HEAT STRESS ON BOARD: RISK AND PREVENTION

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Abstract:

The heat stress is the load of heat that a worker receives and accumulates in his body and that result of the interaction between the environmental conditions of the place where he works, the physical activity he does and the clothes he wears. The direct action of heat on the body causes a defence against this elevation of temperature inside our organism with the aim of keeping the internal temperature within limit parameters. As Directive 89/654/EEC concerning the minimum safety and health requirements for the workplace indicates the thermal and hygrometrical conditions that can cause thermal stress on the workers health have to be studied.

On board ships, specifically in the engine room, seafarers are subjected to very high temperatures during long time periods and to considerable variation in temperature.The objective of this paper is to analyse the impact of thermal stress on engine room workers on board ships, to study the consequences of such thermal stress to the organism and to review the current labour legislation with regard to risks due to thermal stress by heat. At the same time a relationship between heat stress and fatigue on board is stablished. It is concluded that the current thermal regulation measures as well as the applicable legislation are clearly insufficient. Moreover, heat stroke and dehydration are the most serious risks of exposure to heat in the engine room.

Keywords:

heat stress, fatigue, health.

INTRODUCTION

Thermal heat stress is the heat load that workers receive and accumulate in their body and that results from the interaction between the environmental conditions of the workplace, the physical activity they perform and the clothes they wear (1).

The direct action of heat on the body triggers within our body a defense against that temperature rise to try to maintain the internal temperature within parameters.

The most common effect of heat is discomfort at work, but if the conditions are extreme the discomfort can be transformed into danger. The spectrum of heat illnesses include relatively minor heat rashes, cramping, heat syncope and dehydration,to more serious heat exhaustion, which, if untreated, can lead to heat stroke with central nervous system involvement progressing to multi-organ dysfunction syndrome affecting major organs, including the brain, kidneys, and heart, and can be fatal (2,3).

Following Zander et al. (4) negative impacts of hot weather include, higher work accident frequency because of concentration lapses, higher levels of fatigue and poor decision making because time perceptions change, and increased stress hormone levels which also affect cognitive performance and decision quality. Furthermore, according to American Bureau Shipping (5) “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”.

Thermal heat stress is not a pathological effect that heat can cause in workers, but the cause of the various pathological effects that occur when excessive heat accumulates in the body. When working in conditions of thermal stress, the individual's body is disturbed. It suffers a physiological overload, because, by increasing its temperature, the physiological mechanisms of heat loss (mainly sweating and peripheral vasodilation) try to lose the excess thereof. If, in spite of this, the central temperature of the body exceeds 38 ºC, different damages to health may occur, whose severity will be in line with the amount of heat accumulated in the body.

According to Directive 89/654 / EEC, which establishes the minimum health and safety regulations in the workplace (6), the environmental conditions existing in the workplace (air temperature, thermal radiation, humidity and air speed) together with other parameters that influence the thermal equilibrium of the body (heat generated by the physical activity performed, thermal insulation of clothing) can cause situations of risk to the health of workers, either by heat or cold. That is why the thermo hygrometric conditions that can cause thermal stress on the health of workers should be studied.

Seafaring is associated with special mental, psychosocial and physical stressors and cannot be compared with jobs ashore.

Some ships compartments are undoubtedly considered severe hot environments due to high temperature values, such as the engine room and, depending on external conditions, cargo holds and storage areas (7). Such peculiarity further increases already high stress levels related to awkward work postures, lack of space and appropriate lifting tools, noise, vibrations, and poor air quality. Technical spaces such as engine rooms are also affected by the external climate resulting in air temperature values from 10ºC to 20ºC higher than the external temperature. The work in the engine room control has over recent years undergone major changes, mainly due to the introduction of computers on board. This has implied obvious changes in the ECR with regards to both working conditions and equipment (8).

In these machinery spaces, seafarers are subject to very high temperatures for long periods of time while doing their job. It is not only the degree of heat or cold that a marine engineer is exposed, but also the duration of exposure and the relative change between environments (9). The organism of these workers is subject to considerable temperature differences between the different work spaces (for example if the engine room control is closed it will have a temperature lower than the area of engines or boilers), giving rise to the need for intermittent body acclimatization.

