CAD & Detail Drafting
Granville TAFE

7771AP

Fire Protection Services

C-DD016
Edition 1

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Feedback

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Acknowledgments

This student workbook has been compiled from the relevant Australian Standards, Australian Building code and various books relevant to this subject. The current book has been produced by Susan Pardel at Granville College of TAFE.

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Introduction

About this module:
7771AP Drafting – Fire Protection Services is part of the Drafting stream in the Engineering Technician and Engineering Associate National Curriculum. The prerequisites for this module are *ND01 (7771A) – Drafting Concepts* or its equivalent.

Outline of Module:
The module aims to introduce students to the concepts to develop the knowledge and the skills to prepare drawings for fire protection systems. This fire protection services module contains 9 x 4-hour sections that integrate theory, practical exercises and assessments. Each lesson contains review and/or skill practice exercises to reinforce learning.

Assessment Events:
Three (3) assessment tests will be required to be passed to successfully complete the Module. Assessment Test 1 (1½ hours) consists of short answer questions which cover the appropriate parts of learning outcomes 1, 2, 3 & 4. Assessment Test 2 (2 hours) requires the completion of a simple fire protection system drawing to be prepared in accordance with the relevant Australian Standards in reference to fire protection services. Assessment Test 3 includes all completed class skill practice exercises.

Assessment Tests 1 and 2 may be combined at the end of the module at the discretion of the teacher.

Module Organizer

Lesson	Topic	Exercise
1	Introduction to fire protection set-ups	7771AP-SP-01
2	Fire protection systems	7771AP-SP-02
3	Building construction and fire safety systems	7771AP-SP-03
4	Representation of system drawings & Revision	
5	**Assessment 1**	Complete SP-03
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7	Fire doors	
8	Fire stairs	7771AP-SP-08
9	**Assessment 2**	Complete SP-08

Terminology:

Booster pumps –	A machine with rotary action or the reciprocal action of a piston fitted with a device for increasing electrical power for raising water to fight fire
Combustible materials –	Inflammable material that easily set on fire
Fire alarm –	A device for giving warning of fire
Fire door -	A fire–resistant door to prevent the spread of fire
Fire escape –	An emergency staircase or apparatus for escape from a building on fire
Fire extinguisher –	An apparatus with a jet for discharging liquid chemicals, water, or foam to extinguish a fire
Fire hoses –	A hosepipe used in extinguishing fires
Fire hose reels –	A cylindrical device that on a flexible tube is wound to convey water for putting out fires
Fire-plug –	A hydrant for a fire-hose
Fireproof –	Able to resist fire or grate heat
Firetrap –	A building without proper provision of escape in case of fire
Fire hydrants –	A pipe (esp. in a street) with nozzle to which a hose can be attached for drawing water from the fire main
Sprinkler systems –	A system of devices that sprinkles water to extinguish fire

LESSON 1 – Introduction to fire protection set-ups

Learning outcomes:
On completion of the session the participants will be able to:

- Describe various terminology used in conjunction of fire protection services
- Nominate the Australian Standards used in conjunction with fire protection services and drawings
- Nominate classes of fires
- Identify fire protection equipments

Australian Standards:

SAA HB20 – Graphical Symbols for Fire Protection Drawings
AS 1100 – Australian Drawing Standard (Parts 101 & 201)
AS 1851 – Maintenance of Fire Protection Systems and Equipment
AS 2441 – Installation of Fire Hose Reels
AS 1670 – Fire Systems Standard
AS 1603 – Automatic Fire Detection
AS 4428 – Fire Detection, Warning, Control & Intercom Systems
AS 3786 – Smoke Alarms
AS 2118.9 – Support of Sprinkle Piping
AS 2118.4 – Design and Installation Requirements

Introduction:

Fire prevention and control

Fire protection is undertaken:

- In order to safeguard human life and property
- To prevent, detect and extinguish fires
- To improve on fire prevention and suppression of methods by research into the cause of fire
- To study of engineering data leading to the establishment of standards in building design and construction that will limit fire hazards
- In order to educate the public as well as professional fire-fighting personnel to take correct and prompt emergency action
- To develop procedures on the maintenance and improvement of fire fighting equipment
- So the inspection of buildings comply with established fire-preventive practices

<u>History of fire prevention</u>

Until after World War I little official attention was given to fire prevention, for most departments were concerned only with fire extinguishment. Today nearly all-large cities have at least a small staff exclusively concerned with prevention. Modern engineers and architects know that fireproof construction does not exist. However, a fire–safe building and interior design has to seek to:

- Limit interior combustibles so that fires will spread more slowly;
- Minimise the probability of a source of ignition coming in contact with combustible material;
- Supply methods for rapidly detecting and extinguishing fires;
- And to provide adequate space around buildings, thus giving fire fighters easy access.

Once the building is built, periodic inspection helps to ensure compliance with fire codes. To prevent fire a specific fire prevention program of a company or institution has to be developed. Especially important; is to provide fire safety in buildings fitted with up to date equipment, and processes to minimise the cause of fire and explosion. The maintenance of protective equipment such as automatic sprinklers and portable fire extinguishers is absolutely necessary.

Fire policies

A company policy statement shall typically emphasise the importance of safety, prevention of loss, and the responsibilities of supervisory employees. It also includes the duties of fire-prevention personnel, methods of storage and use of explosives and flammables, installation and maintenance of alarm and other protection systems, maintenance and regulation of fire escapes and exits, investigation of causes and circumstances of fires, and the conducting of fire prevention campaigns.

Public awareness

Public awareness campaigns on the removal of fire hazards in homes, places of business and institutions are increasing. These campaigns have also resulted in better maintenance of equipment, better preparation for fire emergencies, and better public support for the needs of professional fire fighters.

Protection of hazardous equipment

Electrical equipment, internal-combustion engines, storage tanks, pipelines carrying liquids or gases of high temperature are potential hazards in all buildings. The best protection against most of these hazards is sound basic design; frequent inspection and good housekeeping practices. Flammable-liquid storage requires approved pumps and containers. Where hazards are unavoidable, extinguishers must be provided. High-hazard processes such as chemical production must be isolated and protected in building design and the personnel facilities planned to minimise danger.

Reasons of the causes of fire and explosion

Several studies of fire of all kinds were conducted and the principal reasons for fire were electrical, smoking, overheated materials, hot surfaces (resulting from defects or heat from boilers, furnaces, lamps or other processes), and burner flames, spontaneous ignition, cutting and welding. Other causes include exposure to neighbouring fires mechanical sparks, molten substances, chemical actions and static electrical sparks, including lightening.

Spontaneous ignition sometimes occurs when combustible solids or liquids are stored loosely enough so that large areas of surface are exposed to oxidation but with inadequate air circulation to dissipate heat. As the combustible material slowly oxidises (unites chemically with atmospheric oxygen), it releases sufficient heat to raise the temperature of the stored material. As additional air steps in, the temperature is gradually raised until the ignition temperature is reached. Soft coal has a tendency for spontaneous ignition. Prevention of spontaneous ignition is accomplished either by total exclusion of air or by good ventilation.

Classes of fires

The system or classification described below, based on types of combustibles, is widely used throughout the world.

Class A fires: Involves paper, wood cloth, trash and other ordinary combustibles. They are most effectively extinguished by cooling until combustion no longer is supported. Extinguishers for such fires called Class A extinguishers containing water, soda-acid, and a solution of fire extinguishing solutions, foam or multipurpose dry chemical.

Class B fires: Involve flammable liquids such as gasoline, oil, paint and tar. Because the flames are on the surface, the extinguishing agent must not cause the liquid to flow and spread. Therefore water is not suitable for such fires. The best Class B extinguishing agent smothers the fire by cutting off its oxygen supply or interrupting the combustion process. If suitable cover is available a Class B fire can be smothered.

Class C fire: Involve electrical equipment and pose the special hazard of electrocution. The oxygen-exclusion principle is used against them. Nonconductive agents in Class C extinguishers include carbon dioxide, dry chemicals or compounds containing fluorine or chlorine, called Halons.

Class D fire: Involve more than one class of combustibles, with very large fires involving all four. Fires that are extensive in damage but not in area, as five in a single industrial complex or group of warehouses is generally called a group fire.

Fire protection equipments

The most commonly used fire protection equipments are:

- Portable fire extinguishers

- Wheeled fire extinguishers
- Fire blankets
- Fire buckets

The simplest and oldest type of extinguisher is the pail or ***bucket***. A common assembly is a large covered cask or drum, holding 100 or 200 litres of water and three buckets. The ***fire blanket*** initially appears to smother the flames and extinguish the fat fire. However, after a short period (maybe 20 seconds), the vapours from the oil saturate and suffuse through the fire blanket, and then begin to combust above the surface of the blanket (note that the blanket does not catch fire). While the size of the fire has been reduced from the initial pre-burn period, it still poses a risk to the safety of people or property. Fire blankets are made from heat resistance fabrics for all severe heat environments from coated ultra-heavy fibreglass Pyroblanket™ to adhesive and heat reflective Fiberflect™ sheets. A full range of heat resistant fabrics are also available in standard or custom formats. They form industrial fire blankets and fire blanket rolls, welding curtains and removable insulation covers.

Fire extinguishers

Pump type extinguishers operated by pumping liquid from a tank. Chemical reaction extinguishers, such as soda-acid and chemical foam, acquire their pressure from the chemical reaction; turning the unit over causes the chemicals to mix. Invert and bump extinguishers have a carbon-dioxide cartridge that must be punctured to create pressure. After the unit is inverted it must be bumped on the floor to puncture the disk on the cartridge. Lever or wheel-operated types used stored pressure from compressed air, carbon dioxide, nitrogen or other gas. A trigger, lever or wheel that opens a valve or punctures a disk activates them.

The type, size, number and location of extinguishers are a matter of engineering judgement, involving the type of anticipated, including heat and smoke. Most modern buildings require more than one type of protection. A hospital for example needs Class A extinguishers for patients' rooms, corridors and offices. Class B extinguishers in laboratories, kitchens and in places where flammable materials used or stored. Class C extinguishers protect electrical switchgear or emergency generator rooms. Class A and Class B extinguishers are normally located on walls and in places that limit travel distance to reach them to about 23 metres. In general, the area protected by each extinguisher does not exceed about 300 square metres. For Class B exposures the maximum travel distance is usually limited to 15 metres.

Foam Extinguisher

Dry Chemical Extinguisher

Water Extinguisher

TYPES OF EXTINGUISHERS

Extinguisher	Type of fire	Effective range
CARBON DIOXIDE	Electrical, solvents, chemicals	2 metres - 3 metres
DRY CHEMICAL	Metal fires, solvent or electrical fires	Immediate proximity only
FOAM	Oil, paint, wood, cloth fires NOT suitable for electrical fires	10 metres
PRESSURISED WATER	Paper, wood, cloth fires NOT suitable for electrical fires	10 metres -15 metres
HOSE REELS	Paper, wood, cloth fires NOT suitable for electrical fires	3 metres -15 metres
BLANKETS	A blanket of fireproof material will often effectively smother a fire and prevent its spread	Immediate proximity only

Fire extinguishing agents

Fire-extinguishing agents include foaming and wetting agents, fog, carbon dioxide; dry chemical systems, dry powder, Halons, steam and inert gas systems.

- Foaming agents

Foam apparatuses may be fixed or portable and may be automatically or manually operated. Discharge rates vary from low to high volume. The larger system is employed to protect areas in which paint, oil, or asphalt is used. Foam systems can extinguish oil tank fires by subsurface injection of foam that rises both to cool and smother the fire. Shutting off the fuel supply as quickly as possible is important. There are two types of foam: ***chemical*** and *mechanical*.

Chemical foam is formed by a chemical reaction in which masses of bubbles of carbon dioxide gas and foaming agent produce an expanded froth. There are four general types of equipment: self-contained units, closed generators, hopper generators and stored solution systems. The self-contained unit has two solutions; both stored separately and mixed before use. Close generators have chemical foam powder stored in large hoppers. When the hopper is opened, the powder is added to a generator that mixes it with water to make foam, which is forced through outlets. It is used mainly on flammable liquid storage tank farms, where a single foam-making unit can service a number of tanks. Hopper generators are either permanent or portable. They permit continuous refilling if it is needed. Lines or towers permit foam application to burning oil storage tanks. Stored solution systems have large, permanently installed tanks that contain two foam-producing solutions stored separately. To make foam, pumps force the solution to outlets where they mix and discharge as foam.

Mechanical foam is formulated by mixing air and liquid concentrate to water in a 2 to 6 percent (by volume) ratios. These concentrates are non-protein or synthetic. Protein types are used to put out fires of hydrocarbon compounds such as oil and gasoline. They can be used with a special stabiliser such as alcohol or ether, which mix with water. Non-protein compounds are used to extinguish certain types of alcohol fires against which an un-stabilised protein form is ineffective. Low in viscosity, these compounds spread quickly over the surfaces of burning liquids. They are not effective against burning liquefied petroleum gas and are not recommended for Class A or Class C fires.

- Wetting agents

Wet water contains a chemical that reduces its surface tension, thereby increasing its penetrating, spreading and emulsifying properties and its cooling ability. It can be applied as a liquid or as foam. As clinging foam, it is often used to protect structures from exposure fires (which might spread form the structure that is already burning), where the foam is acting as an insulating blanket. As heat breaks down to foam, hot water flows away from the protected surface.

- Fog

Conventional sprinklers deliver a rather course spray, but with a special head a fog pattern can be developed. (Flame is burning vapour or gas about on-three thousands the weight of water and sometimes only a few millimetres thick.) The amount of heat that water will absorb depends on amount of water surface in contact with the fire. The more droplets that the water divides into, the more surface produced for a given amount of liquid water. Water fog is quickly evaporated by flame or superheated air. Because a small amount of water can be made to vaporise into a large volume of steam, a fire can be extinguished both by cooling and by smothering with very little water damage to premises.

- Carbon-dioxide

These systems are used to protect areas in which water must not be used, areas in which fire can be extinguished by diluting the oxygen and areas containing electrical equipment, flammable materials or hazardous processes. The compressed gas is stored in high-pressure cylinders at normal temperature or in insulated pressure vessel kept at -18° C, so that pressure can be reduced. Low-pressure systems permit storage of larger quantities more economically then do high-pressure systems. Liquid carbon dioxide is delivered through pipelines to nozzles that can be released up to 1125 kg per minute. After the fire is extinguished the area must be ventilated thoroughly. Hand units filled with carbon dioxide are available for small chemical or electrical fires.

