16) What can brief exposure to very high concentrations of chlorine cause?
    a) Minor skin irritation
    b) Watering eyes
    c) Death
    d) Sneezing

17) List the gases that may be present in sewer gas.
    a) Methane
    b) Helium
    c) Argon
    d) Freon

18) Which of the following are four common fuels found in the commercial/industrial environment?
    a) Gasoline, methanol, propane, natural gas
    b) Gasoline, diesel, propane, natural gas
    c) Gasoline, diesel, ethanol, propane, natural gas
    d) Gasoline, biodiesel, methanol, natural gas

4. Fire safety practices

Overview

Purpose

Gas technicians/fitters are often exposed to hazardous materials that are flammable or potentially explosive. Knowing what preventive measures to take and how to deal with different types of fires will help gas technicians/fitters and the workers around them to avoid serious injury or property damage.

Objectives

At the end of this Chapter you will be able to:

- identify common fire hazards.
- identify classes of fires.
- describe firefighting equipment found in the industry; and
- describe how to match equipment with class of fire.

Terminology

Term	Abbreviation (symbol)	Definition
Fire extinguisher nameplate		Plate on fire extinguishers which designate, by means of a rating code, the types of fires for which each extinguisher can be used.
First-aid firefighting		Extinguishing a fire in its initial stages by using whatever is readily at hand, before the fire can get out of control.
Oxidation		Union of a substance with oxygen.

Common fire hazards

Fire is the rapid oxidation of a flammable material in the chemical process of combustion, releasing heat, light, and various reaction products. Oxidation is defined as the union of a substance with oxygen. Oxidation takes place at varying rates, as shown in the examples in Table 4-1.

Table 4-1
Different rates of oxidation

Rate of oxidation	Example
Very slow	Rusting iron (not fire)
Slow	Spontaneous heating of materials (such as oil-soaked rags)
Fast	Burning paper or wood
Extremely fast	Exploding gunpowder

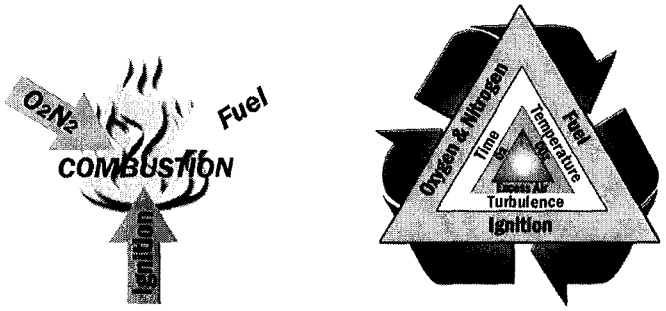
The combustion triangle (tetrahedron)

Before a fire can occur, four components must be present:

Component	What is present
Fuel	Fuel must be a combustible material such as wood, gasoline, paper, or cloth.
Heat (Ignition)	Heat must be sufficient to raise the fuel to ignition temperature.
Oxygen	Oxygen comes usually in the form of air, primarily consisting of oxygen (O_2) and nitrogen (N_2).
Uninhibited chemical reaction	Chemical, exothermic reaction that is fire.

These components are represented graphically as the combustion triangle (or tetrahedron) (Figure 4-1). Later Units and Chapters explain the combustion triangle and process in greater detail.

Figure 4-1
The combustion triangle and advanced combustion triangle



Content on the combustion triangle and the advanced combustion triangle is excerpted from the "Combustion analysis and fuel efficiency" manual courtesy of ESCO Group. For additional information on combustion analysis, visit http://www.escogroup.org/.

You can prevent the occurrence of fire by keeping the required four components of combustion separated. In the same way, removal of any one of the four components will extinguish an existing fire:

Extinguish a fire by...	Example
Removing the fuel from the vicinity of the fire, which results in fuel starvation.	Shutting off the valve of the gas main is an example of fuel starvation.
Removing the heat, which results in cooling.	Applying suppressant or water to the fire.
Removing the oxygen to cause smothering of the fire.	Covering the fire with a lid, wet blanket, or sand, or use carbon dioxide, foam, or a dry chemical (as contained in fire extinguishers).
Breaking up the chemical reaction needed for self-sustained combustion.	Using a flashback arrestor.

Principal causes of fire

In the gas industry, you will encounter a number of preventable causes of fire. Some examples of causes include:

- combustible materials near open flame
- gas leaks
- proximity of LP-gas storage cylinders to oxygen cylinders, electrical circuits, welding or burning tools, gasoline, or other highly flammable liquids
- defective or broken venting systems
- careless handling or transportation of gas cylinders
- storage of gas cylinders in indoor, badly ventilated locations

- storage of full and empty cylinders in the same vicinity

During particular work, be aware of the following fire hazards:

