Portable Fire Extinguishers

Learning Outcome

When you complete this module you will be able to:

Describe the types of portable fire extinguishers and their application for each fire classification.

Learning Objectives

Here is what you will be able to do when you complete each objective:

1. Describe the applicability, construction and operation of various types of portable fire extinguishers.

2. Discuss the inspection and maintenance of portable fire extinguishers.

INTRODUCTION

The requirement for fire safety in commercial and industrial buildings and in manufacturing plants is a result of building and fire codes. Various systems such as communications, fire detection, alarm and annunciation, fire suppression, smoke control, and elevator control are required to be installed and maintained.

Basically, all buildings and manufacturing plants require portable fire extinguishers. Other protection systems such as a fire standpipe system, sprinklers, or a fire hydrant system are governed by the building's design, size and use.

Fire regulations are for the protection of persons and property and the maintenance of fire and life safety systems. Governmental agency regulations are directed to the protection of life and safety. Insurance requirements are more or less geared to prevent excessive loss of property based on risk management experience.

PORTABLE FIRE EXTINGUISHERS

Some portable extinguishers are suitable for only one class of fire, and some extinguishers are suitable for two or three classes of fire. No extinguisher is suitable for all four classes of fire. Fig. 1 shows the most common method of identifying the class of fire for which the extinguisher is suitable. The identification is by the class letter, a distinguishing shape, and a color code.

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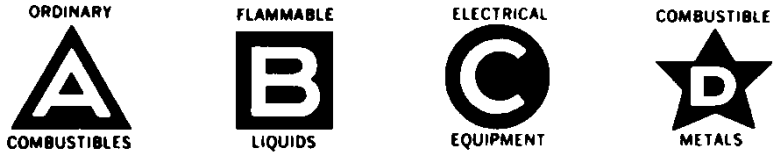

Extinguisher markings that can be used until conversion to pictographs is complete. Color coding is part of the identification system, and the triangle (Class A) is colored green, the square (Class B) red, the circle (Class C) blue, and the five-pointed star (Class D) yellow.

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Figure 1
Fire Extinguisher Markings

The most recently recommended marking system is one that combines pictographs of both the uses and non-uses on a single label. This method of identification is shown in Fig. 2.

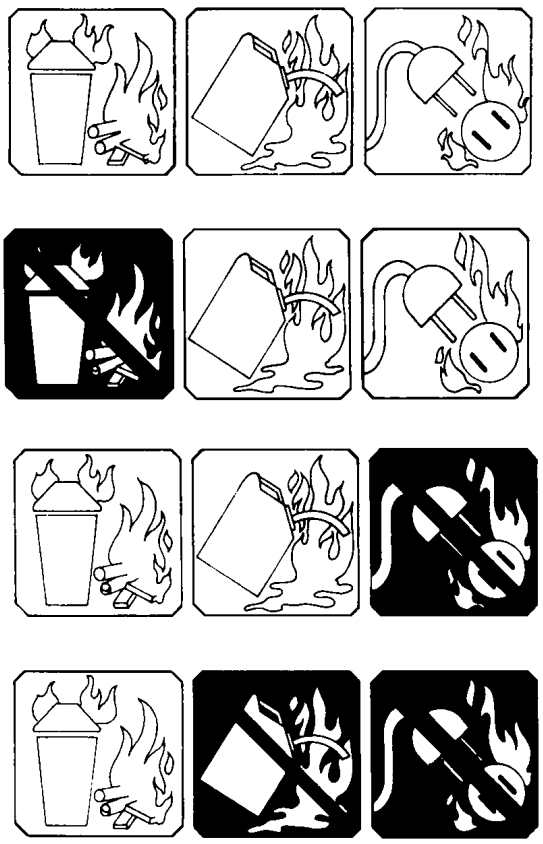

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Figure 2
Pictograph Fire Extinguisher Symbols

The pictographs illustrated in Fig. 2 are designed so that the proper application of the extinguisher can be immediately determined. If the application is prohibited, the background is black and the slash is bright red; otherwise the background is light blue. The top row identifies an extinguisher that is suitable for Classes A, B, or C. The second row shows an extinguisher that is suitable for Classes B and C but not Class A. The third row indicates an extinguisher suitable for Class A and B fires, and the fourth row indicates an extinguisher for Class A fires.

Rating numerals are also used on the labels of portable fire extinguishers. These numerals give the relative extinguishing effectiveness of the extinguisher. This system is only used for Class A and B fire extinguishers. The numeral precedes the Class letter; for example an extinguisher may be marked “2A: 40B:C”. This indicates the effectiveness of this particular make and design of extinguisher as determined by standard reproducible test fires. Class A uses three different standard types of test fire while Class B uses only one.

An extinguisher with a 4A rating is four times more effective than an extinguisher with a 1A rating.

Class C indicates the agent is non-conductive and can be used on energized equipment. Class C extinguishers do not have rating numerals. Electrical equipment is made of materials classified as either ordinary combustibles, or flammable liquids, or both once they have been de-energized. An extinguisher for Class C fires should be chosen according to the nature of the combustibles in the immediate area and the need for working around energized equipment.

