

# Fire Safety

---

Fires are one of the most serious hazards facing workers in any workplace. Dozens of workers have been killed in the last 10 years in Asia in factory fires. One of the worst workplace fires occurred in the United States in 1911 when 146 women working in the Triangle Shirtwaist Co. garment plant in New York City were burned alive or jumped from the 10<sup>th</sup> floor to escape the flames.

Recent fires and worker deaths in Asia include:

<b>Year</b>	<b>Place</b>	<b>Company</b>	<b>Death Rate</b>
1991	China	Raincoat factory	72 dead
1993	Thailand	Kador Toy factory	188 dead
1993	China	Zhili toy factory	87 dead
1993	China	Fuzhon textile plant	61 dead
1994	China	Zhuhai textile plant	93 dead
1999	China	Zhima electronics plant	24 dead
1999	China	Nanyang furniture plant	19 dead
1999	China	Baiyun, Shitan plants	31 dead
2000	Bangladesh	Chowdhury Knitwears	52 dead

The 1993 Kador toy factory fire was the worst industrial fire in history.

**Some of the regulations in China related to fire safety include:**

- “Regulations on Hazardous Chemicals Management” (1987)
- “Electrical Safety Rules for Explosive and Dangerous Locations” (1987)
- GB J16-87: “Fire Prevention Standards in Building Design” (1987)
- GB J140-90: “Fire Extinguisher Allocation Design Standards” (1990)
- GB 13492-92: “Safety Signs for Fire Prevention” (1992)
- GB 15602-95: “Storage Regulation of General Dangerous Chemical Goods” (1995)
- “Fire Prevention Law” (1998)

## Fire Prevention Plans

One of the most important actions that employers should take is to establish a written fire prevention plan to save lives, protect the environment and protect property. The key components of any fire prevention plan include:

- **list of workplace fire hazards and sources of ignition;**
- **correct handling and storage** of flammable and combustible materials;
- **installation of fire protection systems**, from sprinklers to portable fire extinguishers, and procedures to maintain and test these systems;
- **a housekeeping plan** to control accumulation of flammable materials and keep them away from ignition sources;
- **an evacuation plan** including marked routes, assembly areas, procedures for counting workers, first aid and rescue duties;
- **worker training and practice drills** for both the fire prevention and evacuation plans;
- **assignment of responsible persons** to coordinate the housekeeping, fire prevention and evacuation plans.

## **Identifying Flammable and Combustible Materials**

Materials that can catch fire include liquids, solids, gases and dusts. The employer has the responsibility to evaluate all materials in the workplace, to identify materials which are flammable or combustible, and to establish a plan to prevent fires by limiting the accumulation of these materials and eliminating their contact with ignition sources.

Flammable liquids are commonly used in the workplace. Liquids are divided into various classes and sub-categories. "Class I" liquids are called "flammable" liquids. "Class II and III" liquids are called "combustible" liquids.

### **CLASSES OF FLAMMABLE LIQUIDS**

**Class I: Flash point below 100 F**

**Class I-A: Flash point <73 F Boiling Point < 100 F**

**Class I-B: Flash point <73 F Boiling Point < 100 F**

**Class I-C: Flash point between 73 F and 100 F**

**Class II: flash point above 100 F and below 140 F**

**Class III: Flash point above 140 F**

**Class III-A: Flash point above 140 F and below 200 F**

**Class III-B: Flash point above 200 F**

## Classes of Flammable/Combustible Liquids

CLASS IA	CLASS IB	CLASS IC	CLASS II	CLASS III	NON FLAMMABLE
Acetaldehyde	Acetone	Amyl Acetate	Diesel Fuel	Ethylene Glycol	Carbon tetrachloride
Ether	Naptha V.M.&P.	Isobutyl; Alcohol	Kerosene	Glycerine	Trichloromethane
Formic Acid	Denatured Alcohol	Methyl Isobutyl Ketone	JP6 Jet Fuel	Ethylene Glycol	Ethylene Dibromide
Isopentane	Ethyl Acetate	Styrene	Isoamyl Alcohol	Nitrobenzene	1,1,1 Trichloroethane
Pentane	Ethyl Alcohol	Turpentine	Fuel oils	Aniline	Methylene Chloride
Ethylamine	Gasoline	Xylene	Methyl Cellosolve	Cellosolve Solvent	Perchloroethylene
Isopropylamine	Toluene	Propyl Alcohol	Stoddard Solvent	Cyclohexanol	Trichloroethylene
Furan	Isopropyl Alcohol	Mineral Spirits	Coaltar Naptha	Iosphrone	
Ethyl Chloride	MEK	Butyl Alcohol	Cyclohexa none		

Additional Class IA liquids include gasoline, acetone, ethyl alcohol and paint thinners.

