



# Fire prevention and control on construction sites

**F**ire at a construction site can endanger the lives of workers and others who happen to be on the site. A fire during the course of construction also can result in severe structural damage; destruction of machinery, equipment or materials; and untimely delay in project completion.

**2.** The fire-loss potential during the construction phase is far greater than after project completion. During construction, hazards inherently associated with building operations are continually being generated. At the same time, permanent fire protection systems and equipment are usually not yet in place or, at best, only partially in service. Likewise, vertical and horizontal fire-related structures (i.e. walls, floors, doors, etc.), designed to minimize fire spread, are usually not completed until late in the construction schedule.

## Fire protection plan

**3.** It is essential, therefore, that an effective fire prevention and extinguishing plan be developed before the onset of construction. The plan should be put into practice as soon as construction operations begin and should be closely followed throughout the course of construction. The fire protection plan is a vital segment of the overall project safety program. Required detail will depend on the size and complexity of the construction operations involved. This data sheet lists the elements that should be covered in the plan.

## Assignment of responsibility and authority

**4.** Project management – whether owner, construction manager, prime contractor or

a combination thereof – must clearly assign and spell out the responsibility for site fire protection before the start of the project. All contractors and subcontractors should be made aware of this responsibility and authority assignment. Procedures should be established for expedient handling of “imminent danger”-type hazards.

## Coordination with outside agencies

**5.** Determine applicable requirements concerning such items as temporary power and lighting, blasting, storage of flammables and temporary heating devices, and the like.

**6.** The local fire department should be made aware of construction plans and should be kept up to date during the course of construction regarding items such as access to the site during both working and non-working hours; and the location of standpipe systems, pumper connections, fuel storage, stairways, elevators, hoists, power and fuel shutoffs, emergency generators, and fixed-fire extinguishing systems. The fire department also may provide a source for training in the proper use of first aid, fire extinguishers and standpipe hose systems. Inviting the local fire department to inspect the worksite can be beneficial for both parties. Fire departments should be made aware of chemicals or hazardous substances on site.

**7.** Other agencies, such as local police authorities and utility companies, should be consulted concerning such items as site security; location of underground utilities; and emergency shutoff of electricity, gas and water. A liaison may be necessary with agencies such as the National Weather



Service when the site is subject to tornadoes, hurricanes, floods or other natural hazards. Procedures should be established for early warning, orderly shutdown of construction operations, and protection of workers and property. List an appropriate "One Call" number.

### **Fire prevention inspections**

**8.** Periodic site inspections should be conducted by the person responsible for fire prevention and control, or someone who has been delegated to this duty. It is essential that the individual making the inspection be competent in hazard identification as well as the corrective measures required for elimination or control of all hazards noted. The fire prevention inspection report should be written and received by project management. Include an inspection form.

### **Fire investigation**

**9.** Regardless of its size or resultant damage, every fire should be investigated to determine its cause and to evaluate the effectiveness of its extinguishment.

**10.** Each investigation should yield information for corrective measures designed to minimize the possibility of recurrence and, where needed, to improve fire suppression.

### **Training in emergency procedures**

**11.** Worker response in a fire-emergency situation is directly related to training. All workers on site should be aware of the procedure for reporting a fire and evacuating the worksite. These procedures should be posted in prominent areas. All workers should be trained concerning these procedures.

**12.** Emergency telephone numbers should be available to all workers.

**13.** An alarm system should be provided to alert all workers of a fire emergency.

Designate a location where all workers will assemble following evacuation and confirm that all personnel have been safely evacuated.

**14.** Selected workers on each work shift should be trained in the proper use of portable fire extinguishers. Training should address the four classifications of fire, the type of extinguishers suitable for each class and the proper technique to be used in operating each type. Extinguisher suppliers or the local fire department may be willing to provide, or assist in, this training.

Notify fire department first. Then utilize fire extinguishers by trained personnel for the initial small stage of fire.

### **Types of fires**

**15.** Class A fires occur in wood, rubber, paper, cloth and most plastics. The most effective type of extinguishing agent is one using water, or solutions containing large concentrations of water, because the "quenching-cooling" effect reduces the temperature of the burning material below its ignition temperature. Fire extinguishers suitable for this type of fire are designated with a classification of "A" on the label.

