

## Heat Exposure Assessment among Warship Technicians in Machinery Room

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### ABSTRACT

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Some warship compartments are undoubtedly considered severe hot environment due to high-temperature values produced by rotating machinery. Besides, it also depended on the external conditions such as weather and design of the warship, which contributes to high-temperature in specific compartments. Such inconvenient situations which related to space, noise, vibration and poor air quality inside the warship compartment further increase high prevalence risk to the associated technicians. Thus, this study was to examine the awareness state among technicians regarding the heat exposure they faced in machinery room during the daily routine and to propose an action plan to increase awareness state among technicians regarding heat exposure in the workplace. The variables that have been chosen in the study were knowledge awareness, personal influences, environmental influences, interpersonal influences and management influences. The statistical analysis technique was applied in the study by using The Pearson-correlation coefficient. Result shows that the environmental impacts and management authorities have a significant positive relationship with awareness state among technicians.

#### Keywords:

Ship compartment, machineries, heat exposure, prevalence risk, awareness state

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## 1. Introduction

According to Department of Occupational Safety and Health (DOSH), Malaysia, heat stress is the general warmth stack in which a representative might be presented to some consolidated commitments of metabolic heat, ecological factors (i.e air temperature, humidity, air movement and radiant warmth), and garments necessity. Heat stress happens when the body's arrangement of controlling the inward temperature begin towards failure [1].

There are a few people exposed to heat on their everyday work either including outside or inside heat exposure condition. Operations including high air temperatures radiant heat sources, high humidity, direct physical contact with hot articles, or strenuous physical exercises have a high

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potential for causing heat-related ailment [2]. Work environments with these conditions may incorporate with vessels and ship [3].

Numerous vessel and ship compartments have situations of high temperature and humidity, including designing spaces, galleys, laundries, and open decks in hot atmospheres particularly during flight deck operations, activities and drills. Constant high temperatures may prompt warmth stretch conditions and presumably decrease working execution, confidence and weaken mental sharpness accordingly, expanding the predominance danger of work environment and compromising the ship readiness. Extreme heat stress can prompt heat related illness, inabilities, and even death [3].

Warship spaces contain environments of high heat and low humidity, including engineering spaces, galleys, sculleries, laundries, and weather decks in hot climates especially during flight deck operations, exercises and drills. According to American Bureau Shipping [4], *“Sustained high temperatures leading to heat stress conditions can lower work performance and morale and impair mental alertness, increasing the risk of workplace accidents, and ultimately compromising the readiness of the ship. Severe heat stress can lead to heat-related illnesses, disabilities, and even death.”*

Previous studies have shown that the engine crew suffer the highest overall levels of stress [5, 6], specifically the deck and the engine officers [7], which was due to the higher levels of heat stress [8]. In general, engine crew or the technicians need to work at a very confine space without a proper ventilation and appropriate working time. Unlike other equipped air-conditioning rooms, decks normally affected by the external climate. This occurrence results in increasing air temperature values from 10°C to 30°C higher than the external temperature. Consequently, these conditions in the machinery room can be extremely dangerous to the technicians.

In this study, the awareness of the technicians was examined concerning on the heat exposure they faced in the machinery room was implemented. The awareness of the management was also studied, to identify whether the DOSH requirement was followed.

## **2. Methodology**

### *2.1 Materials and Method*

This study used quantitative method where the questions were prepared constructively, to gather awareness among technicians regarding heat exposure. Technicians who participated in this study worked in machinery room daily. Through the survey, the questions reflected the awareness state of technicians regarding heat exposure by knowledge awareness, personal influences, environmental influences, interpersonal influences and management influences. The quantitative method was chosen to collect data due to its flexibility to obtain results regardless of differences in demographics background.

#### *2.1.1 Population and sample*

The focus population in the study were the technicians who worked onboard a warship. The sample size was taken using Krejcie and Morgan Table, which involves 60 technicians. The questionnaires were distributed to all targeted respondents that work inside the machinery room daily.

#### *2.1.2 Survey*

A structured questionnaire was developed based on the pilot test survey outcome. Before the primary survey started, a pilot test survey was conducted among 10 of the sample population. The

questionnaires were edited according for easy understanding by the respondents. The questionnaire was divided into six sections based on the awareness state of heat exposure among technicians. The questions included the demographic factors such as age, rank and years of service in the RMN, marital status and academic qualification followed by five influences factors that contribute to the awareness state. The influences factors that were analysed included the knowledge awareness, personal influences, environmental influences, interpersonal influences and management influences. The scale of answer is constructed on the scale of 1 to 5 as 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree and 5 = strongly agree. All five factors will lead to the state of awareness among technicians regarding heat exposure they faced in the machinery room. Before the primary survey started, a pilot test survey was conducted among 10 of the sample population. The questionnaires were edited according for easy understanding by the respondents.

### 2.1.3 Data analysis

Data was analysed by using IBM SPSS Software, version 16 to evaluate the relationship between factors influencing heat exposure awareness and awareness state among technicians. Descriptive data were presented in percentage, mean and deviations.

