GulfofMexico

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Operations – HSE

Heat Stress Prevention

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3	6/26/17	Revised - Issued for GoM Use	GoM IH Advisor	Health Manager
2	04/01/16	Revised - Issued for GoM Use	GoM Occupational Health Advisor	Health Manager
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AMENDMENT RECORD

Amendment Date	Revision Number	Amender Initials	Amendment
6/26/17	3	Cheryl Metzler	Replaced Work/Rest Schedule using updated table from Heat Stress Index website. Minor verbiage changes.
04/01/16	2	Laura East Mark Glencross Diana Haines Valerie Murray	Minor verbiage changes and reformatting.
08/18/15	1	Laura East	Change next review date to April 1, 2016. Changed Document Authority and Custodian, no other revisions
07/31/12	0		Initial Issue. This new comprehensive practice replaces the heat stress index guidelines UPS-US-SW-GOM-HSE-DOC-00024-2 and SPM Chapter 16, Heat Stress UPS-US-SW-GOM-HSE-DOC-00221-2.

Table of Contents

1 Purpose and Scope

The purpose of this practice is to describe the various physiological effects of heat stress and the methods of recognition and prevention to safeguard personnel from the potential effects. This program applies to BP Gulf of Mexico (GoM) facilities.

2 Key Responsibilities

Managers/Supervisors

Managers and supervisors are responsible for preventing heat stress related illnesses by providing;

- Education and information to ensure that personnel understand the causes and recognition of heat stress illnesses,
- Education and information to ensure that personnel understand and can apply protective methods and procedures to prevent and/or respond to heat stress illnesses,
- An acclimatization schedule for personnel as the hot season begins, as new employees enter the workforce and for those employees coming back to work after an extended leave.
- All administrative, work practice and engineering controls necessary.

Employees

Employees must;

- Understand the causes and hazards associated with heat stress illnesses,
- Understand the protective measures and procedures used to prevent and/or respond to heat stress illnesses,
- Apply the protective measures and procedures to themselves and be alert to practices and work conditions of others.

H&S Site Lead

The H&S Site Lead is responsible for providing;

- Information, training and on-site support as needed.
- Provide the recommended work-rest cycle to the OIM using the Heat Stress Index table.

Industrial Hygienist

The industrial hygienist is responsible for providing information, training and on-site assistance and monitoring as needed.

Medic

The medic is responsible to provide primary care using SMS protocols. Upon notification of a potential heat illness the OIM shall be notified immediately.

3 General Requirements

Operations performed in hot environments can lead to harmful heat stress on the body. Factors affecting the amount of heat stress include temperature, humidity, radiant heat (such as from a flare, furnace, or the sun), air velocity, direct physical contact with hot objects, and the level of physical activity. How a person functions under conditions of heat stress will be unique to the individual and will depend on:

- Age
- Weight
- Metabolism
- Alcohol or drug use
- Pre-existing medical conditions
- Hypertension
- Use of medications
- Level of physical fitness
- Acclimatization

Offshore personnel have the potential to be vulnerable to heat disorders during strenuous physical activity or while working in hot environments. Heat disorders may result in time lost from duty, serious injury, or in extreme cases, death. Many of these disorders also result in prolonged or permanent impairment of the affected person's ability to withstand heat, so initial prevention is particularly important. Personnel who are: not acclimated to a hot environment, overweight, or in poor physical condition may be particularly susceptible to heat illness.

The type of clothing worn and use of personal protective equipment (PPE) will also influence the heat load experienced by a worker. Thick, heavy clothing that does not allow good air flow around the body will increase a worker's heat load. In relation to PPE, the use of respiratory protection, especially self-contained breathing apparatus (SCBA) will increase worker heat load because of the extra weight and the resistance to breathing imposed.

If a worker's body temperature rises too high they can become ill. The severity depends on the temperature of the work area, how active they are, and how well their body copes with heat. Some of the various types of heat disorders in decreasing order of severity include heat stroke, heat exhaustion, heat cramps, heat syncope, heat rashes, and heat fatigue.

