State of Qatar
MINISTRY OF PUBLIC HEALTH


# HEAT STRESS

## Guidelines & Recommendations

# HEAT STRESS

GUIDELINES & RECOMMENDATIONS

BY
OCCUPATIONAL HEALTH SECTION
PUBLIC HEALTH DEPARTMENT

# PREFACE

This updated Heat Stress Awareness Guide was developed by the occupational health section of The Ministry Of Public Health under the supervision of the manager of Health Promotion and Non-Communicable diseases to provide information and advice on preventing managing and controlling heat stress in the workplace.

This guideline may be cited as the Guidelines on Heat Stress Management at Workplace.

It is targeting employers, managers, supervisors, workers, joint health and safety committee members, health and safety representatives, employer associations, and health and safety Professionals.

To address the occupational health challenges, we work in partnership with other governmental agencies, non-governmental organizations, private sector and international organizations such as WHO and ILO.

This guideline provides guidance on how to recognize, estimate, prevent and treat heat stress at work. It also serves as a guide to employers in avoiding discomfort from hot environment at work. Risk assessment and risk control has been elaborated in this guideline based on heat stress estimation using wet bulb globe temperature (WBGT). Heat stress can increase stress and fatigue which can lead to serious health conditions for workers working in hot environments and may increase workplace accidents.

Low awareness among employers and employees on exposure to heat stress is common and need to be addressed.

This guideline is meant to be used by employers having hot environment and activities at work. This guideline will be reviewed from time to time.

We would like to express our sincere gratitude to all those who contributed to the development of the Heat Stress guidelines & recommendations. It is our hope that these guidelines will be adopted by all industries and implemented in all workplaces throughout the state of Qatar.

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# Contents

# 1. Where does heat stress occur?

Workplaces involving heavy physical work in hot, humid environments can put considerable heat stress on workers. Hot and humid conditions can occur either indoors or outdoors.

***Examples**:*

| outdoors | Indoors |
|---|---|
| Road building | Steel mills and foundries |
| Home building | Boiler rooms |
| Work on bridges | Pulp and paper mills |
| Trenching | Generation plants |
| Pouring and spreading tar or asphalt | Petrochemical plants |
| Working on flat or shingle roofs | Smelters |
| Excavation and grading | Furnace operations |
| Electrical utilities | Oil and chemical refineries |
| | Electrical vaults |
| | Interior construction and renovation |

Asbestos removel, work with hazardous wastes, and othet operations that require workers to wear semi-permeable or impermeable protective clothing can contribute significantly to heat stress. Heat stress causes the body's core temperature to rise.

## 2. What happens when the body's core temperature rises?

The human body functions best within a narrow range of internal temperature. This "core" temperature varies from 36°C to 38°C.The body uses two cooling mechanisms:

1 The heart rate increases to move blood and heat from heart, lungs, and other vital organs to the skin.

2 Sweating increases to help cool blood and body.

3 Evaporation of sweat is the most important way the body gets rid of excess heat.

When the body's cooling mechanisms work well, core temperature drops or stabilizes at a safe level (around 37°C). But when too much sweat is lost through heavy labor or working under hot, humid conditions, the body does not have enough water left to cool itself. The result is dehydration and core temperature rises above 38°C. A series of heat-related illnesses, or heat stress disorders, can then develop.

## 3. How can we recognize heat stress disorders?

Heat stress disorders range from minor discomforts to life-threatening conditions:

◊ Heat rash
◊ Heat cramps
◊ Heat exhaustion
◊ Heat stroke.

### (3.1) Heat Rash

Heat rash is also known as prickly heat and is the most common problem inhot work environments.

***Symptoms include:***

◊ Red blotches and extreme itchiness in areas persistently damp with seat

◊ Prickling sensation on the skin where sweating occurs.

***Treatment***

◊ Cool environment
◊ Cool shower
◊ Thorough drying

In most cases, heat rashes disappear a few days after heat exposure ceases.If the skin is not cleaned frequently enough the rash may become infected.

## (3.2) Heat Cramps

Under extreme conditions, such as removing asbestos from hot water pipes for several hours in heavy protective gear, the body loses salt through excessive sweating. Heat cramps can result. These are spasms in larger muscles, usually back, legs, and arm. Cramping creates hard painful lumps within the muscles.

***Treatment***

Stretch and massage the muscles; replace salt by drinking commercially carbohydrate or electrolyte replacement fluids.

## (3.3) Heat Exhaustion

This occurs when the body can no longer keep blood flowing to supply vital organs and to the skin to reduce body temperature.. Signs and symptoms include:

◊ Weakness
◊ Difficulty continuing work
◊ Headache
◊ Breathlessness
◊ Nausea or vomiting
◊ Feeling faint or fainting

Workers fainting from heat exhaustion while operating machinery, vehicles,or equipment can injure themselves and others.

***Treatment***

Heat exhaustion casualties respond quickly to prompt first aid. If not treated promptly, however, heat exhaustion can lead to heat stroke which is a medical emergency.

◊ Call 999.
◊ Help the casualty to cool off by
  - Resting in a cool place
  - Drinking cool water
  - Removing unnecessary clothing
  - Loosening clothing
  - Showering or sponging with cool water.

It takes 30 minutes at least to cool the body down once a worker becomes overheated and suffers heat exhaustion.

## (3.4) Heat Stroke

Heat stroke occurs when the body can no longer cool itself and body temperature rises to critical levels.

The primary signs and symptoms of heat stroke are:

◊ Confusion
◊ Irrational behavior
◊ Loss of consciousness
◊ Convulsions
◊ Lack of sweating
◊ Hot, dry skin
◊ Abnormally high body temperature for example 41°C

***Treatment***

For any worker showing signs or symptoms of heat stroke,

◊ Call 999.
◊ Provide immediate, aggressive, general cooling.
  - Immerse casualty in tub of cool water or
  - Place in cool shower or
  - Spray with cool water from a hose.
  - Wrap casualty in cool wet sheets and fan rapidly.
◊ Transport casualty to hospital.
◊ Do not give anything by mouth to an unconscious casualty.

***Warning***

◊ Heat stroke can be fatal even after first aid is administered. Anyone suspected of suffering from heat stroke should not be sent home or left unattended unless that action has been approved by physician.

If in doubt as what type of heat-related disorder the worker is suffering, call for medical assistance.

