example, arc/air gouging and fettling activities. vibration control: • Purchasing vibration reduced equipment • Using tools with vibration dampers • Avoiding prolonged use of vibrating equipment • Providing protective gloves.
4. Machining (Plant, machinery and electricity)	○ Cuts and lacerations, amputations and burns are some of the injuries that can result from poor maintenance, repair, guarding and use of plant and machinery such as,	• Replacing existing machines with ones that have better guarding • Enclosing or guarding dangerous machines • Neutralizing potential energy sources during maintenance and repairs

	wood cutting and finishing machines, mechanical handling devices and grinders. ○ Electricity can cause death or serious injury.	• Providing personal protective equipment • Prohibiting work on live equipment or installations without proper safeguards in place. • Providing safety switches • Prohibiting the use of double adapters or piggyback plugs • Using insulating gloves.
5. Heat Treatment (Heat)	○ Dehydration, ○ heat cramps, ○ heat exhaustion ○ heat stroke ○ eye cataracts (infrared, ultraviolet radiation) which can be emitted when pouring white hot metal.	• Using insulation and shielding to reduce radiant heat emissions from hot surfaces and plant. • Using local ventilation, spot coolers, blowers, fans, air-conditioning and flues to reduce the air temperature. • Automating and mechanizing as many tasks as possible. • Putting in place administrative measures, including rescheduling hot work, giving regular work breaks in cool areas, job sharing and rotation, and acclimatization. • Providing access to clean, cool fresh water. • Using personal protective equipment such as eye wear, heat reflective clothing, gloves and footwear.
6. Product Inspection (Manual tasks)	○ Manual tasks are common in most	• Redesigning the work processes or the

	areas in a foundry including: -Pattern and core making -Moulding and fettling shops -Stores and dispatch -Inspection and surface coating areas. ○ Workers lifting loads, working in a fixed position or doing repetitive work can, suddenly or over time, damage their upper and lower back and shoulders.	physical work area • Using mechanical lifting devices • Providing task-specific training • Using personal protective equipment • Ensuring tools and equipment are regularly maintained • Ensuring adequate numbers of workers to do the work • Giving workers adequate rest breaks and work variety.
7. Painting & Packing (Gases, vapours, dust and fumes)	○ Exposure to gases ammonia, chlorine, nitrogen, toluene and formaldehyde can result in respiratory irritation, asthma and watery eyes. ○ Exposure to silica or fumes can result in Chronic diseases (such as silicosis, lung or nasal cancer) ○ High airborne concentrations of wood dusts can also contribute to an explosion.	• Using wet or vacuum methods, or brushes to remove loose dust or sand rather than compressed air. • Enclosing major emission points, such as conveyor belt transfer areas. • Installing high-energy scrubbers and bag houses. • Using canopy hoods or other special hoods near the furnace doors to capture contaminants and re-route them through an emission control system. • Continuous monitoring of carbon monoxide levels in the work area to ensure airborne contaminants are within the Workplace Exposure Standard (WES).

		• Providing respiratory protection appropriate to the contaminant.

The main hazards in the foundry industry included airborne contaminants (dusts, gases, vapours and other contaminants), skin irritants, noise and vibration, heat stress and physical injuries.

When considering the hazards associated with any workplace, it is essential to understand the relationship between ‘hazard’, ‘exposure’ and ‘risk’. ‘Hazard’ is the potential for an agent or process to do harm. ‘Risk’ is the likelihood that an agent will produce injury or disease under specified conditions.

Health effects can only occurred if a worker is actually exposed to the hazard. The risk of injury or disease usually increases with the duration and frequency of expose to the agent, and the intensity/concentration and toxicity of the agent. Toxicity refers to the capacity of an agent to produce disease or injury. The evaluation of toxicity takes into account the route of exposure and the actual concentration of any agent in the body.

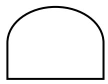
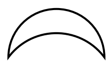
Hazards include biological, chemical, physical, mechanical and ergonomics not to mention psychological hazards. The standard methods used in identifying hazards include walk through inspection, material safety data sheets, accident reports and investigation, workplace health survey form, safety audits and atmospheric and chemical monitoring, hazard assessment form. It is important for personnel carrying out hazards identification to be suitably skilled and knowledgeable in process and capable of understanding operational instruction, label and MSDS (Material Safety Data Sheet).

All these hazards which have been identified are accessed using semi-quantitative risk matrix as in **Table 4.2** and prioritized by using Hazards Log and Risk Assessment as mentioned in **Table 5.5**. And the hazard identified in each of process flow and its control measures are analysed using Job safety analysis method as summarized in **Table 5.3** Hazard Assessment Form.

5.2.2 Fault Tree Analysis (FTA)

A Fault Tree diagram contains two basic elements. 'gates'and 'events'. Gate allows or inhibits the passage of fault logic up the tree and shows the relationships between events needed for the occurence of a higher event.

This method of hazard evaluation visually demonstrates the interelationship between equipment failure, human error and environmental factors that can result to accident. FTA is a backward analysis. A system hazard or top event is the starting point and the study traces backwards to find the possible causes of the hazard.

Analysis is restricted to identifying system elements and events that can lead to the specified accident. By using the probabilistic risk assessment technique, probabilities of events occurring can be calculated. The 'AND' gates, represent by the symbol  are used when the existence of all conditions or events indicated must occur for the tip event to occur. The 'OR' gates represent by the symbol  indicate that any one of the conditions or events indicated that can lead to the top events.

A Fault Tree Analysis used to assess the potential hazard that occurred during the manufacturing process in the foundry. **Figure 5.2** shows the fault tree analysis carried out in the foundry.

