National Council for
Occupational Safety & Health

Guideline

Preventing Effects of Working in High-Temperature

2024

Introduction

This guide aims to inform employers, project managers, and workers about the health risks associated with working in high temperatures, as well as methods for prevention and management. It offers practical advice and preventive measures, both engineering and administrative, along with awareness messages.

This guideline is in line with the procedural manual for occupational safety and health of preventing effects of working in high-temperature issued by the Ministry of Human Resources and Social Development (Ministerial Decision No. 196086, dated 29/10/1442). The procedural manual draws on global best practices, relevant technologies, and established standards as key sources of information.

Scope

This Manual is about the occupational safety and health requirements related to work in thermal environments by clarifying roles, responsibilities and preventive procedures from risks and impacts, through providing the mentoring and education programs, as well as the need to provide preventive occupational safety and health requirements in all workplaces and responding to emergencies from exposure to thermal hazard at workplace.

Terms and Definitions

Sunstroke (Heat stroke):

Heat stroke, the most severe form of heat illness, occurs when the body's heat-regulating system is overwhelmed by excessive heat. It is a life-threatening emergency and requires immediate medical attention.

Heat Syncope:

Heat syncope occurs when a person faints suddenly and loses consciousness because of low blood pressure.

TWL (Temperature Working Limit):

Refers to the maximum temperature at which people can work without being exposed to significant health risks from heat. The TWL is calculated using factors such as air temperature, humidity, wind speed, and solar radiation, and its value is determined based on internationally recognized occupational health and safety standards.

Self-employment:

It is work that allows workers to adjust their work rate according to environmental conditions.

Acclimatization:

The process of the body adapting to heat. Acclimatization may be lost in as little as three days away from work. People returning to work after time away will need to be reacclimated. Acclimatization helps the body redirect blood to the skin’s surface; the heart becomes more efficient, and sweating starts sooner with more regulated salt (electrolytes) loss.

Unacclimatized worker:

This term refers to new workers or those who have been out of work for more than 14 days due to illness or leave (in a colder climate area).

Light work:

It involves minimal effort and is limited to sitting, standing, and moving the arms.

Terms and Definitions

Heavy work:

It involves tasks such as lifting, climbing, pushing, and using the entire body to perform the work.

Indoor workplaces:

These are enclosed work areas where suitable temperatures must be maintained, not less than 20 degrees Celsius in cold areas, with cooling measures available in hot areas, and adequate ventilation in place.

Heat Map:

A map that serves to illustrate the geographic locations with the highest temperatures during the summer season.

Global Warming:

The increase in global surface temperature along with an increase in carbon dioxide levels, and an increase in methane gases as a result of the greenhouse gas effect, which contributes to an overall increase in earth's atmosphere temperature.

Heatwaves:

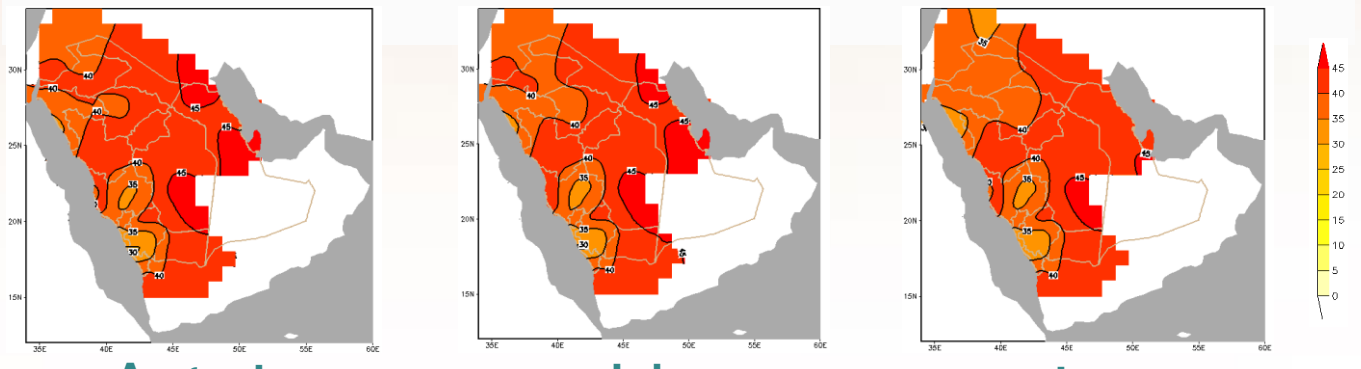
A heat wave is a period of unusually hot weather that typically lasts two or more days over a specific area.

