PORTABLE EXTINGUISHERS

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1.0 SCOPE

This data sheet provides general information on portable extinguishers, including guidance for their selection, installation, use, inspection and maintenance.

1.1 Changes

April 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

2.1.1 Location and Distribution of Extinguishers

2.1.1.1 Locate extinguishers conspicuously where they are not likely to be blocked or hidden by stock or damaged. It is generally best to hang them on building columns or walls with their tops 3 to 5 ft (1 to 1.5 m) above the floor. Painted markings and signs can be used to direct attention to the location of extinguishers and to their proper use.

2.1.1.2 Extinguishers should be distributed as recommended for the specific type of fire. Small hose stations, arranged in accordance with Data Sheet 4-4N, *Standpipe and Hose Systems (NFPA)*, may replace water-type extinguishers, provided the small hose is not fed from sprinkler systems in the area. In general, extinguishers for fires in ordinary combustibles are located according to area coverage and maximum travel distance. These suggested locations are merely guides and may be altered to fit the specific situation. For example, in an unattended warehouse, it may be better to place extinguishers at points of entrance rather than throughout the area.

2.1.1.3 Extinguishers for fires other than in ordinary combustibles should be located close to the hazard to be protected (at least within 50 ft [15 m]) where they will be accessible during a fire.

2.1.2 Hydrostatic Testing of Extinguishers

2.1.2.1 Except for nonrefillable factory-sealed disposable containers, hydrostatic tests should be made on all pressure-operated extinguishers at periodic intervals, as stated under the inspection and maintenance section for each type. Hydrostatic tests should be performed in accordance with Department of Transportation (DOT) requirements, if applicable. Extinguishers not subject to DOT requirements should be tested by application of pressure from 0 to 100% of the factory test pressure in less than 1 minute, and sustained for at least 3 minutes without leakage or permanent distortion of extinguisher shell. Hydrostatic tests should include the hose. Hydrostatic testing should preferably be conducted by an extinguisher-recharging service where available. Hydrostatic testing may be done by plant personnel if they are properly trained and proper equipment is available.

When testing extinguishers, they must be completely filled with water so that in case of failure, no violent rupturing will occur. Never test extinguishers with air pressure. As a safety measure, place a substantial shield between the extinguisher and the operator of the test pump and other personnel in the area. After the hydrostatic test, thoroughly dry and examine the extinguisher prior to recharging.

2.1.3 Damaged Extinguishers

2.1.3.1 If an extinguisher at any time shows signs of damage or corrosion so as to create questions about whether it is safe to use, it should be hydrostatically tested without delay. Leaking, corroded, or otherwise damaged extinguishers should be discarded or returned to the manufacturer for repair. Do not try to repair pressure-operated extinguishers that have been distorted by freezing. Do not mend leaks or breaks by soldering; soldered joints cannot withstand normal operating pressures.

2.1.4 Recharges

2.1.4.1 Extinguishers are designed by the manufacturer for use with a specific charge. It is essential that only the recharge recommended by the manufacturer and specified on the nameplate be used.

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2.1.5 Specific Types of Extinguishers

2.1.5.1 See Appendix C.4 for detailed information and guidance for the specific types of portable extinguishers.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 General

Portable extinguishers are first-aid devices provided close at hand for immediate use on fires in their incipiency. Many industrial fires are promptly discovered and quickly extinguished by alert employees using portable extinguishers before any serious damage is done.

Good fire protection calls for ample hand fire-fighting equipment distributed throughout the plant and maintained carefully, with employees trained to use it properly.

Extinguishers must be in good operating condition whenever fire strikes. Mechanical failure can have serious consequences. Maintenance and recharging must be carried on systematically by competent personnel.

3.1.1 Effectiveness of Portable Extinguishers

Extinguishers are effective only when fires are in the first stages. It is of great importance that they be immediately accessible and promptly used. They are the first line of fire defense and never a substitute for automatic sprinklers, which are the main line of defense.

Extinguishers are only as good as the operators using them. It pays to train key employees on each shift, frequently and thoroughly. The most effective training method is to have as many employees as possible use extinguishers to put out fires in the yard, similar to those that might break out in their own departments. It is also important to train employees in the use of small hose.

4.0 REFERENCES

4.1 FM

Data Sheet 4-4N, *Standpipe and Hose Systems (NFPA)*.

4.2 Others

NFPA 10, *Standard for Portable Fire Extinguishers*.
ANSI/UL 711, *Standard for Rating and Fire Testing of Fire Extinguishers*.

APPENDIX A GLOSSARY OF TERMS

Approved: references to ‘‘Approved’’ in this data sheet means the product and services have satisfied the criteria for FM Approval. Refer to the *Approval Guide* for a complete listing of products and services that are FM Approved.

See Appendix C.2 for explanation of different classes of fires for which portable extinguishers may be rated.

APPENDIX B DOCUMENT REVISION HISTORY

April 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global’s loss prevention recommendations for ignitable liquid hazards.

September 2000. This revision of the document has been reorganized to provide a consistent format.

APPENDIX C SUPPLEMENTARY INFORMATION

Selecting the proper extinguisher to protect a particular situation involves many factors (Tables 1A and 1B). Fires vary in size, intensity, speed of travel and approachability. Each type of extinguisher is designed to do a certain job and cannot be expected to perform efficiently if used beyond its limitations. To select the right extinguisher for the particular job, one must have a general understanding of how various types of fires are extinguished.

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C.1 How Fires Are Extinguished

Extinguishers put out fires by: 1) cooling the burning material below its ignition point, 2) reducing the quantity of available oxygen so that combustion cannot continue, and 3) inhibiting the combustion chain reaction. Another method of extinguishing fire is to separate or remove the fuel. In a gas or ignitable liquid fire, this might be done by closing a valve in the supply pipe; in a dip tank fire by draining the contents to an emergency salvage tank.

Water extinguishes fire mainly by cooling action; the steam formed when water is applied to burning material helps to exclude oxygen. Water is the most common extinguishing agent for ordinary combustible materials. In addition to its use for sprinkler systems, hose, and pump tanks, it is the principal extinguishing agent in extinguishers of the water-filled and anti-freeze types. When water in the form of a fine spray is applied to a ignitable liquid fire, extinguishment is accomplished mainly by its cooling effect and the exclusion of oxygen by the formation of steam.

Aqueous film forming foam (AFFF) extinguishes fire by cooling, by excluding oxygen, and by suppressing vaporization of the fuel. AFFF extinguishes fires in ordinary combustibles primarily through cooling, which is further enhanced by the foam concentrate's wetting agent action. For ignitable liquid fires, the foam acts as a barrier to exclude oxygen and also forms an aqueous film, which suppresses vaporization of the fuel.

Carbon dioxide extinguishes fire by reducing the oxygen content of the surrounding air until combustion can no longer continue. It also has a slight cooling effect. It is used primarily on fires in ignitable liquids and electrical equipment.

Halons extinguish fire by inhibiting the combustion chain reaction (i.e., chemically interfering with the reaction between the fuel and oxygen). Halons have limited effectiveness on fires in ordinary combustibles, but are particularly effective on fires in ignitable liquids and electrical equipment.

Dry chemical extinguishes fire by a combination of several actions: a physical blanketing effect by the powder, interrupting the vapor-oxygen molecular combustion reaction, a dilution of oxygen in the air, and a direct absorption of heat by the fine solid particles.

Solutions of wetting agents, properly applied, are more effective than water alone for fires in ordinary combustibles such as wood, paper and household furniture. A wetting agent, when added to plain water in proper quantity, increases the penetrating and spreading power of water by reducing its surface tension. The presence of a wetting agent in water-filled extinguishers tends to reduce the range and to cause spraying of the stream.

C.2 Classification of Fires

To help simplify the application of firefighting equipment, fire protection engineers have grouped fires into broad classifications as follows:

Fires in ordinary combustibles (Class A), such as wood, cloth or paper, where the cooling and quenching effects of water or solutions containing large percentages of water or the blanketing effect of multipurpose dry chemical are of importance.

Fires in ignitable liquids (Class B), such as oil, gasoline, grease or paint, where a blanketing, smothering or chemical inhibiting effect is essential.

Fires in electrical equipment (Class C), where a nonconducting extinguishing agent is of first importance.

Fires in metals (Class D), such as magnesium, powdered aluminum, zinc, sodium or potassium, where ordinary extinguishing agents are ineffective. Metal fires are best controlled by covering with special dry powdered or granular materials that exclude oxygen and will not react or combine adversely with the metal. Application may be by hand shovel or by cartridge-operated extinguisher.

C.3 Specific Types of Extinguishers

C.3.1 Stored-pressure Water-filled Extinguishers

C.3.1.1 Operating Principle

Stored-pressure water-filled extinguishers (Fig. 1) contain a water charge, which is expelled by air pressure stored in the shell.

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The stream from the ⅛ in. (3 mm) nozzle has range of 30 to 40 ft (9 to 12 m). The discharge time is about 55 sec.

Table 1A. Characteristics of Portable Fire Extinguishers and Recommended Application (English Units)

		Antifreeze	*Carbon Dioxide*	*Dry Chemical*
Suitability	Class A fires: Wood, textile, paper or rubbish	Yes	No, but will control small fires	Sodium bicarbonate base; Potassium bicarbonate base; Potassium chloride base: No, but will control textile surface fires Ammonium phosphate base: Yes
	Class B fires: Oil, gasoline, grease, or paint	No	Yes	Yes
	Class C fires: Electrical equipment	No	Yes	Yes
	Class D fires: Flammable metals	No	No	Yes, special "dry powder" available. See text for other details.
	Nominal capacities and weights fully charged	2½ gal 40 lb	5 lb 16 lb 10 lb 32 lb 15 lb 41 lb 20 lb 53 lb 50 lb 220 lb 100 lb 450 lb 750 lb 2750 lb	2½ lb 5 lb 4-5 lb 10 lb 10 lb 22 lb 15 lb 40 lb 20 lb 40 lb 30 lb 55 lb 75 lb 260 lb 150 lb 530 lb 300 lb 1000 lb
	Normal fire area (sq ft) of gasoline in open tank to be extinguished by nonexpert operator	Not recommended for ignitable liquid fires	4-6 lb 2 ft² 10-12 lb 3 ft² 15-25 lb 5 ft² 2-4 ft 50 lb 8 ft² 75 lb 10 ft² 100 lb 12 ft² 750 lb 50 ft² 20 ft	2½ lb 2 ft² 8 ft 4-5 lb 3 ft² 8 ft 7½ lb 5 ft² 8 ft 10 lb 7 ft² 15 lb 9 ft² 20 lb 12 ft² 8-20 ft 25 lb 14 ft² 30 lb 17 ft²
	Maximum effective range	Range: 30-40 ft		75 lb 25 ft² 25 ft 150 lb 33 ft² 10-35 ft 300-500 lb 67 ft² 15-45 ft
	Effective discharge time	2½ gal 58 sec	5 lb 22 sec 10 lb 25 sec 20 lb 30 sec 50 lb 57 sec 100 lb 60 sec 750 lb 150 sec	2½ lb 4 lb 10 lb 10-16 sec 15 lb 20 lb 30 lb 75 lb 35 sec 150 lb 45-63 sec 300 lb 105 sec
	Means of expelling charge	Air pressure	Under 850 psi pressure at normal temperature (70°F)	Carbon dioxide cartridge or nitrogen cylinder; nitrogen or air pressure
	Composition of extinguisher charge	Solutions of calcium chloride or special salts	Carbon dioxide	Specially treated sodium bicarbonate, potassium bicarbonate, potassium chloride, or ammonium phosphate
	Subject to freezing	No	No	No
	Yearly inspection	Check pressure gauge	Weigh extinguisher semiannually	Weigh carbon dioxide cartridge or check nitrogen or air pressure
	Operation	Press level	Turn handwheel, pull trigger, or squeeze handle	No uniform method
	Approximate spacing (floor area) travel distance (maximum) to extinguisher	3000 ft² (2½ gal) 75 ft	At special hazards	At special hazards 75 ft for multipurpose type on ordinary combustibles