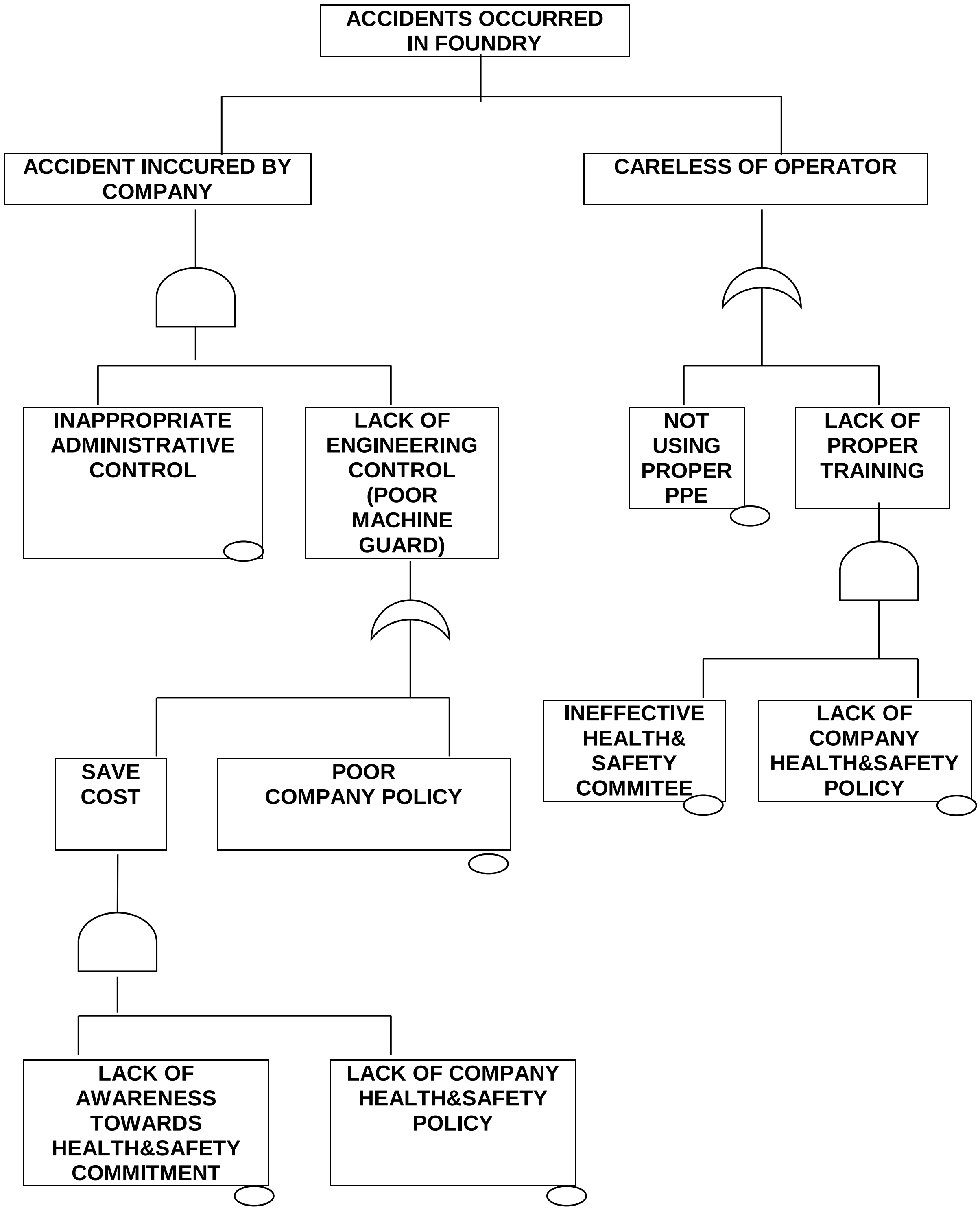


Figure 5.2: Fault Tree Analysis

Based on the FTA analysis, the main accidents occurred in the foundry mainly induced by high temperatue and thick dust inhalation. Therefore, accidents were either incurred by the company or due to the careless of the operators themselves.

Table 5.4 shows the major accidents reported in the selected foundry and the recommended control measures. However, the accidents can be diminished by using proper PPE, giving proper training to the employees, or by applying the appropriate engineering and administrative control.

Table 5.4: Accidents Reported in the Selected Foundry and Control Measures

Identified Accidents	Control Measure Recommendation	Types of Control Measures
High temperature	• Usage of exhaust ventilation or LEV(local exhaust ventilation) • Heat resistant clothing worn at specific areas • Job rotation at effected location or departments	Engineering control Personal protective equipment Administrative
Thick dust inhalation	• Quality respirators • Fabrication of Local Exhaust System • Engineered guards	Personal protective equipment Engineering control Engineering control

The lack of company safety and health policy and poor commitment of health and safety committee were the main contibuting factor to the occurrence of the accident in the selected foundry.

Safety committees can be useful for communicating safety issues, provided that members are trained and are supported senior management. There need to be both a senior management committee, responsible for developing safety policy, and an employee committee to oversee policy implementation once it approved by the management (Robotham 1998).

Besides, the aspect of the company to minimize the financial cost is also another factor which likely to favour the occurrence of accidents. The need for management action may also be expressed from an economical viewpoint. The cost of an injured worker can be measured in terms of lost time, lost production, worker's compensation and rehabilitation costs and in severe cases, the cost, includes the replacement of the employee and the training of a new worker. With regard to the considerable potential costs to the business, it is economically viable for management to take preventative health and safety measures for the company policy.

In the case of the foundry, it is necessary to adopt a risk management approach to ensure the health and safety of the workers, specifically through machine guarding, administrative control with regards to the foundry. It is also important to consider the necessity for risk management in terms of long-term decreases in costs related to injury.

It can be seen from the relevant accident investigation report that the direct causes of the accident occurring in the foundry were lack of effective machine guarding, and lack of training and instructions for the operator. Both of these are managerial responsibilities which lack company's health and safety policy.