Being able to identify Class I flammable liquids and Class II and III combustible liquids is important in walk-around workplace inspections. In addition, there are special operations, which are especially hazardous for fires. These include:

- spray finishing operations (paint, lacquer, other flammable coating materials) which create both hazardous atmospheres and flammable/combustible residues;
- welding and cutting operations where welding sparks and acetylene/oxygen torches can ignite flammable/combustible materials;
- oxygen-enriched atmospheres, which will quickly catch fire in the presence of ignition sources.

## Controlling Fire Hazards

***Remove combustible materials***, such as rags, fabrics, empty solvent containers, paper and cardboard, every shift or every day from inside buildings.

***Isolate ignition sources***, or isolate flammable/combustible materials from the ignition sources. Common ignition sources include:

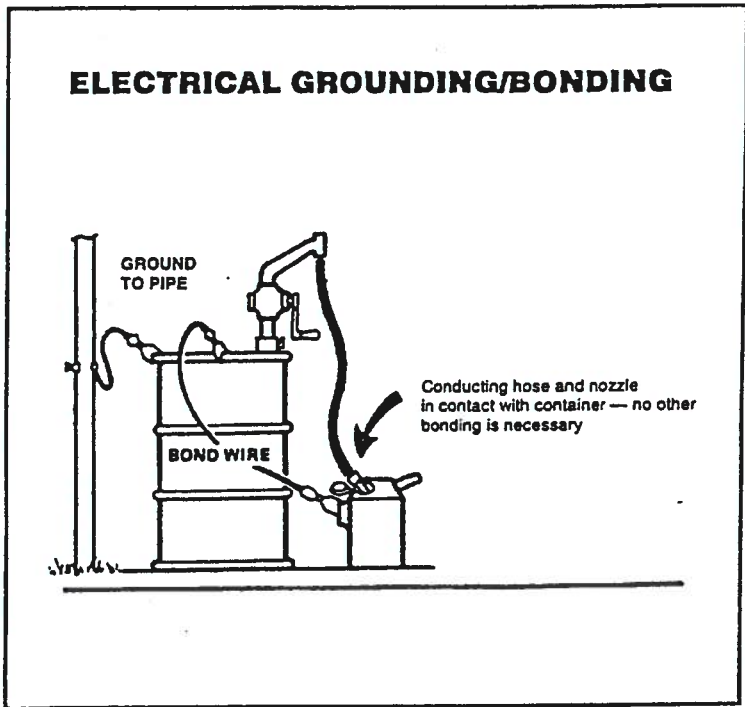
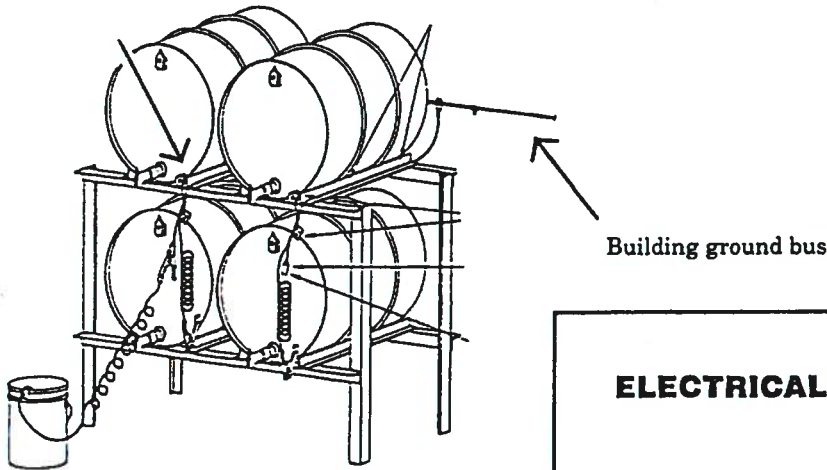
- open flames
- cigarettes
- welding and cutting activities
- hot surfaces
- radiant heat from hot objects
- heat from friction
- sparks from static electricity, mechanical friction, electricity
- chemical reactions
- lighting

***Set up rules to reduce ignition sources***, such as:

- a “no smoking” policy inside buildings
- a “hot work permit” system which requires workers using welders and cutting torches to remove or cover all flammable/combustible materials in the area before starting to weld or cut
- maintain electrical equipment to avoid heat & sparks
- eliminate broken or exposed wiring
- eliminate flexible cords used instead of permanent wiring in conduits, overloaded circuits and junction boxes, and overheated motors
- “Ground” and “bond” all containers when flammable liquids are transferred from one container to another

Static electricity sparks can ignite flammable vapors. The “bond” is a wire between the two containers while the “ground” is a wire that goes to the earth or another metal object in the ground. These wires pass the electrical energy from the movement of liquid to the earth without causing a static electric spark that could ignite flammable vapors around the containers. All transfer operations of flammable liquids should have this bonding/grounding system.

