Atmospheric conditions in the workplace

Important Note:

All the publications in the Publications Archive contain the best guidance available at the time of publishing. However, you should consider the effect of any changes to the law since then. You should also check that the Standards referred to are still current.

Department of Labour

Contents

PUBLISHED BY THE DEPARTMENT OF LABOUR
PRIVATE BAG, WELLINGTON, NEW ZEALAND

IW 85/P199/10000/1984

About this booklet

Comfortable atmospheric conditions in the workplace are essential for the health and wellbeing of employees.

This booklet is a brief, non-technical guide to the various factors involved in achieving optimum conditions — that is, an environment that will satisfy the majority of your workers.

Although its purpose is to assist occupiers to comply with the legislation, the booklet is not intended as a substitute for the legislation.

What the law requires

Section 38 of the Factories and Commercial Premises Act 1981 requires the occupiers of all undertakings* to ensure that workers work in reasonably comfortable atmospheric conditions.

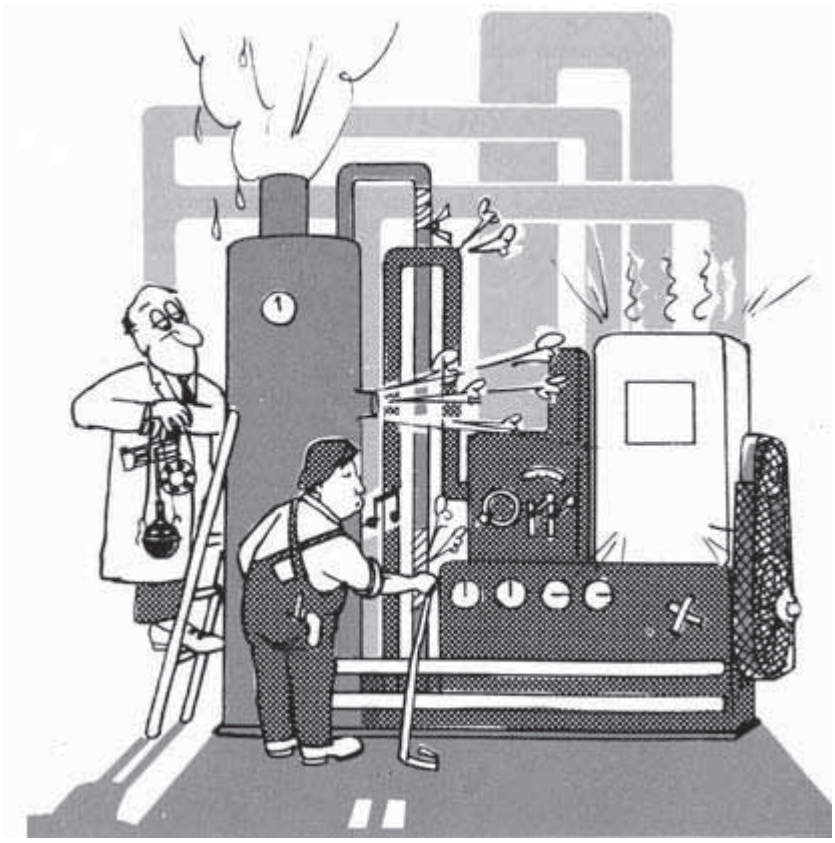
Depending on the processes or activities carried out, you, as the occupier, must provide effective and suitable means in each workroom to control:

- The air temperature, and
- The humidity from any process, and
- The air velocity, and
- The amount of radiant heat, and
- The quantity of fresh air.

Factory inspectors check that the requirements of the legislation are being complied with. When necessary they will use the equipment described later in this booklet to identify any problems, and will advise on any improvements needed.

Occupiers are recommended to consult a professional heating and ventilating engineer when planning a new building or modifying an existing one, or when advised by an inspector that heating or ventilation is inadequate for the purposes of the legislation.

*Refer to clause 2 of the Factories and Commercial Premises Act 1981 for the definition of an undertaking.



What is comfort?

Comfort is easiest to define in negative terms. It's a state in which we're not conscious of being too hot or too cold — in other words, when we're not bothered by the environmental conditions around us.

Whether or not we feel comfortable in a given set of conditions depends on two sets of factors — environmental and physiological.

The environmental factors are:

- Temperature
- Air movement
- Humidity
- Radiant heat.