After discussion with a number of employees on the work floor, it was established that their attitude towards risk prevention was not a positive one. They expressed a belief that fully enclosed guarding of the equipment or using the PPE would interfere with operation. It appears the correct procedure has not been adequately communicated to the employees, or that the employees have not fully understood the inherent danger of not complying with instructions.

However, accidents were induced, as a result of the prevention and caution step which ignored by the management level such as lack of engineering control or lack of proper training of the employee to handle the machine and deal with the toxic chemical.

Despite rigorous safety standards and practices applied in industry, accidents were still occurred form time to time, either due to workers attitude disregarding in the safety procedures or to some exceptional and unforeseen circumstances arising during routine operations. It is sometimes found that the poor company policy or lack of reinforcement of the company towards the health and safety issues is also a contributor to the accidents occurred in foundry.

5.2.3 Risk Matrix Ranking

In the foundry, a Risk Management Assessment Report **(Appendices VI)** is prepared by the health and safety committee after the safety auditing process has been carried out. The report presented in the form of table that prepared by the health and safety committee of the foundry. It is a documentation provided to enhance the efficiency of management practice. The management of the foundry utilizes the summary report to develop risk control strategies or implement further risk prevention.

In this study, to evaluate the risk factors in the foundry, the assigning of relative risk-rankings from severity and probability rankings were done for the foundry, the interpretation of the various risk-rankings is shown in the following table. **Table 5.5** shows the hazards log and risk assessment in the selected foundry.

Table 5.5: Hazards Log and Risk Assessment.

No.	Hazard Identity	Consequence	Likelihood	Ranking Level
1	High temperature exposure	3	3	High
2	Thick dust inhalation	3	3	High
3	Injury through physical	3	3	High
4	Injury to eye	3	3	High
5	Contact through skin	2	3	Medium
6	Falling objects	2	3	Medium
7	Head injury	2	2	Medium

Events assessed as very likely with fatal consequences are the most serious (high risk), those as highly unlikely with negligible injuries are the least serious (low risk). Ratings for each factor and the risk rating are to be recorded in the appropriate columns on the Risk Management Worksheet. When developing risk control strategies, HIGH ratings receive first priority.

The Ranking Matrix was ranked according to its priority as listed below from highest ranking to the lowest:-

1. High temperature exposures
2. Thick dust inhalation
3. Injury through physical
4. Injury to eyes
5. Contact through skin
6. Falling objects
7. Head injury

The highest ranking hazard was temperature exposure factor, prior to the heating of temperatures from 100 up to 1085°C, irrespective of the rate of subsequent cooling effects of tempering. At dangerous temperature interval of this nature from either by heating and holding at this temperature exposure over a long period can lead to serious health effects.

The second highest hazard ranked results from heavy dust inhalation, injury through physical and injury to the eyes.

The results of the personal exposure sampling on dust show that there were high risks of dusty areas in the plant. The dusty work areas pointed out to the production plant. The dust exposure monitoring has confirmed that the following workers exposed, exceed the stipulated permissible limit of $3mg/m^3$ of respirable dust averaged over an 8 hour period:

- Scrap yard – operators
- Sand plant – operators
- Fettling section – operators
- Grinding section – operators

Physical injury poses many of the major injuries such as hand injuries, foot injuries, classified in third as the category of likelihood of risks in ranking of hazards.

The Matrix can be used to help determine the risk ranking of a finding and its associated recommendations. Classification of high, medium or low usually occurred due to the combination of factors.

5.3 Risk Control

"Risk control" is the process of implementing measures to reduce the risk associated with a hazard. It is important that control measures do not introduce new hazards and that the ongoing effectiveness of the controls is monitored.

According to Smith (2000), in many cases a combination of controls will be necessary to reduce the risk to the level required. Managing risks involve the necessary process of preventing the risk from progressing into an incident or attempting to control the risk. Risk control can be most effectively demonstrated using the risk control hierarchy as shown in **Figure 5.3**.