Also, the study carried out by Rengamani and Murugan (10) reveals that heat in work places joined to the long working days, separation from their family, time pressure /hectic activities, insufficient qualifications of subordinate crew members, noise, ship movement, sea sickness, hard physical work, lifting, carrying, lack of exercise and climatic changes during the voyage are considered as the most vital factors in influencing the seafarers stress when they are on-board.

Oldenburg et al. (11) indicate that stress level due to heat in workplaces was lower in seamen with a longer job duration at sea (and consequently of older age) than in those with a shorter job duration. This may be due to the adaptation to job demands or the healthy worker effect.

Additionally, several studies (4, 12, 13) indicate that heat stress not only has an effect on the health of workers but also there is a direct relationship between heat stress, productivity and economy. Productivity losses reported were extended work hours due to fatigue / eshaustion, sickness / hospitalization and wages lost.

It is for these reasons that the study of the impact of thermal stress on engine room workers requires special attention.

1. RISK AND DAMAGE FACTORS

Heat stress causes an increase in heart rate (HR) and internal body temperature. The maximum HR and / or internal temperature of about 40ºC establish the absolute physiological limit of the physical capacity to work in a hot environment (14)

When assessing thermal stress, it is important to take into account various factors that could be triggers of risks and damage to the health of the individual subjected to them. Such factors are the duration and thermal environment.

- Duration of heat exposure: Even if the temperature is not very high, being exposed for many hours would cause the accumulation of heat in dangerous quantities.

An excessive thermal aggression can have serious consequences for the human organism. Therefore, it is necessary to limit the time of exposure (t EX) in places with such characteristics. It will be the time necessary to increase the internal body temperature by 1ºC, considering a specific heat Ce = 0.82 cal / (g ºC).

When we want to assess the risk of thermal stress, we use the “Required Sweating Index” that provides, among other data, the maximum recommended time to stay in a given situation, also called “Exposure Limit Duration” (ELD), for each one of the risks and according to alarm and danger levels.

At the alarm level, no worker will have health problems if the exposure time for such level is not exceeded. If it is exceeded, a worker could have a health problem. In the case of danger level, most of the workers would have health problems if the ELD is exceeded.

- Particular individual factors: They also intervene aggravating the situation, personal factors such as overweight, physical fitness, health status, lack of acclimatization, etc.

Below is a list of possible individual factors that can reduce heat tolerance:

- Age
- Obesity
- Decreased sweat capacity:

- Absence of sweat glands

- Peripheral nerve injury: diabetes, alcoholism, hypothyroidism, etc.

- Drug substances:

- Anti cholinergic

- Psychotropics: barbiturates, IMAO phenothiazines, antihistamines, diuretics (dehydration)

- Excessive salt losses: Mucoviscidosis
- Convalescence after an acute medical condition or surgical intervention
- Febrile state
- Alcohol consumption before and during exposure
- Bad physical condition
- Absence or bad acclimatization

2. THERMAL ENVIRONMENT. HEAT ACCLIMATIZATION

There are various methods to assess the thermal environment in its different degrees of aggressiveness.

In the case of moderate thermal environments, it is useful to know the predicted mean vote index (PMV) index, whose calculation allows to assess the level of comfort or discomfort in a work situation.

The Wet Bulb Globe Temperature index (WBGT) (15) is used, due to its simplicity, to quickly discriminate whether or not the thermal stress risk situation is admisible. Also, its calculation allows decisión making with regard to the possible preventive measures to be applied.

The lack of heat acclimatization is one of the most important personal factors. It can be defined as the decrease in physiological cost that a given exposure implies, when it is repeated several successive days (16).

The study carried out by Arbury et al. (17) over 20 cases of heat illness or death showed that in 13 cases a worker died from heat exposure, and in seven cases two or more employees experienced symptoms of hear illness. Nine of the deaths occurred in the first 3 days of working on the job, four of them occurring on the worker's first day.