Heat Map

The historical climate data from the General Authority for Meteorology and Environmental Protection for the summer season show average maximum temperatures across the Kingdom, with a continued rise in temperatures across all regions generally. However, moderation with coolness often prevails in the southwestern highlands and the coasts of the Tabuk region, as illustrated in the figure below.

The figure1.1 below illustrates the average maximum temperatures at a height of 2 meters above the ground surface for the climatic summer season (June - July - August).

The Heat Map of Kingdome of Saudi Arabia



August **July** **Jun**

Heatwaves:

Heatwaves refer to prolonged periods of excessively hot weather, typically accompanied by high humidity. These extreme heat events can pose significant health risks to individuals, especially vulnerable workers such as those with pre-existing health conditions, pregnant or older workers. Heatwaves can also have adverse effects on farming, infrastructure, and the environment at large.

Therefore, based on reviewing the data provided in the table below and several international sources, including the heat maps for the ban on working under sunlight in Australia and the heat maps for the ban on working under sunlight in Singapore ,New Zealand ,and the United state of America , all this countries have worked to create heat maps illustrating the geographical locations most affected by heat in their respective countries. Taking into account the climatic differences in various geographical regions during the ban on working under sunlight, and based on global comparisons, the heat maps for the Kingdom figure1.1 have been included, indicating the targeted areas of the decision, which are most prone to heatwaves, with the exception of the southwestern region (Asir region) and the coasts of the Tabuk region (from the city of Haql in the north to the city of Al-Wajh in the south) due to the moderation of their weather during the summer period, however, In many equatorial regions (Tihama), temperatures can remain high throughout the year, regularly averaging >30 °C through the year and spiking to >40 °C. as illustrated in the table below table 1.1.

Heat Map

Table 1.1. Weather stations with latitude, longitude, elevation, average maximum (Tmax) and minimum (Tmin) temperature.

ID	Station name	Latitude (°N)	Longitude (°E)	Elevation (m)	Tmax (°C)	Tmin (°C)
1	Abha	18.23	42.66	2096	30.08	16.21
2	Khamis Mushait	18.29	42.8	2057	34.49	21.91
3	Al-Baha	20.29	41.64	1653	31.31	17.18
4	Taif	21.48	40.55	1455	35.05	21.93
5	Najran	17.61	44.41	1217	38.39	22.95
6	Bisha	19.99	42.61	1182	38.97	23.06
7	Hail	27.44	41.69	972	38.04	22.15
8	Turaif	31.68	38.73	846	35.20	19.23
9	Tabuk	28.37	36.6	800	37.55	21.88
10	Sharurah	17.47	47.12	740	41.91	25.22
11	Al-Jouf	29.78	40.10	668	38.27	22.97
12	Gassim	26.30	43.77	646	41.94	24.76
13	Madina	24.54	39.70	636	42.30	28.28
14	Riyadh	24.92	46.72	614	42.02	25.02
15	Arar	30.90	41.14	544	39.57	23.47
16	Guriat	31.40	37.28	507	37.02	18.42
17	Rafha	29.62	43.49	449	40.91	23.73
18	Al-Qaysumah	28.33	46.12	362	42.92	26.54
19	Makkah	21.43	39.79	249	42.96	28.89
20	Al-Ahsa	25.30	49.49	181	43.99	27.31
21	Wejh	26.20	36.47	21	33.46	24.25
22	Dhahran	26.26	50.16	17	37.02	18.42
23	Jeddah	21.71	39.18	16	38.25	26.07
24	Haql	24.14	34.06	10	31.79	25.80
25	Gazan	16.90	42.58	6	38.07	29.32

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Health impacts Related to Working in High Temperatures and Direct Sunlight

Heat gain in the human body can result from both external factors, such as environmental heat, and internal sources, stemming from metabolic processes. Rapid exposure to elevated temperatures beyond the norm can impair the body's thermoregulation mechanisms, leading to various heat-related illnesses like heat cramps, thermal stress, heat strokes, and even death.