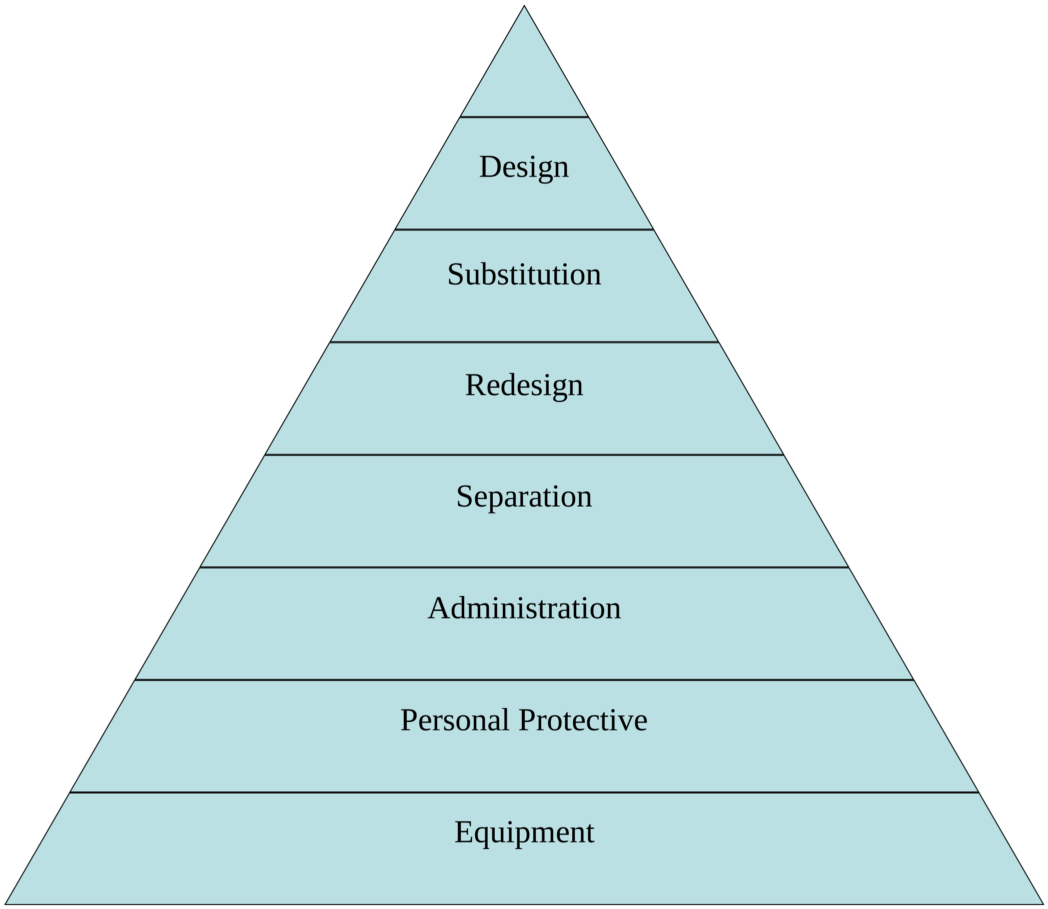


Figure 5.3: Hierarchy of Risk Control

Risk control hierarchy ranks risk control measures in decreasing order of effectiveness. The first level of control option to be considered is whether it is possible to completely eliminate the hazard. If this can be achieved, the associated risks will also be removed.

Where a hazard cannot be eliminated, it will be proceeded to the next level by minimizing the risk, or applying engineering controls. Substitute the hazardous processes or materials with safer ones, such as to modify the plant, isolate the plant or the hazardous aspects in the worksite.

The final level of control measures, include administrative systems and personal protective equipment (PPE) are only be contemplated as supporting measures and not used as the primary level of control. They may be used as temporary measures whilst a more permanent system is being implemented.

Besides, Signs are a cheap and alternate method of risk control. This method of control, although do not prevent the operator from putting themselves at risk, but signs do warn of the dangers. However, signs are also required, by law, to show hazards.

Whichever method of risk control is determined, the aim is ensure that the control does not contribute to the existing hazard or introduce a new hazard to the area.

Whichever method of controlling the hazard is determined, it is essential that an evaluation of its impact on the use of the equipment, substance, system or environment is carried out to ensure that the control does not contribute to the existing hazard or introduce a new hazard to the area. It is also essential that employee concerned be informed about the changes and where necessary provided with the appropriate information, instruction, training and supervision as are reasonably necessary to ensure that each employee is safe from injury and risks to health.

Training and education is crucial for the employees in learning the use of equipment and understanding safety procedures. The cost of the programme would consist a number of hours wages and perhaps a number of lost work hours. It is likely that these costs are lower than the cost of compensation and rehabilitation and the hours likely to be lost in the event of an injury taken place.

The risk control measures implemented for the hazards identified is always the main concern at workplace to protect the workers. The workplace is reviewed on a regular basis, and proper documentation is done to ensure safety.

5.3.1 Health & Safety Committee

The selected foundry has formed a health & safety committee compliance with the Health and Safety at Work Act.

The Act states that it is essential to provide healthy and safe conditions for all employees and workers at work. The Act has a number of important requirements but the most important are the duties laid on employers and employees to cooperate in securing health, safety and welfare of all workers at work. The Act enforces that at every place of employment where five or more people are employed, the employer shall cause a committee to establish to be known as health and safety committee.

The committee is made up of no less than two and no more than twelve persons. In the committee at least half are persons representing employees, they are either elected by the employees they represent or appointed in accordance with the constitution of the trade union of which the employees are members.

The functions of the health & safety committee include:

- Participation in the identification and control of the health and safety hazards within the place of employment
- The establishment and promotion of thealth and asfety programmes for the education and information of the imployees
- The receipt, consideration and dispositon of matters respecting the health and safety of the employees
- Such other duties as many be specified in the Act or the regulations.
- Cooperationg with the employer in identifying and controlling hazards in the workplace
- Maintaining contact with all persons at work and by cosidering for those persons with appropriate education and training in health and safety matters.

In the foundry, the health and safety committee of the company met once bi-monthly to inspect and evaluate the matters of health and safety in the foundry include the Personal Protective equipment usage of employees, the maintenance system of the foundry and any issuew regarding to health and safety. **Figure 5.4** shows the safety and health committee organization of the selected company.