# لون البول يشير إلى مدى حاجة الجسم للماء

## The color of urine tells how your body needs water

## پیشاب کا رنگ کہتا ہے کتنا پانی آپ کے جسم کو ضرورت ہے؟

## മൂത്രത്തിന്റെ ഈ നിറങ്ങൾ ശരീരത്തിൽ എങ്ങനെ വെള്ളം ആവശ്യമെന്ന് പറയുന്നു

اشرب ماء على الفور

Drink Water Immediately

پانی کو فوری طور پر پیو

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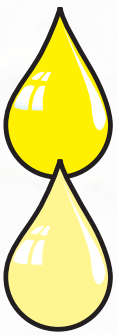

اشرب مزيداً من الماء

Drink More Water

اور زیادہ پانی پیو

ധാരാളം വെള്ളം കുടിക്കുക

جيد: استمر في شرب الماء

Good: Continue Drinking Water

اچھا ہے : پانی پینا جاری رکھو

നല്ലത് : വെള്ളം കുടി തുടരുക

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*Heat stress Disorders*

| | Cause | Symptoms | Treatment | Prevention |
|---|---|---|---|---|
| **Heat rash** | Hot humid environment; plugged sweat glands. | Red bumpy rash with severe itching. | Change into clean dry clothes often and avoid hot envi-ronments. Rinse skin with cool water. | Wash regularly to keep skin clean and dry. |
| **Heat cramps** | Heavy sweating from strenuous physical activity drains a person's body of fluid and salt, which cannot be replaced just by drinking water. Cramps occur from salt imbal-ance resulting from failure to replace salt lost from heavy sweating | Painful cramps commonly in the most worked muscles (arms, legs or stomach) which occur suddenly at work or later at home. Heat cramps are serious because they can be a warning of other more dangerous heat-induced Illnesses. | Move to a cool area; loosen clothing, gently massage and stretch affected muscles and drink cool salted water (1/4 to 1/2 tsp. salt in 1 liter of water) or balanced commer-cial fluid electrolyte replacement bever-age. If the cramps are severe or don't go away after salt and fluid replacement, seek medical aid. Salt tablets are not recom-mended. | Reduce activity levels and/or heat exposure. Drink fluids regularly. Workers should check on each other to help spot the symptoms that often precede heat stroke. |

| | | | | |
|---|---|---|---|---|
| **Fainting** | Fluid loss, inadequate water intake and standing still, resulting in decreased blood flow to brain. Usually occurs in people who have not been acclimatized. | Sudden fainting after at least 2 hours of work; cool moist skin; Weak pulse. | GET MEDICAL ATTENTION: assess need for CPR. Move to a cool area; loosen clothing; make person lie down; and if the person is conscious offer sips of cool water. Fainting may also be due to other illnesses. | Reduce activity levels and/or heat exposure. Drink fluids regularly. Move around and avoid standing in one place for too long. Workers should check on each other to help spot the symptoms that often Precede heat stroke. |
| **Heat exhaustion** | Fluid loss and inadequate salt and water intake causes a person's body cooling system to start to break down | Heavy sweating; cool moist skin; body temperature over 38°C; weak pulse; normal or low blood pressure; person is tired and weak, and has nausea and vomiting; is very thirsty or is panting or breathing rapidly; vision may be blurred. | GET MEDICAL ATTENTION: This condition can lead to heat stroke, which can kill. Move the person to a cool shaded area; loosen or remove excess clothing; provide cool water to drink; fan and spray with cool water. Do not leave affected person alone. | Reduce activity levels and/or heat exposure. Drink fluids regularly. Workers should check on each other to help spot the symptoms that often precede heat stroke. |

| | | | | |
|---|---|---|---|---|
| **Heat stroke** | If a person's body Heat has used all its water and salt reserves, it will stop sweating. This can cause the body temperature to rise. Heat stroke may develop suddenly or may follow from heat exhaustion. | High temperature (over 41°C) and any one of the following: the person is weak, confused, upset or acting strangely; has hot dry, red skin; a fast pulse; head-ache or dizziness. In later stages, a person may pass out and have convulsions. | CALL AMBULANCE. This condition can kill a person quickly. Remove excess clothing; fan and spray the person with cool water if the person is conscious | Reduce activity levels and/or heat exposure. Drink fluids regularly. Workers should check on each other to help spot the symptoms that often precede heat stroke. |

## 4. Medical Monitoring

The employer should institute a medical monitoring program for all workers who are or may be exposed to heat stress above the Action Level (AL), whether they are acclimatized or not (NIOSH 2016). A medical monitoring program is essential to assess and monitor workers' health and physical well-being both prior to and while working in hot environments; to provide emergency medical care or other treatment as needed and gather medical information.

The employer should ensure that all medical evaluations and procedures are performed by or under the direction of the responsible healthcare provider (e.g., licensed physician or other licensed and/or credentialed healthcare professional).

## (4.1) Preplacement Medical Evaluations

For the purposes of the preplacement medical evaluation, all workers should be considered to be unacclimatized to hot environments. At a minimum, the preplacement medical evaluation of each prospective worker for a hot job should include the following elements:

(1) A comprehensive work and medical history. The medical history should include a comprehensive review of all body systems as would be standard for a preplacement physical examination, along with specific questions regarding previous episodes of diagnosed heat-related illness, rhabdomyolysis, and questions aimed at determining acclimatization to the new employment environment.

(2) A comprehensive physical examination should be conducted. At the discretion of the responsible healthcare provider, candidates who anticipate increased stress of physical activity of the job in a hot environment, those over 50 years of age or those younger than 50 years of age with underlying cardiac risk factors may need to have additional testing (e.g., electrocardiogram (ECG) with interpretation by a cardiologist).

(3) An assessment of the use of therapeutic drugs, over-the-counter medications, supplements, alcohol, or caffeine that may increase the risk of heat injury or illness.

(4) An assessment of obesity, defined as a body mass index (BMI) ≥ 30. Measure height and weight to calculate body mass index.

(5) An assessment of the worker's ability to wear and use any protective clothing and equipment, especially respirators, that is or may be required to be worn or used.

(6) In addition, greater physical demand and exertion in a hot environment can result in more stress on the cardiopulmonary system; therefore screening may need to be more thorough [Ramphal-Naley 2012].

## (4.2) Periodic Medical Evaluations

Periodic medical evaluations should be made available at least annually to all workers who may be exposed at the worksite to heat stress exceeding the AL.