Heat-related fatalities or recoveries can occur swiftly, even within the same day, or manifest with delayed effects, sometimes days later, particularly exacerbating risks for vulnerable individuals during initial phases of heatwaves. Even minor deviations from seasonal temperature averages correlate with increased illness and mortality rates. Extreme heat exacerbates chronic conditions like cardiovascular, respiratory, renal, cerebrovascular diseases, and diabetes-related ailments.

Workers' Health Problems Related to Working

at High Temperatures and Under Direct Sunlight

Heat Exhaustion	Heat Stroke.
Heat Rash	Heat Cramps.

Symptoms and Signs of Heat Stroke Associated with Working

at High Temperatures and Under Sunlight

Excessive sweating or red, hot and dry skin

Fainting

Confusion

Very high body temperature (over 40 degrees Celsius)

Convulsions

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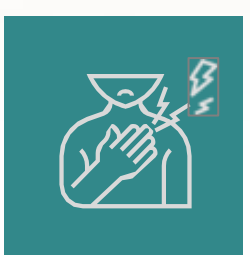
Symptoms and Signs of Heat Exhaustion Associated with Working in High Temperatures and Under Sunlight

Nausea or vomiting

Headache

Vertigo and dizziness

Irritability



Rapid heart rate

Very high body temperature (over 40 degrees Celsius)

Excessive sweating

Cold and moist skin

Generalized weakness

Thirst

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Symptoms and Signs of Heat Cramps Associated with Working at High Temperatures and Under Sunlight

Muscle spasm

Pain

Symptoms and Signs of Heat Rash Associated with Working at High Temperatures and Under Sunlight:

Red skin spots or clear blisters with itch often occurs on the neck, upper chest and skin folds

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Steps to be followed if a worker suffers a Heat Exhaustion

Steps to be followed if a worker suffers a Heat Exhaustion:

1. Call the supervisor at work and ask for medical help.
2. Move the person to a shaded and cooler place to rest with observation.
3. Give the person cold water as long as he is conscious and not vomiting.
4. Remove and loosen the person's clothes.
5. Help cool and ventilate the person by placing cold compresses and ice packs on the thigh and underarm or soaking the person's clothes in cold water.
6. Stay with hem/them until they're better or take the worker to the medical care center or emergency room for medical evaluation or treatment if the signs or symptoms worsen or did not get better.
7. The worker must not return to work on this day even if he gets better.
8. Active the acclimatization procedures.

Steps to be followed if a worker suffers Heat cramps:

1. Make the worker rest in a shaded and cool place.
2. The worker should drink electrolyte beverage or water if not available.
3. Pour water over the person or spray with a hose.
4. Wrap the person in wet cloth and position a fan toward him/her.
5. Wait for a few hours before allowing the worker to get back to the hard work.
6. Ask the worker to seek medical care if the cramps do not get better.

Steps to be followed if a worker suffers a Heat rash:

1. Try to work in a cooler and less humid environment whenever possible
2. Keep the affected area dry.
3. Do not put ice on the rash areas, as this may cause for cold burns.

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In case of emergency in the workplace, dial the emergency number provided or contact 997 for Red Crescent Operation.

We would like to note that thermal stress is the health condition resulting from the body's inability to get rid of unhealthy high temperatures when exposed to many internal and external factors

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Acclimatization for New Workers in Hot Areas and Training Methods

Acclimatization means the helpful physiological coping which occurs during the recurrent exposure to a hot environment

Increase the efficiency of sweating:

(Early sweating, increased sweat secretion, reduced salt loss in sweat with recommending to drink electrolyte beverages during work to replace salts).

Circulatory Stability:

Aerobic capacity will ensure ability to do work with lower core temperature and effective heart rate to increased blood flow to the skin at a certain core temperature with minimal impact on physical ability.

Acclimatization Schedule:

To acclimatize workers, their exposure time can be gradually increased in hot environmental conditions over the period of 7-14 days. New workers will need more time to adapt than workers who have previously been exposed. As for the new workers, the exposure schedule must not exceed 20% of exposure on the first day, and this percentage should be increased by no more than 20% on every additional day.