Note: Important identical grounding arrangement required for each pair of drums





## Storage of Flammable Materials

The National Fire Protection Association (NFPA) in the United States has a comprehensive set of requirements for storage of flammable and combustible materials, which have been implemented by employers in many other parts of the world.

The maximum amount of flammable and combustible liquids that can be inside of an approved storage cabinet is:

- up to 120 gallons (454 liters) of Class I, II and IIIA liquids
- but not exceeding 60 gallons (227 liters) of Class I or II liquids.

There can be no more than three storage cabinets per fire area, unless the groups are separated by at least 100 feet (30.5 meters). A “fire area” is an area separated from the rest of the building by walls having a fire resistance of at least one hour. The storage cabinets must be labeled: “Flammable – Keep Fire Away.”

Limited amounts of flammable and combustible liquids may be kept outside of an approved storage cabinet or inside storage room near spraying operations. The maximum amounts are no greater than:

- the supply of flammable/combustible liquids needed for one day or one shift; or
- 25 gallons (95 liters) of Class IA liquids in containers; or
- 120 gallons (454 liters) of Class IB, IC, II or IIA liquids in containers; or
- 660 gallons (2,498 liters) of Class IB, IC, II or IIA liquids in a single portable tank.

The maximum amounts of flammable and combustible liquids that can be kept in outside warehouse or storage buildings are indicated in the chart below.

<b>Class Liquids</b>	<b>Storage Level</b>	<b>Protected* Storage Maximum Gallons (55 gal drums)</b>	<b>Unprotected Storage Maximum gallons (55 gal drums)</b>
IA	Ground & Upper Floors	2,750 (50)	660 (12)
	Basement	Not permitted	Not permitted
IB	Ground & Upper Floors	5,500 (100)	1,375 (25)
	Basement	Not permitted	Not permitted
IC	Ground & Upper Floors	16,500 (300)	4,125 (75)
	Basement	Not permitted	Not permitted
II	Ground & Upper Floors	16,500 (300)	4,125 (75)
	Basement	Not permitted	Not permitted
III	Ground & Upper Floors	55,000 (1,000)	13,750 (250)
	Basement	8,250 (150)	Not permitted

\*Sprinkler or equivalent protection system

Note 1: If two or more classes stored, use smallest allowed maximum gallonage.

Note 2: No container more than 12 feet from an aisle. Main aisles at least 8 feet wide, side aisles at least 4 feet wide.

Additional note: 1 gallon = 3.785 liters  
1 foot = 0.3048 meter

## Fire Protection Systems

All workplaces must have a fire protection system, whether it is a sprinkler system throughout the building or a large number of fire extinguishers located throughout the building.

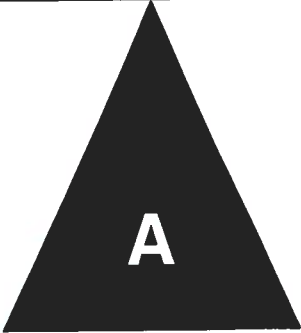

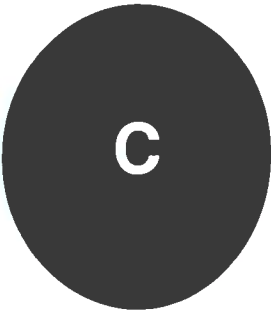
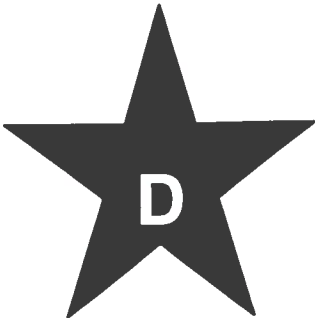
Automatic sprinkler systems are the most effective fire protection system – provided that the systems are maintained and regularly tested.

Fire extinguishers can be effective **if**:

- the right type of extinguisher is available,
- there are enough extinguishers in the fire area, and
- workers know how to use the fire extinguishers. No worker should be assigned (or attempt on their own) to use a fire extinguisher if the worker has not received training on how to use a fire extinguisher and on the dangers of fighting fires.