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Air Foam (AFFF)	*Pump Tank*	*Stored-Pressure Water-Filled*	*Halon*
Yes	Yes	Yes	Limited. Larger units of 9 lb Halon 1211 capacity or greater have Class A rating.
Yes	No	No	Yes
No	No	No	Yes
No	No	No	No
2½ gal 28 lb 33 gal 550 lb	2½ gal 40 lb 3 gal 30 lb* 5 gal 65 lb *plastic tank	2½ gal 35 lb	2½ lb 5 lb 3-3½ lb 6-6½ lb 5 lb 10 lb 6½-7 lb 15 lb 9 lb 12*, 17.5 lb 13-14 lb 19*, 21-22 lb 16-17 lb 27*, 32-33 lb 20 lb 30* lb 22 lb 40 lb 150 lb 375 lb *aluminum shell
2½ gal 5 ft^2 30 ft 33 gal 25 ft^2 20-30 ft	Not recommended for ignitable liquid fires Range: 30-40 ft	Not recommended for ignitable liquid fires Range: 30-40 ft	2-3½ lb 2 ft^2 10 ft 5-9 lb 3 ft^2 10-18 ft 13-17 lb 5 ft^2 12-18 ft 20-22 lb 8 ft^2 20 ft 150 lb 33⅓ ft^2 15 ft
2½ gal 60 sec 33 gal 60 sec	2½ gal 60 sec 3 gal 65 sec 5 gal 115 sec	2½ gal 50 sec	2½ lb 3-3½ lb 5 lb 6½-7 lb 9 lb 10-20 sec 13-14 lb 16-17 lb 20 lb 22 lb 150 lb 40 sec
Air pressure or nitrogen cylinder (wheeled unit)	Manually operated pump	Air pressure	Nitrogen
Water and fluorochemicals	Water or calcium chloride solution	Water	Normally bromochlorodifluoromethane (Halon 1211)
Yes	Yes, unless antifreeze charge is used	Yes	No
Check pressure gauge	Discharge	Check pressure gauge	Weigh extinguisher semi-annually and check pressure gauge
Press lever	Pump	Press lever	Press lever
At special hazards	3000 sq ft (2½ gal) 75 ft	3000 sq ft 75 ft	At special hazards

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Table 1B. Characteristics of Portable Fire Extinguishers and Recommended Application (Metric Units)

		Antifreeze	*Carbon Dioxide*	*Dry Chemical*
Suitability	Class A fires: Wood, textile, paper or rubbish	Yes	No, but will control small fires	Sodium bicarbonate base; Potassium bicarbonate base: No, but will control textile surface fires; Potassium chloride base
				Ammonium phosphate base: Yes
	Class B fires: Oil, gasoline, grease, or paint	No	Yes	Yes
	Class C fires: Electrical equipment	No	Yes	Yes
	Class D fires: Flammable metals	No	No	Yes, special "dry powder" available. See text for other details.
	Nominal capacities and weights fully charged	9.5 l 18.1 kg	2.3 kg 7.3 kg 4.5 kg 14.5 kg 6.8 kg 18.6 kg 9.1 kg 24.0 kg 22.7 kg 99.8 kg 45.4 kg 204 kg 340 kg 1247 kg	1.1 kg 2.3 kg 1.8-2.3 kg 4.5 kg 4.5 kg 10.4 kg 6.8 kg 18.1 kg 9.1 kg 18.1 kg 13.6 kg 25.0 kg 34.0 kg 118 kg 68.0 kg 240 kg 136 kg 454 kg
	Normal fire area (m^2) of gasoline in open tank to be extinguished by nonexpert operator	Not recommended for ignitable liquid fires	1.8-2.7 kg 0.2 m^2 4.5-5.4 kg 0.3 m^2 6.8-11.3 kg 0.5 m^2 0.6- 22.7 kg 0.8 m^2 1.2 m 34.0 kg 1.0 m^2 45.4 kg 1.1 m^2 340 kg 4.6 m^2 6 m	1.1 kg 0.2 m^2 2.5 m 1.8-2.3 kg 0.3 m^2 2.5 m 3.4 kg 0.5 m^2 2.5 m 4.5 kg 0.7 m^2 6.8 kg 0.9 m^2 9.1 kg 1.1 m^2 2.5-6 m 11.3 kg 1.3 m^2 13.6 kg 1.6 m^2 34.0 kg 2.3 m^2 7.5 m 68.0 kg 3.1 m^2 3-11 m
	Maximum effective range	Range: 9-12 m		136-159 kg 6.2 m^2 5-14 m
	Effective discharge time	9.5 l 58 sec	2.3 kg 22 sec 4.5 kg 25 sec 8.1 kg 30 sec 22.7 kg 57 sec 45.4 kg 60 sec 340 kg 150 sec	1.1 kg 1.8 kg 4.5 kg 6.8 kg 10-16 sec 9.1 kg 13.6 kg 34.0 kg 35 sec 68.0 kg 45-63 sec 136 kg 105 sec
	Means of expelling charge	Air pressure	Under 5860 kPa (58.6 b) at normal temperature (21°C)	Carbon dioxide cartridge or nitrogen cylinder; nitrogen or air pressure
	Composition of extinguisher	Solutions of calcium chloride or special salts	Carbon dioxide	Specially treated sodium bicarbonate, potassium bicarbonate, potassium chloride, or ammonium phosphate
	Subject to freezing	No	No	No
	Yearly inspection	Check pressure gauge	Weigh extinguisher semiannually	Weigh carbon dioxide cartridge or check nitrogen or air pressure
	Operation	Press level	Turn handwheel, pull trigger, or squeeze handle	No uniform method
	Approximate spacing (floor area) travel distance (maximum) to extinguisher	279 m^2 (9.5 l) 23 m	At special hazards	At special hazards 23 m for multipurpose type on ordinary combustibles

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Air Foam (AFFF)	*Pump Tank*	*Stored-Pressure Water-Filled*	*Halon*
Yes	Yes	Yes	Limited. Larger units of 4.1 kg Halon 1211 capacity or greater have Class A rating.
Yes	No	No	Yes
No	No	No	Yes
No	No	No	No
9.5 l 12.7 kg 125 l 250 kg	9.5 l 18.1 kg 11.3 l 13.6 kg* 19 l 29.5 kg *plastic tank	9.5 l 15.9 kg	1.1 kg 2.3 kg 1.4-1.6 kg 2.7-2.9 kg 2.3 kg 4.5 kg 2.9-3.2 kg 6.8 kg 4.1 kg 5.4*, 7.9 kg 5.9-6.4 kg 8.6*, 9.5-10.0 kg 7.3-7.7 kg 12.2*, 14.5-15.0 kg 9.1 kg 13.6* kg 10.0 kg 18.1 kg 68 kg 170 kg *aluminum shell
9.5 l 0.5 m^2 9 m 125 l 2.3 m^2 6-9 m	Not recommended for ignitable liquid fires Range: 9-12 m	Not recommended for ignitable liquid fires Range: 9-12 m	0.9-1.6 kg 0.2 m^2 3.0 m 2.3-4.1 kg 0.3 m^2 3.0-5.5 m 5.9-7.7 kg 0.5 m^2 3.7-5.5 m 9.1-10.0 kg 0.7 m^2 6.1 m 68 kg 3.1 m^2 4.6 m
9.5 l 60 sec 125 l 60 sec	9.5 l 60 sec 11.3 l 65 sec 119 l 115 sec	9.5 l 50 sec	1.1 kg 1.4-1.6 kg 2.3 kg 2.9-3.2 kg 4.1 kg 10-20 sec 5.9-6.4 kg 7.3-7.7 kg 9.1 kg 10.0 kg 68 kg 40 sec
Air pressure or nitrogen cylinder (wheeled unit)	Manually operated pump	Air pressure	Nitrogen
Water and fluorochemicals	Water or calcium chloride solution	Water	Normally bromochlorodifluoromethane (Halon 1211)
Yes	Yes, unless antifreeze charge is used	Yes	No
Check pressure gauge	Discharge	Check pressure gauge	Weigh extinguisher semi-annually and check pressure gauge
Press lever	Pump	Press lever	Press lever
At special hazards	279 m^2 23 m	279 m^2 23 m	At special hazards

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C.3.1.2 Use

Recommended for fires in ordinary combustibles where a cooling and wetting action is required. *Not recommended* for fires in oils, greases, ignitable liquids, electrical apparatus, or metals such as magnesium, powdered aluminum, zinc, sodium, or potassium.

C.3.1.3 Size

2-½ gal (9.5 l).

C.3.1.4 Location and Distribution

Provide one 2-½ gal (9.5 l) extinguisher for each 3,000 ft^2 (279 m^2) of floor area having occupancy of ordinary combustibility. Locate it so that the operator will not have to travel more than 75 ft (23 m) from any point within the area to reach it.

C.3.1.5 Advantages and Limitations

Water-filled extinguishers are easily used, are capable of being operated intermittently, and are easily maintained and recharged. They must be protected from freezing.

The stream from a water-filled extinguisher has long range and good pressure, which enables it to get into overhead locations, racks, and corners and to penetrate burning material. Water-filled extinguishers can be used effectively on small fires on oily floors or woodwork.

These extinguishers are not advised for use on electrical equipment, although the water causes less damage than solutions of sodium bicarbonate or antifreeze materials, which are better conductors of electricity. They may be safely used on live equipment rated at less than 600 volts from a distance of more than 10 ft (3 m).

C.3.1.6 Inspection and Maintenance

Weekly: Check accessibility. *Monthly*: Be sure extinguisher is full and undamaged. Check pressure gauge. Check nozzle for obstruction. *Annually*: Examine shell. Test hydrostatically if corroded or otherwise damaged. Check hose for obstruction or deterioration, and replace if necessary. *Every five years*: Discharge and inspect. Test hydrostatically.