TYPES OF PORTABLE EXTINGUISHERS

Currently approved types of fire extinguisher are characterized into six major groups based on the extinguishing agent used. The six types are:

1. Water
2. Carbon dioxide
3. Halogenated agent
4. Dry chemical
5. Dry powder
6. Foam

Water Extinguishers

Water extinguishers have two basic designs, stored pressure and pump types.

1. Stored Pressure Type

A common type of stored pressure water base extinguisher (shown in Fig. 3) contains 10 litres and has a mass of about 14 kg. It can be operated intermittently and is easily recharged. The unit consists of a single chamber, which contains both the agent and the expellant gas. The cap, or head assembly, consists of a siphon tube, combination carrying handle/operating lever, discharge valve, air pressure valve, pressure gage, discharge hose, and nozzle. A stored pressure type is shown in Fig. 3.

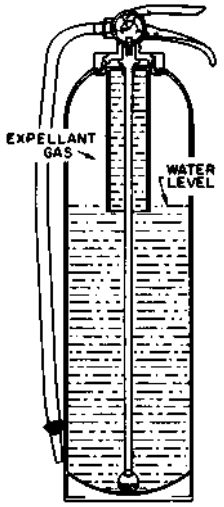

Figure 3
Stored Pressure Water Extinguisher

If the extinguisher is to be used in an area where it may be subject to freezing, it should be charged with a loaded stream (a type of antifreeze agent).

The extinguisher is pressurized with air or an inert gas in the range of 600 to 900 kPa. The air or gas is charged through a Schrader type tire valve on the head. A 14 kg unit has a horizontal range of 9 to 12 m and will discharge in about 60 seconds. The ULC classification is 2A.

Most models include a ring pin to lock the operating lever to prevent accidental discharge. To operate the extinguisher, set it on the ground, hold the combination handle loosely in one hand and pull out the ring pin with the other hand. Move the unit to the best position, hold the hose in one hand and squeeze the discharge lever with the other

2. Pump Tanks

Two types are available, a floor standing model and a backpack model.

The floor standing model is cylindrical and has carrying handles on the container or built into the pump handle. The capacity ranges from about 7 to 25 litres. The pump is a vertical piston type mounted inside the cylinder. A short length of hose with a discharge nozzle is attached to the external part of the pump. The duration of operation ranges from 45 seconds to 180 seconds depending on capacity. The range of the stream is 9 to 12 m.

To operate the pump, the unit is set on the ground, and an extension bracket is lowered on which one foot is placed to steady the unit. To force water through the hose, pump the handle up and down with one hand while holding the hose in the other hand. The disadvantage of this type of unit is that to move the unit, pumping has to stop. Also the force, range and duration of water flow depend to some extent on the operator.

The ULC ratings are given in Table 1.

Capacity (litres)	Underwriters Laboratory Canada Rating (ULC)
7	1A
11	2A
18	3A
23	4A

Table 1
ULC Ratings

Fig. 4(a) shows a floor model pump tank extinguisher.
Fig. 4(b) shows the backpack pump type. The principle of operation is similar to the floor model except that the pump is of the "trombone" type and the discharge nozzle is mounted on the pump. The capacity is usually 10 litres and the performance and rating will be the same as the floor mounting type of the same capacity.

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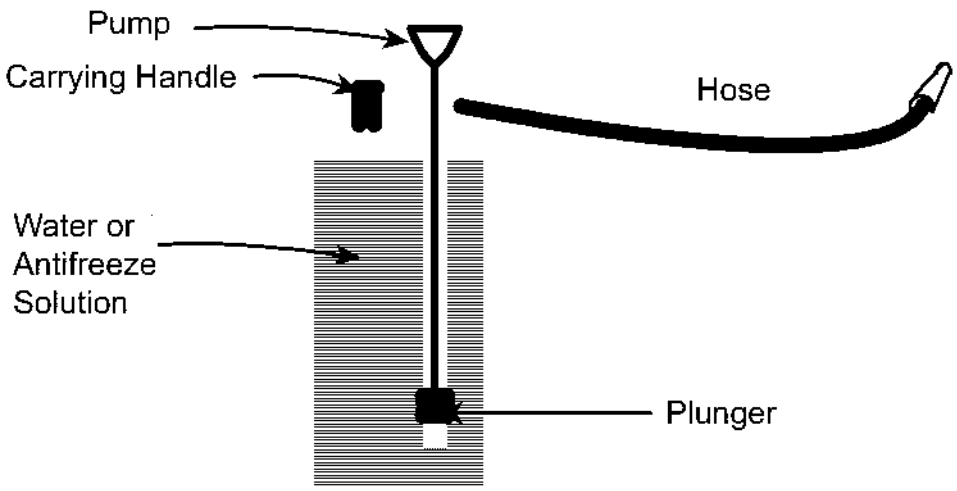