**16.** Class B fires occur in flammable or combustible liquids, such as petroleum products and greases. A "blanketing-smothering" effect of an agent that excludes oxygen or inhibits the chemical chain reaction is most effective. Extinguishers labeled "Class B" employ carbon dioxide, dry chemical, Halon or foam.

**17.** Class C fires involve electrical equipment. The extinguishing agent must be non-conductive. Carbon dioxide, dry chemical and Halon are the normal types used for electrical fires.

**18.** Class D fires involve combustible metals such as aluminum, magnesium, zirconium and titanium. The use of water and some

other conventional types of extinguishing agents are ineffective and may cause a violent reaction. These fires can be extinguished with specially prepared agents. Where this hazard exists, extinguishing agents with a D-class rating should be provided.

All on-site fire extinguishers should be serviced and inspected.

### **Cutting and welding**

**19.** Cutting and welding sparks cause more construction fires than any other ignition source. The person responsible for fire safety should implement fire protection systems and ensure adequate precautions are taken. Special safeguards may be needed for combustible materials, such as relocating the combustibles or covering them with flameproof tarpaulins. At some locations, it may be unsafe to use a torch regardless of the precautions taken. Store

fuel gas and oxygen cylinders upright and secure in safe locations, protected from high temperatures and adequately separated from each other. Obtain hot work permits. Establish a fire watch before and after cutting.

### **Flammable and combustible liquids**

**20.** The storage and use of flammable liquids is a hazard. Fuels, solvents, paints and adhesives are among those liquids requiring control and safeguarding. Controls include proper storage and adequate ventilation.

### **Woodworking**

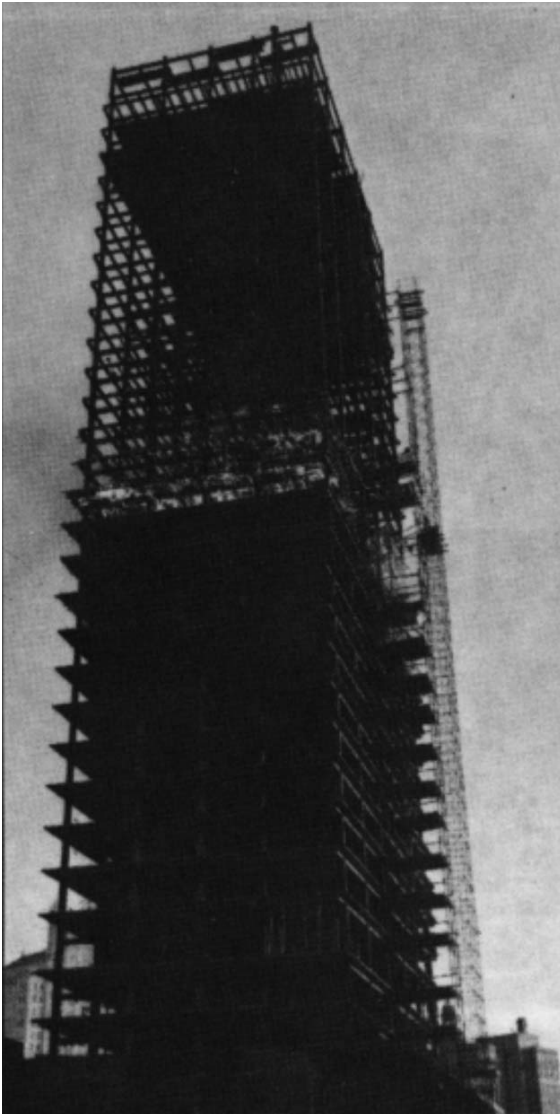
**21.** When appropriate, the woodworking area should be set up in a remote area of the project. Where possible, dust-collecting apparatus should be installed for power equipment. Dust, scraps and refuse should be removed regularly and properly disposed of. Smoking should be prohibited in the area.



**Figure 1.** Good housekeeping could probably have averted this building construction fire.



**Figure 2.** Flaming debris showering down from atop this blazing 34-story building under construction. Fortunately, there were no serious injuries.