C.3.2 Antifreeze Extinguishers

C.3.2.1 Operating Principle

Antifreeze extinguishers contain a nonfreezing (to -40°F [-40°C]) solution that is expelled by air pressure stored in the shell (Fig. 1).

Two types of liquids are used in antifreeze extinguishers. In stainless steel containers, an alkali-metal salt solution is used (often called ‘‘loaded stream’’); in brass containers, a calcium chloride in water solution is used.

The range of the hand-portable units is 30 to 40 ft (9 to 12 m); the discharge time, 45 to 60 sec at 70°F (21°C) and about 100 sec at -40°F (-40°C).

C.3.2.2 Use

Recommended for use on fires in ordinary combustibles in areas subject to freezing temperatures as low as -40°F (-40°C) where a cooling and wetting action is required. *Not recommended* for fires in oils, greases, ignitable liquids, electrical apparatus or metals such as magnesium, powdered aluminum, zinc, sodium, or potassium.

C.3.2.3 Sizes

2-½ gal (9.5 l)

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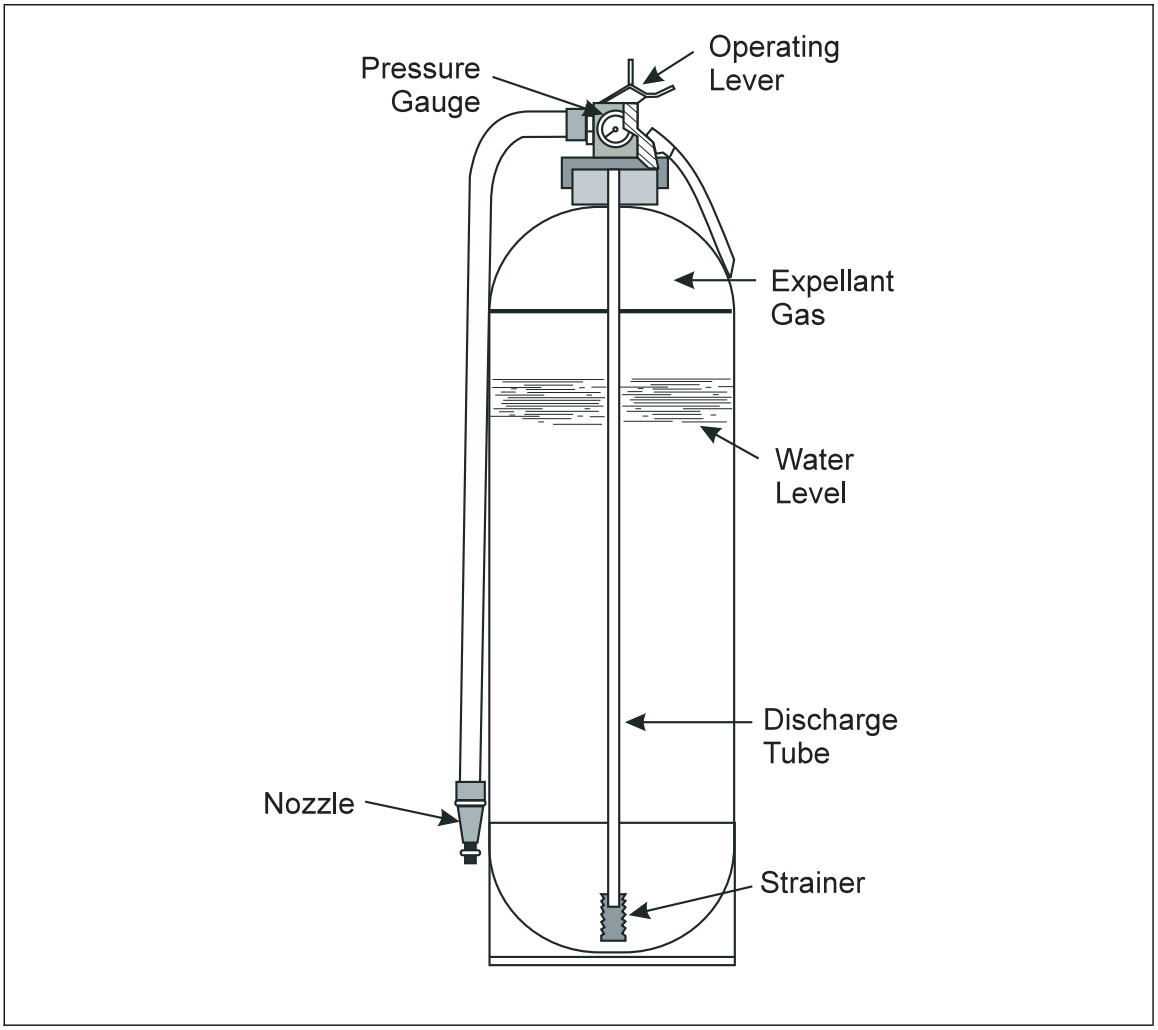

Fig. 1. Stored-pressure water-filled extinguisher.

C.3.2.4 Location and Distribution

Provide one 2-½ gal (9.5 l) extinguisher for each 3,000 ft^2 (279 m^2) of floor area having occupancy of ordinary combustibility. Locate it so that the operator will not have to travel more than 75 ft (23 m) from any point within the area to reach it.

C.3.2.5 Advantages and Limitations

Antifreeze extinguishers have all the advantages of water-filled extinguishers and may be used on fires in all ordinary combustibles. They are designed primarily for use in unheated warehouses, buildings under construction, or other locations where freezing temperatures may be encountered.

Antifreeze solutions are good conductors of electricity and dangerous if applied to live apparatus.

The salts in the loaded-stream extinguisher retard oxidation of the burning material and make it somewhat more effective than water-filled extinguishers of equal capacity.

C.3.2.6 Inspection and Maintenance

Weekly: Check accessibility. *Monthly*: Be sure extinguisher is full and undamaged. Check nozzle for obstruction. *Annually*: If calcium chloride antifreeze solution is used, strain solution and check specific gravity. Clean extinguisher thoroughly. Examine interior and exterior for corrosion. Test hydrostatically if corroded

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or otherwise damaged. Check hose for obstruction or deterioration, and replace if necessary. Every three years: Discharge. Wash thoroughly and recharge. *Every five years*: Test hydrostatically.

Specific gravity of antifreeze solutions at 60°F (16°C) is shown in Table 2.

Table 2. Specific Gravity of Antifreeze Solutions

Freezing Point		*Calcium Chloride Solutions*	*"Karbaloy," For Example*
°F	(°C)		
0	(-18)	1.183	1.275
-10	(-23)	1.212	1.306
-20	(-29)	1.237	1.335
-30	(-34)	1.258	1.360
-40	(-40)	1.274	1.380

C.3.3 Pump Tanks

C.3.3.1 Operating Principle

Pump tanks (Fig. 2) are covered containers provided with a vertical force pump discharging through a short length of hose with a ⅛ in. (3 mm) nozzle. The tank is filled with water or an antifreeze solution through an opening in the top. The range is 30 to 40 ft (9 to 12 m).

C.3.3.2 Use

Recommended for fires in ordinary combustible materials such as wood, paper, and cloth, where a cooling and wetting action is required. One model of the 5 gal (19 l) size, which is used while carried on the back, is suitable particularly for outdoor fires in grass, brush or rubbish. *Not recommended* for fires in oils, grease, ignitable liquids, electrical apparatus or metals such as magnesium, powdered aluminum, zinc, zirconium, sodium, or potassium.

C.3.3.3 Sizes

2-½, 3 and 5 gal (9.5, 11.3 and 19 l).

C.3.3.4 Location and Distribution

Provide one 2-½ gal (9.5 l) extinguisher for each 3,000 ft^2 (279 m^2) of floor area having occupancy of ordinary combustibility, and locate the extinguisher so that the operator will not have to travel more than 75 ft (23 m) from any point within the area to reach it.

C.3.3.5 Advantages and Limitations

The operation of pump tanks is easily understood. The discharge is under the complete control of the operator and can be started or stopped as desired. Pump tanks are easily refilled. They can be made nonfreezing by charging the extinguisher with a water solution of a special antifreeze preparation available from the manufacturer, as outlined on the nameplate.

Antifreeze solutions are good conductors of electricity and especially dangerous if applied to live apparatus. When filled with antifreeze solutions, these extinguishers should be used only on dead electrical equipment and then only if more suitable extinguishers are not available or prove ineffective. The residue may be difficult to remove and is somewhat corrosive.

When filled only with water, they may safely be used on live equipment rated less than 600 volts if applied from a distance of more than 10 ft (3 m).

The conventional pump tank cannot be moved while pumping. The 5 gal (19 l) size, which weighs about 65 lb (29.5 kg) when full, is awkward for one person to carry to a fire. The backpack type has neither of these disadvantages since it is supported from the shoulders by straps, leaving the hands free to operate the pump.

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C.3.3.6 Inspection and Maintenance

Weekly: Check accessibility and liquid level. *Monthly*: Operate pump, directing discharge back into tank. Apply oil to the pump shaft if necessary. *Annually*: If filled with water, discharge completely and wash thoroughly. Examine for corrosion and refill. If filled with antifreeze solution, strain the solution and check specific gravity. Clean extinguisher thoroughly. Examine interior and exterior for corrosion. Check hose for obstruction or deterioration, and replace if necessary. Record date on tag. *Every three years*: If filled with antifreeze, discharge completely and wash thoroughly. Refill with fresh solution. Record date on tag.