Evaluations should include the following:

(1) An occupational and medical history update and a physical examination focused on the cardiovascular, respiratory, nervous, and musculoskeletal systems and the skin, performed annually.

(2) Consideration of specific medical tests when deemed appropriate by the responsible healthcare provider.

## (4.3) Emergency Medical Care

If the worker develops signs or symptoms of heat stroke or heat exhaustion, the employer should provide immediate emergency medical treatment (e.g., call 999 and cool down the worker). Other non-life-threatening heat-related illnesses may be treated with appropriate first aid procedures.

## (4.4) Surveillance of Heat-related Sentinel Health Events

### *a. Definition*

Surveillance of heat-related sentinel health events is defined as the systematic collection and analysis of data concerning the occurrence and distribution of adverse health effects in defined populations at risk for heat injury or illness.

### *b. Requirements*

In order to evaluate and improve prevention and control measures for heat-related effects, the following should be obtained and analyzed for each workplace:

(a) Workplace modifications,

(b) Identification of highly susceptible workers,

(c) Data on the occurrence or recurrence in the same worker,

(d) Distribution in time, place, and person of heat-related adverse effects, and

(e) Environmental or physiologic measurements related to heat.

## 5. What factors are used to assess heat stress risk?

Factors that should be considered in assessing heat stress include:

- ◊ Personal factors
- ◊ Environmental factors
- ◊ Job factors

### (5.1) Personal factors

It is difficult to predict just who will be affected by heat stress and when, because individual susceptibility varies. There are, however, certain physical conditions that can reduce the body's natural ability to withstand high temperatures:

◊ **Weight**

Workers who are overweight are less efficient at losing heat

◊ **Poor physical conditions**

Being physically fit aids your ability to cope with the increased demands that heat places on your body .

◊ **Previous heat illnesses**

Workers are more sensitive to heat if they have experienced a previous heat – related illnesses.

◊ **Age**

As the body ages, its sweat glands become less efficient. Workers over 40 years may therefore have trouble with hot environments. Acclimatization to the heat and physical fitness can offset some age- related problems.

◊ **Heart disease or high blood pressure**

In order to pump blood to the skin and cool the body, the heart rate increases This can cause stress on the heart.

◊ **Recent illness**

Workers with recent illnesses involving diarrhea, vomiting, or fever have an increased risk of dehydration and heat stress because their bodies have lost salt and water.

◊ **Alcohol consumption**

Alcohol consumption during the previous 24 hours leads to dehydration and increased risk to heat stress

### ◊ Medication

Certain drugs may cause heat intolerance by reducing sweating or increasing urination. Workers who work in a hot environment should consult their physician.

### ◊ Lack of acclimatization

When exposed to heat for a few days, the body will adapt and become more efficient in dealing with raised environmental temperature. This process is called acclimatization. Acclimatization usually takes six to seven days. Benefits include:

- Lower pulse rate and more stable blood pressure
- More efficient sweating ( causing better evaporative cooling)
- Improved ability to maintain normal body temperatures.

Acclimatization may be lost in as little as three days away from work. People returning to work after a holiday or long weekend – and their supervisors–should understand this. Workers should be allowed to gradually re-acclimatize to work conditions.

## (5.2) Environmental Factors

Environmental factors such as ambient air temperature, air movement, and relative humidity can all affect an individual's response to heat. The body's exchanges heat with its surroundings mainly through radiation and sweat evaporation. The rate of evaporation is influenced by humidity and air movement.

### ◊ Radiant heat

Radiation is the transfer of heat from hot objects through air to the body. Working around heat sources such as kilns or furnaces will increase heat stress. Additionally, working in direct sunlight can substantially increase heat stress. A worker is far more comfortable working at 24°C under cloudy skies than working at 24°C under sunny skies.

### ◊ Humidity

Humidity is the amount of moisture in the air. Heat loss by evaporation is hindered by high humidity but helped by low humidity. As humidity rises, sweat tends to evaporate less. As a result, body cooling decreases and body temperature increases.

### ◊ Air movement

Air movement affects the exchange of heat between the body and the environment. As long as the air temperature is less than the worker's skin temperature, increasing air speed can help workers stay cooler by increasing both the rate of evaporation and the heat exchange between the skin surface and the surrounding air.

## (5.3) Job Factors

### ◊ Clothing and personal protective equipment (PPE)

Heat stress can be caused or aggravated by wearing PPE such as fire or chemical-retardant clothing. Coated and non–woven materials used in protective garments block the evaporation of sweat and can lead to substantial heat stress. The more clothing worn or the heavier the clothing, the longer it takes evaporation to cool the skin. Remember too that darker-colored clothing absorbs more radiant heat than lighter- colored clothing.

### ◊ Workload

The body generates more heat during heavy physical work. For example, workers shoveling sand or laying brick in hot weather generate a tremendous amount of heat and are at risk of developing heat stress without proper precautions. Heavy physical work requires careful evaluation even at temperatures as low as 23°C to prevent heat disorders. This is especially true for workers who are not acclimatized to the heat.

## 6. Acclimatization

Acclimatization is a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Acclimatization usually takes several days with gradual build-up to expected heat loads, work loads and duration of the job. If a person has not been working in a hot area, the same level of performance should not be expected as that of a person who has become acclimatized to the heat. Generally, it takes about a week to become 90 per cent acclimatized to high heat levels. This is done by starting at a reduced pace on the first day and gradually increasing the amount of work and duration of exposure in the hot area each day the first week.

Consideration should be given to workers returning from rotation, for example from offshore duty. If the worker has been away for several days in a significantly cooler area and/or has experienced a less strenuous work or exercise setting, an acclimatization schedule should be implemented if possible. Some acclimatization is lost after being on vacation for several weeks or returning from an extended illness.

| Table 4 suggested acclimatization / re acclimatization guidelines | | | | | |
|---|---|---|---|---|---|
| **Acclimatization** | | | | | |
| Day | Activity (as apercentage of full work assignment) | | | | |
| | Experienced worker | New worker | | | |
| 1 | 50% | 20% | | | |
| 2 | 60% | 40% | | | |
| 3 | 80% | 60% | | | |
| 4 | 100% | 80% | | | |
| 5 | 100% | 100% | | | |
| **Re- acclimatization** | | | | | |
| Absence | Illness ( day away from heat- related jobs routine) | Exposure sequence (percent of full work assignment per day) | | | |
| | | Day 1 | Day 2 | Day 3 | Day 4 |
| <4 | - | 100% | | | |
| 4-5 | 1-3 | R/E* | 100% | | |
| 6-12 | 4-5 | 80% | 100% | | |
| 12-20 | 6-8 | 60% | 80% | 100% | |
| >20 | >8 | 50% | 60% | 80% | 100% |
| *R/E = reduced expectations by the worker and supervision | | | | | |

## 7. Measurement of Heat Stress

Heat stress is the net heat load to which a worker is exposed from the combined contributions of metabolic heat, environmental factors, and clothing worn which results in an increase in heat storage in the body.

