



What you need to know about

TEMPERATURE

in places of work





An introduction to Temperature at work

Temperature a complex issue

The thermal environment we live and work in has been a subject of interest to people for centuries. Even in ancient cultures we find buildings that were designed for the thermal comfort of the occupants. Since the start of the industrial revolution, scientists have researched what factors affect our perception of temperature, and looked at different ways to measure them.

Despite all the research over the years, it remains a complex issue, dependant on the subjective evaluation of the individual. Although it's possible to create conditions in places of work that will make a majority of people comfortable, it's almost impossible to please everyone.



Overview of these information sheets

There are six main **factors that affect how hot or cold we feel**. In addition to these general factors, individual differences also affect how we perceive temperature. These are outlined in Sheet 2.

We can divide thermal environments into three broad categories, although the boundaries between these categories aren't always obvious.

The first is **thermal comfort**, where people feel neither too hot or too cold, and do not perceive the temperature to be a problem. The second is **thermal stress**, where the thermal environment will cause clearly defined medical conditions, and can prove fatal. The third is **thermal discomfort**, which is the area between the first two. People can feel too hot or too cold, but do not display medical symptoms beyond irritability and fatigue. These topics are discussed in Sheets 3, 4 and 5.

There are many **options for solving thermal problems in the workplace**. These are outlined in Sheets 6 and 7.

Some **methods for assessing the thermal environment** are given in Sheet 8.

The **legislative aspects of temperature at work** are summarised in Sheet 9.



Factors that influence How hot or cold we feel

There are six main factors that influence how hot or cold we feel.

Air temperature

Air temperature is how hot or cold the air around us is. It is measured with a normal thermometer. Although this is the easiest of all the factors to measure, in hot situations it's the least important of them. If air temperature is the only measurement taken, it's hard to predict how the temperature will affect people.



Humidity

Humidity is the moisture content of the air. In hot situations, high humidity makes people feel hotter than low humidity. If the air already has a high moisture content, sweat will not quickly evaporate to cool us. Cold air will always have a lower moisture content, and so humidity is not important in cold.



Radiant heat

Radiant heat is emitted from anything that's hot, such as sunlight, a furnace or a heater. In time it will heat the air, but it will heat people and solid surfaces such as furniture or machinery more quickly. Radiant heat will affect people anywhere there is direct sunlight, or when they are close to any work process that emits heat.



Air speed

Wind speed or air speed will, in most situations, cool a person. This will provide relief to people in a hot situation, but extra chill to people in a cold situation.



Physical activity

Our bodies generate heat, and as our level of physical activity increases, so does our heat production. In a cool situation, physical activity can help to warm a person. In a warm or hot situation, physical activity can increase the effect of heat on a person.



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Clothing

Clothing insulates us from our environment to a greater or lesser degree. It can shield us from radiant heat, prevent heat escaping, prevent sweat from evaporating, or aid heat transfer. This will make a person feel cold, warm or hot, depending on the situation, and the clothing. Of particular concern is where an employee needs to wear protective clothing, and the clothing is not appropriate for the thermal situation.



Other factors

Other factors that may affect the way individuals feel about the thermal environment include:

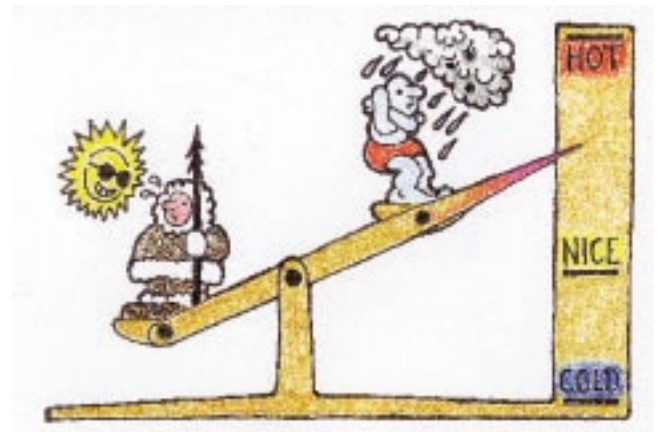
- Age;
- State of health;
- Body build and weight;
- Use of prescribed medicines;
- Use of substances such as alcohol;
- Use of illegal substances such as cannabis.



How these factors affect you

The various factors we've discussed all interact to leave you feeling hot, cold or comfortable. For example:

- High temperature with high wind speed may make you feel comfortable.
- Low temperature and high air speed will make you feel cold.
- High activity and low temperature could make you feel comfortable.
- High physical activity, and high radiant heat will make you feel hot.





What you need to know about Thermal comfort

What is thermal comfort?