3.1 Heat-Related Illnesses – Signs, Symptoms, and First Aid

Acute overheating may lead to numerous heat-related illnesses, such as heat rash, heat cramps, heat exhaustion, and heatstroke. Redness of the skin is often the first sign noted, and personnel with this

appearance need to be scrutinized for additional symptoms. If dizziness, upset stomach, or changes in sweating from profuse to almost none occur, first aid must promptly be rendered. When the body is unable to cool by sweating, heat stress, heat exhaustion, and the most severe, heat stroke can occur and result in death.

3.1.1 Heat Stroke

Heat stroke occurs when the body's system of temperature regulation fails and the body's temperature reaches critical levels. The body temperature can be so high that the victim loses consciousness. Continued exposure can strain the circulatory system, and can result in stroke or heart failure. Individuals with heart or circulatory problems are at even greater risk. The elevated metabolic temperatures caused by a combination of work load and environmental heat load, both of which contribute to heat stroke, are highly variable and difficult to predict.

Heat stroke can be life-threatening and must be treated as a medical emergency. Symptoms are:

Table 1. Heat Stroke – Signs, Symptoms, and Treatment

Signs and Symptoms	**First Aid**
Signs and symptoms of heat stroke center around its effects on the brain. They include: Throbbing headache/dizziness Skin may be hot & dry – not always Slurred speech Chills and/or shivering Erratic or unexpected behavior Confusion Unconsciousness Convulsions	Take the following steps to treat a worker with heat stroke: Call Medic immediately. Transport by Stokes, Stair Chair, or carry to IP Sick Bay while **cooling immediately** with water soaked cloth. Make arrangements for transportation to medical facility identified in the Facility Emergency Response Plan.

Medical attention should be obtained immediately. If the body temperature rises too high, death will follow. While waiting for professional treatment, the victim should be moved to a cool area and efforts should be made to lower the body temperature. The victim's outer layer of clothing should be removed. Cool compresses should be applied or cool water should be showered over the victim's body with a hose. Care should be taken not to cool the individual too rapidly such as through the use of ice bath. Air movement around the victim's body should be increased to improve evaporative cooling. Fluids should be replaced immediately. The medical outcome of a heat stroke episode will depend on the fitness level of the victim and the timing and effectiveness of first aid treatment.

Personnel suspected of suffering a heat stroke should never be left alone, sent home to a physician unattended, or left without treatment, even if the individual requests otherwise. If the individual became unconscious, an IV is administered, or other medical treatment is given (prescription drugs), the event is classified as an OSHA recordable illness.

3.1.2 Heat Exhaustion

Heat exhaustion is usually not life-threatening, but can strike any worker who is physically active in a hot work environment. Heat exhaustion occurs when the body loses more water than it is consuming. Symptoms include:

Table 2. Heat Exhaustion – Signs, Symptoms, and First Aid

Signs and Symptoms	**First Aid**
Signs and symptoms of heat exhaustion include: Noticeable weakness or fatigue Dizziness Nausea Clammy, moist skin Pale or flushed complexion Fast and shallow breathing Associated with heat syncope (fainting)	Treat a worker suffering from heat exhaustion with the following: Call Medic. Rest in a cool, shaded or air-conditioned area. Drink electrolyte drinks or water. If it persists, consider a cool shower, or similar means to cool the skin. Use Stair Chair if available to assist with transport to Sick Bay.

Fortunately, this condition responds readily to prompt treatment. However, heat exhaustion should not be dismissed lightly. The possibility of fainting associated with heat exhaustion can be dangerous in situations where the victim is operating machinery or controlling an operation that should not be left unattended.

3.1.3 Heat Syncope ("Fainting")

Heat syncope occurs when the brain does not receive enough oxygen because of excessive pooling of the blood in the body's extremities. Consequently, the exposed individual loses consciousness. This reaction is similar to that of heat exhaustion. It is rapid and unpredictable. For prevention, the worker should gradually acclimatize. Symptoms include:

Table 3. Heat Syncope – Signs, Symptoms, and First Aid

Signs and Symptoms	First Aid
Signs and symptoms of heat syncope include: Sudden light-headedness Sudden dizziness Grey-out or black-out Fainting	Workers with heat syncope should: Sit or lie down in a cool place when they begin to feel symptoms. Call Medic. Slowly drink water or electrolyte drink per Medic orders. If they have fainted, assist Medic in transportation to Sick Bay for further evaluation. Use Stair Chair if available.

