# TOPIC TWO - FIRE SUPPRESSION URBAN

## CONTENTS

# SECTION ONE - MAP READING

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# 1 MAP READING

## 1.1 Introduction

Everyone in the NSWFB who responds to an incident can at some time be called upon to locate the scene of an incident or to find a route to an incident. Each of us must be able to fulfil these tasks quickly and efficiently. Not only are we expected to locate and find a route to an incident, but we must also be able to adapt to both temporary and permanent changes in the topography of the area in which we work.

A good understanding and working knowledge of maps is essential to meet the challenges of our work. In this section, we discuss these maps and how to use them.

## 1.2 Types of Maps Used

We use *Universal Business Directories* (UBD's) to identify the location of incidents in the major population centres including Sydney, Newcastle and Wollongong. Current editions of these directories are located in every fire station and on all appliances.

## 1.3 Main Features of UBD's

To use UBD's efficiently, you must be familiar with their features. Table 1A details some of the main features of UBD's.

| FEATURE | DESCRIPTION |
|---|---|
| Key Map | The key map on the inside the front cover of the UBD shows the relative positions of all street maps and suburbs covered in the Directory. |
| Australian Map Grid | UBD street maps are aligned with the Australian Map Grid (AMG). This grid is the national grid system that covers the entire country in a series of zones. Sydney is within AMG Zone 56. The small numbers in the map borders refer to AMG co-ordinates that are spaced at 1000 m intervals. |
| Orientation | For all practical purposes, *grid north* and *true north* are always to the top of the map. Each map features a directional arrow pointing to the GPO. |
| Grid Lines | The blue grid lines serve two (2) purposes:<br>• they form the reference squares for locating streets and facilities;<br>• they allow easy calculation of distances. |
| Red Large Scale City Maps 1 to 20 | The red large scale city maps that cover the congested city area are drawn at a scale of 1:10 000. This allows them to show much more detail as each grid square measures a distance of 125 m. |
| Blue Suburban Maps 27 to 366 | The blue suburban maps that cover the suburbs are drawn at a scale of 1:20 000. On these maps, each grid square measures a distance of 250 m. |
| Map Symbols | Most of the map symbols are self explanatory. However, to ensure that you can use the maps most efficiently you should familiarise yourself with all map symbols used. |
| Overlap Areas and Map Borders | The street maps have an overlapping area on each edge of the map to help you maintain your position. When you move from one map to an adjoining map, the numbers are shown in the borders and corners. |

**Table 1A Main Features of UBD's**

## 1.4 How to use a UBD

### 1.4.1 How to Find a Street

When you use the UBD, you would generally look up the street name first in the index. When you find the street, the index directs you to a map number and the reference co-ordinates on that map where you will find the street you are looking for.

Here is an example of an exercise to find Thorn Street in Ryde, Sydney.

- to look up the street name, *Thorn Street* in *Ryde*, you would find the following entries under *Thorn Street*:

| | | | |
|---|---|---|---|
| pl. | Mt. Pritchard | 248 | J9 |
| pl. | North Rocks | 171 | F14 |
| st. | Hunters Hill | 214 | K5 |
| st. | Liverpool | 269 | A8 |
| st. | Pennant Hills | 152 | K12 |
| st. | Revesby | 271 | J13 |
| **st.** | **Ryde** | **213** | **G3** |
| wy. | Kingswood Park | 163 | P2 |

- turn to the appropriate map page, 213, and locate the street by following the grid lines down from the reference letter (G) and across from the number (3) to where they intersect.

### 1.4.2 What To Do If You Can't Find A Street

If the Street Index does not list the street you are seeking under a particular suburb, you can check to see if the street is actually in an adjoining suburb.

To do this, you should refer to the Suburbs and Localities Index and determine on which map the suburb appears. Then, turn to that map and note the names of surrounding suburbs. Now return to the Street Index, and look for the street in one of the suburbs.

## 1.5 Choosing a Route

To find a good route to the scene of an incident, you must consider several factors, including:

- road conditions;
- weather;
- topographic hazards; and
- traffic conditions.

Here are some considerations when selecting a route to an incident:

- ensure that the quickest possible route is taken;
- ensure the safe delivery of the appliance and crew to the incident; and
- use local knowledge.

**Local knowledge.**

Your knowledge of the local area and landmarks is a key factor in your selecting and following an effective route to the incident. Your detailed knowledge and experience about the area can, however, only be gained and developed over a period of time.

If you are unfamiliar with the local area, it is to your advantage to familiarise yourself with the following:

- names of highways, main roads, streets and avenues;
- road conditions;
- traffic conditions (e.g. rush hours);

- housing density;
- weather conditions (seasonal factors);
- topographic conditions; and
- specific hazards.

 

# SECTION TWO - PRINCIPLES OF EXTINGUISHMENT

## CONTENTS

# 2 PRINCIPLES OF EXTINGUISHMENT

## 2.1 Introduction

As firefighters, we are all concerned both with the prevention of fire and the extinguishment of fire.

For a fire to thrive, several factors must be present to form the *fire triangle* or the *fire tetrahedron*. To extinguish a fire, we must remove one of these essential factors so that the fire cannot survive. The methods we use to remove one of these factors include:

- starvation;
- smothering;
- cooling; and
- interruption of the flame chain reaction.

⚠ **NOTE**

**We should note at the outset that it is often a combination of extinguishing methods that we use to stop the combustion process successfully and put out a fire e.g. when we apply water to a fire, the primary effect is the *cooling* of the fire and the secondary effect is the *smothering* of the fire by the production of steam through the displacement of oxygen.**

## 2.2 Starvation

The combustion process requires fuel, and the combustion process will cease in either of the following cases:

- when all fuel is consumed; or
- when the unburned fuel is removed from the fire.

Essentially what we do when we starve a fire is to remove its food or fuel. We have several ways we can do this. Here are some examples:

- we can allow the fire to consume all of the fuel under conditions that we control i.e. in a magnesium fire, we can apply a water spray to accelerate the burning of the magnesium;
- we can remove the unburned fuel from the fire thus depriving it of the remaining fuel i.e.

  - in an oil fire, we can drain fuel from burning oil tanks;

  - in a bushfire, we can create fire breaks and back burn the bush;

  - in a fire on board a ship, we can remove the cargo and thus prevent a continuing supply of the fuel necessary for the fire to spread; and

  - in an urban fire, we can demolish buildings to create a fire break.
- we can separate burning materials by pulling them apart i.e. this method would apply in a fire in bales of wool, jute, bedding, upholstery, or haystacks.

## 2.3 Smothering

The combustion process requires oxygen, and if we can reduce or remove the oxygen content in the immediate area of the burning material, the combustion process will cease.

⚠ **NOTE**

**The smothering process does not work well when you are trying to extinguish a fire in a substance that has a high level of oxygen in its chemical composition i.e. celluloid, chlorates, and nitrates.**

Here are some examples of smothering the fire by removing the oxygen supply:

- snuffing a candle;
- capping a burning oil well;
- the battening down of a ship's hold;
- covering a small fire involving clothing with a rug or a blanket; and
- placing sand or earth on a small metal fire.

⚠ **NOTE**

**Foam is an excellent agent for smothering a fire as it forms a viscous coating over burning material and quickly reduces the oxygen content.**

## 2.4 Cooling

The combustion process of a fire generates heat. If this heat generated by combustion is disbursed faster than it is generated, then the fire cools, and it cannot support the combustion process. Combustion then ceases.

The cooling process is the most commonly used method of extinguishing a fire. The most common medium for the cooling process is the application of water to the burning materials. The extinguishing medium absorbs heat from the fire.

The water, in turn, undergoes one or more of the following changes when its temperature is raised:

- it converts to the vapour state;
- it decomposes; or
- it reacts chemically with the burning material.

Table 2A defines some of the terms used in the cooling process.

⚠ **NOTE**

**Some extinguishing media may prove dangerous and cause a chemical reaction to burning substances resulting in the explosion rather than the absorption of heat.**

## 2.5 Interruption Of The Flame Chain Reaction

For combustion to commence and continue, the chemical chain reaction must remain intact.

One method of extinguishing the combustion process is to interrupt this chemical chain reaction in the flame zone. When this happens, the combustion rapidly terminates.

During the combustion process, small particles known as *free radicals* are created. These free radicals normally react with each other and produce both the heat and the chemical products of combustion. These in turn accelerate the chain reaction. When the chemical reaction chain is broken, the combustion process cannot continue.

| TERM | DEFINITION |
|---|---|
| Thermal capacity | The amount of heat absorbed for any given increase in temperature. |
| Latent heat of vaporisation | The amount of heat required to vaporise a unit weight of the extinguishing medium. |
| Heat of decomposition | The amount of heat required to cause decomposition of a unit weight of the extinguishing medium. |
| Heat of reaction | The amount of heat required to cause a unit weight of the extinguishing medium to react chemically with the burning material. |

**Table 2A Cooling Process Terms and Definitions**

We have several dry chemical powders that have the ability to interrupt the flame chain reaction.

## 2.6 Fire Classification

The various *classes of fire* are determined by the type of combustible material being consumed in the fire. We use different extinguishing media on different classes of fire.

The *International Standard* is recognised by the *Australian Standards Association*. It classifies fire into six classes: **A, B, C, D and F** plus **Electrical Fires**. Table 2B summarises the characteristics of each class of fire.

| CLASS | CHARACTERISTICS |
|---|---|
| **A** | All fires that involve solid materials of an organic nature, or carbon compounds. Combustion generally occurs with the formation of glowing embers. **Cooling** is the most effective method of extinguishing this class of fire. |
| **B** | All fires involving liquids or liquefiable solids. **Smothering** or **interrupting the flame chain reaction** are the most effective methods of extinguishing these fires, but **cooling** plays a part in reducing the material to below its flash point. |
| **C** | All fires involving gases including liquefied gases in either liquid or vapour state. **Interrupting the flame chain reaction**, or **smothering** and absorbing heat by creating a radiation barrier are the best methods for extinguishment of this class. |
| **D** | All fires involving metals. **Smothering** or **starvation** are normally the only means by which these fires can be extinguished. |
| **F** | All fires involving cooking oils or fats. **Smothering** or **interrupting the flame chain reaction** are the most effective methods of extinguishing these fires. |
| **Electrical** | These are not considered a class. By definition an electrical arc is not a fire, but an electrical arc can lead to a fire in any of the foregoing classes. |

**Table 2B Classification of Fires**

# SECTION THREE - EXTINGUISHING MEDIUMS

## CONTENTS

# 3 EXTINGUISHING MEDIUMS

## 3.1 Water

### 3.1.1 Introduction

Water is the best cooling agent we can use to fight fires. Water is:

- highly efficient;
- readily available;
- inexpensive;
- transportable; and
- easily applied to fires.

Water has the capacity to absorb a large amount of extreme heat. When water contacts the burning material, the water temperature rises rapidly. In the process, the water changes to steam. As it changes to steam, the water absorbs the heat and reduces the temperature of the burning material to a point below its ignition temperature. Combustion is thus reduced or stopped.

When you use water to fight a fire in a building, you should try to contain the water from your application in the building as much as possible. This ensures that the water works most efficiently in reducing the temperature of the fire.

In the early stages of fighting a fire, the heat of the fire is very high. When the water is applied to the fire, the steam formed is not visible. However, as the temperature falls, the steam begins to condense above the fire. This is a sign that the fire is being brought under control. As well, the steam formed begins to fall on the seat of the fire. This has a smothering effect on the fire and helps in the extinguishing process.

### 3.1.2 Use of Water on Various Classes of Fire

Table 3A details the use of water on various classes of fire. For fire classification cross refer to Topic 2 Section 2.

| CLASS | USE OF WATER |
|---|---|
| **A** | Water is the most effective medium for use on this class. The two most common forms of water application are *jet* and *diffused* (spray and fog). Ideally, you should apply water in sufficient quantity to achieve maximum cooling and fire extinction. The amount depends upon the size of the fire. |
| **B** | Water is the most effective medium for this class of fire. It should be applied in the diffused, or fog and spray form. |
| **C** | *Water is not effective as an extinguishing medium for this class of fire*. However, you can use water to protect and cool cylinders and containers, and to diminish exposure from the direct burning and radiant heat of a gas fire. |
| **D** | *Water will not extinguish this class of fire*. Many burning metals react chemically with water. This reaction decomposes the water to hydrogen and oxygen gas. These gases then cause a violent increase in the intensity of the fire. **Caution: If you apply water to molten metal, the immediate vapourisation of water to steam can cause the molten metal to splash over a wide area**. |
| **F** | *Water is not effective on this class of fire*. **Caution: If you apply water to this class it may sink in the fat or oil. This can cause *slop-over* and violently expel the oil or fat from a container**. |
| **Electrical** | *Generally, you should not use water on fires involving live electrical circuits.* However, you can use water on some occasions:<br>• if located on dry ground or on an insulted surface;<br>• if a sufficient distance from the run-off water; and<br>• if other safety procedures are followed. |

**Table 3A The Use of Water on Various Classes of Fire**

### 3.1.3 Characteristics of Water used on Fire

By understanding how water reacts with fire, you can determine the best use and application of water to extinguish a fire. Here is a list of some of the characteristics of water when it is applied to fire:

- water requires a large amount of heat to change into steam;
- when water converts to steam, it occupies several hundred times its original volume;
- water has a greater capacity for absorbing heat than any other common extinguishing agent; and
- the greater the exposed surface area of the water, the more rapidly it will absorb heat.

The purpose of applying water to a fire is to convert the water to steam and absorb enough heat to reduce the fire to a temperature below its ignition temperature. Ideally, you should use just enough water so that none of the water is wasted in the conversion. This optimum application also keeps water damage to a minimum.

As a firefighter, you are presented with a wide range of fires. By using the most efficient hose stream application, you can achieve a fast knock down of a fire while minimising water and structural damage.

### 3.1.4 Methods of Hose Stream Application

Hose streams are the methods by which you apply water directly to a fire. We use three basic patterns of hose streams:

- jet streams;

- sprays; and
- fogs.

Hose streams are also classified by the size or volume of the stream:

- low volume streams discharge less than 2 L/sec and these include streams fed by hose reels;
- handline streams discharge 5 to 10 L/ sec, these include streams fed by 38 mm hose;
- streams discharge 5 to 30 L/sec, these include streams fed by 70 mm hose; and
- master streams discharge 20 to 75 L/ sec, these streams are usually fed by two or more hoselines.

Hose streams are difficult to handle while jet streams are especially difficult. Water from a jet stream nozzle projects directly away from the nozzle, and the reaction in the opposite direction is equal to the strength of the projection of the stream. This reaction can make the nozzle hard to handle.

**Jet Streams**

A jet stream is an unbroken stream of water projected from a nozzle. This is the most common form of delivering water for fire fighting.

Jet streams differ in shape and size. Within the effective ranges of the various streams, they all have the following characteristics:

- they have continuity over the majority of their reach;
- they do not break into a spray; and
- they are stiff enough to attain the height required in a fresh breeze with minimal loss of continuity.

**Projection**

Projection is the distance that a jet stream travels before breaking up or dropping off. Projection is important when you have difficulty in making an approach close to a fire. A jet stream has two forces acting on it that prevent it from projecting straight: velocity and gravity.

- velocity through the nozzle gives the stream its projection; and
- gravity pulls the stream down to the ground.

The projection ends when the stream hits the ground. To get maximum penetration with a lower trajectory, you should place the branch as far away from the target as the reach of the jet permits.

A turntable ladder or hydraulic platform monitor can give you an advantage when you are projecting a stream through a window or another opening in a building in that it can project a jet almost horizontally and strike a fire well inside the building.

If you are on a hydraulic platform, you have greater flexibility in applying the stream. You can alter the angle of the monitor vertically and horizontally, and you can change the pattern of the stream without the need to adjust the platform.

**Large Jet Streams**

To fight a fire that has a large combustion area, a large jet stream is the only effective stream. Smaller jets are not effective, and you may need to replace several smaller jets with a larger one.

When you use a large diameter jet, you must consider the part of the building the stream strikes. Unless you handle the stream carefully, it can bring down the walls and other structural elements, especially if the building has been weakened by fire. Large streams can also make it difficult for you to work in some restricted parts of a building where the use of high water pressure and large water volume would be inappropriate.

Monitors help conserve resources and prevent strain. As soon as it is practical to do so, you should revert to the use of smaller jets inside the building to completely extinguish the fire.

### Where not to Direct a Jet Stream

Following is a guide to where not to direct a jet stream:

- **straight over head:** a jet directed straight overhead can bring loose materials down onto those below, and the falling water may be very hot;
- **onto loose matter such as hot ashes, slag or molten metal**: the force of the jet can scatter the loose material, steam can form in the body of the material, and the sudden expansion of the steam can cause the material to disperse dangerously;
- **on flammable powders or areas with large concentrations of dust**: if these materials are stirred up by a jet, they can form explosive mixtures with air; and
- **onto live electrical equipment:** electricity can travel along the stream back to you and can cause serious injury or death.

### Sprays

When you use a spray nozzle in the appropriate circumstances, it can be the most effective method of reducing the heat of a fire. A spray nozzle breaks the water stream into small droplets. These droplets have a much larger total surface area than a jet.

⚠ **NOTE**

**A given volume of water in a spray absorbs more heat than the same volume of water in a jet.**

Sprays range from those with large or heavy droplets to very fine droplet particles. The larger droplets increase the throw of the water or the distance the water can travel. The finer droplet particles form a much wider spray pattern and can absorb more heat. The formation of spray patterns are many and varied and are governed by the design and variety of the nozzles.

You can create sprays in a number of ways, including:

- using rotary distributor nozzles;
- using water curtain nozzles; and
- directing two jet streams together in mid-air.

The characteristics of sprays include:

- rapid heat absorption;
- much wider coverage area of burning material; and
- the formation of heat protective barriers for branch operators.

### Water Curtain

A water curtain is a spray stream that has a fan shape for use between a fire and other combustible material. It can protect people or building facades from heat. To achieve its purpose, a water curtain must cover a wide area and be reasonably heavy.

Tests confirm that a water curtain placed between a fire and burning combustible material is not as effective as the same amount of water flowing over the surface of the burning material. Where it is possible to do so, it is better to direct streams onto exposed burning surfaces than to establish a water curtain for the same purpose.

In major fires, water curtains can help cool down a building facade and prevent glazing from shattering.

**Use of sprays**

Sprays are used extensively in the suppression of fires, especially on hose reel equipment. Sprays are also effective when you are dealing with quite large fires. You can use sprays on most fires except where you need a solid jet of water to reach the heart of the fire.

Sprays can be very useful when you first enter a burning building or room. A quick circular movement with the branch to create a spray can immediately reduce the temperature of the fire and drive back the smoke. This can make your entry much easier. However, the steam generated by the spray can cause discomfort to firefighters in a highly heated confined space.

Sprays can be useful for extinguishing fires in confined situations e.g. insertion of a spray nozzle into the blind space under a stairway can rapidly bring a fire under control.

Sprays can also be used to cool large surfaces such as steel bulkheads or storage tanks. Its greater heat absorption qualities mean less water is required. In a ship fire, the use of a spray can help maintain stability.

Sprays are essential on fires involving flammable powders. If you use a jet on flammable powder, you may raise clouds of the burning substance and increase the possibility of explosions. Sprays are also very effective in extinguishing fires involving liquids or liquefiable solids.

**CAUTION**

**High pressure sprays can be very dangerous on flammable powders, liquids, or molten metals.**

**Miscibility**

The ability of liquids to mix with each other is known as miscibility. Liquids such as methyl alcohol, ethyl alcohol, and acetone are completely miscible with water. Liquids such as oil and petrol will not mix with water and are described as immiscible.

**Effects of spray**

Following is a list of some of the effects that a high velocity water spray can produce:

- it can cool the surface of the burning liquid;
- it can displace the oxygen from the fire and help extinguish the fire by smothering it;
- it converts to steam and provides an additional smothering blanket;
- it dilutes flammable liquids that are miscible with water; and
- it emulsifies the surface of immiscible flammable liquids forming a temporary layer that prevents the escape of flammable vapours.

**Fogs**

Fog is a stream composed of fine droplets of water that form a mist pattern. To produce fog, you need a high pressure at the branch.

The high concentration of droplet particles in a fog rapidly absorbs heat energy due to the large exposed surface area of the water. This is the primary extinguishing ability of a fog. The rapid conversion of water to steam acts as an important secondary extinguishing capability.

Fog streams are more easily handled than other streams because the reaction is divided and counterbalanced as the nozzle deflects the stream into its pattern. The adjustable fog nozzle is the most popular method of making a fog stream. You can adjust a fog nozzle to produce a fog from a wide-angle fog pattern to a hollow jet. The hollow jet is essentially equivalent to a solid stream.

If you use a fog stream, you should divide it into a fine spray with a uniform discharge pattern around the cone regardless of the branch setting you are using.

**Uses of Fog**

The performance of a fog is judged by the rate at which the water is converted into steam and the amount of heat that it will absorb. These two factors decrease temperature, displace smoke and gas, and minimise water damage.

**Fog to Steam**

Fog converts rapidly to steam in a heated space e.g. a fog spray discharging 5 L of water every second, into a space heated to approximately 100° C converts rapidly into steam. In 1 min, 300 L of water vaporise into steam and expand to approximately 500 $m^3$ of steam. This is enough to fill a room about 3 m high by 8 m wide by 20 m long.

In extremely hot atmospheres, steam will expand to greater volumes. This expansion is rapid, and the steam quickly displaces smoke and gases already in a room. As the room cools, the steam condenses and allows the room to refill with cooler air.

**CAUTION**

**The rapid expansion of steam can cause danger to branch operators. You must protect yourself by staying low to allow steam or combustion products to pass over you and through the opening in a room or a building, otherwise you could be seriously burned.**

Steam helps to extinguish certain types of burning materials by smothering the fire, much as the expansion of steam reduces the oxygen in a confined space.

**Volume of Water**

For a fog stream to be effective, you must deliver it in sufficient volume so that it absorbs heat faster than the heat is generated. Fog streams absorb heat more readily than solid streams, but they must carry sufficient volume to cool the heated area. Water does not absorb its full capacity of heat until it is completely converted into steam. If a low volume fog stream delivers fine particles where heat is generated faster than it is being absorbed, the fire might be controlled, but it will not be extinguished.

**Master Stream.**

The master stream is any fire stream that is too large to be controlled without mechanical aid. Examples of master streams are ground monitors, large branches, and aerial appliance monitors. You must use safety precautions when you are using any of these devices.

A master stream can be a solid, fog, or spray. It uses special nozzles, parallel hoselines, and large capacity pumps.

## 3.2 Foam

### 3.2.1 Introduction

Foam is the visible product of foam concentrate, water and air when mixed. How vigorous the solution is agitated, together with the amount of air induced, will control the expansion ratio. The expansion ratio required may vary, depending on the type of concentrate or the flammable liquid or fuel it is being applied to.

Traditionally, the NSWFB have considered foam for use on class **B** or burning liquid fires. However, changes in techniques and foam concentrates now permit foams to be used on class **A** carbonaceous material fires.

Foam extinguishes a class **B** fire by smothering and this action may be aided by the production of an aqueous or polymeric film as the foam contacts the fuel surface.

Foam aids the extinguishment of a class **A** fire by reducing the surface tension of the water therefore allowing it to penetrate and cool the fuel more rapidly. This also results in less water and time being required to gain extinguishment. The potential for re-ignition is also reduced.

All types of finished foam are fully compatible and can be used on a single fire.

Foam concentrates are incompatible and must never be mixed.

### 3.2.2 Use of Foam on Various Classes of Fire

Foam is very effective in fighting some fires but will not work with others. In fact, with some fires, it is dangerous to use foam. In terms of what is the appropriate type of foam to use the following guidelines should be used.

**NOTE**

**Details of fire classification - cross refer to Topic 2 Section 2.**

**Class A**

**A** class fire fighting foam i.e. bushfire fighting foam is the most appropriate for this class of fire. Additionally, compressed air foam systems (CAFS) and high expansion foam (Expandol concentrate) can also be used effectively.

**Class B**

**B** class foam is one of the most effective extinguishing mediums for this type of fire.

**Class C**

Normal foams are totally ineffective on these fires. Special Hazmat foams have been developed for this class of fire.

**Class D**

Normal foam (**B** class) is not used on these fires because the water content in the foam can react with the burning metal.

**Class F**

Foam is not effective on this class of fire as it can cause slop-over and violently expel oil or fat from containers.

**Electrical**

Use of foam on live electrical apparatus can be dangerous in that the foam can conduct electricity back to the operator and cause an electric shock.

### 3.2.3 Expansion Ratio/Factor

The expansion ratio/factor is a volume-to-mass ratio calculated by comparing the mass of equal volumes of foam and water e.g. 1 L of water has a mass of 1000 g and 1 L of foam has a mass of 125 g. The expansion ratio/factor of water to foam is then 1000/125 or 8:1

This expansion ratio/factor is used with the four formulae to create the following types of foam:

- **light water** is a product of a synthetic foam concentrate and water that has an expansion rate below 2:1 This is generally produced using a fog nozzle and eductor and is the most common form of application in the NSWFB;
- **low expansion foam** has an expansion ratio of up to 50:1, however, the ratio is usually between 5:1 and 10:1. This is generally produced by aerating foam branch pipes;
- **medium expansion foam** has an expansion ratio of between 50:1 and 500:1, however, the ratio is usually between 75:1 and 150:1. This is produced by aerating foam branch pipes fitted with mesh screens; and
- **high expansion foam** has an expansion ratio from 500:1 to 1000:1, however, the ratio is usually between 750:1 and 1000:1. This is produced by foam generators with air fans and nets.

### 3.2.4 Foam Concentrates

Foam concentrates used by the NSWFB have been developed for both specific and general applications. There are five synthetic detergent-based concentrates in use suitable for use with fresh or salt water:

- AFFF - 1%
- AFFF - 6%
- ATC - 3% - 6%
- EXPANDOL
- BFFF - .05 - 1%

**AFFF - 1% (B class foam)**

This is a super concentrated **Aqueous Film Forming Foam** that is proportioned at a rate of 1% and is manufactured for use on flammable hydrocarbon fuels. Its characteristics are its rapid knock-down capability, vapour suppression power, self healing and fast flowing.