Thermal comfort has been described as “a condition of the mind which expresses satisfaction with the thermal environment”. A person can be described as being “thermally comfortable” when they are not conscious of being either too hot or too cold.

A “thermally comfortable” environment is the ideal thermal environment for people to work in. Not only do people perform their work more efficiently, but they are less likely to make mistakes that could result in an accident.

Thermal comfort can be very subjective. Conditions that are very comfortable to one person can be uncomfortable to another. Factors that affect how hot or cold we feel are listed in the Information Sheet 2: *Factors that Influence How Hot or Cold We Feel*.



Thermal comfort for people in sedentary occupations

Most people will be thermally comfortable in the following conditions:

Condition	Value	
	Summer	Winter
Air temperature	19-24°C	18-22°C
Relative humidity	40-70%	
Air speed	0.1-0.2 m/s, without creating a draught	
Radiant heat	No direct exposure to a radiant heat source	
Clothing	Light clothing	Winter clothing

If any of these conditions are not met, others will need to be adjusted to maintain comfort. For example, if there is not measurable air movement, the air temperature would need to be lower than the maximum stated.

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Thermal comfort for people in active occupations

Because of the addition of physical activity, it becomes less possible to predict a comfort environment. A decrease in the recommended temperatures for sedentary occupations of between 3 to 5°C, or an increase in air speed up to 0.5 m/s, will create a more comfortable environment for people with active work.

Condition	Value	
	Summer	Winter
Air temperature	16-21°C	16-19°C
Relative humidity	40-70%	
Air speed	0.2 m/s	



What you need to know about Thermal discomfort

What is thermal discomfort?

Thermal discomfort is the uncomfortable place between a thermal environment that is ideal, and one that will cause a person to be harmed.

A person feeling thermal discomfort will feel either too hot or too cold. However, a person will not suffer harm as a direct result of the thermal environment.



Should people be allowed to experience thermal discomfort at work?

While a thermal environment that causes discomfort may not directly cause harm, it does have many disadvantages. People can feel tired and irritable. They may be less productive and make more mistakes with their work. There's a greater risk of someone making a mistake that could result in an accident.

It's therefore not desirable for people to work in thermally uncomfortable conditions. This is reflected by the Health and Safety in Employment Regulations 1995, which put duties on employers to provide facilities to control the thermal environment. These are outlined in Sheet 9: *Legislation*.

In many work situations, it may not be possible to avoid some thermal discomfort. The thermal environment obviously cannot be controlled for people working outdoors, although clothing, physical activity and the timing of the work can be. If people experience discomfort for only a few days a year, it may not be practicable to spend a lot of resources to control the thermal environment. Administrative controls may be more appropriate.



Is there a maximum and minimum temperature employees should be exposed to?

It's very difficult to give a maximum or minimum level based on air temperature alone. All the six main factors outlined in Sheet 2 will affect how people perceive temperature. If employees are experiencing discomfort, some form of control will be necessary. Control options are outlined in Sheets 6 and 7: *Control Options for Hot/Cold Situations*. An OSH inspector would not ask for improvement of a situation without investigating and being satisfied that intervention was necessary.

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General and local thermal discomfort

General thermal discomfort occurs when a person's entire body feels uncomfortable. It's possible for situations to occur when one part of a person's body feels comfortable, and another, such as the feet, feel either too hot or too cold. This is referred to as local thermal discomfort. In these situations, the cause of the discomfort should be identified, and if practicable eliminated.

Thermal discomfort in buildings

Many industrial and commercial buildings are not designed to provide thermally comfortable conditions for employees. Often such buildings allow a high radiant heat loading on the occupants, for example through lack of insulation in roof spaces, or large glass areas in the walls.

In order for an employer to ensure thermal comfort for employees, some alterations may need to be made to the building itself. An air conditioning system that has to compete with a high radiant heat source will never be completely effective.

Employers moving into an existing building, or building a new one, should consider the thermal comfort of their employees at an early stage of the moving or planning process.





Some basic facts on Thermal stress

What is heat and cold stress?

Heat or cold stress occurs when the thermal environment directly causes harm to a person. This harm falls into two main categories:

- Non life threatening medical conditions such as dehydration or heat exhaustion in hot environments, and frostbite in cold environments; and
- Life threatening conditions such as hypothermia (a fall in core body temperature), or hyperthermia (a rise in core body temperature). These occur when the thermal environment causes a breakdown in a person's temperature control mechanisms. Both these conditions are very serious and can be fatal.

More information is available in the OSH booklet *Guidelines for the Management of Work in Extremes of Temperature*.



When should a hot situation be treated as heat stress?