3.1.4 Heat Cramps

Heat cramps may affect people who sweat a lot during strenuous activity. This sweating creates a fluid and electrolyte imbalance in the muscles which causes painful cramps. Heat cramps may also be a symptom of heat exhaustion.

Table 4. Heat Cramps – Signs, Symptoms, and First Aid

Signs and Symptoms	First Aid
Signs and symptoms of heat cramps: Muscle pain or spasms usually in the abdomen, arms, or legs	Workers with heat cramps should: Stop all activity, and sit in a cool place. Drink water or a sports beverage (3 waters to 1 Gatorade volume). Do not return to strenuous work for a few hours after the cramps subside to assure recovery Seek medical attention if any of the following apply or for any questions: The worker has heart problems. The worker is on a low-sodium diet. The cramps do not subside within one hour.

Heat cramps usually result from performing hard physical labor in a hot environment. Cramps often occur in the muscles used during work and can be alleviated easily by resting and drinking water. The condition should not be allowed to progress to a more serious level of heat stress.

Salt tablets should not be used for treatment because they tend to cause retention of both salt and water in the digestive system, which will deprive the rest of the body of water and electrolytes.

Methods for preventing heat stroke, heat exhaustion, heat syncope and heat cramps include the following:

Drink Plenty of Fluids

During hot weather you will need to increase your fluid intake, regardless of your activity level. Don't wait until you're thirsty to drink. During heavy work in a hot environment, drink 1 cup/15 or 20 mins (16-32 ounces) of cool fluids each hour.

Warning: If your doctor generally limits the amount of fluid you drink or has you on water pills, ask how much you should drink while the weather is hot.

Don’t drink in excess of 50 ounces of water each hour as this can lead to water intoxication or hyponatremia; not more than 12 quarts (50 cups) in a 24 hour period.

Don't drink liquids that contain alcohol, or large amounts of sugar—these actually cause you to lose more body fluid. Also avoid very cold drinks, because they can cause stomach cramps.

Replace Salt and Minerals

Heavy sweating removes salt and minerals from the body. These are necessary for your body and must be replaced. If you must work, drink two to four glasses of cool, non-alcoholic fluids each hour. A sports beverage can replace the salt and minerals you lose in sweat. However, if you are on a low-salt diet, talk with your doctor before drinking a sports beverage or taking salt tablets.

3.1.5 Heat Rashes

Heat rash is the least serious of the heat-related illnesses. It is a skin irritation caused by excessive sweating in humid weather or with prolonged use of chemical protective clothing.

Table 5. Heat Rashes – Signs, Symptoms, and First Aid

Signs and Symptoms	First Aid
Signs and symptoms of heat rash include: Red cluster of pimples or small blisters. More likely to occur on the neck and upper chest, in the groin, under the breasts, and in elbow creases.	Workers experiencing heat rash should: Keep the affected areas clean and dry. Periodically allow the skin to dry. Dusting powder may be used to increase comfort. Seek medical attention if the symptoms do not improve.

3.1.6 Heat Fatigue

A predisposing factor of heat fatigue is the lack of acclimatization. Symptoms include impaired performance of skilled sensorimotor, mental, or vigilance jobs. There are not any specific recommendations for treatment unless the condition is accompanied by other heat illness. The use acclimatization and training for work in hot environments is advisable.