The manufacturer recommends its use **non-aspirated** for fire fighting and **low expanded** for vapour suppression.

Its excellent foam for weight ratio makes it ideal for foam motors or for transportation by air.

**Uses**

AFFF produces a very fluid fast flowing foam that forms a vapour suppressing film. This is important where you require the greatest speed for fire knock-down and initial positive vapour suppression. The foam produced remains stabilised and prolongs vapour suppression, heat absorbing capabilities and burn back resistance.

When you use AFFF, an aqueous solution that drains from the foam spreads and floats over the fuel surface. The vapour seal improves extinguishment and inhibits re-flash, even when the foam blanket is ruptured. This filming action also occurs on non burning fuels and secures them against accidental ignition.

**Use on Specific Fires**

AFFF can be applied to fires simultaneously with dry chemical fire fighting agents because both agents are mutually effective and compatible. Compatibility with other mechanical foaming agents is satisfactory when applied in separate foam streams.

AFFF can be used on the following fires:

- pooled fuel or fuel spill;
- fuel flowing into spill fires;
- crashed aircraft;
- open top fuel tank;
- fuel fires in grassy or sandy areas;
- hot depth fuel fires;
- fuel fires on water; and
- rubber tyres.

⚠ **NOTE**

**AFFF will extinguish rubber tyre fires, securing them against re-ignition. The foam would also be effective on A class fires, however, as water would also be effective, the use of foam on such fires would only be justified in certain special circumstances.**

**Limitations**

AFFF has certain limitations; it is not recommended for use on fires involving the following:

- polar solvents (Acetone, Methyl Ethyl, Iso Propanol);
- live electrical equipment;

- chemicals that react with water such as Butyl Acetate (Butanol) with a low water solubility, and Methanol and Acetone with a high water solubility;
- other materials that react violently with water such as sodium metals;
- fires involving liquefied gases such as propane. In this case severe boiling and increased vapour release can occur, due to the latent heat of the water draining from the foam;
- fires in vessels containing materials such as hot oils and asphalts. The use of foam in this situation can cause violent frothing and even forceful expulsion of a portion of the contents.

**Storage**

AFFF concentrate stores well. It does not produce sedimentation or significant precipitation during storage. It has a storage life of fifteen years minimum.

**AFFF - 6% (B class foam)**

This is a concentrated Aqueous Film Forming Foam that is proportioned at 6% and is manufactured for use on flammable hydrocarbon fuels. It has the fastest knock-down time of any synthetic detergent foam and is an excellent vapour suppressant. It is self healing and fast flowing.

The manufacturer recommends its use non aspirated for fire fighting and low expanded for vapour suppression.

This concentrate has changed little since it was developed in 1960 and has successfully seen service with the NSWFB since 1978.

The uses and limitations of 6% AFFF are similar to 1% AFFF.

⚠ **NOTE**

**This concentrate is being discontinued in the NSWFB except for specific risks.**

**ATC - 3% - 6% (B class foam)**

This is an **Alcohol Type Concentrate** that may be proportioned to suit the flammable liquid type it is being applied to:

- 3% for fires or spills involving hydrocarbon flammable liquids; and
- 6% for fires or spills involving miscible flammable liquids.

It is important to note when dealing with water miscible products that ATC has a resistance to that type of flammable liquid, it is not **alcohol proof**.

When applied to hydrocarbons ATC's performance is similar to AFFF in that an aqueous film forms on the fuel surface acting as a vapour suppressant. Similarly on water miscible fuels, a polymeric film forms on the fuel surface, protecting the foam and acting as a vapour suppressant. However, there is a noticeable reduction in the self healing qualities of the foam and firefighters must ensure that a 125 mm foam blanket is maintained.

**Uses**

Sometimes normal foams are ineffective when used with fires involving the following materials:

- fuels that are water-soluble;
- fuels that are water-miscible; or
- fuels that are of a polar-solvent type.

These substances readily mix with the water contained within the foam mass and destroy the foam blanket.

ATC can be effective against these fires. The alcohol type concentrates contain either an additive that stabilises the foam or a polymer, a substance with a complex molecular structure, that drains from the foam bubbles to form a stable, impervious barrier between the foam and the solvent.

**Expandol**

This is a synthetic detergent based concentrate that is suitable for both medium and high expansion applications. It may be applied to both **A** and **B** class fires in enclosed areas.

It extinguishes fires by smothering and cooling, due to limiting the flow of air to the fire by its volume and by the production of steam as the foam is attacked by the fire. The foam produced with this concentrate has poorer back-burn characteristics than other types of foam.

Foam produced from this concentrate is susceptible to breakdown when exposed to the following substances:

- hot depth oil fires;
- direct flame contact; and
- fuel contamination.

**High Expansion Foam**

The foam mass is an aggregation of bubbles generated mechanically by the passage of air through a net screen that is wetted by a solution of synthetic foam concentrate and water.

High expansion foams provide an extinguishing agent suitable for use on **A** and **B** class fires in enclosed areas. Extinguishment is achievement by:

- the large volume of foam produced which blankets the fire and prevents air from reaching it;
- the cooling effect of the water contained in the foam; and
- steam generation which reduces the oxygen in the immediate vicinity of the burning material.

**NOTE**

**High expansion foam sometimes fails to deal with a fire that is located just below ceiling level. The compartment will need to be vented.**

**CAUTION**

**When you enter a room or confined space filled with high expansion foam, you may experience severe disorientation caused by the loss of a sense of direction, vision and hearing. Always use a rope or line attached to you that leads to the entry of the room. In this situation, you must also wear BA.**

**Medium Expansion Foam**

Medium expansion foam is produced the same way as high expansion foam but the expansion ratio is not as great.

Medium expansion foam is effective as a method of rapidly blanketing **B** class fires or **A** class fires confined in small areas.

**BFFF (A class foam)**

BFFF looks like a fluffy foam and acts just like a blanket on a fire, cutting out oxygen and smothering the fire. It can stop fuel from getting dangerously hot as the foam absorbs so much of the oncoming heat. The foam helps to cool the fire by releasing trapped water gradually. The foam penetrates right into wood materials, wetting them faster than pure water, without evaporating or running off as fast as water does.

**Uses**

This foam is useful on both class **A** fuels (common in bush and forest) and class **B** fuels (associated with forestry equipment) and is environmentally safe because it is bio-degradable and non-toxic. Depending on the concentrate and how its aerated different types of foam can be produced.

When used for initial suppression it is proportioned between 0.25% and 0.5% and its expansion/air to water ratios are between 7:1 to 15:1. The foam flows easily and can be generated via foam nozzles or hose lines. In this concentration it penetrates canopies well and drains to the forest floor layers.

When used for protecting buildings and trees it is proportioned between 0.8% and 1% and has expansion/air to water ratios of between 15:1 and 45:1. The foam appearance is thick and fluffy (resembling shaving foam) and is generated by CAFS and air aspirated foam nozzle.

In this concentration it adheres well to walls, ceilings and eaves. It coats and penetrates through forest canopies and insulates well.

### 3.2.5 Other Types of Foam Concentrates

Two other forms of mechanical foams are used within the NSWFB:

- protein; and
- fluoro-protein concentrates

**Protein**

Protein concentrate produces low expansion mechanical foam. This foam is effective on substances where a low foam drainage is required, including:

- hot depth oil fires; and
- pooled liquid chlorine.

You can use protein concentrate with low expansion equipment and it is also suitable for use with sea water.

**Fluoro-Protein**

Foam produced with fluoro-protein concentrate has similar properties to protein foam, but the fluoro-protein has greater fluidity and gives more rapid control and extinguishing potential.

Fluoro-protein foam is the foam that is most resistant to fuel contamination. It is the concentrate usually used in oil refinery fires.

### 3.2.6 Equipment

To produce mechanical foam the following equipment is required:

- a pressurised water supply;
- a means of introducing foam concentrate into the water stream;
- a method of aerating the concentrate/ water solution;
- hose to deliver the water, solution or foam; and
- a means of projecting the foam onto the fire.

Three types of foam producing equipment are used by the NSWFB:

- branches (low and medium expansion);
- eductors; and
- generators.

**Low Expansion Branches**

Branches mix concentrate, water and air in preset proportions and direct the foam stream. The following low expansion branches are used:

- FB5X
- F225
- FB10X
- FB10/10
- Quick Attack Foam Tube

All low expansion foam branches used by the NSWFB are capable of aerating a foam solution supplied from foam eductors or foam motors.

**FB5X**

This branch (Fig 3.1) is fitted with a 70 mm threaded inlet, water shut-off control and a foam concentrate regulator. The water control is held in the fully open position by a leaf spring.

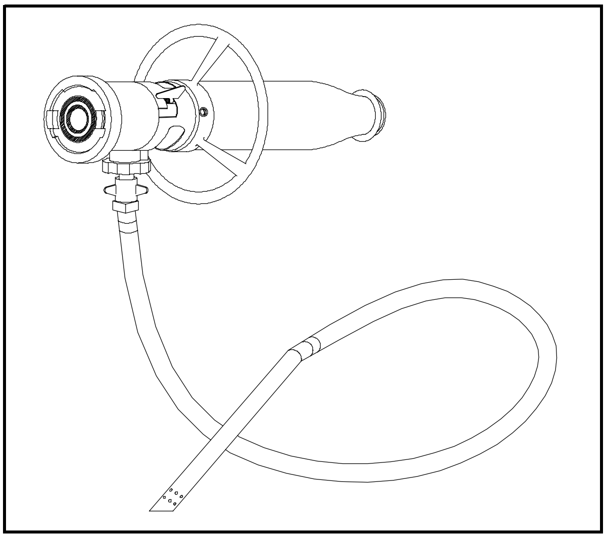

**Fig 3.2 FB5X Branch**

**CAUTION**

**It is essential that the leaf spring is depressed before operating the lever to shut off the water supply. Failure to do so will cause the spring to be distorted. A distorted spring will prevent the shut-off from fully opening and render the venturi effect inoperative.**

Experience with this branch has indicated that the foam concentrate regulator should be maintained at the limit stop (fully clockwise). At other settings incorrectly proportioned foam or failure to induce concentrate may result.

The concentrate pick-up incorporates a strainer, flexible hose and coupling.

**F225**

This branch is fitted with a 38 mm *Storz* inlet and is readily identifiable by its yellow colour. No controls are fitted for water shut off or foam concentrate regulation.

A flexible hose and pick-up tube with strainer is used to induct concentrate.

**Operating Instructions for FB5X/F225**

The optimum pressure to operate these branches is 700 kPa at the branch. Foam may be produced at lower pressures, but for best results the optimum pressure should be used.

To operate the branches carry out the following actions:

- run out a 38 mm (or 70 mm as required) to the point of operation, preferably on the windward side of the fire;
- attach the foam branch with pick-up tube (sufficient foam concentrate to commence the attack is to be available at the branch):
- charge the hose line and rapidly pressurise to 700 kPa;
- insert pick-up tube into concentrate container;
- run collector lines in to the appliance to maintain the water supply;
- when foam is produced, commence attack on fire;
- containers of concentrate are to be maintained at the branch so that no interruption to foam application occurs.

**NOTE**

**Water issuing from the branch during pressurisation is to be directed away from the flammable liquid fire.**

**By operating the pick-up tube from a container filled with concentrate, interruption of the foam attack is avoided.**

## FB10X and FB10/10

Both of these low expansion foam branches are fitted with 70 mm water inlets and are designed to aerate the solution at the branch (see Fig 3.2). They do require a pick-up tube as concentrate is induced into the water stream at the pump. A control handle operates the internal vanes which enables the branches to project the foam as a jet or spray.

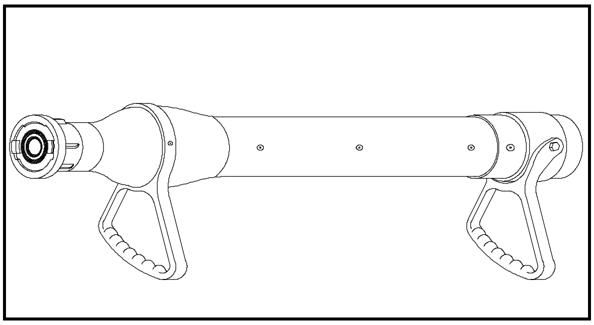

**Fig 3.3 FB10X Branch**

## Operating Instructions for FB10X/FB10/10

The optimum pressure to operate these foam branches is 700 kPa at the branch. You can use higher or lower pressure so that you can achieve correct concentrate induction rates at the foam pumper.

To operate these branches carry out the following actions:

- run out the hose line/s and attach the branch/es;
- charge and pressurise the hose line/s;
- maintain the output from the branch away from the flammable liquid fire until the foam is evident; and
- direct the foam onto the fire in a jet or spray pattern.

## Quick Attack Foam Tube

This piece of equipment is gradually replacing the FB5X and F225 branches and similar 38 mm equipment. It is used in conjunction with an *Akron* 2600 in-line eductor and fog nozzle to produce light water or aerated foam.

## Operating Instructions

To operate the foam tube carry out the following actions:

- clamp the foam tube onto the *Akron* fog nozzle;
- open the nozzle fully and ensure that it is free of debris; and
- operate the pump to ensure that a pressure of 1000 kPa min. to 1500 kPa max. is set.

## Medium Expansion Branches

The NSWFB currently only use one type of medium expansion branch the *Foamaster* (see Fig 3.3). The fibreglass branch is fitted with two handles and a 70 mm coupling. Air is inducted at the base of the branch to aerate the foam solution.

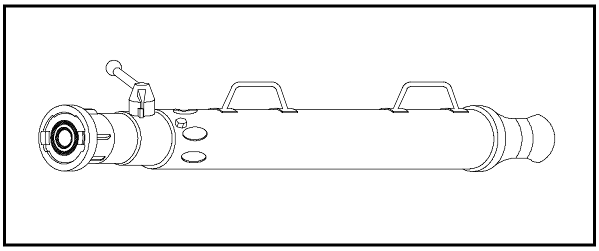

**Fig 3.4 Foamaster Branch**

A conical mesh screen is fitted near the mouth of the branch which produces foam bubbles of uniform size.

## Operating Instructions

To operate the Foamaster branch carry out the following actions:

- place the eductor in the hose line at

the pumps;

- adjust the control wheel for the induction rate required;
- charge the hose line and pressurise it to 700 kPa at the inductor
- insert foam pick-up tube into Expandol concentrate;
- when foam appears at the branch, direct it onto the fire.

To avoid interruption of foam production, maintain sufficient quantities of Expandol concentrate at the eductor.

### Eductors

The NSWFB currently have two models of eductor in service:

- *Akron* 2120; and
- *Akron* 2600 in-line.

### Akron 2120

This eductor (Fig 3.4) is the older of the two models and can supply foam solution for the FB10X/FB10/10 branches, *Akron* axial playpipe (25 mm) and turbo jet nozzles (1724). Table 3B details the eductor with various nozzle combinations.

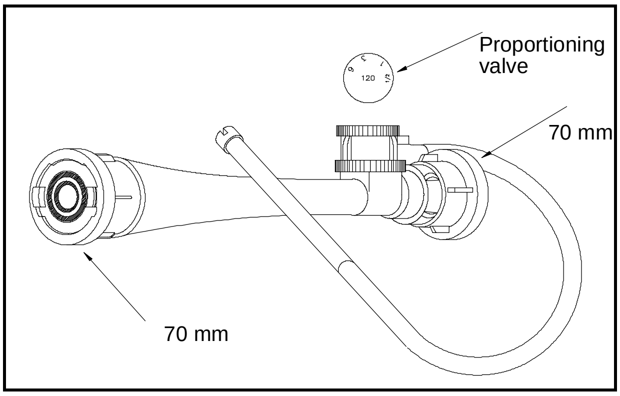


**Fig 3.5 Akron 2120 Eductor**

### Operating Instructions

To operate the *Akron* 2120 eductor carry out the following actions:

- connect the eductor to the delivery of the pump or to a 70 mm delivery hose as required;
- connect the delivery hose and nozzle;
- open the delivery and charge the line to 1400 kPa;
- the branch main will open the shut-off (if fitted); and
- the branch main is not to be directed towards the spill or fire until foam is produced.

| BRANCH | SUPPLY | DELIVERY | PROJECTION | TIME/20 L | EXPLANATION |
|---|---|---|---|---|---|
| FB10X/FB10/10 | Fixed | 450 L/min | 25 - 30 m | 0.45 | Low expansion foam |
| Axial Playpipe 25mm nozzle | Fixed | 500 L/min | 35 - 40 m | | Non aspirated foam |
| 1724 Turbo jet nozzle | | 475 L/min | 35 m | | Non aspirated foam |

**Table 3B Akron 2120 with Various Nozzles**

⚠ **NOTE**

**The pump operator is to ensure that the eductor is set at the correct proportioning ratio to suit the foam concentrate type and the flammable liquid being applied**

### Akron 2600 In-Line

This is the more modern of the two eductor models and has several advantages over the 2120 model:

- it produces either light water or aerated foam;
- it can be used with degreasing solutions, such as *Slixit* to remove hazards;
- foam compound supplies are usually introduced at the pump;
- the nozzle operator controls the production of foam; and
- this eductor is compatible with all types of foam concentrate.

The eductor (Fig 3.5) is used in conjunction with the *Akron* 1717 and 1717P Turbo-jet nozzles. It has the capacity to deliver 230 L/min of foam solution with proportioning ratios of 1, 2, 3 and 6%. The recommended pump pressure is 1400 kPa and the maximum length of hose between eductor and nozzle is three lengths.

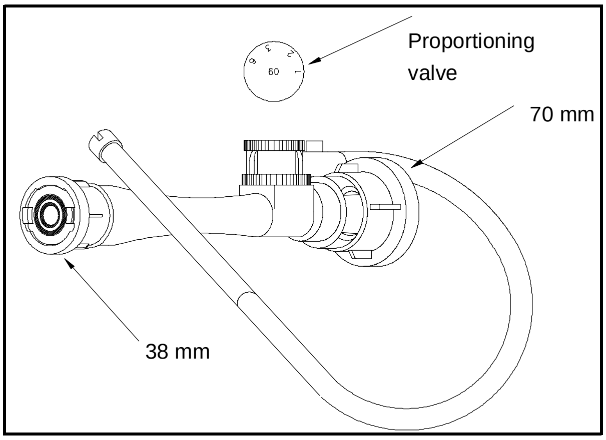


**Fig 3.6 Akron 2600 Eductor**

Table 3C details the operating range of the eductor with a 1717/1717P turbo-jet nozzle fitted.

### Operating Instructions

To operate the *Akron* 2600 eductor carry out the following actions:

- ensure that the nozzle and the eductor are matched and set the Akron 38 mm fog nozzle at 230 L/min;

⚠ **NOTE**

**The system will fail if a nozzle or setting is below 230 L/min (4 L/sec) flow rate.**

| L/MIN SETTING | SUPPLY | PROJECTION | TIME/20 L | EXPLANATION |
|---|---|---|---|---|
| 115 | No Foam | 25 m | Nil | For cooling exposures, personal protection |
| 230 | Foam | 20 m | 1.30 | For fire fighting. Max. protection, min. concentrate application |
| 360 | Foam | 12 -15 m | 1.10 | Vapour suppression. Medium protection and medium concentrate application |
| 475 | Foam | 6 - 8 m | 0.45 | Vapour suppression. Min. projection, max. concentrate application |

**Table 3C Akron 2600 Operating Range**

- set the metering valve to the required percentage for the foam compound being used - 1%, 2%, 3% or 6%;

- use a maximum of three lengths of 38 mm hose between the eductor and the nozzle. If a longer hose lay is required, use 70 mm hose from the delivery to the eductor so that you do not exceed the maximum of three lengths;

**NOTE**

**This eductor differs from the old style in that air is introduced into the hose line making it possible to use longer hose lays.**

- open the nozzle fully and ensure that it is free of debris;

- operate the pump to ensure a pressure of between 1000 kPa and 1500 kPa max.

Although the eductor will operate from 350 kPa at the lower pressures the mixture will be rich.

After each use the eductor and nozzle should be flushed thoroughly for a minimum of 5 mins and the metering valve should be rotated to all pick-up rates while flushing.

## Generators

The only generator currently in use with the NSWFB is the *Angus* Turbex high expansion foam generator (Fig 3.6). The generator is used to generate high expansion foam that is suitable for extinguishing **A** and **B** class fires in confined areas and additionally, to remove smoke and gas.

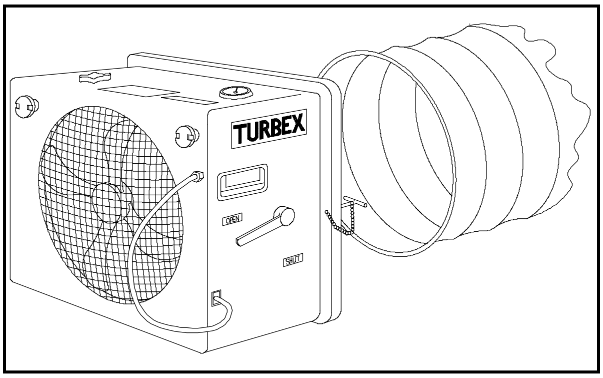


**Fig 3.7 High Expansion Foam Generator**

The generator housing has couplings where you attach the foam supply and waste hoses.

## Operation of the Generator

The generator operates as follows to generate foam:

- water coming into the generator passes through a mesh filter, this water drives a water turbine that is fitted with a four blade fan;

- the water then passes through a by-pass valve that controls the volume of water flowing to four spray nozzles;

- a small volume of water that passes to the turbine is diverted through two venturi devices to induct Expandol concentrate that is introduced into the water stream as the water passes through the spray nozzles;

- this mixture of water and Expandol is projected from the spray nozzles onto a nylon mesh net. Air from the fan passes through the mesh net and produces foam bubbles of a uniform size;

- a pressure gauge and by-pass valve control are located on the top of the casing. The pressure gauge indicates incoming pressure and the by-pass valve control regulates the expansion ratio of the foam and the speed of the fan;

- if you close the by-pass valve, all incoming water is used to produce foam. This results in foam with a lower expansion ratio; and

- if you open the by-pass valve, more water is directed to the turbine and less for foam production. This produces foam with a higher expansion ratio. The increased air flow and higher expansion ratio allow you to convey the foam over longer distances or to greater heights.

⚠ **NOTE**

**You can adjust the expansion ratios by varying the pressure and the by-pass valve settings. You will find a description of these settings and ratios on an engraved plate located adjacent to the by-pass valve control.**

- a foam pick-up tube is permanently connected under the inlet connection.

**Smoke and Gas Expeller**

When the generator is used as a smoke and gas expeller it operates as follows:

- the spray control valves, one on either side of the casing, are used to stop water/concentrate spray to the nylon net. In addition, an internal cock is closed to stop the out flow of water from the pick-up tube;

- ribbed, flexible ducting is attached in concertina fashion to the generator casing and secured by leather straps. The ducting aids the expellation of the smoke and gas

### 3.2.7 Miscellaneous Equipment

**Halo 500 Foam/Water Unit**

This unit (Fig 3.7) is a transition piece that allows existing water monitors fitted with fog nozzles to be instantly converted to a foam/ water monitor without affecting the performance of the water stream. There is no frictional loss through the unit.

The standard unit is pre-set for 3% proportioning but can be varied for other settings. The unit can be used on fixed and portable monitors and mobile units.

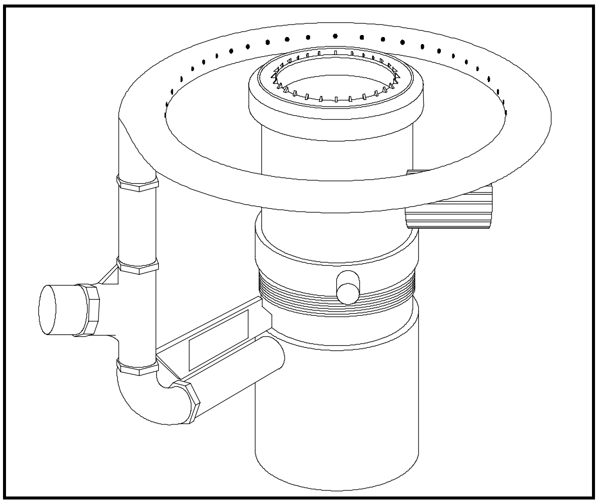

**Fig 3.8 Halo 500 Foam/Water Unit**

### 3.2.8 Techniques of Foam Application

Foam is most effective when applied to flammable liquid in a two-dimensional state. A flowing flammable liquid fire e.g. from a leaking flange, is difficult to contain as it is three-dimensional.

The following application techniques described are designed to suit the flammable liquid fires and spills that are two-dimensional and that you confront most often.

**Ground Application**

The *bounce and roll* technique is recommended for spills and fuel fires on the ground. The following actions should be taken:

- commence the attack on the fire at the maximum distance from the fuel;

- apply the foam on the ground between the fuel and the branch person;

- allow a head of foam to build up at the edge of the fire;
- as the head of foam flows over the surface of the fuel, advance slowly towards the fire as you bounce foam off the ground in front of the burning fuel;
- avoid placing the stream directly onto the surface of the burning fuel as this will cause turbulence and interfere with the vapour blanket.

**Above Ground Application**

The technique for applying foam above ground is known as *footprinting*. In this technique you can use several nozzles. The foam is directed so that it lands in one area of the fuel surface. You build the foam up from that target area and allow it to spread over the surface of the fuel.

This method is the most effective and economical method of applying foam. It reduces the amount of foam in contact with the flame or the vapours released by the burning fuel.

## 3.3 Dry Chemical Powders

### 3.3.1 Introduction

Dry chemical powders can be very effective in fire fighting when used appropriately. The most impressive feature of dry chemical powders is their ability to suppress very rapidly the flames of many fires, especially Class B fires.

**Standard Powder**

The standard type of dry chemical powder we use in the NSWFB is a finely milled sodium bicarbonate to which metal stearates are added. These stearates prevent the absorption of moisture and enable the powder to maintain its free flowing characteristics.