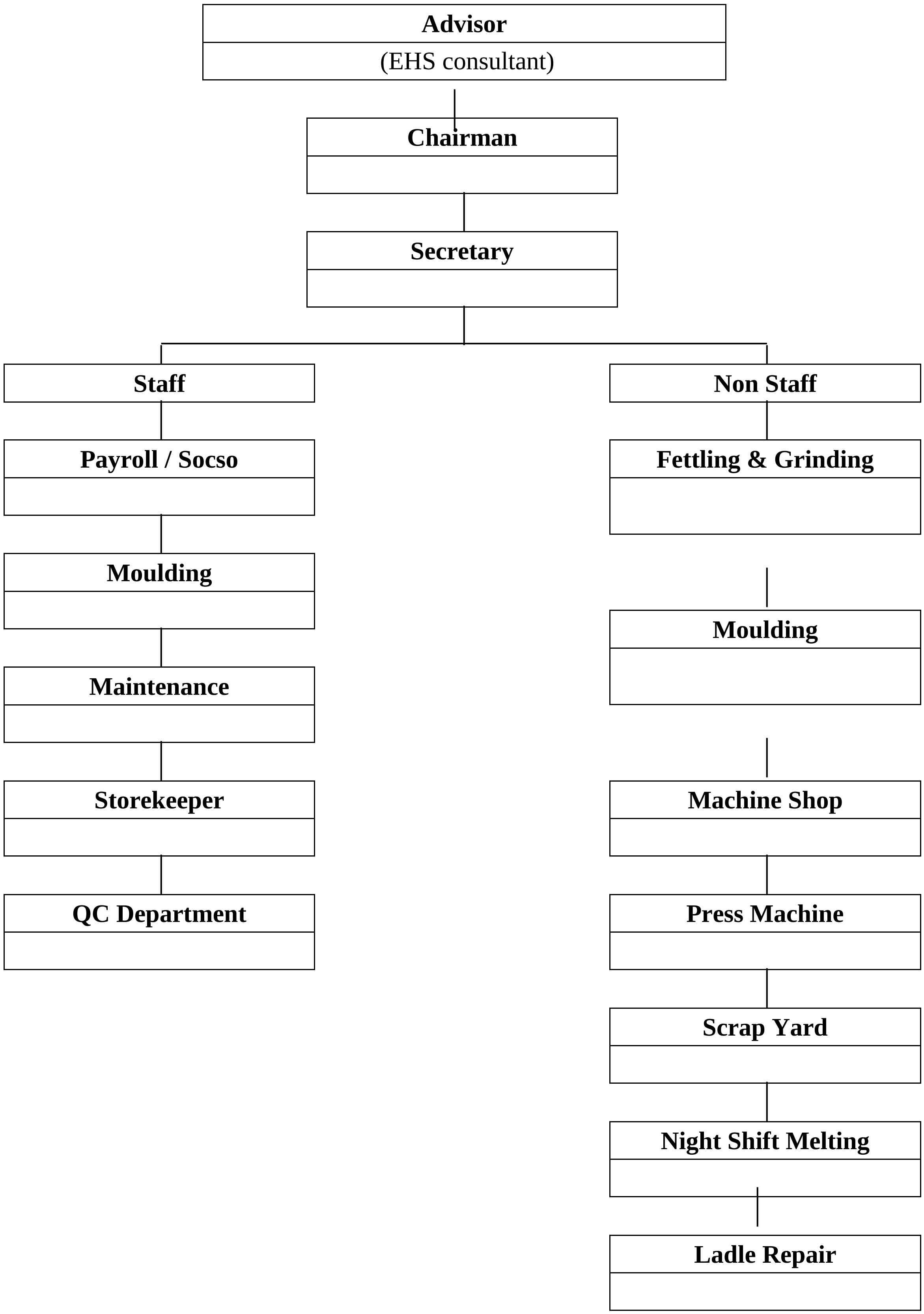


Figure 5.4: Safety and Health Committee Organization of The Selected Foundry.

5.3.2 Education and Training

According to Malaysia regulations, all employees who working with foundry must informed of the hazards and the necessary steps to prevent risks and damage to their health. Employees exposed to contaminants should be trained to follow the appropriate procedures to ensure that they carry out their work so that contamination is reduced. Besides, training help employees to understand the importance of the proper use of all safeguards against exposure to themselves and their fellow workers. Adequate training, in the proper execution of the task and in the use of all associated engineering controls, as well as of any personal protective equipment, is essential as means of safeguarding oneself from all possible hazards.

The selected foundry provided adequate training for its employees. The foundry implemented skill training programmes to educate the workers on the exposure of contamination hazards and the proper use of facilities, clothing and equipment in order to maintain a high standard of personal cleanliness.

They also paid special attention to ensures that all personnel understand the instructions, especially newly recruited employees and those with English language difficulties.

Material safety data sheets were utilized in the selected foundry for the safety usages. Besides, the foundry has formed a health & safety committee who also responsible for personal protective equipment supply, maintenance and training.

5.4 REVIEW

Review is carried out to monitor the hazards and control measures to ensure that no new hazards have been introduced and that the process is working effectively to identify the risks and control the hazards.

Risk assessments were done whenever the circumstances in the workplace change for example,

- when information is obtained about previously unknown design or manufacturing fault, or about previously unidentified hazard
- the design is revised or modified
- there is a change to a risk control measure after a review of its effectiveness
- the system of work associated with the plant is changed
- plant is moved
- ownership of the plant is changed
- there is a change to the work environment
- there is any other change that makes the existing risk assessment irrelevant.

Monitoring frequency is sufficient to provide representative data for the parameter being monitored. Monitoring is conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment.

Monitoring is designed and implemented by accredited professionals. In the selected foundry, the monitoring process is undertaken by the health & safety committee. Facilities also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents.

Monitoring data is analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions to be taken.

Monitoring of the work environment involves the measurement of atmospheric contaminants at selected locations in the workplace (static, positional monitoring). Personal monitoring involves the measurement of atmospheric contaminants in the breathing zone of the individual worker. Biological monitoring involves measurement of the concentration of a contaminant, its metabolites or other indicators in the tissues or body fluids of the worker. In some cases, biological monitoring may be required to supplement static or personal monitoring.

When developing a monitoring program in the foundry, due consideration is given to heat stress, exposure to noise, gases, for example, carbon monoxide, vapours, fumes, for example, zinc and copper fumes, and dusts, for example, silica and olivine sand dusts.

In the control of health hazards due to a specific contaminant, where it has been demonstrated that the exposure of the employee to the contaminant is approaching the unacceptable exposure standard, immediate action must be taken to reduce the health hazard, also intensive monitoring should be continually observed to eliminate health hazards.

Records of the results of any monitoring are maintained and employees are informed of these results.

Table 5.6 shows the proposed review plan prepared by the selected foundry after the bi-monthly Safety and Health meetings to control and review matters related to Occupational Health and Safety hazards arising at the workplace.