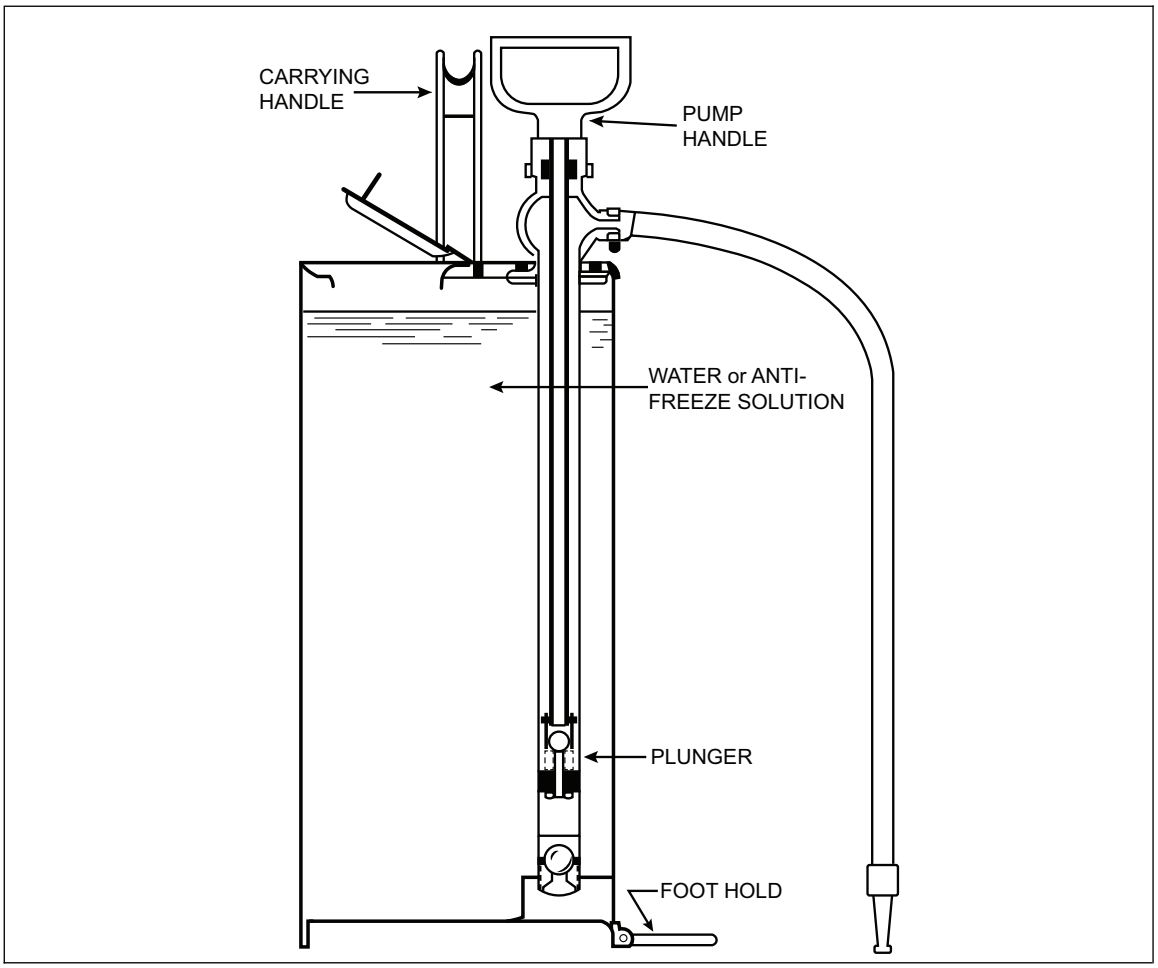

Fig. 2. Pump tank.

C.3.4 Air Foam Extinguishers

C.3.4.1 Operating Principle

Air foam extinguishers are essentially stored-pressure water-filled extinguishers that discharge a foam concentrate solution through a special air aspirating nozzle to produce foam. The foam concentrate solution, an aqueous film-forming foam (AFFF) surfactant in water, is either stored as a premixed solution in water within the cylinder (Fig. 3) or created by discharging water through an external solid AFFF cartridge (Fig. 4). The foam produced is a very fluid foam that forms an aqueous film over the fuel, extinguishing the fire and minimizing the chances of reignition.

Air foam extinguishers have a range of approximately 30 ft (9.1 m) and an effective discharge time of approximately one minute.

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C.3.4.2 Use

Recommended for fires in ignitable liquids of the oil and gasoline types and fires in ordinary combustibles. *Not recommended* for fires in electrical equipment; fires in metals such as magnesium powdered aluminum, zinc, sodium, or potassium; fires in alcohols, ketones, esters, ethers, or carbon disulfide; or fires in hot oils or asphalt heated above 212°F (100°C).

C.3.4.3 Sizes

2-½ gal (9.5 l) and 33 gal (125 l) (wheeled unit).

C.3.4.4 Location and Distribution

When air foam extinguishers are used to protect a special hazard such as a small dip tank, locate them in accessible places near the hazard. A fire in an ignitable liquid similar to gasoline requires a 2-½ gal (9.5 l) foam extinguisher for 10 ft^2 (0.9 m^2) of unobstructed liquid surface and a 33 gal (125 l) extinguisher for 50 ft^2 (4.6 m^2). Any obstructions that might interfere with the spread of foam necessitate greater extinguishing capacity.

When 2-½ gal (9.5 l) units are used for general protection of an area with an ignitable liquid occupancy, provide sufficient units so that the operator will not have to travel more than 50 ft (15 m) from any point within the area to reach an extinguisher.

The level of ignitable liquid must be kept at least 6 in. (152 mm) below the top of open tanks to provide a backboard against which the foam may be discharged so that the blanket of foam will be contained without overflowing.

For tanks inside buildings, because of the hindrance to approach caused by smoke and heat, portable extinguishers alone should not be relied upon except for small tanks (usually not over 10 ft^2 [1 m^2]).

C.3.4.5 Advantages and Limitations

Air foam extinguishers, like stored-pressure water-filled extinguishers, are easily used, are capable of being operated intermittently, and are easily maintained and recharged.

Foam is particularly suited for extinguishing fires in ignitable liquids of the oil or gasoline type. The foam floats on the liquid surface and effectively excludes oxygen. Foam also is well adapted to fighting fires in ignitable liquids on floors or machinery.

Ordinary foam is not suited for fires in alcohols, ketones, esters, or lacquer thinners (butyle or amyl acetate), all of which react with the foam and break down the blanket or film.

Aqueous film-forming foam also is suitable for fires involving ordinary combustibles, due to its cooling and penetrating capabilities.

Foam is not suitable for fires in carbon disulfide and ether, which have very low boiling points. The vapors from these materials may penetrate the foam and burn above the blanket.

Foam from hand extinguishers should not be applied to tanks containing tempering or other oils, asphalt, tars, or waxes heated above 212°F (100°C) since the application of foam will cause boiling over.

Foam is not suitable for fires in electrical equipment. The residue is somewhat corrosive and hard to remove and would require considerable cleaning if deposited on some types of electrical equipment.

Foam extinguishers must be protected from freezing. Calcium chloride or other depressants must not be added to the charges of foam extinguishers to prevent freezing.

C.3.4.6 Inspection and Maintenance

Weekly: Check accessibility. *Monthly*: Check lockpin, seal and pressure gauge. Check to see that the seal plug is in place (AFFF cartridge type). Check to see that the AFFF cartridge is in place, dry and undamaged. Check nozzle for obstruction. *Annually*: Examine shell. Test hydrostatically if corroded or otherwise damaged.

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Check hose for obstruction or deterioration, and replace if necessary. *Every five years*: Test hydrostatically and recharge using appropriate recharge kit and following manufacturer's instructions.

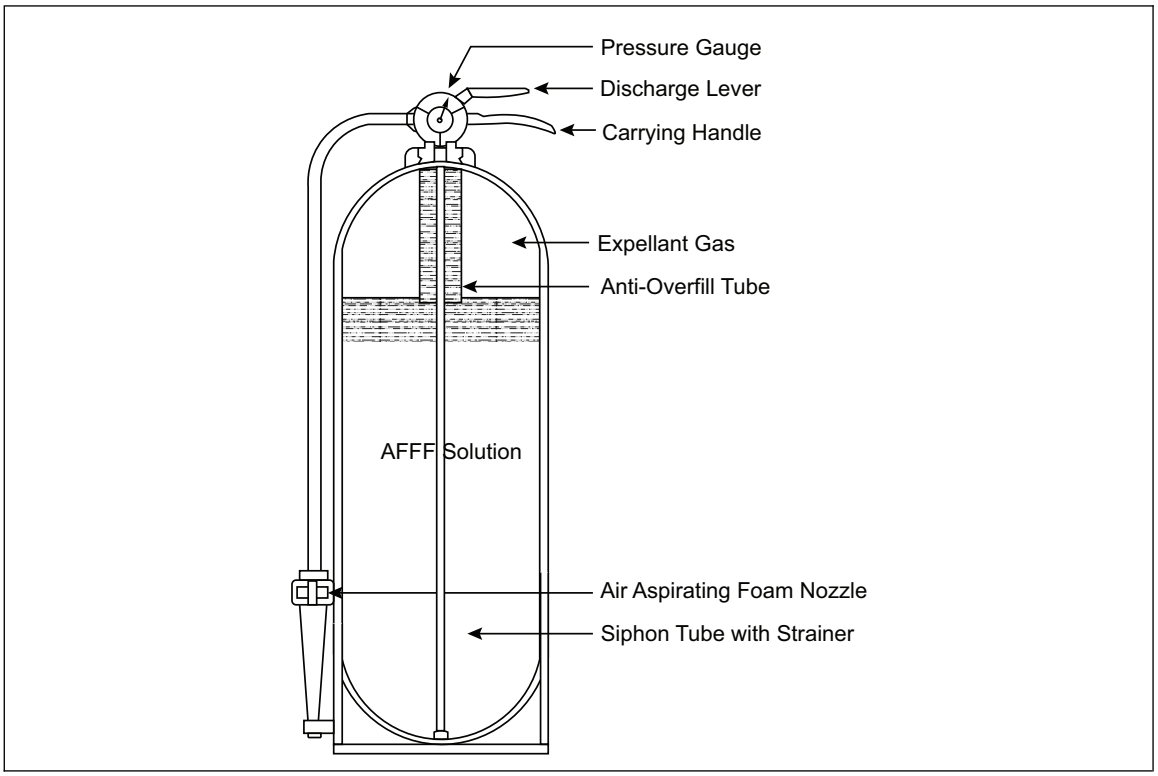

Fig. 3. AFFF extinguisher (premixed solution).

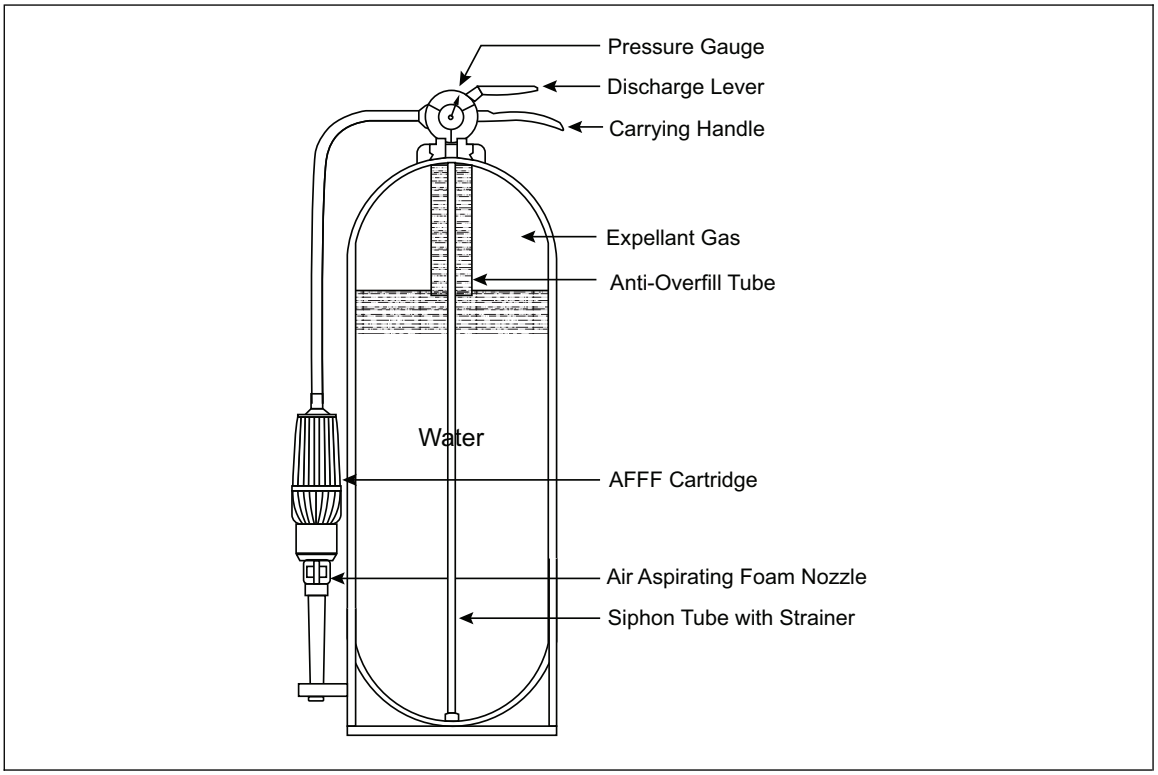

Fig. 4. AFFF extinguisher (solid cartridge).