**Other Powders**

Other powders that we use re those based on:

- potassium salts;
- potassium salts and urea; and
- ammonium phosphate (tri-class powder). This powder is suitable for use on Class A, Class B and electrical fires.

⚠ **NOTE**

**Special powders have been developed for use on Class D fires and Class F fires.**

### 3.3.2 Flare-up Phenomenon

The initial blast of dry powder produces flame flare-up and increases the volume of the flame to approximately three times the original volume. This flare-up is of very short duration and is completely harmless as it is carried up and away by normal convection.

The flare-up effect is created by the high velocity injection of finely divided dry chemical particles into the fire zone. Air is pulled into this powder stream. Fuel vapour is displaced outwards and mixes with the air to form a more combustible substance than originally existed in the basic fire zone, resulting in a near-explosive combustion.

### 3.3.3 Thermal Barrier

You should note that the heat absorption properties of dry powders act to form an effective heat barrier between the fire and the operator. Class B fires produce large amounts of radiant heat. If you are unable to get close to the fire, you can apply a burst of dry powder above and in front of you. This burst can provide a heat resistant screen through which you can approach the fire with safety.

### 3.3.4 Flashback

Flashback can occur when you have used dry chemical powders to extinguish a Class B fire and the vapours of the fire re-ignite. This is because the powder itself does not form an effective blanketing layer over the surface of the flammable liquid as foam does.

If vapours continue to rise from the liquid surface to form a combustible mixture with the air, they may be ignited by:

- auto-ignition, should the vapour be still above its ignition point;
- heated objects such as metal or carbon that have been involved in the previous fire and are still above the auto-ignition temperature of vapours with which they come in contact; and
- some other external ignition source.

You should take every precaution to guard against flashback, leave the liquid surface intact i.e. don't walk over the surface after extinguishing a spillage fire. If you are in doubt about the state of the fire, you can take the following actions:

- discharge further dry powder onto it;
- cover the surface with compatible foam; or
- stand by with extinguishing equipment.

# SECTION FOUR - WATER SUPPLY

## CONTENTS

# 4 WATER SUPPLY

## 4.1 Introduction

Water is the most commonly used medium of fire extinguishment. It is:

- abundant;
- cheap; and
- effective.

As a firefighter, your ability to bring water to bear on a fire depends on your practical knowledge of two things:

- the location and type of water supply; and
- the particular conditions of water supply in each response area.

We have two basic sources of water supply available to us:

- reticulated water supply, both fresh and recycled; and
- static or open supply such as rivers, dams, tanks, swimming pools.

## 4.2 Reticulated Potable (Drinkable)

Most of the water we use for fire fighting purposes comes from reservoirs established to supply domestic and industrial water needs. The water from these reservoirs is distributed through water mains by the local Water Authority. The water from these mains is available through hydrants at various intervals for firefighters to draw water when they need it.

### 4.2.1 Mains

We draw water from three types of mains:

- **trunk mains** that supply water from the original source to a secondary distribution point;
- **distributary mains** that supply water from the secondary distribution point to sub-divided areas such as a suburb; and
- **reticulation mains** that feed off distributary mains and feed individual streets and buildings.

The flow of water in the mains depends upon several factors including:

- the size of the main;
- the internal condition of the main (tuberculosis and encrustation);
- the pressure at which the main is working;
- the length of the main; and
- the fittings attached.

Table 4A details the flow rates from various size mains:

| SIZE | FLOW RATE |
|---|---|
| 100 mm | 2220 L/min |
| 150 mm | 4500 L/min |
| 200 mm | 6720 L/min |
| 250 mm | 11 220 L/min |
| 300 mm | 18 000 L/min |

**Table 4A Water Mains Flow Rates**

### 4.2.2 Recycled Water Mains

Recycled water is available only in 100 and 150 mm mains. The availability of recycled water is identified by lilac identification plates. (See Fig 4.1)

**NOTE**

**Recycled water is not fit for human consumption.**

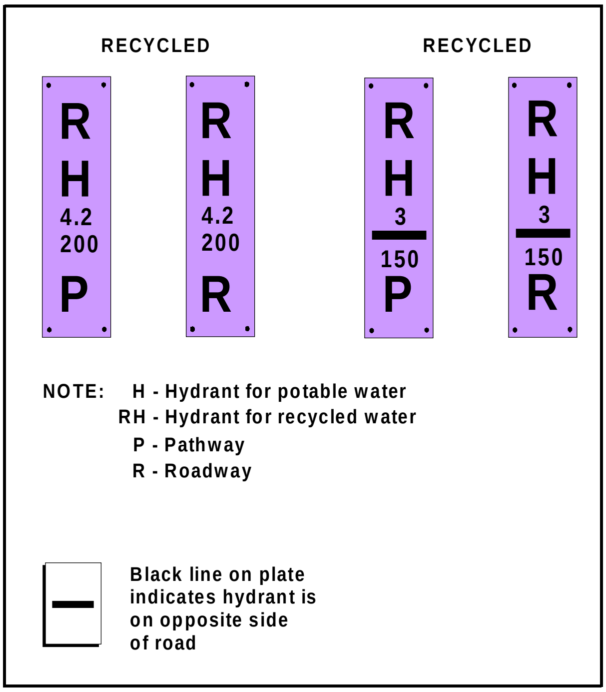


**Fig 4.1 Recycled Water Identification Plates**

## 4.3 Static

We can use an open accumulation of water such as that found in rivers, dams, lakes, tanks, or swimming pools by drafting the water with a pump and a suction hose.

Under ideal conditions, pumping water from a static water supply allows the pumpers to supply energised water at its maximum capacity. However, when we obtain water from a static supply, we can also have some problems. These problems include the following:

- the appliance needs to be close to the supply, but it must be located on a solid surface as an appliance can be easily lost or rendered useless through bogging or flooding;
- the more lengths of suction hose you use, the more the capacity loss you will experience, this is due to the vertical distance from the water surface to the pump;
- mud, weeds, and other foreign bodies can render pumps inoperable;
- the quantity of water needs to be sufficient for the purpose and sufficiently deep to draught; and
- tidal water sources can endanger appliances and affect water flow.

## 4.4 Hydrants

### 4.4.1 Location

Hydrants are located at regular spaced intervals along the water mains of reticulation systems. The exact spacing depends on the hazards and the nature of the area. We have a number of ways to locate these hydrants. (See Fig 4.2)

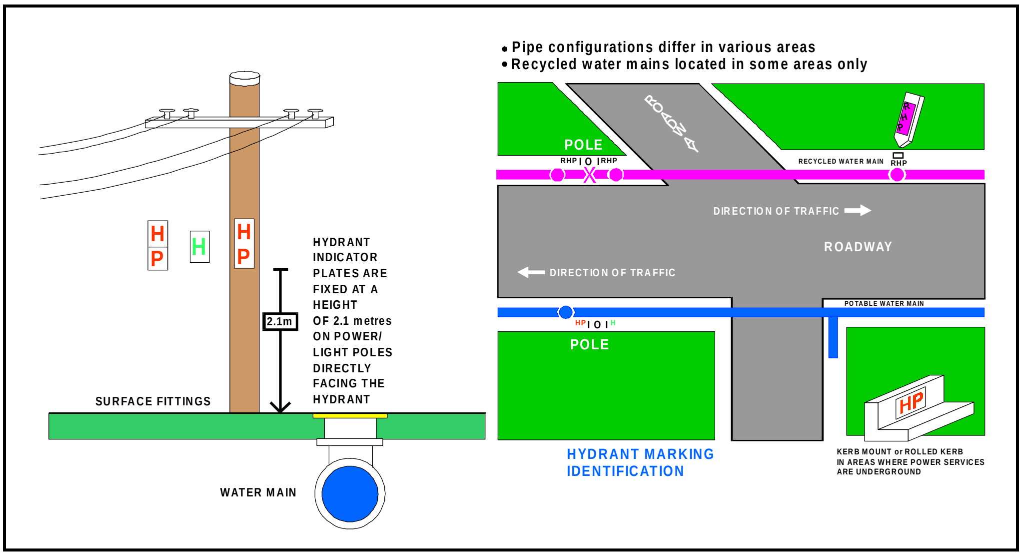


**Fig 4.2 Location of Hydrants**

Here are some of the common requirements that Water Authorities must observe relating to hydrants:

- they are required by law to provide and maintain hydrants at appropriate and convenient places to supply water to extinguish fire;
- they must keep the hydrants charged with water unless prevented by drought, accident, or repairs; and
- they must provide a conspicuous method of identifying the location of each hydrant.

### 4.4.2 Spacing

The spacing of hydrants depends on the density of population, the nature of the area, and the hazards relating to the installation of hydrants. For example:

- in city shopping areas or dense business and industrial districts, hydrants are placed at intervals of between 50-100 m.
- in residential and suburban shopping districts, hydrants are usually placed at intervals of between 150 - 200 m.
- in rural districts, hydrants are placed at intervals of 200 m or more.

### 4.4.3 External Indicators

In most parts of the country, Water Authorities are expected to provide conspicuous signs by which to identify the location of hydrants. These signs include:

- hydrant indicator plates that are usually white metal with reflective lettering. They are attached to conspicuous places such as poles, fences, and sides of buildings. The position of the plate and the lettering clearly identify the type and location of a hydrant;
- painted or other clear kerb markings;
- stripes on telegraph poles or small coloured posts; and
- painted and embossed hydrant covers.

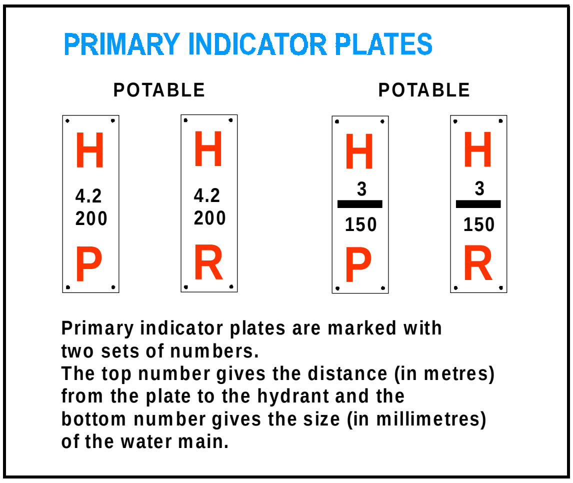


**Fig 4.3 Primary Indicator Plates**

### 4.4.4 Water Supply Maps or Hydrant Index Cards

Fire Services usually have other methods by which to identify the location of hydrants close to the fire site. These include:

- water supply maps, that mark the location of each hydrant on a reticulation system; or
- hydrant index cards.

Hydrant index cards are usually carried on the appliances. They identify the location of hydrants by street number on each street.

### 4.4.5 Types of Hydrants

A hydrant is a fitting installed in a water pipeline that provides a valved outlet to permit a controlled supply of water to be taken from a pipeline for fire fighting. Hydrant types are constructed according to *AS 2419 - 1980, 1.2.6.* (See Fig 4.4)

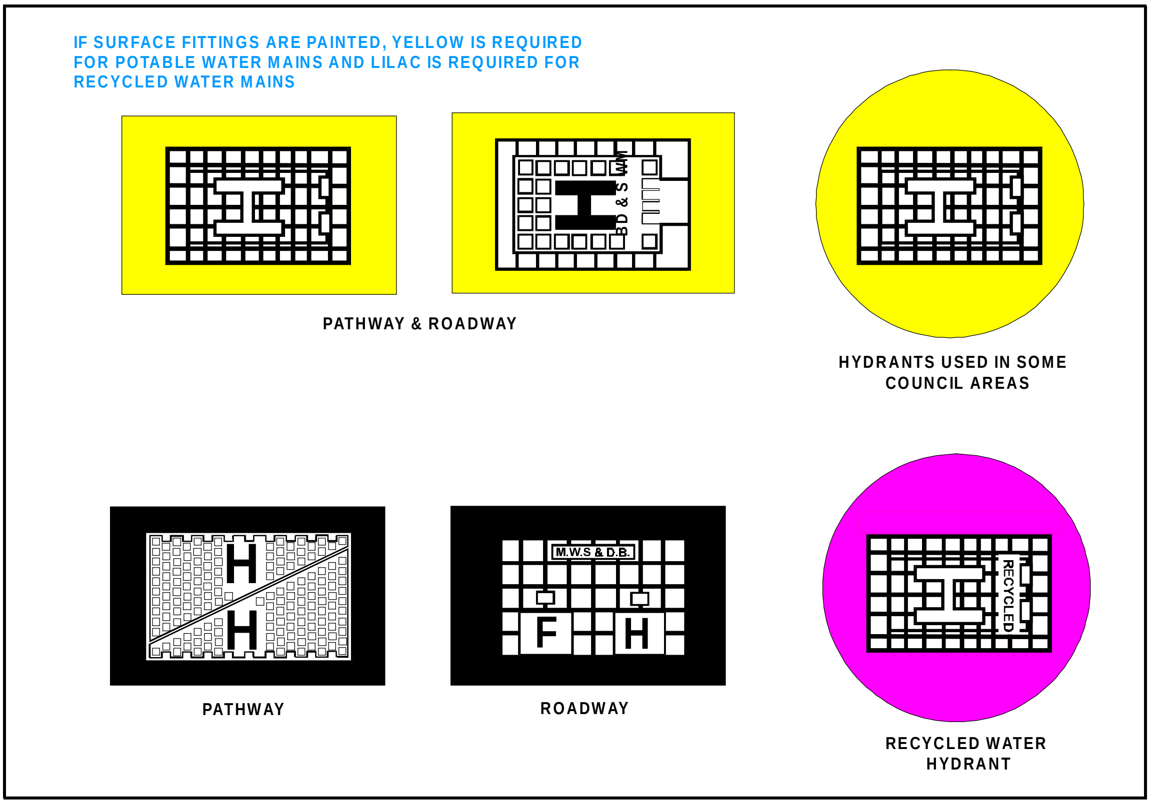


**Fig 4.4 Hydrant Surface Fittings**

We have three types of hydrants:

- ball valve used on reticulated water main systems;
- screw valve used on reticulated water main systems; and
- wheel valve pillar used on private hydrant systems.

**Ball Valve Hydrants**

Ball valve hydrants are all ball valve and mushroom-headed spring valves. These hydrants are located below ground and attached to a main by a T-piece and riser. They are housed in a cast iron pit and surrounded by concrete. They usually have a hinged iron cover plate marked with the letter **H.**

A ball valve hydrant uses water pressure against the spherical rubber valve to keep it closed.

This type of hydrant has two casings:

- the lower casing is bolted to the junction pipe on the main;
- the upper casing acts as the seat for the ball and has a lugged outlet to which the stand pipe is connected.

The mushroom-headed spring valve uses a spring as well as water pressure to keep the valve closed. The valve is, as its name implies, mushroom shaped.

The ball valves are simple and cheap, but they are also hydraulically inefficient. If pressure fails in the main, the ball drops permitting dirt and debris to enter and contaminate the main.

**Screw Valve Hydrants**

The screw valve hydrant is housed below the ground in a brick and concrete pit. It is generally fitted directly to the main by a hydrant **T** onto which the hydrant is bolted.

This type of hydrant has a cast-iron chamber and seating at the base for a disk-shaped valve. The valve is attached to a threaded spindle that terminates in a tapered square for application of the hydrant key that is used to open it.

The outlet flange is bolted to the side of the chamber and generally has a standard **V** male thread for an elbow or double delivery.

**Wheel Valve and Pillar Hydrants**

The wheel valve hydrant has a cast iron spherical water chamber. It has a seating against which a disk-type valve seals when it is closed by a threaded spindle. The spindle is operated by a hand wheel.

These hydrants operate on a similar principle to the domestic tap. They are generally located above ground on a pillar with a threaded outlet to which fire fighting equipment can be attached.

⚠ **NOTE**

**Older pillar hydrants do not always have *Storz* couplings attached so adaptors may be required.**

### 4.4.6 Operation of Hydrants

You should remember the following points when you operate hydrants:

- open the valve slowly to prevent damage to the hose through the sudden build up of water pressure;
- close the valve slowly to prevent water hammer and a possible burst mains. Water is not compressible, and the effect called water hammer is the result of shock generated if water is suddenly stopped or constricted;
- after using the hydrant, check to ensure that the hydrant is properly closed, that no water is leaking out, and that the hydrant pit is left clean of debris; and

- don't open the hydrant valve unless you have first securely shipped the standpipe, this prevents sand and small obstructions from entering the hydrant outlet. Such debris can contaminate the mains and prevent a good seating between the standpipe washer and the hydrant outlet.

### 4.4.7 Inspection And Testing

Hydrants are inspected and tested each year to detect faults or poor water supply.

The procedure for testing a hydrant is as follows:

- ship a standpipe or double delivery or elbow delivery;
- connect a one-into-two breaching to the standpipe;
- connect the hydrant pressure gauge to one outlet of the breaching and an *Akron* branch with 26 mm nozzle to the other;
- close the rotary valve of the breaching leading to the branch;
- turn on the hydrant to the required discharge;
- read the pressure gauge to obtain the static pressure of the main;
- open both outlets; and
- read the pressure gauge to obtain the running pressure of the main.

**NOTE**

**If the test reveals a drop of 70 kPa between the static pressure and the running pressure, this indicates that the mains flow is inadequate: report this to the local Water Authority.**

The following conditions within the main can contribute to an unsatisfactory running pressure:

- **encrustation**: living organisms or chemicals in the water have built up a crusty scale on the inner walls;
- **tuberculation**: rust and oxides have built up on the inner wall of the main;
- **sedimentation**: mud, clay, silt and/or decayed organic matter have built up within the main.

## 4.5 Equipment and Tools for Hydrant Operation

### 4.5.1 Introduction

Before you can operate a hydrant, you must attach a delivery to the hydrant outlet. Hydrants have three types of deliveries:

- double delivery;
- elbow delivery; and
- standpipe delivery.

### 4.5.2 Double Delivery

A double delivery connects to a screw-valve hydrant. A female thread at the bottom of the double delivery screws onto the hydrant. Water passes up to a swivel head that has two 70 mm *Storz* fitting outlets. The double delivery has two outlets. The water is directed to one or both outlets by a cylindrical rotary valve. This valve is operated by the indicating lugs.

**CAUTION**

**Do not use the cylindrical rotary valve to stop the water supply, this may cause the hydrant pressure valve to distort. The swivel head and valve are to be turned on only in a clockwise direction.**

### 4.5.3 Elbow Delivery

An elbow delivery connects to a screw-valve hydrant. A female thread at the bottom of the elbow delivery screws onto the hydrant. Water passes up to a swivel head that has a single *Storz* fitting.

**CAUTION**

**Turn the swivel head only in a clockwise direction.**

### 4.5.4 Standpipe Delivery

A standpipe delivery connects to a ball-valve hydrant. Lugs on a threaded collar at the base of the standpipe engage the clutches of the hydrant. You attach the standpipe to the hydrant by turning the standpipe clockwise by the two handles. A leather washer on the standpipe prevents water leakage. Connection of a standpipe to a hydrant is referred to as shipping a standpipe.

When the standpipe is shipped to the hydrant, you can control the water flow from the hydrant by operating the handwheel at the top of the standpipe. The handwheel is connected by a spindle to a concave disc. This disc depresses the hydrant valve.

When you turn the handwheel in a clockwise direction, the water flows to the swivel elbow outlet. This outlet has a 70 mm *Storz* fitting.

**CAUTION**

**When a standpipe is shipped, turn the swivel elbow *only in a clockwise direction*.**

Here are the operating instructions for the standpipe delivery:

- before you ship the standpipe, ensure that the threaded collar is screwed completely down, that the washer is in place, and that the handwheel is turned completely up;
- turn the water on **slowly** and flush the hydrant before you connect the hose: this minimises the risk of gravel or foreign matter blocking nozzles or entering pumps;
- when you turn off the supply from the hydrant, reduce the water flow **slowly** until the rate of discharge is roughly equivalent to the flow you obtain from a household tap. Maintain this discharge for 30 secs before you fully close the hydrant.

**CAUTION**

**If you do not observe this instruction, water hammer may cause damage to the water main or hydrant.**

## 4.6 Tools for Hydrants and Deliveries

### 4.6.1 Introduction

Fire appliances carry a number of tools that are used to access and operate hydrants and deliveries. In this section we discuss some of these tools and we describe their uses.

### 4.6.2 Hydrant Bar

The hydrant bar is used for loosening and opening covers on hydrants. One end of the bar is weighted, this is for striking the cover to loosen it. The other end has a chisel point for prising the cover loose.

### 4.6.3 Hydrant Cover Lifter

The hydrant cover lifter is used for removing heavy duty hydrant covers. The handle is a T-Bar. The other end is shaped to enter and engage the slots in the cover.

**CAUTION**

**When you remove a cover, use two lifters and raise the cover no more than 500 mm above ground so that you avoid injury to your feet if you drop the cover.**

### 4.6.4 Hydrant Key

The hydrant key is used to lift the covers on the screw valve hydrants and to turn the hydrant on and off. This is a T-shaped tool. The handle is chisel-shaped at one end to loosen the cover. The other end is shaped to engage and lift the cover. The shaft terminates in a tapered socket that fits the hydrant spindle.

### 4.6.5 Turncock Tools

You use the turncock tools to operate stop valves on water mains. They can also be used for valves on gas mains supplying high-rise buildings.

The turncock tool comprises a key and a bar. A tapered square socket at the lower end of the key accommodates a second detachable socket that is retained by a set screw. The key fits screw valve hydrant spindles on water main stop valves. To turn the key, insert the bar in the eye of the top of the key. This bar is similar to a hydrant bar.

## 4.7 Delivery Hoses

The delivery hose is used to convey water under pressure from a hydrant or pump to wherever it is required. We have five types of delivery hose:

- lined;
- unlined;
- percolating lined;
- high pressure; and
- rubber.

### 4.7.1 Lined Hose

This hose is manufactured mainly from a polyester fibre, such as nylon or terylene, that is synthetic, rot-resisting, lightweight and very strong. The lined hose has an internal lining of rubber or plastic to prevent water seepage.

### 4.7.2 Unlined Hose

This hose, as the name implies, does not have an internal lining, and it is usually made from natural fibres such as flax or cotton though it can be made of a combination of both synthetic and natural fibre. Unlined hose is gradually being replaced by lined hose.

⚠ **NOTE**

**When you need to take hose lines through parts of buildings that are not affected by fire, use lined hose. Unlined hose can cause water damage.**

### 4.7.3 Percolating Lined Hose

This hose is constructed so that when it is charged it permits the continual emission of droplets of water through its lining, this helps the hose to resist burning and scorching when the hose comes into contact with heated materials and embers.

### 4.7.4 High Pressure Hose

This type of hose is made entirely of terylene that has sufficient strength to withstand the high pressures required to pump water into high rise building installations. A rubber lining reinforces the fabric and improves the water flow.

### 4.7.5 Rubber Hose

This hose is manufactured from layers of rubber and canvas vulcanised together to form a tubing and it is used on first aid hose reels and on the delivery side of water tankers. The hose retains its shape even if no water is flowing through it. A special steel reinforced rubber hose is used on the first aid reel of appliances equipped with high pressure pumps.

### 4.7.6 Construction

Delivery hose is made of two sets of yarn that run at right angles to each other. The yarn that runs lengthwise is called the *warp* and the yarn that runs crosswise is called the *weft*.

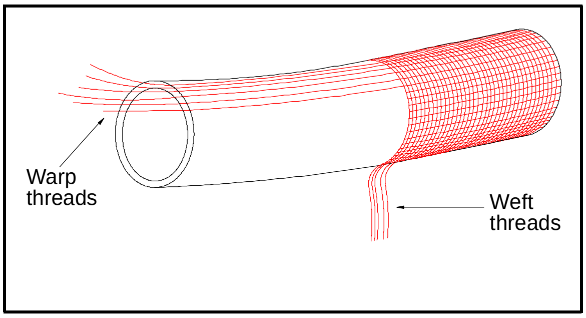


**Fig 4.5 Construction of Delivery Hose**

The warp threads in the hose give it durability to resist wear and tear. The weft threads resist the water pressure and keep the hose from bursting. The weaving is arranged so that warp threads are on the outside so that you can clearly see them when you look at the hose.

### 4.7.7 Size

The principal sizes of delivery hose used by firefighters are:

- 38 mm hose - 30 m
- 70 mm hose - 30 m

### 4.7.8 Identification Markings

Here are some of the characteristics of the identification markings for the various hoses:

- the hose identification number is branded within 0.5 m of the end of the hose;
- the hose identification number is branded at both ends of the hose;
- the hose identification number is located on both sides of the hose when the hose is in a lay-flat state;
- the centre of the hose has **NSWFB** branded on it;
- the digits of the brand are displayed as follows:
  - the station
  - the hose type
  - the hose number

**NOTE**

**The numbers are separated by a horizontal dash and the station number is closest to the couplings e.g.**

*280* *Station Number, Dubbo*

*-70NP* *70 mm Non Percolating Hose*

*-05* *Station Hose Number*

### 4.7.9 Hose Straps

The hose strap is used for two purposes:

- to keep hose rolled when in storage; and
- to identify the hose type (colour of strap).

**38 mm Hose Strap**

All 38 mm non-percolating hose have a fluorescent **lime green** hose strap attached.

All 38 mm percolating hose have a fluorescent **pink** hose strap attached.

**70 mm Hose Strap**

All 70 mm non-percolating hose have a fluorescent **lime green** hose strap attached.

### 4.7.10 Preparing Hose For Repair

When a hose is sent for repair, it must be prepared as follows:

- it must be clearly marked showing where the hole is i.e. circle the hole with a hose marking pen;

- it must be tagged with the fault described in writing explaining what part of the hose is damaged. Here are some examples of fault descriptions:

  - small hole approximately 12.5 m from strap end;

  - distorted coupling non-strap end;

  - full of pin holes, entire length;

  - new strap required;

  - leaking from beneath coupling non-strap end;

  - leaking from old patch.