4 Procedure/Process

4.1 Administrative and Work Practices Controls

4.1.1 Training

Training provides information on good work practices for the prevention of heat stress illnesses. A good heat stress training program should cover at least the following components:

- Signs and symptoms of heat stress
- Risk factors for developing heat stress
- First-aid procedures
- Employee responsibilities in avoiding heat stress
- Dangers of the use of drugs (including prescription medications) and alcohol in hot work environments
- Correct use of protective clothing and equipment

4.1.2 Exposure Monitoring

Screening – Recommended Work Rest Cycle

Even fit individuals who are acclimated to the high temperatures can be affected by temperatures above 86 degrees Fahrenheit. Table 6 GoM recommended Work Rest Cycle lists the recommended work:rest schedule and the respective water intake recommendations. This table is to be used in conjunction with the Heat Stress Index tool found on the BP GoM Weather website. The forecasted risk level from the heat stress index will correlate to the recommended resting times. This tool is available May 1 through September 30 (the high risk months for heat stress for Gulf of Mexico operations). It includes all GoM work locations onshore and offshore (shown on the left side of the website); the location list is regularly updated by the GoM Meterologist.

Table 6. GoM recommended Work Rest Cycle.

Work/Rest Cycles & Water Intake*							
		Light Work		Moderate Work		Heavy Work	
	Heat Index (° F)	Work/Rest (Minutes)	Water Intake/Hr (Qts)	Work/Rest (Minutes)	Water Intake/Hr (Qts)	Work/Rest (Minutes)	Water Intake/Hr (Qts)
	< 78	No Limit	N/A	No Limit	N/A	No Limit	N/A
	78 - 81.9	No Limit	1/2	No Limit	3/4	40/20	3/4
	82 - 84.9	No Limit	1/2	50/10	3/4	30/30	1
CAUTION	85 - 87.9	No Limit	3/4	40/20	3/4	30/30	1
CAUTION	88 - 89.9	No Limit	3/4	30/30	3/4	20/40	1
CAUTION	90 - 95	50/10	1	20/40	1	10/50	1
WARNING	95 - 105	50/10	1	20/40	1	------	------
DANGER	>105						

*The work/rest recommendations above are conservative values (Ref. US Army Technical Bulletin Med 507). Task risk assessments should use professional judgement to determine the work/rest schedule.

Body Leading Indicator

In a hot environment, the heart beats faster to circulate more blood to the skin for heat loss to the environment and sweating brings water to the skin's surface for heat loss by evaporation. Heart rate is strongly correlated with work intensity. The sustained peak heart rate (180 – subject's age) is the leading indicator that an individual's thermal regulatory control may not be adequate. The sustained

peak heart rate represents cardiovascular demand of about 75% of maximum aerobic capacity and the heart should not spend more than several minutes at or above this rate. Heart rate monitors provide a sensitive measure for immediate feedback. These can be used intermittently as an educational tool or continuously during heavy work.

Body Lagging Indicator

Weight loss greater than 1.5% over a shift indicates a greater risk of heat strain. Workers should weigh at the beginning of the shift and at the end of the shift; before and after weighing should be done wearing the same clothing.

The % weight change is calculated as follows:

$$\% \text{ weight change} = \frac{(\text{Final weight} - \text{Initial weight})}{\text{Initial weight}} \times 100$$

4.1.3 Task Management Controls

Task Management Controls that should prove effective are:

- Position job task to optimize prevailing wind. Provide extra ventilation, such as fans.
- Reduce the physical demands of work by reducing manual handling or using worker rotation.
- Provide recovery areas such as air conditioned enclosures and rooms. Shaded break areas at 76 degree F with drinking water at 50-60 F – cool, but not ice-cold, are considered adequate.
- Hot jobs should be scheduled for the cooler part of the day and routine maintenance and repair work in hot areas should be scheduled for the cooler seasons of the year.
- Use different work shifts, e.g. early morning, cool part of the day, or night work.
- Use intermittent rest periods with water breaks.
- Use relief workers.
- Use worker/task pacing.
- Assign extra workers.
- Limit worker occupancy, or numbers of workers present especially in confined or enclosed spaces.
- Use Buddy System to monitor team members. “Stop the Job” when the buddy needs a break.

4.1.4 Acclimatization

The human body can adapt to heat exposure up to a point. This physiological adaptation is called acclimatization. After acclimatization, the same activity will produce lower level cardiovascular demands. The worker will sweat more efficiently (causing better evaporative cooling), may lose less salt, and thus will more easily maintain normal body temperatures.