Fire hazard	Example
Welding and burning	• Flying sparks or slag, which can travel great distances and disappear through cracks in walls and floors or into ducts, can immediately result in obvious fires or cause smouldering fires. • Welding against a wooden back or dust, which can result in a smouldering fire that does not ignite until several hours after the job is completed. • Poor grounding during welding, which sometimes causes electrical motor fires • Soldering and brazing around flammable materials or dusts • Improper use of oxyacetylene torches • Inadequate ventilation of storage areas
Electrical sources	• Short circuits and arcing • Broken electrical wiring • Light bulbs in contact with fine dust or oily surfaces • Unprotected bulbs and unshielded switches in dusty areas
Friction	• Fallen material resting on fast-moving equipment, such as a belt • A belt running off-centre and rubbing against a fixed surface • Hot bearings igniting oil or dust
Worker-engendered	• Workers ignoring No Smoking signs • Workers ignoring gas ventilation and dust-abatement regulations • Workers with sloppy housekeeping practices

Types of fires

Fires are divided into main types or classes, which dictate the type of extinguisher required to fight them. Fires are rated by type: A, B, C, D, and K. Designations that coincide with each of these types– A, B, C, D and K–are also used to rate fire extinguishers.

The following symbols or pictograms (Table 4-2) may be the main or only indications you will have of the best use of a fire extinguisher. Note carefully the classes, letters, symbols, and pictograms for when you will need them.

Table 4-2
Fire and extinguishers types

Symbol and its colour	Pictogram	Type of fire	Type of extinguisher	Extinguishing agent
A Green		Ordinary combustibles (wood, cloth, paper, rubber, and many plastics)	Uses the heat-absorbing (cooling) effects of certain chemicals that retard combustion.	A wet or dry formula or other clean agent systems (i.e., halon[1], nitrogen, argon, and carbon dioxide). Extinguishes fires via oxygen depletion. [1]Note: In the mid 1990s, the manufacturing of halon was banned because of the environmental effects of the gas. However, the use of halon was not banned. In fact, these types of fire extinguishers may still be in service.
B Red		Flammable or combustible vapours	Uses extinguishers that prevent these vapours from being released or that interrupt combustion.	
C Blue		Energized electrical equipment	Uses non-conductive extinguishing agents to protect the operator (you can use Class A or B extinguishers only when electrical equipment is de-energized).	

(Continued)

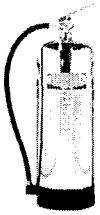
Table 4-2 (Concluded)

Symbol and its colour	Pictogram	Type of fire	Type of extinguisher	Extinguishing agent
 Yellow	None	Certain combustible metals, such as magnesium, titanium, zirconium, sodium, or potassium	Uses heat-absorbing extinguishing medium not reactive with the burning materials. Smothering, using an appropriate dry chemical Class D extinguisher or sand is used to put out small Class D fire such as burning pile of metal shavings. Class D fires (certain combustible metals) can be similar to class C flames, except water cannot be used on fires that burn metal. Spraying water on a class D fire will actually serve to energize the flames, potentially spreading the fire and creating additional heat and damage.	A dry powder that absorbs heat and smother the flames, cutting off oxygen. Removing these two essential elements of the fire tetrahedron will enable safe and rapid extinguishing of the fire.
 Black	 Black	Vegetable oils, animal oils, or fats in cooking appliances.	Dispenses the solution as a fine mist that doesn't splash blazing oil. The potassium acetate mist cools the air surrounding the flames and reacts specifically with oils and grease to form a foam that blankets the surface of the blazing substance, smothering the fire. This foaming reaction occurs only with burning animal fats. This extinguisher type is not effective on Type B fires involving petroleum products or other flammable liquids.	A wet chemical that reacts specifically with vegetable oils, animal oils, or fats in cooking appliances to form a foam that blankets the surface of the blazing substance, smothering the fire.

Firefighting equipment found in the industry

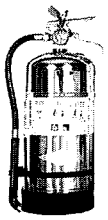
Fire extinguishers are a gas technician/fitter's main firefighting tools of concern. It can be critical that gas technicians/fitters know the location of and method of operating each extinguisher in their workplace. Figure 4-3 shows common types of portable extinguishers and the classes of fire for which each is effective.

Table 4-3
Fire extinguishers

Type	Effective on fire class	Example
Water extinguisher		
Dry chemical extinguisher	 (some)  	
CO_2 extinguisher	 	

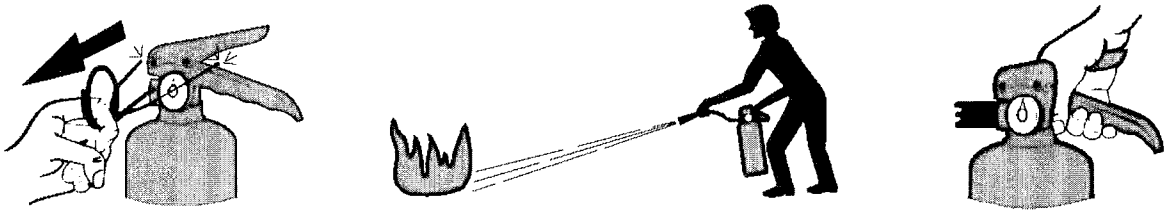
(Continued)

Table 4-3 (Concluded)

Type	Effective on fire class	Example
Flammable solids		
Cooking oils and fats		

Since each manufacturer uses a slightly different operating procedure, you should look carefully at the markings and instructions on the extinguisher. These markings (Figure 4-2) will tell you how you can most effectively use the extinguisher.