**Figure 3.** Fire damage that could have been averted by use of proper safeguards.

### Automatic sprinklers

**22.** Expedite the installation of automatic sprinklers. Underground mains, hydrants and a source of water should be provided in the earliest stages of construction. The goal should be to get sprinklers in service ahead of combustible occupancy and immediately following combustible construction.

In multi-story buildings, capped standpipes with hose connections should be extended upward as the various floors are constructed. There should be a conspicu-



**Figure 4.** Firefighters preparing to extinguish a blaze that began at the foundation area of this building project. Storage areas should be located far enough away to avert a possible fire.

ously marked fire department pumper connection on the outside of the building at street level. The local fire department should be aware of the existence of the connection as soon as it is in service.

### Security service and fire alarms

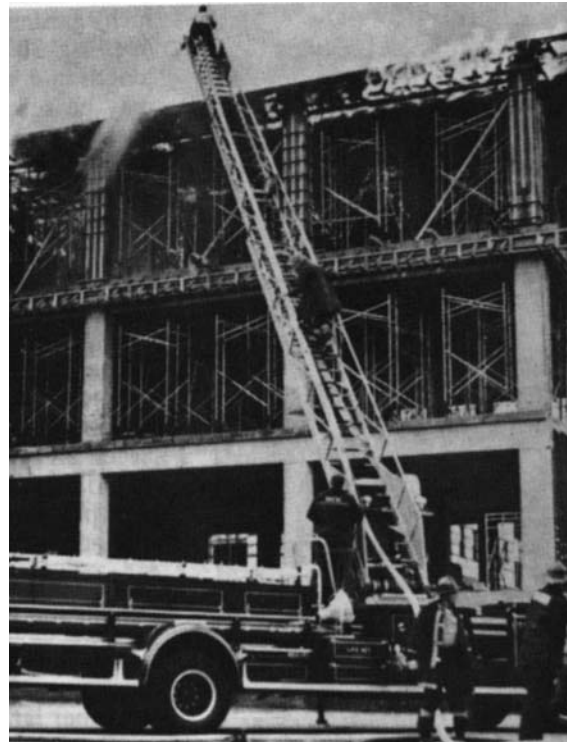
**23.** Provide watch service at night and during non-working days as soon as construction is started for construction projects. Make sure the security service is familiar with special fire hazards.

### Temporary heating

**24.** Local codes may vary as to the types of heating equipment and fuel storage arrangements permitted. All heating equipment must be provided with proper clearance from combustible materials and with necessary ventilation. Fuels must be properly stored and handled. Heating equipment must be properly maintained and operated by trained personnel. Temporary



**Figure 5.** Blaze caused by a faulty heater backfiring and setting the scaffolding and other timbers afire on this partially constructed apartment building. Note: Fire alarm is attached to lamppost.



**Figure 6.** Firemen atop an aerial ladder and directing water spray on flames around and at the top of this burning building. Fire broke out during the early stages of construction.

enclosures should be made with flame-resistant materials.

### Combustible materials

**25.** A wide range of combustible materials is likely to be found on a construction project. These include form materials; scaffolding; shoring; and many building materials such as plastics, trim and roofing material. Such materials should be stored in a remote location away from other hazards. Quantities that are kept inside the building should be minimal and stored away from construction activities. Surplus quantities should be removed from the site as soon as possible.

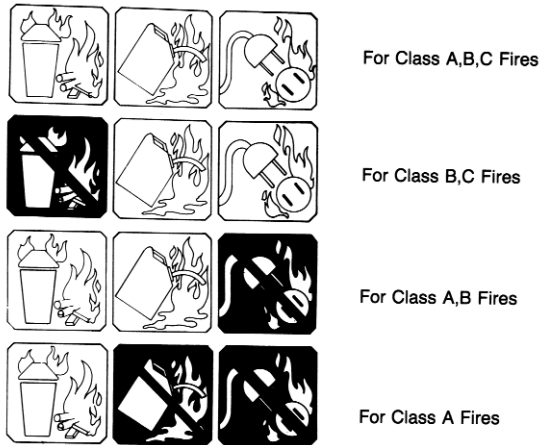
### Housekeeping

**26.** All combustible refuse, including scrap materials, packaging and waste paper should be removed regularly. Oily rags

should be separated from other refuse and stored in closed metal wastecans. On-site burning is prohibited.