A properly designed acclimatization program decreases the risk of heat-related illnesses and unsafe acts. Such a program basically involves exposing employees to work in a hot environment for progressively longer periods. According to NIOSH, workers who have had previous experience in jobs where heat levels are high enough to produce heat stress, the regimen should be 50 percent exposure on day 1, 60 percent on day 2, 80 percent on day 3, and 100 percent on day 4. For new workers who will be similarly exposed, the regimen should be 20 percent on day 1, with a 20 percent increase in exposure each additional day.

During high heat (temperatures which equal or exceed 95◦F), and where there is a sudden rise in temperatures, heat illness can develop even faster. Remember, if you are acclimated to 95◦F, acclimation does not scale up overnight to 100 ◦F!!

Acclimatization is lost quickly. Workers returning to work after three or more days away from a hot work environment, i.e. first three days of shift, should be monitored more closely for heat stress.

4.1.5 Fluid Replacement

Cool (50-60° F) water or any cool liquid (alcoholic beverages excluded) should be made available to workers in such a way that they are able to frequently drink small amounts, e.g., one cup every 15-20 minutes. Ample supplies of liquids should be placed close to the work area. Commercial replacement drinks that contain salt are not usually necessary for acclimatized individuals.. Unacclimatized individuals may need salted drinking water in a concentration of 0.1%.

Note: Caffeinated products can act as diuretics and may result in additional dehydration.

4.2 Engineering Controls

Ventilation, air cooling, fans, insulation and shielding are the five major types of engineering control used to reduce heat stress in hot work environments. The same goal may also be achieved by using power assists and tools that reduce the physical demands placed on a worker. However, for this approach to be successful, the metabolic effort required for the worker to put these devices into use or to operate them must be less than the effort required without them.

4.2.1 Ventilation

General ventilation is used to dilute hot air with cooler air (generally cooler air that is introduced from the outside). This technique clearly works better in cooler climates than in hot ones. A permanently installed ventilation system usually handles large areas or entire buildings. Portable or local exhaust systems may be more effective or practical in smaller areas.

4.2.2 Air Cooling/Air Treatment

Air cooling and treatment differs from ventilation because it reduces the temperature of the air by removing heat (and sometimes humidity) from the air.

Air conditioning is a method of air cooling, but it is expensive to install and operate. An alternative is the use of chillers to circulate cool water through heat exchangers over which air from the ventilation system is then passed. Chillers, like general dilution ventilation, are more efficient in cooler climates than in warmer ones. Local air cooling can be effective in reducing air temperature in specific areas.

Two methods have been used successfully in industrial settings. The first method is to provide cool rooms enclosing a specific work place or offering a recovery area near hot jobs. The second method is using a portable blower with built-in air chiller. The main advantage of a blower, aside from portability, is its minimal set-up time.

4.2.3 Convection

Another way to reduce heat stress is to increase the air flow or convection using fans, etc. in the work area (as long as the air temperature is less than skin temperature). Changes in air speed can help workers stay cooler by increasing both the convective heat exchange (the exchange between the skin surface and the surrounding air) and the rate of evaporation. Because this method does not actually cool the air, any increases in air speed must impact the worker directly to be effective.

If the temperature is higher than 95° F, the hot air passing over the skin may actually make the worker hotter and offset any increase gained in evaporative cooling. Increases in air speed have no effect on workers wearing vapor-barrier clothing.

4.2.4 Heat Conduction

Heat conduction solutions include insulating the hot surface(s) that generate(s) the heat and changing the surface itself.

4.2.5 Radiant Heat

Simple engineering controls, such as shields or barriers, can be used to reduce the effects of radiant heat coming from hot surfaces. Any shield, whether temporary or permanent, should be situated so as not to interfere with the air flow. The reflective surface of the shield should be kept clean to maintain its effectiveness.

The maximum allowable thermal radiation levels are specified in GP 44-80 Relief Disposal and Depressurization Systems, 7.5.e. Contact the Industrial Hygiene Group for additional guidance as appropriate.