Table 5.6: Proposed Review Plan of The Selected Foundry

Method of review	Frequency of review
Effective local exhaust ventilation provided	Bi-monthly review and inspection by immediate supervisor
Protective clothing checks	Daily checklist by line supervisor
Training on PPE correct usage	Weekly checklist by line supervisor
Renewal of expired PPE	Bi-monthly review and inspection
Maintenance and inspection	Bi-monthly maintenance checklist by maintenance personal
Maintenance	Weekly inspection by supervisory team

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

Based on the research and analysis those have been done in this study, There were five categories of common hazards that can be identified in the selected foundry. They were physical hazards, chemical hazards, radiation hazards, psychological hazards and biological hazards. The hazards included high temperature exposures, thick dust inhalation, injury to physical body, exposure to hazardous substance, radiation risks and etc. They were identified and analyzed in the Hazard Assessment form.

On analyzing the corresponding results of the checklist, it indicated accidents still occur form time to time, which either due to workers attitude and unforeseen circumstances during routine operations or the foundry's poor Health and Safety Policy. However, overall appeared that health, safety and environmental management system in this foundry was up to their concern.

Management was taking responsibility towards the safety and health management system in its foundry. They were monitoring their risk assessment program using variety of approaches. The foundry has it own Environmental Health & Safety committee, continuously enhances the health and safety issues in the foundry.

The management of the foundry was striving to put in extra concern on its occupational, safety and health management, hazardous substance communication, employees programs for safety and health, first aid facilities and personal protective equipment, in order to comply with the country enforcement act.

The foundry's occupational, safety and health policy was communicated well, safety committee is active, health, safety and environmental training programs are conducted, but yet to the satisfactory level which still resulted in the lack of employee knowledge and awareness on health, safety and environmental issues.

In conclusion, the selected foundry provided and maintained health and safety practices at the workplace for its employee. The foundry provided adequate information and training to all employees. Both managerial level and employees were also seen to be cooperating as a team to ensure the safe systems at workplace. The selected foundry has shown an initiative commitment to the EHS performance.

6.2 RECOMMENDATION

6.2.1 Hazardous Impact on Organization

Hazardous impact unfortunately is always a detrimental image on the company. It can be also said for the selected foundry if major accidents have taken place in the event.

The pattern of work organization, which has a direct influence on job content, largely determines whether work is arduous or enhancing, unpleasant or satisfying. This could have a negative impact on the productivity for the employees in giving rise to slower performance for the organization as a whole.

Workers whose skills are poorly utilised and who are over supervised, tired, bored and frustrated are unlikely to give attention on the company productivity. They are most likely to make mistakes and encounter accidents which results to loss of productivity and time.

Time spent by supervisory bodies and safety and health committee members on accident investigations and reports where machineries are given 'Prohibition Notice' and held in operational incurs tremendous losses for the companies profitability.

With the Department of Occupational Safety and Health officers, there is not much the management can do away with but to comply with Safety and Health requirement standards, more if, there occurs major accidents in the company premise. In the event of stop work orders or compounds to be paid up will further add to the image aspect of the organization.

With the absence of the injured employees away from work extra overtime work need to be done by the replacement workers. Retraining of new employees to expected standard will incur extra cost on the company and time factor. Finally, hidden or unincured cost namely workers on socso and medical leave, transportation and salary insufficiency, will add to the overall company compensation benefits.

Hence, in order to reduce the detrimental impact of the company, the Safety Culture in the company is encourageable. Safety culture of an organization will have a strong influence on the behavior of employees at all level. The safety culture of an organization is influencing the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior. It also determines the commitment to, and the style and proficiency of, an organization's health and safety management.

Key aspects of a positive safety culture are:

1. Safety commitment of all managers
2. Commitment to involve the workforce in key decision making
3. Effective means of informing and consulting all staff

4. Effective two-way communications between management and the workforce
5. Acceptance of the importance of each person's role in the organization
6. Co-operation between employees
7. An organization seeking continual improvement and excellence.

From this survey, it is evident that the employees of the foundry did not give full commitment and participation towards health and safety management system. The overall indication is that it is possible for workers to change their attitude towards health and safety at workplace, if the employer gives full commitment by enforcing more effort on the aspect of safety culture in the foundry.

6.2.2 Recommendations Benefiting the Organization

The improvement on safety, health and working conditions and environment is gaining attention in numerous areas in the selected foundry. However, to further realize the improvement, a programme of action is required on concrete measures for introducing changes. Active participation of management and workers are essential in the attempt at resolving practical solutions.

Improvements in Occupational Safety and Health and work organization enhances productivity by lessening the number of interruptions in the manufacturing process, by reducing absentees, by decreasing the number of accidents and by improving work efficiency. It is to the benefit of the workers because they run lesses risks of injury or illness and enjoy safe and healthy work culture.

Inspecting individual items against a checklist, the employees at each workplace should be inquired whether they have any problems or suggestion regarding safety, health and working conditions.

Besides, pollution reduction is another crucial aspects, There are numerical targets for reducing pollution as well as maximum emissions levels that are normally achievable through a combination of cleaner production and end-of-pipe treatment. By reducing pollution emissions from the production process, in many cases, can result in protecting human health, reduce mass loadings to the environment, draw on commercially proven technologies, be cost-effective, follow current regulatory trends, and promote good industrial practices, which offer greater productivity and increased energy efficiency. Sustainable development is needed to alter the trajectory of the foundry management.

Thus, the awareness of the foundry to the health and safety aspects would result in overall benefits to the company and enhance better productivity achievement. The prompt and scheduled output maintenance also will bring rise to stability and good morale workers.

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APPENDIX I
Interview Questions

Interview Questions

It is assured that anything you said or commented is confidential and anonymous.