- Dry chemical systems

Dry chemical pipe systems quickly extinguish electrical or flammable liquid fires. These systems are operated either manually or automatically. Extinguishment results mainly from the chemical agent's interruption of the flame chain reaction. This chemical agent usually is a powdered mixture of sodium or potassium bicarbonate or an ammonium phosphate base chemical. Dry chemicals are designed to be stored in a tank that is pressurized by an inert gas cylinder or in a pressurized container. Dry chemical systems can also be mounted on vehicles or in portable extinguishers.

- Dry powder

Dry powder is designed to extinguish burning metal, such as magnesium, alkali metals or

nuclear reactor materials. The powder is usually dispensed by a special extinguisher or simply applied with a shovel. No single powder is successful on all metal fires. One of the oldest approved dry materials is graded granular graphite with organic phosphate added to improve effectiveness. It is used against magnesium and magnesium alloy fires and is applied with a scoop. Other materials include dry sand, talc, asbestos powder, powdered limestone and sodium carbonate (soda, ash).

- Halons

Halons or halogenated hydrocarbons are created when methane or ethane have some or all of hydrogen atoms replaced with atoms of halogen elements such as bromine, chlorine, or fluorine, which change them from flammable substances to fire-extinguishing agents. Halogen elements, particularly bromine, increase fire-extinguishing effectiveness. These compounds extinguish a fire by inhibiting the flame chain reaction and ion formation. Engineers devised a five number system for numbering Halon compounds which is used worldwide. The first digit of each identifying number represents the number of carbon atoms in the molecule; the second digit, the number of carbon atoms in the molecule; the third, the number of chlorine atoms; the fourth, the number of bromine atoms; and the fifth; the number of iodine atoms. Any atoms accounted are hydrogen.

- Steam and inert-gas

Automatic or manually controlled steam-jet systems are used to smother fires in small rooms or in closed containers such as heaters, drying kilns, smokehouses, asphalt-mixing tanks and dry cleaning tumble dryers. These systems require a large supply of steam and pose and injury hazard from burns. Inert gas is used to replace a specified percentage of the oxygen in air. Gases that may be used include carbon dioxide, nitrogen, helium, and argon or flue gas. Depending on the type of combustible material that is involved and the type of gas used; the amount of oxygen is reduced from about 21 percent to between 2 and 16 percent. The system is to prevent gas, vapour or dust fires and explosions, because when the oxygen content of the atmosphere is less than 16 percent, many common materials will not burn.

High-pressure pumps

"Fire Captain" pump

High performance fire pump made by Honda

High-pressure pumps are portable fire fighting equipments. Australian Pump Industries Pty Ltd is Australia's leading high pressure fire pump supplier with a product range that extends from lightweight through to big village protection style fire pumps.

The "Fire Captain" which is a high-pressure fire-fighting pump is designed to provide first

class fire fighting capability for farmers and domestic users as well as professional fire fighting authorities. It comes with a big 7 1/2" diameter one-piece heavy-duty impeller, severe service mechanical seal and bolt-on flanged style inlet port for ease of service. The heavy duty steel roll cage comes with anti-vibration mounts, serving the double purpose of both protecting the pump and cushioning vibration to provide longer pump and engine life.

Diesel & electric hydrant booster pumps

Electric hydrant booster pumps are used to boost hydrant landing valve pressure where mains are insufficient or unavailable.

Skill Practice Exercise: 7771AP-SP-01

Complete an emergency plan for a manufacturing company in Sydney. The layout of the industrial complex is accessible on the network drive. The underlay includes the production area, the machinery layout and the office area. The symbols used in the drawing legend are based on the Australian Drawing Standard SAA HB20-1996 "Graphical Symbols for Fire Protection Drawings". The symbols are drawn in colour so they can be easily noticed on the plan. The size of the symbols is relevant to the drawing layout and it will change according to the scale factor and layout size. The lineweight used for the symbols are also relevant to the size of the layout and to the visibility of the symbols on the final print. (Please note, the size and lineweight of the symbols are already set on the provided underlay.)

The task is to place the fire services symbols on the plan at locations as shown on the provided A3 copy of the finalised drawing. The plan should include also an egress route and all exit signs. The drawing is to be plotted on an A2 drawing sheet that is placed at 1:1 scale in paper space. Fill in the title block; scale to fit the drawing in a single viewport so it fits the sheet border and print the drawing in colour.

Note:
For fire protection drawing symbols refer to the sketches at the end of this workbook.

LESSON 2 – Fire protection systems

Learning outcomes:
On completion of the session the participants will be able to:

- Identify fire protection
- Nominate five major types of sprinkler systems
- Identify fire detection and alarm systems
- Identify typical component parts and produce a drawing of component used in fire protection services

Fire protection systems

Fire hydrants

Fire hydrant systems are installed in buildings to help fire fighters quickly attack the fire. Essentially, a hydrant system is system used to transport water in order to limit the amount of hose that fire fighters have to lay; thus speeding up the fire fighting. Fire hydrants are for the sole use of trained fire fighters (which includes factory fire fighting teams). There is a high risk that serious injury can occur if an untrained person attempt to operate the equipment connected to such installations.

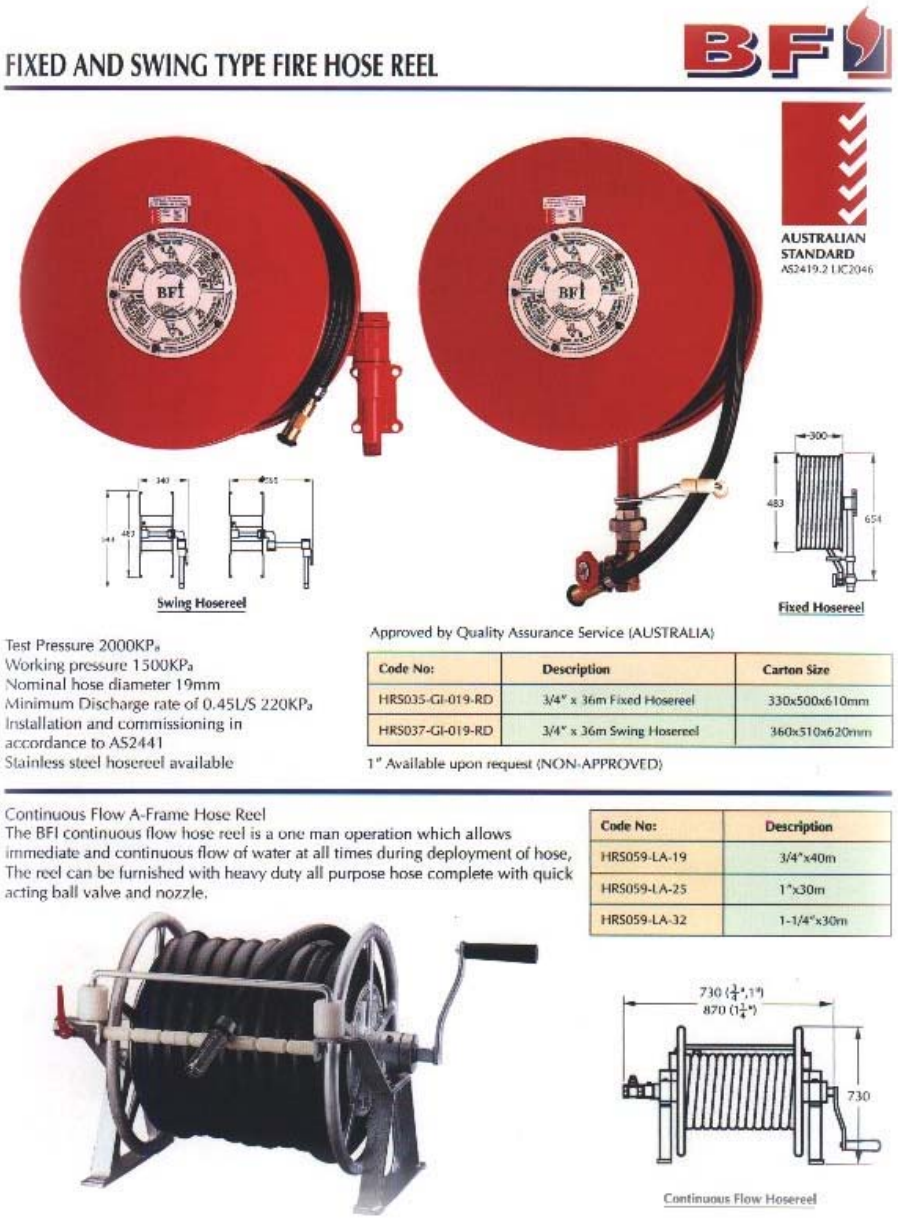
Fire hydrant systems sometimes include ancillary parts essential to their effective operation such a pumps and tanks. These systems must be maintained and regularly tested if they are to be effective when needed. The placement of such equipment needs to closely interface with fire service operational procedure; simply complying with department provisions is a potential recipe for disaster.

Fire hose reels

Fire hose reels are provided for use for occupants as a "first attack" fire fighting measure. The fire hose is designed to be rugged and dependable. It must be capable of carting water under substantial pressure, yet flexible and easy to manage. After each use, the hose is dried thoroughly. It is usually tested annually, to three or five minutes at working pressure. During testing the nozzle is closed so that the hose must take the full pressure. When storing fire hose reels, it is important to first attach the nozzle and the hose reel valve to relieve pressure in the wound hose. This achieves two principle objectives:

- A depressurised hose reel seal will last longer than the permanently pressurised
- When the hose reel is next used, the operator will be forced to turn on the isolating valve, thus charging the hose to water supply, before being able to drag the hose to the fire.

As the hose reels are generally located next to an exit, in an emergency it is possible to reach a safe place by simply employing a floor mounted swivel house which lays the hose at floor level prior to the operation. In practice, for a single person, this makes withdrawal of the hose much easier than that of a traditional high-level guide.



Automatic fire sprinkler systems

A typical sprinkler system consists essentially of a piping network, connected to a permanent water supply and control valves feeding automatic sprinklers. They are spaced regularly throughout the protected premises, incorporating local and fire department service alarms. Converted heat from a fire causes operation of one or more thermally sensitive sprinklers, thereby permitting water to be discharged directly over the fire affected area.

This system can be designed to extinguish or control virtually any type of fire. Sprinkler protection involves the automatic discharge of water in density sufficient to control or extinguish a fire before it can build up. Four factors are involved in the effectiveness of a sprinkle system:

- The system design itself
- The building construction
- Special hazards of occupancy
- And the water supply

Records for more than five decades from cities throughout the world have showed that automatic sprinklers proved 96% effective, with 65% of alarms resulting in complete extinguishing and 32% in control until other equipment could be mobilised. The few failures were generally attributable to insufficient water supply or an inadvertently shut-off valve. However, to keep up these statistics, precautions must be taken to prevent unnecessary discharge of water as a result of mechanical injury, freezing, overheating or corrosion.

There are four major types of sprinkler systems in wide use:

1. In the ***wet pipe system***, water stands in the pipes at all times ready to discharge. Where the possibility of freezing exists, a dry-pipe system can be used where the pipes are filled with air under pressure. A valve holds the water back until the actuated sprinklers cause a loss of air pressure.
2. The ***pre-action system*** is a dry-pipe system with a smaller time lag between the tripping of the dry-pipe valve and the release of water from the sprinklers. A separate detector sends a preliminary warning signal to the valve, which opens to let the line fill with water. These systems are used primarily to protect properties such a computer rooms where there is a danger of serious water damage as a result of defective pipes or sprinkler operation.
3. ***Deluge systems*** have open sprinklers with the water held back by a central valve. Where fire is sensed by the detector system, a signal is sent to the central valve and water is released to all the sprinklers at once. Wetting down the entire floor is an advantage in extra-hazard occupancies, such as where flammable liquids are handled or stored and where there is a possibility that a flash fire may spread ahead of the operation of ordinary sprinklers. It can also be used in an area such as an aircraft hangar with a very high ceiling where air rafts may deflect the heat of a fire and confuse an individually activated sprinkler system.
4. ***On-off multi-cycle sprinkler systems*** are heat-actuated in both directions, turning on water to the sprinklers when fire strikes and off when the fire is under control. Detectors actuate the individual sprinklers as in conventional systems. The on-off cycle can be repeated in any number of times. The valves can be operated manually.

Variation in building contents and materials determine proper sprinkler spacing. Minimum spacing is normally two metres; closer spacing is sometimes used with baffles to keep an operating sprinkle from wetting an adjacent sprinkle. Sprinklers are positioned close to the ceiling if they are designed to operate fast, because hot gases rise quickly to the ceiling.

Where occupancy hazards are classed as light, effective protection can be anticipated from water supplies and sprinklers; most apartments, churches, hotels, public buildings, offices and schools are in this class. Occupancy hazards are classed as ordinary (kitchens, stores or manufacturing plants) or classed extra (oil, chemical or explosive plants) which may require increased protection.

Water supply:

Sprinkler systems can be supplied with water from one or more sources; street mains, gravity tanks, reservoirs, fire pumps, pressure tanks, rivers and lakes and wells. Both a primary and one or two secondary supplies must be considered. Major sources of sprinkler-water supply include direct connection to municipal mains; connection to mains through private water–supply systems, gravity tanks and fire department connections, designed to match fire department hose fittings. The minimum water flow for adequate sprinkler supply is about 1000 litres per minute for light hazard occupancy and up to six times as much for ordinary occupancy. Water pressure must suffice to overcome system-pressure losses. The discharge rate of a sprinkler is proportional to the pressure of the water at the sprinkler.

Sprinkler mechanism:

The discharge of water from an automatic sprinkler is restrained by a valve cap held tightly against the orifice by a system of levers and links anchored by a frame. The linkage is designed to give way at a certain temperature. There are three types of automatic sprinklers; soldered-link automatic sprinklers, frangible-bulb sprinklers and frangible-pallet sprinklers. Temperature ratings of all soldered-link sprinklers are stamped on the link; for other types, temperature rating is on one of the releasing parts. Ordinary temperature rating heads are used where room temperatures do not exceed 38°C, as in schools; hospitals, offices, hotels and apartments and if they are exposed to the direct rays of the sun. Intermediate ratings are used for ordinary occupancy in industrial and commercial properties. Higher ratings are specified in areas such as foundries and in areas where a fast developing high heat release fire could be anticipated.

Automatic fire detection and alarm systems

Alarm and signalling systems

A protective-signalling system is designed to:

1. Alert building occupants to permit prompt evacuation of the premises; to do this it must be distinctive and take precedence over all other signals. Fire drills are of critical importance in practising orderly evacuation.
2. Alarm the fire-fighting agency and signal the location of fire.
3. Monitor automatic extinguishing facilities and signal failures.
4. Monitor building functions and industrial processes and signal any dangerous phase, such as a boiler or furnace failure or a breakdown of electrical or air-conditioning equipment.