### Temporary electrical equipment

**27.** Temporary electrical installations often present serious fire and shock hazards to employees. All electrical installations and repairs should be performed by qualified personnel and must comply with applicable provisions of the National Electrical Code (NFPA 70). The type and size of conductors should be adequate for the expected load. Proper fuses or circuit breakers must be provided. Conductors must be located off floors where possible and be installed so as not to be subject to physical damage. In areas containing flammable vapors, smoking or dusts, only electrical equipment specifically designed



**Figure 7a.** Recommended extinguisher marking labels. When an application is prohibited, the background is black and the slash is bright red. Otherwise the background is light blue.

Portable fire extinguisher selection chart showing Underwriters Laboratories classifications, characteristics and NFPA maintenance requirements

**Equipment maintenance**

**28.** An important part of fire protection is proper maintenance of equipment, particularly gasoline- or diesel-powered types. Attention should be given to fuel tanks and lines, carburetors, hydraulic reservoirs, and exhaust systems. For fixed equipment such as power units for hoists, exhausts and muffler systems should be clear of combustibles. Equipment should be regularly inspected and maintained by qualified personnel, and complete records should be maintained. Give particular attention to fueling methods. Mobile equipment should be fueled outside the building.

for use in such hazardous locations should be used.

**PORTABLE FIRE EXTINGUISHER SELECTION CHART SHOWING UNDERWRITERS LABORATORIES INC. CLASSIFICATIONS, CHARACTERISTICS, AND NFPA MAINTENANCE REQUIREMENTS**

NOTE: Discontinued types are not shown, although service and parts are available from manufacturers.

TYPE OF EXTINGUISHER	WATER		LIGHT WATER	CARBON DIOXIDE	DRY CHEMICAL								HALOGENATED AGENTS	DRY POWDER SPECIAL COMPOUND	
	STORED PRESSURE	PUMP TANK	STORED PRESSURE		REGULAR OR ORDINARY		POTASSIUM BICARBONATE "PURPLE K"		POTASSIUM CHLORIDE		MULTI-PURPOSE "ABC"				
					STORED PRESSURE	CARTRIDGE OPERATED	STORED PRESSURE	CARTRIDGE OPERATED	STORED PRESSURE	CARTRIDGE OPERATED	STORED PRESSURE	CARTRIDGE OPERATED			STORED PRESSURE
Sizes Commonly in Use (Nominal Capacity)	2 1/2 Gal.	2 1/2 and 5 Gal.	2 1/2 Gal.	2 1/2 to 20 Pounds	2 to 30 Pounds	4 to 30 Pounds	2 to 30 Pounds	4 to 30 Pounds	2 to 30 Pounds	4 to 30 Pounds	2 to 30 Pounds	4 to 30 Pounds	2 1/2 Pounds to 5 Pounds	30 Pounds	
CLASSIFICATION OF FIRES		Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	No	No
		No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
		No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
		No	No	No	No	No	No	No	No	No	No	No	No	No	Yes for specific metals only
Extinguishing Agent	Water	Water	Aqueous Film Forming Foam	Carbon Dioxide	Sodium Bicarbonate Base	Potassium Bicarbonate Base	Potassium Bicarbonate Base	Potassium Chloride Base	Potassium Chloride Base	Potassium Chloride Base	Ammonium Phosphate Base	Ammonium Phosphate Base	Halon 1301 (or 1211)	Sodium Chloride Base	
Method of Operation	Pull Pin—Squeeze Handle	Pump Handle	Pull Pin—Squeeze Handle	Pull Pin—Squeeze Handle	Pull Pin—Squeeze Handle	Rupture Cartridge—Squeeze Handle	Rupture Cartridge—Squeeze Handle	Pull Pin—Squeeze Handle	Rupture Cartridge—Squeeze Handle	Rupture Cartridge—Squeeze Handle	Pull Pin—Squeeze Handle	Rupture Cartridge—Squeeze Handle	Pull Pin—Squeeze Handle	Rupture Cartridge—Squeeze Handle	
Range	30-40 Ft.	30-40 Ft.	30 Ft.	3-8 Ft.	5 to 20 Ft.								4-8 Ft.	5-20 Ft.	
Approximate Discharge Time	1 Minute	1-2 Minutes	60-65 Seconds	8-30 Seconds	8 to 25 Seconds								8-10 Seconds	25-30 Seconds	
MAINTENANCE (Plus Monthly Inspection)	Check Air Pressure Gauge Monthly	Discharge, Refill Water Annually	Check Pressure Gauge Monthly Weigh Annually	Weigh Semi-Annually	As Specific Types Designate. Weigh Gas Cartridge. Check Pressure Gauge. Condition of Dry Chemical Annually										
Hydrostatic Minimum Test Interval	5 Yrs.	—	5 Yrs.	5 Yrs.	5 Years on Stainless Steel or Soldered Brass Shells, 12 Years on Aluminum, Brazen Brass or Mild Steel Shells								12 Yrs.	12 Yrs.	
Is Protection Required Below 40° F. (No Extinguisher May be Stored at Over 120° F.)	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No