The environmental factors of heat stress are temperature and movement of air, water vapor pressure, and radiant heat. Physical work contributes to total heat stress of a job by producing metabolic heat in the body in proportion to the work intensity. The amount, thermal characteristics, and type of clothing worn also contribute by altering the rate of heat exchange between the skin and the air [OSHA 1999].

## (7.1) The Wet Bulb Globe Temperature

The wet bulb globe temperature (WBGT) index is the most widely used and accepted index for the assessment of heat stress in industry.

The WBGT index is an empirical index. It represents the heat stress to which an individual is exposed. The index was developed specifically for use in industrial settings. The practicalities of an industrial application necessitated a compromise between the requirement for a precise index and the need to be able to easily take controlled measurements.

## (7.2) Position Of Measuring Equipment

For the determination of the WBGT index, it is sufficient to carry out one measurement at 1.1 meters from the floor level where the heat stress is maximum. The equipment will be placed as near as possible to the source of heat.

## (7.3) Sampling Duration

The time base for measurement of WBGT shall be taken in total one hour corresponding to the maximum heat stress. i.e. generally in the middle of the day or when the heat-generating equipment is in operation. In addition, the measurement time is set to be taken at intervals of every five minutes that will give a total of 12 samples for one hour at specific areas.

## (7.4) Sampling Methods

***Environmental Measurements***

Environmental heat measurements should be made at, or as close as possible to, the specific work area where the worker is exposed. When a worker is not continuously exposed in a single hot area but moves between two or more areas having different levels of environmental heat, or when the environmental heat varies substantially at a single hot area, environmental heat exposures should be measured for each area and for each level of environmental heat to which employees are exposed.

# 8. Are there measures for evaluating heat stress risk?

To prevent heat stress, scientists from the (WHO) have determined that workers should not be exposed to environments that would cause their internal body temperature to exceed 38°C. The only true way of measuring internal body temperature is rectally (oral or inner ear measurements are not as accurate). As an alternative, the American conference of governmental industrial hygienists (ACGIH) has developed a method of assessing heat stress risk based on a wet bulb globe temperature (WBGT) threshold (table 2).

This method of assessment involves the three main components of the heat burden experienced by workers:

- ◊ Thermal environment
- ◊ Type of work
- ◊ Type of clothing.

## (8.1) Thermal environment

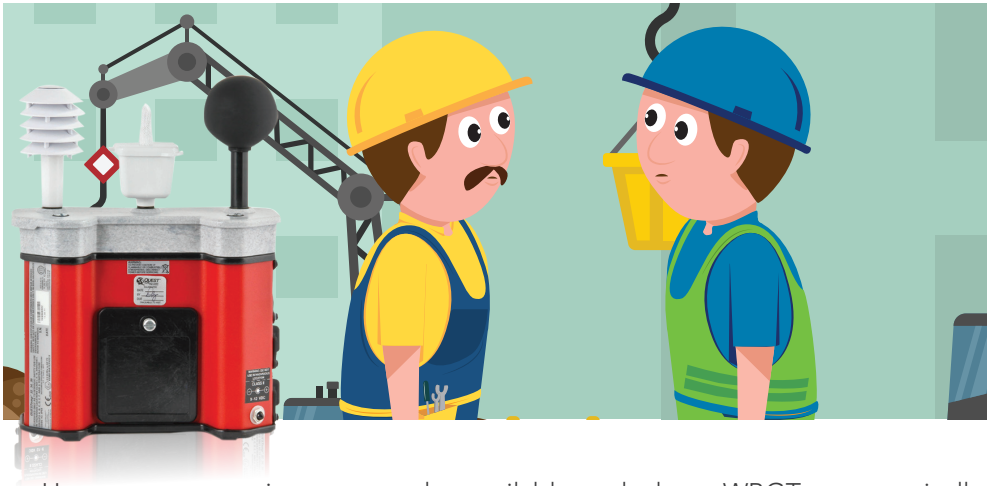
The first factor in assessing heat stress is the thermal environment as measured by WBGT index. WBGT is calculated in degrees Celsius using a formula which incorporates the following three environmental factors:

- ◊ Air temperature
- ◊ Radiant heat (heat transmitted to the body through the air from hot objects such as boilers or shingles heated by the sun)
- ◊ Cooling effects of evaporation caused by air movement (humidity).

To measure WBGT, a heat stress monitor consisting of three types of thermometers is required:

- ◊ A normal thermometer called a dry bulb thermometer is used to measure air temperature.
- ◊ Radiant heat is measured by a black bulb globe thermometer. This consists of a hollow; 6-inch diameter copper ball painted flat black and placed over the bulb of a normal thermometer.
- ◊ A wet bulb thermometer measures the cooling effect of evaporation caused by air movement (wind or fan). It consists of a normal thermometer wrapped in a wick kept moist at all times. As air moves through the wet wick, water evaporates and cools the thermometer in much the same way that sweat evaporates and cools the body.

## Heat stress Monitor



Heat stress monitors currently available calculate WBGT automatically. Theequipment required and the method of measuring WBGT can be found in the ACGIH booklet.
Calculation depends on whether sunlight is direct (outdoors) or not (indoors).