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C.3.5 Carbon Dioxide Extinguishers

C.3.5.1 Operating Principle

Carbon dioxide extinguishes fires by smothering action (exclusion of oxygen). The cooling effect is limited unless the object becomes coated with carbon dioxide snow.

The carbon dioxide extinguisher (Fig. 5) consists of a high-pressure cylinder containing liquid carbon dioxide, a siphon tube, a valve and a discharge horn. Cylinders are constructed according to the Department of Transportation's specifications for tanks containing liquid carbon dioxide. At 70°F (21°C) the internal pressure is approximately 850 psi (5860 kPa) (58.6 bar). The valve is mounted in the top of the extinguisher, which is operated in an upright position. A siphon tube extends from the valve to a point close to the bottom of the cylinder.

When the valve is operated, liquid carbon dioxide flows through the siphon tube, valve and a small orifice at the base of the horn, where it is transformed into gas and snow.

The range of the 5 to 100 lb (2.3 to 45.4 kg) units is 2 to 4 ft (0.6 to 1.2 m); the discharge time is 15 to 60 sec, increasing with the size of the unit.

The valve is of the seat type and is operated either by a handwheel, squeeze, grip, trigger or thumb release. It provides on and off control so that carbon dioxide may be conserved while moving from one point to another when fighting a fire. If 20% or more of the net weight is discharged, the extinguisher should be recharged before being returned to service.

Some of the wheeled units have a cutter type valve operated by a handwheel or lever control that forces a plunger through a sealing disk to release the liquid carbon dioxide from the cylinder. On and off control is provided by a valve at the horn.

C.3.5.2 Wheeled Extinguishers

Wheeled carbon dioxide extinguishers of 50, 75 and 100 lb (22.7, 34.0 and 45.4 kg) capacity consist essentially of one or two cylinders connected to a hose, all mounted on a carriage. Gas is released by operating a handwheel or lever at the cylinder. A quick closing valve at the horn provides a temporary shutoff.

A 750 lb (340 kg) wheeled unit is also available. It consists of an insulated and refrigerated tank and hose reel with playpipe, all mounted on a steel truck chassis. After wheeling the unit to the fire and pulling off sufficient hose, the carbon dioxide is released by opening valves at the hose reel and playpipe.

C.3.5.3 Use

Recommended for fires in ignitable liquids and electrical equipment. Will control small fires in ordinary combustibles. *Not recommended* for deep-seated fires in ordinary combustible materials, textile lints, or metals such as magnesium, powdered aluminum, zinc, sodium, or potassium.

C.3.5.4 Sizes

Hand portables are available in 5, 10, 12, 15, 20 and 25 lb (2.3, 4.5, 5.4, 6.8, 9.1 and 11.3 kg); and wheeled units in 50, 75, 100 and 750 lb (22.7, 34.0, 45.4 and 340 kg).

C.3.5.5 Location and Distribution

Locate one or more carbon dioxide extinguishers in an accessible place near the hazard to be protected; the size and number of units is governed by individual conditions.

The size of extinguishers considered adequate for inexperienced operators to use on fires in open tanks of ignitable liquids of various areas is shown in Table 3.

For tanks inside buildings, because of the hindrance to approach caused by smoke and heat, portable extinguishers alone should not be relied upon except for small tanks (usually not over 10 ft^2 [1 m^2]).

For use in powerhouses or near large electrical equipment, 15 or 20 lb (6.8 or 9.1 kg) hand extinguishers are ordinarily recommended. In large powerhouses, it may be desirable to have larger wheeled units to back up the hand extinguishers. In laboratories or at small telephone switchboards, 10 lb (4.5 kg) or even smaller sizes are suitable.

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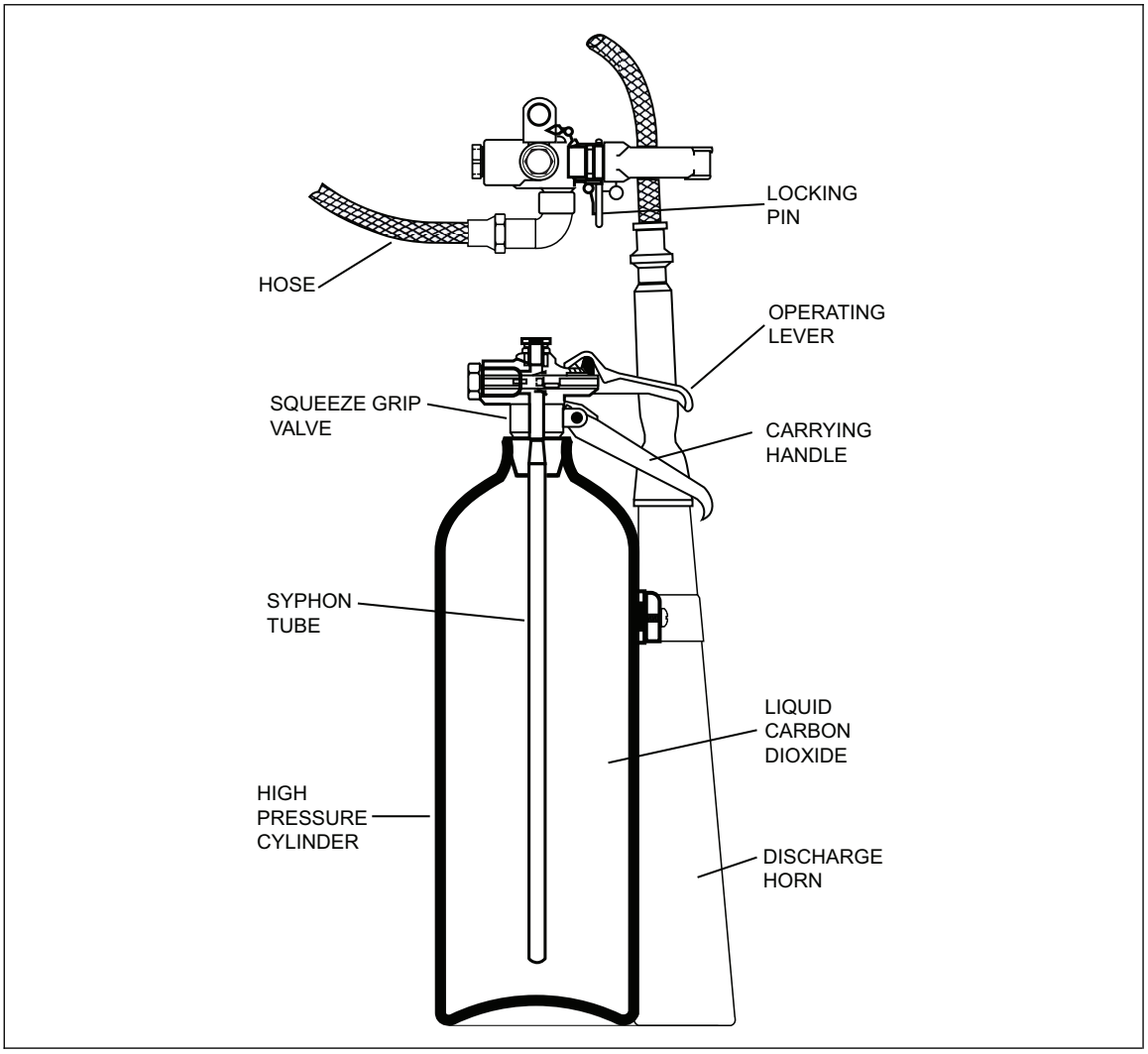

Fig. 5. Carbon dioxide extinguisher.

C.3.5.6 Advantages and Limitations

Carbon dioxide is noncorrosive and leaves no residue. It will not conduct electricity, freeze or deteriorate with age.

Carbon dioxide extinguishers are used chiefly for fires in electrical equipment or ignitable liquids. They are particularly suited for extinguishing fires in alcohol and other ignitable liquids (ethers and esters) that tend to break down foam, and for fires in delicate high-valued apparatus that would be damaged by other extinguishing agents.

Carbon dioxide extinguishers have no wetting action and are not considered suitable for fires in ordinary combustible material or in materials such as pyroxylin that decompose and liberate oxygen needed for combustion. These extinguishers produce no lasting blanketing effect on ignitable liquids to overcome ignition sources. Their use must be confined to moderately small fires; successful operation requires close approach to the fire because of their characteristic short range.

C.3.5.7 Inspection and Maintenance

Weekly: Check accessibility. *Monthly*: Be sure lockpin is in position and seal unbroken. *Semiannually*: Weigh and record weight on tag. Compare with weight stamped on valve body, and recharge if loss in net weight is 10% or over. Test hydrostatically if corroded or damaged. *Every five years*: Test hydrostatically.

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Table 3. Carbon Dioxide Extinguishers for Fires in Open Tanks of Ignitable Liquids

Extinguisher Size		*Gasoline and Similar Liquids*		*Kerosene and Similar Liquids*		*Alcohol and Similar Liquids*	
lb	(kg)	ft^2	(m^2)	ft^2	(m^2)	ft^2	(m^2)
4-6-½	1.8-2.9	2	0.2	3	0.3	5	0.5
7-9-½	3.2-4.3	3	0.3	4	0.4	8	0.8
10-14	4.5-6.4	3	0.3	4	0.4	8	0.8
15-29	6.8-13.2	5	0.5	7	0.7	13	1.2
50-74	22.7-33.6	8	0.8	10	1.0	20	1.9
75-99	34.0-44.9	10	1.0	13	1.2	20	1.9
100	45.4	12	1.1	16	1.5	24	2.3
750	340	50*	4.6*	65*	6.0*	100*	9.3*

*Based on outdoor fire tests.