**NOTE**

**Do not tag a hose for survey.**

### 4.7.11 Lay Flat Hose

Lay flat hose is issued in both 38 mm and 70 mm diameters. It is lined with rubber or a synthetic elastomer. The jacket of the hose is constructed of woven synthetic yarns 30 m in length.

Pressure ratings for lay flat hose are detailed in Table 4B.

### 4.7.12 Rubber Hose

Rubber hose comes in two different sizes:

- 20 mm hose - 18 m (First aid reels); and

- 20 mm hose - 20 m (Water Tankers).

| PRESSURE TYPE | RATING (KPA) | |
|---|---|---|
| | M CLASS | H CLASS |
| Working pressure | 1400 | 2100 |
| Proof pressure test | 2100 | 3150 |
| **Note: The NSWFB have recommended a maintenance test pressure of 1400 kPa for all hose** | | |

**Table 4B Lay Flat Hose Pressure Ratings**

### 4.7.13 Suction Hose

Suction hose is designed to resist external pressure. It is used **exclusively** between a static water supply and the pump.

#### Construction

Suction hose is made of layers of rubber and canvas. These materials are vulcanised together around a metal spiral. This spiral prevents the hose from collapsing when a vacuum is created within it.

The length of suction hose varies from 2.5 m upwards. The length conforms to the available stowage of a particular appliance.

#### Suction Strainers

Suction strainers are used on the end of suction hose to prevent foreign matter from entering the pump.

Strainers are perforated with holes small enough to prevent entry of sizeable matter. The total area of the holes is in excess of the pump inlet area.

Strainers are fitted with either threaded or *Storz* couplings. Two special types of strainers are also used:

- basket strainers which are placed over a normal strainer and secured to the suction hose by canvas lapping and leather straps. These strainers allow water to be draughted where mud, weeds, or other foreign matter might ordinarily block the normal strainer; and

- floating strainers which are used with water tankers. These strainers have a sealed chamber just below the surface of the water to prevent sand, silt or foreign matter from being drawn into the pump.

## 4.8 Hose Couplings

We use two types of hose coupling to join each hose length together:

- *Storz* couplings; and
- threaded couplings.

### 4.8.1 Storz Couplings

The *Storz* coupling comprises a shank and swivel collar. A special rubber washer is fitted to the shank. The swivel collar has two lugs that engage an internal collar flange. When you rotate the swivel collar 90°, the joint is secured.

When the coupling is secure in this position, it will not accidentally release when subjected to internal water pressure. The couplings are not male or female, and hence either end of the hose can be connected to any hose or equipment having *Storz* couplings or the equivalent diameter.

### 4.8.2 Threaded Couplings

The threaded coupling comprises a male or female thread. This coupling is used mostly in industry.

### 4.8.3 Collectors

A collector is attached to a pump inlet to allow 70 mm hose to be used to supply water to a pump.

Collectors have two or four 70 mm inlets fitted with non-return valves and an outlet that attaches to the pump. The couplings are either all female **V** thread or all *Storz*.

### 4.8.4 Blank Caps

Blank caps are used to prevent water leakage from pump collectors, suction inlets, or suction hose.

We use four types of these caps:

- 70 mm male threaded caps that are used on threaded collectors;
- female threaded caps that are used on threaded suction inlets;
- 70 mm *Storz* caps that are used on *Storz* collectors and deliveries; and
- *Storz* suction caps that are used on *Storz* suction inlets and suction hose.

### 4.8.5 Tools

Fire appliances carry a number of tools that are used to attach various devices such as hoses and couplings.

Suction spanners are used to tighten and loosen collector couplings, suction hose couplings, and strainers on suction hose.

The spanner for *Storz* couplings is crescent shaped at both ends. The larger end engages the boss on the *Storz* suction couplings. The smaller end engages the boss on *Storz* 70 mm couplings.

# SECTION FIVE - FIRE FIGHTING EQUIPMENT

## CONTENTS

# 5 FIRE FIGHTING EQUIPMENT

## 5.1 Introduction

The standard NSWFB appliance is equipped with a standard set of fire fighting equipment and tools. You should be familiar with the preparation and stowage of this equipment on an appliance.

It is important that you be able to identify all of this equipment and that you have a good working knowledge of where each item is stored on the various appliances.

Your ability to locate and use all of this equipment can help save lives and property from the effects of fire.

## 5.2 Water Extinguishing Equipment

The following equipment is used to supply and apply water and/or extinguishing mediums for fire suppression:

- branches;
- nozzles; and
- monitors.

**NOTE**

**Hoses are also classed as water extinguishing equipment but these are dealt with in Topic 2 Section 7.**

## 5.3 Branches

### 5.3.1 Introduction

Branches are attached to hose line for controlling, directing, and increasing the velocity of a stream of water.

Our aim as firefighters is to bring the fire under control with as little water damage as possible. We achieve this with good fire fighting techniques and the proper use of the branches, hoses, and related equipment.

### 5.3.2 Control of Branches

If the circumstances permit you to do so, you should shut off the branch before *lighting up* (moving forward) or *lighting back* (moving backwards) with the hose. This permits easier movement of the hose line.

If it is necessary to maintain a jet or diffuse stream while lighting up or lighting back hose, you should call for additional firefighters to support the line behind the branch and assist with the movement of the hose.

If you are the branch operator, you should slide your feet forwards or backwards in unison, one step at a time, so that you can maintain your balance and directional control of the branch.

Firefighters assisting the branch operator should support the hose line and ensure that the line is straight behind the branch operator. Everyone must exercise caution so that the balance of the branch operator is not upset by pulling or pushing the hose.

### 5.3.3 Precautions

Here are some precautions you should take when you are operating a branch:

- operate the shut-off controls on branches **slowly**: the sudden opening of shut-off control may throw branch operators off balance and the sudden closure of the branch can burst a hose line and/or give an unexpected pressure increase on other hose lines operating from the same pump;
- be careful of jet reaction: it can cause dangerous loss of stability if the branch is lowered below 30° elevation; and
- don't let a charged line get out of control; it is better to hang onto it and suffer minor injuries, than to let the

branch get away, as it can cause serious injury to fellow firefighters and others on the incident ground if it is allowed to escape.

### 5.3.4 Holding a Branch

It is essential that you adopt the correct method of holding a branch on a charged hose line.

Fig 5.1 illustrates the correct method of holding branches and overcoming the effects of back pressure.

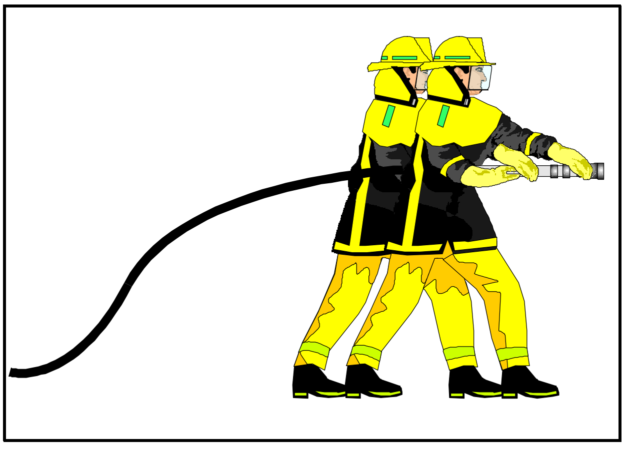

**Fig 5.1 Correct Method of Holding a Branch**

### 5.3.5 Stream Patterns

We use various types of streams to combat various types of fires and other incidents. These include:

- spray;
- fog;
- solid jet; and
- hollow jet.

**Spray streams**

A spray stream is a stream with the water broken up into coarsely divided droplets that are larger than fog. They also have a greater range and penetration than fog droplets.

The volume of the spray stream is similar to that of a solid stream. Spray streams are used when you are more concerned with extinguishing the fire than you are with water damage. With a spray stream, a considerable amount of water is projected over the general area.

**Fog streams**

A fog stream is a stream that is composed of extremely fine droplets of water. Each droplet is surrounded by air. This type of spray is easy to handle because the jet reaction is counter-balanced as the nozzle deflects the stream into its characteristic wide or narrow **V** pattern.

The performance of a fog stream is extremely efficient in quelling fires. This is because of the large surface area of water that is available with this stream. This stream allows a rapid heat absorption and results in a quick fire knock-down e.g. 300 L of water (0.3 $m^3$) will vaporise into 500 $m^3$ of fog. This is enough to fill a room 3 m x 8 m x 20 m.

**CAUTION**

**In the above example, the stream produced could result in scalding or discomfort to the firefighters in the room.**

When you use a fog stream, you must adjust it so that you produce fog in quantities capable of absorbing the heat of the fire faster than the heat is generated. You can usually accomplish this if you use a minimum pressure of 700 kPa at the nozzle of either 70 mm or 38 mm hose.

**Solid Jet Streams**

A solid jet stream is a compact stream that has great projection but has little spray or shower. It will not break up greatly over the majority of its range. It is therefore still enough to reach considerable heights in fresh breezes with minimal break-up.

**Hollow Jet Streams**

A hollow jet stream has similar characteristics to solid jet streams, but the hollow stream can be affected by wind. It generally breaks up over its trajectory.

Essentially, the hollow jet stream allows greater versatility of the *Turbojet nozzle*: you can use a jet where you must reach the seat of the fire, and, as the fire becomes more approachable, you can turn the spray to cover a greater area without having to change the equipment you are using.

### 5.3.6 Jet Spray Shut-off Branch

The jet spray shut-off branch can be used with the 70 mm hose and the 38 mm hose.

The branch used with the 70 mm hose consists of a cylindrical shaft with an internal taper. It is lever operated to provide a straight jet, spray jet, and shut-off. Rotation of an external sleeve provides a fine water spray for user protection.

The jet spray shut-off branches for use with 70 mm hose come in four models:

- 22 mm outlet with 16 mm nozzle;
- 19 mm outlet with 12 mm nozzle;
- 22 mm outlet with 19 mm + 16 mm nozzle; and
- 26 mm outlet with 19 mm + 16 mm nozzle.

The branch used with the 38 mm hose provides a straight jet, dense spray, and shutoff. It has a 16 mm outlet plus a 12 mm nozzle.

### 5.3.7 Akron Branches

These branches are designed as a medium between the hose and the nozzle. They have several purposes:

- to supply a means of directing a stream of water;
- to turn the stream on;
- to shut the water off; and
- to increase the velocity of the water by use of the branch's tapered shaft.

Both the *Pistol Grip* and the *Axial Playpipe* are made of lightweight anodised alloy (Pyrolite). They both have an in-built ball-valve shut-off located within the body of the branch.

The attachment point for the nozzles on both branches consists of a 38 mm BSP thread that can be used with a 38 mm *Storz* adaptor for the attachment of 38 mm hose (allowing the 70 mm Playpipe to be used as a reducer/shut-off and the Pistol grip as a shut-off).

**Pistol Grip Shut-off**

The Pistol Grip is designed for easy control by one person using a 38 mm hose. It is 110 mm long and incorporates a 26 mm smooth bore waterway.

It is used with a Turbo jet nozzle or it can be used with Stacked Tip nozzles to provide a solid jet stream.

**Axial Playpipe.**

The Axial Playpipe with its 35 mm waterway and an overall length of 265 mm can be fitted with 26, 29 and 32 mm stacked tip nozzles (Solid bore) or alternatively with a Turbo jet nozzle.

### 5.3.8 Hoenig Branches

The *Hoenig* branch used with a 70 mm hose can provide streams from a spray to a hollow jet.

## 5.4 Nozzles

### 5.4.1 Introduction

The nozzle is the section at the end of the branch which controls the size and pattern of the water jet or stream.

By using nozzles with different size orifices, variations in the volume of water delivered is achieved. Special nozzles are used when specific patterns of water application are required.

The nozzles generally used in the NSWFB are:

- turbo jet;
- stacked tip; and
- multi-jet.

### 5.4.2 Turbo Jet

The turbojet nozzle is designed to give the correct amount of water in the most appropriate manner to extinguish a range of fire types.

It has adjustable selection rings so that you can adjust both the water flow, litres per minute (L/min), and the water pattern, while you are operating the branch. The branch has spinning turbine teeth located at the front of the nozzle. These teeth determine the quality of the fog delivered by the nozzle. The minimum pressure required to deliver an acceptable fog is 700 kPa.

The Turbojet nozzle can also be attached directly to a length of hose using *Storz* adaptors. The in-built twist shut-off can then be used as the medium for turning the water on and off.

**CAUTION**

**You must not use the twist shut-off at pressures in excess of 1400 kPa.**

If the turbine becomes blocked, you can flush it by turning the flow ring to the flush position; you can do this without shutting down.

Table 5A details the discharge control for Turbo-jet nozzles of both 38 mm and 70 mm size.

| 38 mm (700 kPa) | 70 mm (850 kPa) |
|---|---|
| 115 L/min | 450 L/min |
| 230 L/min | 550 L/min |
| 360 L/min | 750 L/min |
| 475 L/min | 950 L/min |
| Fully open for flush | Fully open for flush |

**Table 5A Turbojet Nozzle Discharge Control Setting**

### 5.4.3 Stacked Tip

Stacked tip nozzles come in three sizes; 26 mm; 29 mm; and 32 mm. These nozzles have smooth tempered bores (waterways).

Table 5B details the recommended nozzle pressures for the three sizes of nozzle.

### 5.4.4 Multi-Jet

This type of nozzle is used with rubber hose from hose reels. The jet size is adjusted by rotating a collar that aligns different size orifices with the waterway. It uses two types of jets: the *Dial-a-Jet* and *Grascos Norvent:*

- *Dial-a-jet* orifices: 3 mm, 6 mm, 9 mm, and spray;
- *Grascos Norvent* orifices: 3 mm, 5 mm, 7 mm, 8 mm and spray.

| HOSE DIA | NOZZLE SIZE | NOZZLE PRESSURE | DELIVERY RATE | PROJECTION (METRES) |
|---|---|---|---|---|
| 70 mm | 26 mm | 850 kPa | 960 L/min | 34 m |
| 70 mm | 29 mm | 850 kPa | 1500 L/min | 39 m |
| 70 mm | 32 mm | 850 kPa | 1800 L/min | 42 m |

**Table 5B Recommended Nozzle Pressures**

**CAUTION**

**Damage to the sharp edge of the bore of a nozzle seriously affects the jet you can obtain from the nozzle. For this reason, the edge of the bore is recessed. You must take utmost care when you are handling and cleaning the nozzles to avoid damage to the bore or leading edge.**

## 5.5 Monitors

### 5.5.1 Introduction

When discharge rates exceed approx. 1200 L/min it becomes impracticable for branches to be hand-held. In these circumstances and when safety factors preclude a manned attack, monitors may be used.

Monitors usually have more than one inlet and may be fitted with straight stream, fog foam making outlets. They may be attached to a fire appliance or be portable.

Monitors are used to deliver large streams of water. They are designed so that they can be operated by one person. If necessary, they can even be left unattended while operating.

### 5.5.2 Apollo Ground Monitor

This monitor can deliver large volumes of water over long periods of time from a fixed position. It is made of lightweight pyrolite and consists of the following:

- two 70 mm inlets with non-return valves;
- a centre base with floating legs;
- hardened steel ground spikes;
- a safety chain with hammer;
- a discharge pipe; and
- a large diameter with internal vanes.

The nozzle diameters of this monitor are:

- 26 mm;
- 35 mm;
- 38 mm;
- 44 mm; and
- 63 mm.

It also has one diffuser nozzle.

### 5.5.3 Other monitors

The following monitors are also used by the NSWFB include:

- terminator;
- titan; and
- *Hoenig*.

## 5.6 Maintenance Of Minor Equipment

All of the equipment detailed in this section needs to have periodic maintenance. Table 5C details particular points regarding daily maintenance of this equipment.

| EQUIPMENT | INSPECTION/RECTIFICATION |
|---|---|
| Branches | • True shape<br>• Waterway undamaged<br>• All joints tight (jet/spray branch)<br>• Free operation of spray adjusting sleeve<br>• Free operation of shut-off lever |
| Nozzles | • Orifice edge sharp, no scratches |
| Monitors | • Non-return valves seated and free to move<br>• Elevation and swivel movement free<br>• Locking device operational |

**Table 5C Equipment Inspection and Rectification**

**NOTE**

**All minor equipment used with salt or polluted water is to be thoroughly cleaned internally and externally with clean fresh water on return to the station.**

When minor equipment is issued to a station, or when it is returned from repair or loan, the equipment must be tested before it is placed into service. Station records and inventory cards are to be adjusted accordingly.

# SECTION SIX - PORTABLE FIRE EXTINGUISHERS

## CONTENTS

# 6 PORTABLE FIRE EXTINGUISHERS

## 6.1 Introduction

All portable fire extinguishers operate by stored pressure. The extinguisher maintains air or gas ($CO_2$ or nitrogen) under pressure. When the extinguisher is operated, the air or gas pressure expels the extinguishing agent.

**NOTE**

**All extinguishers must be recharged before use.**

## 6.2 Method Of Operation

Most portable hand held fire extinguishers manufactured after 1981 use a squeeze-grip type release. A hand operated squeeze-grip is located above or below the carry handle. Most small models have a trigger control. A locking pin prevents accidental operation. Operation of the squeeze-grip discharges the contents.

A helpful way to remember how to use a portable extinguisher is to use the acronym:

**P - pull the pin;**

**A - aim low;**

**S - squeeze the handle;**

**S - sweep from side to side.**

Here are the four steps that are required to be carried out in order to be able to correctly operate a portable fire extinguisher:

- pull the pin; some extinguishers require you to release a lock latch, press a puncture lever, or perform some other action;
- aim low; point the extinguisher at the base of the fire;
- squeeze the handle; this releases the extinguishing agent; and
- sweep from side to side; sweep the base of the fire until it appears to be out.

**NOTE**

**Always test the extinguisher before approaching the fire.**

**CAUTION**

**Remember that portable fire extinguishers are for small fires only: don't put your life in danger while using them.**

In selecting a portable fire extinguisher for home use, choose one that is suitable for fires involving electrical equipment and for flammable liquid fires; these fires are the most common in the home.

Fig 6.1 details all types of fire extinguishers currently in use with the NSWFB and indicates their suitability for certain fire situations.

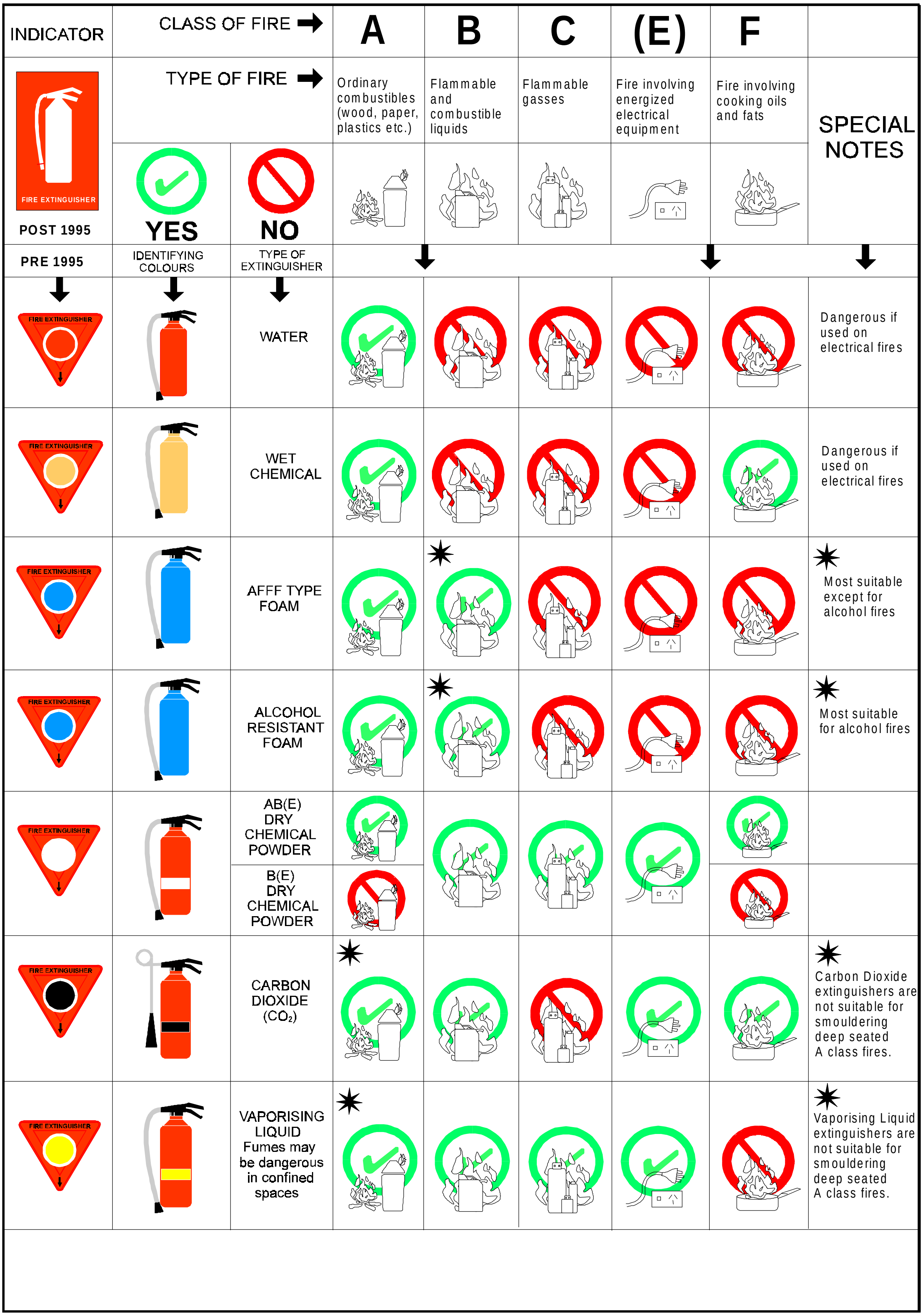


**Fig 6.1 Fire Extinguisher Selection Chart**

## 6.3 Stored Pressure Water Extinguisher

### 6.3.1 Characteristics

Characteristics of this extinguisher include:

- colour: red;
- capacity: 9 L;
- duration of release: 60 secs; and
- range: 9 m.

### 6.3.2 Checks

This extinguisher should be subjected to the following quality checks:

- daily: inspect seal, gauge, water contents;
- three monthly: discharge and recharge; and
- five yearly: hydrostatic test to be carried out by a servicing company.

### 6.3.3 Contents

The contents of this extinguisher are:

- 9 L of water;
- + air pressurised to 700 kPa.

### 6.3.4 Safe Working Practices

The safe working practices that apply to this extinguisher are as follows:

- ensure that you have a safe exit path before you use the extinguisher;
- operate the extinguisher upwind from the fire;
- operate the extinguisher from its maximum range;
- test the extinguisher with a short burst before approaching the fire; and
- test the extinguisher with a short burst on the fire.

## 6.4 AFFF Stored Pressure Extinguisher

### 6.4.1 Characteristics

Characteristics include:

- colour: blue;
- capacity: 9 L;
- duration of release: 45 secs; and
- range: 6 m.

### 6.4.2 Checks

This extinguisher should be subjected to the following quality checks:

- daily: inspect seal, gauge, contents;
- three monthly: discharge and recharge; and
- five yearly: hydrostatic test to be carried out by a servicing company.

### 6.4.3 Contents

The contents of this extinguisher are:

- 8.4 L of water;
- + 600 mL AFFF Concentrate;
- + air pressurised to 700 kPa

### 6.4.4 Safe Working Practices

The safe working practices that apply to this extinguisher are as follows:

- ensure that you have a safe exit path before you use the extinguisher;

- operate the extinguisher upwind from the fire;
- operate the extinguisher from its maximum range;
- test the extinguisher with a short burst before approaching the fire;
- test the extinguisher with a short burst on the fire; and
- do not use this extinguisher on hot depth fires.

**NOTE**

**Pressurising of the above extinguishers is to be carried out in accordance with *In Orders*.**

## 6.5 Carbon Dioxide Extinguisher

### 6.5.1 Characteristics

Characteristics include:

- colour: red with a centrally located black band;
- capacity: 3.5 & 5.5 kg of $CO_2$
- duration of release: 25 - 35 secs; and
- range: 2.5 m.

### 6.5.2 Checks

This extinguisher should be subjected to the following quality checks:

- daily: inspect seal: if the seal is broken, weigh the extinguisher and if necessary replace the gauge and contents;
- weekly: inspect for damage, check the hose connections, and ensure that the retaining nut and diffuser are intact;
- three monthly: weigh the extinguisher: if there is a difference of 500 gms between Tare (empty) and gross weight, replace the extinguisher and send it for servicing; and
- hydrostatic testing is carried out by the service company. - 5 yearly.

### 6.5.3 Safe Working Practices

The safe working practices that apply to this extinguisher are as follows:

- ensure that you have a safe exit path before you use the extinguisher;
- operate the extinguisher upwind from the fire;
- operate the extinguisher from its maximum range;
- test the extinguisher with a short burst before approaching the fire;
- use BA when operating the extinguisher in enclosed spaces;
- beware of static spark in explosive atmospheres; and
- beware of flashback: $CO_2$ dissipates due to draughts.

### 6.5.4 Contents

The contents of this extinguisher are:

- liquefied $CO_2$; and
- a pressure relief valve which operates at 18 kPa.

## 6.6 Dry Chemical Extinguisher B(E)

### 6.6.1 Characteristics

Characteristics include:

- colour: red with a centrally located white band;

- capacity: 1.25 & 9 kg of dry chemical;
- duration of release: 12 secs and 20 secs; and
- range: 2.5 and 4 m.

#### 6.6.2 Checks (9 kg only)

This extinguisher should be subjected to the following quality checks:

- daily: inspect seal and pressure gauge to ensure they are correct;
- weekly: invert extinguisher several times to prevent contents from caking; and
- five yearly: hydrostatic test to be carried out by a servicing company.

#### 6.6.3 Safe Working Practices

The safe working practices that apply to this extinguisher are as follows:

- ensure that you have a safe exit path before you use the extinguisher;
- operate the extinguisher upwind from the fire;
- operate the extinguisher from its maximum range; and
- test the extinguisher with a short burst before approaching the fire.