If work is carried out with appropriate clothing, with no heat source other than the sun, and there is only light to medium physical activity, heat stress is unlikely.

Heat stress is possible if, in addition to the weather (or sometimes on its own), the work process has one or more of the following conditions:

- High radiant heat (e.g. from a dryer, an oven or a furnace);
- High humidity (e.g. from a kitchen or laundry);
- Heavy physical activity;
- A person wearing clothing (such as protective clothing) that means they cannot lose heat to the environment.



When should a cold situation be treated as cold stress?

The following situations may present a risk of cold stress (at some time or most of the time):

- Any work situation where employees work outside in cold or wet weather, or where there is a wind chill factor;

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- Any situation where employees are required to work in, and spend some time in, an artificially cold environment such as a walk in fridge, coolstore or freezer;
- Any other work situation where a person will be chilled for a period of time, such as commercial diving.

Definitions of physical activity

(Taken from ISO 7243 *Hot Environments - Estimation of the heat stress on working man, based on the WBGT-Index (wet bulb globe temperature.)*)

Light physical activity

Sitting at ease: light manual work (writing, drawing, sewing, book keeping); hand and arm and leg work (driving a vehicle in normal conditions, operating foot switch or pedal).

Standing: drilling (small parts); milling machine (small parts); coil winding; small armature winding; machining with low-power tools; casual walking (speed up to 3.5 km/h).

Medium physical activity

Sustained hand and arm work: (hammering in nails, filing); arm and leg work (off-road operation of lorries, tractors or construction equipment); arm and trunk work (work with pneumatic hammer; tractor assembly; plastering; intermittent handling of moderately heavy material; weeding, hoeing, picking fruit or vegetables); pushing or pulling lightweight carts or wheel barrows; walking at a speed of 3.5 to 5.5 km/h; forging.

Heavy physical activity

Intense arm and trunk work: carrying heavy material; shovelling, sledge hammer work; sawing, planing or chiselling hard wood; hand mowing; digging; walking at a speed of 5.5 to 7 km/h. Pushing or pulling heavily loaded hand carts or wheel barrows; chipping castings; concrete block laying.

Very heavy physical activity

Very intense activity at fast to maximum pace: working with an axe; intense digging or shovelling; climbing stairs, ramp or ladder; walking quickly with small steps; running or walking at a speed greater than 7 km/h.

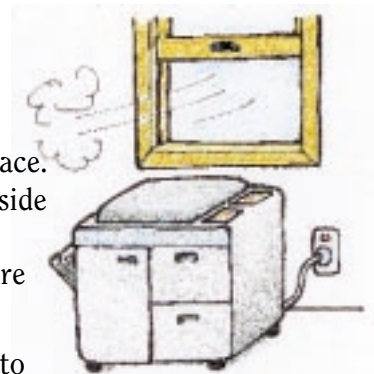




Some control options for Hot situations

Lower the air temperature through . . .

- Air conditioning. While many people see air conditioning as the ideal in summer, it also has some drawbacks. Sometimes air conditioning units do not supply enough fresh air to an area which can cause sick building type problems. If not maintained properly, they can harbour fungi or bacteria that can affect the health of employees.
- Ventilation. Many heat problems are a result of poor ventilation. A good ventilation system can remove hot air from a building. It is also good for removing any contaminants from the air. New Zealand Standard 4303: *Ventilation for Acceptable Indoor Air Quality*, Table 2, recommends ventilation rates for different types of workplace. In offices, for example, a ventilation rate of 10 litres of outside air per second, per person, is recommended. The disadvantage is that you are at the mercy of the temperature of the air you bring in to replace what you remove.
- If possible, open windows and doors to allow any breeze into the work area.



Lower the humidity

- Provide good extraction ventilation, especially if there is any moisture given off in a work process.
- You can use dehumidifiers to lower humidity. This is another form of air conditioning.



Reduce exposure to radiant heat

- Install insulation to prevent heat radiating through roofs or walls.
- Use blinds, curtains or reflective coatings on windows to reduce direct sunlight.
- Place office machinery that produces heat in a well ventilated or isolated area.
- Shield employees from any hot process.

Increase air speed and movement

- Increase air speed. Many offices and factories have almost no air movement. A well-designed ventilation system should

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create air movement, and help cool people, without creating an unwanted draft.

- Use individual fans. These will be more effective on a hot day if they are directed at a person rather than generally around the work area.
- Increase air changes per hour. With any work process that produces either hot air or moisture (e.g. laundries or kitchens), changing the air to remove excess moisture is essential.