ATTITUDES TOWARD SAFETY

1. Who do you see as responsible for safety at the Foundry? (Is it the responsibility of the company and individual worker?)
2. What are the general attitudes of management towards safety at the Foundry?
3. Do you encourage your workmates/subordinates to work safely?
4. Do you believe all accidents are preventable?
5. Where / when do accidents usually occur?
6. Do you believe that people who work to procedures will always be safe?

SAFETY PROGRAMME

7. Can you explain the safety program for us?
8. What safety mechanisms presently exist? (E.g. policies, weekly safety meetings)
9. How are they working? Are they successful? (Strengths & weaknesses)
10. What improvements do you think could be made to the program?
11. How are you involved in safety at Foundry?
12. After an accident occurs is the company more concerned with apportioning blame than future prevention?
13. How is the reporting of minor injuries and near misses affected by the safety program?
14. Do you remind you workmates/subordinates of safe working practices regularly?

ATTITUDES TOWARD THE PROGRAMME

15. Are there any cases of near miss or accidents took place? Was it reported to the management? Why / Why not?
16. Do you think management is committed enough to safety?
17. What do you think employees think of the safety program?

INCENTIVES

18. What rewards do you have to encourage safety work practice?
19. How appealing are these to you?
20. What is the future planning to get them done better?

SAFETY AWARENESS/TRAINING

21. Is it important for everyone to have regular safety updates?
22. How is the need for safety communicated?
23. How was the safety program communicated?
24. Is the training provided enough?
25. What can be improved?

MISCELLANEOUS

26. Do you think everyone is aware of safety requirements?
27. Is signage adequate?

(Adapted from Cox, S. & Cox. T. 1996, Safety Systems and People, Butterworth-Heinemann, Cornwall, Great Britain, p. 328)

APPENDIX II
Safety Audit Checklist

Safety Audit Checklist

DESCRIPTION	YES	NO	REMARK
GENERAL CLEANLINESS			
1. Is the layout designed to facilitate order and cleanliness?			
2. Are aisles, passageways, transport areas and exits clearly marked and free of obstacles?			
3. Are special areas set aside for storage of raw materials, finished products, tools and accessories?			
4. Are there racks for hand tools or other necessary items above work tables?			
5. Are there under bench slots or other spaces for storage of small personal belongings?			
6. Are receptacles for waste and debris in convenient locations?			
7. Are floor-covering materials suitable for the work and for cleaning?			
8. Are there screens or simple devices to prevent deposits of oil, liquid wastes or water on the floors?			
9. Are there drainage channels for waste water?			
10. Are there special groups of people to carry out day-to-day cleaning and weekly or monthly cleaning?			
11. Have arrangements been made to remove finished goods and wastes?			
12. Is there a clear assignment of duties for maintenance and repair of work premises, particularly stairs, walkways, walls, lights and toilet/washing facilities?			

MACHINE GUARDS			
1. Are the operators' hands, fingers and bodies kept safely away from the danger areas when a machine is being operated?			
2. Are starting and stopping controls within easy reach of the operator?			
3. If operators are not within sight or hearing distance or other workers, is an alarm device provided in case of an accident?			
4. Is there an effective system for disconnecting and locking out the machine from its power sources when guards are removed during maintenance?			
5. Is the company following all local or national requirements for machine guarding and any special rules for guarding of hand and portable powered tools?			
6. Are there proper guards or safety devices attached to dangerous moving pats of machines and power transmission equipment?			
7. Are guards installed without interfering with visibility, production or maintenance?			
8. Are machines well maintained?			
LOCAL EXHAUST VENTILATION			
1. Any chemical odors or see dust building up near the hood or machines?			
2. Is the hood close enough to the place where air contaminants are being released?			
3. Does the hood pull contaminants in the proper direction away from the worker's face rather than past it?			
4. Does the amount of clean air brought into the system equal the amount exhausted?			
5. Are clear passageways provided and marked?			

PERSONAL PROTECTIVE EQUIPMENT			
1. Has all protective clothing (masks, helmets, gloves, eye protectors, overalls, boots, aprons, etc.) been personally fitted and issued?			
2. Are protective clothing items immediately replaced when damaged or lost?			
2. Are protective clothing and equipment of good quality and the correct type for the job being done?			
3. Are respirators handled carefully? Is the type of respirator correct for the conditions?			
4. Have workers been properly trained in the use of PPE?			
5. Is all PPE provided to workers free of charge?			
6. Is protective clothing only worn for limited periods of time?			
7. Is PPE inspected, cleaned and maintained by management?			
8. Are workers expected to take contaminated clothing home?			
9. Does the use of PPE create other risks? (reduction vision, mobility or hearing)			
10. Are respirators approved by recognized standard-setting institutions?			
PERSONAL HYGIENE			
1. Eat in locker rooms, working areas, washrooms or where dangerous materials are used?			
2. Wash hands and the exposed parts of body regularly and take daily baths or showers?			
3. Wear proper clothing and footwear?			
4. Clean working clothes, towels etc. with the help of special laundry?			

5. Is there an adequate supply of safe drinking water in workplace?			
6. Are there clean sanitary facilities for washing and separate toilets for women?			
FIRST-AID AND FIRE-FIGHTING EQUIPMENT			
1. Is adequate first-aid equipment provided and checked regularly?			
2. Are trained and adequate first-aid personnel present during all shifts?			
3. Is adequate fire-fighting equipment provided?			
4. Is fire-fighting equipment maintained in a usable condition?			
5. Are locations of fire-fighting equipment posted?			
6. Have workers been trained in the use of fire-extinguishing equipment?			
7. Are emergency telephone numbers posted?			
LABELLING, INFORMATION AND EMERGENCY MEASURES			
1. Are containers with chemicals in them labeled indicating the contents and warning of the hazard?			
2. Is necessary information on safe handling and first-aid measures given on the label or as written instructions?			
3. Have workers been trained on health risks and safe handling of hazardous chemicals?			
4. Does training include information on safe storage and transportation of chemicals?			
5. Are emergency showers and eye-wash stations available at the worksite?			