#### 6.6.4 Contents

The contents of this extinguisher are:

- finely milled sodium bicarbonate with metal stearates to maintain free-flowing characteristics; and
- propellant gas, usually nitrogen or $CO_2$.

### 6.7 Dry Chemical Extinguisher AB(E)

#### 6.7.1 Characteristics

Characteristics include:

- colour: red with a centrally located white band;
- capacity 9 kg of dry chemical;
- duration of release 20 secs; and
- range: 3 - 4 m.

#### 6.7.2 Checks

This extinguisher should be subjected to the following quality checks:

- daily: inspect seal and pressure gauge to ensure they are correct;
- weekly: invert extinguisher several times to prevent contents from caking; and
- five yearly: hydrostatic test to be carried out by a servicing company.

#### 6.7.3 Safe Working Practices

The safe working practices that apply to this extinguisher are as follows:

- ensure that you have a safe exit path before you use the extinguisher;
- operate the extinguisher upwind from the fire;
- operate the extinguisher from its maximum range; and
- test the extinguisher with a short burst before approaching the fire.

### 6.7.4 Contents

The contents of this extinguisher are:

- finely milled monammonium phosphate with metal stearates to maintain free-flowing characteristics; and
- propellant gas, usually nitrogen or $CO_2$.

## 6.8 Wet Chemical

### 6.8.1 Characteristics

Characteristics include:

- colour: oatmeal;
- capacity: 7 L of fire suppressant;
- duration of release: 90 secs; and
- range: 5 m.

### 6.8.2 Checks

This extinguisher should be subjected to the following quality checks:

- daily: inspect seal and pressure gauge to ensure they are correct;
- three yearly: hydrostatic test to be carried out by a servicing company.

### 6.8.3 Safe Working Practices

The safe working practices that apply to this extinguisher are as follows:

- ensure that you have a safe exit path before you use the extinguisher;
- operate the extinguisher upwind from the fire;
- operate the extinguisher from its maximum range; and
- test the extinguisher with a short burst before approaching the fire.

### 6.8.4 Contents

The contents of this extinguisher are:

- 7 L of liquid fire suppressant; and
- propellant gas, nitrogen or air (700 kPa)

# SECTION SEVEN - HOSE HANDLING

## CONTENTS

# 7 HOSE HANDLING

## 7.1 Introduction

As a firefighter, your ability to handle hose competently can be developed only by constant practice. To you, hose handling should become almost an automatic activity.

If you can handle hose efficiently, you are better able to concentrate your attention on the overall emergency. You can observe aspects of the situation that might otherwise go unnoticed.

These observations can help you avoid danger to yourself and others. They also provide you with an opportunity to re-assess the fire fighting tactics that you and your team have planned to attack an incident.

## 7.2 Stowage of Hose on Appliances

Hose carried on fire appliances is flaked and joined together in hose trays. This arrangement allows the hose to be run out to the fire quickly and efficiently. Additional lengths of hose that are carried on the appliance are rolled and are used to supply water from hydrants to the collector.

A line of hose consists of one or more lengths. The first length is connected to the delivery or hydrant. The second length is connected to the first length, and so on. The branch is attached to the last length.

## 7.3 Terminology

Table 7A details some common terminology that is used with the NSWFB when handling hose.

## 7.4 Orders Used in Hose Handling

### 7.4.1 Introduction

When working with hose certain orders are given and need to be responded to with specific actions:

- *to pick up and carry rolled hose;*
- *to run out hose*; and
- *on the bight*.

| TERM | MEANING |
|---|---|
| *ship* | to connect equipment to a hydrant |
| *down with the hydrant or delivery* | water supply is to be turned on |
| *knock-off the hydrant or delivery* | water supply is to be turned off |
| *light up the hose* | a hose line is to be advanced |
| *light back the hose* | a hose line is to be withdrawn |
| *all ready number one* | tells the member in charge of a branch that another member carrying out some specified duties is ready to commence or has completed the task |
| *make-up* | all equipment is to be disconnected, hoses are to be drained and re-rolled, and all items are to be returned to their place of origin |
| *flaking* | the hose is doubled back and forward on itself and carried on trays |
| *on the bight* | rolled hose |

**Table 7A Hose Handling Terminology**

### 7.4.2 *to pick up and carry rolled hose*

When this order is given, you place the length of hose vertically on the ground with the couplings on top. Take hold of the hose straps on either side of the hose and lift the hose onto your shoulder so the couplings rest against your chest.

When you reverse these movements, the couplings are in the correct position for the hose to be run out.

**NOTE**

**When you pick up the hose in this manner, you can see the couplings and can ensure that the washers are in place.**

### 7.4.3 *to run out hose*

When this order is given, you work with the flaked hose. On appliances fitted with trays, if you are the first firefighter, you take the length of hose, with branch attached, from the tray and carry it over your shoulder or under your arm. You then move clear of the appliance and allow other firefighters to each obtain a length of hose and carry it in a similar manner.

If you are the last firefighter, you leave the coupling and sufficient hose to connect to the pump and move towards the fire and allow your hose to run out. As each firefighter finishes running out their length of hose, they call out *stand by.* The firefighter in front of them then runs out their length of hose.

### 7.4.4 *on the bight*

When this order is given, carry out the following actions:

- place the roll of hose on the ground with the couplings on top;
- face the hose waterway and release the strap;
- lay the couplings on the ground and roll out sufficient hose to allow the coil to be lifted;
- place your foot on the hose and lift the coil to chest height, cradle the coil along the forearm and grasp the uncoiled part of the hose with the other hand;
- take a step forward and bowl the coil in the required direction. As the hose rolls out, jerk the hose to add momentum to the coil; and
- take the uppermost coupling and proceed in the required direction.

## 7.5 Hose Laying Precautions

When you are running out hose you should observe the following precautions:

- keep the hose free of kinks and sharp bends so the water flow is clear;
- allow sufficient hose at the branch so the hose line can be advanced as the fire is extinguished;
- don’t drag hose around corners of buildings, over rough ground, or over collapsed debris;
- don’t lay hose over burning or hot debris;
- avoid hose contact with chemicals, oils, and fuels; and
- lay hose close to the wall on stairways so the egress is not impeded and maximum curvature of hose is obtained.

## 7.6 Connecting Hose to a Delivery

When you connect a hose to a delivery, make the joint by holding the shank of the coupling in one hand and turn the swivel clockwise with the other hand until the joint is tight.

### 7.6.1 To Connect Two Lengths of Hose

To connect two lengths of hose with *Storz* couplings, stand to one side of the hose and take a coupling in each hand. Engage the lugs of the couplings and rotate them in opposite directions to their full extent.

### 7.6.2 To Attach a Branch

To attach a branch with *Storz* couplings, stand to one side of the hose. Take the hose coupling in one hand and the branch in the other. Engage the lugs and secure the joint by rotating the branch and coupling in opposite directions.

### 7.6.3 To take off a branch

To take off a branch with *Storz* couplings, stand to one side of the hose. Grip the branch with one hand and turn the coupling in an anti-clockwise direction with the other hand.

### 7.6.4 To Attach a Short Line

To attach a short line at 3 m from the branch, make a round turn with the eye-spliced end of the short line around the hose. Then pass the other end of the line through the eye-splice.

⚠ **NOTE**

**A pocket line is used to support a charged line of hose.**

### 7.6.5 Under-running Hose

Lay the hose out in a straight line. Pick up the hose approximately 2 m from a coupling and lift it above your shoulder. Walk toward the opposite end. As you walk, pass the hose from hand to hand above shoulder height. The hose should then be made up in the desired manner.

### 7.6.6 To Flake Hose on the Ground

The hose is flaked in convenient bights approximately 2 m in length.

### 7.6.7 To Haul a Line of Hose Aloft

Take a General Purpose Line (GPL) aloft to the place selected. Lower one end of the line to the ground. Secure the line to prevent it from falling. Flake sufficient hose with branch attached on the ground below the GPL.

Leave 3 m of GPL for use as a short line. Secure the GPL to the hose with a round turn and two half hitches 3 m from the branch.

Form a clove hitch in the standing part of the GPL. Slip it over the nozzle and secure it below the coupling of the branch.

As the hose is hauled aloft, a firefighter on the ground should assist in keeping the hose and branch clear of the wall and any other obstructions.

After hauling the hose aloft, secure the 3 m length of GPL to support the hose. Remove the clove hitch from the branch and draw sufficient hose through the round turn and two half hitches for fire fighting operations before the hose line is charged.

### 7.6.8 To Lower Hose

After the hose is drained, lower the branch by the hose until it is supported by the 3 m length of GPL. Haul the GPL up to support the hose while the 3 m length of line is untied from the support. Lower the hose line to the ground by the GPL.

# SECTION EIGHT - SIGNALS AND COMMANDS

## CONTENTS

# 8 SIGNALS AND COMMANDS

## 8.1 Introduction

In training and in drill exercises, we use various specific signals and commands. Knowledge of these signals and commands is essential if you are to work as part of a crew and to ensure maximum effectiveness from every firefighter in the team.

When we are all familiar with the various types of signals and commands, we are much more efficient. The signals and commands we use are grouped into the following categories:

- verbal commands;
- whistle signals; and
- hand/light signals.

## 8.2 Verbal Commands

Table 8A details the verbal commands that are used on the incident ground. Each command has a specific meaning and purpose.

⚠ **NOTE**

**For details of verbal commands used when handling hose, refer to Topic 2 Section 7.**

Table 8B details the verbal commands used when using ladders.

| COMMAND | MEANING |
|---|---|
| *Get to work* | Carry out the instruction you have been given |
| *As you were* | Cancels the order you were given |
| *Carry on* | Given after *stop* command |
| *Still* | This command is for **emergency use only** to prevent an accident from happening: it means cease all action immediately |
| *Under below* | Move away from the structure. This command is used if equipment or material has fallen or is falling near the structure |

**Table 8A General Incident Verbal Commands**

| COMMAND | MEANING |
|---|---|
| *Elevate* | Raise the head of a ladder from the horizontal to the vertical position |
| *Extend* | Increase the length of a ladder |
| *Foot (a ladder)* | Maintain the stability of a ladder by placing a foot on the lowest rung and pressing on both strings with the hands |
| *Head* | The top part of a ladder which contacts the wall |
| *Heel* | The bottom part of a ladder which makes contact with the ground |
| *House* | Reduce the length of a ladder. This is the command that is the opposite to the *extend* command |
| *Plumb* | At right angles to the horizontal |
| *Projection* | The horizontal distance from the heel of a ladder to a vertical line extending from the head of the ladder to the ground |
| *Under-run* | This command tells you to lower the ladder by walking away from the heel of a ladder while you grasp each successive rung with the hands above the head |

**Table 8B Verbal Ladder Commands**

## 8.3 Whistle Signals

The OIC uses whistle signals at an incident to issue instructions and to indicate danger as follows:

- *one blast:* turn the water on;
- *two blasts:* turn the water off; and
- *three blasts:* general assembly.

## 8.4 Hand/Light Signals

The hand/light signals detailed in Table 8C are used when other types of signals might not be effective.

| MEANING | SIGNAL |
|---|---|
| Water on | A vertical movement of the hand/light and arm |
| Water off | A horizontal movement of one hand/light and arm across the body |
| General assembly | A circular movement of one arm/lamp in front of the body |
| Increase water pressure by 100 kPa | A short repeated upward movement of the hand and arm with the palm of the hand facing up |
| Decrease water pressure by 100 kPa | A short repeated downward movement of the hand and arm with the palm of the hand facing down |
| Stop immediately | Arm held at shoulder height, palm of hand vertical and facing the person receiving the message |

**Table 8C Hand/Light Signals**

# SECTION NINE - GAINING ENTRY

## CONTENTS

# 9 GAINING ENTRY

## 9.1 Introduction

Firefighters frequently encounter situations where entry to a room or building requires force. In some instances, the firefighter uses physical strength to successfully remove the barrier to entry. However, the job will be made much easier by the firefighters' knowledge of barrier's characteristics and the techniques to be applied.

## 9.2 Entering Premises

As a firefighter in the NSWFB, you are empowered by legislation to make forced entry to premises when you are responding to a fire alarm. Legislation states that any damage caused in making a forced entry to a fire situation shall be deemed to be *damage by fire,* within the meaning of any policy for fire insurance.

## 9.3 Security Keys

Keys to premises are held under security in fire stations to enable firefighters to gain entry to buildings after hours and on weekends. When we are called to an incident, the keys are taken by the OIC to the fire call to enable us to enter a building without causing damage.

### 9.3.1 Station Occurrence Book

When keys are taken from or returned to a security cabinet for any reason, an appropriate entry is made in the Station Occurrence Book.

### 9.3.2 Key Tag Colours

We need to be able to identify keys quickly and easily. The key tags are colour-coded according to the various areas of a premises to which they allow access.

**Green keys** allow access to the following:

- locks requiring the building master key;
- fire alarm panel; and
- sprinkler room.

**Red keys** allow access to the following:

- fire escape;
- firefighters' lift key;
- plant room;
- air conditioning room; and
- machine room.

**Blue keys** allow access to the following:

- buildings with sections or floors under one occupancy.

**Yellow keys** allow access to the following:

- buildings with sections or floors under separate occupancy.

### 9.3.3 Keys and Locks

When simulated exercises or inspections are carried out at various buildings for which we hold keys, OIC's should check that the keys held under security do in fact operate the locks and allow access.

### 9.3.4 New keys

When we receive a new key to a premises, it is essential that we conduct an exercise at the premises **as soon as possible** to ensure that the keys operate the appropriate locks. There have been some instances when the keys we have received have not fitted or operated the intended locks.

If the keys do not fit the locks, you should inform the person from whom we received the keys of any defects, so that they can provide replacements. You should then check the replacement keys to ensure that they are operable.

## 9.4 Locking Systems

To ensure smooth and efficient entry into premises, you should familiarise yourself with the various locking systems.

Here is a list of the types of locks you are likely to encounter on entering premises:

- padlocks;
- night-latches;
- mortice locks;
- deadlocks;
- rivers' locks: these locks secure doors at two or more points; and
- electronic locks: these locks use card keys with an encoded magnetic chip. The card is placed in a slot in the wall near the door.

Some of the more common types of door locks are illustrated in Fig 9.1.

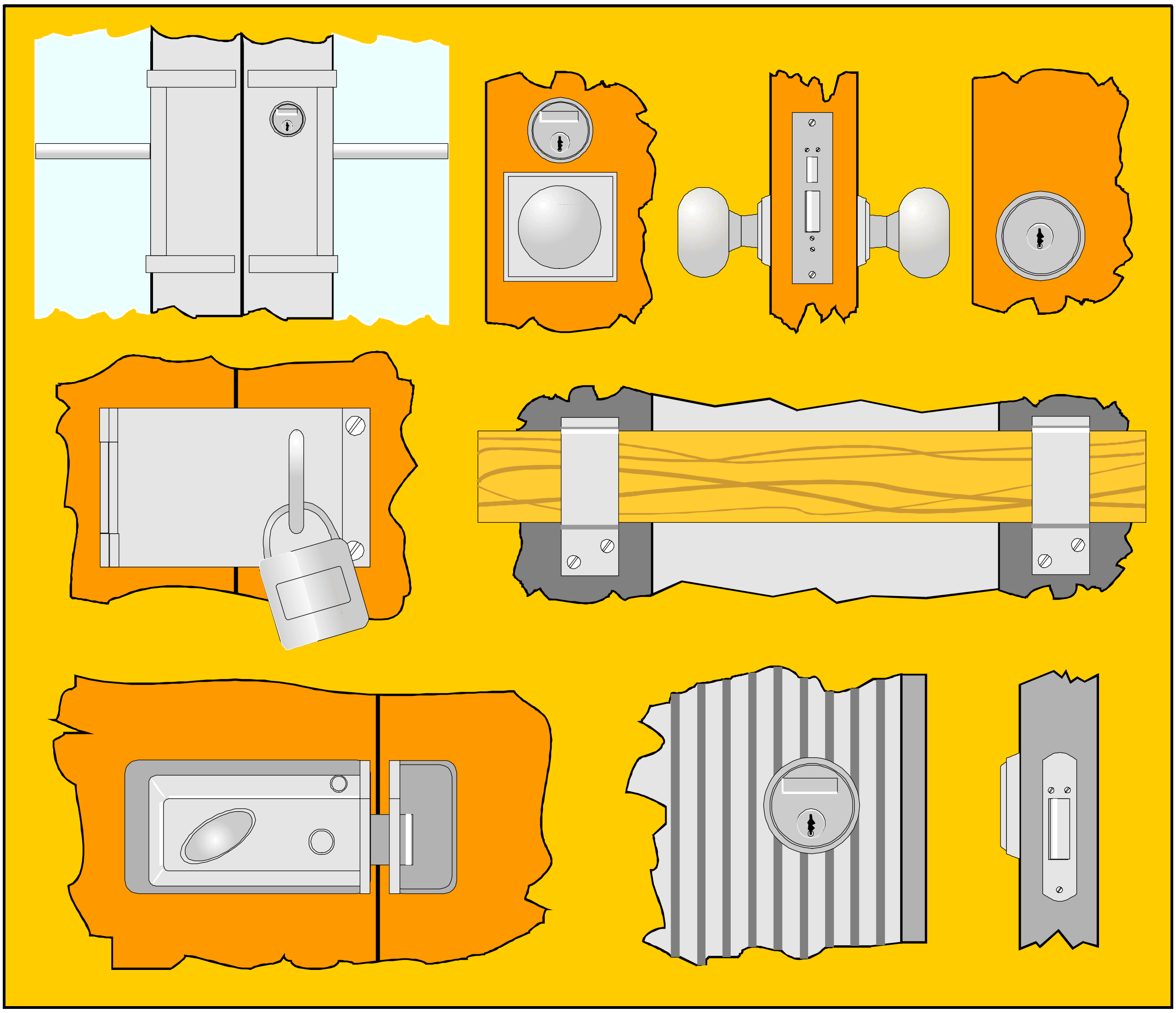

**Fig 9.1 Common Door Locks**

## 9.5 Forced Entry Principles

When you arrive at the incident ground, you should make every effort to enter the premises by normal means with keys. You should identify yourself and inform any occupant of the presence of the NSWFB and obtain entry keys from caretakers or security personnel.

If you are not able to enter the premises by normal means, you should not hesitate to make a forced entry. Each appliance carries a selection of specially designed tools that you can use for this purpose.

If you can see that the situation is life-threatening, you should make entry for rescue by the quickest method possible.

When you are entering premises, you should keep in mind the following three principles:

- enter without undue delay;
- enter with the minimum of structural damage; and
- enter so as to provide access to as much of the building as possible.

## 9.6 Point of Entry

The usual point of entry to premises is by the principal entry or main door or gate. This provides access to grounds, halls or stairways leading to the remainder of the premises.

If you cannot enter the premises through the main point of entry, you may be able to enter through an open window. Often, windows are unlocked or open particularly on the floors above ground level.

Other possible entry points are the secondary entrances, and most premises have at least one secondary entrance either on the side or at the rear of the building. If no side entrance exists, the quickest way into the building may be by a rear entrance. You may need to go through an adjoining property to access the rear entrance.

When you are looking for an entry point, carry a short ladder for scaling walls and reaching first floor windows.

⚠ **NOTE**

**When you must make a forced entry to an area or building, consider these points:**

- **the most suitable point of entry;**
- **the safety of personnel and appliances;**
- **the damage must be kept to a minimum; and**
- **the procedure must be carried out with rescue in mind.**

## 9.7 Fences

When premises are bounded by security fences, the principal entry point is probably a gate or boom barrier secured by padlocks and chains. When you need to bring an appliance into the grounds, but you are prevented entry by security fences, you should remove a section of the fence to provide access. Generally, there are three types of fence that you will come across:

- paling;
- wire; and
- chain wire.

### 9.7.1 Paling Fences

To remove a section from paling fences, knock out the palings next to the posts at both ends of a fence panel. Then cut the rails with a hand or power saw. This allows you to remove the panel.

### 9.7.2 Wire Fences

To gain emergency entry through a wire fence, cut the wire between the posts with bolt cutters.

**CAUTION**

**Take extreme care when you cut strand wire; the wire fence may whip back and cause injury.**

### 9.7.3 Chain Wire Fences.

If you need to cut a section of a chain wire fence, use an air chisel or cold chisel and hammer to cut the wire ties that secure the chain wire to the posts and rails. Then, roll back the chain wire to provide access. You can remove intermediate and top pipe rails by loosening the clamp bolts and springing the posts apart to release the rails.

**CAUTION**

**Take extreme care when you scale walls and fences: find out what is on the other side. Frequently, fences erected at street level can have excavations of considerable depth and other hazards behind them.**

## 9.8 Doors

Doors vary in design, construction, and material. Each type of door requires a different and special treatment to force it open with a minimum of damage. It is often more effective to concentrate effort on the lock or fixtures rather than on the door itself.

Here is a brief discussion of the various types of doors and some of the methods used to make a forced entry through them.

### 9.8.1 Hinged

Hinged doors closing against a rebate or door jamb are the most common type of doors found.

You can usually make a forced entry through a hollow door If the door is solid, you may have difficulty in cutting through it. It might be better to try to force the lock or separate the hinges. An example of both a solid and hollow door is illustrated in Fig 9.2.

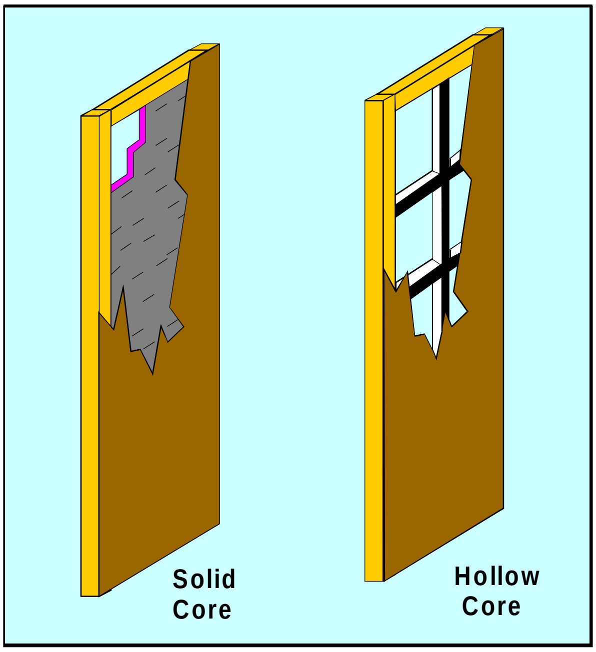


**Fig 9.2 Two Types of Hinged Door**

### 9.8.2 Panel

Panel doors usually have a wooden frame with panels of wood or glass or both.

To make a forced entry, break a panel and attempt to unlock the door by passing a hand through to the inside. If this is unsuccessful, remove the panelling.

Select a bottom panel to remove as you are less likely to be injured if you climb through the lower part of the door. Also, if you need to pass a hose through the opening, the hose will not kink or be damaged as it might be if it were suspended through a panel halfway up the door.

### 9.8.3 Flush

Flush doors are hollow or solid. If the door is hollow, it may be strengthened by cross members. You can usually make a forced entry through a hollow door in the same manner as you would through a panel door. If the door is solid, you may have difficulty in cutting through it. It might be better to try to force the lock or separate the hinges.

### 9.8.4 Steel Covered

Steel covered doors are difficult to force open. It is impossible to cut through them with an axe. It is probably best to attack them on the hinge side or use rescue equipment such as power saws or hydraulic equipment.

### 9.8.5 Barred

Barred doors present similar difficulties to steel doors. If the bars are of light construction, you can use boltcutters or hacksaws to cut through them; otherwise, you may need to use a power saw or hydraulic equipment to force entry.

### 9.8.6 Swing

Swing doors are hinged doors with special pin hinges that allow them to swing in either direction. These doors are used in restaurants, hotels, department stores, and office buildings. They are used as smoke-stop doors on stairwells and long corridors.

Swing doors are often partly glazed. If they are to provide some fire resistance, wired glass is used in the glazing. There is no rebate or jamb to stop the doors.

Some large department stores and modern office blocks have frameless swing doors of toughened glass. If you cannot unlock the lock, then a break-in is the last resort. You can usually break toughened glass by a sharp blow in one corner with a tool such as a 2 m crowbar.

### 9.8.7 Swing Leaf

Swing leaf doors are often used as smoke-stop doors opening to staircases. They often have a padlock and staple similar to normal doors. They may have drop-in swing bars.

### 9.8.8 Sliding

Sliding doors are often of solid construction. A folding door can collapse into a relatively small space. Solid sliding doors running in a track from overhead tracks are used on commercial premises as fire resisting doors.

Sliding doors are not always immediately identifiable, but the design of the handle and the recess constructed at the side are a good guide.

You can force a sliding door open with a crowbar by levering the door away from the jamb on the side from which the door moves.

⚠ **NOTE**

**If the door is distorted, it may not be able to slide.**

### 9.8.9 Automatic

Automatic doors usually have **break-out** panels in their construction. If they don't, then a single hung door is probably located nearby. You can gain entry through either the panels or through the hung door.

### 9.8.10 Revolving

Revolving doors present problems to firefighters because they do not permit passage of hose lines and bulky objects. As with automatic doors, a single hung door is usually constructed nearby. If you must make a forced entry, it is better to do it through the single hung door.

If necessary, you can probably dissemble the panels on revolving doors. Here are two common methods of forced entry through these doors:

- in the first method, either brackets or a solid bar hold the panels in place and the panels can be dissembled by releasing the bars or undoing the fastenings;
- in the second, two panels are hinged to a single leaf and a chain runs through them and holds the panels fast by way of catches at either end.

 

**NOTE**

**When you conduct an inspection of a building, examine the types of doors that are fitted to the buildings.**

### 9.8.11 Cantilevered

A cantilevered door is counter-balanced and pivoted so that the whole door rises. When it is open, it lies horizontally. To force it open, use a crowbar and lift the door.