During exposure to heat, the non-acclimatized person has a high rectal temperature, high heart rate and low sweat loss.

Non-acclimatized workers may suffer damage under heat stress conditions that are not harmful to their peers who have been working in those conditions for some time.

Acclimatization is a complex process involving the circulatory system (increasing cardiac output, increasing volume / heartbeat, since maximum heart rate is reduced), the endocrine system (increases aldosterone to increase blood volume and circulating plasma) and sweat glands that secrete more sweat and less sodium. This helps dissipate heat through cutaneous vasodilation and sweating. Since the cooling effect occurs when that sweat evaporates, this happens as long as the relative humidity of the air is able to accommodate that water vapour, otherwise, i.e. tropical environments with high humidity rates, the sweat does not evaporate and the body does not refrigerate. Therefore, ventilation and good equipment maintenance are essential to avoid excessive humidity in the enigne room.

This progressive physiological adjustment, increasing the duration of exposure to heat, makes it possible for a person to work effectively under conditions that would be unbearable prior to acclimatization.

Heat acclimatization makes the body able to better tolerate the effects of heat, as it favors physiological thermoregulation mechanisms: it increases sweat production and decreases its salt content, increases peripheral vasodilation without increasing heart rate. In this way the central body temperature does not rise so much.

But this is not an immediate process and can last between 7 and 14 days depending on the worker. During this time, the body adapts to perform a certain physical activity in hot environmental conditions progressively.

In the holiday or leave periods of the worker, he suffers an acclimatization that will require a new period of adaptation at the time of his return to work. Unfortunately, in most cases this intermediate period of labor production is not allowed, as in the case of the engine room personnel of a merchant ship, subjected to thermal shock from the outset when joining the crew and entering watch from the first day, the engine rooms being at high temperatures and generally poorly conditioned.

A study by Orosa and Oliveira (18) found temperature differences between the engine room and the engine room control of more than 12 º and differences in the average relative humidity of more than 15% between these spaces. These differences are so pronounced that they can cause thermal shock among workers.

With the aim of reducing this workplace risk, Orosa and Alvarez (9) propose to change the limit values of the thermal comfort conditions in the control engine room and, therefore, a new thermal comfort control system must be designed. This new control system must take into consideration the difference between the thermal environments in the control engine room and the own engine room in the working conditions at all latitudes.

Of course, the ship as a work and living place is a very particular case and its temperature or thermal environment conditions are sometimes difficult to improve due to various factors (changes in the route and therefore variations in seawater temperature, ambient temperature and ultimately weather conditions, design of the ship and its compartments in the absence of legislation in this regard at the time of its construction) as noted Montero et al. (19) sometimes it is impossible for different reasons to establish comfort situations in a position. Under such conditions, ergonomics must find solutions that at least place the work in permissible conditions or, otherwise, establish work and rest regimes applying different techniques. That is, to achieve an environment that imposes a load as small as possible for the body thermoregulatory system, taking into account the productive efficiency of the system.

Another parameter that may have an impact on the acclimatization process is the physical size of the person. It is advisable not to expose people under 50 kg to extreme conditions neither to people with obvious obesity who usually have cardiovascular problems. Age is also a factor to take into account. The ideal age of acclimatization is between eighteen and forty, due to high cardiovascular responses (200 beats per minute) and oxygen consumption (5 l / m), factors that are significantly reduced with age. Heat tolerance is reduced in the elderly as they take longer to sweat than young people, reacting with greater peripheral blood flow during exposure to heat.

It has also been proven that women tolerate moisture better than men; although in its menstrual stage they can retain up to 1-2 kg of water.

In the case of people with lower aerobic capacity, they will register a greater increase in heart rate and body temperature, which means that their ability to withstand additional external heat stress will be lower than for people with higher VO2 max (maximum absorption of oxygen).

The American Conference of Governmental Industrial Hygienists of the United States, summarizes in a table the threshold limit values (TLVs), according to different categories of workloads (20).