C.3.6 Halon Extinguishers

C.3.6.1 Operating Principle

Halon extinguishers (Fig. 6) consist of a storage cylinder, a siphon tube and a valve with nozzle to a hose-and-nozzle assembly. The extinguishing agent is normally bromochlorodifluoromethane (Halon 1211), which is further pressurized with nitrogen to ensure proper operation at -40°F (-40°C). Some halon extinguishers may contain bromotrifluoromethane (Halon 1301) only, or mixtures of Halon 1211 and Halon 1301 where the higher vapor pressure of Halon 1301 ensures proper operation at -40°F (-40°C). Halon 1301 has a vapor pressure of 17 psi (117 kPa) (1.2 bar) at -40°F (-40°C), whereas Halon 1211 has a vapor pressure less than atmospheric at -40°F (-40°C).

Halon 1211 extinguishers have a range of 10 to 15 ft (3.0 to 4.6 m) and a discharge time of 10 to 20 sec.

C.3.6.2 Use

Recommended for fires in ignitable liquids and electrical equipment. Halon extinguishers also have a limited effectiveness on fires in ordinary combustibles with units of 9 lb (4.1 kg) Halon 1211 capacity or greater having a Class A rating. *Not recommended* for deep-seated fires in ordinary combustibles or fires in combustible metals such as magnesium, powdered aluminum, zinc, sodium, potassium or sodium potassium alloys.

C.3.6.3 Sizes

Hand portable available in 2.2, 2-½, 3, 3.3, 5, 6-½, 7, 9, 13, 14, 16, 17, 20 and 22 lb (1.0, 1.1, 1.4, 1.5, 2.3, 2.9, 3.2, 4.1, 5.9, 6.4, 7.3, 7.7, 9.1 and 10.0 kg); a 150 lb (68 kg) wheeled unit is also available.

C.3.6.4 Location and Distribution

Locate one or more halon extinguishers in an accessible place near the hazard to be protected; the size and number of units is governed by individual conditions.

The size of extinguishers considered adequate for inexperienced operators to use on fires in open tanks of ignitable liquids of various areas is shown in Table 4.

For tanks inside buildings, because of the hindrance to approach caused by smoke and heat, portable extinguishers alone should not be relied upon, except for small tanks (usually not over 10 ft^2 [1 m^2]).

Table 4. Halon Extinguisher Size for Fires in Open Tanks of Ignitable Liquids

Extinguisher Size		*Gasoline and Similar Liquids*		*Kerosene and Similar Liquids*		*Alcohol and Similar Liquids*	
lb	(kg)	ft^2	(m^2)	ft^2	(m^2)	ft^2	(m^2)
2-3-½	1.0-1.5	2	0.2	3	0.3	5	0.5
5-9	2.3-4.1	3	0.3	4	0.4	8	0.8
13-17	5.0-7.7	5	0.5	7	0.7	13	1.2
20-22	9.1-10.0	8	0.8	10	0.9	20	1.9
150	68	33*	3.1*	43*	4.0*	66*	6.1*

*Based on outdoor fire tests.

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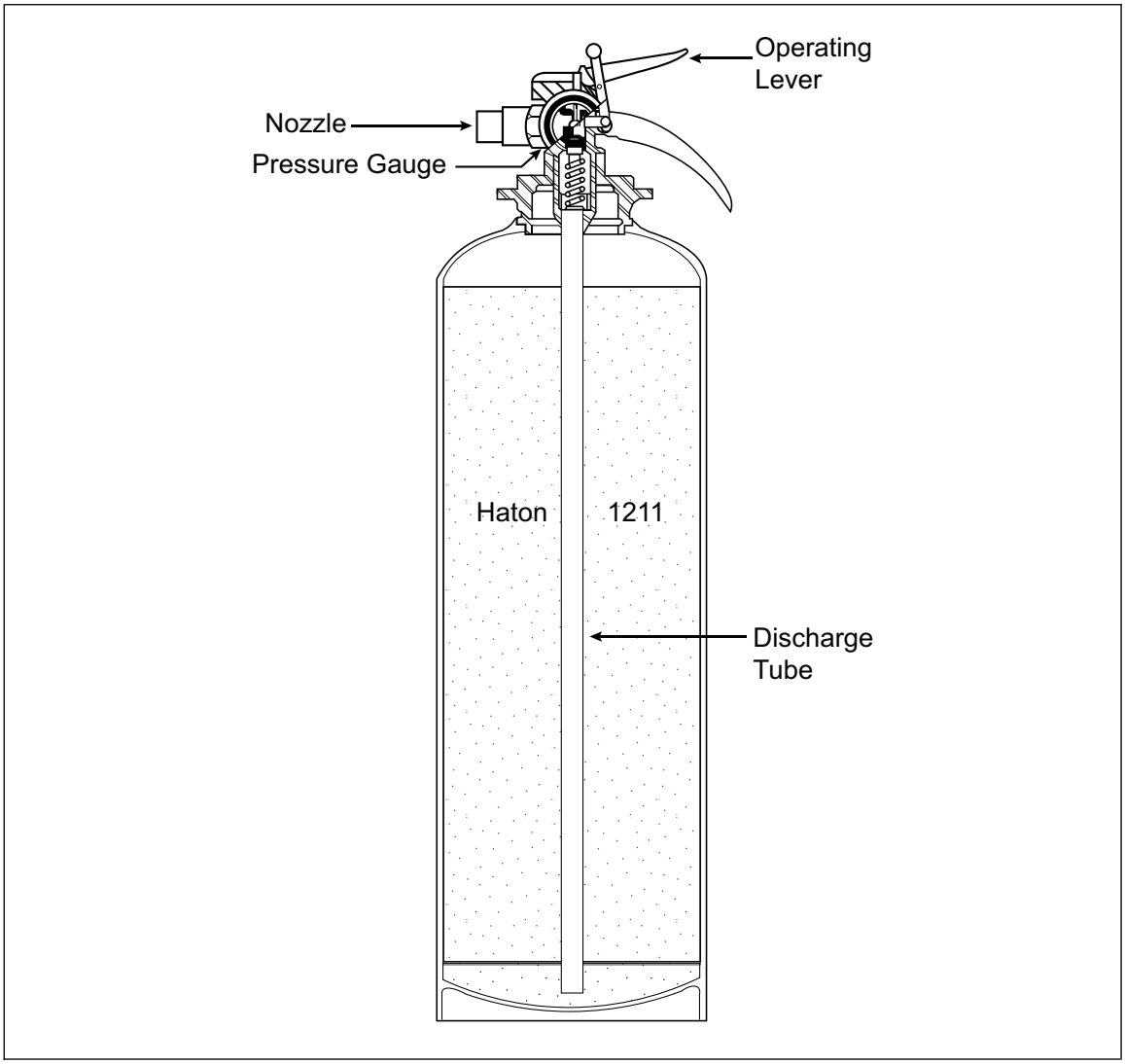

Fig. 6. Halon 1211 extinguisher.

C.3.6.5 Advantages and Limitations

Halons are not subject to freezing, leave no residue and are normally noncorrosive. Halon extinguishers are lightweight and particularly effective for fires involving electronic equipment.

While Halon 1211, and particularly Halon 1301, in their natural states are not harmful for short exposures at low concentrations, the decomposition products can be hazardous. Consequently, when using halon extinguishers in unventilated places, such as small rooms, closets, vehicles or other confined spaces, personnel should avoid breathing the gases produced by the thermal decomposition of the extinguishing agent. Decomposition products should be minimal if the fire is rapidly extinguished. Also, their presence will be indicated by acrid odors.

C.3.6.6 Inspection and Maintenance

Weekly: Check accessibility. *Monthly*: Check lockpin, seal, and any pressure guage. Recharge if loss of pressure exceeds 10% adjusted for temperature. *Annually*: Weigh and record weight on tag. Compare with weight stamped on valve body and recharge if loss in net weight exceeds 5%. Test hydrostatically if corroded or otherwise damaged. *Every twelve years*: Test hydrostatically.

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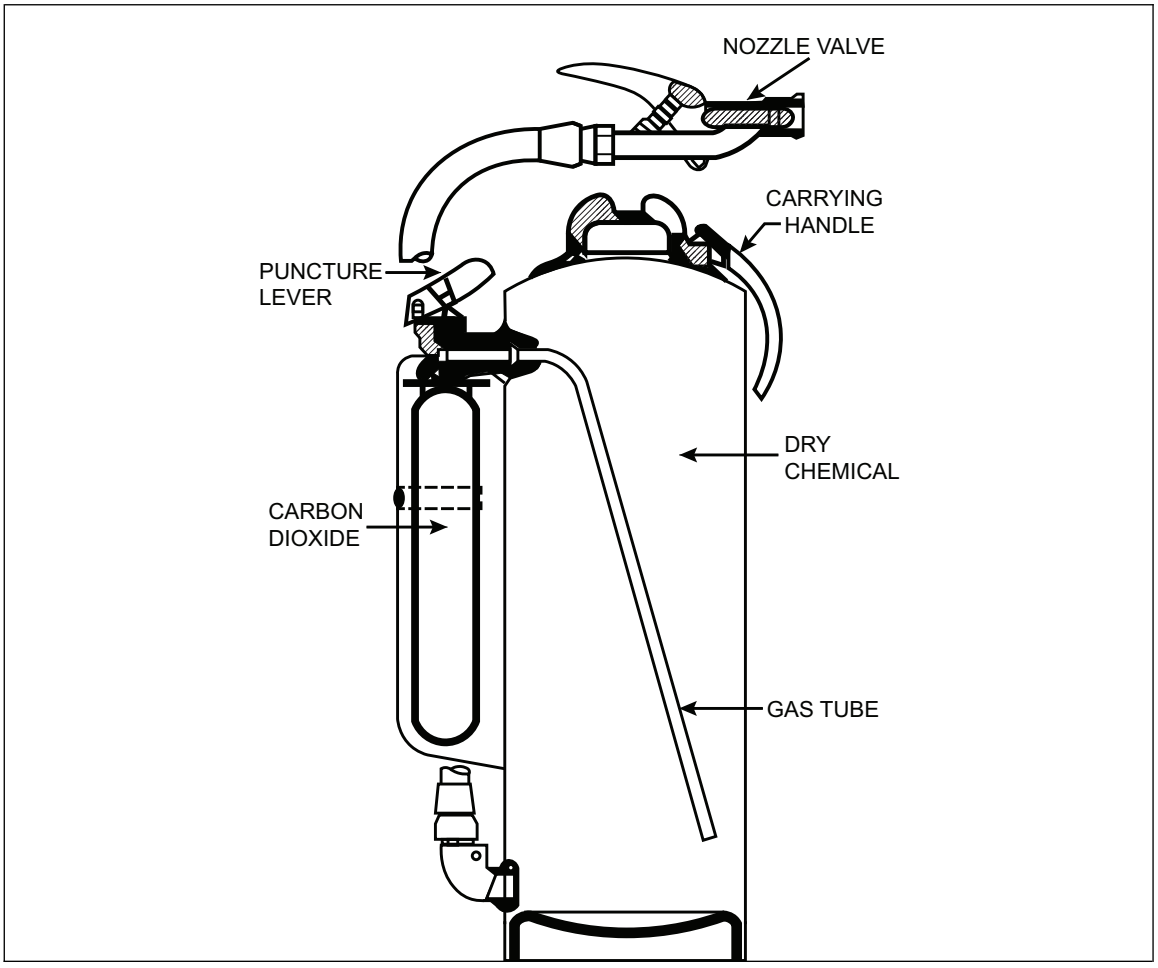

Fig. 7. Dry chemical extinguisher, cartridge-operated.