### 9.8.12 Roller Shutter

Roller shutter doors are nearly always made of steel, but sometimes they are made of wood. Steel shutters are difficult to open. If possible, try to find another entry before you try to break through one of these doors.

If you must force open one of these doors, use two crowbars inserted under the bottom edge of the door. You may be able to lever the shutter up enough to part the lock. Insert the crowbars on either side of the fastening and apply leverage equally. You can then use air bags and hydraulic rescue equipment.

**NOTE**

**If you distort the shutter when you are forcing it, it will be impossible to open the door.**

You can use a power saw fitted with a metal cutting blade on this type of door. Make two quick cuts in the shape of a Λ. The top of the Λ will lie down leaving a rounded edge at the bottom. You can re-secure the door by inserting holes at the top of the cut panel and in the door and attaching a lock and chain.

**CAUTION**

**When you use a power saw, observe strict safety procedures.**

If the door has wooden shutters, it may be possible to lever one end out of the guides and pull out sections until you have an opening of sufficient size.

**CAUTION**

**If the shutter has already been opened and people are working on the other side of the door, you should wedge the door so that it cannot fall and trap them.**

### 9.8.13 Wicket Gates

A *wicket gate* is a small door set into a larger door or into a gate. This type of arrangement is often found at the entry to industrial premises. A wicket gate can be a good primary entry point, and you should try it first before making a forced entry.

## 9.9 Windows

### 9.9.1 Glass

If you need to break a pane of glass, use the flat of the small axe. (See Fig 9.3) Give a sharp blow, but not too hard, to the top corner of the pane of glass. Drive the glass into the room, and be careful that it does not fall on those working below. Keep your hand above the head of the axe to prevent pieces of glass slipping along the handle and cutting your hand.

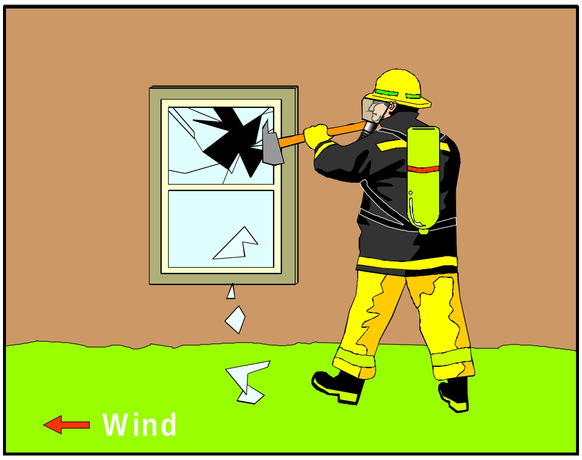


**Fig 9.3 Breaking a Pane of Glass**

Clear the jagged edges around the frame to prevent injury to personnel and damage to equipment such as hose lines. (See Fig 9.4) Form a saddle from a piece of sacking or a mat to give protection.

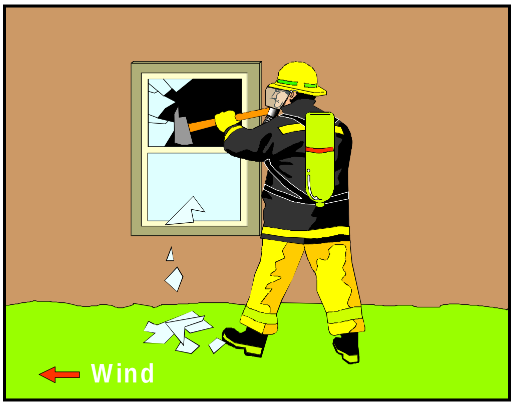


**Fig 9.4 Clearing away Glass**

To break toughened or armoured glass, make a sharp tap in one corner of the glass with a pointed instrument such as a crowbar or a firefighter's axe. The whole pane of glass will shatter.

### 9.9.2 Sash

The frame of a sash window is usually made of wood. You may be able to slip back the catch from the outside by using a knife or the blade of an axe. If you can do this, you won't need to break the glass.

When you cannot do this, first break the pane opposite the catch. Always hold the upper window sash with the free hand to prevent it from falling if the sash cords are broken.

### 9.9.3 Casement

Casement window frames are made from both wood and steel. It is usually impossible to release the catch of a casement window from the outside.

To force entry, break the pane of glass nearest to, but below, the catch. As casement windows almost always open outwards, do not project a ladder over the sill.

### 9.9.4 Fixed

Fixed windows are those that have been constructed not to open or have been rendered inoperable. If you need to force entry through one of these windows, break a sufficient number of panels of glass so that you can enter through the window and then cut the glazing bars away. You may be able to break the glazing bars away from the framework with the back of a large axe.

### 9.9.5 Barred

Barred windows present a serious problem. If they are made of light gauge metal, they may just be nailed or screwed into place. You can usually knock these out or prise them away with an axe. If the bars are set into brick or stonework, you can use shears, a power saw (with metal cutting disk), a hacksaw, or air operated saw.

You can often free the bars by bending them with blows from an axe. This causes a relative shortening so that you can pull them away from the stonework. Alternatively, you can break the stone or brick and then pull them clear.

You may be able to force the bars apart with hydraulic equipment or air bags or cut them using hydraulic equipment, air equipment or a power saw (with metal cutting disk).

# SECTION TEN - ATTACKING THE FIRE

## CONTENTS

# 10 ATTACKING THE FIRE

## 10.1 Introduction

When you are actually moving in to fight a fire, you must be aware of three very important things:

- the basic actions on first entering the area of the incident;
- the procedure to secure a line of retreat; and
- the safe working practices used by NSWFB to protect you and your fellow firefighters from injury at this critical initial stage of the incident.

As a firefighter, you deal constantly with emergency situations such as fires or rescues. In such emergencies, where life and property are in danger, it is essential that all personnel present know the precise actions they must take at every turn of the incident. To guarantee an efficient operation, a well organised deployment of resources is crucial.

In this section, we discuss some of the important concepts and practices that we follow in attacking a fire.

## 10.2 Siting of Appliances and Equipment

When you arrive at the scene of an incident, the siting and protection of appliances and equipment is of utmost importance. After ensuring the safety of yourself, your fellow firefighters, and other people present at the scene, the next most important consideration is the safeguarding of the means of fighting the fire.

Here we discuss some of the factors you must consider when you are deciding where to site the appliances at the scene.

### 10.2.1 Wind Direction

At the incident, fire appliances and major equipment must be sited clear of smoke and toxic fumes. You need to consider the direction of the prevailing wind and to expect and anticipate changes in the wind direction.

### 10.2.2 Exposure to Radiant Heat

When you site appliances or other equipment, consider the radiant heat from the fire.

When you first arrive, the radiant heat may be minimal. However, as the fire grows in intensity, the heat can damage or destroy appliances and equipment that have been incorrectly placed. If you must reposition appliances later, you may need to shut down hose lines. Moving the appliances and hose lines can have a detrimental effect on fire fighting.

### 10.2.3 Electrical Hazards

You must be aware of the location of overhead power cables and electrical equipment. Whenever possible, site the appliances well clear of electricity lines and keep other equipment away from overhead lines. Keep in mind that during the incident, radiant heat, fire, or the collapse of a building can cause live cables to sag or fall.

### 10.2.4 Traffic

You must also consider the traffic and road conditions. It is important to minimise traffic disruptions, but you must also ensure that appliances and equipment are not sited in dangerous situations.

If you must place appliances and equipment in the line of traffic, it is important to park appliances and other vehicles in such a way that you give warning to approaching traffic and protect the site and firefighters.

To help keep the area safe, you can place cones and flashing beacons in strategic positions to give a warning to approaching traffic.

## 10.3 Incident Safety

In the NSWFB, we have established proven procedures to ensure safe working practices at every stage of the operation. We now discuss some of the procedures you should observe.

### 10.3.1 Prior to Entry

Prior to entering the site of the incident, you should consider the following:

- ensure that everyone is wearing the approved level of protective clothing when they are performing the actual fire fighting operations or duties associated with them. **All firefighters should keep their helmets on at all times;**
- when you are breaking glass, stand to one side and not in front of the glass so that the falling glass will then drop clear of you. Use the flat of the axe head and hold the handle horizontally so that the glass does not slide down the axe handle onto your hand;
- don’t look up in any situation where glass, tiles, or debris may fall on or near you;
- always test the temperature of the door handles with the back of your hand before trying to open a door;
- always open a door cautiously and in a way that offers you the most protection;
- if you open **an outward-opening door**, stay behind the door with one foot against it, then ease it open to release any pressure that may have built up behind it. The door can give protection against the first rush of hot smoke that might be released;
- if you are opening **an inward-opening door**, crouch as low as possible and use the adjoining wall for protection as much as you can;
- if you enter a room that is on fire, keep the door of the room closed until you are ready to attack the fire, this helps to stop the spread of fire to other areas;
- use spray or fog nozzles when you first enter the burning building or room; and
- when you first enter a burning building or room, make a quick circular movement with the branch, this immediately reduces the temperature and drives back the smoke and facilitates the firefighters’ entry.

### 10.3.2 Actions on First Entry

Upon entering the actual site of the fire, you should consider the following:

- at any fire in enclosed premises, before the *water-on* signal is given, you should try to identify the nature and location of the burning materials and to determine whether the fire is spreading up stairwells, lift shafts, or into other rooms: this important information will be difficult to obtain once water has been applied to the fire because of the increased amount of smoke and steam; and
- if the room is small where the fire is located, use a small fire fighting team and avoid crowding several firefighters into a small room. If only two firefighters tackle a job, then congestion and disturbance is kept to a minimum.

### 10.3.3 Securing a Line of Retreat

When you are working in the actual fire site, you should consider the following:

- when you are working hose in a building that contains large quantities of flammable materials, you should make sure that the fire does not get behind you. If the fire travels unnoticed behind stock piles, the fire may cut off your retreat or operate fusible links that automatically close doors or shutters, and this can restrict water supply and access for any back-up crews; and
- when you take up a position, ensure that your line of retreat is secure: the rapid advance of a roof fire can cut firefighters off from a ladder, or falling debris can block a means of retreat. **You should always be alert to the possibility of dangerous conditions.**

### 10.3.4 Working within Buildings

When you are working inside buildings, you should consider the following:

- the safest places under a weakened ceiling are beneath a door arch and next to the walls. If the ceiling collapses, the door arch will give some protection, and the walls may provide some voids where the ends of the joists are located since the ceiling usually collapses in the centre;
- ventilate a bottled-up fire from above and not from below. A sudden flow of air into an atmosphere heavily charged with smoke and hot gases can result in backdraught, ventilation from above safely releases the build-up of heat and smoke;
- illuminate the building as soon as possible, this improves visibility and reduces the danger of injuries;
- if you must search a building at night when there is no internal lighting available, you should work in pairs and at least one firefighter must carry a hand torch;
- when you are working in smoke and must feel your way along, protect your face behind the crook of your arm, with the back of the hand outwards to stop you from running into obstructions and suffering serious injury. If you touch some live electrical wire or device with the back of your hand, you avoid the chance of your fingers closing on the live device by involuntary muscular reaction;
- when you are moving across a floor in darkness or smoke or across a damaged floor, slide your feet forward and test the floor with the front foot before putting weight on it;
- when you must move on a damaged floor, stay near the walls as much as possible and tread on the floor only over the joists because less leverage is placed on the floor joists and boards near the walls. If there is any doubt about the strength of a damaged floor or stairway, bridge the area with a short extension ladder as this will distribute the weight over a larger area;
- if you are moving on a damaged stairway, stay near the strings, preferably the wall string, as the wall string is less likely to be weakened;
- if you descend a stairway, descend backwards, and feel each tread with the foot and keep hold of the treads;
- if you enter a large building while you are wearing BA, take a guide line: you can use the guide line to locate firefighters who have lost their way in smoke or become casualties. A line of hose can be used as a guide in and out of a building;

- if you are entering an area that you suspect may be contaminated with flammable gas, liquid vapour, or dust, do not take naked lights with you;

- do not use lifts in a building involved in fire; the fire can affect the lift machinery and firefighters can become trapped between floors;

- if you enter an area where acid fumes are present, remain upright, as acid fumes are heavier than air and they concentrate at floor level. Remember, that if you inhale acid fumes, you may not feel the symptoms immediately even though damage has taken place. Remember to report all such incidents;

- if you are trapped on an upper floor and unable to get below the fire, do not go up any higher as heat, smoke, and gases rise to the higher floors. Move away from the fire on the same floor, preferably to a part of the building with a window to the street, and as you move, close every door behind you; and

- if you attempt escape from a first floor window sill, hang by your hands and drop off, **don't jump off**. When you fall, push off by the toes as you let go to avoid catching the toes on any obstruction or projection that could cause an awkward fall.

## 10.4 Safe Working Practices: General

In this section, we continue our discussion of safe working practices. This section contains procedures and practices that apply to general situations.

### 10.4.1 Helmets

**You must wear your helmet at all times when you are performing fire fighting or associated duties:** your helmet protects you from falling objects and the perspex visor protects your eyes from hazards such as flying objects, smoke, and heat.

### 10.4.2 Live Electricity

When you are operating water or foam extinguishers in the vicinity of live electrical apparatus, break the jet into a spray so that you leave no continuous conductor through which the electricity can travel to you. Observe safe working distances.

### 10.4.3 Ventilating A Fire

Always ventilate a confined fire **from above not from below**. A sudden influx of air from below or at the level of the fire into an atmosphere that is heavily charged with hot smoke and gases can cause *back-draught*, but high level ventilation releases pent-up heat and smoke and any ignition occurs in the atmosphere outside the building.

Keep a charged hose line available to deal with any possible ignition of the evacuating smoke and gases.

### 10.4.4 Flammable Re-ignition

When you have used inert gas or dry powder to extinguish a fire in flammable liquids, be prepared for possible re-ignition and keep at a safe distance. The gas may be moved away by draughts, and the flow of air may cause re-ignition with a characteristic flash if the temperature of the liquid is still high enough. Before ventilating, give the liquid time to cool.

### 10.4.5 $CO_2$

Do not enter a confined area that contains a large amount of $CO_2$ discharged into it unless you are wearing a SCBA because the $CO_2$ will have displaced the air and left insufficient oxygen to breathe; just 10% $CO_2$ in the atmosphere can lead to asphyxiation.

### 10.4.6 Water Jets

Do not play a jet of water directly overhead; the falling water may bring down debris onto those underneath, and the debris may be dangerously hot.

Do not direct a jet of water into loose matter such as hot ashes, molten metal, or slag as the water will turn into steam and the sudden expansion can scatter the hot material about dangerously. To cool hot materials, use a diffuser type branch and nozzle, such as the *Akron*, with the setting on fine spray.

Where large amounts of dust have accumulated and a source of ignition exists, avoid stirring up the dust in any way by playing water jets into the dust, dragging hoses through it, or wading through it. Use a diffuser type branch and nozzle on a fine spray setting to wet down the dust without disturbing it.

With nozzles larger than 20 mm, the jet reaction is greater than the nozzle pressure. Even if the pressure is kept constant with various nozzle sizes, this jet reaction greatly increases in pressure with every increase in nozzle size, i.e. if you compare a 20 mm nozzle at 700 kPa and a 26 mm nozzle at 700 kPa, the 26 mm nozzle will give a far greater jet reaction than the 20 mm nozzle, because the larger nozzle expels a much greater volume of water with the same pressure. The 26 mm nozzle also projects water to a greater distance because the friction loss is less with the larger nozzle.

### 10.4.7 Water Supply

Do not turn the water supply to a branch on or off without a signal from the branch operator as this can compromise the safety of the operators, only the branch-person knows the prevailing conditions;

Do not turn the water supply to a branch on or off **suddenly** as this can cause an accident at the branch, cause the hose to burst, cause damage to the pumper, or cause damage to the water mains. A sudden change in pressure can cause the static pressure to be higher than the running pressure and cause damage because of the absence of friction.

**⚠ NOTE**

**When you are using a *shut-off* type branch, turn the water on and off with care to avoid the damage mentioned above.**

### 10.4.8 Hose and Branch

If you follow a line of hose back to a pumper so that you can notify a driver to increase or decrease the pressure in the hose, ensure that you follow the correct line back to the pumper.

When you are assisting at the branch, keep the hose behind the branch as straight as possible for a distance of at least 6 m because a curved hose has a tendency to try and straighten out. The branch operator must contend with back-thrust and a curved hose makes them contend with side-thrust as well;

Do not lose control of the branch, for a branch out of control can cause major injuries or death. Hang on to the branch even at the risk of minor injury to yourself. If the branch pressure is making the branch difficult to control, then it should be reduced in the interest of safety.

### 10.4.9 General Assembly

When *General Assembly* is sounded by three blasts on a whistle or a circular hand/light movement, pump drivers should throttle down to give the branch operators a chance to shut off their branches without risk of injury or damage.

### 10.4.10 Gas Cylinders

Do not play a jet of water directly onto a heated gas cylinder as the sudden cooling in a small area can cause the cylinder to fracture with violent disintegration and possible *BLEVE*. To cool the cylinder, apply a diffused spray over the whole cylinder area;

### 10.4.11 Roadway hydrants

When you are using water hydrants in the roadway, warn the on-coming traffic with a *Delta* strobe light or the three portable warning signals.

### 10.4.12 Damaged Structures

When you doubt or question the strength of a damaged floor or stairway, use a portable ladder to bridge the damaged area; this distributes your weight over a larger area.

When you move across a floor in dark or smoky conditions or on a damaged floor, slide your feet forward and test the floor with your front foot before putting weight on the floor, in this way, you can detect holes or weak spots in the floor.

When you must cross a damaged floor, keep as near to the walls as is possible and tread on the floor joists near the walls; you apply less leverage as you move and therefore you have less chance of breaking the boards and joists.

When you move on a damaged stairway, stay near the wall strings and descend the stairway facing backwards. Feel each tread with your foot and hold onto the treads.

When you must move under a roof that has been weakened, the safest place is beneath a door arch and the next safest is close to a wall. The door arch will give you some protection if the roof collapses, as a falling roof usually falls around the middle of the room, and the falling debris may still leave some safe areas near the walls.

Be careful of damaged structures as they cool after a fire as they can collapse without notice. Knock out glass, pull down lighter structures, and erect barricades if the structure appears to be a potential hazard.

### 10.4.13 Ladder Safety

When you climb any ladder, ask another firefighter to foot the ladder, have them put one foot on the bottom rung and hold on to both strings.

When you are on a ladder and a ladder belt is not available, and you need both hands to perform a task, use the *leg-lock* or a pocket line.

### 10.4.14 Moving Through Smoke

When you are feeling your way through a smoke-filled area, do not handle objects unnecessarily as you can suffer injury from materials that are hot, sharp, electrified, or dangerous in some other way or from acids and alkalis which are corrosive.

When you are moving in a smoky or darkened area, you can use a line of hose as a guide to the fire area and to the exit

When you are working in smoke, stay low and crawl if necessary to escape the heat and smoke as they rise and give a better possibility of greater vision and comfort at floor level. If your BA becomes damaged or out of air, you will find it easier to breathe if you are near the floor.

If you must work in smoke without BA, breathe through your nose at the normal rate and avoid the tendency to take short sharp breaths through your mouth, as this can lead to a fit of coughing that may be difficult to stop, because of the reflex nature of coughing. A coughing fit can leave you prostrate. Keep your eyes closed as much as safely possible.

### 10.4.15 Entering a Burning Building

Do not enter alone and unseen into a building that is well alight except in an emergency situation to attempt to save a life as you may become injured and no-one will be aware of it. **Always work at least in pairs.**

When you prepare to enter a room that is on fire, keep the door closed until you are ready to enter and attack the fire. If you open the door before you are at the ready with a charged hose line, the fire may spread quickly and force you back out or cause you injury.

### 10.4.16 Toxic Gases

When you must enter an area where you suspect toxic gases may be present, you must wear BA.

### 10.4.17 Unconscious Personnel

If you must move an unconscious person, do not exhaust yourself trying to pick up and carry the person with the firefighter's lift and carry. If you are working alone, drag the person; if you are working with another person, use the fore and aft mode.

### 10.4.18 Searching a Building

When you must search a building at night and no internal lighting is available, you should work with others in a group and you should carry with you a hand light/tote light.

### 10.4.19 Walking on Roofs

When you are walking on a roof, place your feet over the lines of nails/screws/fasteners that indicate the location of the roof battens or purlins, and stay off *fibro* roofs if possible. If you must move on a *fibro* roof, then distribute your weight using a roofing ladder or aluminium extension ladder.

### 10.4.20 Naked Lights

Do not take naked lights into an atmosphere that you know or suspect may be hazardous due to explosive gas, flammable liquid, vapour, or dust. In these areas, use only intrinsically safe hand-held transmitters (HHT's) and torches (usually marked SAFE).

### 10.4.21 Means of Escape

If you become trapped on an upper floor and you are unable to get below the fire, do not go up to higher levels. Stay on the same floor and move away from the fire. Close doors behind you as you move, as this prevents the spread of the fire and lateral draughts of smoke, heat, and fire. If possible, make your way to a window and signal for assistance.

If you are forced to a window where you cannot be seen, look for other means of escape such as plumbing on the wall, projecting ledges, and skillion roofs. You can also climb down a hose leading from the ground to an upper floor or use a private fire hose attached to an internal hydrant.

If you must escape from an upstairs window, sit on the window sill with your legs outside, then turn over and slide out of the window till you have a finger grip hold on the window sill, and then let go. The drop will be reduced by the length of your body. To cushion the impact of your fall, throw out of the window the mattresses, bed clothes, pillows, and other items that may be located near the window. If possible, consider also the use of ropes or sheets tied together.

**CAUTION**

**This technique should be used only as high as the first level of a building, and not on higher levels, unless absolutely necessary.**

### 10.4.22 Fumes

If you suspect that acid fumes are in an area, remain standing because the fumes are heavier than air and they will concentrate at floor level.

If you have been exposed to and inhaled fumes, report for treatment even though you may not feel any effects at the time, sometimes the reaction to fumes on the human body can be delayed for some time.

**NOTE**

**This also applies to civilians who have been exposed to the fumes.**

### 10.4.23 Darkened Buildings

In darkened buildings, set up lighting as soon as practicable as darkness, like smoke, can cause accidents. Use hand lights, *Tote* lamps, portable generators (flood and cage lights).

**NOTE**

**City of Sydney Fire station has a lighting vehicle.**

### 10.4.24 Use of Lifts

Do not use lifts in a building that is involved in fire; the lift machinery may become damaged at any time and trap firefighters in the lift between floors.

## 10.5 Building Collapse

### 10.5.1 Introduction

When fighting structural fires, it's important to keep a close watch to ensure that dangerous conditions which might lead to the collapse of a building are not developing.

When fighting fires in buildings with large floor areas, the water that comes from branches can weigh several tonnes and together with the merchandise and equipment already stacked there, may load the structure beyond its capacity, weakening floors or supports.

Water should be removed from these floors as soon as possible.

### 10.5.2 Expansion

Water directed onto absorbent materials creates a two-fold risk. Firstly, it will cause materials to expand considerably and, if the material is tightly packed, this may force out the walls or displace columns. Secondly, all water that is absorbed by these material's adds to the loading of that floor. The most absorbent materials are wool, cotton bails, paper and wood pulp.

### 10.5.3 Signs of Collapse

The first signs of impending collapse of a building are often the falling pieces of motar, brick, concrete etc. from the walls. These are often accompanied by leaning or bulging. When this occurs, collapse may be imminent. (See Fig 10.1)

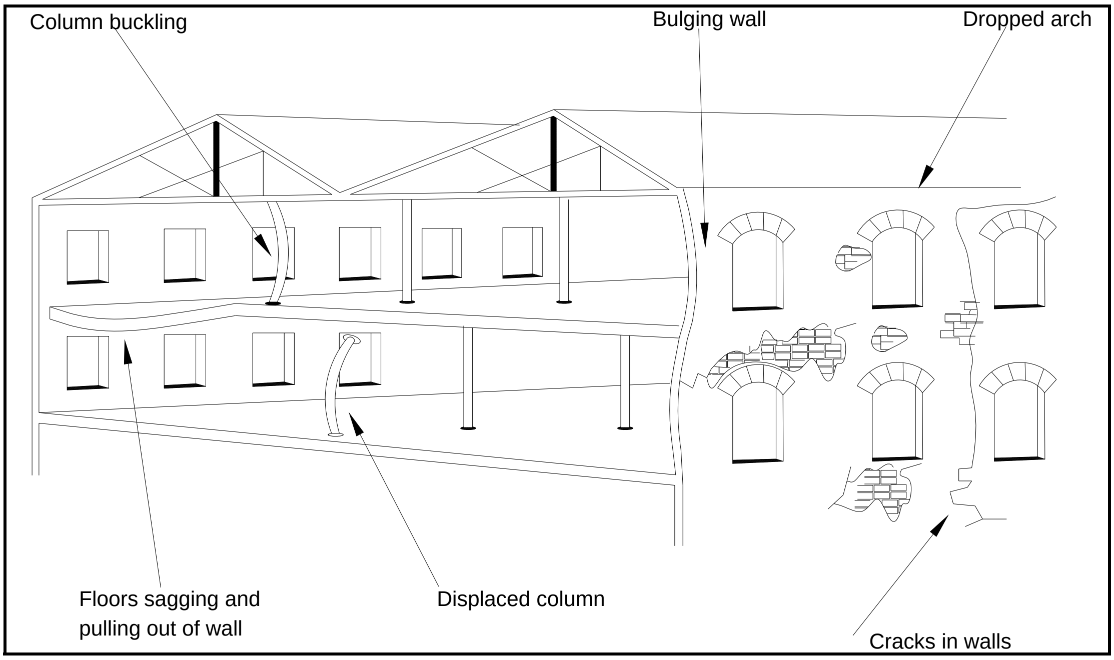


**Fig 10.1 Signs of Building Collapse**

Leaning or bulging walls can often be detected by going to one end of the building and looking along the face. In assessing the probability of wall collapse, consideration should be given to:

- the apparent age of the building;
- the condition of the mortar;
- the intensity of the fire;
- the length of time the fire has been burning;
- long stretches of wall which are not keyed to cross walls at close intervals; and
- walls which are relatively thin in relation to their height.