These limits, specify the maximum combination of environmental heat and metabolic heat to which workers should be exposed. Exposure limits are lower for workers who are unacclimatized to heat, who wear work clothing that inhibits heat dissipations, and who have predisposing personal risk factors (3).

Likewise, ISO 7243:2017 (15) Ergonomics of the thermal environment -- Assessment of heat stress using the WBGT (wet bulb globe temperature) index presents a screening method for evaluating the heat stress to which a person is exposed and for establishing the presence or absence of heat stress. This method applies to the evaluation of the effect of heat on a person during his or her total exposure over the working day (up to 8 h) and to the assessment of indoor and outdoor occupational environments as well as to other types of environment, and to male and female adults who are fit for work.

In this method adjustment to the WBGT value to account for the effects of clothing that has different thermal properties from that of standard work clothing is made.

3. EFFECT OF HEAT STRESS ON HEALTH

About 60% of the total weight of an adult person is made up of water; one third is located in the extracellular fluid and the remaining two thirds at the intracellular level. The water balance is of the utmost importance for workers who perform their tasks in high temperature environments.

Human body’s response to ambient temperature depends primarily on a very complex balance between the level of heat production and the level of heat loss.

Heat is lost by radiation, convection and evaporation, so that in normal resting conditions the body temperature is maintained between 36.1ºC and 37.2ºC.

When workers are exposed to high levels of radiant or directed heat, they can suffer damage to their health in several ways. Thus, for example, the high temperature on the skin (above 45 ° C) can burn the tissue.

The key effects of an elevated temperature occur if the deep body temperature is increased to more than 42 ° C, that is, it is increased by 5 ° C.

An inadequate thermal environment causes reductions in physical and mental performance, irritability, increased aggressiveness, distractions, errors, discomfort from sweating or shivering, increased or decreased heart rate and even death.

Different repercussions on the person are derived according to an internal temperature scale:

- 42º- 44 ° C Heat stroke. Hot and dry skin; t> 40 ° C, convulsion, coma (15-25% mortality)

- 40 ° C Possible brain injuries

- 38 ° C NORMAL

- 36 ° C NORMAL

- 34 ° C Feeling cold, shivering

- 33 ° C, 32 ° C, 30 ° C Hypothermia: bradycardia, hypotension, drowsiness, apathy, stiff muscles.

- 28 ° C Relaxed muscles, respiratory function failure

The risk of thermal stress for a person exposed to a hot environment depends on the heat production of his/her body as a result of his/her physical activity and the characteristics of the surrounding environment, which determines the heat exchange between the environment and the body. When the heat generated by the organism cannot be emitted to the environment, it accumulates inside the body and its temperature tends to increase, and irreversible damage can occur.

The fundamental risks of excessive exposure to heat are dehydration and heat stroke. Sometimes these risks can occur very quickly, suddenly, and have rapid and irreversible outcomes. Most of the time the causes of thermal stress are easily recognizable and the possibility of damage is equally easily predictable. In other circumstances, in which the environmental conditions are not extreme, thermal heat stress can go unnoticed and cause damage to workers.

Excess of body heat can cause:

- an increase in the likelihood of accidents at work,
- previous illnesses (cardiovascular, respiratory, renal, skin, diabetes, etc.) are aggravated.
- health damage occurs.

To try to eliminate heat excess the thermoregulation mechanisms of the body itself (physiological thermoregulation) are started: workers begin to sweat (when the sweat of the skin evaporates, it cools) and, the flow of blood to the skin increases (peripheral vasodilation) to bring heat from the inside of the body to its surface and from there it can be expelled to the outside. This causes the heart rate to increase.

In workers who have a chronic disease, it can be aggravated. If these heat conditions continue and the workers continue to work and accumulate heat, there will come a time when they will produce various damages, including in so-called heat-related illnesses, the severity of which is proportional to the amount of heat accumulated. The most serious one is the heat stroke (it appears when the central temperature, regardless of the degree of ambient temperature, exceeds 42 ° C) that often causes death. On the other hand, even if the work under high thermal stress conditions ceases and there is no excessive accumulation of heat in the body, workers will also suffer damage if they do not replace the water and electrolytes (salts) lost in sweating. Severe dehydration can cause heat exhaustion and circulatory collapse, the person is unable to maintain blood pressure and loses consciousness.