Figure 4 (a)
Floor Model Pump Tank Extinguisher

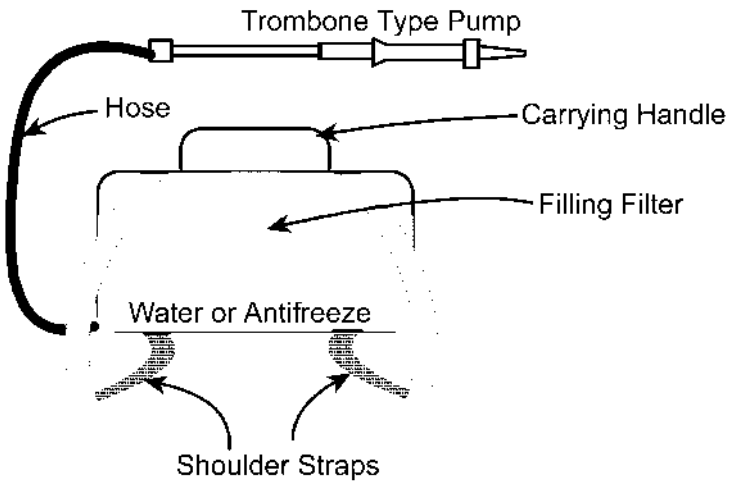

Figure 4(b)
Backpack Pump Tank Extinguishers

Carbon Dioxide

Carbon dioxide (CO_2) is a compressed gas agent. It is intended for use on Class B and C fires, but can be used on Class A fires until a suitable agent can be obtained. The carbon dioxide is stored in cylinders as a liquid at 5600 to 6300 kPa at temperatures below 31°C. The maximum storage temperature should not exceed 55°C.

When released from the extinguisher, CO_2 displaces oxygen in the vicinity of discharge to the point where it no longer supports combustion. The rapid expansion from a liquid to a gas when the CO_2 is discharged converts about 30% of the liquid into "dry ice" which then sublimes (evaporates directly) into a gas. Carbon dioxide extinguishers have a short range as the agent is expelled in the form of a cloud consisting of a mixture of gaseous and solid CO_2.

If a CO_2 extinguisher is used in a confined or unventilated area, precautions should be taken to ensure people are not overcome due to a lack of oxygen in the atmosphere. The carbon dioxide "snow" may also cause visibility problems and the noise of discharge may frighten anyone who has not used a unit previously. The CO_2 may also drift into adjacent low spaces, if large quantities are released.

Carbon dioxide extinguishers are self-expelling; that is, they do not require any operating medium to discharge the agent. The extinguisher consists of a pressure cylinder (or shell), a siphon tube, and a valve to release the agent. Connected to the valve is a discharge horn, or a horn and hose combination. The siphon tube extends from the valve to almost the bottom of the cylinder. Normally only liquid CO_2 reaches the discharge horn. After about 80% of the cylinder contents have been discharged the remainder enters the siphon tube as a gas.

Fig. 5 shows a typical carbon dioxide extinguisher.

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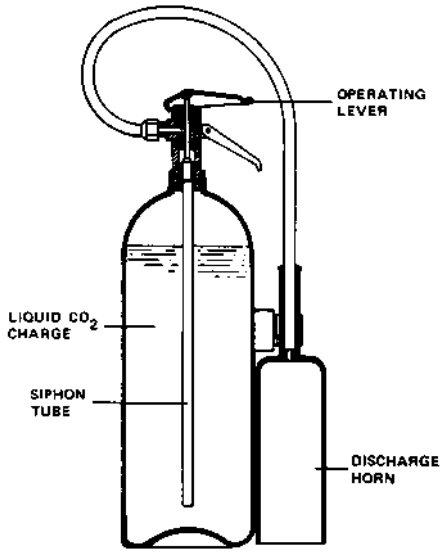

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Figure 5
Carbon Dioxide Extinguisher

The characteristics of CO_2 extinguishers are given in Table 2.

Capacity (kilograms)	Horizontal range of stream (metres)	Approx. time of discharge (seconds)	ULC Class
0.9 - 2.25	0.9 - 2.5	8 - 30	1 - 5B:C
4.5 - 7.0	0.9 - 2.5	8 - 30	2 - 10B:C
9.0	0.9 - 2.5	10 - 30	10B:C
23 - 45 (Wheeled Units)	0.9 - 3.0	10 - 30	10 - 20B:C

Table 2
Characteristics of CO_2 Extinguishers

Operation of one type of CO_2 extinguisher is illustrated in Fig. 6. The smaller hand held models often have the horn directly connected to the valve assembly by means of a metal tube swing joint connector. Larger models have the discharge horn connected to the valve by a short length of hose. The extinguisher discharge is controlled by squeezing the valve operating lever. Touching the discharge horn during operation should be avoided as it is likely to be very cold. If CO_2 extinguishers are used in subzero temperatures, the valve must remain open until the extinguisher is fully discharged, otherwise the discharge system may become blocked unless a special low temperature charge has been added.

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Figure 6
Use of a CO_2 Extinguisher

Carbon dioxide extinguishers have a limited range and are affected by wind and drafts. The extinguisher discharge should be directed as close to the base of the fire as possible. The agent should be applied even after the flames have been extinguished in order to allow time for cooling and to prevent reflash. For flammable liquid fires the usual method is to begin at the nearest edge, sweeping from side to side towards the back of the fire. Another method, called "overhead application", can be used. In this method, the discharge horn is pointed down at an angle of about 45° towards the center of the burning area. Usually the horn is not moved.