4.3 Personal Protective Equipment

4.3.1 Ice Vests

Commercially available ice vests, though heavy, may accommodate numerous ice packets, which are usually filled with water. Carbon dioxide, dry ice, can also be used as a coolant. The cooling offered by ice packets lasts only two to four or less hours at moderate to heavy heat loads, making frequent replacement necessary. However, ice vests do not encumber the worker with air supply or power cords, therefore permitting maximum mobility. Cooling with ice is also relatively inexpensive.

4.3.2 Water-cooled Garments

These garments range from a hood which cools only the head, to vests and “long-johns”, which offer partial or complete body cooling. This equipment requires a battery-driven circulating pump, liquid-ice coolant and a container.

Although this system has the advantage of allowing wearer mobility, the weight of the other components limits the amount of ice that can be carried and thus reduces the effective use time. The heat transfer rate in liquid cooling systems may limit their use to low-activity jobs; even in such jobs, their service time is only about 20 minutes per pound of cooling ice.

An outer insulating jacket should be an integral part of these systems to keep outside heat from melting the ice.

4.3.3 Air Circulation Cooling

The most highly effective, as well as the most complicated, personal cooling system is one that uses circulating air. By directing compressed air around the body from a supplied air system, both evaporative and convective cooling are improved. The greatest advantage occurs when circulating air is used with impermeable garments or double cotton overalls.

One type, used when respiratory protection is also necessary, forces exhaust air from a supplied-air hood ("bubble hood") around the neck and down inside an impermeable suit. The air then escapes through openings in the suit.

Air can also be supplied directly to the suit without using a hood. This can be done three ways:

- By a single inlet
- By a distribution tree
- By a perforated vest

Also, a vortex tube can be used to reduce the temperature of circulating air. The cooled air from this tube can be introduced either under the clothing or into a bubble hood. The use of a vortex tube acts as a heat pump which separates the air stream into a hot and a cold stream and also can be used to heat in cold climates. It is, however, noisy and requires a constant source of compressed air supplied through an attached air hose. One problem with this system is the limited mobility of workers whose suits are attached to an air hose. These systems should therefore be used in work areas where there is not much moving around or climbing.

4.3.4 Respirator Usage

The use of a self-contained breathing apparatus (SCBA) itself and its additional weight adds stress to the user, and this stress will add to the overall heat stress of the worker.

4.3.5 Chemical Protective Clothing

Chemical protective clothing such as the totally encapsulated chemical protection suits will also add to the heat stress problem. Frequent rotation of workers may be necessary.

4.4 Heat Stress Prevention/Monitoring

When working in hot environments, a supervised system of breaks vs. worktime should be established. When breaks are given a cool or shady area should be available for rest with plenty of water and fluids.

Drinking water should be made available to the workers in such a way that they are stimulated to frequently drink small amounts (i.e. 1 cup every 15 minutes in the Caution risk level).

The Industrial Hygiene Group can monitor various worksite conditions, such as temperature, humidity and the sun's radiant effect to determine protective measures and work/rest regimens.

5 Definitions

Acclimatization - The American Conference of Governmental Industrial Hygienist (ACGIH) defines acclimatization as a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Acclimatization requires physical activity under heat-stress conditions similar to those anticipated for the work.

Conduction - is the transfer of heat from particles that are touching each other in a stationary situation such as in the transfer of heat from the skin to air. The air temperature must be cooler than skin temperature for this to occur.

Convection - is the circulation of that air next to the skin, which results in an increased cooling action.

Evaporation - is the cooling of the body that takes place when sweat evaporates on the skin surface.

Heat Stress - ACGIH defines heat stress as "the net heat load to which a worker may be exposed from the combined contributions of metabolic cost of work, environmental factors and clothing requirements.

Metabolic heat - is a by-product of the body's activity.

Radiation - is the transfer of heat energy through space. For example, the heat from a flare or from the sun will transfer to (or heat) objects in their surrounding areas.

6 Key Documents, Tools, Reference

ACGIH TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices

GP 44-80 - Relief Disposal and Depressurization Systems

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Document Authorization Form

Navigate through the form with the Tab key to fill in data. Just click on the boxes you wish to check

This form to be used for non-critical documents only.
Refer to GOO GoM Management of Change Procedure for list of critical documents and additional guidance.

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Other Instructions & Comments
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