Walls may fail in buildings which have steel joints. The expansion of the joints pushes the walls sufficiently out of the perpendicular to cause them to collapse. If, on the other hand, the wall does not collapse, the joints will contract when they are cooled by applying water or extinguishing the fire. This may cause the joists to fall off the wall plates, causing the floors to collapse.

Horizontal cracks appearing over windows and doorways are usually more indicative of danger than vertical cracks.

Unprotected steelwork e.g. steelwork not encased in concrete, is very vulnerable to the affects of high temperature, and in some cases the collapse of a complete steel framed building has occurred after a relatively short exposure to the fire.

Walls will usually fall outwards, but may be brought down inwards, particularly if one or more floors collapse. Particular attention must be paid to siting the appliance with regard to the collapse of walls. Under such conditions the corners of a building will be the safest points from which to work.

The principal signs of collapse of a building are:

- cracked or dropping arches over doors, windows and other openings;
- falling concrete and falling corruces;
- sagging floors or beams;
- gaps between the edges of floors and the walls; and
- displacement of steel or cast iron pillars supporting joints or beams.

**CAUTION**

**If any signs of collapse are found consider evacuation.**

## 10.6 Fire Fighting Tactics

### 10.6.1 Introduction

Fire fighting tactics are a crucial part of an operational plan. Firefighters constantly deal with emergency situations involving both fires and rescues. To undertakes these activities efficiently and safely, firefighters need to be skilled in the principles of fire attack. The acronym RECEO provides a basis for fire attack plans and tactical priorities. RECEO refers to:

- Rescue;
- Exposures;
- Containment;
- Extinguishment; and
- Overhaul/Salvage.

Memorise this term as it provides an easy way to remember tactical procedures to be undertaken at an incident. The principles of RECEO will be explored in the following material.

### 10.6.2 Rescue

The protection and preservation of life is the first consideration of any firefighter when responding to an incident.

Upon arrival at an incident, the crew leader or OIC will survey the situation and determine if human life is in danger. If it is determined that lives are at risk, then all efforts must be directed towards protecting and preserving life. Firefighters will then be instructed to remove persons or valued property from the structure or hazardous situation and take them to a place of safety.

In conducting a rescue, firefighters will be required to apply search and rescue procedures to locate people in the structure and to remove them from danger. The OIC will determine the most appropriate plan of action to take, and will direct search and rescue activities. The rescue will be determined by several factors including:

- how immediate the threat is;
- the number of persons to be rescued and the location in the structure; and
- the availability of personnel, equipment and resources.

When conducting the rescue, firefighters should:

- apply search and rescue procedures acquired through previous training;
- conduct all activities in accordance with occupational health and safety guidelines and standard operational procedures (SOP's); and
- remain alert at all times. Be aware of other events taking place and other potential dangers that may prevent a successful rescue.

### 10.6.3 Exposures

Exposures are any adjoining structure or property not directly involved in a fire but which are at risk of being damaged or burnt if a fire is not contained.

Building regulations have been developed to ensure there is sufficient spacing, across streets and between adjacent building structures to limit the chance of fire spreading from one structure to another. In major fires, however, this is often not enough to stop the spread of fire. In blazes such as these, large amounts of radiant heat are projected and it is this which increases the threat of fire to other parts of the same structure or to adjoining properties.

If sufficient heat is generated and allowed to burn long enough without protective sprays being used, there is a strong chance that fire may spread to other exposures.

To minimise the threat of radiant heat to exposures, water is applied to cool down building facades and protect glazing from shattering.

⚠ **NOTE**

**Water curtains which do not wet and cool exposures, are ineffective.**

Adjacent structures may have fire rated separating walls and this will provide a degree of protection, however, in older buildings, many are not fire rated. For these structures, fire can spread through timber extensions and common roof voids.

The likely spread of fire is affected by a number of factors:

- the temperature of the fire;
- shielding to the adjacent premises;
- the height of structures;
- wind direction; and

- space between structures.

When this threat is likely, the OIC will need to determine through the size-up, the appropriate action to protect these exposures from threat of fire.

### 10.6.4 Containment

Containment includes those operations which are required to prevent a fire from extending to uninvolved parts of the building.

Actions that firefighters can take include:

- looking outwards and recognising potential areas of spread and taking action to deal with them; and
- using cooling jets/sprays to protect other parts of the building from becoming involved in the fire.

### 10.6.5 Extinguishment

Extinguishment involves the Crew Leader or OIC determining the method of fire attack through the initial size-up. Fire fighting tactics may vary substantially during the course of an incident to reflect changing circumstances.

A number of factors to be considered in the extinguishment of the fire are:

- the type of fuel involved - this will impact on the type of extinguishing medium to be used;
- quantity of fuel involved - this will indicate the quantity of extinguishing medium required; and
- physical arrangement of the fuel - this will determine how the extinguishing medium is to be applied.

### 10.6.6 Overhaul/Salvage

Overhaul and Salvage operations are dealt with separately in Topic 2 Sections 13 and 11 respectively.

## 10.7 Type of Attack

### 10.7.1 Introduction

The four types of attack employed by the NSWFB when fighting a fire are:

- internal (offensive);
- external (defensive);
- combination; and
- marginal.

### 10.7.2 Internal

During an offensive operation, fire conditions will allow an internal attack. In this situation, hose lines are extended into the fire area to support the primary search and to control the fire, while related offensive support activities are provided to clear the way for the attack.

An offensive fire attack is aimed at achieving rapid containment and reduction of secondary damage (heat, smoke, water).

### 10.7.3 External

When fire conditions prevent an internal attack, external fire streams will be placed between the fire and any exposures to prevent fire spread. This mode is a heavy duty cut-off orientated approach. It may include operating external streams around a large or inaccessible fire area that is essentially burning itself out. During active defensive operations, perimeter control becomes critical as firefighters should not enter the fire area. The OIC decides where the cut-off will take place.

### 10.7.4 Combination

Offensive and defensive operations are never combined within the same incident ground sector. Operation of external, or aerial appliance streams into areas where crews are working inside a structure, can lead to injury or even death.

It will sometimes however, be necessary to combine offensive and defensive strategies to effectively combat a fire e.g. a partially involved commercial building, where fire conditions at the front require exposure protection and knockdown with heavy streams, however, crews are able to mount an offensive attack from another side, unaffected by the external streams.

### 10.7.5 Marginal

Marginal fire attack is a dangerous strategy which will only be implemented where **persons are trapped and are considered savable.**

Fire conditions would normally dictate a defensive strategy, however, the need for search and rescue becomes apparent.

In marginal situations:

- search and rescue crews must be backed up by hose lines to secure a path of retreat; and
- hose lines will be set up to protect exposures.

When the **all clear** is given, crews will withdraw to the external incident ground perimeter.

# SECTION ELEVEN - SALVAGE OPERATIONS

## CONTENTS

# 11 SALVAGE OPERATIONS

## 11.1 Introduction

The value of good salvage operations cannot be overstated. Good salvage operations not only build goodwill in the community, but they also help to save untold amounts of money and resources.

Salvage operations are an inherent part of good fire fighting. These operations consist of methods and operating procedures that aid in reducing damage by fire, water, and smoke, during and after fires. Some damage cannot be avoided; sometimes we need to make forcible entry, or apply water, or vent a building, or search for fires quickly throughout a structure.

However, our improved techniques in fire extinguishment plus the prompt and effective use of good salvage procedures can minimise total losses.

## 11.2 Approach To Salvage

Effective salvage is a continuous process. It involves a wide range of activities and considerations. The order in which we perform various tasks when we attend an incident may vary. Sometimes we perform many tasks simultaneously. There is no clear demarcation between different phases of the work.

The various aspects of the work and the tasks to be done can be arranged in the following groups which roughly follow this sequence:

- preliminary work;
- practical considerations to be borne in mind while fighting the fire;
- active measures to prevent avoidable damage;
- steps to mitigate the effects of the fire and fire fighting operations from unavoidable damage; and
- subsequent rehabilitation and protection of a property and its contents.

## 11.3 Practical Considerations

As a firefighter, you can assist in salvage operations by performing your duties in such a way that you help to prevent unnecessary damage.

In particular you can help in the salvage operation if you:

- keep the amount of water used to a minimum;
- use hand-controlled branches where possible;
- move to smaller jets, fog, or spray as soon as possible;
- replace damaged and leaking hose quickly; and
- use NSWFB booster fittings.

## 11.4 Non-Fire Damage Factors

The damage caused by a fire is not restricted to the burning of property. Damage can also be caused by many other factors as well, including:

- heat, smoke, steam, fumes, and condensation;
- water and or other extinguishing agents;
- debris, dirt, and breakages;
- adverse weather conditions on exposed interiors and their contents;
- deterioration of stock, plant, machinery, furniture and other assets that are not properly attended to immediately after the incident; and

- vandalism and pilfering at insecure premises.

The losses attributable to these non-fire factors of late, can often exceed (by a considerable sum), the losses that occur due to actual fire damage. Further, the amount of losses due to the non-fire factors appears to be increasing.

## 11.5 NSWFB Involvement

The level of specific salvage work that we need to undertake can vary considerably from one incident to another. In a minimal case, we need use only salvage sheets. In the extreme, the operation may include work made possible by the attendance of a salvage appliance.

The extent of the salvage operations necessary varies according to the size of the fire. At a large fire there may be little potential for salvage. At a smaller fire, the risk of avoidable damage from causes may be much greater than the actual fire damage.

Successful salvage depends on an early start to the salvage operation. The longer we wait to begin the salvage operation, the more the possibility of a successful operation decreases.

## 11.6 Commencement of Salvage

Depending on the circumstance of the fire and the availability of personnel, we try to begin salvage work as soon as possible. The sooner that plant and stock can be protected by salvage sheets or plastic sheeting, the more we can help to prevent damage.

If possible, we begin salvage work on the level of the building where the fire is located. If that is not possible, then we start the salvage operation on the floor or floors below the fire. (See Fig 11.1)

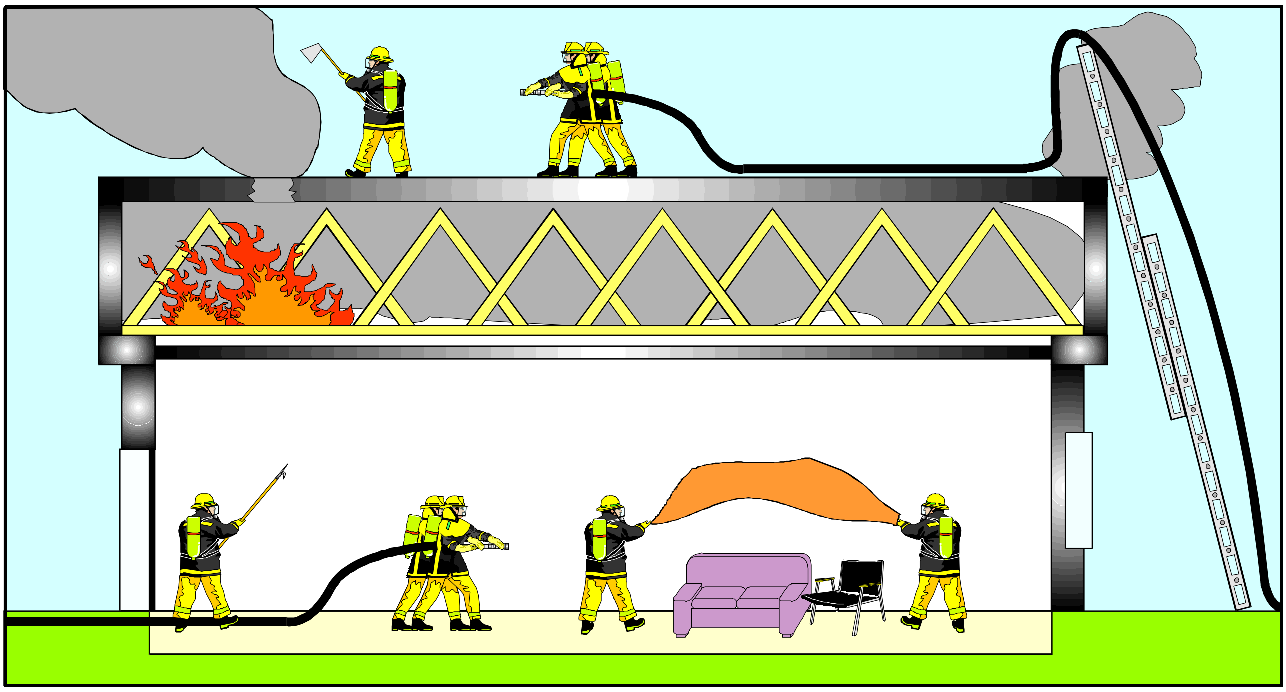

**Fig 11.1 Start Salvage on the Floor Below the Fire**

Whenever possible, we arrange the contents of the building into close piles so that they can be covered with a minimum of salvage sheets. This allows more contents to be protected and saves the sheets for other uses.

### 11.6.1 Salvage in Homes

When we are working in a home, we try to place household furnishings in a group in the centre of the room i.e.

- if the floor covering is a removable rug, slip the rug out from under the furniture as each piece is moved, and roll the rug up for convenience of movement;
- place chests of drawers, wardrobes, and other high objects at the end of the bed;
- group all other furniture close by; small articles such as lamps, curtains, pictures and clothes can be placed on the bed. (See Fig 11.2)

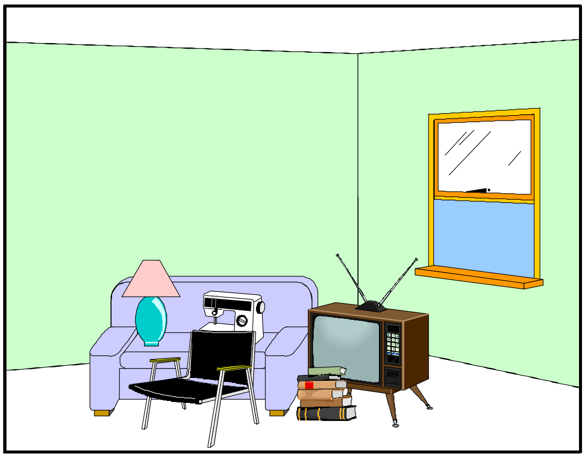

**Fig 11.2 Furniture Gathered into the Centre of a Room**

### 11.6.2 Salvage in Commercial Premises

Commercial and retail premises provide challenges for firefighters. We may be limited in how much we can re-arrange the contents of the premises i.e. large stacks and display features are hard to move and stack.

Display shelves are frequently built to the ceiling and directly against the wall. This construction feature makes it difficult to cover shelving. When water flows down a wall, it naturally comes into contact with each shelf and can damage the contents of the shelf.

One common obstacle to efficient salvage operations in commercial and retail premises is the lack of pallets under stock susceptible to water damage. Some examples of perishable stock include:

- flour;
- material in cardboard boxes;
- feed;
- paper; and
- dry goods.

Stock that has been stored in the basement of a building should be placed on pallets at least 125 mm above the floor, but stock on floors above the basement is reasonably safe with smaller pallets. If the stock is stacked too close to the ceiling, this also presents a salvage problem. When stock is stacked, we need enough space between the stock and ceiling to apply salvage sheets.

**CAUTION**

**You must be extremely cautious when you are working near high piled stock such as boxed materials or rolled paper that has become wet at the bottom. The wetness can reduce the strength of the material and cause the piles to collapse. Some rolls of paper can weigh a ton or more.**

## 11.7 Removal of Water

You can prevent water from flowing into unaffected areas by damming the openings of the rooms. For this, you can use *dollies*, but sometimes it is better to use salvage sheets. You can also use salvage sheets as dams to collect water dripping from a floor above. You should place the sheets on the floor then fold the four edges several turns inwards.

Part of an effective salvage operation is diverting the water out of the building. You can do this very effectively with salvage sheets by forming them into water chutes.

### 11.7.1 Water Chutes on Windows

You can make an effective water chute with two ceiling hooks and a salvage sheet. To do this:

- extend the two ceiling hooks between a window and a ladder or other support (the window serves as the water discharge point);
- the ladder or support should be elevated higher than the window sill so that the water will flow out of the window; and
- place the salvage sheets over the ceiling hooks so that the water can drain down the chute and out of the window.

### 11.7.2 Water Chutes on Stairways

You can also construct water chutes on stairways or in stairwells. When you use sheets for this purpose, roll the sides of the sheet up at the sides to prevent water from seeping off the edges. (See Fig 11.3)

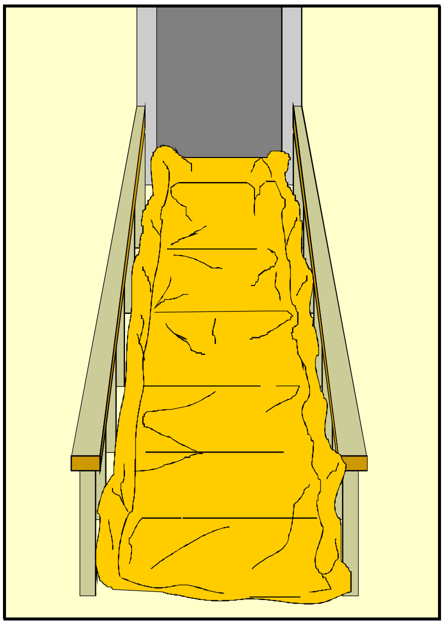

**Fig 11.3 Salvage Sheets Used as a Water Chute on a Stairway**

To make a chute of this type, open a salvage sheet to its full length but to only half its width. Then fold the edges in lengthways to give the depth you require. If you place several sheets end to end in this manner with each overlapping the other, the water will flow smoothly down the chute.

### 11.7.3 Other Methods

Here are some other ways to divert the water:

- you can sling one end of a salvage sheet from the other end out of a window or other opening at a lower level; and
- you can divert water by means of a hopper. The amount of water this type of chute can handle is, however, limited by the size of the hose.

⚠ **NOTE**

**The hopper should be put into place, connect the hose, and direct it outside before opening a hole in the floor above and the hole must not be larger than the hose coupling orifice, otherwise the hopper will overflow.**

## 11.8 Reducing Water Damage

You can provide a first-line protection against water damage by using the chutes and other devices that we have discussed thus far. However, to reduce the water damage, you also probably need to take some further action.

### 11.8.1 Preventing Water Collection

Even when the water is diverted, you should keep water on the move with brooms and squeegees so that it does not collect. Water collected in pools or puddles can increase the weight on the floor and possibly even overflow the dams that you have constructed at the doorways in the building.

### 11.8.2 Opening the Floor

You can also improve the exit flow of water by opening the floor. You can bore small holes in the floor or use a crowbar to prise up a floorboard where it joins with another and wedge the joint open. Of course, before you open up such flow holes, check to see that the openings are not over any valuable or important items stored in the level below. Also take care that no one trips over the raised floorboard.

**⚠ NOTE**

**It is not advisable to tear up large strips of floorboards, as this causes unnecessary damage.**

### 11.8.3 Diverting Water Down Lift Shafts

You can also divert water down lift shafts which will direct the water to the basement. If no outlet exists in the basement to allow the diverted water to flow out, you can remove the water with a pump.

**CAUTION**

**Do not use petrol driven pumps in basements or poorly ventilated areas: they emit dangerous carbon monoxide. These fumes can rapidly cause a person to collapse. In the extreme, the fumes can be fatal.**

### 11.8.4 Water Vacuum

A water vacuum device provides one of the easiest and fastest ways to remove water and other non-flammable liquids. This device also removes dirt and smaller debris from carpets, tiles and other types of floor coverings. It has a suction powerful enough to extract liquids from deep pile carpets.

### 11.8.5 Water Installations

Water damage is also caused by water escaping from a burst or fractured pipe or from a water tank that overflows. When this happens, you should close the stop-cock if it is accessible. If you cannot close the stop-cock, flatten the lead pipes on either side of the burst in the pipe. You can divert water from a fractured pipe or an overflowing tank to a suitable place for disposal.

## 11.9 Sprinklers

Sprinklers are usually activated by a fire on the premises. You can help reduce damage by checking to see that any activated sprinkler head is actually operating over the fire. Those sprinklers that are not operating in the fire area merely add to the water damage.

### 11.9.1 Sprinkler Stops

To stop water damage from activated sprinklers that are not in the fire area, you use sprinkler stop pliers inserted into the sprinkler head. However, you should shut down a sprinkler system altogether **only** on the orders of the OIC. If you close down the sprinkler, you should also operate the main drainage valve immediately after closing the main stop valve. This keeps water from draining from sprinklers and causing further damage.

## 11.10 Reducing Damage To Stock

If stock in a commercial premises has collapsed or been dislodged into a walkway, you can help reduce damage to the stock by removing it to a safer position. If the stock is left in the way, the stock may be damaged further. It also poses a hazard for firefighters and rescue operators. When you remove or replace stock, avoid placing wet goods on top of dry goods.

You should also give special attention to carpets and rugs. In shops, hotels, and offices, losses from damage to carpeting alone can be very extensive and expensive. Loose carpets and rugs may be very valuable. As much as possible, try to prevent dirt and debris from being trodden into carpets. Take up the loose carpets or rugs and place them in a safe place. Then cover them with a salvage sheet or other material.

### 11.10.1 Weather Protection

If you remove stock or other items from a building, you should cover these items after you take them outside.

Additionally, you should also protect the building and the goods still within the building especially if the roof has been damaged. If a hole has formed in the roof, you may need to move items that are directly below the hole.

Try also to cover the hole if possible. If the hole is sizeable, you can use a tarpaulin to cover the hole. If a tarpaulin is not available, you can give some protection with salvage sheets especially if the hole is small.

If you use sheets to cover a hole in the roof, remove loose items such as tiles and slates before you spread the cover on the roof. Hammer flat any protruding nails, and ensure that gutters and other channels for water drainage are free from obstructions.

If tarpaulins are not available, you can use disposable polythene sheeting, but this type of sheeting is more difficult to secure especially in adverse weather conditions. It is a lightweight sheeting, that requires more care in placing it, than do the heavier tarpaulins, to ensure that it is carefully secured.

⚠ **NOTE**

**City of Sydney station has roof tarpaulins available.**

### 11.10.2 Covering Building Openings

One of the final steps in a good salvage operation is to cover any openings to prevent further damage to the property by weather. Cover any doors or windows that have been broken. However, before covering them, first remove any cracked or broken glass. Then cover the openings with heavy polythene sheeting. If security is an issue, you can use corrugated iron or boarding materials if they are available.

# SECTION TWELVE - SALVAGE EQUIPMENT

## CONTENTS

# 12 SALVAGE EQUIPMENT

## 12.1 Introduction

On our NSWFB salvage appliances, we carry many tools for salvage operations. Some of these tools are in common use, and you will be familiar with many of the items and how to use them. In this section, we discuss the general equipment that is designed for particular application in salvage work.

## 12.2 General Equipment

### 12.2.1 Augers

We use augers to bore holes in timber floors to drain accumulated water. To operate the auger, you insert a steel bar through the eye of the auger, then turn the auger clockwise to bore the hole.

### 12.2.2 Ceiling Hooks

We use ceiling hooks for the following purposes:

- to pierce ceilings to release water that is trapped above the ceiling;
- to pull down burning material in the ceiling; and
- to remove wall or ceiling linings and other materials that are out of reach.

### 12.2.3 Debris Sheets

We use debris sheets to remove fire debris from buildings.

The sheet is made of canvas. Its dimensions are 2 m x 1 m, and it has four rope handgrips for carrying.

### 12.2.4 Dollies

Dollies are made from pieces of old hose filled with sand. We make them in various convenient lengths. We use dollies across door openings to prevent the entry of water and to channel water that we are removing from buildings.

### 12.2.5 Gloves

We provide several different types of gloves for hand protection:

- leather industrial gloves issued to all firefighters, for general hand protection;
- heat resistant gloves for handling hot or cold material;
- corrosive chemical gloves for handling corrosive acids, alkalis, or chemicals that can be absorbed through the skin;
- rubber gloves for handling live electrical wiring or equipment up to 415 V; and
- disposable rubber gloves for handling patients and fatalities.

### 12.2.6 Hooks

We use hooks to assist in the removal of baled and bagged goods. Bag hooks and bale hooks provide a secure hold when you are removing heavy baled or bagged materials.

### 12.2.7 Keys

We use special keys to open windows in high rise buildings and lift (elevator) doors.

Sometimes, you may need to open windows in high rise buildings to provide ventilation. You may need to open lift doors to rescue persons trapped in a lift car.

### 12.2.8 Plastic Sheeting

We use polythene plastic sheeting to cover stock, vehicles, furnishings, and carpets so we can minimise the damage from water, smoke, and fire debris.

The sheeting is manufactured in roll form. We cut it to length as required. We use a staple gun or masking tape to hold the sheeting temporarily in position.

### 12.2.9 Salvage Locks

We use salvage locks to secure premises temporarily to prevent unauthorised entry after we attend an incident. When we place a salvage lock in position, we attach a metal plate, on which is engraved the name of the fire station at which the key is held.

### 12.2.10 Salvage Sheets

We use salvage sheets for covering and protecting buildings and contents from water, smoke, and fire damage and for other purposes associated with salvage operations.

Salvage sheets are made from proofed canvas. They are approximately 3.5 $m^2$ with twelve short rope lines spliced through eyelets at the corners and edges of the sheet.

The sheets are identified with the fire station and sheet number stencilled diagonally on opposite corners. The sheet number is also stencilled on both sides near the centre of the sheet.

### 12.2.11 Sprinkler Stop Pliers

We use sprinkler stop-pliers to stop the water flow temporarily from sprinkler heads after we have extinguished a fire.

To use the pliers, you insert them between the yoke and orifice of the sprinkler head. When you release the handles, a strong spring forces the ball on the jaws against the orifice and stops the flow of the water.

### 12.2.12 Sprinkler Spanners

We use sprinkler spanners to remove and replace sprinkler heads that have already operated.

### 12.2.13 Slixit Concentrate

*Slixit* is supplied as a super concentrate degreasing agent. Prior to using *Slixit*, you dilute it with four parts of water to form a working concentrate.