Fire extinguishers come in different types, including water, carbon dioxide, dry chemical and foam. Extinguishers must be mounted off the floor and have signs indicating their location. Not all types are effective for extinguishing all types of fires – the right type of extinguisher must be used.

There are NFPA requirements for the distance between fire extinguishers depending on the type of extinguisher.

<b>TYPES OF PORTABLE FIRE EXTINGUISHERS</b>		<b>Maximum Distance Between Units</b>
	<b>Ordinary Combustibles</b> Fires in paper, wood, trash, or cloth	75 feet (23 meters)
	<b>Flammable Liquids</b> Fires in fuel oil, gasoline, paint, etc.	50 feet (15 meters)
	<b>Electrical Equipment</b> Fires in wiring, fuse boxes, etc.	50-75 feet (15 – 23 meters)
	<b>Metals</b> Certain metals such as magnesium and sodium require special dry powder extinguishers	75 feet (23 meters)

# Emergency Action Plans

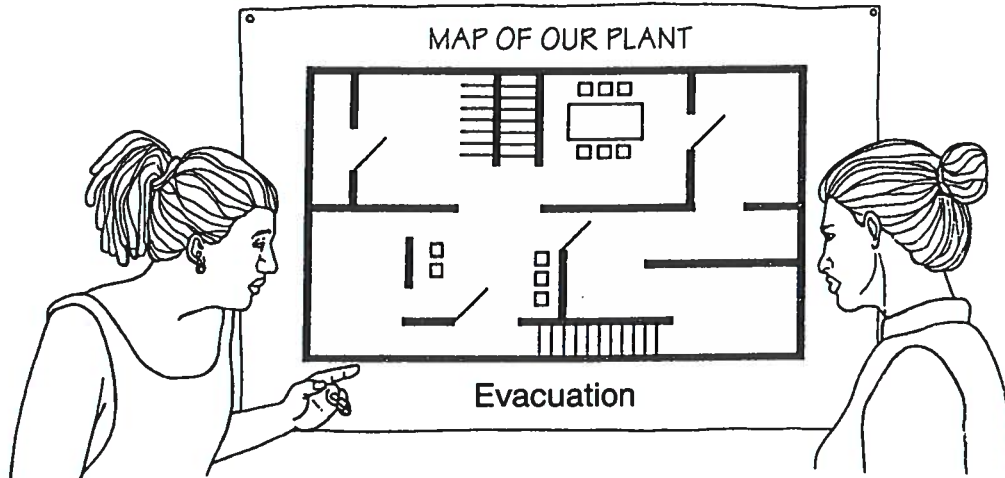
---

Emergency Action Plans (EAP) are often used to evacuate workplaces in the event of fires. However, there are other emergencies – earthquakes, tornadoes, floods – that should also be kept in mind when evaluating EAPs.

The key elements of any Emergency Action Plan include:

- **a written plan** which calls for trained coordinators; established evacuation routes and assembly areas; procedures for accounting for workers and for maintaining critical operations (if necessary); assignments for rescue and medical duties;

- **worker training and regular practice drills** so that workers know how to activate the plan, what to do, and who to contact for more information;



- **alarm systems** and regular testing of the systems;
- **exits** of sufficient number, width and location so that workers can rapidly evacuate;
- **emergency lighting** for exit routes in all areas where work is performed after daylight hours;
- **testing of fire protection systems**, from building sprinkler systems to portable fire extinguishers;
- **first aid kits and trained personnel** to use them.

## National Fire Protection Association Codes

In the United States, an organization called the National Fire Protection Association (NFPA) has developed a “Life Safety Code 101” which is used in many workplaces to set requirements for:

- maximum building occupancy
- minimum number of exits

- minimum requirements for doors, stairways, ramps, slides, lighting, signs, evacuation routes, discharge areas, and areas of refuge.

Chapter 28 of the “NFPA Life Safety Code 101” contains the minimum requirements for industrial occupancies such as factories. Among the topics addressed by Chapter 28 are:

- exits
- exit passageways
- doors, stairs and landings
- ramps
- balconies
- fire escapes
- floor and wall openings
- guard rails
- discharge areas
- assembly areas
- areas of refuge
- exit signs
- fire protection systems
- building ventilation systems
- elevators and escalators