4. HEAT RELATED DISORDERS

Skin disorders: Uneven red rash on the skin caused by excessive sweating or humidity. The obstruction of the sweat ducts prevents sweat from reaching the skin surface and steaming. It is the most common skin disorder associated with heat exposure.

Thermal cramps: They are involuntary and painful muscular contractions, which appear due to an excessive loss of salts when sweating in a lot. The individual replenishes a lot of water but not the sodium lost by sweat. These low levels of sodium raise the concentration of calcium in muscle fibers causing muscle contraction. They can appear during work or later.

Heat syncope: It is a temporary loss of consciousness as a result of reduced cerebral irrigation. Cutaneous vasodilation and hypovolemia due to profuse sweating can reduce preload to the heart to cause orthostatic hypotension. The cutaneous vessels are influenced by vasodilation to favor thermolysis and vasoconstriction to maintain blood pressure, in which case vasodilation dominates. The worker will present a picture of weakness, thirst, nausea, vomiting, cold and wet skin sweating, hypotension and tachycardia.

It can be suffered mainly by workers not acclimatized to heat at the beginning of the exposure.

It is not serious, but in many cases its onset is not different from a heat stroke. It is therefore necessary to assess in all cases:

- The central temperature.
- Heart rate and blood pressure.
- Heat stroke symptoms such as confusion or / and disorientation.
- Monitor the worker on subsequent days and assess the possibility of a temporary change of job. (This measure is hardly applicable in members of the engine room department of a ship).

Heat exhaustion: It occurs as a result of severe dehydration after losing a large amount of sweat. It is a systemic reaction secondary to the depletion of water and salts by profuse sweating when it is not adequately replenished. Water loss causes intense thirst and weakness (tiredness), volume depletion (hypotension, tachycardia) and hyperventilation. The loss of salt causes muscle cramps, nausea, vomiting, weakness and also hypotension and tachycardia. It can lead to heat stroke.

Heat stroke: It is a complex clinical picture characterized by uncontrolled hyperthermia that causes significant tissue damage. There is a failure of the cooling system, accumulating heat in the body, raising the core temperature above 42 °, damaging the cells. When the capacity of thermolysis is exceeded, proteins are denatured and lesions arise that can lead to cytolysis or cell death. The increase in temperature increases the metabolism with which a vicious circle is established, increasing from 10 to 15% for each degree the temperature rises.

Heat stroke is a clinical entity not too frequent, but of high mortality (15 to 25% of cases despite correct treatment). It is more frequent in:

- Children or the elderly who are suddenly exposed in a heat wave or on a trip to a warm country. In the elderly, more care must be taken because they lose their sense or sensation of thirst, and do not hydrate.

- Young people who exercise intensely in a warm environment (eg, military training)

- Workers who perform moderate to heavy physical work in warm and humid environments with significant radiant heat or waterproof work clothes.

The first symptoms may resemble the aforementioned clinical entities, then the three clear symptoms of heat stroke are manifested:

- Warm and dry skin, without sweating

- Very high internal temperature: greater than 40ºC

- Neurological symptoms: confusion, incoherent language, coma, convulsions.

Generally, the complete triad is difficult to observe. Other important symptoms found are:

- Tachycardia greater than 130 beats per minute, low blood pressure

- Hyperventilation

- Liver injury: increased transaminase levels, which can be maintained for several weeks

- Muscle injury: CPK elevation

- Renal injury: elevation of serum creatinine

- Disruption of blood coagulation tests

These symptoms can occur in the workplace itself or after a few hours of ceasing exposure.

The first treatment should be carried out immediately by removing the patient from the heat source and undressing, watering or bathing in water, ventilating and if possible by passing ice through the neck, armpit and groin. Later she/he will be transferred to a hospital.