### ◊ Working outdoors in direct sunlight

For work in direct sunlight, WBGT is calculated by taking 70% of the wet bulb temperature, adding 20% of the black bulb temperature, and 10% of the dry bulb temperature.
WBGT (OUT)= (70%(0.7)×wet bulb temperature)+(20%(0.2)× black bulb globe temperature)+ [10%(o.1)×dry bulb temperature]

### ◊ Working indoors (no sun light)

For work indoors or without direct sunlight, WBGT is calculated by taking 70% of the wet bulb temperature and adding 30% of the black bulb temperature.
WBGT (in) = [70 %( o.7) ×wet bulb temperature] + [30 %( 0.3) ×black bulb globe temperature]
Example
Suppose it's a bright sunny day and a crew of roofers is working 20 feet above ground. Our assessment yields the following readings:
Wet bulb temperature (cooling effects of evaporation) = 20°C
Black bulb globe temperature (radiant) = 36°C

Dry bulb temperature (air temperature) = 33°C
Using the formula for work in direct sunlight, we calculate as follows:
WBGT=90.7×wet bulb temperature) + (0.2×black bulb globe temperature)
+ (0.1×dry bulb temperature)
= (0.7×20) + (0.2×36) + (0.1×33)
= 14+7.2+33
WBGT (outdoors) = 24.5°C

## (8.2) Type of Work

The second factor in assessing heat stress is the type of work being performed. Following are the four categories, with some examples of each:

| | |
|---|---|
| **Light work** | • Using a table saw<br>• Walking<br>• Operating a crane, truck, or other vehicle<br>• Welding |
| **Moderate work** | • Laying bricks<br>• Walking with moderate lifting or pushing<br>• Hammering nails<br>• Tying rebar<br>• Raking asphalt<br>• Sanding drywall |
| **Heavy work** | • Sawing by hand<br>• Shoveling dry sand<br>• Laying blocks<br>• Ripping out asbestos<br>• Scraping asbestos fireproofing material |
| **Very heavy work** | • Shoveling wet sand<br>• Lifting heavy objects |

## (8.3) Types of Clothing

Free movement of cool, dry air over the skin maximizes heat removal. Evaporation of sweat from the skin is usually the major method of heat removal. WBGT-based heat exposure assessments are based on a traditional summer work uniform of long-sleeved shirts and long pants. With regard to clothing, the measured WBGT value can be adjusted according to table 1

**Table1:** additions to measured WBGT value for some types of clothing

| Clothing type | Addition to WBGT |
|---|---|
| Work clothes (long-sleeved shirt and pants) | 0 |
| Cloth (woven material) coveralls | 0 |
| SMS polypropylene coveralls | +0.5 |
| Polyolefin coveralls | +1 |
| Double-layer woven clothing | +3 |
| Limited-use vapor-barrier coveralls | +11 |

**Note:** these values must not be used for completely encapsulating suits, often called Level A. Clothing adjustment factors cannot be added for multiple layers. The coveralls assume that only modestly clothing is worn undemeath, not a second layer of clothing.

## 9. Determine Work / Rest Schedules

The WBGT can be used to determine work/rest schedules for personnel under various conditions. Knowing that the WBGT is 24.5°C in the example above, you can refer to Table 2 and deWtermine that workers accustomed to the heat "acclimatized ", wearing summer clothes, and doing "heavy" work can perform continuous work (100% work). Suppose work is being performed indoors at a pulp and paper mill under the following conditions:

- Workers are wearing cloth coveralls.
- Boilers are operational.
- Work load is moderate
- General ventilation is present.

Our assessment yields the following readings:
Wet bulb temperature (Cooling effects of evaporation) = 23°C
Black bulb globe temperature (radiant heat) = 37°C
Dry bulb temperature (air temperature) = 34°C
Using the formula for work indoors, we calculate as follows:
WBGT= (0.7×wet bulb temperature)+(0.3×black bulb globe temperature)=
(0.7×23)+(0.3×37) = 27.2°C
Addition for cloth coveralls
(table1) = 0
WBGT (indoors) = 27.2°C
Referring to Table 2, we determine that workers accustomed to the heat, wearing cloth coveralls, and performing "moderate" work can work.

The WBGT must never be used as indicator of safe or unsafe conditions. It is only an aid in recognizing heat stress. The ultimate assessment and determination of heat stress must lie with the individual worker or co-worker trained to detect its symptoms. Supervisors must allow individual workers to determine if they are capable of working in heat.Table 2 is intended for use as a screening step only. Detailed methods of analysis are fully described in various technical and reference works.

**Table 2:** screening criteria for Threshold Limit Values (TLV) and Action Limit for Heat Stress Exposure

| Allocation of work in acycle of work and recovery | TLV* | | | | Action Limit* | | | |
|---|---|---|---|---|---|---|---|---|
| | Light | Moderate | Heavy | Very Heavy | Light | Moderate | Heavy | Very Heavy |
| 75 to 100% | 31.0 | 28.0 | - | - | 28.0 | 25.0 | - | - |
| 50 to 75% | 31.0 | 29.0 | 27.5 | - | 28.5 | 26.0 | 24.0 | - |
| 25 to 50% | 32.0 | 30.0 | 29.0 | 28.0 | 29.5 | 27.0 | 25.5 | 24.5 |
| 0 to 25% | 32.5 | 31.5 | 30.5 | 30.0 | 30.0 | 29.0 | 28.0 | 27.0 |

Table 2 is intended as an initial screening tool to evaluate whether a heat stress situation may exist. These values are not intended to prescribe work and recovery periods.

***Notes***

- ◊ WBGT values are expressed in °C. WBGT is NOT air temperature.
- ◊ WBGT-based heat exposure assessments are based on a traditional summer work uniform of long –sleeved shirt and long pants.
- ◊ If work and rest environments are different, hourly time-weighted average (TWA) should be calculated and used. TWAs for work rates should also be used when demands of work vary within the hour.
- ◊ Because of physiological strain produced by very heavy work among less fit workers, the table does not provide WBGT values for very heavy work in the categories 100% work and 75% work;25% Rest. Use of the WBGT is not recommended in these cases. Detailed and /or physiological monitoring should be used instead.

Because many workplaces are transient and variable in nature it may not be practicable to measure WBGT. It's therefore reasonable to ask if there are other ways to evaluate heat stress risk.

## 10. Risk Evaluation

The risk of heat-related stress depends on the WBGT. In general, the following criteria in Table 8 can be used to make a decision on the severity of the risk, see table 3.

**Table 3:** Risk Decision

| **RISK DECISION** | |
|---|---|
| ADJUSTED WBGT VALUE | DECISION |
| WBGT adjusted < Action Limit | Low Risk |
| Action Limit < WBGT adjusted<TLV | Medium Risk |
| WBGT adjusted > TLV | High Risk |

The occupational exposure limits can be given as work/rest regimen for working in hot environments, see (Table7).

