# HEAT STRESS ASSESSMENT SYSTEM BASED ON GUIDELINE ON HEAT STRESS MANAGEMENT

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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Occupational Safety and Health with Honours.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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## ABSTRACT

Heat stress related-illnesses can occur and may result in death where is can cause loss of focus and physical performance. In fact, mental performance for worker who is working in a hot environment will degrades in advance. Proper management of heat stress according to the established Guideline on Heat Stress Management at Workplace 2016 is to guide employers in to recognize, estimate, prevent and treat heat stress at workplace where to avoiding discomfort from hot environment at work. It is believed that most of the industries already recognized the guideline, but unavailability of effective technique had delay the implementation of this requirement. This research study is conducted to introduce a systematic technique of heat stress assessment in industries to achieve a safe working environment and without risk to the organization. At the same time to prevent the presence of heat related-illness. This study covered analysis of element requirements for heat stress assessment based on Guideline on Heat Stress Management at Workplace 2016, development of framework and database assessment system as well as concept validation through case study from real data of a manufacturing industry. Implementation of this technique will help employer to control the presence of heat stress related-illness among the worker.

# ABSTRAK

Penyakit yang berkaitan dengan stres haba boleh berlaku dan mungkin mengakibatkan kematian di mana dapat menyebabkan kehilangan tumpuan dan prestasi fizikal. Malah, prestasi mental bagi pekerja yang bekerja di persekitaran yang panas akan menurun secara mendadak. Pengurusan tekanan haba yang betul mengikut garis panduan yang ditetapkan dalam garis panduan Pengurusan Tekanan Haba di Tempat Kerja 2016 adalah untuk membimbing majikan untuk mengenali, menganggarkan, mencegah dan mengawal tekanan haba di tempat kerja di mana untuk mengelakkan ketidakselesaan persekitaran yang panas di tempat kerja. Seperti yang diketahui sebahagian besar industri sudah tahu mengenai garis panduan itu tetapi disebabkan tidak mempunyai Teknik yang berkesan untuk mengaplikasikan garis panduan tersebut di mana telah menangguhkan pelaksanaan keperluan ini. Kajian penyelidikan ini dijalankan untuk memperkenalkan teknik perlaksanaan penilaian risiko tekanan haba yang sistematik dalam industri untuk mencapai persekitaran kerja yang selamat dan tanpa risiko kepada organisasi. Pada masa yang sama untuk menghalang penyakit yang berkaitan dengan haba. Kajian ini merangkumi analisis elemen keperluan untuk penilaian tekanan haba berdasarkan Garis Panduan Pengurusan Tekanan Haba di Tempat Kerja 2016, pembangunan rangka kerja dan sistem penilaian pangkalan data serta pengesahan konsep melalui kajian kes daripada data sebenar industri perkilangan. Pelaksanaan teknik ini akan membantu majikan menghalang kewujudan penyakit berkaitan tekanan panas di kalangan pekerja.

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# LIST OF SYMBOLS

$^{o}C$ Degree Celcius

% Percentage

# LIST OF ABBREVIATIONS

| | |
|---|---|
| ACGIH | American Conference of Governmental Industrial Hygienist |
| AL | Action Limit |
| DOSH | Department of Occupational Safety and Health |
| FMA | Factories and Machinery Act 1967 |
| ISO | International Organization for Standardization |
| OSHA | Occupational Safety and Health Act 1994 |
| PPE | Personal Protective Equipment |
| Rh | Relative Humidity |
| SHW | Safety, Health and Welfare Regulation 1970 |
| $T_{db}$ | Dry Bulb Temperature |
| $T_g$ | Globe Temperature |
| TLV | Threshold Limit Value |
| $T_{nwb}$ | Natural Wet Bulb Temperature |
| V | Air Velocity |
| WBGT | Wet Bulb Globe Temperature |

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

In this chapter, several information about background study was discussed which about heat stress risk. Explained how heat stress occur, who are more prone to get the illness and what is the factor of heat stress. Other than that, in this chapter also was state clearly the objective of this study. There are three objectives in this study.

Besides, research question also was stated as a guide to get the information about the study to achieve the objective. Then, a conceptual framework was developed to explain the field study. There are many variables involve in heat stress study. The element in colour blue is under study while black colour is the variable is not study.

There is also scope of study explanation which as guide to complete the objective. Significant of study was explained about the benefit of the study to the industry. Definition variable was explained the term involve in heat stress study.