CLASS A fires are fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics. Symbol color: GREEN.  
 CLASS B fires are fires in flammable liquids, gases, and greases. Symbol color: RED.  
 CLASS C fires are fires which involve energized electrical equipment where the electrical nonconductivity of the extinguishing media is of importance. Symbol color: BLUE.  
 CLASS D fires are fires in combustible metals, such as magnesium, titanium, zirconium, sodium and potassium. Symbol color: YELLOW.

Potassium Bicarbonate/Urea available in 11 to 23 pounds, 5 to 30 ft. range; 20 to 31 seconds discharge time; other factors same as for Potassium Bicarbonate

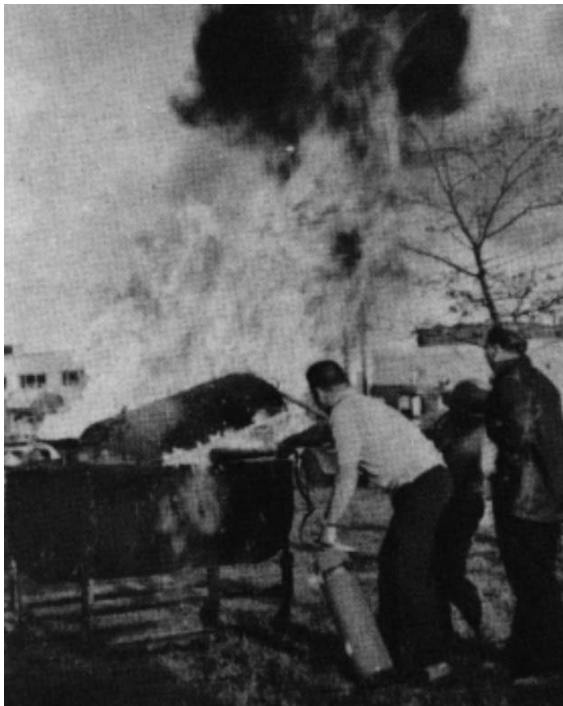
**Figure 7b.** Summary of uses, starting techniques and ranges of approval for portable fire extinguishers.



## Typical fire safety checklist

(self-inspection form for construction work)