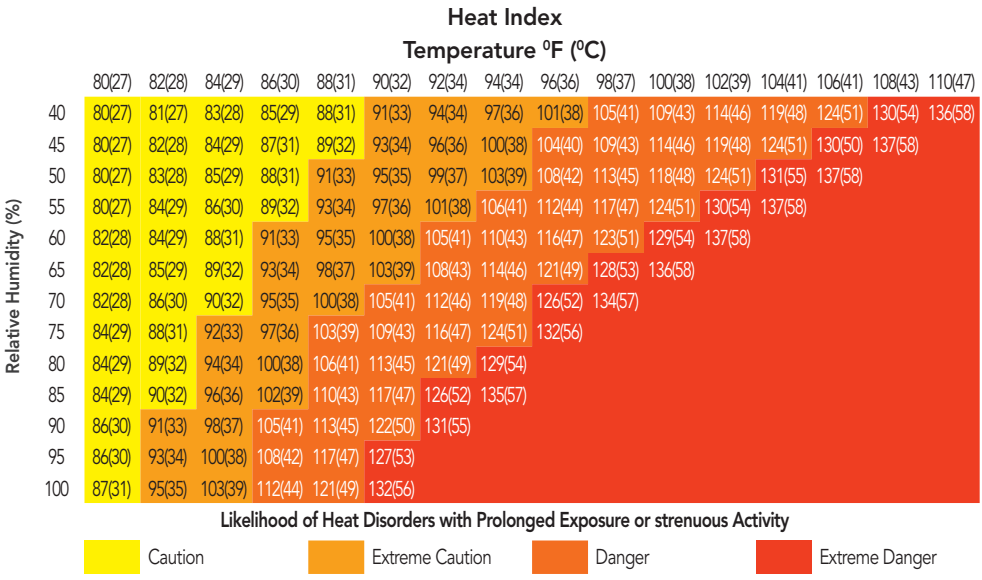
| Work Load | Work Rate | | | |
|---|---|---|---|---|
| | Continuous work | 15 minutes rest per hour | 30 minutes rest per hour | 45 minutes rest per hour |
| Heavy | up to 25.0$^0$C | 25.0$^0$C to 26.0C | 26.0$^0$C to 26.0$^0$C | 28.0$^0$C to 30.0$^0$C |
| Moderate | up to 27.0$^0$C | 27.0$^0$C to 28.0C | 28.0$^0$C to 29.0$^0$C | 29.0$^0$C to 31.0$^0$C |
| Light | up to 30.0$^0$C | 30.0$^0$C to 30.6C | 30.6$^0$C to 31.4$^0$C | 31.4$^0$C to 32.2$^0$C |

Table 7 Recommended Rest Break Schedules for Acclimatized Workers,(Wet Bulb Globe Temperature (WBGT) Index )
OSHA
Sources: "http://www.labour.gov.sk.ca/safety/thermal/hot/page%208%20.htm"

### *Heat Index and Relative Humidity RH*

The National Oceanic and Atmospheric Administration (NOAA) issues heat alerts based on the heat index values, as seen in the chart above. The Heat Index is a measure of how hot it feels when RH is taken into account with the actual air temperature. Since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15°F.

**Table 5:** Heat Index from (NOAA)




Adapted from NOAA (2012)

**Table 6:** Heat index–associated protective measures for worksites

| Heat index | Risk level | protective measure |
|---|---|---|
| Less than $91^0$F($33^0$C) | Lower (caution) | Basic health and safety planning |
| $91^0$F to $103^0$F ($33^0$C to $39^0$C) | Moderate | Implement precautions and heighten awareness |
| $103^0$F to $115^0$F ($39^0$C to $46^0$C) | High | Additional precautions to protect workers |
| Greater than 1150F($46^0$C) | Very high to extreme | Even more aggressive protective measures |

Adapted from OSHA (2012 c)
Additional information about protective mentioned in the above table can be found on OSHA's website
Note: The presence of a radiant heat source may decrease the accuracy and usefulness of the above heat index

### *Heat Index vs. Web Bulb Globe Temperature*

Wet Bulb Globe Temperature (WBGT) is a more accurate, though more complex, way to measure heat stress than the heat index. In addition to combining temperature and humidity, WGBT takes into account radiant heat, wind velocity, the angle of the sun, cloud cover and other factors. Because it's more difficult to measure, WGBT isn't used as often as the heat index. However, if you have an industrial hygienist or other safety professional familiar with WBGT on your site, you can get a more accurate idea of the risks faced by workers.

In 2002 Coyle (Coyle, J.F., 2002) published a paper in which he developed an equation to estimate WBGT based on the Heat Index (HI) under 3 different conditions. The WBGT estimations are as follows for:

| HI | WBGT |
|---|---|
| 80 | 81 |
| 82 | 82 |
| 84 | 83 |
| 86 | 84 |
| 88 | 85 |
| 90 | 86 |
| 92 | 87 |
| 94 | 88 |
| 96 | 89 |
| 98 | 90 |
| 100 | 91 |
| 102 | 92 |
| 104 | 93 |
| 106 | 94 |
| 108 | 95 |
| 110 | 96 |
| 112 | 97 |
| 114 | 98 |
| 116 | 99 |
| 118 | 100 |
| 120 | 100 |

## 11. How can Heat Stress be Controlled?

Heat stress can be controlled through education, engineering, and work procedures. Controls will:

◊ **Protect health**

Illness can be prevented or treated while symptoms are still mild.

◊ **Improve safety**

Workers are less likely to develop a heat- related illness and have an accident. Heat stress often creeps up without warning. Many heat- induced accidents are caused by sudden loss of consciousness.

◊ **Increase productivity**

Workers feel more comfortable and are likely to be more productive as a result.

## (11.1) Training and Education

According to the (NIOSH), heat stress training should cover the following components:

- ◊ Knowledge of heat stress hazards
- ◊ Recognition of risk factors, danger signs, and symptoms
- ◊ Awareness of first–aid procedures for, and potential health effects of,heat stroke
- ◊ Employee responsibilities in avoiding heat stress
- ◊ Dangers of using alcohol and/or drugs (including prescription drugs) in hot work environments.

## (11.2) Engineering Controls

Engineering controls are the most effective means of preventing heat stress disorders and should be the first method of control. Engineering controls seek to provide a more comfortable workplace by using

- ◊ Reflective shields to reduce radiant heat
- ◊ Fans and other means to increase airflow in work areas
- ◊ Mechanical devices to reduce the amount of physical work.