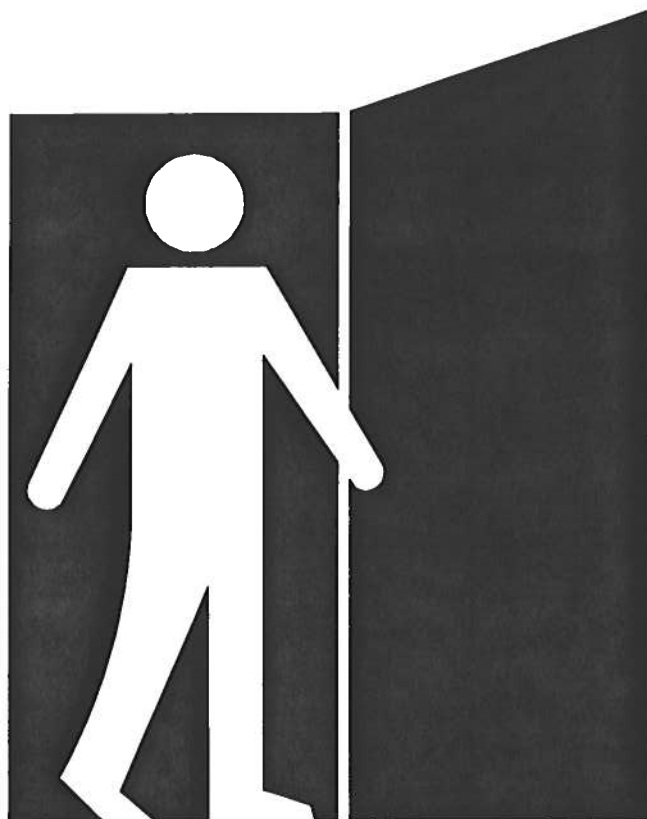


The table below includes some of the most important requirements of Chapters 5 and 28 of the NFPA document.

<b>Subject</b>	<b>Requirement</b>	<b>Chapters 5 &amp; 28 Sections</b>
"Occupant load," or the maximum number of people in the space	<ul style="list-style-type: none"> <li>• 1 person for every 9.3 square meters (100 square feet)</li> </ul>	Chap. 28-1.7
Minimum number of exits	<ul style="list-style-type: none"> <li>• Minimum of 2 for all spaces above ground level;</li> <li>• Minimum of 3 for spaces with more than 500 workers but less than 1,000 workers;</li> <li>• Minimum of 4 for more than 1,000 workers</li> </ul>	Chap. 28-2.4.1 and Chap. 5-4.1.2
Maximum travel distance to exits	<ul style="list-style-type: none"> <li>• 60 meters (200 ft) for spaces without sprinkler systems;</li> <li>• 76 meters (250 ft) for spaces with sprinkler systems;</li> <li>• 122 meters (400 ft) for ground level spaces with sprinkler systems and roof venting for smoke</li> </ul>	Chap. 28-2.6.1 and 28-2.6.2
Maximum "common path of travel" where exit passageways from two areas coincide en route to the exit	<ul style="list-style-type: none"> <li>• 15 meters (50 ft)</li> </ul>	Chap. 28-2.5.3
Minimum width of exit passageways (aisles leading to exits)	<ul style="list-style-type: none"> <li>• 91 centimeters (36 inches)</li> </ul>	Chap. 5-3.4.1



<b>Subject</b>	<b>Requirement</b>	<b>Chapters 5 &amp; 28 Sections</b>
Minimum width of doors (both single and multiple doors)	<ul style="list-style-type: none"> <li>• 81 centimeters (32 inches) for each door</li> </ul>	Chap. 5-2.1.2.2
Emergency lighting for exit passageways and doors	<ul style="list-style-type: none"> <li>• 30 second tests must be done every 30 days;</li> <li>• 90 minute tests must be done every year</li> </ul>	Chap. 5-9.3
Signs	<ul style="list-style-type: none"> <li>• Exits and exits routes must be marked</li> </ul>	Chap. 5-10



## Exits

One of the most important parts of evaluating any workplace is to ensure that exits meet the minimum requirements. The fundamental principles for exits include:

- A sufficient number of exits to permit rapid escape, at least two exits are required from any work area where one exit may be blocked by fire or smoke;
- Exits arranged and maintained to provide free and unblocked exit;
- Every exit should be visible or the escape route conspicuously marked;
- Exit aisles must be clear and at least 91 centimeters wide;
- No locks or fasteners on doors which could prevent free escape;
- Any door which is not an exit, but might be mistaken for an exit, must be marked “not an exit”;
- “Dead end” spaces with no exit must be marked or blocked to prevent workers being trapped in them while trying to escape;
- Doors must be side-hinged and swing open in the direction of travel outward. Exit doors must not open inward;
- No exit routes should go through bathrooms or other rooms that may be locked, except for the exit door for that room;
- Adequate and reliable lighting must be provided.