## 3. Results and Discussion

Analysis of the results was based on 2 (two) sections which are taken from the demographic data and five more variables that were assessed equivalent to the research objectives. The questions were based from the following variables; (i) Knowledge Awareness, (ii) Personal Influences, (iii) Environment Influences, (iv) Interpersonal Influences, (v) Management Influences. Table 1 shows the overall mean of factors influencing the heat exposure awareness among the technicians. The mean score for the knowledge awareness is 3.92 (SD=0.840). The results represent that the technicians have an average knowledge of heat exposure during their working period. If this situation is not resolved, it may lead to a physical and mental illness. The excessive temperature inside the machinery room and permissible heat temperature can exposed to their body depends on type of work they conducted. From the results, the awareness of environmental influences which was supposed to give highest impact on the technicians was not achieved. This indicates that the technicians are lacked in knowledge.

**Table 1**  
Factors Influencing Heat Exposure Awareness among Technicians

Factors	Mean (M)	Level of Score Mean
Knowledge Awareness	3.92	High
Personal Influences	3.90	High
Environment Influences	3.09	Medium
Interpersonal Influences	3.80	High
Management Influences	3.25	Medium
<b>Overall Mean</b>	<b>3.59</b>	<b>Medium</b>

The mean score of personal influences is 3.90 (SD=0.7333). In general, most technicians always take safety precautions and do pre-job evaluation before start work in the machinery room. They also wear suitable proper personal protective equipment (PPE) while working and take a break in between a long period working inside machinery room. However, they are a few technicians who do not sure how to avoid the heat stress. Whereby for the score mean of environment influences is 3.09 (SD=1.049). In general, majority of the technicians agree that machinery room is suitable for working

condition but they do not agree that temperature inside there is suitable for working activity. Some of them agree that temperature in machinery room can be controlled by engineering control and it is adequate to control the temperature. Moreover, most of them are agree that temperature in machinery room is influenced by weather and the location of its compartment.

Another variable is the interpersonal influences, with the mean score is 3.80 (SD=0.741). In general, the overall mean score represents the superior of technicians have an average interpersonal influences of heat exposure they faced in machinery room during working period. Most superior always give safety briefing, pre-job evaluation and ensure proper clothing and PPE of their technicians. However, some of them have not conducted heat stress management course to their technicians. The final variable that was studied is the management influences with the mean score is 3.25 (SD=1.046). In general, majority of the technicians agree that RMN has provided them with adequate training of heat stress in workplace. However, the knowledge of heat stress in RMN is not enough for the technicians. Majority of the technician is uncertain whether RMN has the module on heat exposure in workplace and has conducted heat stress management course. They are also not sure of official memo or guideline from RMN to avoid heat stress in workplace.

The relationship between knowledge awareness with factors influencing the perception of heat exposure in machinery room among technicians is shown in Table 2. Knowledge awareness has been set as dependent variable meanwhile another four factors as independent variable.

**Table 2**  
 Relationship between factor influencing the perception of heat exposure with knowledge awareness

Influence Heat Exposure Factor	Knowledge Awareness	
	Significant Score	Strenght of Correlation
Personal Influences	$r = 0.564^{**}$ sig (2-tailed) = 0.000	<b>Moderate</b>
Environment Influences	$r = 0.207$ sig (2-tailed) = 0.112	<b>No</b>
Interpersonal Influences	$r = 0.296^{*}$ sig (2-tailed) = 0.022	<b>Weak</b>
Management Influences	$r = 0.013$ sig (2-tailed) = 0.919	<b>No</b>

Based on Pearson Correlation Coefficient [9], (r) personal influences has a moderate relationship with knowledge awareness where ( $r = 0.564^{**}$ , sig (2-tailed) = 0.000). Meanwhile interpersonal influences have a weak Pearson Correlation Coefficient with knowledge awareness where ( $r = 0.296^{*}$ , sig (2-tailed) = 0.022). Other 2 (two) factors which are environmental influences and management influences seems does not have any correlation with knowledge awareness.

The result of this analysis show that personal influences of the technicians has a significant contribution to the knowledge awareness of heat exposure inside machinery room. Technicians has to improve their awareness of heat exposure and heat stress management in workplace by increasing their knowledge on this issue. Besides that, interpersonal influence also has a relationship with knowledge awareness among technicians. Superiors has to show good knowledge of heat stress management and good examples to their subordinates or technicians. Superiors must be able to explain the prevalence risk of heat stress while working in machinery room. Moreover, they should conduct safety briefing, pre-job evaluation before start working inside machinery room and ensure

their technicians wear a proper clothing's and PPE.

#### 4. Conclusion

In conclusion, this study has highlighted the factors influencing heat exposure awareness among technicians in machinery room. The findings indicate that management influences and environment influences have lower impact to awareness state among technicians. Since the management of the warship is responsible for all the ship crews especially who are working in dangerous or high-risk job, the management should consider an appropriate guideline and action plan to increase awareness state among technicians regarding heat exposure in the workplace. Besides that, further studies are needed to assess the environmental influences such as engineering control to decrease the surrounding temperature inside machinery room.

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