C.3.7 Dry Chemical Extinguishers

C.3.7.1 Operating Principle

Extinguishers are of the gas cartridge-operated type (Fig. 7) or stored-pressure type (Fig. 8).

The cartridge contains carbon dioxide and is usually mounted externally on the extinguisher. Gas is released into the dry chemical chamber by puncturing a sealing disk in the cartridge.

The stored pressure type (Fig. 8) has the expellant gas, dry air, or nitrogen, and the agent stored in the same container. When charging with air, a moisture trap must be used to prevent water in the air supply from entering the extinguisher. A pressure-indicating gauge is provided. A hose and/or nozzle directs the discharge, and a valve is provided for intermittent operation.

The agent can be one of four types: sodium bicarbonate base, potassium bicarbonate base, potassium chloride base, or ammonium phosphate base dry chemical. The first three are recommended for ignitable liquid and electrical fires, and the fourth is suitable for fires in ordinary combustibles in addition to ignitable liquid and electrical fires.

These extinguishers discharge a dense stream of dry chemical, which has a range from 6 to 15 ft (2 to 5 m), and the effective duration of discharge ranges from 10 to 17 sec for the portable sizes.

C.3.7.2 Wheeled Extinguishers

Wheeled extinguishers are suited for extinguishing fires in open tanks of ignitable liquids, in spilled liquids, and on ordinary combustibles when using multipurpose powder.

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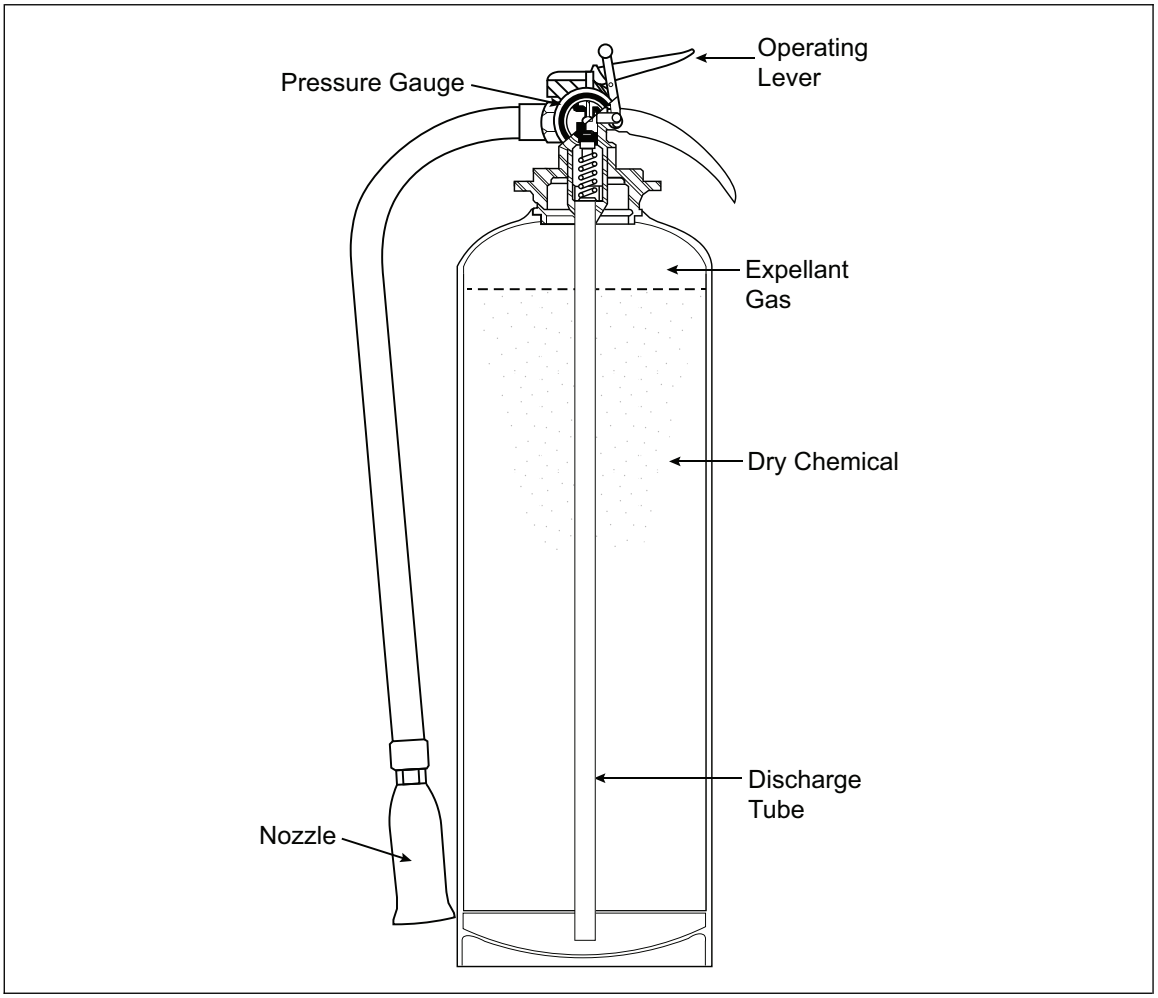

Fig. 8. Dry chemical extinguisher, stored-pressure type.

Each unit consists of a welded-steel cylinder for holding the dry chemical charge, a cylinder of nitrogen gas to expel the charge or a stored-pressure container with agent and expellant gas charge, and 50 ft (15 m)long, ¾ or 1 in. (19 or 25 mm) rubber hose equipped with a shutoff nozzle to direct the discharge of dry chemical. Discharge streams are fan shaped, although some nozzles are of the adjustable type that will also provide a straight stream. The 300 and 350 lb (136 and 159 kg) wheeled extinguishers have wheels with an extra wide tread to facilitate moving them in the plant yard.

Extinguishers with external pressurizing tank(s) are equipped with a pressure-reducing valve between the nitrogen cylinder and the inlet to the powder chamber. Two pressure gauges are ordinarily provided to indicate the gas pressure in the nitrogen cylinder (about 2,200 psi [15,170 kPa] [152 bar] when full) and the pressure supplied to the dry chemical chamber (about 220 psi [1517 kPa] [15.2 bar]).

The range with a straight stream is 35 ft (11 m) for the 150 lb (68.0 kg) unit and 45 ft (14 m) for the 350 lb (159 kg) unit. With the fan-shaped stream, the range is 10 and 15 ft (3 and 5 m) respectively. The time required to discharge the entire contents of wheeled and stationary units ranges from 30 to 90 sec.

Extinguishers with an external pressurizing tank(s) are operated by opening a valve in the nitrogen cylinder, which pressurizes the dry chemical tank and forces the dry chemical through the hose and nozzle. Wheeled stored-pressure extinguishers are operated by opening the valve between container and hose and then controlling discharge at the nozzle.

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C.3.7.3 Use

Recommended for fires in ignitable liquids in open tanks or pans, or spilled on floors, including those heated over 212°F (100°C); for fires in electrical equipment (except telephone switchboards and delicate relays); for surface fires in textile fibers (cotton, wool or rayon) if there is in reserve an extinguisher having a wetting action, such as water spray, which may be needed to extinguish smoldering and subsurface fires; and for fires in rubber tire storage, to supplement small hose. Dry chemical extinguishers do not cause boilover of hot asphalt or other liquids heated over 250°F (121°C).

Bicarbonate-base dry chemical extinguishers can be particularly effective for extinguishing fires in deep fat fryers caused by overheating. The saponification reaction between the dry chemical and fat or grease prevents reignition. Multipurpose-type (ammonium phosphate base) will not saponify the fat or grease. In fact, multipurpose dry chemical can prevent the saponification reaction between the fat or grease and any bicarbonate-base dry chemical subsequently used.

Only the multipurpose-type (ammonium phosphate) dry chemical is recommended for use on ordinary combustibles.

Dry chemical should not be used on fires in flammable metals such as magnesium, powdered aluminum, zinc, sodium, potassium or sodium-potassium alloys.

C.3.7.4 Sizes

Hand units are available in 2-½, 2-¾, 4, 5, 6-½, 7-½, 10, 15, 20, 25 and 30 lb (1.1, 1.2, 1.8, 2.3, 2.9, 3.4, 4.5, 6.8, 9.1, 11.3 and 13.6 kg); wheeled units in 75, 150 and 350 lb (34.0, 68.0 and 159 kg); and stationary units in 150 and 300 lb (68.0 and 136 kg).

C.3.7.5 Location and Distribution

For ignitable liquids, locate one or more dry chemical extinguishers in an accessible place near the hazard to be protected; the size and number of units is determined by individual conditions.

The size of extinguisher considered adequate for an inexperienced operator to use on open tanks of ignitable liquids is shown in Table 5.

For tanks inside buildings, because of the hindrance to approach caused by smoke and heat, portable extinguishers alone should not be relied upon except for small tanks (usually not over 10 ft^2 [1 m^2]).

For textile processes, provide dry chemical extinguishers where large quantities of loose fibers are exposed to the rapid spread of fire, as at opening, picking and garnetting processes; lap storage; heavy twisting; jacquard weaving; plush weaving and waste handling. Locate an extinguisher within 50 ft (15 m) of any point except at jacquard weave rooms, where they should be not more than 25 ft (7.5 m) from any loom. (This is because of the combustible nature of the loom installations and their unusual susceptibility to fire and water damage.) Back up the extinguishers with ¾ or 1 in. (19 or 25 mm) hose equipped with spray nozzles to mop up smoldering or deep seated fires.

Provide 4 to 10 lb (1.8 to 4.5 kg) extinguishers for processes where moderate quantities of fibers are exposed, as at carding, light twisting, warping and plain weaving. Back up the dry chemical extinguishers in these areas with water.

C.3.7.6 Advantages and Limitations

The most common application of dry chemical extinguishers is protection of ignitable liquid hazards. Sodium and potassium bicarbonate-base powders are effective also on textile surface fires. However, multipurpose-type dry chemical is effective on practically all ordinary combustible fires where it can reach the surfaces involved in combustion.