We discuss these more fully later in this booklet. What is important to realise here is that these are all physical variables, which we can measure with instruments, and control through heating and ventilating systems to achieve an optimum balance.

The main physiological factors which govern how people perceive conditions around them are:

- Age
- Sex
- State of health
- Body build and weight
- Degree of physical activity.

We can't control or measure these variables as they are. essentially an individual matter. We know from experience that wide variations are possible in how people respond to the same set of conditions. Some people "feel the cold" more than others or ''can't stand draughts"; others like to work in shirtsleeves with all the windows open.

An extreme example of these differences would be that of a thin, elderly person in poor health doing sedentary work compared with a fit, heavily-built young person doing strenuous physical labouring.

Because of these differences it follows that, no matter how well environmental conditions are regulated, it will usually not be possible to satisfy everyone.

However, by following the guidelines in this booklet, you should be able to provide conditions that will be acceptable to about 85% of your staff.

Those who still find it too hot or too cold should make personal adjustments such as putting on or taking off clothes, drawing blinds, using personal fans or heaters, and so on. These actions, however, should not be allowed to affect the comfort of the majority.

Factors affecting atmospheric conditions

We have mentioned the four factors that determine atmospheric conditions. We now look at these in more detail and the inter-relationships between them.

Temperature — the hotness or coldness of the air — is the single most important factor affecting people's comfort. But even if the air temperature is satisfactory, one person sitting in a draught may feel cold and another close to a window with the sun streaming in may be too hot.

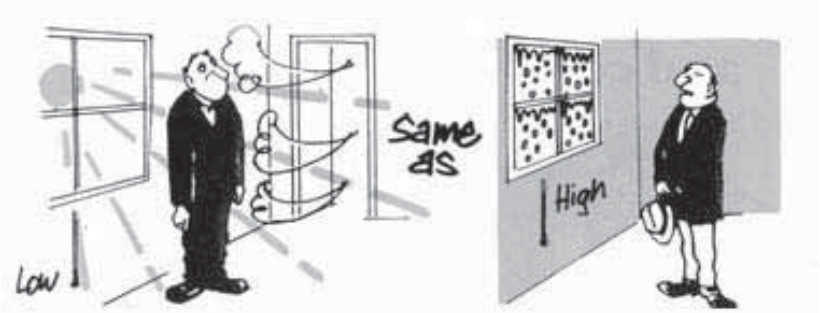
Humidity — the amount of moisture in the air — has only a small effect on comfort and can usually be ignored. An increase in humidity from 48% to 68% has the same effect as a rise of 0.4°C in air temperature. However, if an atmosphere is extremely dry (e.g. in the cold chamber of a refrigerating plant) or extremely wet (e.g. in the washroom of a steam laundry), the humidity must be controlled within acceptable limits. Otherwise, workers may develop respiratory problems.

Air movement has a significant effect on comfort. Too much air movement makes a room draughty — too little makes it feel stuffy. On still, hot days, or in humid weather, a fan will greatly increase comfort, even though it does not reduce air temperature.

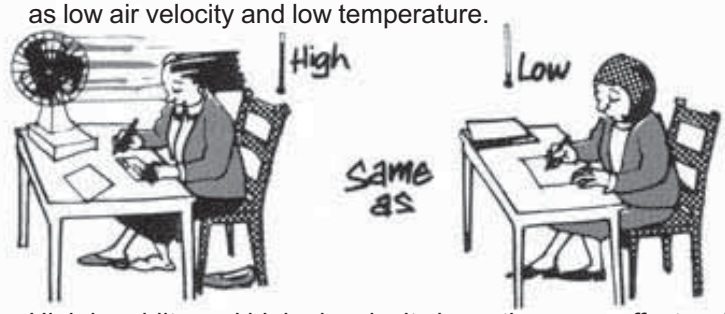
Radiant heat is energy which passes through the air without warming it appreciably but which heats any object on which it falls. An example of this is a person sitting next to an unshaded window on a sunny day who feels hot even though the air temperature is comfortable. On cold days, radiant heat from gas or electric heaters can pass out through windows, resulting in a heat loss in the workplace.

It is important to realise that certain combinations of these four variables produce exactly the same feeling of heat or cold — our bodies cannot recognise the difference. For example:

- High radiant heat and low air temperature have the same effect as low radiant heat and high air temperature.