## 1.2 Background Study

Workers who are exposed to extreme heat or work in hot environments includes indoor and outdoor may be at risk of heat stress. Heat stress occurs when the body is unable to cool itself to maintain a healthy temperature where is normally, the body will cool itself by sweating. However, sometimes sweating isn't enough and the body temperature keeps rising. Elderly people are more prone to heat stress compared to younger people due to their body may not easily adapted well to sudden or prolonged temperature change (Victoria State Government, 2015). Same as the people who are have a chronic medical condition or taking medical medicine where the condition is influence the body's ability to regulate temperature (Victoria State Government, 2015). This

condition will decrease the body ability to adapt to the changed environment temperature. Therefore, exposure to extreme heat may result in occupational illnesses and injuries such as heat stroke, heat exhaustion, heat cramps or heat rashes (Department of Occupational Safety and Health Malaysia, 2016). Similarly, heat also can lead to injuries as it can be sweaty palms, safety glasses will fog up and dizziness. Besides, burns may also occur because of accidental contact with hot surfaces or steam.

Some long-term effects from heat stress is severe heat-related illness that can cause permanent damage to a person's organs, such as the heart, kidneys, and liver, which consequently result in a chronic disorder (Bouchama & Knochel, 2002). In 2001, a bakery worker in Barrie died because of heat stress during a heat wave where the outdoor temperature on that day was 34$^{o}$C while the temperature inside the bakery was 46$^{o}$C which it believed that lack of water and not enough rest are the factors of the incident happen (CBC News, 2001). From incident investigation it found that bakery do not comply with regulation of maximum temperature of heat stress in the workplace (CBC News, 2001). It is important for the employer to conduct risk assessment of current heat condition to ensure the occupational safety and health.

Besides, there are some environmental and job-specific factors that increased the risks of heat-related illnesses. Environmental factor includes high temperature and humidity, radiant heat sources, direct contact with hot objects, direct sun exposure, limited air movement where is no breeze, wind or ventilation (Department of Occupational Safety and Health Malaysia, 2016). Next, for job specific is physical exertion also use of bulky or non-breathable protective clothing and equipment during working hours (Department of Occupational Safety and Health Malaysia, 2016). There are several indoor and outdoor activities that expose to heat (WorkSafeBC, 2000). Outdoor work activity such as construction, roofing, forestry, forest fire fighting, and road construction. On the other hand, indoor activity includes glass manufacturing, industrial laundries, bakeries, steel manufacturing and fabricating (WorkSafeBC, 2000). Workers who were exposed to hot environments working condition must be trained in order to recognize the early stage symptoms of heat stress to prevent heat related illness.

Meanwhile, there are other certain factors that increase workers sensitivity to heat. Worker who is age at 50 years old and older normally have poor health status and low level of fitness cause them more susceptible to feeling the extremes of heat (Oakley &

Surgeon, 1987). Apart from that, worker who has health disease such as cardiovascular disease, respiratory disease and diabetes may take special precautions because people with skin disease and rash are more susceptible to heat (Bailes & Reeve, 2007). Workers who have obesity body mass index which they are carrying excess weight can affect body's ability to regulate its temperature and cause body to retain more heat. Other than that, gender differences also one of the factors susceptibilities to heat in term of t cardiovascular fitness, body size, and acclimatisation (Department of Occupational Safety and Health Malaysia 2016). Even have equal fitness, size and acclimatisation, women are prone to have a lower sweat rate than men where the lower sweat rate means that there can be an increased in body temperature (Department of Occupational Safety and Health Malaysia, 2016).

Heat acclimatization is the improvement in heat tolerance that comes from gradually increasing the intensity or duration of work performed in a hot setting (Department of Health and Human Services, 2017). The best way to acclimatize the heat by increasing the workload performed in a hot setting with gradually over a period of 1–2 weeks, it is because acclimatization lost after about 1 week away from working in the health condition (Department of Health and Human Services, 2017). When a person is move permanently away from a hot environment, acclimatisation will loss gradually (Department of Occupational Safety and Health Malaysia, 2016). Employer should have a good acclimatization plan for their worker who is working in the hot environment where a new worker is not suitable to start work at full intensity because not safe. In addition, adjustments to the acclimatization schedule may be needed depending on the workplace situation and individual factors (Department of Health and Human Services, 2017).

### 1.3 Problem Statement

All employers are requested to adopt and adapt the Guidelines on Heat Stress Management at Workplace 2016 as a source of reference in managing heat stress at workplace and to comply with the general duties under the Occupational Safety and Health Act 1994 and the Factories and Machinery Act 1967. Section 15(1) and Section 15(2)(e) of Occupational Safety and Health Act 1994 stipulates the duty of employers and self-employed persons to their employees. The provision and maintenance of a working environment for the employees should be as far as is practicable, safe and

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