When engineering controls are not feasible or practical, work procedures are required to prevent heat stress disorders.

## (11.3) Work Procedures

The risks of working in hot environments can be diminished if labor and management cooperate to help control heat stress.

## Management

◊ Give workers frequent breaks in a cool area away from heat. The area
◊ should not be so cool that it causes cold shock – around 25°C is ideal.
◊ Increase air movement by using fans where possible. This encourages
◊ body cooling through evaporation of sweat.
◊ Provide unlimited amounts of cool (not cold) drinking water conveniently
◊ located.
◊ Allow sufficient time for workers to become acclimatized.

A properly designed and applied acclimatization program decreases the risk of heat-related illnesses. Such a program exposes employees to work in a hot environment for progressively longer periods. NIOSH recommends that for workers who have had previous experience in hot jobs, the regimen should be

- 50% exposure on day one
- 60% on day two
- 80% on day thee
- 100% on day four.

For new workers in a hot environment, the regimen should be 20% on day one, with a 20% increase in exposure each additional day.

- ◊ Make allowances for workers who must wear personal protective clothing and equipment that retains heat and restricts the evaporation of sweat.
- ◊ Schedule hot jobs for the cooler part of the day; schedule routine maintenance and repair work in hot areas for the cooler seasons of the year.
- ◊ Consider the use of cooling vests containing ice packs or ice water to help rid bodies of excess heat.

## Labor

- ◊ Wear light, loose clothing that permits the evaporation of sweat.
- ◊ Drink small amounts of water- 250ml- every half hour or so.
- ◊ Avoid beverages such as tea, coffee, or beer that make you pass urine
- ◊ more frequently.
- ◊ Where personal PPE must be worn,
- ◊ Use the lightest weight clothing and respirators available.
- ◊ Use PPE that allows sweat evaporate.
- ◊ Avoid eating hot, heavy meals.
- ◊ Don’t take salt tablets unless a physician prescribes them.

# 12. What are the responsibilities of workplace parties regarding Heat Stress?

## (12.1) Employers

Employers should develop a written health and safety policy outlining how workers in hot environments will be protected from heat stress. As a minimum, the following points should be addressed:

- Adjust work practices as necessary when workers complain of heat stress.
- Make controlling exposures through engineering controls the primary means of control wherever possible.
- Oversee heat stress training and acclimatization for new workers, workers who have been off the job for a while, and workers with medical conditions.
- Provide worker education and training, including periodic safety talks on heat stress during hot weather or during work in hot environments.
- Monitor the workplace to determine when hot conditions arise.
- Determine whether workers are drinking enough water.
- Determine a proper work/rest regime for workers.
- Arrange first-aid training for workers.

When working in manufacturing plant, for instance, a contractor may wish to adopt the plant's heat stress program if one exists.

## (12.2) Workers

- Follow instructions and training for controlling heat stress.
- Be alert to symptoms in yourself and others.
- Avoid consumption of alcohol, illegal drugs, and excessive caffeine.
- Find out whether any prescription medications you're required to take can increase heat stress.
- Get adequate rest and sleep.
- Drink small amounts of water regularly to maintain fluid levels and avoid dehydration.

# 13. APPENDIX

## Assessing Heat Stress Hazards Using the Humidex

WBGT is the most common index for setting heat stress limits, especially when sources of radiant heat are present. It has proven to be adequate when used as part of a program to prevent adverse health effects in most hot environments.

However, taking WBGT measurements properly is quite complicated. This section provides a simplified version of the WBGT by converting the WBGT into humidex. The method was developed by the occupational health clinics for Ontario workers. It allows workplace parties to measure heat stress using only workplace temperature and humidity. The following five steps are designed to help workplaces determine whether conditions require action to reduce heat stress.

## Step 1: Clothing

- The humidex plan assumes workers are wearing regular summerclothes (light shirt and pants, underwear, and socks and shoes).
- If workers wear cotton coveralls on top of summer clothes, add 5°C humidex to the workplace humidex measurement.
- Estimate correction factor for other kinds of clothing by comparing them with cotton coveralls (e.g. gloves, hard hat, apron, and protective sleeves might be equivalent to a little less than half the evaporation resistance of coveralls, so add 1°C or 2°C humidex).

## Step 2: Training

- Measurements by themselves cannot guarantee workers protection from heat stress. It is essential that workers learn to recognize the early signs and symptoms of heat and how to prevent them.
- If it is possible, workers need to be able to alter their pace of work, take rest breaks, and drink in response to early symptoms ( a cup of water every 20 minutes). The ideal heat stress response plan would let workers regulate their own pace by “listening to their body”.

## Step 3: Select a measurement location

- Divide the workplace into zones which have similar heat exposures.
- Select a representative location in each zone where you can take measurements. Note: the humidex heat stress response (Table B) is based on workplace measurements, not weather station/media reports (temperatures inside buildings don't necessarily correspond with outside temperature).

## Step 4: measure workplace humidex

- A thermal hygrometer is a simple way to measure the temperature and relative humidity in your workplace. Avoid placing the thermal hygrometer in direct sunlight or in contact with hot surface. Once you have the temperature and humidity, use Table A (or the humidex calculator located: http:www.ohcow.on.ca/menuweb/heat_stress_calculator.him) to determine the corresponding humidex value.
- From Table B, select Humidex 1 or Humidex 2 according to the amount of physical activity involved with the work and the level of acclimatization. This helps you determine what steps should be taken to reduce the heat stress. Humidex 1 is for moderate unacclimatized and heavy acclimatized work; humidex 2 is for light unacclimatized work (sitting/standing doing light am work).

## Step 5: Adjust for radiant heat

- Outdoor work in direct sunlight between the hours of 10 am and 5 pm, 1-2°C (pro-rate according to percentage could cover) to your humidex measurement.
- For indoor radiant heat exposures (such as boilers or furnaces),use common sense to judge whether the exposure involves more or less radiant heat than direct sunlight and adjust the 1-2°C correction factor appropriately.

See Table A and Table B on the following pages.