Signal systems may be classified as ***manual*** or ***automatic***. Local systems simply warn occupants of the protected area. These often have separate auxiliary systems to notify the public fire-force. The familiar fire-alarm box seen all over the world cities notify the local fire station by means of signals carried over wire lines. Remote station system may register alarm in an office or fire department located away from the premises.

Fire alarm boxes

Fire bell

Heat sensitive devices

Automatic fire-detecting systems employ a variety of detecting devices, of which the most common are simple thermostats set to a certain fixed temperature. In the UK and some European countries however, the unit is fitted with movable stops and can be adjusted to lower or higher temperatures. Bimetallic-strip types operate against a fixed contact; the distance the strip must travel to close against a contact determines the temperature ratings.

Rate-of-rise detectors usually combine two functioning elements, one trigger the alarm on a rapid rise in temperature, the other on a slow rise. The detectors combine a number of advantages: they usually operate faster than fixed-point devices, they can be used in high and low temperature areas, and they recycle rapidly and are quicker in delivering a continued service. There are two types of rate-of-rise detectors. Pneumatic-tube detectors use a tubing circuit filled with air. Pressure is built up in the detector diaphragm when heat reaches the tubing and causes the air inside to expand. When the temperature reaches the set point, the pressure expands the diaphragm to close the alarm circuit. Thermoelectric detectors have two sets of thermocouples (devices for measuring temperature that depend upon the electrical current produced when two different conducting metals are joined) mounted in a single housing. One set points outward the sense heat transferred by convection or radiation; the other set is shielded to sense only surrounding heat. When one of the set thermocouples gets hotter than the other, an electrical voltage difference is produced. When this difference becomes grate enough, a detector circuit signals the alarm.

Combined rate-of-rise and fixed-temperature detectors are being used increasingly because they have the advantages of both types. Other devices are pneumatic rate-of-rise devices and metal-expansion rate-of-rice actuating devices.

Smoke detectors

Smoke detectors are used where the materials stored are likely to create much smoke before generating enough heat to activate a heat detecting system. Some detectors are placed in heating and cooling ducts where a heat-sensing unit is set at a fixed temperature. Smoke

detectors are best located after an engineering survey determines the effects of air velocity, ventilating and air-conditioning facilities, and existing dust or vapours that could effect their operation. All detectors must be kept clean. On sensing smoke the detectors emit a loud, high-pitched alarm tone, usually warbling or intermittent and usually accompanied by flashing lights.

The ***photoelectric smoke detector*** measures the change in current caused by smoke as it partially obscures the transmission of a beam of light. An alarm is tripped when the density of the smoke reaches critical value.

The ***refraction smoke detector*** uses the principle that particles of smoke can reflect and scatter light. A small chamber open to the atmosphere contains a light source set an angle to a photoelectric cell. When smoke particles enter the chamber some of the light reaches into the cell. This light changes the electrical resistance of the photoelectric cell and a signal is given.

Other types are including a ***flame detector*** that is responsive to the changes of light intensity caused by the flickering of flames.

Single-station alarms:

Single–station alarm units are composed of a self-contained sensing element, power supply and sounding mechanism. The photoelectric (or optical) smoke detector type is powered either by house circuit or dry-cell batteries, as are the ionisation type home alarms. Most battery-powered smoke alarms can be easily installed by the homeowner or a maintenance contractor and do not require professional installation. Hard-wire smoke alarms however, will need to be installed by a licensed professional.

Smoke alarms should be installed according to their instructions. They are most effective when located on the ceiling, preferably away from walls and fittings. The best locations are in the hallway leading from bedrooms and in sleeping areas.

Since smoke alarms respond to airborne particles other than smoke, it is better not to install them in kitchens, bathrooms, laundries and garages. However, if a garage is a separate level a smoke alarm must be installed. If possible, avoid installation of smoke alarms in areas with strong drafts.

Spacing of sensing devices:

In most countries established fire testing laboratories and safety organisation recommend spacing for fire detection devices. Where there are smooth ceilings and large open areas in the building, sensing devices are spaced about 3 to 4.5 m apart. Devices are installed in all parts of building, including unused and service areas. Because it takes time for heat sensitive device and its signal-actuating part, the temperature of surrounding air in case of fire is higher than the operating temperature of the device itself. This is called thermal lag.

MINIMUM NUMBER OF SMOKE ALARMS FOR CLASS 1 TO CLASS 4 BUILDINGS		
Building Class	Type of dwelling	Number of smoke alarms
Class 1a (Houses, villas and relocatable homes, etc)	Single storey house where bedrooms grouped together Single storey house with separated sleeping areas Two storey dwelling containing bedrooms on first floor	1 2 1 on ground floor + 1 on first floor
Class 1b (Small boarding houses, guest houses, hostels, B&Bs etc)	All types under Class 1b Every storey containing bedrooms	1 on every storey 1 in each bedroom + 1 in the corridor or hallway
Class 2 (Apartments, units and flats)	Each home unit or apartment	1
Class 3 (Large boarding houses, guest houses, hostels, backpacker accommodation, residential parts of hostels, motels, schools, health care buildings, detention centres, certain accommodation for the aged, children and people with disabilities)	Every sole occupancy unit If the building does not have a functioning sprinkler system	1 Extra 1 smoke alarm at public corridor and other internal public space
Class 4 parts of building (Caretakers flats and shop-top housing)		Same regulations apply as for Class 1a building
Class 3 and Class 9a (Health care buildings)	All types of buildings	In each patient care area (bathrooms, ensuites and toilet areas excepted), each public corridor, any other internal public space associated with care area, like foyers and lobbies

Extinguishing systems as detectors

Automatic sprinklers can also be used for fire detection, signalling through a water-flow alarm switch. To overcome the possibility of a false alarm as a result of water system pressure fluctuations, a retarding device delays transmission of the alarm signal until the flow has persisted for some special time.

Skill Practice Exercise: 7771AP-SP-02

Open the industrial complex drawing underlay, (the same drawing as for skill practice exercise 1) and draw a separate sprinkler system layout for the office and for the production area. The industrial complex has a 10º steel roof structure consisting of steel portal frames that are braced each direction with tilt-up panel wall construction. The internal office area has a suspended ceiling, while the production and storage areas have no ceiling under the roof structure.

The drawing to be printed on an A2 sheet in not to scale so the layout fit the sheet size. Apply the following standard requirements to your sprinkler system layouts.

- Area of coverage: the maximum of floor are to be protected by an installation shall not exceed 5000 m².
- Sprinklers shall not be closer than 2 m.
- Where the roof has exposed common rafters, the distances from walls and partitions shall not exceed 1.5 m.
- Spacing of sprinklers is 4.6 m max. for light hazard, 4.2 m for ordinary hazard
- Distance between rows of sprinklers is 3.7 m for high hazard
- Spacing x distance = 21 m² for light hazard, 12 m² for ordinary hazard and 9 m² for high hazard
- Sprinkler deflectors shall be parallel to any slope of the ceiling or roof
- Spacing measurements are taken horizontally
- When fitted under a sloping surface which is grater than 1 in 3, a line of sprinklers shall be fitted at the apex
- Sprinklers shall be located not more than 300 mm below combustible ceilings or roofs
- Foe open joists and exposed common rafter construction, measurements shall be taken from the underside of joists or rafters
- Sprinklers shall be placed more than 600 mm from any face of columns
- The clear space below sprinklers is to be not less than 500 mm.

Distances from beams for standard sprinklers		
Min. horizontal distance from sprinkler to side of beam	Max. height of sprinkler deflector above bottom of beam	
	Conventional sprinklers	Spray sprinklers (upright and pendant)
100	-	17
200	17	40
400	34	100
600	51	200
800	68	300
1000	90	415
1200	135	460
1400	200	460
1600	265	460

LESSON 3 – Building construction and fire safety systems

Learning outcomes:
On completion of the session the participants will be able to:

- Identify basic building components such as walls, windows and doors
- Identify fire exists and egress systems

Building design

Building codes usually contain strict requirements aimed at fire prevention and safety. Every area of a building will have at least two separate exits, arrange to minimise the possibility of a fire blocking both of them. Often an open iron exterior stairway or an interior stairway enclosed in fire-resistant construction is provided from roof to street.

Any fire, especially one involving explosion or structural collapse, may cause panic and can be a major cause of loss of life. Construction plans should consider all such potential circumstances. Exit stairs, for example, must be separated from the building interior by heavy, metal, self-closing and self-latching fire doors rated by established fire-testing laboratories to resist fire of a specified number of hours. Plans also must include alarm systems, exit signs, safeguards in hazard areas such as storerooms in which highly flammable or explosive materials are stored and interior surface materials and contents that inhibit rapid spread of flames. Glass with wire embedded in it may be used in exterior windows to prevent fires from spreading to or from adjoining structures and in fire doors to allow users to see through them.

Fire-retardant paints, which have good heat-insulating qualities, have been developed for application over combustible surfaces. Such coatings often applied in older structures to help to smother small fires and slow the progress of large blazes long enough for the building to evacuate and for fire fighters to control the fire. Regulations existing in practically all countries require that fabrics used in theatres and other buildings where large numbers of people congregate must be either incombustible (as glass fibre) or treated to reduce combustibility. A significant problem common to such treatments is that many impregnating chemicals are water-soluble. Each time the fabric is washed, the treatment must be repeated. Another material used to reduce possibility of spreading fire is fire-retardant lumber, produced by impregnating wood with fire-retardant chemicals such as ammonium bromide, borax, boric acid, phosphates and sodium salts (that are water soluble), under high pressure.

Fire-safe construction

A broad range of structures can totally withstand fires of specified intensity and duration. Although the structures are relatively safe, inevitable some combustible materials used in interior furnishing, ceilings, or trim can contribute fuel to fire. For this reason, sprinkler systems were developed.

Several types of construction are considered basically fire-resistant. Heavy timber construction, with masonry walls, timber columns and beams, heavy plank floors are not

immune to fire, but the mass of wooden members slows the burning. The char that forms on wooden surfaces insulates the wood within. Exposed steel construction with masonry or metal panel walls is commonly termed as non-combustible. But under moderate fire exposure, the steel may warp, buckle and collapse; therefore sprinkler systems are required except where occupancy is low hazard.

Protected ordinary construction has floor and roof construction of on-hour fire resistance rating. All openings through floors, including stairways are enclosed by partitions with one-hour rating. This is the minimum requirement in most places. In brick veneer construction the internal wall frames, floors and roofs are wood, but exterior walls are brick or other fire-resistant material. This construction can be made reasonably safe for light hazard if enough exits are provided, and combustible interiors are minimised. Sprinkler protection however greatly improves safety.

Fire defence

There are two types of fire defence: active and passive. ***Active fire defence*** includes fighting fire with hoses, early warning alarms and automatic sprinklers. ***Passive fire defence*** involves designing buildings so that fire cannot spread easily, with fireproof fittings, as well as fire escapes. Most cities have building codes that require at least two good exists from a building. Exits must be distinctly marked. An enclosed staircase will prevent a fire from moving quickly from floor to floor. It also provides a safer exit. Specially built firewalls and fire doors also keep a fire from spreading. Most laws require such protection in places where there are large numbers of people. These include hospitals, theatres, business and industrial plans. Each building should have plans for getting people out of the building if fire takes place. Time is the key factor in dealing with fire. If there is no detection system, the fire will spread before the alarm can be raised. These days, public buildings, offices, hotels, stores and especially high-risk places such as air terminals, oil rigs and chemical plants all need the most up-to-date sprinkler systems, which both foam and water.

Fire engines and other motorised equipment

In practically all-modern communities the basic fire-fighting vehicle is the fire engine, a gasoline or diesel engine truck that carries hose, water tanks, pumps, ladders and portable tools. Moat cities keep extra equipment available for emergencies and as a reserve when first-line equipment is undergoing repair or service.

Apparatus carrying pump trucks have pump capacities of up to 8000 litres per minute for high hazard and industrial service. Most trucks carry a water tank for supplying water before hydrants or suction sources can be brought into use.

Ladder and rescue trucks are equipped with ladders, forcible-entry tools, generators, lights and rescue equipment. About one-third of the labour at a fire is in truck and rescue work. Aerial ladder units and elevating platform trucks usually employed for this service. Their power-operated equipment reaches higher than manual ladders and can provide effective water tower service. Besides aerial ladders, manually raised ladders, often aluminium is also carried. A common arrangement is a booster pump, water tank and small hose on an aerial ladder truck.

Fire trucks with hydraulically operated elevating platform apparatuses; sometimes-called snorkels have become standard equipment in many cities. These booms vary from 15 to 27 metres maximum elevation. Equipped with a standpipe, they can throw a 3200 litres per minute stream through one or more nozzles on the basket at the maximum elevation.

Piping

Pipeline is a tube that is carrying liquid or gas products from one place to another. Usually pipelines are made of steel, cast iron, copper, PVC or reinforced concrete. However, those that carry products under high pressure are always made of steel in order to protect against explosions or breakage and pipe range in size will depend on their use. Fire services mains are made from cast iron and are usually painted with red paint.

Piping in all systems including piping in wet systems should be arranged to drain to the installation drain valve which should be not less than DN 50 in diameter for Ordinary and High Hazard systems and not less than DN 40 in diameter for Light Hazard systems. Range piping shall have a slope of not less than 4mm in 1m and distribution piping have a slope of not less than 2mm in 1m.

Valves

To control a flow of fluids, that is liquids and gases, valves are used. Shut-off valves are used for to isolate equipment and they can be also partially or fully opened. Common shut-off type valves are gate, plug and ball valves. The plug type of valve is suitable only for low pressures. For higher pressures a *gate valve* is used because they can control large flows of liquid. The valve slides across the pipe, and when open allows an uninterrupted flow. The ***non-return valves*** are used where fluid must flow in one direction only. The valve is forced open by the pressure of the fluid. If that pressure becomes less; the backward pressure from beyond the valve closes the valve against its seating, preventing the return flow. ***Reducing valves*** are used to lower the pressure of a fluid. Valves of this kind are fitted to the oxygen cylinders to reduce the high pressure of the gas inside the cylinder to the lower value, but they may also be used to reduce the pressure of the mains water supply.
Water supplies to each sprinkler installation shall pass through a main ***stop valve***. Before passing through the main stop valves, water supplies shall be combined. The main stop valve shall be secured open by a padlocked or riveted strap and shall be adequately protected form the effect of frost. Provision should be also made for closure of the main stop valve to give a visible and audible alarm at a place under constant surveillance. In the elevated private reservoirs and gravity tanks the stop valve shall be fixed close to the non-return valve and on the reservoir of tank side. A location plate should be fixed on the outside of an external wall, as near to the main stop valve as possible, bearing the following words in clear permanent lettering:

SPRINKLER STOP VALVE INSIDE

Note: The words should be in letter at least 35 mm high and the words painted white on a black background.