Control your activity

- If you can pick the time of day to carry out physically exerting tasks, do them either early in the morning before it gets too hot, or in the evening. In summer, a physical task done in the heat of the day can put you at risk of heat stress.

Wear suitable clothing for the thermal conditions

- Ensure you are suitably clothed for the thermal conditions. If you have control over what you wear to work, this is an easy option. If you wear a uniform, the employer will need to ensure that it is appropriate to the thermal conditions.
- If working outdoors, wear a sunhat.



Drink plenty of fluids

- Remember to drink plenty of fluids. If it's very hot, you may need to drink more than you feel you need. Signs that indicate you are not drinking enough include dark-coloured urine, or urinating less frequently than normal. It's better to be slightly over-hydrated than dehydrated. For most people, heat at work will not cause any real health problems unless they become dehydrated. Employees should be able to get a drink of water at any time during the working day without going too far from their work station



Administrative controls

- If all affected parties are agreeable, change the shift time to avoid physical tasks during the hot part of the day.



Some control options for Cold situations

Raise the air temperature through . . .

- Heating. This is the most common and useable control method for cold environments. Although clothing is also a control method, there are jobs where increase in clothing is not appropriate, or where protective clothing such as gloves cannot be worn. In these situations, localised or general heating is the only option.



Humidity

- Cold air cannot hold as much water as warmer air (which is why water condenses on cold windows). Humidity is not a factor in cold environments, and needs no controlling.

Radiant heat

- Radiant heat is one form of heating, and an increase will warm people. This may be the most cost-effective approach for heating large areas.
- Eliminate heat loss through radiation; ensure work buildings are adequately insulated.



Decrease excess air speed and draughts

- Eliminate unwanted draughts, without eliminating ventilation necessary for good health.

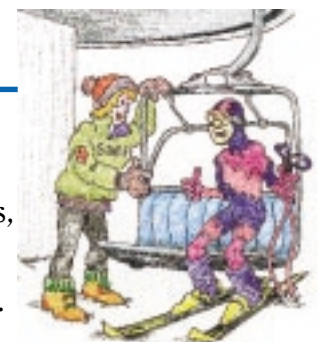
Physical activity

- Employees in jobs with a medium to high level of physical activity may not require as warm an environment.
- Introducing “exercise” into a workplace is not an appropriate control method for cold



Wear suitable clothing for the thermal conditions

- Ensure you are suitably clothed for the thermal conditions.
- If you need to carry out a task that requires some manual dexterity of your hands, which means you cannot wear gloves, the environment may need to be warmed.
- Remember that one third of all heat loss is through the head. Wear a hat that will prevent this.



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Administrative controls

- Some jobs may be able to be carried out in a warmer time of the day.
- A job can be done sequentially by a number of people so that no one person is exposed to a cold environment for an excessive length of time.



Methods of investigating Thermal problems

Using a thermometer to assess heat and cold

Before spending a lot of money on control options, it's worth getting some information on the thermal environment. In particular, it's worth knowing:

- What are the hottest or coolest parts of the day?
- What are the maximum or minimum temperatures?
- What is the average maximum or minimum temperature?
- How often the average is exceeded?

Another way of looking at this information is to work out how much of the time a particular temperature is exceeded, expressed as a percentage. Look at the 90, 10, 5 and 1 percentage levels.

- Is there a pattern as to what temperature people feel discomfort at?
- You can also compare your readings with the daily weather high. How does your maximum reading compare?

Set up a thermometer in the area you want to measure, but place it out of direct sunlight and away from a radiant heat source. Choose a period of time you want to take readings at. They can be hourly, two-hourly or over a particular part of the day only. Write them down for future reference.

If your workplace has a computer with spreadsheet software, you can make a up a spreadsheet of your temperature readings. From this, you can work out the seasonal average for each time of day readings are taken.

A more detailed survey would also include readings for humidity, radiant heat and air speed.



Observing thermal influences in your workplace

Look at the six main heat influences on Sheet 2: *Factors that Affect How Hot or Cold We Feel*. What can you see in your workplace that would add or subtract to the air temperature from them? The following checklist may help.

Humidity

- Does any part of your work process create steam or moisture (e.g. a kitchen or laundry)?

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- Is there a lot of (or a little) humidity in the part of New Zealand where you live and work?
- Do you get very wet from sweat? In a dry environment you will hardly notice sweat because it evaporates easily. If you are “dripping” sweat, the humidity may be high.

Radiant heat

- Do you get either direct sunlight in your place of work, or does heat radiate through poorly insulated building materials?
- Do you have any office machinery such as large computer banks or photocopiers near where you work?
- Do you work close by a source of heat such as a furnace or oven?