- High air velocity and high temperature have the same effect as low air velocity and low temperature.

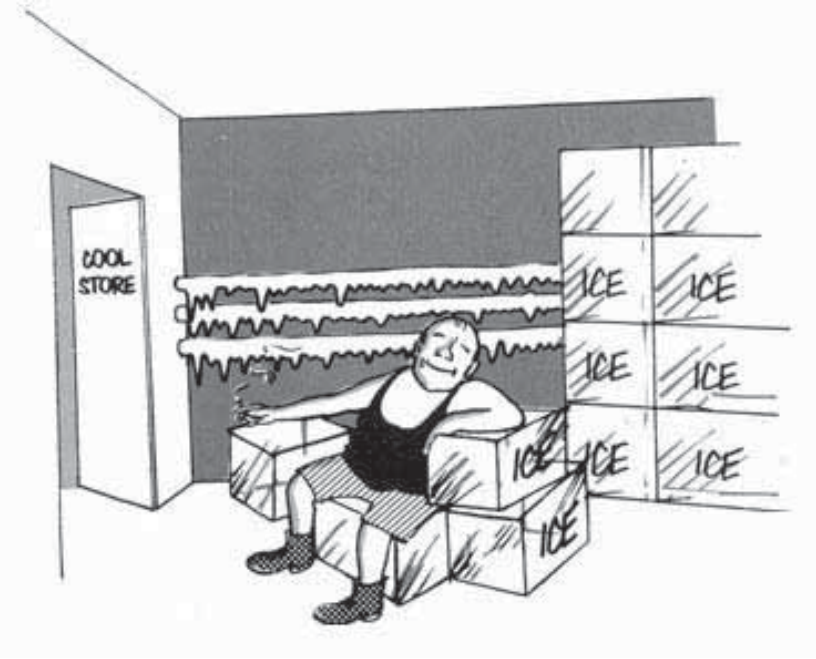


- High humidity and high air velocity have the same effect as low humidity and low air velocity.

Equivalent temperatures and comfort zones

We can see now why a simple measurement of air temperature may not give a true indication of environmental conditions in a workplace. Heating and ventilating engineers take measurements of air temperature, humidity, air movement and radiant heat and combine the results to obtain an “equivalent temperature index”.

The formulae used are rather complicated, and to explain how this index is derived is beyond the scope of this booklet. Using these indices, however, a scale can be developed for measuring people’s responses to atmospheric conditions.



A seven-point scale is often used in polling responses:

MUCH TOO WARM
TOO WARM
COMFORTABLY WARM
COMFORTABLE
COMFORTABLY COOL
TOO COOL
MUCH TOO COOL

For most individuals it requires a 1.5° Celsius change in “temperature” to move one unit up or down the scale. So a person who finds 20°C the most comfortable temperature will be:

- comfortable between 18.5°C and 21.5°C; and
- comfortably warm from 21.5°C to 23°C; and
- comfortably cool from 18.5°C to 17°C; but
- too warm or too cool anywhere outside this range.

The Department of Labour has carried out a survey to determine the temperature range in which the majority of New Zealand workers will feel comfortable. It was found that virtually all work in New Zealand falls into one of three classifications, and that most people in these categories feel comfortable at their work within the equivalent temperature range shown:

Table 1: Comfort Zones Equivalent Temperatures (°Celsius)

	Type of Work	*Summer*	*Winter*
Class 1	Sedentary work such as clerical or machining clothes	17 to 20	16 to 19
Class 2	Light work usually done standing, e.g. assembly and packaging	16 to 21	16 to 19
Class 3	Work involving lifting, or other physical activities	15 to 19	14 to 18

Remember that these equivalent temperatures are the combination of air temperature, air velocity and radiant heat, and are not the same as air temperature measured with a thermometer.

If air movement and radiant heat are not a significant factor (although they usually will be) it is possible to state comfort zones in terms of air temperature only:

Table 2: Comfort Zones — Air Temperature Only (^{0}Celsius)

Type of Work	*Summer*	*Winter*
Class 1	19 to 21	17 to 21
Class 2	18 to 22	18 to 21
Class 3	16 to 20	16 to 19

In practice, therefore, the temperatures in tables 1 and 2 may be recommended as a guide, although in some situations there may be other factors such as ambient temperatures that make them impracticable to attain — particularly in summer.