The side to side sweeping method is likely to give better results on spill fires' while the overhead method may be best on confined fires. For electrical equipment fires, direct the discharge at the source of the flames. The equipment should be de-energized as soon as possible to prevent possible reignition.

Carbon dioxide is nontoxic; however, in the concentrations required to extinguish a fire, it can produce unconsciousness and death due to suffocation rather than to toxic affects.

Halogenated Agent

Extinguishers using halogenated agents are mostly intended for use on Class B:C fires. The most common are Halon 1211 (bromochlorodifluoromethane) and Halon 1301 (bromotrifluoromethane). Halon 1211 is effective on Class A fires, and extinguisher sizes of 4 kg and greater have Class A ratings. The characteristics of some Halon extinguishers are given in Table 3.

Type	Capacity (kilograms)	Horizontal Range of Stream (metres)	Approx. Time of Discharge (seconds)	ULC Class
Halon	1.0	1.3 to 1.8	8 to 10	2B:C
1301	1.0 to 1.8	2.4 to 3.7	8 to 12	2 to B:C
Halon	2.5 to 4.1	2.7 to 4.6	8 to 15	1A &10B:C
1211	7.3 to 10.0	4.3 to 4.9	10 to 18	1 to 4A & 20 to 80B:C

Table 3
Characteristics of Halon Extinguishers

Halon agent extinguishers are operated and applied in the same manner as carbon dioxide extinguishers. Halon agents are toxic and the permitted times of exposure are given in
Table 4.

Type	Concentration % by Volume	Permitted Time of Exposure
Halon 1301	up to 7	15 minutes
	7 to 10	1 minute
	10 to 15	30 seconds
	above 15	Prevent Exposure
Halon 1211	up to 4	5 minutes
	4 to 5 1 minute	
	above 5	Prevent Exposure

Table 4
Permitted Halon Exposure Times

Halon 1301 is permitted for normally occupied areas where the concentration will not exceed 10%, or up to 15% in areas not normally occupied. Halon 1211 is not acceptable in areas that are normally occupied. Both types produce toxic by-products in extinguishing a fire.

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In order to ensure adequate operation of Halon extinguishers over a wide temperature range, the pressure in the Halon cylinder is increased by the addition of nitrogen gas.

Some portable Halon extinguishers may contain a mixture of Halon 1211 and Halon 1301.

NOTE: At the time of printing of this module, the use of Halons is being discouraged due to concerns about the environmental impact of halogenated hydrocarbons.

Dry Chemical

Do not confuse dry chemical agents with dry powder agents which were developed for use on combustible metals. Dry chemical extinguishing agents are known as regular or ordinary dry chemicals, and as multipurpose dry chemicals. Regular or ordinary dry chemicals are suitable for Class B (flammable liquids) and Class C (electrical equipment). The multipurpose chemicals are also suitable for Class A (ordinary combustibles) as well as Classes B and C.

The usual dry chemical agents for use on Class B:C fires include sodium bicarbonate, potassium bicarbonate, urea-potassium bicarbonate, and potassium chloride-base agents. The multipurpose dry chemicals use an ammonium phosphate base agent.

There are two basic designs of dry chemical extinguishers. One design uses a cartridge of carbon dioxide or nitrogen to expel the agent. In this type of extinguisher, the cartridge can be either internal or external. The expellant gas is released to the bottom of the shell when the puncture lever is depressed, forcing the dry chemical out the nozzle. The rate of flow of dry chemical agent can be controlled by squeezing the operating lever at the nozzle on the end of the hose.

The other design is of the stored pressure type, with either a rechargeable or disposable shell. The disposable shell type has the agent and the expellant gas factory sealed. The shell is then screwed onto a valve and nozzle assembly. Some smaller extinguishers are of a throwaway type where the entire device is disposed of after use. Fig. 7 shows both types of dry extinguishers.