Gate valve

Ball valve

Where there is more than one water supply to an installation, a ***non-return valve*** should be fitted in each water supply pipe and a test cock provided between the non-return valve and the supply control valve in accordance with the water supply authority. The non-return valve on the supply pipe shall be not less than 5m below the base of the reservoir tank, where an elevated private reservoir or gravity tank forms one of the water supplies.

Alarm valves (wet) to be fixed on the main supply pipe immediately above the main stop valve and before any connection is taken off to supply any part of the installation.

Alarm valves (dry) to be fixed on the main supply pipe immediately above the main stop valve in installations on the alternate wet and dry system. It should not employ a composite alarm valve and be installed before any connection is taken off to supply any part of the installation. Dry systems are maintained permanently under air pressure, the water motor alarm to be connected to the atmospheric chamber or the alarm motor auxiliary valve of the alarm valves (dry).

Deluge valves are used to control the water to any array of open sprinklers or sprayers, which are required to discharge simultaneously. The valve, normally held closed, is released automatically either by the loss of air pressure from independent piping carrying sprinklers acting as heat detectors, or by the operation of heat or smoke detection system.

Pre-action valves are used for following purposes:

- To control the water supply to a dry sprinkler installation to prevent discharge from piping or sprinklers which have suffered mechanical damage.
- To admit water to the piping of a dry installation prior to the operation of a sprinkler or sprinklers. The valve should be a standard alarm valve (dry), which may be fitted with an accelerator. The heat or smoke detection system is arranged to trip the valve in a similar manner to the operation of an exhauster.

For the purpose of the commissioning and periodic testing, a remote ***test valve*** is to be provided on each installation. The remote test valve piping should not to be less than 25mm nominal diameter and shall be taken from the end of a range pipe in the most remote group of sprinklers on the installation. The remote test valve shall be readily accessible, locked shut, and to be labelled as follows: "Sprinkler remote test valve – to be locked shut".

Skill Practice Exercise: 7771AP-SP-03

Open the industrial complex drawing underlay, (the same drawing as for skill practice exercise 1 & 2) and add two sprinkle system support details, one applicable for the production area and one for the office area. The production area does not have a ceiling therefore the sprinkler head pipes are attached with pipe clamps to 100x100x6 EA steel support that spans between the steel roof structure rafters. In the office area a suspended ceiling is attached to 200x50mm timber joists spanning over the load bearing walls. The vertical pipes of the sprinkler system are attached to the side of the joists and the horizontal range pipes are placed on the top of the ceiling joists.

All main pipes of the sprinkler system are to be 100mm of diameter and all range pipes are to be 50mm of diameter. (Range pipes are the pipes that connect the sprinkle heads). The main pipes are running both sides of the building and they connect to a sprinkler control assembly box. The sprinkler control assembly contain a sprinkler isolating valve and a drain with a stop valve. The sprinkler control box is then connected to a pipe that has a water meters and a stop valve. This main pipe then connects through fire main isolating valves to a fire hydrant, to the town fire main or to a fire brigade booster connection.

Place the typical details on the drawing and print it on an A2 sheet with a monochrome setting. (The drawing scale of the sprinkle system layout is 1:100 and the details to be printed to scale 1:5).

Notes to be placed on a sprinkle system layout & detail drawing:
The drawing shall be read in conjunction with all architectural, structural and other consultants' drawings and specifications and with such other written instructions as may be issued during the course of contract.
Dimensions shall not be obtained by scaling the sprinkler system layout drawings.
All workmanship and materials shall be in accordance with the requirements of the SAA Codes and BY-Laws and Ordinance of the relevant Building Authority all Codes shall be current editions.
The sprinkler system is to be installed and supported according to the relevant sections of the Australian Standard AS 2118.4 – Design and installation requirements & AS 2118.9 - Support of sprinkler piping
Substitution of any materials or layout change is to be made only with the approval of the sprinkler system design engineer.

LESSON 4 – Representation of system drawings & Revision

Learning outcomes:
On completion of the session the participants will be able to:

- Identify line types, parts of layout and symbols of system drawings
- Identify the types of various system drawings
- Prepare an orthogonal representation at least of two types of system drawing

Working drawings

Prior to commencing installation of orthogonal system drawings, the installation shall obtain the necessary approvals from the regulatory authorities and lodge certified drawings. Any variation from approved drawings will require additional approval.

Approval requirements

Completed working drawings of each floor to a suitable scale (typically 1:100) shall be prepared and submitted with the following information:

- Name of owner and occupant
- Address and location of premises
- North point of compass
- A key to all symbols used
- Location and size of concealed spaces, attics and other enclosures
- Occupancy, size and construction of enclosures not provided with sprinkle protection
- Type and class of fire protection, or detection, provided in all areas not sprinkled under the standard of AS 2118.4 – 1995
- Construction of walls, ceilings, floor s and partitions
- Full height cross section to show elevation of known water supply and highest point of the installation
- Types, K factor, model and temperature rating of sprinklers and manufacturer's installation data sheets
- Water supply details, including water authority water main performance data, tank capacity and elevation, and pump ratings
- Location of nearest external hydrant and where fitted, booster connection.
- Location and details of aural alarms
- Location and type of valves, ain pipes, and test connections
- Summary of hydraulic calculations, including relevant distribution pipework and reference and design points
- Type and nominal size of pipes, joints and fittings
- A schedule of the number of sprinklers on each installation and the area protected
- Location and details of underground pipework including nominal size, tapping, metres, valves and depth
- An undertaking system has been designed and will be installed in accordance with the Australian Standard AS 2118.4 – 1995

- Name and address of designer and installer

The installer shall also perform the following acceptance tests prior to issuing the completion certificate:

- All underground mains and lead-in connections to risers shall be fully flushed before connection made to the sprinklers piping
- Hydrostatic pressure tests shall be carried out at 1500 kPa for a period of not less than 30 minutes
- Prove the operation of the water supply and pump if fitted.

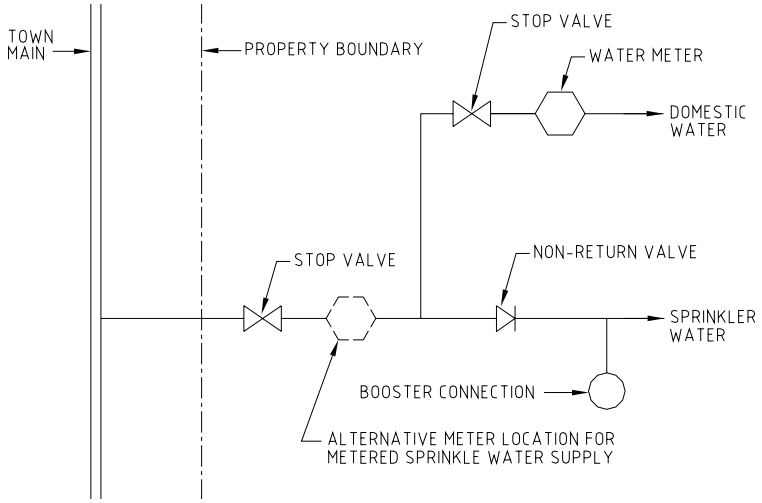
Once the acceptance test is completed, the installer shall provide the building owner with the certificate from an independent authorised inspector certifying that the work has been completed in accordance with the relevant Australian Standards.

Water supply

Every automatic sprinkler system shall have at least one automatic water supply such as town main or private reservoir. Where a combined domestic/sprinkler tapping arrangement is utilised for connection to town mains, it has to comply with the requirements of the local water authority. A non-return valve approved by the water supply authority is required at the property boundary at the brunch take-off to the sprinkler system. The common water supply tapping size is determined by adding the domestic demand to the sprinkler demand. The domestic demand used shall not be less than 43% of the "Probable Simultaneous Demand for Multiple Dwellings" specified in AS 3500.1. This demand can be estimated using the following equation:

$$Q = (0.03n + 0.4554n^{½}) \times 0.43 \times 60$$

Q = Flow rate (L/min)
n = number of sole occupancy units



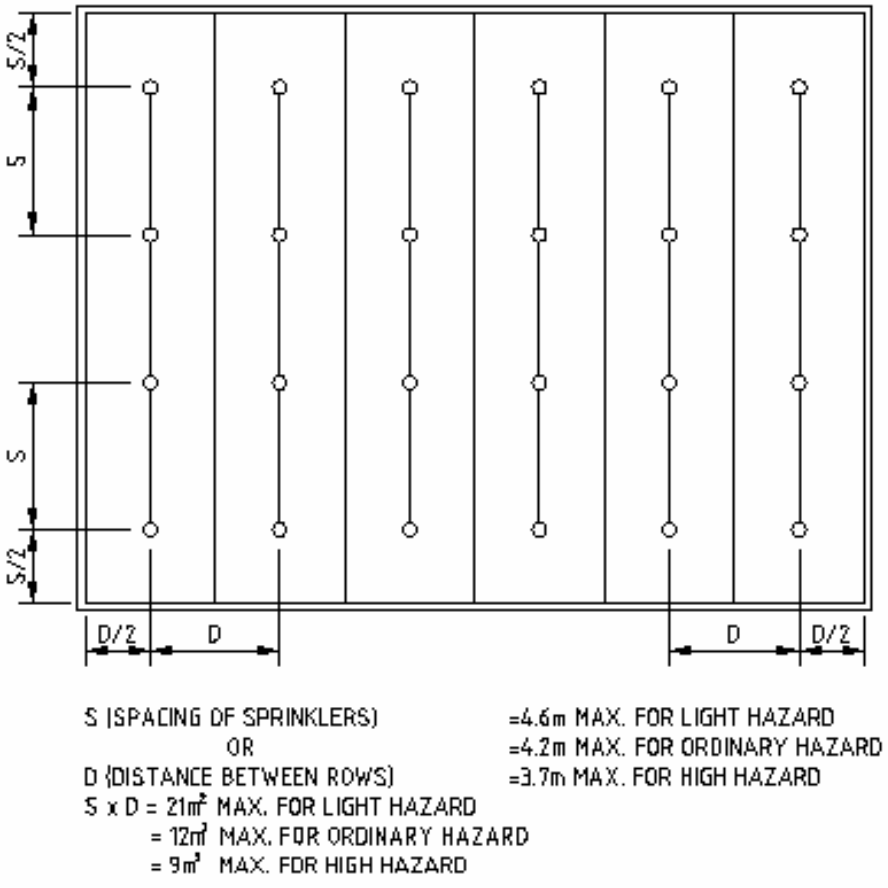
WATER MAIN TYPICAL TAPPING AND VALVE ARRANGEMENT

Types of orthogonal system drawings:

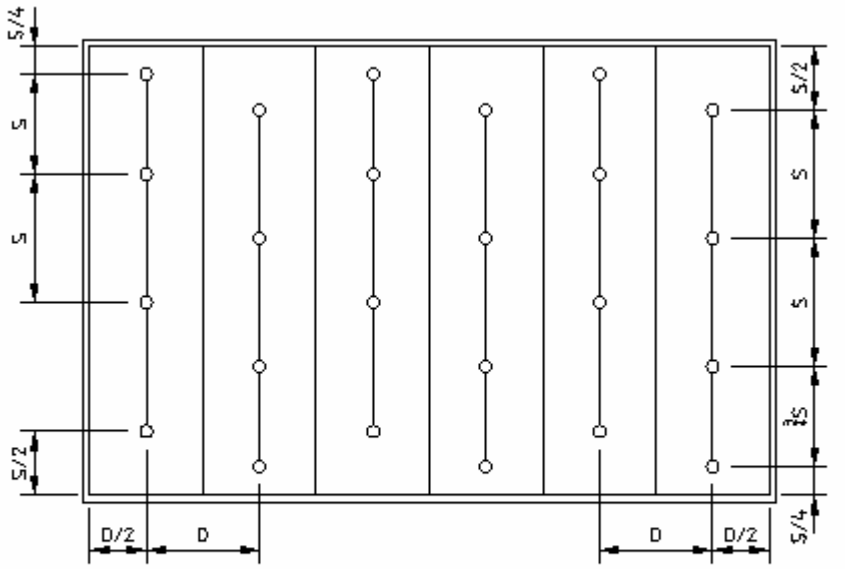
- Sprinkler head layout
- Pipe layout & size
- Smoke detection layout
- Heat detection layout

Sprinkler head layout drawings

The orthogonal sprinkler system drawing is representing the location of the sprinklers, range and distribution pipes within the building. The layout also includes the connection to the town main through the sprinkler control box, its location and its content. The drawing has to include the sprinkler system type; all pipe sizes, type of sprinkler heads used in the design, valve type locations and their catalogue number. The layout should include the sprinkler head set-out distance at each direction and the distance from all major structural elements such as columns and walls. The system drawing shall include a typical detail for each type of relevant sprinkler system support and general notes in reference to the sprinkler system installation and design. If the building is a multi storey building and contains fire stairs, the sprinkler control assemblies will be located within that stair. The sprinkler head layout can be staggered or standard spacing.



Standard Spacing Sprinkler Layout



Staggered Spacing Sprinkler Layout

Sprinkler system pipe layout drawings

Whether the pipe layout of a sprinkler system is prepared as an orthogonal drawing or as an isometric drawing will depend on the knowledge that all sprinkler heads are to be installed in the same level under a roof structure or a ceiling. If the sprinkler system is attached to a ceiling, only orthogonal piping layout will be required because the vertical pipes attached to the sprinkler heads will be all of the same length. However, if the sprinkler system is attached to an open roof structure, an additional isometric view of the pipe layout will be required, because the length of the vertical pipes will vary based on the roof pitch and the structural elements of the roof. The isometric view of the pipe layout will represent the changes of the sprinkler heads' vertical pipe length, which will be necessary for the calculation of the overall material usage in the pipe schedule.

Smoke and heat detection layout drawings

A smoke and a heat detection layout drawing will be prepared for a specific type of building or a specific area of a building. This layout can be a part of the sprinkler head layout drawing but it has to contain information about the types and location of a smoke or a heat detection device. Some sprinkler systems are trigged by heat sensitive devices such as rate-of-rise detectors or combined rate-or rise and fixed-temperature detectors. These drawings are very specific and the representation of these layouts will vary and will be based on company standards that are based on relevant Australian Drawing Standard requirements.