Remember, the final and deciding factor in terms of the legislation is whether the atmospheric conditions in your premises allow your employees to feel reasonably comfortable.

Simple trouble shooting

If there is something wrong with atmospheric conditions in your workplace, you'll generally hear about it quickly. Here are a few simple things you can check and perhaps put right yourself.

Is the temperature too hot or too cold?

If you have a thermometer, check the air temperature and compare it with those shown in table 2 on p.11. (If your thermometer is in Fahrenheit, use the conversion chart on p.19.)

If the temperature is outside the recommended range, the problem is obvious — more heating or cooling is needed.

If the temperature is within the recommended range, it is likely. that air movement, radiant heat or humidity is affecting people. Contact your nearest Department of Labour office and arrange for an inspector to determine the *equivalent temperature.* This should establish the cause of the problem. If a remedy is not readily apparent, you will have to consult a heating and ventilating engineer.

Is the workplace draughty?

Check window and door seals, and renew if defective. A common cause of draughts is doors and windows being left open. The actions of one staff member can cause a lot of discomfort for the others.

Is sunlight causing overheating?

If so, suitable solar curtains, window shades or blinds are the obvious answer.

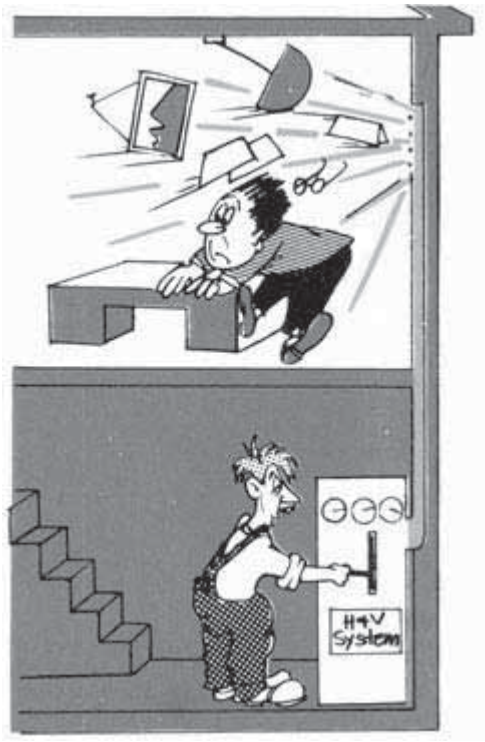
Is central heating or air conditioning at fault?

Problems here are indicated by a temperature that is too hot or too cold, or by excessive dryness of the air. Staff may complain of sore throats, headaches or flu-like symptoms.

Always treat such complaints seriously. Experience shows that there are real psychological effects if staff are unable to exert any control

over their work environment because of non-opening windows, non-adjustable ventilation grills, lack of curtains, and so on.

Modifications to an existing building may be impracticable, but you may be able to provide personal fans or heaters to allow staff this control.



Another point to remember is that no heating or ventilating system will perform satisfactorily if it is incorrectly operated or poorly maintained. If you suspect this as the cause, you will need to find out:

- Who is responsible for operating the system?
- Is a suitable operating manual supplied and is it being complied with?

- Who is responsible for maintenance?
- Is that person adequately trained?
- Is there a maintenance manual and/or schedule, and is it being complied with?

Depending on the answers to these questions, it may be necessary to refer to the supplier/installer of the equipment, to the building owner/controller, to a heating and ventilating engineer, or to the Department of Labour.

Heating and ventilation problems in buildings

Modern buildings create special problems with heating and ventilation. Usually — but not always — the designers are able to solve them successfully.

Factors that need to be considered are:

- Because of the sheer mass of a large building, heating it up or cooling it down takes a long time.
- On higher floors of tall buildings especially, some windows get too much sun and rooms become too hot. In wider buildings there may be rooms that get little or no natural light or fresh air.
- Many problems arise because of internal partitioning which may prevent free circulation of air.
- In some buildings, the heat output from artficial lighting, electrical equipment and the occupants themselves can be considerable.
- Wind pressures can be high, resulting in draughts if windows are opened. To overcome this, some buildings are fitted with permanently sealed windows.

Such factors create the need for heating and ventilating systems, loosely called “air conditioning”, to be an integral part of the building.