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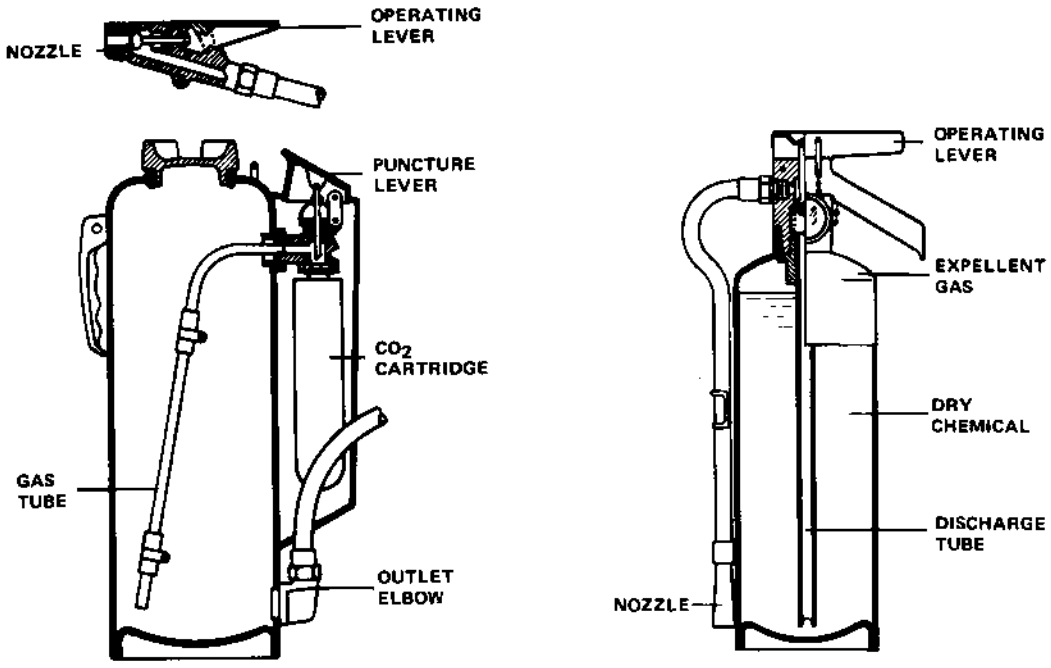

Figure 7
Dry Chemical Extinguishers

Fig. 8(a) shows how to operate the cartridge type, while Fig.8(b) shows how to operate the stored-pressure type.