TYPICAL FIRE SAFETY CHECKLIST (SELF-INSPECTION FORM FOR CONSTRUCTION WORK)			
Adequate protective equipment and planning for fire emergencies helps keep small fires small, limits losses.			
Yes	No	Yes	No
CONDITION		CONDITION	
<b><u>Housekeeping</u></b>		<b><u>Extinguishers and Small Hose</u></b>	
<input type="checkbox"/>	<input type="checkbox"/> Are construction materials stored in an orderly manner?	<input type="checkbox"/>	<input type="checkbox"/> Are sufficient portable extinguishers of the proper type provided throughout?
<input type="checkbox"/>	<input type="checkbox"/> Is combustible scrap and trash removed from the site regularly?	<input type="checkbox"/>	<input type="checkbox"/> Are extinguishers and small hoses kept in good operating condition?
<input type="checkbox"/>	<input type="checkbox"/> Are metal containers with covers provided for disposal of oily or paint-soaked rags?	<input type="checkbox"/>	<input type="checkbox"/> Is equipment unobstructed and its location highlighted?
<b><u>Smoking</u></b>		<input type="checkbox"/>	<input type="checkbox"/> Is equipment protected against freezing?
<input type="checkbox"/>	<input type="checkbox"/> Are NO SMOKING signs posted in hazardous areas?	<input type="checkbox"/>	<input type="checkbox"/> Are selected personnel trained to operate extinguishers and small hose?
<input type="checkbox"/>	<input type="checkbox"/> Are NO SMOKING regulations enforced?	<b><u>Sprinkler Systems</u></b>	
<b><u>Electrical</u></b>		<input type="checkbox"/>	<input type="checkbox"/> Is sprinkler installation progressing with construction?
<input type="checkbox"/>	<input type="checkbox"/> Is temporary wiring installed according to the provisions of the <i>National Electrical Code</i> ?	<input type="checkbox"/>	<input type="checkbox"/> Are sprinkler controlled valves accessible, labeled and open where necessary?
<input type="checkbox"/>	<input type="checkbox"/> Is wiring, including connections to junction boxes, panels, equipment, and the like in good condition?	<input type="checkbox"/>	<input type="checkbox"/> Are systems adequately protected against freezing?
<input type="checkbox"/>	<input type="checkbox"/> Are overcurrent protective devices (fuses, circuit breakers) in good operating condition?	<input type="checkbox"/>	<input type="checkbox"/> Are sprinkler alarms in service?
<input type="checkbox"/>	<input type="checkbox"/> Are ground fault circuit interrupters (GFCI) provided where required?	<input type="checkbox"/>	<input type="checkbox"/> Are sprinkler system pumper connections clearly marked and accessible to the public fire department?
<b><u>Welding and Cutting</u></b>		<input type="checkbox"/>	<input type="checkbox"/> Is the public fire department familiar with the sprinkler installation?
<input type="checkbox"/>	<input type="checkbox"/> Are any welding, cutting, or brazing operations in progress?	<b><u>Hydrants</u></b>	
<input type="checkbox"/>	<input type="checkbox"/> Are any combustible materials exposed by these operations?	<input type="checkbox"/>	<input type="checkbox"/> Are hydrants unobstructed and accessible to the public fire department?
<input type="checkbox"/>	<input type="checkbox"/> Is a fire watch provided during, and for at least 30 minutes after, these operations?	<input type="checkbox"/>	<input type="checkbox"/> Are hydrants in good operating condition?
<input type="checkbox"/>	<input type="checkbox"/> Is portable fire extinguisher or small hose protection available where these operations are carried on?	<b><u>Standpipes</u></b>	
<b><u>Temporary Heaters</u></b>		<input type="checkbox"/>	<input type="checkbox"/> Are standpipe systems installed and in service up to the highest level of construction operations?
<input type="checkbox"/>	<input type="checkbox"/> Are temporary heaters in use of "approved" type?	<input type="checkbox"/>	<input type="checkbox"/> Are standpipe system hose connections unobstructed and accessible to the public fire department?
<input type="checkbox"/>	<input type="checkbox"/> Is sufficient clearance maintained between heaters and combustible materials?	<input type="checkbox"/>	<input type="checkbox"/> Are standpipe systems adequately protected against freezing?
<input type="checkbox"/>	<input type="checkbox"/> Is a competent (licensed, where required) person responsible for temporary heating operations?	<input type="checkbox"/>	<input type="checkbox"/> Are standpipe system pumper connections clearly marked and accessible to the public fire department?
<input type="checkbox"/>	<input type="checkbox"/> Are fuel storage and refueling arrangements satisfactory?	<b><u>Fire Alarms</u></b>	
<b><u>Flammable-Combustible Liquids</u></b>		<input type="checkbox"/>	<input type="checkbox"/> Is a standard procedure established for reporting a fire to the fire department?
<input type="checkbox"/>	<input type="checkbox"/> Are flammable-combustible liquids stored and dispensed in a satisfactory manner?	<input type="checkbox"/>	<input type="checkbox"/> Are all workers instructed in this procedure?
<input type="checkbox"/>	<input type="checkbox"/> Is adequate ventilation provided where flammable adhesives, paints, solvents, and other chemicals are in use?	<input type="checkbox"/>	<input type="checkbox"/> Is an audible alarm in operation to alert workers of a fire on the site?
<input type="checkbox"/>	<input type="checkbox"/> Are roofing operations involving tar kettles supervised by a competent person?	<input type="checkbox"/>	<input type="checkbox"/> Is there a public fire alarm pull box located nearby?
<input type="checkbox"/>	<input type="checkbox"/> Are tar kettles in use equipped with metal covers?	<input type="checkbox"/>	<input type="checkbox"/> Has the public fire department visited the site during the past month?
<input type="checkbox"/>	<input type="checkbox"/> Are asphalt-saturated roofing mops removed from the building and safely discarded after use?	<b><u>Watchmen-Guards</u></b>	
<b><u>Exits</u></b>		<input type="checkbox"/>	<input type="checkbox"/> Is watch service provided during all nonoperating hours?
<input type="checkbox"/>	<input type="checkbox"/> Are fire exits unobstructed, including access ways and discharge areas?	<input type="checkbox"/>	<input type="checkbox"/> Does service cover the entire project site?
<input type="checkbox"/>	<input type="checkbox"/> Are all exits clearly marked?	<input type="checkbox"/>	<input type="checkbox"/> Are watchmen-guards instructed in the fire reporting procedure?
<input type="checkbox"/>	<input type="checkbox"/> Are exits adequately lighted?	<b><u>Construction Offices, Trailers, Sheds</u></b>	
<input type="checkbox"/>	<input type="checkbox"/> Are stair exit fire doors in good operating condition?	<input type="checkbox"/>	<input type="checkbox"/> Are combustible offices, trailers and sheds located at least 30ft (10m) away from major buildings and materials storage?
<input type="checkbox"/>	<input type="checkbox"/> Is adequate egress provided from uppermost work areas?	<input type="checkbox"/>	<input type="checkbox"/> Are heating devices in offices, trailers and sheds of an "approved" type?
		<input type="checkbox"/>	<input type="checkbox"/> Are heating devices properly installed and vented?
		<input type="checkbox"/>	<input type="checkbox"/> Are fuel cylinders and fuel lines for heating devices protected against vehicular damage?
		<b><u>Tarpaulins</u></b>	
		<input type="checkbox"/>	<input type="checkbox"/> Are tarpaulins used for temporary enclosure of building construction?
		<input type="checkbox"/>	<input type="checkbox"/> Are tarpaulins in use of the flame-resistant type?
		<input type="checkbox"/>	<input type="checkbox"/> Are tarpaulins in use tightly secured to prevent contact with ignition sources such as temporary heaters?