The multipurpose-type dry chemical forms a soft sticky mass when heated and clings to hot surfaces after they cool. Consequently, it usually cannot be brushed or blown from surfaces as sodium and potassium bicarbonate-base dry chemicals often can, particularly from metallic surfaces. Therefore, it is not recommended for areas such as textile card rooms or any other locations where many fine machine parts may require individual cleaning after a fire. Multipurpose-type dry chemical, in combination with moisture, can corrode copper and copper-alloy materials.

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Table 5. Dry Chemical Extinguisher Size for Fires in Open Tanks of Ignitable Liquids

Extinguisher Size		*Gasoline and Similar Liquids*		*Kerosene and Similar Liquids*		*Alcohol and Similar Liquids*	
lb	*(kg)*	*ft^2*	*(m^2)*	*ft^2*	*(m^2)*	*ft^2*	*(m^2)*
2-½	*1.1*	*2*	*0.2*	*3*	*0.3*	*5*	*0.5*
4-6-½	1.8-2.9	3	0.3	4	0.4	8	0.8
7-9-½	3.2-4.3	5	0.5	7	0.7	13	1.2
10-14	4.5-6.4	7	0.7	9	0.9	18	1.7
15-19	6.8-8.6	9	0.9	12	1.1	23	2.1
20-24	9.1-10.9	12	1.1	16	1.5	30	2.8
25-29	11.3-13.2	14	1.3	18	1.7	35	3.3
30-34	13.6-15.4	17	1.6	22	2.0	35	3.3
75	34.0	25*	2.3*	32*	3.0*	50*	4.6*
150	68.0	33*	3.1*	43*	4.0*	66*	6.1*
300-350	136-159	67*	6.2*	87*	8.1*	134*	12.4*

*Based on outdoor fire tests.

Potassium chloride-base dry chemical in combination with moisture can corrode many metallic construction materials.

Dry chemical produces no lasting blanketing effect on ignitable liquids, and consequently, ignition source must be overcome. Extinguishers are not subject to freezing.

C.3.7.7 Inspection and Maintenance

Weekly: Check accessibility. *Monthly*: Check lockpin, seal and any pressure gauge. *Annually*: With a cartridge-operated type, examine the chemical and replace with a fresh charge if caking is noted. Weigh gas cartridge and record weight on tag. Replace gas cartridge if loss of weight is over 10% of the net weight or as marked. Check nozzle for obstruction. Test hydrostatically if corroded or damaged. *Every six years*: Operate extinguisher. Recharge. Record date on tag. Test hydrostatically stainless steel shells or soldered-brass shells. *Every twelve years*: Test hydrostatically brazed-brass shells, mild steel shells, or aluminum shells.

Keep all extra dry chemical in tightly sealed containers and store in a dry location. Exposure to high humidity must be avoided; otherwise, the dry chemical will eventually lose its free-flowing properties. Discard any that has become lumpy. Do not mix different dry chemical compounds even in minute quantities.

C.3.7.8 Directions for Recharging

C.3.7.8.1 Hand Units

1. Invert the extinguisher after discharging and relieve any gas pressure through the nozzle.

2. Open the extinguishers, remove remaining dry chemical, and check the hose and nozzle to see that they are free of dry chemical. Failure to remove packed dry chemical from the hose and nozzle may result in sluggish operation or stoppage.

3. Refill with the dry chemical recommended by the manufacturer and indicated on the nameplate. The remainder of the previous charge may be used if in freeflowing condition. Discard any dry chemical that shows signs of caking.

4. Remove the used gas cartridge, reset and seal the actuating mechanism, and insert a fully charged cartridge.

5. Replace and tighten the fill cap.

6. For stored-pressure extinguishers it is very important to clean and properly lubricate the pressure seal after filling. Then secure valve to container and pressurize with dry air or nitrogen. When pressurizing with air, use a moisture trap.

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C.4.7.8.2 Wheeled Units

1. Close valves on nitrogen cylinder and dry chemical tank. Tip extinguisher backward to horizontal position and open nozzle to relieve pressure. Return extinguisher to upright position and remove fill cap.

2. Fill tank with the dry chemical recommended by the manufacturer and indicated on the nameplate. Replace fill cap tightly.

3. Replace nitrogen cylinder if pressure is less than 1,500 psi at 70°F (10340 kPa at 21°C) (103.4 bar at 21°C).

C.3.8 Dry Powders For Metal Fires

Proprietary powders for metal fires have been specifically developed. Dry sand, clean coarse iron filings, and sawdust-talc mixtures have also been used to control fires in magnesium and other metals.

Dry powders can be obtained commercially in 40 lb (18.1 kg) pails and 325 lb (147 kg) drums or in 30, 105 and 350 lb (13.6, 68.0 and 159 kg) gas cartridge type extinguishers.

C.3.8.1 Use

Recommended for extinguishing small fires in metals such as magnesium, powdered aluminum, titanium, zinc, sodium and potassium. *Not recommended* for fires in other materials.

Fires in the above metals are best extinguished by covering with dry powdered or granular materials that exclude oxygen.

C.3.8.2 To Use on Fire

The powder is generally applied with a shovel or by an extinguisher, covering the burning metal with a layer at least 1-½ in. (38 mm) deep. If the fire is on a wood floor, spread a layer of extinguishing powder on the floor, cover the burning metal, and then shovel the whole mass onto the layer of powder on the floor, covering the whole with more powder if necessary. The powder should be applied with a minimum of disturbance to the burning metal.

To extinguish a fire in magnesium chips in a machine shop, cover the burning chips with extinguishing powder, shovel the mixture into an empty drum, and haul the drum outdoors.

C.3.8.3 Inspection and Maintenance

Follow the recommended guidelines for gas cartridge-operated dry chemical extinguishers with mild steel shells.

C.4 Electrical Conductivity of Extinguishing Agents

Fires in electrical equipment should be extinguished with agents that minimize the shock hazard to the operator (if the equipment is energized) and the probability of damage to, or short circuits in, the electrical equipment.

It is best to de-energize the equipment before attempting to extinguish a fire with portable equipment. This will eliminate the life hazard in case the operator comes in contact with electrical conductors while extinguishing a fire. It will also shut off any possible fault current that might tend to prolong electrical disturbance and fire. However, because it may be impossible to shut off the current properly, there is great advantage in being able to use fire extinguishing agents that can be applied without delay.

C.4.1 Fire Extinguishers

Carbon dioxide, halon, and dry chemical extinguishers may be used with safety on fires in live equipment at any voltage ordinarily found in industrial plants.

These extinguishing agents are nonconductors, and their use will not result in shock to the operator or cause damage or short circuits. They have been discharged with safety on live equipment with potentials up to 100,000 volts. Care must be taken that no part of the extinguisher, nozzle or applicator is brought within sparking distance of a live high-voltage conductor. A clearance of 1 ft (0.3 m) may be adequate, but 2 to 3 ft (0.6 to 0.9 m) provides a desirable margin of safety.

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Dry chemical may interfere with the proper functioning of relays or signaling equipment.

Avoid using antifreeze or foam extinguishers on fires in electrical equipment whether energized or not. Used on live equipment, solid streams from antifreeze or foam extinguishers, which are conductors of electricity, may cause dangerous shocks to the operator and short-circuit the equipment.

Even when applied to de-energized equipment, antifreeze or foam extinguishing agents may damage the insulation and necessitate complete rewinding of a machine that is only slightly damaged by electricity and fire.

Table 6 shows the results of tests made to determine whether various extinguisher streams directed at live 550 volt conductors would carry enough current to be dangerous to life or to interfere with fire fighting.

Table 6. Extinguisher Streams Conducting Electricity

Type of Extinguisher	*Maximum Length of Stream Through Which Objectionable Current was Conducted*
Calcium chloride	6 ft (1.8 m)
Carbon dioxide	0*
Dry chemical	0*

*Static electricity may be generated by discharging these extinguishers. The operator who receives a static electric shock may wrongly assume that the shock is caused by current from the electrical equipment.

C.4.2 Extinguishment With Water

Sometimes fires in electrical equipment increase and spread so rapidly that they cannot be extinguished with available nonconducting extinguishing agents. In such cases, the best procedure is to de-energize the electrical equipment and extinguish the fire with water. If pure fresh water is used, the equipment can usually be dried with little or no added damage.

C.4.2.1 Water Spray

If the equipment cannot be de-energized promptly and the fire is beyond the control of nonconducting extinguishers, use water-spray nozzles. No appreciable current is conducted by streams of water (fresh or salt) from spray nozzles directed on live high-voltage conductors up to 250,000 volts if the nozzles are 6 ft (1.8 m) or more distant from the conductors. At voltages below 33,000, there is no appreciable current in the stream when the spray nozzle is 2 ft (0.6 m) or more distant from the live conductor.

Avoid using either spray nozzles with long applicators or combination nozzles (solid-stream or spray) to extinguish fires in or near live high-voltage equipment. Fatal electric shocks may result. Use only spray nozzles approved for use on live electrical equipment.

C.4.2.2 Hose Streams

In situations where it is impossible to de-energize all electrical equipment in the vicinity of a fire and where safe extinguishers are unable to cope with the fire, it may be necessary to let the fire burn unchecked, or to use hose streams cautiously. There is no damage to personnel in directing a solid stream of fresh water on live low-voltage electrical equipment (600 volts or less) unless the nozzle is less than 3 ft (0.9 m) from the equipment. There is no danger in playing a hose stream on live high-voltage conductors, if the stream is broken into drops before it reaches the conductors. The point at which a stream breaks up depends on the size, shape, and condition of the nozzle and on the water pressure and wind.

If a solid stream strikes a live high-voltage conductor, an electric current will flow down the stream and ‘‘charge’’ the nozzle. The amount of currrent that will flow through the body of a person holding the nozzle under these conditions depends upon the voltage of the conductor, the length and cross section of the stream, the resistivity of the water, and the ratio of the resistance to ground through the person’s body and the resistance to ground through the hose. The amount of current will vary considerably under different conditions; it may be sufficient to cause the operator to lose control of the nozzle or to cause death.

Tables that purport to show safe distances between hose nozzle and live high-voltage conductors for various voltages and nozzles and with fresh- and salt-water streams are generally not reliable because of the many variables.

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C.4.3 Summary

De-energize electrical equipment if possible.

For small fires in de-energized electrical equipment, use carbon dioxide, halon or dry chemical extinguishers.

For large fires in de-energized electrical equipment, use fresh water in the form of spray or solid stream. (Spray is preferable for fires in switch or transformer oil.)

For small fires in live electrical equipment, use carbon dioxide, halon or dry chemical extinguishers.

For large fires in live electrical equipment, use spray nozzles approved for use around live electrical equipment.

Avoid using antifreeze or foam extinguishers on electrical equipment, live or de-energized.

Avoid using salt water on electrical equipment, live or de-energized.

Avoid using solid hose streams on live high-voltage electrical equipment.

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