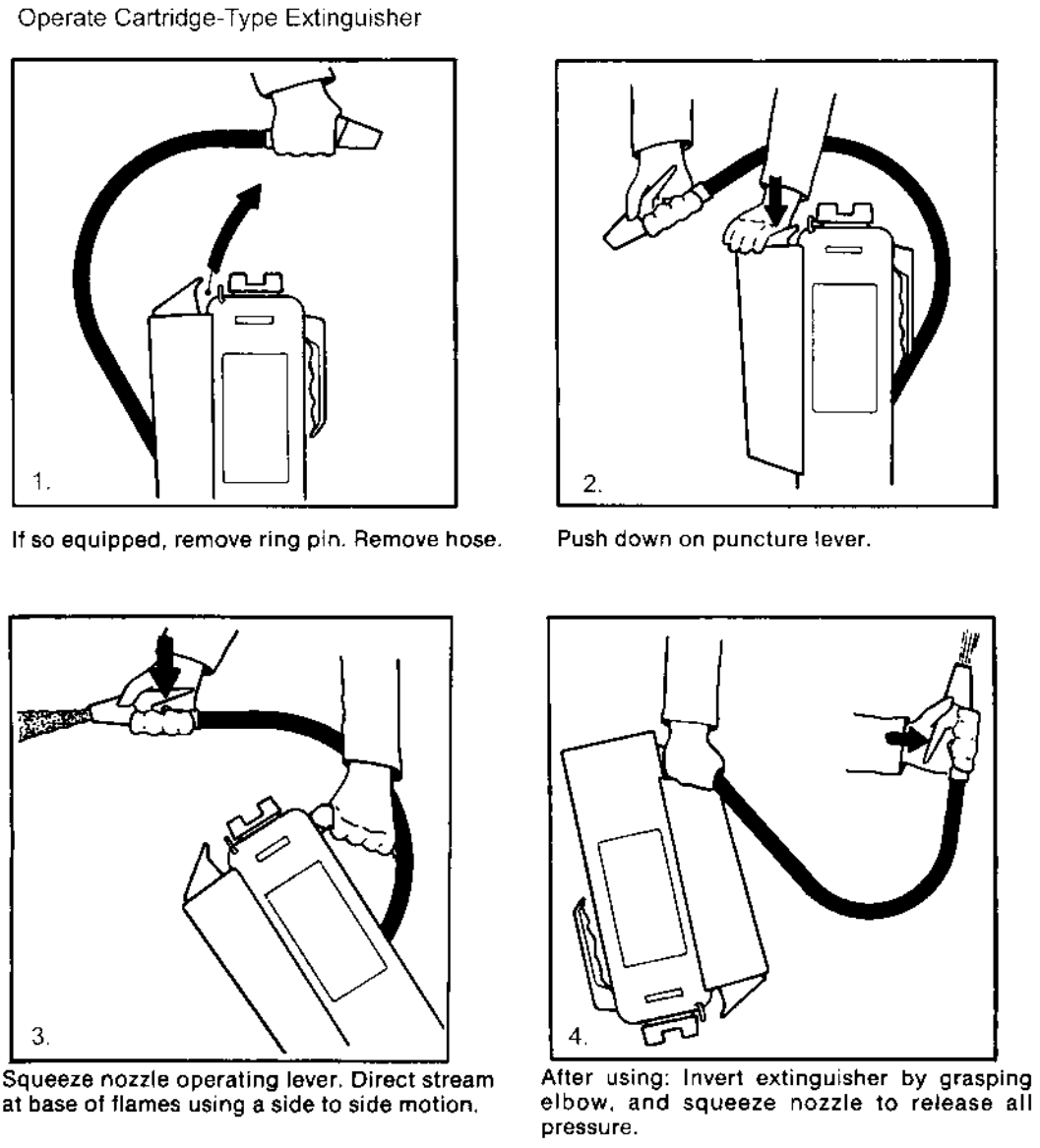

Figure 8(a)
Using the Cartridge-type Dry Chemical Extinguisher

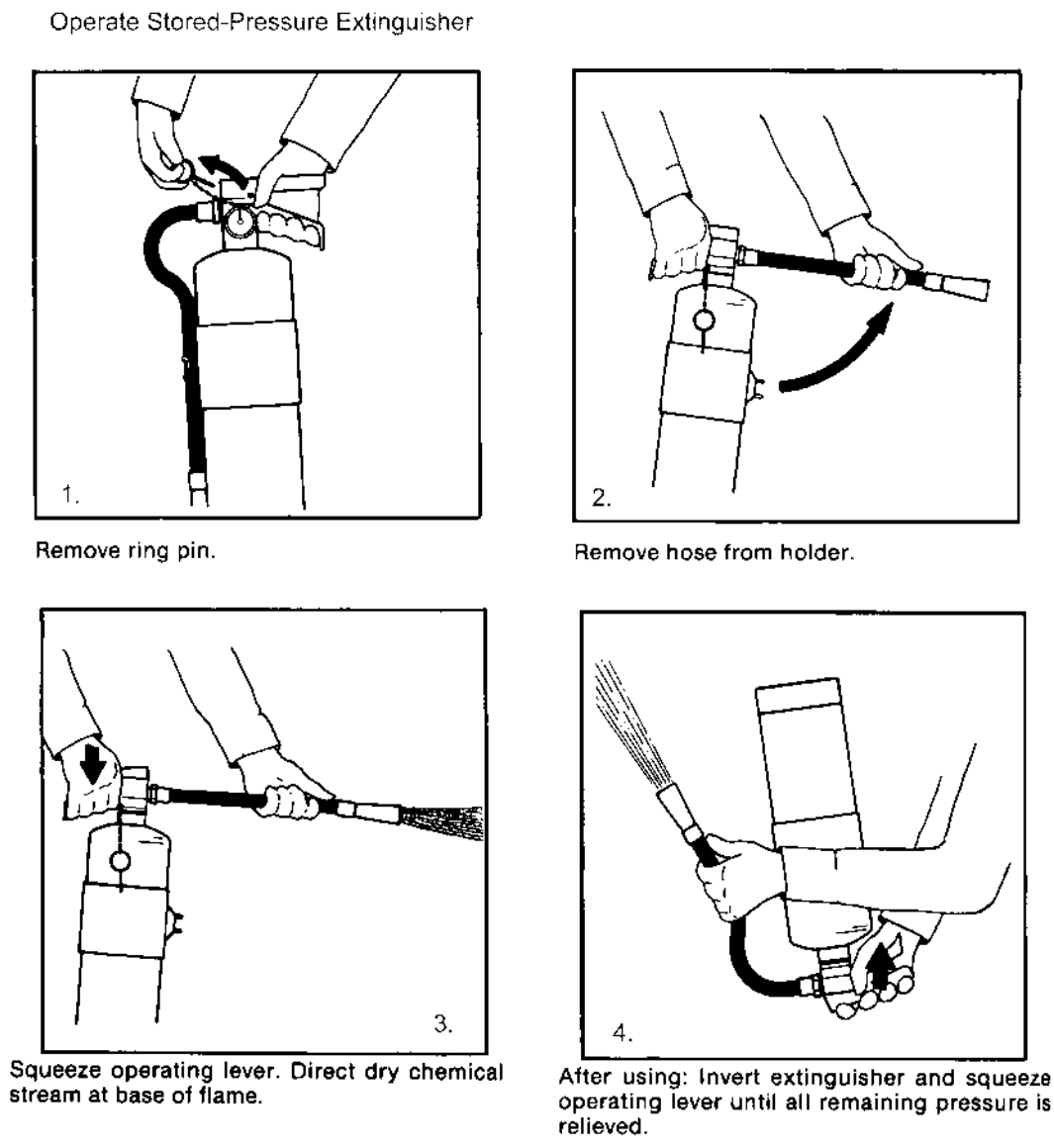

Figure 8(b)
Using the Stored-Pressure Dry Chemical Extinguisher

The characteristics of dry chemicals are given in Table 5. Note that the table does not include all available, manufactured sizes.

