

Sources of oxygen

The most obvious source of oxygen is in the air that surrounds us. The typical concentration of oxygen in the air that we breathe is 21%; this is more than enough to allow a fire to start and to continue to burn.

However, there are other sources of oxygen that must also be considered. For example:

- oxygen bottles (used for welding or medical purposes);
- ventilation systems; and
- air-conditioning systems.

These sources of oxygen can enrich the normal oxygen levels in the air, which will lead to a more intense fire.

Oxidising materials

An oxidising material is a chemical that can easily decompose to release oxygen or an oxidising substance. The oxygen is chemically bound in a material until it is freed by heat and/or a chemical reaction. These materials can add to a fire and cause it to spread. Oxidising materials should always be kept away from sources of fuel. Oxidising materials can ignite sources of fuel without the presence of an ignition source.

These materials are easily identified by their Globally Harmonized System (GHS) hazard pictogram. The pictogram for oxidising material is shown in Figure 2.

Examples of oxidising materials include:

- hydrogen peroxide, which is sometimes used in hairdressing salons as a bleaching agent; and
- sodium chlorate, sometimes used in weedkillers.



Figure 2: The oxidising symbol¹

APPLICATION

Draw the fire triangle and then look around your current location. Identify the sources of ignition, fuel and oxygen and add these to your fire triangle.

10.1.2 Classification of fires

Fires are classified according to the fuel source. The fire classification will influence the type of extinguishing media that will be needed (see 10.3: Fire alarms and fire-fighting).

Different fire classification systems are used in different parts of the world, but here we will look at the UK classifications. The UK fire classifications are shown in Table 1.

Classification	Types of material
A	General combustibles, such as paper, wood, textiles, rubber and other organic carbon-based compounds
B	Flammable liquids
C	Flammable gases
D	Metals
F	Cooking oils
L	Lithium-ion batteries and cells where no lithium metal is present ²

Table 1: UK fire classifications

Electrical fires are sometimes referred to as Class E fires. In the UK electrical fires are not formally classified because electricity itself does not burn. However, firefighters do need to be aware of electrical hazards when attending an incident as the majority of buildings have an electricity supply.

10.1.3 Principles of heat transmission and fire spread

A basic principle of fire science is that heat energy moves along a high-to-low gradient; that is, heat will always move from a hot area to a cooler one. This transfer of heat can occur by one or more of the following:

- conduction – the transfer of heat in a static material;
- convection – by molecular movement in a liquid or gas;
- radiation – the transfer of heat through a gas or vacuum; and
- direct burning – the transfer of heat from one material's surface to another.

Conduction

Conduction happens when there is a difference in temperature between two parts of the same material; the heat will either travel along or through this material. The heat is 'passed' via microscopic particles in the material (molecules, atoms or electrons, depending on the material); the heated section's particles will vibrate quicker than in the cooler section. The particles will collide with their neighbour, which will pass the energy (heat) to the cooler area.

Materials differ greatly in their heat conducting ability. Metals are usually good heat conductors, while building materials such as brick and stone are poor conductors. If a building has a steel frame with untreated or uninsulated girders, the girders can conduct heat from one area to another and initiate secondary fires.

Convection

This is the process by which heat is transferred by movement of a heated fluid such as air or water. As air is heated, its density decreases and it rises, being replaced by cooler air that is drawn in from below. Hot air can travel both vertically and horizontally through gaps in building fabric, along air vents and roof spaces, spreading the fire to other parts of the building.

KEY POINTS

- The three sides (components) of the 'fire triangle' are heat, fuel and oxygen. A fire will not form (or will be quickly extinguished) without all three components.
- Oxidising materials are chemicals that can add to a fire and cause it to spread.
- There are five UK fire classifications. They influence what should be used to extinguish a fire.
- The four principles of heat transmission are convection, conduction, radiation and direct burning. These contribute to how fire can spread if left uncontrolled. Other things that affect fire spread include building design and the presence of fuel, waste or flammable material, dusts, gases and vapours.
- Workplace fires are commonly caused by people (including deliberately), equipment and electrical faults, certain work activities and natural conditions.
- Fires can result in injuries and fatalities, property and environmental damage, financial losses and reputational harm.

Reference

¹Source: HSE, 'Hazard pictograms (symbols)' (<https://www.hse.gov.uk/chemical-classification/labelling-packaging/hazard-symbols-hazard-pictograms.htm>)

²The new Class L category was introduced by BSI, 'BS ISO3941:2026 Classification of fires' (<https://knowledge.bsigroup.com/>)

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Page 522 correction

Correction to structural measures content for chapter "10.2 Preventing fire and fire spread"

The fourth sentence of the paragraph under the "Steel" heading should read:

"An unprotected steel frame will begin to deform at a temperature of around 600 °C, which severely compromises the structural integrity of the building and can also contribute to a partial or even total collapse of the building."

Page 527 correction

Correction to flame detectors content for chapter "10.3: Fire alarms and fire fighting"

The final two sentences under the "Flame detectors" heading should read:

"Flame detectors use ultraviolet or infrared sensors (or a combination of both) to identify specific wavelengths of light emitted by flames. When the receiving unit detects flames, the alarm is sounded or the suppression unit is activated."

Correction for page 531

Table 1 shows the extinguishers that are commonly used.

Type	Label colour	Fire classification	Information
Water	Red (with white lettering)	A	Must not be used on electrical, metal or oil-based fires
Carbon dioxide (CO ₂)	Black	B and electrical fires	Must not be used in enclosed spaces as it displaces oxygen in the area
Dry powder	Blue	A, B, C	Must not be used in enclosed spaces as the powder is easily inhaled
Foam	Cream	A, B	Water based so must not be used on electrical, metal or oil-based fires
Wet chemical	Yellow	A, F	Can be used on class A fires although it is more usual to use water and/or foam

Table 1: Fire extinguishers for different classifications

Special powders are available for Class D metal fires; such extinguishers will be needed in environments where metals such as manganese and aluminium are formed and processed.

Specialised fire extinguishers are available for Class L lithium-ion battery and cell fires, however the majority of these fires should only be tackled by trained/specialist people.

Advantages and limitations of fire extinguishers

Extinguishers have both advantages and limitations. We have already touched on some of these.

Advantages

The biggest advantage is that the extinguishing media is immediately available; this can be the difference between stopping a fire or letting it take hold.

Another advantage is that the actual operation of the fire extinguisher is relatively easy (by pulling out the pin and pressing the trigger) and the training is simple and straightforward. This obviously has financial advantages for organisations, as they will not have to release workers from their 'day jobs' for very long or pay for expensive training courses. However, this is only the case for low- to medium-risk organisations. Those working on high-hazard sites will require much more extensive training, but that falls outside the scope of this qualification.

Limitations

Organisations must understand that extinguishers are only the first line of defence. In some cases, other fire suppression systems (such as sprinklers) may also be appropriate. The organisation's fire risk assessment should specify the types of firefighting equipment required.

Some types of extinguishers could have specific health effects on the users.

Fire extinguishers are readily accessible in the majority of buildings. There is, therefore, a danger of the extinguishers being overlooked as essential firefighting equipment. For example, they could be used for activities that they were not meant for (as doorstops, for example) so they may not be available when they are required. They could also be used when people are playing practical jokes, or just generally