## 13.1. Table A

| °C | Relative Humidity (in percent) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100 | 95 | 90 | 85 | 80 | 75 | 70 | 65 | 60 | 55 | 50 | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 |
| 49 | | | | | | | | | | | | | | | | | | | 50 |
| 48 | | | | | | | | | | | | | | | | | | | 49 |
| 47 | | | | | | | | | | | | | | | | | | 50 | 47 |
| 46 | | | | | | | | | | | | | | | | | | 49 | 46 |
| 45 | | | | | | | | | | | | | | | | | 50 | 47 | 45 |
| 44 | | | | | | | | | | | | | | | | | 49 | 46 | 43 |
| 43 | | | | | | | | | | | | | | | | 49 | 47 | 45 | 42 |
| 42 | | | | | | | | | | | | | | | 50 | 48 | 46 | 43 | 41 |
| 41 | | | | | | | | | | | | | | | 48 | 46 | 44 | 42 | 40 |
| 40 | | | | | | | | | | | | | | 49 | 47 | 45 | 43 | 41 | 39 |
| 39 | | | | | | | | | | | | | 49 | 47 | 45 | 43 | 41 | 39 | 37 |
| 38 | | | | | | | | | | | | 49 | 47 | 45 | 43 | 42 | 40 | 38 | 36 |
| 37 | | | | | | | | | | | 49 | 47 | 45 | 44 | 42 | 40 | 38 | 37 | 35 |
| 36 | | | | | | | | | 50 | 49 | 47 | 45 | 44 | 42 | 40 | 39 | 37 | 35 | 34 |
| 35 | | | | | | | | 50 | 48 | 47 | 45 | 43 | 42 | 40 | 39 | 37 | 36 | 34 | 33 |
| 34 | | | | | | | 49 | 48 | 46 | 45 | 443 | 42 | 40 | 39 | 37 | 36 | 34 | 33 | 31 |
| 33 | | | | | 50 | 48 | 47 | 46 | 44 | 43 | 41 | 40 | 39 | 37 | 36 | 34 | 33 | 32 | 30 |
| 32 | | | 50 | 49 | 48 | 46 | 45 | 44 | 42 | 41 | 40 | 38 | 37 | 36 | 34 | 33 | 32 | 30 | 29 |
| 31 | 50 | 49 | 48 | 47 | 45 | 44 | 43 | 42 | 40 | 39 | 38 | 37 | 35 | 34 | 33 | 32 | 30 | 29 | 28 |
| 30 | 48 | 47 | 46 | 44 | 43 | 42 | 41 | 40 | 39 | 37 | 36 | 35 | 34 | 33 | 31 | 30 | 29 | 28 | 27 |
| 29 | 46 | 45 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 |
| 28 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 |
| 27 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | | |
| 26 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 33 | 332 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | | | |
| 25 | 37 | 36 | 35 | 34 | 33 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 26 | 25 | | | | |
| 24 | 35 | 34 | 33 | 33 | 32 | 31 | 30 | 29 | 28 | 28 | 27 | 26 | 25 | | | | | | |
| 23 | 33 | 32 | 31 | 31 | 30 | 29 | 28 | 28 | 27 | 26 | 25 | | | | | | | | |
| 22 | 31 | 30 | 30 | 29 | 28 | 27 | 27 | 26 | 25 | 25 | | | | | | | | | |
| 21 | 29 | 29 | 28 | 27 | 26 | 26 | 25 | | | | | | | | | | | | |

## 13.2. Table B

| **Humidex 1**<br>moderate unacclimatized<br>and heavy acclimatized work | **Response**<br>Never ignore someone's symptoms no matter what you measure! | **Humidex 2**<br>light unacclimatized work (sitting/ standing doing light arm work) |
|---|---|---|
| 30-37 | **Low**<br>• Alert workers to potential for heat stress.<br>• Ensure access to water. | 34-41 |
| 38-39 | **Medium**<br>• Reduce physical activity (e.g., slower pace, double up, breaks).<br>• Drink a cup of water every 20-30 minutes. | 42-43 |
| 40-42 | **Moderate**<br>• Reduce physical activity further.<br>• Drink a cup of water every 15-20 minutes. | 44-45 |
| 43-44 | **High**<br>• Ensure sufficient rest and recovery time. Severely curtail physical activity.<br>• Drink a cup of water every 10-15 minutes | 46-48 |
| 45<br>or over | **Extreme**<br>• It is hazardous to continue physical activity. | 49<br>or over |

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# الإجهاد الحراري

# HEAT STRESS

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## PROTECT YOURSELF AT WORK

## احمي نفسك أثناء عملك

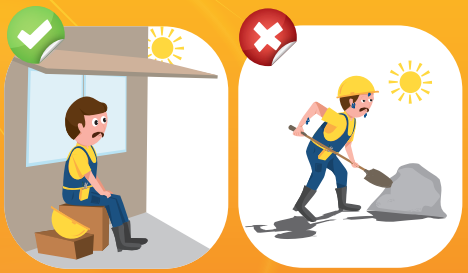
- إشرب الماء البارد كل ١٥ دقيقة
- تجنب شرب الشاي والقهوة ومشروبات الطاقة والمشروبات الغازية

- DRINK COOL WATER EVERY 15 MINUTES
- AVOID TEA, COFFEE, ENERGY DRINKS & SOFT DRINK

- ഒരോ 15 മിനുറിലും തണുത്ത വെള്ളം കുടിക്കുക
- ചായ, കാപ്പി, ഉത്തേജക പാനീയങ്ങൾ, ശീതള പാനീയങ്ങൾ തുടങ്ങിയവ ഉപേക്ഷിക്കുക

- خذ قسطاً من الراحة بشكل متكرر أثناء العمل

- SCHEDULE MORE FREQUENT BREAKS DURING THE WORK
- ജോലി സമയങ്ങളിൽ ഇടക്കിടെ വിശ്രമിക്കാൻ ശ്രമിക്കുക



- تناول الغذاء الصحي والخفيف

- EAT RIGHT EAT LIGHT
- നല്ല ഭക്ഷണം മിതമായ അളവിൽ കഴിക്കുക

- احرص على إرتداء ملابس خفيفة وواسعة
- غطي رأسك في الأماكن الخارجية

- WEAR LIGHT, LOOSE CLOTHING
- KEEP YOUR HEAD COVERED WHEN OUTDOORS
- അയഞ്ഞതും, കനം കുറഞ്ഞതുമായ വസ്ത്രം ധരിക്കുക
- പുറത്ത് പോകുമ്പോൾ തല മറക്കുക

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