Figure 4-2
Sample markings on different types of extinguisher



First-aid firefighting

First-aid firefighting is extinguishing a fire in its initial stages by using whatever is readily at hand, before the fire can get out of control.

Fire extinguishers used in homes and offices are designed to deal with fires in their infancy. They are still necessary even though sprinkler systems and other devices may protect an area.

Although fires fueled by metal are rare, being aware of the potential risks is important. Because people do not expect metal to burn or for the flames to spread so quickly, a small class D fire can soon turn into a very dangerous situation before appropriate action is taken. Knowing the conditions and dangers of a class D fire is essential.

In a commercial kitchen, open flames, red-hot cooking surfaces, and a heavily grease-laden environment combine to make the modern commercial kitchen a potentially dangerous fire hazard. These fires spread quickly and have proven to be very difficult to extinguish, making

them the leading cause of structural fire damage. Use a class K extinguisher for these types of fires.

Matching equipment with class of fire

As described in the previous sections, there are five classifications of fires and the fire extinguishers used to fight them. The nameplates of fire extinguishers designate, by means of a rating code, the types of fires for which you can use each extinguisher (see Table 4-4 for class A, B, and C extinguisher ratings).

Class A, B, and C extinguishers

Table 4-4
Class A, B, and C Fire Extinguisher Ratings
Underwriters' Laboratories of Canada (ULC) ratings show the relative hazard, coverage, and travel distance specifications of extinguishers.

ULC rating codes			
1-A 10-B: C	Light hazard • Light hazard-3000 sq ft (27 m^2) of Class A fire • 75 ft (23 m) travel distance	Light hazard • Light hazard-10 sq ft (0.93 m^2) of Class B fire • 50 ft (15 m) travel distance Ordinary hazard • Ordinary hazard-10 sq ft (0.93 m^2) of Class B fire • 30 ft (9 m) travel distance	Sufficient for Class C conditions
2-A 10-B: C	Light hazard • Light hazard-6000 sq ft (55 m^2) of Class A fire • 75 ft (23 m) travel distance Ordinary hazard • Ordinary hazard-3000 sq ft (27 m^2) of Class A fire • 75 ft (23 m) travel distance	Light hazard • Light hazard-10 sq ft (0.93 m^2) of Class B fire • 50 ft (15 m) travel distance Ordinary hazard • Ordinary hazard-10 sq ft • (0.93 m^2) of Class B fire • 30 ft (9 m) travel distance	Sufficient for Class C conditions

(Continued)

Table 4-4 (Concluded)

ULC rating codes			
4-A 40 B: C	Light hazard • Light hazard-11 250 sq ft (1045 m^2) of Class A fire • 75 ft (23 m) travel distance Ordinary hazard • Ordinary hazard-6000 sq ft (557 m^2) of Class A fire • 75 ft (23 m) travel distance Extra hazard • Extra hazard-4000 sq ft (371 m^2) of Class A fire • 75 ft (23 m) travel distance	Light and ordinary hazards • Exceeds Class B requirements for light and ordinary hazards Extra hazard • Extra hazard-40 sq ft (3 m^2) of Class B fire • 50 ft (15 m) travel distance	Sufficient for Class C conditions

Class D and K extinguishers

Class D fire extinguisher

Class D fire extinguishers are generally not given a numerical rating and are simply classified as a Class D extinguisher.

The type of class D extinguisher needed depends upon the type of flammable metals at the work area:

- Copper extinguishing medium is used on lithium and lithium alloy metals.
- Sodium chloride extinguisher works better for fires involving magnesium, sodium, potassium, uranium, and powdered aluminum.

Class K fire extinguisher

Class K fire extinguishers are rated for use on kitchen fires involving cooking oils and deep fryers. Class K is not given a numerical rating.

Example: A Fire Extinguisher with a rating of 2A: K would contain the equivalent to 2.5 gallons of water (2 x 1.25) and would also be approved for use on a class K (cooking oil and fats) fire.

Assignment Questions – Chapter 4

1) Which of the following is an example of extremely fast oxidation?
   a) Exploding gunpowder
   b) Rusting iron
   c) Spontaneous heating of materials (such as oil-soaked rags)
   d) Burning paper or wood

2) Which of the following is not a component of the combustion triangle (tetrahedron)?
   a) Fuel
   b) Heat
   c) Oxygen
   d) Humidity

3) What is shutting off a gas main valve during a fire an example of?
   a) Heat suppressing
   b) Fuel starvation
   c) Oxygen starvation
   d) Breaking up the chemical reaction

4) Which of the following is a way an electrical source can cause a fire?
   a) Wrong size marrett connector
   b) Light bulb in contact with fine dust
   c) Wiring is run too long

5) Which of the following are the five main classes fires divided into?
   a) A, B, C, D and E
   b) A, B, C, D and H
   c) A, B, C, D and N
   d) A, B, C, D and K

6) A gasoline fire belongs to what class?
   a) Class B
   b) Class A
   c) Class C
   d) Class K