Revision Questions: 7771AP-RQ-01

1. Give brief description for the following terminology applicable to fire protection services:

   - Combustible materials
   - Fire hose reels
   - Fire alarm
   - Booster pump

2. Name three of the Australian Standards in reference to Fire Protection Services

3. List three reasons why fire protection is undertaken

4. Name the type of materials in reference with the four classes of fires:

   Class A

   Class B

   Class C

   Class D

5. List four of the most commonly used fire protection equipments

6. Fill the extinguisher types next to the materials listed below to extinguish a particular fire

   - Metal, solvent or electrical fires …….
   - Paper, wood and cloth fires…….
   - Oil, paint, wood and cloth fires……...

7. Name six of the most commonly used fire extinguishing agents:

8. List the four major types of sprinkler systems:

9. Describe in your own words what the protective-signalling system is designed for:

10. Name all heat sensitive devices used for fire protection

11. List three types of smoke detectors:

12. What is the minimum number of smoke alarms required for each Class 2 buildings?

13. Describe the function of two types of valves of your choice used in fire protection systems

14. List ten of the twenty approval requirements in lieu of fire protection working drawings:

-
-
-
-
-
-
-
-
-
-
-
-
-
-

15. Name the four types of orthogonal drawing systems:

LESSON 5 – Assessment 1 (Theory) & Sprinkler piping supports

Learning outcomes:
On completion of the session the participants will be able to:

- Identify various types of sprinkler piping supports
- List necessary steps to achieve corrosion protection
- Recall the spacing of supports and identify the right location for the supports

Sprinkler piping supports

When a pipe support system is designed for a sprinkler system, the location of the pipe supports has to be considered. For domestic sprinkler system installation the requirements shall comply with AS 3500.1 and for all other sprinkler system installation pipe supports shall be designed in accordance with AS 1538 or an equivalent Standard to support twice the load due to water-filled piping plus a load of 115 kg at each point of support.

The typical pipe support components are:

- Hook bolts
- U-bolts clamping down
- U-bolts clamping up and rods
- U-hangers (clips)
- Cantilever type supports, saddle brackets, girder or beam clamps
- Pipe bands (for non-corrosive and for corrosive atmosphere)
- Pipe support beams (Trapeze bar, using mild steel angles)

Fixing of pipe supports

Sprinkler systems may be supported from the building structure provided the structure is capable of supporting the load. Where sprinklers are located below ducts, the piping may be supported from the duct support, provided that these have sufficient strength to support the combined design load.

Fixing to concrete, brick or masonry

Explosive powered fasteners, through-bolts, expanding metal fasteners, or bolts or screws set in concrete may be used in this type of construction for fixing pipe support. Wooden or plastic plugs shall not be used for fixing pipe supports to concrete, brick or masonry.

Fixing to timber

Acceptable methods of fixing to timber are wood screws, drive screws, coach screws and coach bolts. Nails should not be used for fixing pipe supports to timber. The following requirements are used for fixing to timber:

- Wood screws shall not be hammer driven
- Drive screws not to be used for securing upwards
- Wood screws or drive screws not to be used for fixing piping exceeding 50 mm nominal diameter
- The fixing shall be capable of supporting the design load of 115 kg at each point of support
- For coach bolts and coach screws minimum length based on the nominal pipe size refer to AS 2118.9

Fixing to steel

Explosive –powered fasteners may be used for fixing pipe supports to steel provided that the steel is not less than 5 mm thick. This fixing shall be capable of supporting the design load of 155 kg at each pipe support.

Spacing of supports

The distance between supports for horizontal and vertical sprinkler piping shall be in accordance with the following table:

MAXIMUM SPACING OF PIPE SUPPORTS				
Nominal pipe size (DN)	Maximum spacing of brackets and clips, m			
	Copper & light wall steel	Galvanised steel and ductile iron	Plastic	
			Horizontal	Vertical
20 22 25	1.50 - 2.00	4.00 - 4.00	0.70 0.70 0.75	1.40 1.40 1.50
32 40 50	2.50 2.50 3.00	5.00 5.00 5.00	.85 0.90 1.05	1.70 1.80 2.10
63 65 75	- 3.00 -	- 5.00 -	1.10 1.20 1.30	2.20 2.40 2.60
80 90 100	4.00 4.00 4.00	5.00 5.00 5.00	1.35 1.40 1/50	2.70 2.80 3.00
110 125 140 ≥150	- 4.00 - 4.00	- 6.00 - 6.00	1.50 1.70 1.70 2.00	3.00 3.40 3.40 4.00

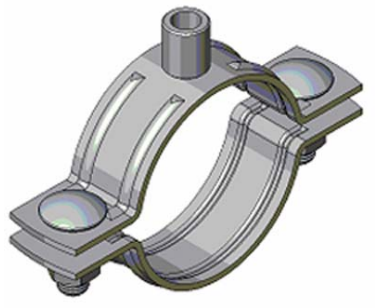
Location of supports

Pipe supports shall be located so they do not obstruct the distribution of water from any sprinkle head. A support shall be located not further than 1m from any change of direction in the piping, like bend or elbow.

Range pipes exceeding 500 mm in length shall have at least one support. The first support on any range pipe shall be not more than 2 m from the distribution pipe or riser (drop). The distance from the last support to the end of a range pipe shall not exceed the following:
For pipes ≤ 25 mm nominal diameter ……1 m
For pipes > 25 mm nominal diameter…….1.5 m

Distribution pipes shall not be more than 2 m from the connection to the main distribution pipes. The distance from the last support to the end of any distribution pipe shall not exceed 1m. ***Main distribution pipes*** distance from any the last support to the end of any horizontal main distribution pipe shall not exceed 1 m.

Main vertical rising or dropping pipes shall be supported directly from the structure or any supports on horizontal branch piping from the riser not more than 300 mm from the riser.



Pipe clamp

Pear hanger

Saddle clamp

Twist clip

Swivel cage

U-bolt

LESSON 6 – Isometric sprinkler system drawings

Learning outcomes:
On completion of the session the participants will be able to:

- Identify various types of isometric sprinkler system drawing set-ups
- Prepare an isometric sprinkler system layout with a pipe schedule

Isometric sprinkler system drawings are prepared on the bases of an orthogonal sprinkler system drawing layout. Isometric sprinkler system drawings are prepared mostly for industrial buildings, because they have suspended ceiling only above some areas of the building, such as office or storage areas. Because most industrial buildings are usually constructed from steel portal frames and their roof pitch will vary from 2º to 15°, the sprinkler head vertical pipe system length will vary. If the roof pitch is less than 10°, only orthogonal sprinkler system drawing will be necessary to prepare. If the roof pitch however is equal or larger then 10°, an isometric drawing is to be completed for the project.

The sprinkler system installed in any industrial building will consist of vertical pipes that connect the sprinkler heads to the range pipes of a sprinkler system. The range pipes then are connected to the main pipe or pipes of a sprinkler system. These pipes will then connect the system through a sprinkler control assembly to the water main. The sprinkler heads are to be installed at a same level under the roof structure, (at the minimum distance of 300mm), but the vertical pipe length in the area where the roof is exposed, will vary depending on the roof pitch. To be able to calculate accurately the total vertical pipe length under a sloping roof it is necessary to prepare an isometric sprinkler system drawing.

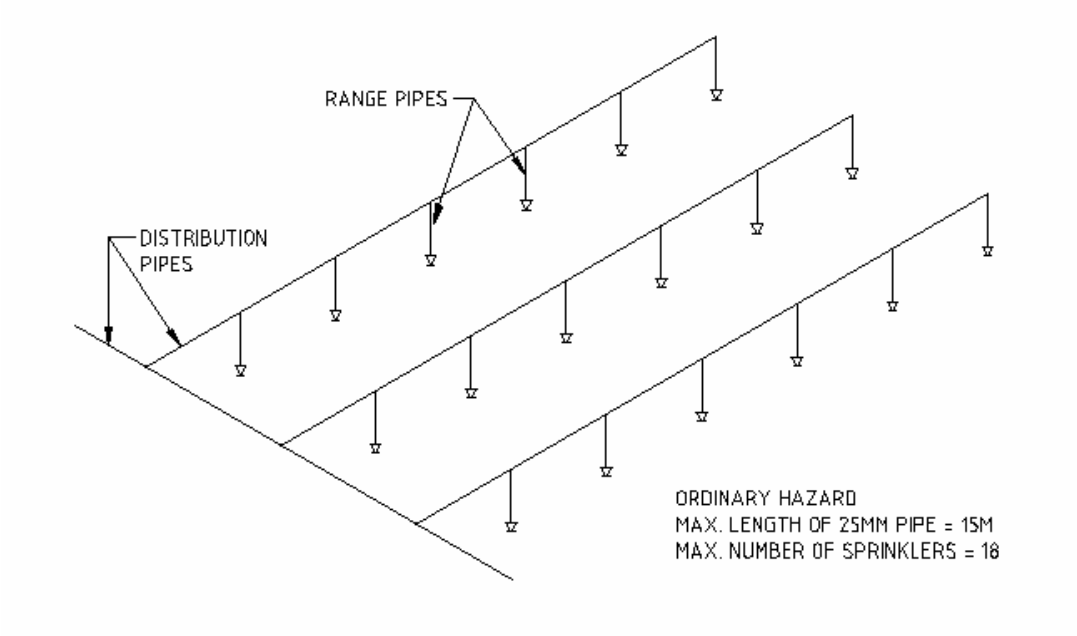
All isometric drawings should contain an isometric view of a sprinkler system, a key diagram and a pipe schedule. The key diagram shows a front view of the sloping roof structure and the true vertical pipe length. All vertical pipes to be tagged and incorporated in the pipe schedule. The pipe schedule has to include the total length of each type of pipe calculated separately for each area if it is applicable. The drawing shall also include the type of valves used in the project, tagged with the valve catalogue number and listed in the parts schedule of the drawing.

Skill Practice Exercise: 7771AP-SP-06

Draw an isometric piping layout of a sprinkler system based on the industrial complex drawing that was an underlay for the previous lessons' exercises. The isometric layout will be a line diagram that includes all vertical and horizontal pipes, (internal and external) for the production area. (The drawing should include the building outline only and the roof structure shape.) The pipe layout drawing has to represent the designed pipe size by using correct lineweights, attached to the pipes drawing layer. All types of valves should be drawn with a correct symbol and should be numbered so their catalogue number can be included in the parts schedule on this drawing. The drawing should include a pipe schedule and the length of each pipe type to determine the total pipe material usage for the project. The length of the pipes should be calculated in metres (include the length of the pipes for the office area as well, based on the fact that the vertical pipes to each sprinkler head are 300mm long. However, the pipe length for the office and the production areas should be calculated separately). The pipe diameters used for the sprinkler system are:

Main pipes of the sprinkler system within the building: Ø100mm
Range pipes of the sprinkler system: Ø50mm
Vertical range pipes: Ø32mm
Main pipes connected to the town water main: Ø150mm

The final drawing should contain an isometric view, a key diagram showing the various length pipes numbered and a pipe schedule with the total pipe length for each type of pipe. The drawing is to be printed on an A2 sheet with a monochrome setting. The drawing scale of the isometric sprinkler system pipe layout is 1:200.



Isometric Piping Interpretation
(For drops greater than 300 mm)

LESSON 7 – Fire doors

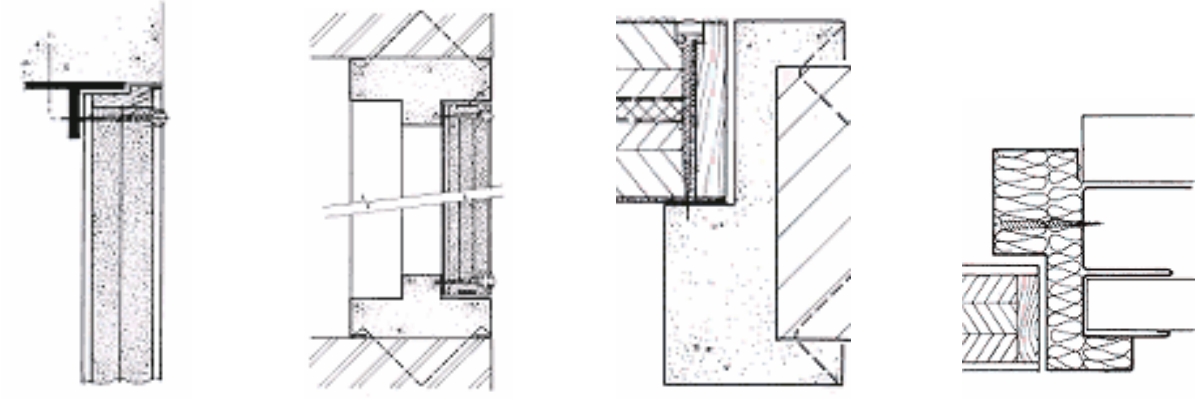
Learning outcomes:
On completion of the session the participants will be able to:

- Identify various types of fire doors & windows
- Nominate heat ratings of fire doors & windows
- Recognise and able to explain fire rating settings

Fire door, fire window and fire wall heat ratings

Fire doors, windows and fire walls provide protection against fire. Their fire ratings are of resistance levels of -/60/30, -/60/60, -/90/90, and -/120/120 will meet any requirement of the Building Code of Australia. All fire windows and doors are supplied as a certified system consisting of glass and frame, and are classified according to their ***fire resistance level*** as required by the Australian Standards and the Building Code of Australia. Fire resistance levels are a series of numbers that describes the ability of a certified product to resist the spread of fire.

For example a typical fire rated wall may have a fire resistance level of 120/120/120, and the typical insulated fire window may have a fire resistance level of -/120/120. The first number simply refers to how long the product can withstand the spread of fire and still support what is designed to support, and it refers to a ***structural adequacy***. Doors and windows are not structural items, and therefore are not tested for this aspect of fire resistance. The first number for doors and windows is generally is represented with a "-". The second number refers to the ability to keep the spread of flames back and therefore to the material ***integrity***. There are particular requirements under the Australian Standards as to the pass and fail criteria. The final number refers to the length of time that the product can prevent the spread of fire due to heat transfer, so it refers to ***insulation***. Special requirements include the ability to prevent a localised temperature increase on more than 180 degrees C, or an average temperature increase of 140 degrees C for the duration of the test.