As for workers who have prior experience in the job, Acclimatization schedule should not exceed 50% on the first day, 60% on the second day, 80% on the third day and 100% on the fourth day.

In addition, the acclimatization level reached by each worker is related to the primary physical fitness of the person and overall thermal stress suffered by the person.

Preserving Acclimatization:

Workers can preserve their acclimatization even if they were away from work for a few days, like when going back home to spend the weekend. However, if they were absent for a week or more, there might be a great loss in the helpful adaptations which leads to an increased possibility of developing heat related diseases and the need to gradually adapt to the hot environment.

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Criteria of choosing a temperature indicator and dealing with it

There is more than an indicator to use, and they are as follows:

- **Limit work temperature in work environments.**
- **Outdoor temperature indicators.**

The two previous indicators have been chosen based on applying them to work environments similar to the work environment in the Kingdom of Saudi Arabia. The National Council for Occupational Safety & Health recommends using the limit work temperature especially in internal and external work environments exposed to different weather conditions such as humidity, wind speed and high temperatures in dry areas.

Thermal Work Limit Indicator in Indoor and Outdoor Work Environment:

When to use the Thermal Work Limit Indicator?

Thermal Work Limit Indicator is used in indoor and outdoor work environments, during exposure to different weather conditions such as humidity, wind speed and high temperature in dry areas.

To calculate the thermal Work Limit Indicator, the value of the following measurements should be taken into consideration:

- Dry thermometer temperature (ambient air temperature) (Celsius)
- Wet thermometer temperature (humidity/evaporation) (Celsius)
- Black thermometer temperature (radiant temperature) (Celsius)
- Wind speed (m/s)

The devices used to take all these measurements and automatically calculate the limit work temperature are available. There are also alternate devices that can be used to take the measurements, and then entering these measurements in the electronic calculator to calculate the limit work temperature

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Engineering & Administration Controls

Thermal Work Limit Indicator (TWL)- Work Zones

Procedures and Measures- Rest and Work, Schedule of Drinking Water Needs

Work Zones	Procedures	Schedule for Needed Amounts of Drinking Water (hours)	Schedule for Rest/Work (minutes
Low risk Unrestricted zone TWL from 140 to less than 220	No restriction on self-working rhythm for trained workers who drink large amounts of water	Light work 600 – 1000 mL/h	This zone is safe for all continuous self-works
Intermediate risk Warning zone TWL from 115 to less than 140	Caution area refers to the situations where environmental conditions require additional precautionary procedures: practically applying the engineering preventive measures to reduce thermal stress, for example, providing shaded areas and enhancing ventilation. It is not recommended for any person to work alone, nor to hire a nonadaptive person. Make sure to drink enough fluids suitable for the work type.	Light work 1-1.2 L/h	This zone is safe for all continuous self-works
		Heavy work More than 1.2 L/h	Continuous self-work 45 minutes work- 15 minutes res
High risk zone TWL less than 115	Focus on applying the required (work - rest cycle): It is not recommended for any person to work alone. It is not recommended to hire a non-adaptive person. In a high-risk zone, drinking water and identifying the signs of thermal stress should be emphasized. The worker should be equipped with a personal 2 liters water bottle on the site at all times.	All types of work More than1.2 L/h	Light work 45 minutes work– 15 minutes rest
			Heavy work 20 minutes work- 40 minutes rest

Table No. 1

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Outdoor Temperature Indicator

Temperature Measuring Definition:

It means measuring the increase in the ambient temperature of the worker above the limit it cannot endure, which exposes the worker to many risks where death may be the final stage. The source of heat in the work environment may come from natural sources such as sunlight or from industrial sources such as heat resulting from ovens, welding operations or other work equipment.

Target Group:

All people who work in outdoor work environments with high temperatures according to table **No. 2.**

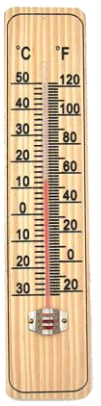
Outdoor Workplaces (in the Open Air)

When working in the open air, the weather's effects in this environment can have a very significant and dangerous impact on the employee's safety, and if the risks are not properly considered and managed, this effect might be immediate or might occur on the long run.