Type	Capacity (kilograms)	Horizontal Range of Stream (metres)	Approx. Time of Discharge (seconds)	ULC Class
Sodium Bicarbonate	0.5 - 1.0	1.5 - 2.4	3 - 12	2 - 10B:C
	1.25 - 2.3	1.5 - 6.1	8 - 20	5 - 20B:C
Potassium Bicarbonate	1.0 - 2.3	1.5 - 3.7	8 - 10	5 - 20B:C
	22	6.1	30	120B:C
Potassium Chloride	1.0 - 3.9	1.5 - 2.4	8 - 10	5 - 10B:C
	2.3 - 4.1	2.4 - 3.7	10 - 15	20 - 40B:C
Ammonium Phosphate	0.5 - 2.3	1.5 - 3.7	8 - 15	1 - 2A & 2 - 10B:C
	0.5 - 4.0	1.5 - 3.7	8 - 15	1 - 4A & 10 - 40B:C
	21	4.6 - 13.7	25	20A & 80B:C

Table 5
Characteristics of Dry Chemical Extinguishers

Dry Powder

Many agents have been developed to extinguish Class D combustible metal fires. However, there is no one agent that is suitable for all fires. Some agents can be successfully used on several metals while others can be used only for one particular metal.

Agents that are used for other classes of fire should be avoided in the case of metal fires because of violent reactions. Water should not be used on sodium fires. Vaporizing liquids should not be used on magnesium fires. The agent, extinguisher, and method of application should be selected in accordance with the manufacturer's recommendations.

The powder may be applied to the fire by means of an extinguisher using a CO_2 cartridge as the expellant, or from cardboard tubes or metal pails by means of a scoop or shovel. The agent should be applied so that it covers the fire and provides a smothering blanket. Additional agent may be required for hot spots. Care should be taken not to scatter the fire. The fire should be left undisturbed until it has cooled. A dry powder extinguisher is shown in Fig. 9.

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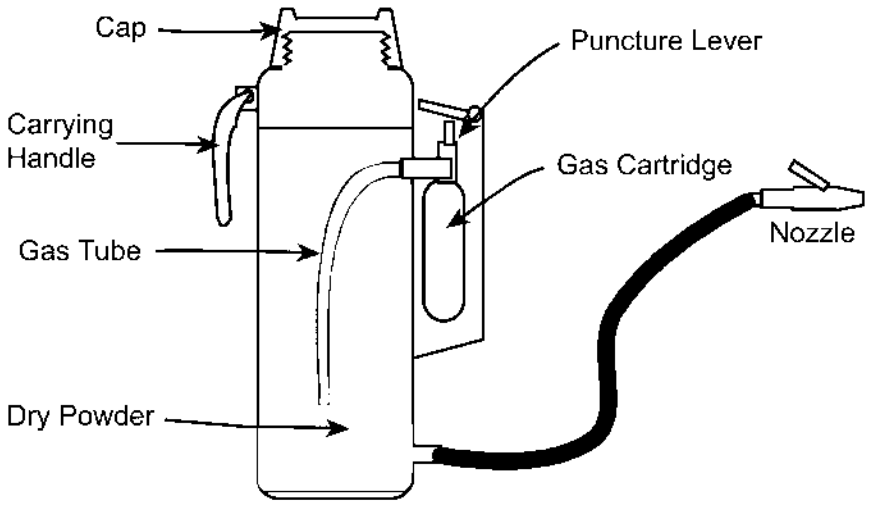

Figure 9
Dry Powder Extinguisher

Extinguishing combustible metal fires involves hazards such as high temperatures, steam explosions, hydrogen explosions, and toxic products of combustion. If common extinguishing agents are used, explosive reactions may occur. Dangerous radiation may be present in the case of certain nuclear materials. General numerical ratings for Class D extinguishers are not used. An extinguisher for combustible metal fires will have a nameplate detailing the type of metal fire for which the agent is suitable.

Foam

The AFFF type of extinguisher is suitable for water soluble flammable liquids such as alcohols, acetone, esters, or ketones. AFFF should have a nameplate identification for use on various polar solvents. Certain protein foams are not suitable but AFFF is a surfactant. The characteristics of AFFF extinguishers are given in Table 6.

Type	Capacity (litres)	Horizontal Range Of stream (metres)	Approx. Time of Discharge (seconds)	ULC Class
Stored Pressure	11	7 - 8	50	3A 20B
Nitrogen Cylinder	150	9	60	20A 160B

Table 6
Characteristics of AFFF Extinguishers

The hand held extinguisher is a stored pressure type. One type has a liquid solution of AFFF in the tank. Another type has plain water in the tank and a replaceable charge of solid AFFF in a compartment of the nozzle. Both types have an air aspirating nozzle. The two types are shown in Fig. 10.