If this cooling has an effect, in the majority of cases the evolution will be favorable; but the evolution towards acute renal failure or disseminated intravascular coagulation is always a possibility to consider.

Symptoms and signs derived from heat thermal stress could be summarized in the following list:

 Hyperthermia

 Vasodilation

 Activation of sweat glands

 Increase in peripheral circulation

 Sweat electrolyte change: loss of NaCl

 Psychic disorders

5. RELATIONSHIP BETWEEN HEAT STRESS AND FATIGUE. EFFECTS AND CAUSES.

Fatigue is generally described as a state of tiredness, exhaustion or drowsiness caused by prolonged physical or mental work, long periods of anxiety, exposure to a hostile environment or lack of sleep. Fatigue implies a decrease in performance and alertness (21).

As Willmore and Costill (22) describe, in a hot environment there is a large amount of blood that goes to the skin instead of the muscles, increasing oxygen consumption, an increasing muscle lactate, heart rate, a large production of sweat, a greater use of muscle glycogen; and ultimately a greater energy production.

It is believed that this fatigue and these changes in the body may be due to the direct effects of hyperthermia on the central nervous system, and are a defense mechanism of the body that acts as a "fuse" that prevents the worker from continuing to produce heat and exceed an internal limit temperature that causes heat injury, heat stroke, and even death (23).

If thermal stress is important, or not being so, and workers continue to work for a long time without taking breaks, there comes a time when they are so hot that they cannot work well. They are very uncomfortable, with apathy, diminished capacity for perception and attention and memory, etc. In this state, the probability of accidents at work increases greatly.

Excess of body heat can cause a series of diseases or conditions directly related to heat (skin rash, dehydration, cramps, exhaustion), it can aggravate previous ailments (respiratory, cardiovascular, diabetes) and of course, it boost the work accidents occurrence.

Fatigue as a result of a heat stress situation is present in several occupational accidents on ships. In 1986, the IMO Subcommittee on Standars of Training, Certification and Watchkeeping conducted a study on the effects of fatigue in safety, where it is concluded that, in the face of fatigue, the crew is impaired its ability to react and act in various situations.

6. LABOR LEGISLATION REGARDING RISKS CAUSED BY HEAT THERMAL STRESS: INTERNATIONAL, EUROPEAN AND SPANISH CASES

Although the occurrence of fatigue in the crew is recognized as a risk factor for both the integrity of the ship and its crew, the existing legislation generally focuses on fatigue due to exhaustion, that derived from an insufficient rest period, an excess of working hours or situations of greater psychological stress, leaving the issue of heat stress fatigue abandoned. As for this type of pathology, there is a legal gap in the maritime field, leaving without timely legislation for example the temperature limits of compartments such as the Engine Room in which the temperatures far exceed the permissive values for health.

Several studies show the presence in engine rooms of environmental conditions outside the appropriate values to preserve the health of workers. In a study by Orosa et al. (24) in which data on temperature and relative humidity measurements are provided in various compartments of a ship, it is clearly seen how the actual values are far from the indications of the ISO 7730: 2006 (25), according to which the reference values for indoor conditions in summer would be above 23ºC of temperature and between 30-65% of relative humidity. In the aforementioned study, the average values of temperature and relative humidity recorded in the engine room are 32.5ºC with peaks up to 38.5ºC (excessive) for the first parameter and 25% for the second (value clearly lower than recommended).

In addition, another problem added to the performance of tasks in these conditions, is that the crew does not usually carry out periods of thermal recovery in an appropriate environment, to release the accumulated heat, which implies a greater exhaustion and risk of occurrence of important damages in its Health.

The MSC Circular / Circ. 1014 Guidance On Fatigue Mitigation And Management (21) describes the possible causes and effects of fatigue on the different crew members, but an error is made when encompassing bridge and engine officers in the same group. It is clear that the temperature conditions in the main engine room is much higher than in the cargo control office where the first deck officer is located, possibly with a built-in air conditioning unit and doing a job, usually more sedentary. But it is also true that throughout the circular, only the harmful effect on the health of an excess of temperature is mentioned in its first paragraph, this factor being forgotten in the whole document when deepening the issue of fatigue. Excessive heat and cold are also a problem among deck staff (officers and seafarers) in deck jobs.