Measuring the Temperature:

The devices used to take these measures are available, some are electronic, and others are mercurial.

Example of an electronic thermometer



Example of a mercurial thermometer

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When to use an Outdoor Temperature Indicator?

A thermometer can be used to help identify the risks of heat-related diseases for workers in the open air the procedures needed to protect the workers, and when to put such procedures into force. Depending on the value the thermometer indicates, the risks of developing heat-related diseases may range from low to very high to extreme. With the increase of the thermometer indicator value, there is a need for more preventive measures to protect the workers.

The thermometer values are divided into four scopes associated with four risk levels, which help to take the appropriate procedure according to the temperature data. This has been developed for workers to use on worksites according to table **No. 2.**

Thermometer Indicator	Preventive Measures	Risk Level
Less than 32.7 degrees Celsius	Thermal safety basics	Low (caution)
From 32.7 to 39.4 degrees Celsius	Implement precautions and raise awareness.	Intermediate
From 39.4 to 46.1 degrees Celsius	Additional precautions to protect the workers.	High
More than 46.1 degrees Celsius	Issue stricter preventive measures.	High Risk

Table No. 2

Employers should respond to any high temperature indicator; such response matches the type of steps to be followed to treat the other risks in the workplace including the following:

1. Train workers on how to identify and prevent heat-related diseases.
2. Daily Monitoring of the thermometer on working site and notify the workers to take necessary precautions.
3. Implement a preventive plan with ongoing review and feedback.

Use of protection measures to be taken at each level of risk to notify the workers with the appropriate preventive plan. The plan should address the following:

Preventive Plan	Risk Indicator Level			
	High Risk	High	Intermediate	Low caution
Providing supplies (ensure availability of enough water, provisions for break areas and other supplies)	✓	✓	✓	✓
Providing canopies, personal protective equipment, fans, steam sprayers, air fresheners and portable thermometer.)	✓	✓	✓	✓
Emergency planning and response (train supervisors and crews for emergencies)	✓	✓	✓	✓
Workers' acclimatization (increasing the workloads gradually, allow more frequent breaks so that workers can adapt to temperature)	✓	✓	✓	✓
Modified work schedules (create systems to enable modifications to the work schedule)	✓	✓	✓	
Training (train workers to identify diseases related to heat and acquaint them with the relevant preventive measures)	✓	✓	✓	✓
Physiological, visual and verbal monitoring (using direct observation and physiological monitoring to check for symptoms and signs of heat-related diseases)	✓	✓	✓	

General Risk Management Principles

The following can be considered when you are managing the risks associated with working in thermal environments (note that the list could stretch even further):

1. Risk Assessment: Conduct a thorough risk assessment to identify potential heat stress hazards. This could include evaluating the thermal environment, the nature of work being conducted, the metabolic heat load, and the type and condition of the Personal Protective Equipment (PPE).

2. Heat Stress Management Plan: Develop and implement a heat stress management plan tailored to your workplace and the type of work being conducted. This plan should include, but not limited to, heat stress conditions, worker acclimatization processes, hydration policies, and emergency procedures for heat-related disorders.

3. Environmental Monitoring: Regular monitoring of the environmental factors, including air temperature, humidity, air velocity, and radiant heat, using suitable instruments as outlined in BS EN 27726 (or ISO 7726).

4. Modify the Work Environment: Whenever possible, control the work environment to reduce exposure to hot conditions. This includes the use of ventilation, air conditioning, shielding from radiant heat sources, or scheduling work at a cooler time of the day.

5. PPE Selection and Use: Ensure that the PPE provided is suitable for the task and offers a balance between protection and thermal comfort (see section 5.4 in the appendix for a subjective assessment).

6. Consideration of the Impact of Wearing PPE: Recognize that wearing PPE can increase metabolic heat production and reduce the body's ability to lose heat. Adjust work practices accordingly, such as by incorporating more frequent rest breaks in cool (or shaded) areas (see section 5.6 in the appendix for rest cycles).

7. Acclimatization: Gradually acclimatize workers to hot environments, especially those wearing thermal or impermeable PPE, to increase their tolerance to heat.

8. Health status: Those with any chronic disease should inform their physician of occupational exposures to heat stress and follow the recommendations.

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Thank You