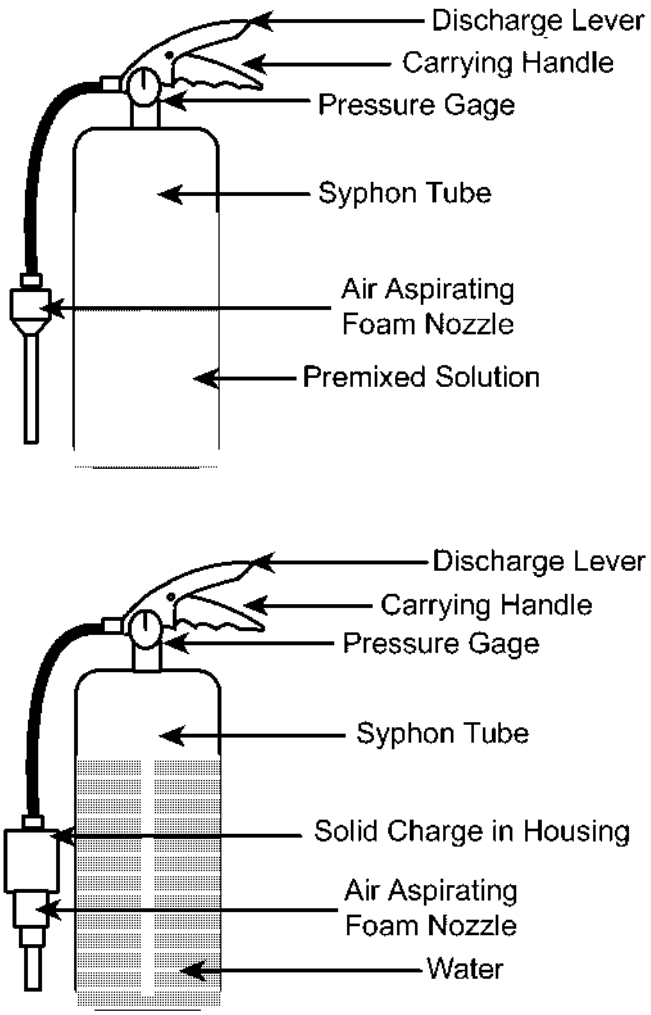

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Figure 10
Stored Pressure AFFF Extinguishers

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The larger capacity units are of the wheeled type and have a separate cylinder of nitrogen to pressurize the agent container. The discharge is controlled by a special type of aspirating nozzle at the end of the hose assembly. The aspirating nozzle induces air into the water/agent solution and the mixing of the air and solution causes the solution to form foam. The AFFF type of extinguisher should only be installed or stored in areas where the temperature remains above 5°C.

On a flammable liquid fire of any appreciable depth, the best results are obtained when the discharge is played against the backwall of the tank. The foam should be placed just above the burning surface to permit the natural spread of the foam back over the burning liquid. If this is not possible, stand far enough away from the fire so as to allow the foam to fall lightly on the burning surface. Do not allow the foam to splash into the burning liquid. If possible the operator should move around the fire while directing the foam stream. This will give maximum coverage during the extinguisher discharge period.

For flammable liquid spill fires, the foam can be made to flow over the burning surface by bouncing it off the floor just in front of the burning area. For fires in ordinary combustibles (Class A) the foam can be used to cool and coat the burning surface. Foam is not effective on fires involving flammable liquids and gases escaping under pressure.

INSPECTION AND MAINTENANCE OF EXTINGUISHERS

Once an extinguisher has been purchased, it is the responsibility of the purchaser, or an assigned agent, to maintain the extinguisher. Extinguishers should be periodically inspected, recharged after use, and hydrostatically tested as needed or as may be legally required.

Inspection

An inspection is performed by the owner or his agent and is a quick check that visually determines that the fire extinguisher is properly placed and will operate. The purpose is to give reasonable assurance that the extinguisher is fully charged and will function effectively if needed. An inspection should determine that the extinguisher:

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1. Is in its designated place.
2. Is conspicuous.
3. Is not blocked in any way.
4. Has not been activated and is neither partially nor fully discharged.
5. Has not been tampered with.
6. Has not been damaged or subjected to a hazardous environment.
7. The gages are indicating satisfactory operating pressure.

Maintenance

Maintenance is required by Code to be performed annually by a certified agency. It should also be done after each use and when an inspection shows the need is obvious. If an inspection indicates tampering, leakage, or physical damage, then a complete maintenance check should be conducted. Maintenance, as distinguished from inspection, means a complete and thorough examination of each extinguisher. Maintenance involves:

1. Disassembling the extinguisher.
2. Cleaning and replacing any defective parts.
3. Reassembly.
4. Recharging.
5. Repressuring where appropriate.

Maintenance checks may reveal the need for special testing of the extinguisher shell or other components. It may, for example, show the need for hydrostatic testing of the shell (cylinder) or even replacement. Maintenance work is required to be contracted out to certified service companies. It is advisable to discharge portable extinguishers prior to sending them for maintenance for two reasons:

1. Personnel have the opportunity to practice using the extinguishers.
2. It ensures that the extinguishers are filled with a new extinguishing agent after servicing.

Obviously it is not advisable to send all the extinguishers for maintenance at the same time. The maintenance schedule should be staggered and if possible, replacements taken from storage so that no area is left without an extinguisher. Service companies usually provide loaners. For more detailed instructions, see NFPA 10, Appendix A, Tables A-4-4.2(a) and A-4-4.2(b).

Reference Material

For more information on this topic, the following are recommended:

1. *Fire Protection Handbook* - National Fire Protection Association.

2. National Fire Protection Association (NFPA) Codes and Standards.

   NFPA 10 Standard for Portable Fire Extinguishers.

   NFPA 12A Standard on Halon 1301 Fire Extinguishing Systems.

   NFPA 12B Standard on Halon 1211 Fire Extinguishing Systems.

3. Provincial Statutes - refer to the applicable fire and building codes for your location.