**Figure 8.** Employees being trained to extinguish a common type of storage tub fire by using a portable fire extinguisher. Such training is highly recommended for construction workers.

### Blasting

**29.** Highly specialized controls are necessary whenever explosives of any kind are to be used. All recognized precautions relating to qualification of personnel, storage locations, containers, transportation and handling should be strictly followed.

### Temporary structures

**30.** Temporary offices, storage sheds and other temporary structures should preferably be separated from other structures and storage areas. Temporary structures located inside the building should be of non-combustible construction or protected by automatic sprinklers. Temporary structures located outside should be separated by 30 feet and not closely clustered.

### Smoking

**31.** Smoking should be prohibited in the



**Figure 9.** The fire pyramid, which illustrates the four factors necessary for a fire to exist. Remove any one of the four and the fire is extinguished.

vicinity of hazardous operations or locations. "No Smoking" signs should be placed in hazardous areas and strictly enforced. If specified smoking areas are provided, suitable ash receptacles should be provided.

### Acknowledgment

This data sheet was revised by the Construction Division of the National Safety Council, 1121 Spring Lake Drive, Itasca, IL 60143.

### Sources of information

Associated General Contractors of America, 333 John Carlyle St., Suite 200, Alexandria, VA 22314: "Manual of Accident Prevention in Construction".

Industrial Commission of Ohio, 30 W. Spring St., Columbus, OH 43215: *Monitor Magazine*.

Institute of Makers of Explosives, 1120 19th St., N.W., Washington, DC 20036: "Safety in the Handling and Use of Explosives".

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169: National Fire Codes; National Electrical Code (NFPA 70).

National Safety Council: "Accident Prevention Manual for Industrial Operations, 9th ed."

Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402: Title 29, Labor Code of Federal Regulations, Section



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