1 hour 2 hours 3 hours 4 hours

Fire rated panel door cross sections

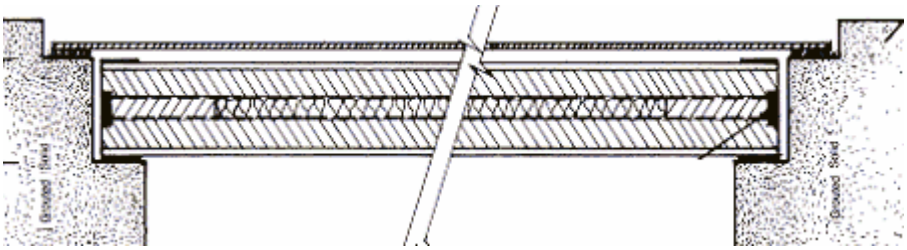
Usage of fire rated doors:

1 hour fire rating:
These doors are used as a removable panel on duct or access openings for service inspections. They are available in a concealed type steel frame or pressed Zincanneal steel frames of selected profile. Panels are 38mm or 48mm thick with optional facings of plywood, MDF, laminate or clad steel. Heat activated expanding seals for 'hot' smoke protections are also available.

2 hours fire rating:
Designed to protect duct or access openings from spread of smoke and hot gases and fire, these panels provide ready access by simply removing screw fixings.

3 & 4 hours fire rating:
These fire-rated doors are used for fire protection in high fire-risk openings.

Fire rated floor hatches are specially designed for motor room and plant room hatches. They are designed for 4 hour fire rating. These units (which incorporate a checker p-late steel cover plate) are manufactured to size including the special profile, four side pressed Zincanneal steel frame suitable for casting into concrete floors. The fire resistant panels are faced with non-combustible sheet material and have anodised aluminium channel edges to provide a robust lightweight floor hatch. The fixing is optional as screws, masonry anchors or hinged, with recessed finger grips provided. Finger holes provided in the checker plate steel cover for ease of removal. Pair hatches are also available with removable support pillion.



4 hour fire rated floor hatch

Fire door and fire window types

Fire door and window frames are made from steel or timber. All insulated fire rated glazed doors and windows utilise *Pilkington Pyrostop* insulated fire glass in a variety of thicknesses, all of which are tested to AS 2208 for impact resistance, and provide excellent acoustic performance. This glass is perfectly clear glass with the same light transmission as 5mm float glass and it has a fire rating from 1 hour to 4 hours.

Fire rated doors are available in a variety of profiles and ratings. Timber glass doors are available as single doors, up to maximum size of 2200mm x 1100mm, while the steel glass doors are available as per assemblies, up to an overall penetration size of 2400mm high x 2200mm wide, and a fire rating of -/60/30.

Insulated Fire Rated Doors

Double acting fire doors utilise the latest Pyropanel fire resistant door core and design technology. These doors are fully tested and certified to AS 1530.4 and AS 1905.1, and have the benefit of a double action swinging mechanism. They are ideal for a heavy traffic area where two ways swing is an important function and where fire resistance up to 2 hours is is required. Typical installations include hospitals, public buildings, corridors, nursing homes and schools.

All insulated windows use steel framing and are available for internal and external applications. There are a variety of profiles designed to suit most glazing applications and classifications under the Building code of Australia. These insulated steel glass systems are available in either steel frames suitable for powder coating or painting, or high grade Stainless Steel frames, and are available as single or multi-lite assemblies up to a maximum panel size of 2700mm x 1800mm.

Frame types, both pressed metal and RHS tube frames are capable of providing a 4 hours fire rating while the general method of fixing is with anchors. The fixed glazing system incorporating 13mm part-insulating glass that is capable of providing a rating of -/60/- in all wall types (external and internal applications).

Fire rated doors design guidelines

Fire doors provided are to satisfy the requirements of BCA and to be finished as described below. The use of fire doors in lieu of standard doors to provide access to and from spaces which experience high level of traffic, shall be avoided wherever is possible, however if this cannot be avoided than doors shall be held open by magnetic hold-open devices interlinked with the fire alarm system, and mounted at 1800mm above finished floor level near the leading edge of the floor. Where fitted to external doors, electro-magnetic hold-open devices will be linked to the EAC system for time controlled lock down of the building.

All doors in the external building façade other than entry doors, such as to plant rooms, service ducts, fire egresses etc. are to be aluminium framed with aluminium faced plywood or aluminium louver infill panels as appropriate for the application. All aluminium doors shall have an anodised finish. Timber doors not to be used unless they are fully protected from the weather by building overhangs. Any timber door shall be solid core with marine plywood facing both sides, edge stripped all round with hardwood. Glue used in timber doors shall be Type A bond “waterproof” glue, ***not*** “water resistant” glue. Timber doors shall be finished with an approved full gloss enamel paint system.

LESSON 8 – Fire stairs

Learning outcomes:
On completion of the session the participants will be able to:

- Identify various types of fire stairs and their settings
- Nominate parts of fire stair setups

Fire stairs

Fire stairs are designed to minimise the danger of falling, as one person falling on a stairway may result in a complete blocking of an exit. Stairs must be wide enough so that two people can descend side by side even though an aged person may slow the travel on one side. There should be no decrease in width along the path of travel.

Steep stairs are dangerous, so treads must be wide enough to give good footing. Stairs should be designed that individual stair flights are not excessively long and good railing at a centre of the flight should provide a safer use of the stairs.

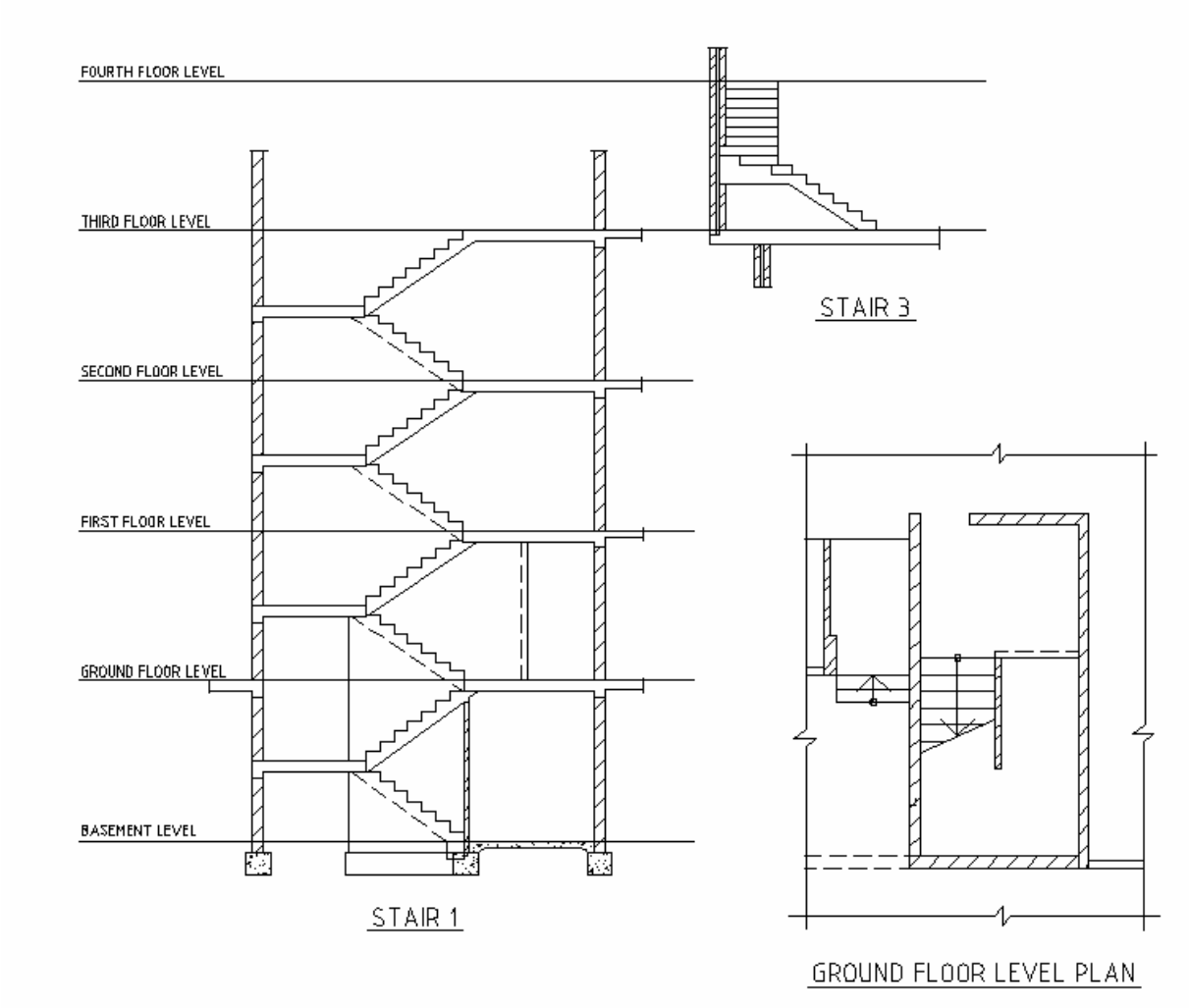
Construction details of stair enclosures involve the principles of limitation of fire spread. Doors on openings from each story are essential to prevent the stairway serving as a flue. Stairway enclosures should in general include not only the stairs, but also the path of travel from the bottom of the stairs to the street, so the people are protected all the way out of the building.

Fire escape stairs

Fire escape stairs should be stairs not ladders; however the same design principles apply for these escape stairs as for the fire stairs although the requirements for width, pitch and other dimensions are less strict. The principal use of fire escape stairs is to provide a safer escape route where additional standard stairs cannot be provided. These stairs are ideally extended to the street or ground level. When permanent stairs would obstruct sidewalks, swinging stair sections are designed to swing down with the weight of the person, and may be used for the lowest flight of the fire escape stair. The fire escape stair design should provide suitable railing security needed for safety. Fire escapes must be well anchored to building walls and kept painted to prevent rust. The best location for fire escapes is on exterior masonry walls without exposing windows with access to fire escape balconies by exterior type fire doors.

Skill Practice Exercise: 7771AP-SP-08

Draw a fire hydrant and a sprinkle control assembly for each level of a four storey residential unit staircase in plan and in sectional view. The staircase key diagram is provided on the network drive with a typical stair layout. Based on the sketches given as examples, prepare a drawing on an A2 drawing sheet that will include a staircase sectional view in scale of 1:50, and the staircase layouts at level where the layout changes, in scale of 1:100. The sprinkle diagram is to be prepared for a typical return stair. The lineweight of the layouts and the sections is 0.09mm (use Layer 9 - grey colour); set the pipe lineweight to 0.35mm on the sectional and the plan views. The plans and the section should include annotations similar to the assemblies on the provided sketches.



LESSON 9 – Assessment 2

Drawing Symbol Tables

SYMBOL	MEANING
	WATER
	FOAM
	WET CHEMICAL
	POWDER
	CARBON DIOXIDE
	HALON
	EXTINGUISHING GAS OTHER THAN HALON OR CARBON DIOXIDE
	OUTLET
	INLET
	PIPING
	WIRING
	MANUAL ACTUATION
	BELL
	SOUNDER
	SPEAKER
	TELEPHONE
	ILLUMINATED SIGNAL
	HEAT
	SMOKE
	FLAME
	EXPLOSIVE GAS
	COMBUSTIBLE MATERIALS
	OXIDIZING AGENT
	EXPLOSIVE MATERIALS