The directive of the Council of the European Communities concerning the minimum health and safety provisions in the workplace stipulates in its annexes I and II (6, 26) that the temperature of the workplaces must be adequate for the human body during working time, taking into account the work methods applied and the physical risks imposed on workers.

In Spanish legislation, specifically in RD 486/97 concerning minimum safety and health provisions in the workplace (27) sets the environmental conditions of the workplaces and in one of its sections establishing that the environmental conditions of the workplaces must not constitute a source of discomfort or inconvenience for the workers.

For this purpose, extreme temperatures and humidity, sudden temperature changes, annoying air currents, unpleasant odors, excessive irradiation and, in particular, solar radiation through glazed windows, lights or partitions must be avoided.

In this regulatiion, the National Institute for Occupational Safety and Health (INSHT) was obliged to elaborate the "Technical guide for the evaluation and prevention of risks related to the use of workplaces" (28). In this guide the conditions to be met in the enclosed workplaces are established:

a. The temperature of working places where sedentary works of offices or similar are carried out will be between 17 and 27º C. The temperature of working places where light works are carried out will be between 14 and 25º.

b. The relative humidity will be between 30 and 70%, except in places where there are risks of static electricity where the lower limit will be 50%.

But both the RD 486/97 and the Technical Guide leave doubts about the risk diagnosis method, comfort or discomfort and especially about its prevention.

Furthermore, Directive 93/103 / EC, of November 23, establishes the minimum safety and health at work provisions on board fishing vessels (29), but merchant ships remain in the limbo of the General Ordinance of Safety and Hygiene at Work (OGSHT), of 1971, specifically, of its Title II, "General conditions of workplaces and protection mechanisms and measures" (30).

It is also important to mention the absence of recommendations and regulations related to the thermal shock that workers suffer when they suddenly pass and without a period of acclimatization of a room at a high temperature to another of much lower temperature, with their corresponding negative response in the health of these individuals. A clear example are greasers, officers and other engine room personnel of a ship, who continually have to leave the engine control room and enter other compartments subject to high temperatures and poor ventilation in many cases.

7. CONCLUSIONS

- The two most serious risks of heat exposure are dehydration and heat stroke.

- The pathology produced by thermal heat stress, is characterized by its acute onset; and can cause death. The first step to be taken will be from prevention; eliminating or at least reducing the risk.

- Sea professionals, on numerous occasions are exposed to inadequate work environments with high temperatures and humidity indices. This poses a serious health risk as well as an obstacle to their productivity. But cost plays an important role, and in the absence of legislation and / or management that regulates the need to improve thermohygrometric conditions (ambient temperature, radiant temperature, humidity, air renewal, ventilation) in enclosures such as the engine rooms of ships, shipowners and shipping companies cut costs and limit themselves to conditioning these spaces with jets of air directed to the interior of the room that take their drive, in many cases, from garages or warehouses located in upper holds and decks, but that are stale environments with fumes and gases and high temperatures.

- Due to the particularity of the ship as a work and living place and the complexity of its design and structure, in terms of regulations and legislation on minimum conditions that must be met by workplaces and maximum permissible values of various variables, this is generally excluded from compliance with those laws. This is the case, for example, in Spain, where Royal Decree 486/97, on the minimum provisions for Safety and Health in Workplaces, in its section a) of Article 1.2 excludes workplaces located within the means of transport (ships), and in section e), to fishing vessels. Subsequently, Royal Decree 1216/1997, dated July 18, established the minimum health and safety regulations at work on board fishing vessels, but merchant ships remain in the limbo of the General Ordinance of Occupational Health and Safety (OGSHT), of 1971, specifically, of its Title II, "General conditions of workplaces and protection mechanisms and measures".

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