METHODS OF CONTROL			
1. Does it adequately control the hazard?			
2. Does it allow workers to do their job comfortably without creating new hazards?			
3. Does it protect every worker who may be at risk of exposure to the hazard?			
4. Does it eliminate the hazard from the general environment as well as the workplace?			
5. Are less toxic chemicals used whenever possible?			
6. Are works processes used which minimize the release of gases, vapors, dusts or fumes?			
7. Are the sources of the release of gases or vapors completely enclosed?			
8. Are workstation locations chosen so that exposure to gases, vapors, dusts or fumes is minimal?			
9. is there a proper procedure storage and for disposal of hazardous waste?			

APPENDIX III
Survey Form

SURVEY FORM

Name of work place : ______________________________
Age : ______________________________
Gender : ______________________________
Duration of job commence: ______________________________
Work Area/Section : ______________________________
Job/Task : ______________________________
Date : ______________________________

It is assured that anything you said or commented is confidential and anonymous.

Instruction: Please tick the square under the column that best describes the situation that you agree to.

	Descriptions	**Yes**	**No**	**N/A**
1	Is it merely the responsibility of the company to enforce safety at the foundry?			
2	Does safety always get in the way of getting the job done?			
3	Is safety a priority all of the time whenever you get busy in which other things or not?			
4	Do you encourage your workmates to work safely?			
5	Do you think of safety when you are working?			
6	Do you believe all accidents are preventable?			
7	Do you believe that people who work to procedures will always be safe?			
8	After an accident occurs is the company more concerned on apportioning blame than future prevention?			
9	Does your manager/supervisor remind you of safe working practices regularly?			
10	Do you ever have a near miss?			
11	Do you think management is committed to safety?			

12	Do you think management has done enough for the safety program?			
13	Is it important for everyone to have regular safety updates?			
14	Is the training received enough?			
15	Is the work area neat in appearance?			
16	Is the lighting adequate?			
17	Are the exits clearly marked and easy to find and free from obstruction?			
18	Is hazard areas clearly defined?			
19	Do you aware of the method to occupied hazards?			
20	Are flammables stored in flammable storage cabinets?			
21	Are the chemicals properly inventoried and stored away?			
22	Is the proper fire and safety equipment available?			
23	Do you aware of correct use of equipment and tools?			
24	Is the accessibility and labeling of switches/fuses/circuit breakers available?			
25	Are Fire Warning/No smoking signs available?			
26	Is signage adequate?			
27	Are the first aid kits available?			
28	Are hand cleanser, towel supplied?			
29	Cleanliness of eating area satisfied?			
30	Do you using PPE(Eye protection, glasses, gloves, face shields, safety shoes) every time you work?			
31	Is there a system for reporting and correcting hazards?			
32	Are accidents reported and recorded?			
33	Do you think everyone is aware of safety requirements?			

Other comments:

****************** THANK YOU FOR YOUR COOPERATION****************

APPENDIX IV
JKKP Forms

APPENDIX V
Summary of Audit Form

Summary of Audit

– The Selected Foundry

KESELAMATAN DAN KESIHATAN UNIT PEMBUATAN

Summary of Audit

No	Item	Auditor's Comments & Recommendation	Management's Response	Decision of Meeting

APPENDIX VI
Risk Management Assessment Report Form

Risk Management Assessment Report

– The Selected Foundry

RISK ASSESSMENT FORM Manufacturing Department	No. 01
ACTIVITY or ELEMENT of DESIGN	HAZARD

<table>
<tr><th>RISK</th><th colspan="5">LIKELIHOOD</th></tr>
<tr><td rowspan="4">SEVERITY: (tick appropriate box)

☐ H FATALITY, MAJOR INJURY OR ILLNESS CAUSING LONG-TERM DISABILITY

☐ M INJURY OR ILLNESS CAUSING SHORT-TERM DISABLEMENT

☐ L OTHER MINOR INJURY OR ILLNESS</td><td colspan="2"></td><td>HIGH
=3</td><td>MEDIUM
=2</td><td>LOW
=1</td></tr>
<tr><td rowspan="3">S
E
V
E
R
I
T
Y</td><td>H=3</td><td>9</td><td>6</td><td>3</td></tr>
<tr><td>M=2</td><td>6</td><td>4</td><td>2</td></tr>
<tr><td>L=1</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>LIKELIHOOD: (tick appropriate box)

☐ H CERTAIN OR NEAR-CERTAIN TO OCCUR

☐ M REASONABLY LIKELY TO OCCUR

☐ L UNLIKELY TO OCCUR</td><td colspan="5">PROCEDURE:
CIRCLE VALUE FOR SEVERITY VERSUS LIKELIHOOD & TAKE APPROPRIATE ACTION AS FOLLOWS:

ACTION FOR 9- DESIGN OUT WHEREVER POSSIBLE
ACTION FOR 6- COMBAT AT SOURCE
ACTION FOR 4/3- CONTROL/MANAGE RISK
ACTION FOR 2/1- ACCEPTABLE RISK</td></tr>
</table>

PRINCIPLE OF PROTECTION: MEASURES REQUIRED TO AVOID OR MINIMISE RISK
BEFORE STARTING WORK: BEGINNING OF EACH SHIFT: SAFE WORKING: EXCLUSION ZONE:

SITE AUDIT	COMMENT
ARE CONTROL EFFECTIVE (YES/NO) ARE OPERATIVES COMPLYING (YES/NO) IS ADDITIONAL TRAINING NEEDED (YES/NO)	
AUDITED BY:	DATE:

APPENDIX VII
Organization Chart - The Selected Foundry

Organization Chart

- The Selected Foundry