Table 1 - BASIC ELEMENTS

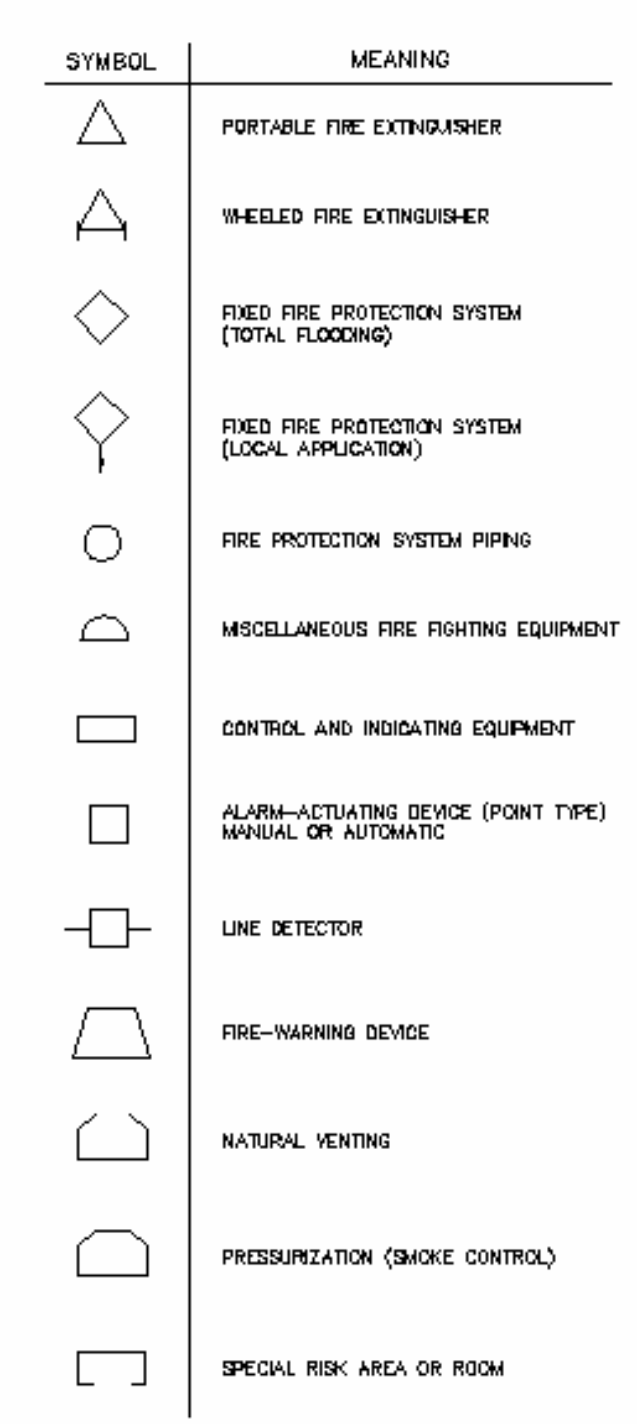


Table 2 - BASIC SHAPES

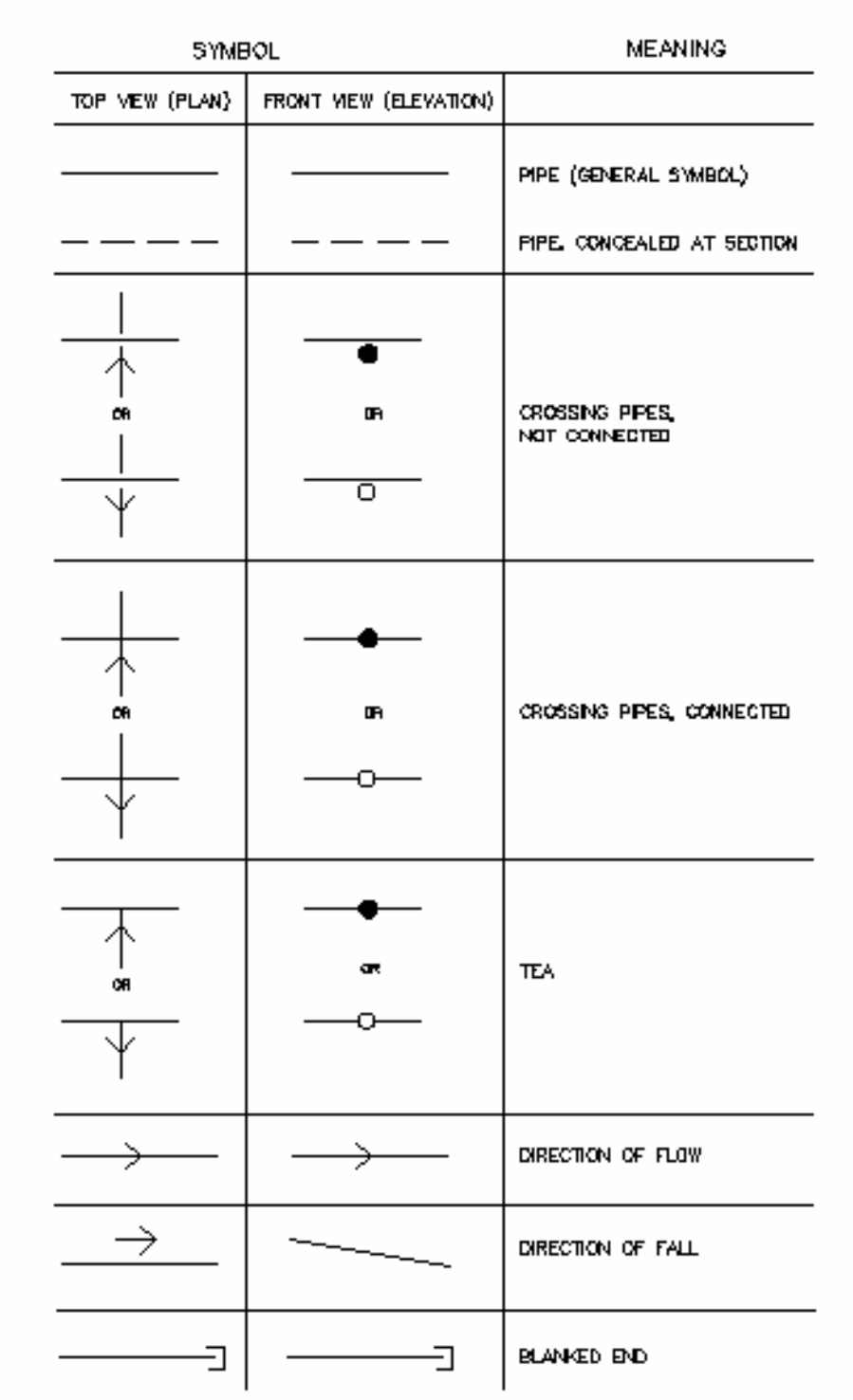


Table 3 - FIRE PROTECTION SYSTEMS - PIPING

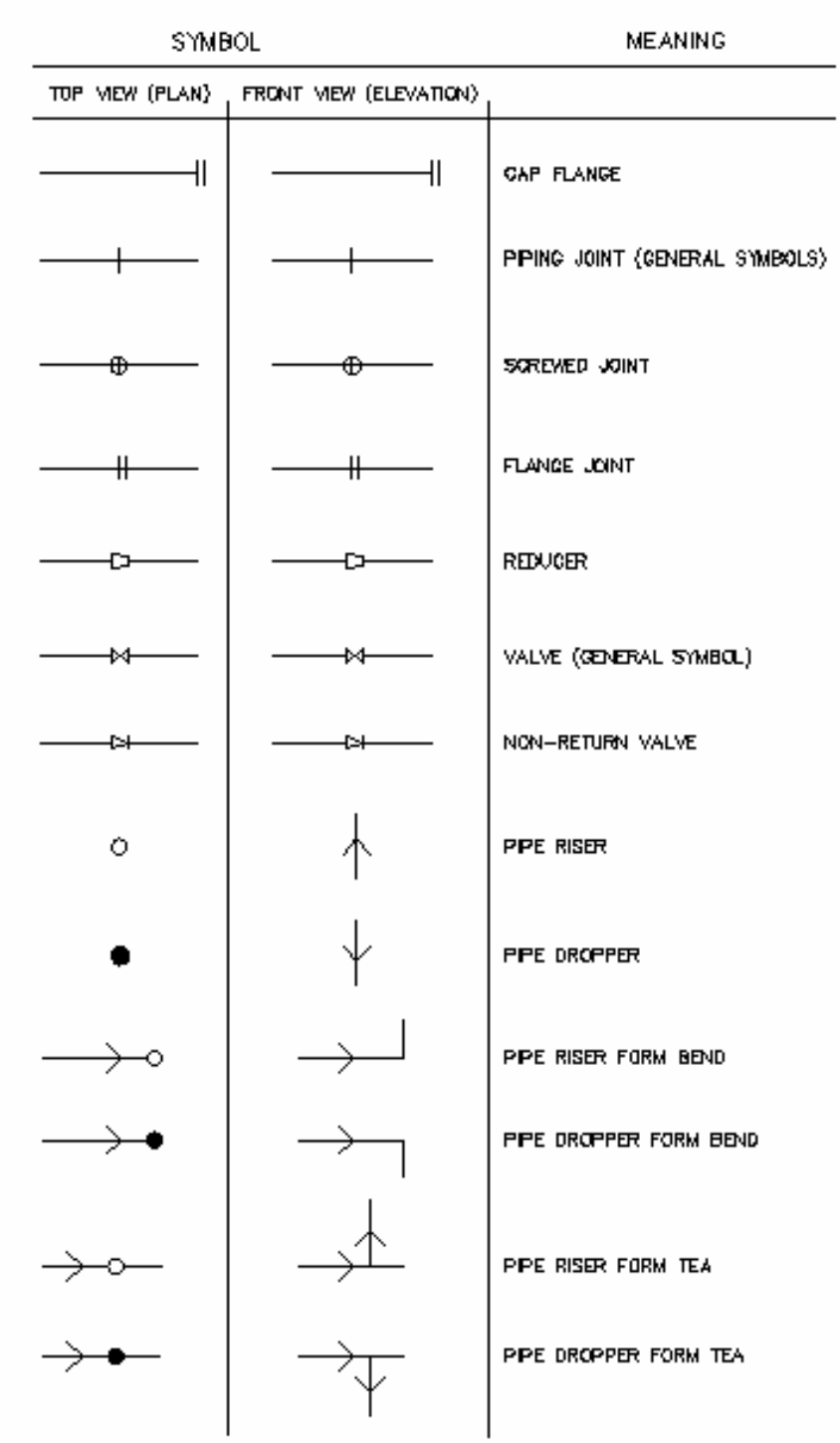


Table 4 - FIRE PROTECTION SYSTEMS - PIPING (Continue)