Air speed

- Do you have any air movement in your place of work? You can purchase smoke tubes from some safety equipment suppliers that can be used to show how the air is moving.

Physical activity

- Does anyone in your workplace have a job where medium to high levels of physical activity are required?

Clothing

- Are people sensibly clothed for the season and the temperature?
- Does anyone need to wear protective clothing that adds to the thermal equation?
- In cold, does anyone need to do a task that means that protective clothing such as gloves can't be worn?



Subjective evaluation of thermal comfort

Use the Bedford scale to evaluate how employees perceive comfort. This can be used in conjunction with environmental readings. Ask employees to rate themselves on the following scale:

- Much too warm
- Too warm
- Comfortably warm
- Comfortable
- Comfortably cool
- Too cool
- Much too cool

These ratings are most useful if they are completed at the same time as the environmental readings.



Temperature in workplaces: Legislative aspects

Introduction

Temperature in places of work is governed by the Health and Safety in Employment Act 1992, and the Health and Safety in Employment Act 1995. This is a brief summary only. For the complete text, the Act and Regulations themselves should be consulted.

Summary of the Health and Safety in Employment Act 1992

The principal object of the Health and Safety in Employment Act 1992 is to prevent harm to employees at work. To do this, it imposes duties on employers, employees, principals and others, and promotes excellent health and safety management by employers. It also provides for the making of regulations and codes of practice.

EMPLOYERS' DUTIES

Employers have the most duties to perform to ensure the health and safety of employees at work. Employers have a general duty to take all practicable steps to ensure the safety of employees. In particular, they are required to take all practicable steps to:

- Provide and maintain a safe working environment;
- Provide and maintain facilities for the safety and health of employees at work;
- Ensure that machinery and equipment is safe for employees;
- Ensure that working arrangements are not hazardous to employees; and
- Provide procedures to deal with emergencies that may arise while employees are at work.

Taking "all practicable steps" means what is reasonably able to be done to achieve the result in the circumstances, taking into account:

- The severity of any injury or harm to health that may occur;



- The degree of risk or probability of that injury or harm occurring;
- How much is known about the hazard and the ways of eliminating, reducing or controlling it; and
- The availability, effectiveness and cost of the possible safeguards.

HAZARD MANAGEMENT

Employers must have an effective method to identify and regularly review hazards in the place of work (existing, new and potential). They must determine whether the identified hazards are significant hazards and require further action.

If an accident or harm occurs that requires particulars to be recorded, employers are required to investigate it to determine if it was caused by, or arose from, a significant hazard.

"Significant hazard" means a hazard that is an actual or potential cause or source of:

- Serious harm; or
- Harm (being more than trivial) where the

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severity of effects on a person depends (entirely or among other things) on the extent or frequency of the person's exposure to the hazard; or

- Harm that does not usually occur, or usually is not easily detectable, until a significant time after exposure to the hazard.

Where the hazard is significant, the HSE Act sets out the steps employers must take:

- Where practicable, the hazard must be eliminated.
- If elimination is not practicable, the hazard must be isolated.
- If it is impracticable to eliminate or isolate the hazard, the employer must minimise the likelihood that employees will be harmed by the hazard.

Where the hazard has not been eliminated or isolated, employers must:

- Ensure that protective equipment is provided, accessible and used;
- Monitor employees' exposure to the hazard;
- Seek the consent of employees to monitor their health; and
- With their informed consent, monitor employees' health.

INFORMATION FOR EMPLOYEES

Before employees begin work, they must be informed by their employer of:

- Hazards employees may be exposed to while at work;
- Hazards employees may create which could harm people;
- How to minimise the likelihood of these hazards becoming a source of harm to themselves and others;
- The location of safety equipment; and
- Emergency procedures.

Employees should be provided with the results of any health and safety monitoring. In doing so, the privacy of individual employees must be protected.

TRAINING OF EMPLOYEES

Employers must ensure employees are either sufficiently experienced to do their work safely or are supervised by an experienced person. In addition, employees must be adequately trained in the safe use of all plant, substances and protective clothing and protective equipment that the employee may be required to use or handle.

Health and Safety in Employment Regulations 1995

Regulation 4: Duties in respect of facilities at every place of work

Employers have a duty to take all practicable steps to provide the following facilities (amongst others) in every place of work. They are:

- Ventilation providing either fresh or purified air;
- Means for controlling humidity that arises from any work process or activity;
- Means for controlling atmospheric conditions, including air velocity, radiant heat, and temperature.

These facilities must be

- Suitable for the purpose for which they are to be used;
- Provided in sufficient numbers;
- Maintained in good order and condition; and
- All employees have access to any such facilities in a way that is convenient to them.