Full air conditioning means the control of air temperature, humidity, velocity and purity. The system comprises heating and refrigeration equipment, humidifiers, filters, fans and ducting.

Less sophisticated air conditioning systems provide only air heating or cooling, mechanical ventilation, or manually controlled natural ventilation.

Most problems with air conditioning systems are caused by poor maintenance or incorrect operation: Excessive dryness of the air, the commonest complaint in centrally heated buildings, is usually a result of a malfunctioning or incorrectly adjusted humidifier. Sore throats and other respiratory tract infections among the occupants could indicate a build-up of micro-organisms in the humidifiers and ducting systems. Such organisms thrive when air is constantly being recirculated unless there is a regular cleaning and maintenance programme.

Air conditioning problems due to design or installation faults are difficult and expensive to rectify. For this reason it is imperative that architects employ the services of a heating and ventilating engineer when designing such systems.

Measuring atmospheric conditions

In this section we describe the equipment used by factory inspectors, and by heating and ventilating engineers, to measure environmental conditions and to determine equivalent temperature indices.

We are not suggesting that you purchase this equipment and attempt to take the measurements yourself. If you think you have atmospheric problems in your undertaking, a factory inspector will be pleased to take the measurements for you. But it may be helpful to know just what the equipment is, and what it does.

Hygrometer: Humidity is not usually a significant factor in comfort levels in most New Zealand workplaces, but the hygrometer can be used as necessary to determine relative humidity.

The whirling hygrometer has both a dry bulb thermometer and a wet bulb thermometer. The wet bulb has a small fabric sock covering the bulb, and a wick connects the sock to a small container of water beneath. Evaporation cools the wet bulb so that it shows a lower reading than a dry bulb. The evaporation rate varies according to the amount of moisture already in the atmosphere. Humidity tables provided with the hygrometer show the relative humidity from the readings taken.

Mercury thermometer: A dry bulb mercury thermometer is normally used to measure air temperature. It is suspended in the air on a string or cord so that it is not touching anything, and should be at about work height, away from any draught or source of radiant heat.

Kata thermometer: This is used to measure air velocity in the workplace. An alcohol thermometer with a large bulb and two marks (corresponding to 37.7°C and 35°C) on the stem, it can take into account the various eddying currents in the atmosphere. The bulb is immersed in hot water until the alcohol rises past the high mark. The bulb is then wiped dry and the time taken for the alcohol to drop from the high mark to the low mark is measured. The time and air temperature are then referred to a set of tables or graphs, and the air velocity is shown.

Globe thermometer: Used to measure radiant heat, this is an ordinary dry bulb mercury thermometer inside a matt black copper sphere. Heat from radiation falling onto the matt black surface is transmitted to the thermometer, which rises above the room air temperature. The globe thermometer should be suspended in mid-air by a cord and some time allowed for the full effects of radiant heat to register on the thermometer.

Appendix: Fahrenheit to Celsius conversion table

^{0}F	0	1	2	3	4	5	6	7	8	9
20	-6.7	-6.1	-5.6	-5.0	-4.4	-3.9	-3.3	-2.8	-2.2	-1.7
30	-1.1	-0.6	0.0	-0.6	1.1	1.7	2.2	2.8	3.3	3.9
40	4.4	5.0	5.6	6.1	6.7	7.2	7.8	8.3	8.9	9.4
50	10.0	10.6	11.1	11.7	12.2	12.8	13.3	13.9	14.4	15.0
60	15.6	16.1	16.7	17.2	17.8	18.3	18.9	19.4	20.0	20.6
70	21.1	21.7	22.2	22.8	23.3	23.9	24.4	25.0	25.6	26.1
80	26.7	27.2	27.8	28.3	28.9	29.4	30.00	30.6	31.1	31.7
90	32.2	32.8	33.3	33.9	34.4	35.0	35.6	36.1	36.7	37.2
100	37.8	38.3	38.9	39.4	40.0	40.6	41.1	41.7	42.2	42.8
110	43.3	43.9	44.4	45.0	45.6	46.1	46.7	47.2	47.8	48.3
120	48.9	49.4	50.0	50.6	51.1	51.7	52.2	52.8	43.3	53.9
130	54.4	55.0	55.6	56.1	56.7	57.2	57.8	58.3	58.9	59.4
140	60.0	60.6	61.1	61.7	62.2	62.8	63.3	63.9	64.4	65.0