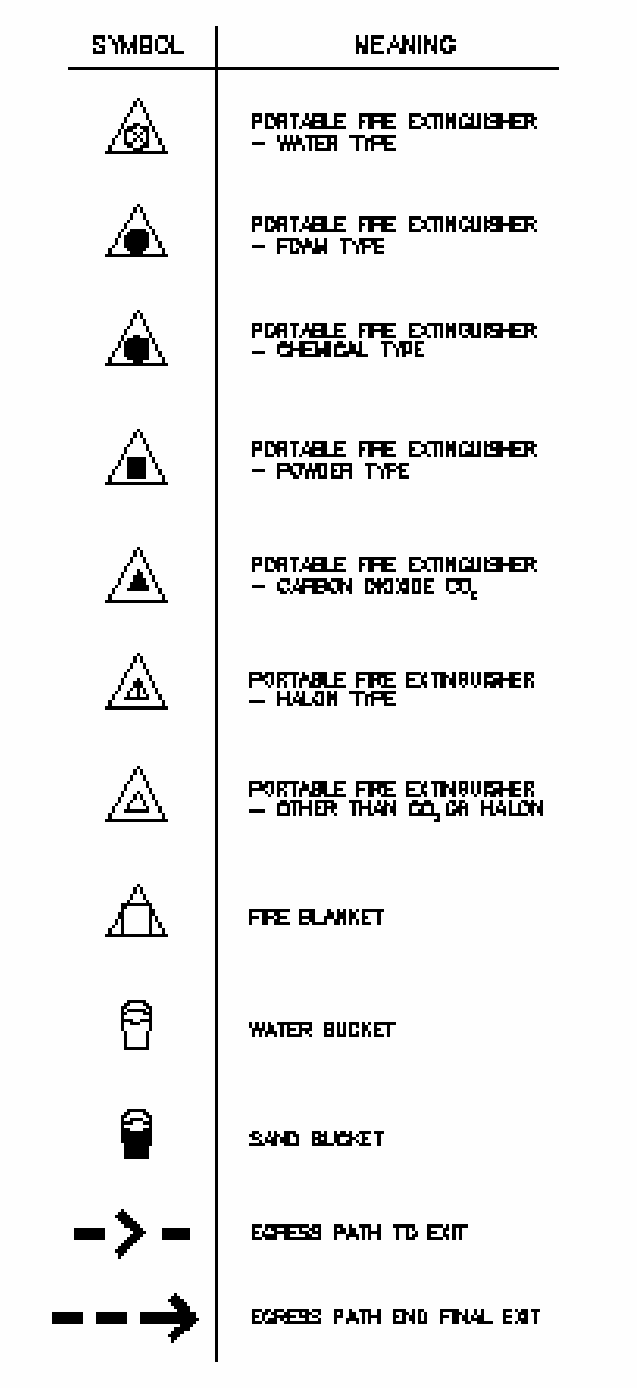


Table 5 - PORTABLE FIRE EXTINGUISHERS & FIRE EXITS/EGRESS SYSTEMS

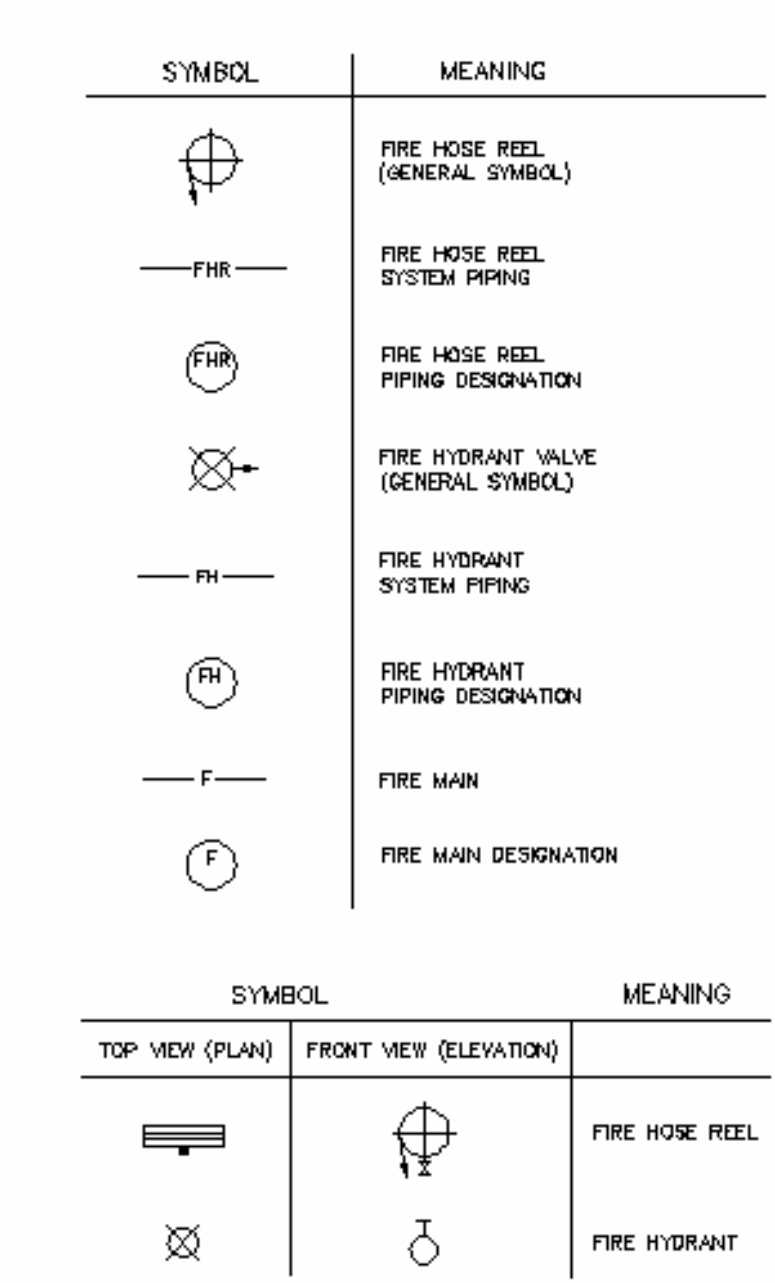


Table 6 - FIRE HOSE REELS, FIRE HYDRANTS AND FIRE MAINS

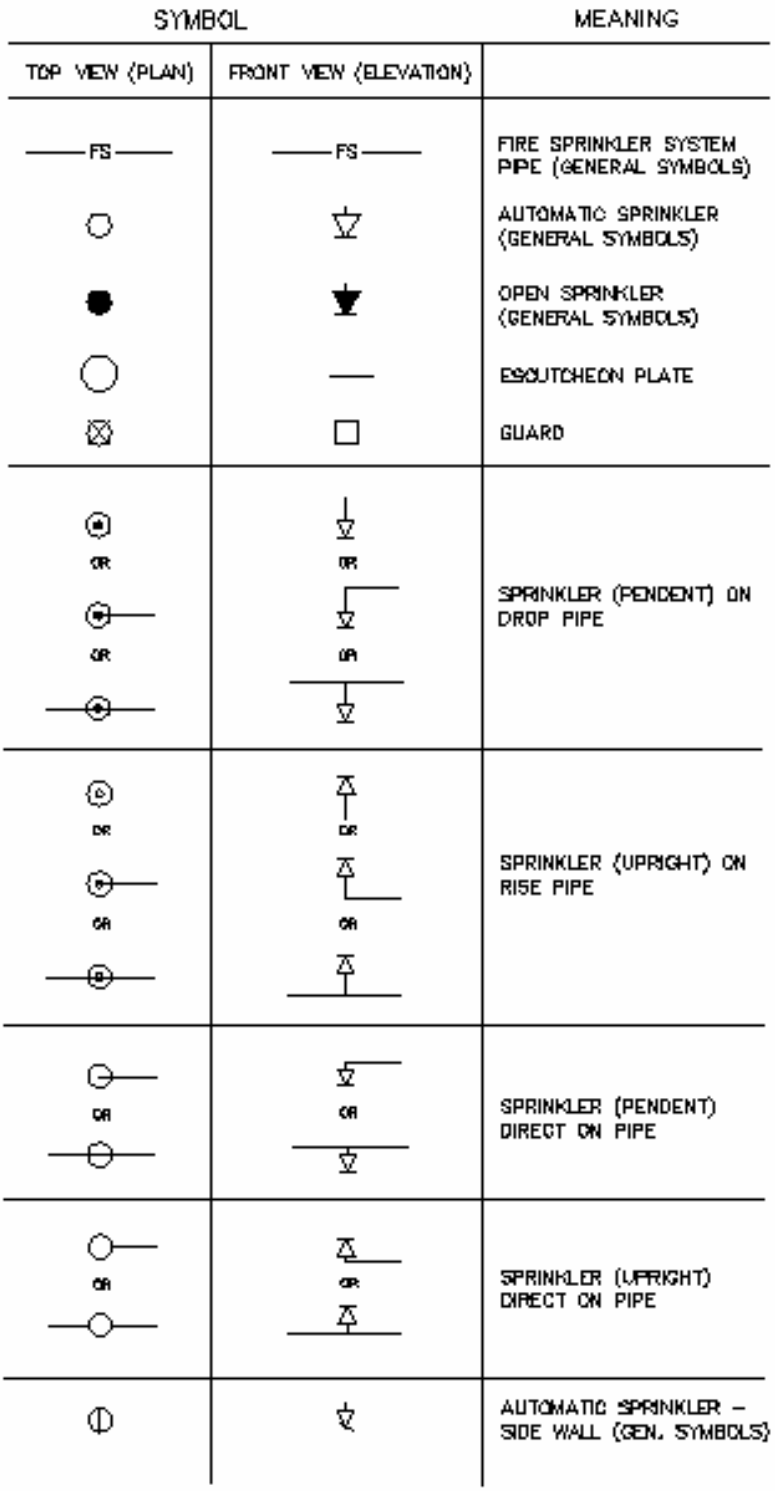


Table 7 - AUTOMATIC FIRE SPRINKLER SYSTEMS

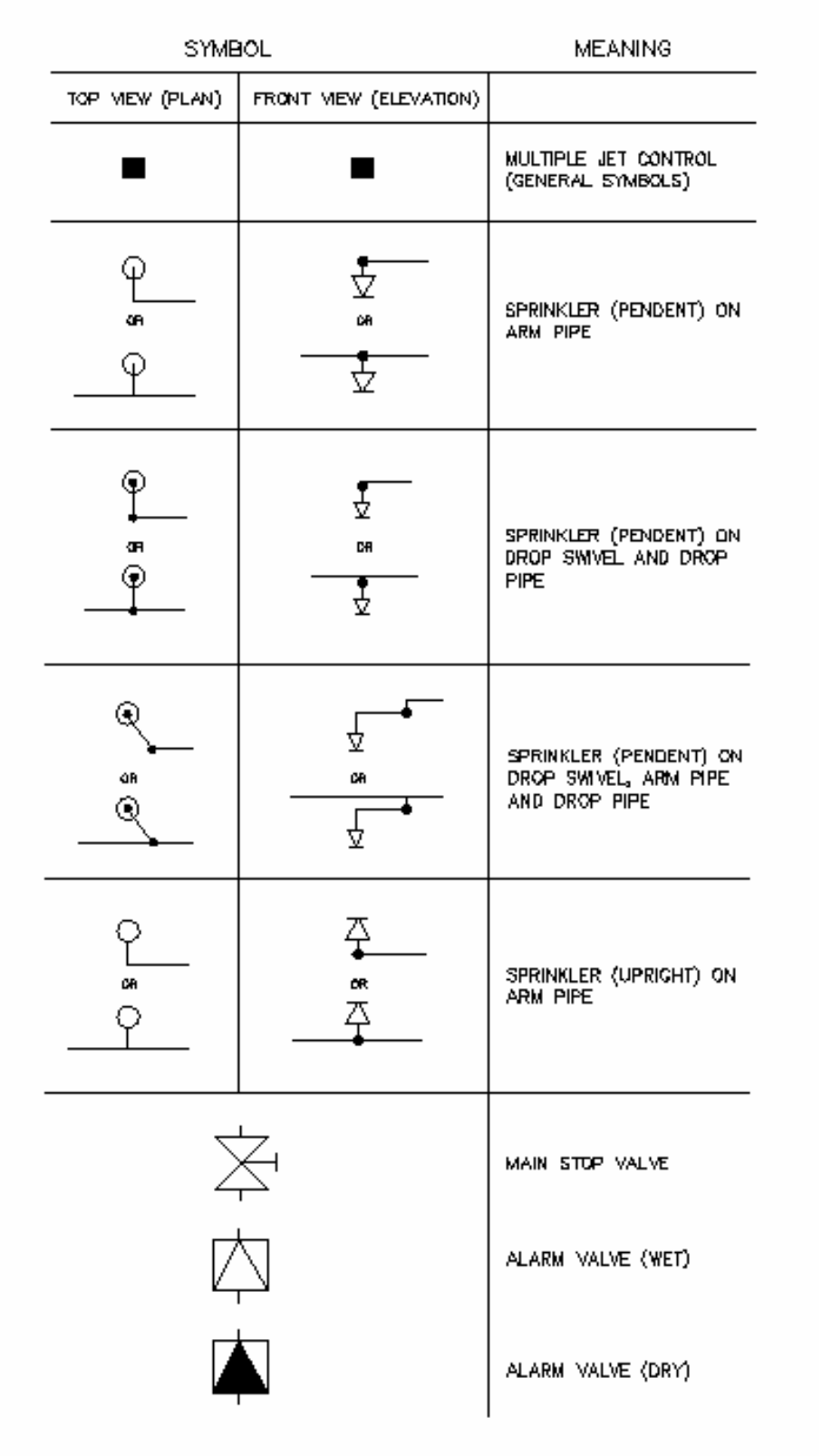


Table 8 - AUTOMATIC FIRE SPRINKLER SYSTEMS (Continue)

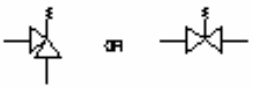
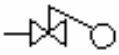
SYMBOL	MEANING
	PRESSURE RELIEF VALVE
	STOP VALVE – NORMALLY OPEN (GENERAL SYMBOL)
	STOP VALVE – NORMALLY CLOSED (GENERAL SYMBOL)
	GATE VALVE
	GLOBE VALVE
	BUTTERFLY VALVE
	PLUG VALVE
	NON–RETURN VALVE
	PUMP (GENERAL SYMBOL)
	FLOAT VALVE
	BOOSTER VALVE INLET
	PRESSURE REDUCING VALVE
	FLOW SWITCH
	PRESSURE SWITCH
	PRESSURE GAUGE
	SPRINKLER CONTROL ASSEMBLY

Table 9 - AUTOMATIC FIRE SPRINKLER SYSTEMS (Continue)

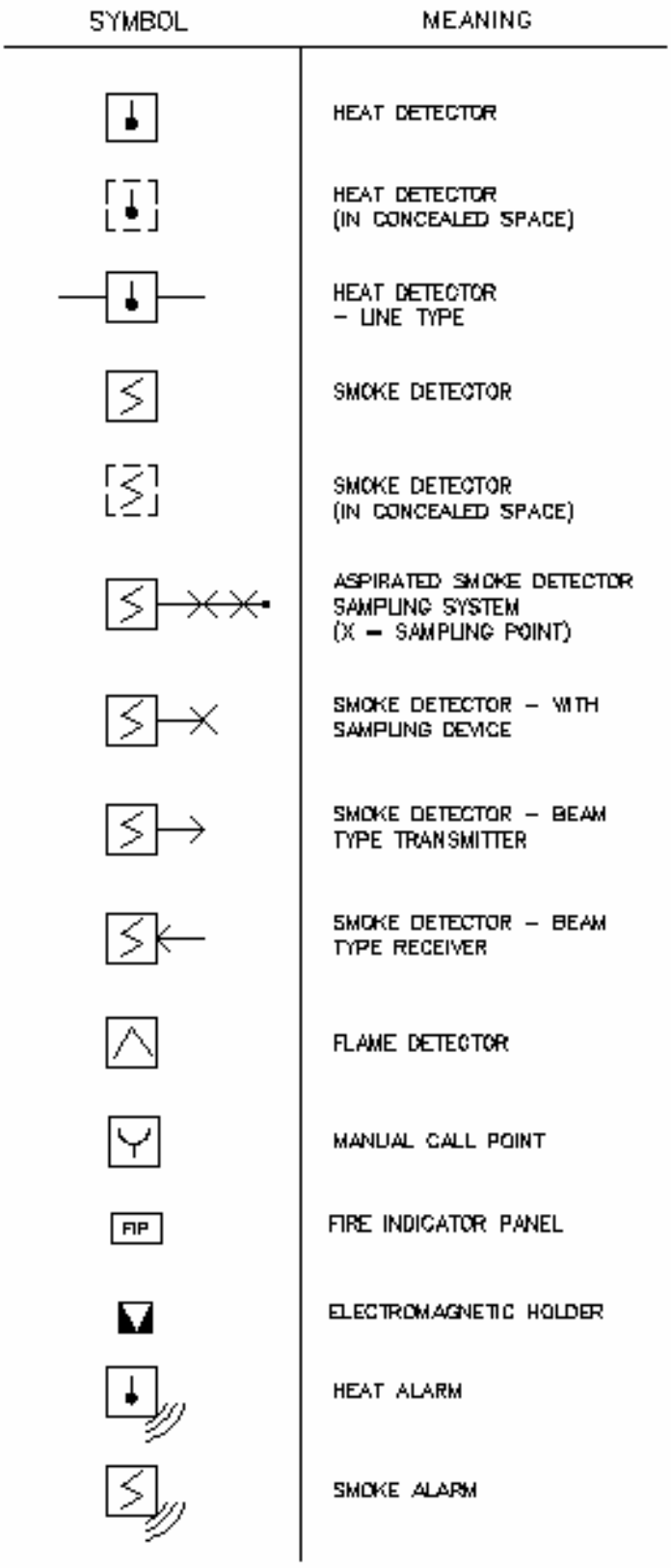


Table 10 - AUTOMATIC FIRE DETECTION AND ALARM SYSTEM

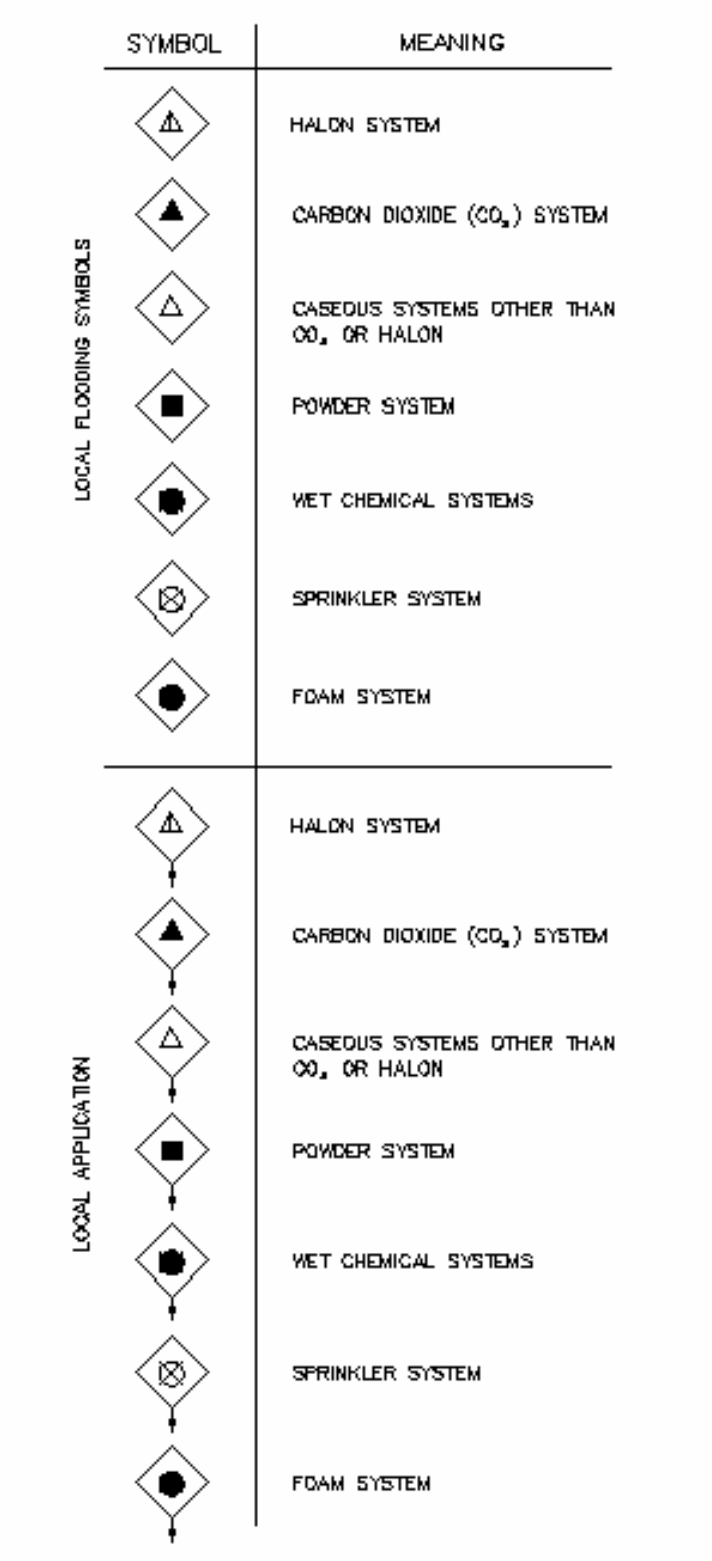


Table 11 - FIXED FIRE EXTUINGISHING SYSTEMS