**Large Area Application - over 10 $M^2$**

We apply *Slixit* with a FB5X at pump pressure of 650 kPa. To apply the working concentrate, spray it lightly over the entire area to be cleaned.

**Small Area Application - up to 10 $M^2$**

To apply *Slixit* working concentrate to small areas up to about 10 $m^2$ carry out the following:

- place 4 L of *Slixit* into a knapsack pump;
- fill the knapsack pump with water and spray onto the area to be cleaned;
- following application, clean the entire area with a broom; and
- finally, hose the entire area with a strong water spray to achieve maximum results from the use of *Slixit*.

**NOTE**

**The concentrate is activated only when it is diluted. The mixture recommended above produces the most efficient application.**

### 12.2.14 Submersible Pump

The NSWFB currently use the *Tsurumi* LSC4 submersible pump. It is a residual dewatering pump used to remove water from structures or vessels leaving approx. 1 mm depth of water remaining.

The dimensions of the *Tsurumi* pump are:

- height: 360 mm
- width: 196 mm
- 240 V: Single Phase
- liquid temperatures: 0° to 40° C

Service of the *Tsurumi* pump includes:

- service dry after use;
- check electrical leads; and
- electrical test every 6 mths.

### 12.2.15 Water Hopper

We use a water hopper to collect water seeping from an upper level of a building and to direct it to an external drain.

The water hopper is made from proofed canvas with short rope lines spliced through eyelets at the corners and edges. A short length of 70 mm hose with *Storz* couplings is fitted to the bottom of the hopper. To use the hopper, you suspend it by the rope lines beneath the area of water seepage. Then attach a length of 70 mm hose to the *Storz* coupling to drain the water from the building.

## 12.3 Minor Equipment

Table 12A details a list of other minor salvage equipment that is used by the NSWFB.

| EQUIPMENT TYPE |
|---|
| Brooms |
| Buckets and mops |
| Carpenters' tools |
| Hammers (claw, ball peine, sledge) |
| Masking tape |
| Padlock chains |
| Plugs (wooden and threaded) |
| Plumbers' tools |
| Sawdust |
| Screw eyes |
| Shovels |
| Squeegees |
| Staple gun |
| Steel wedges |
| Thread tape |
| Waterproof clothing |
| Water scoops |
| Whiting (for neutralising acid spillages) |
| Soda ash |
| Torches |

**Table 12A Minor Salvage Equipment**

## 12.4 Electrical equipment

This section has been rescinded. Refer to current Standard Operational Guidelines, Recommended Practices and SIMS Worksheets.

## 12.5 Ladder Types

NSWFB appliances generally carry a set of portable ladders for use in attacking fires and for salvage work. This set of ladders includes:

- roof;
- extension; and
- multi-purpose.

### 12.5.1 Roof Ladders

Roof ladders are designed to distribute the mass of your body when you are working on sloping or fragile roofs. These ladders provide you with a foothold. The roof ladders are approximately 5 m long and are fitted with steel hooks at the head of each string.

⚠ **NOTE**

**A roof ladder is of very lightweight construction. It is not to be placed against a wall and climbed.**

**CAUTION**

**You should always use a roof ladder if you have any doubt as to the strength of the roof cladding.**

### 12.5.2 Extension Ladder

The NSWFB uses aluminium extension ladders in the following lengths:

- 4 m;
- 8 m;
- 9m; and
- 12 m.

**4 m Ladders**

This ladder is for both external and internal use on the incident ground. It has one main length and one sliding length. The 4 m extension ladder has no trussing.

The hauling line is attached to the bottom rung of the sliding length. This line passes through a sheave attached to the top rung of the main length.

When you place the extension ladder against a wall and pull the hauling line, the sliding length extends into the uppermost position.

**Operation**

To operate the extension ladder, you extend it in a vertical position to the required height until the spring-loaded pawls move into position and engage a rung on the main length. This stabilises the ladder at the required height. You then place the ladder head against the wall.

To house the ladder, bring the ladder head away from the wall to a vertical position. Then extend the ladder until the tripping device attached to the pawls is above the rung. This frees the sliding length so that it can descend, and you can lower it with the hauling line.

**8 m, 9 m and 12 m Ladders**

These ladders have one main length and one sliding length. Both lengths are trussed. When positioned against a wall or object to be ascended, **the sliding length and the trussing are on the underside.**

**Operation**

Here are some points to keep in mind regarding the operation of these ladders:

- when you remove the ladder from the appliance, you should carry it to the desired location with No. 1 firefighter at the heel and No. 2 firefighter at the head;
- when practicable, you should carry the ladder *stretcher style* with the trussing uppermost;
- when you have carried the ladder to the required location, No. 1 firefighter places the heel on the ground, and you can then raise the ladder to the vertical position;

⚠ **NOTE**

**When you raise the ladder, ensure that the sliding length and trussing are on the underside.**

- when you extend the ladder, raise it to the required height in a vertical position until the spring-loaded pawls move into position and have engaged a rung on the main length;
- lower the ladder head to make contact with the wall;

- adjust the heel of the ladder so that the ladder rests against the wall at a safe and workable angle. Ideally, this angle should be one quarter of the height of the ladder;

- No. 1 firefighter then engages both **anti-slip devices** and secures the hauling line around two lower rungs of the standing length; then, tie the line off with a clove hitch around a lower rung: this prevents the ladder from retracting if the pawls did not engage or if the pawls become disengaged during operation;

- whenever possible, you should secure the head of the ladder with a pocket line in order to prevent movement of the ladder; and

- a firefighter must foot the ladder at all times when the ladder is in use.

**Housing**

To house the extension ladder:

- elevate the head of the ladder to a vertical position;

- untie the hauling line from around the lower rungs;

- extend the ladder until the tripping devices attached to the pawls have activated;

- control the descent of the sliding length with the hauling lines;

- when the sliding length has been housed, engage the pawls and tie off the hauling line; and

- lower the ladder by under-running in the approved manner and return it to the appliance.

### 12.5.3 Multi-purpose Ladders

The NSWFB use *Jumbo* multi-purpose ladder model TL14 (see Fig 12.1) as a standard piece of salvage equipment. This ladder can be used in a variety of roles and lengths as detailed in Table 12B.

| ROLE | LENGTH (MAX) |
|---|---|
| Step Ladder | 1.86 m |
| Sliding Extension Ladder | 4.2 m |
| Staircase Ladder | 4.2 m |
| Platform Trestle | 1.2 m |

**Table 12B Uses and Lengths of Multi-purpose Ladders**

The overall weight of the type TL14 ladder is 12 Kg.

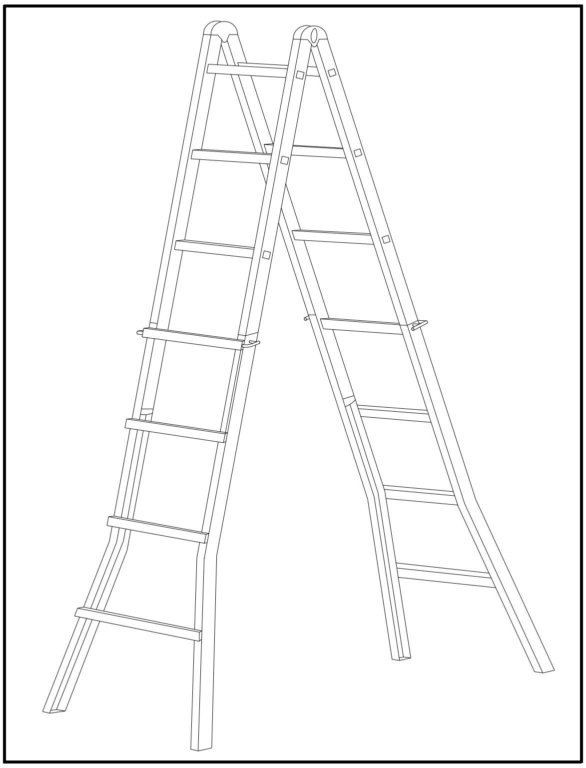

**Fig 12.1 Multi-purpose Ladder**

## 12.6 Ladder Procedures

### 12.6.1 Positioning

When you position a portable ladder, ensure safety and stability of the ladder by observing the following directions:

- place the heel of the ladder parallel to the wall on a firm surface;

**NOTE**

**If you are using the ladder on sloping ground, use packing or level the surface and adjust the heel so the ladder is plumb.**

- set the ladder at its safe working angle, by taking the heel of the ladder away from the wall a distance of 25% of the vertical height of the extended ladder (see Fig 12.2);

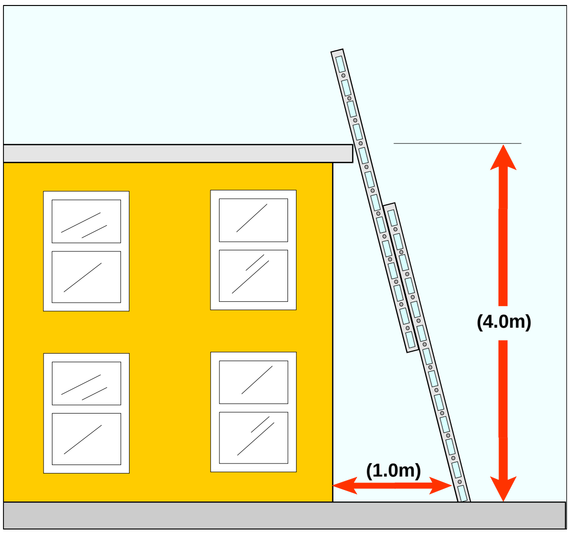


**Fig 12.2 Correct Ladder Positioning**

- place both strings of the head of the ladder firmly against the wall to provide maximum stability;
- whenever you are using a ladder to gain access through a wide opening or window, place the head of the ladder into the opening and to one side against the window frame to allow maximum working space;
- if the opening or the window is narrow, place the ladder against the wall adjacent to the opening;
- extend the ladder to a sufficient height to allow the firefighter to step from the ladder onto the sill or the floor while they are still holding onto the ladder; and
- if smoke or flame is issuing from an opening, position the ladder on the windward side of the opening.

### 12.6.2 Climbing

When you climb a portable ladder, ensure your own safety and the safety of others by observing the following directions:

- when you ascend the ladder, keep your body erect and look slightly upwards;
- when you descend the ladder; look straight to the front;
- when you move on the ladder, move the hand and foot on the same side of the body in unison. That is, move the left hand and left foot together then right hand and right foot together;
- place the ball (not the arch) of your foot towards the centre of the rung;
- extend your arms straight but not rigid; if you are too close to the ladder your knees might strike the rungs;
- grasp each rung (but not the strings), with your hand (knuckles upward), and your thumb encircling the rung; this allows you to test each rung before the full weight of the body is placed upon it. If you grasp each rung firmly when you are climbing, this will prevent you from falling if a rung breaks under your feet; and
- move your hands between your waist and shoulders. If you move your

hands above or below this range, you will have less body control and you will expend more energy.

### 12.6.3 Safety

Here are some points on safety and the use of ladders:

- whenever you are climbing, descending, stepping on, stepping off, or working from a ladder, ensure that another firefighter foots the ladder to maintain its stability;
- if the head of the ladder rests against an uneven surface, such as a pole, or if the ladder is to remain in position as a means of entry, you should secure the head of the ladder with a pocket line; and
- no more than two persons should be on a portable ladder at one time.

### 12.6.4 Working from Ladders

#### Leg Lock

When you are working on a ladder and you must use both hands, such as when you are operating with a branch, you should use the *leg-lock* to help you keep a secure balance. The leg-lock is performed as follows:

- while you are standing on one rung **above** the desired height, pass your leg between the second and third rungs **above** the rung on which you are standing;
- pass that foot back through the ladder between the first and second rung and hook the instep of the foot under the first rung; and
- then step down one rung with the other foot.

⚠ **NOTE**

**If you are working to the right hand side of the ladder, apply the leg lock with the left leg. If you are working to the left, apply the leg lock with the right leg.**

#### Ascending with a Hose Line

If you are ascending a ladder while carrying a hose line, flake the hose on the ground at the heel of the ladder. Place the hose with branch attached over one shoulder **without crossing the body** and rest the branch on your back. Have another firefighter help you by supporting the weight of the hose and feeding the hose out as you ascend the ladder.

If you have any difficulty while you are climbing the ladder, you can discard the hose you are carrying by simply dropping the shoulder on which you are carrying the hose, and the hose does not become entangled.

### 12.6.5 Operating a Branch from a Ladder

Firefighters working on ladders who are required to operate a branch, are to observe the following safety points:

- because of jet reaction, the heel of the ladder is withdrawn farther than normal to improve ladder stability;
- be aware that directing a branch to the side may upset ladder stability because the jet reaction will cause a side thrust;
- the person footing a ladder assists the person holding the branch by supporting the mass of the charged hose line; and
- if the branch is to be operated from a ladder for an extended period, attach a pocket line to support the hose from a ladder rung.

### 12.6.6 Other Uses for Portable Ladders

Other uses for portable ladders include the following:

**Bridging**

You can use the 4 m aluminium extension ladder to bridge floors and stairs weakened by fire. Extension ladders are not usually used for the purpose of horizontal rigging as this would reduce the strength and rigidity of the ladder.

When you use ladders for bridging, make sure that both ends of the ladder rest on structurally sound surfaces and allow adequate overlap at the head and heel of the ladder.

**Means of Access to Areas such as Basements**

When you use a ladder to gain access to areas such as a basement, the hold of a ship, or a trench, you should first extend the ladder to the required length. Then, to prevent the extension ladder from further extending while you are manoeuvring it into position, lash the rungs on the sliding length to the fixed length before moving. Similarly, you secure the joints on scaling ladders by lashing the rungs together on either side of the joint.

When you lower the ladder into position, the heel of the ladder must rest on a stable surface at a safe working angle. If you have any doubt regarding the stability of the ladder, lash the head to prevent it from moving, or use two firefighters to hold the ladder head before anyone descends.

### 12.6.7 Inspection

The inspection and cleaning of ladders includes:

- damage to strings, trussing or rungs;
- deterioration of the ladder finish;
- tightness of holding bolts, nuts, screws, and rivets;
- free and correct operations of pawls, tripping devices, and pulleys; and
- condition of the hauling line, including splices and hooks.

Refer to *Standing Orders*.

# SECTION THIRTEEEN - OVERHAUL

## CONTENTS

# 13 OVERHAUL

## 13.1 Introduction

Overhaul is a procedure we follow after we attend an incident and extinguish the fire.

In overhaul:

- we search the fire scene to detect hidden fires or sparks that can re-ignite; and
- we note the possible point of origin and cause of the fire.

## 13.2 Searching For Hidden Fires

### 13.2.1 Procedure

Generally, the overhaul begins in the actual area of fire involvement. Your process of looking for possible fire extension should begin as soon as possible after the fire has been knocked down.

First, check the primary area of fire damage. Then move the overhaul process systematically away from the areas of heaviest fire involvement until you are certain that no hidden fires remain.

In starting the overhaul procedure, you should first determine the condition of the building in the area to be searched. The condition of the building is affected by two important factors:

- the strength of the fire; and
- the amount of water used for its control.

### 13.2.2 Danger Factors in a Burned Building

Before you start the overhaul operation, you must consider all factors carefully for the protection of personnel. You should be aware of the conditions that can make the building dangerous:

- floors that have been weakened by the burning away of the floor joists;
- concrete that has weakened by the heat of the fire;
- steel roof members that have been weakened by fire and building damage;
- walls that have been cracked or offset by elongation of steel roof supports; and
- roof trusses that have been weakened by burn-through of key members.

### 13.2.3 Methods of Detection

Here are some points to consider during your initial general overhaul inspection:

- check the fire side of the wall to see whether the fire or water has come through;
- check the insulation materials thoroughly; they can harbour hidden fires for a prolonged period, and usually, you need to remove the material in order to check for hidden fires or to extinguish the fire; and
- inspect the windows and doors as a hot spot or *bulls-eye* may still remain in the casing. Open these areas by simply pulling off the moulding to expose the inner framework.

If you must open concealed spaces below floors, above ceilings, or within walls during the search for hidden fires, move the furnishings of the room to locations where they will not be damaged. Remove only enough wall, ceiling, or floor covering to ensure complete extinguishment.

⚠ **NOTE**

**Do not disturb weight-bearing members of the structure.**

When you open a ceiling from below, use a ceiling hook.(See Fig 13.1) Don't stand under the space to be opened. Position yourself between the area being pulled and the doorway so you can keep an exit route from being blocked with falling debris. Your pull on the ceiling hook should be **down and away** to prevent the ceiling from dropping on the heads of the firefighters.

**Fig 13.1 Use of a Ceiling Hook**

You can often detect hidden fires by sight, touch, or electronic sensors.

**Sight**

When you are looking for hidden fires, consider the following:

- materials that are discoloured;
- paint that has peeled;
- smoke that is emitting from cracks;
- plaster that has cracked; and
- wallpaper that has become dried and cracked.

**Touch**

When you touch the structure and materials in the building, feel the walls and floors for heat with the back of your hand.

**Sound**

When you are walking around the building, listen for the sound of popping or cracking of burning material.

## 13.3 Extinguishing Hidden Fires

When you are looking for and extinguishing hidden fires, it is essential for you to wear BA and a full set of fire fighting clothing. Keep charged hoselines available for extinguishment of hidden fires. However, during the overhaul operation, you can use the same lines that you used to bring the fire under control, but break them down to smaller sizes for easier handling.

Keep at least one charged line available in the event it is needed. Regardless of the size of hose being used, keep the nozzle placed so that if it is accidentally opened, it will not cause additional damage.(See Fig 13.2)

**Fig 13.2 Positioning of Nozzle During Overhaul**

Quite frequently, small burning objects are uncovered during overhaul. Because of their size and condition, it is better to submerge the entire object in a container of water than to drench it with a stream of water.

Remove larger furnishings, such as mattresses, stuffed furniture, and bed linen, to the outside so that if they contain hidden fires, the fires can be easily and thoroughly extinguished.

⚠ **NOTE**

**Remember that all scorched or partially burned articles may prove helpful to an investigator in preparing an inventory or determining the cause of fire.**

Always monitor indiscriminate use and direction of hose streams.

## 13.4 Scene Preservation

After you have extinguished the main fire and you are confident that you have found and extinguished any hidden fires, take appropriate steps to preserve the scene of the incident.

Here are some considerations relating to the preservation of the scene:

- commence the overhauling operations only when the cause of the fire has been established. The cause may be readily apparent to the OIC or it may require the attendance of an officer from the FIU, and it is most important that the scene remain undisturbed;

⚠ **NOTE**

**Take note of any persons at the scene who act suspiciously or whom you may have seen at other fires in the past.**

- ensure that the Fire Investigation Officer and the Police Physical Evidence Section Officer have the opportunity to see the remains of the fire before possible evidence is disturbed. The OIC must ensure that debris is disturbed as little as possible and that damping down, overhaul, or salvage work that might interfere with evidence of the cause of the fire, are restricted to only actions that are essential until the investigation is complete;

- erect barrier tape to secure the scene. The entry of personnel to the scene should be restricted to ensure evidence is not disturbed;

- keep the scene under security. Normally, this may mean denying access to the owner or occupant(s) of the premises until the investigation is complete, particularly where the cause of the fire appears suspicious or incendiary. Materials, records, stock, and equipment should not be removed from the scene until the investigation is complete.

## 13.5 Waste Containment and Disposal

After the evidence of the cause of the fire has been properly preserved, you can proceed to clean up the debris by carrying out the following actions:

- remove the charred material to prevent the possibility of re-ignition and to help reduce the loss from smoke damage;
- separate and clear away any unburnt materials from the debris;
- use debris sheets to carry the material outside where it can be placed so that it will not interfere with the movement of the public.

Dumping the damaged contents of a house or building on the footpath results in poor public relations. Doing so, indicates a lack of concern over the loss suffered by the owners of these goods. If you carefully dispose of all of the damaged contents, you assist the owner in assessing their insurance claim or recovering treasured mementos.

⚠ **NOTE**

**It is poor practice to throw materials out of a window. Not only is it dangerous, but the discarded items must then be handled again to clear the footpath or roadway.**

When you remove debris during salvage operations, always be aware of the possibility of re-ignition of items such as bedding that can re-ignite spontaneously when damp and hot.

⚠ **NOTE**

**Never confine yourself in a small space such as a lift when you are removing this material.**

For waste containment at chemical fires cross refer to Topic 11, Hazmat.

# SECTION FOURTEEN - VENTILATION

## CONTENTS

# 14 VENTILATION

## 14.1 Introduction

Ventilation is the systematic removal of heated air, smoke and gases from a structure and replacement with cooler air. The cooler air facilitates entry for fire fighting and other rescue operations.

A fire is very unpredictable. The number of variables associated with fire is so great that your decision to ventilate must be made with attention to the details of previous and similar incidents and an in-depth analysis of the present incident.

Effective ventilation is an integral part of the proper attack and extinguishment of confined fires. When ventilation is properly performed:

- it helps us to deploy our attack lines more rapidly;
- it enhances search and rescue operations; and
- it can result in a considerable reduction in fire loss.

In this first section on ventilation, we look at the considerations governing your approach to the ventilation operation.

## 14.2 Factors to Consider Prior to Ventilation

The type of fire and its location will require the OIC to make a series of decisions on how and when to ventilate. These decisions are reached by answering the following questions:

- when should ventilation be commenced?
- where does ventilation need to be carried out?
- how can ventilation be best achieved?

### 14.2.1 When should ventilation be commenced?

This depends on whether or not there is any danger to life.

### 14.2.2 Where does ventilation need to be carried out?

The answer to this question involves:

- the nature and proximity of exposures;
- the size of the fire;
- the seat of the fire;
- the wind and weather conditions;
- the type of building construction; and
- the presence of vertical or horizontal openings and how they may affect ventilation.

### 14.2.3 How can ventilation be best achieved?

This will be based on your knowledge of the following three methods of ventilation:

- providing openings for the smoke, heat, and gases to vent naturally into the atmosphere;
- using a water fog to aid ventilation through an opening; and
- using mechanical ventilation.

Insulation materials present in the ceiling space may cause *flashover* by causing retention of heat. This in turn can cause a rise in the temperature of the combustibles within the building. Because of this, it is even more important to ventilate as soon as possible.

To limit the possibility of the spread of the fire and to protect firefighters from exposure to further combustion, you must have charged lines of hose and crews ready to enter in BA, as soon as you have established the need to ventilate.

## 14.3 Indications of Smoke and Heat Conditions

### 14.3.1 Smoke

Smoke is present in all stages of combustion. The amount and colour of the smoke from the fire depend on two factors:

- the types of fuel being burned; and
- the amount of oxygen present.

As the fire progresses, the amount of carbon particles increases, and the smoke becomes darker and hotter.

The colour and behaviour of the smoke can help you to identify the fuel that may be burning. These can also help you determine the conditions within the building and the ventilation method you should use.

For example, a fire that is burning freely in a confined space will cause slight positive pressure within the building. This may force the smoke out through gaps around the roof, through the tiles and skylights, and through gaps in the walls. The rate at which the smoke emerges may indicate the conditions inside the building.

If smoke is escaping from openings in the lower part of the building, this may indicate that openings higher up in the building are blocked. This can give you an indication as to how to ventilate.

⚠ **NOTE**

**You can sometimes find out what fuel is burning by the colour of the smoke, but this indication is not always reliable.**

### 14.3.2 Heat

If you feel the walls, doors, and windows, you may be able to determine the intensity of heat within a building. The existence of *hot spots* can help you determine the direction of travel or the actual location of the fire. They can also help you decide when, where, and how to ventilate.

## 14.4 Conditions Required before Ventilating

Before ventilating a building, you should determine the existence of the following four conditions:

- the seat of the fire has been located;
- crews are ready to enter with charged hose lines;
- back-up crews are ready to enter; and
- communications have been established amongst all crews.

### 14.4.1 The Seat of the Fire has been Located

You should locate the seat of the fire before you begin to ventilate. Fire crews should endeavour to enter the building at the point closest to the seat of the fire. You must also consider the building security system and wind direction: these can both affect your choice of entry point.

### 14.4.2 Crews are Ready to Enter with Charged Hose Lines

As you approach the ventilation operation, the building is probably choked with smoke and fire gases. **Ventilation has the potential to intensify the fire**. It is therefore crucial you have sufficient fire crews ready to enter the building to attack the fire with charged lines when the ventilation procedure begins.

### 14.4.3 Back-up Crews are Ready to Enter

A closed, smoke-filled building always harbours a potential danger of *back-draught*.

Back-up crews must be ready at alternative entry points to enter and attack the fire should it flare up.

#### 14.4.4 Communications have been Established Amongst all Crews

If a crew enters through the rear of the building, the new opening can create a back-draught explosion. To safeguard other crews that may be entering at other entry points, communication amongst crews must be established to minimise the danger at the moment of entry.

## 14.5 Potential Hazards In a Smoke-Filled Building

#### 14.5.1 Hazards to Occupants

The saving of human life is always the prime consideration at any incident.

Danger to life invariably dictates your first action at the incident. You may decide to clear the smoke and heat by ventilating, or you may decide to fight the fire. You may need to perform both of these actions at the same time to allow access and evacuation of trapped occupants.

Each incident has its own circumstances about which you will make critical decisions. The saving of life must always be of the prime importance, and this is followed by the saving of property. Your decisions about action to be taken should be based on these considerations.

#### 14.5.2 Potential Hazards to Firefighters

Occupants face many hazards, and firefighters face them as well. Your decision to ventilate is determined by the type of construction of the building and whether there are any natural openings that you can use for ventilation.

If you are about to attack a fire that has been contained and is now smouldering, you should anticipate the hazards to life by fire and back-draught.

The nature and type of smoke during a fire often creates the following hazards:

- diminished visibility due to dense smoke;
- presence of toxic gases;
- breathing hazards due to lack of oxygen;
- build-up of flammable gases; and
- potential structural damage.

## 14.6 Hazards Associated with Smouldering Fires

Often, the greatest hazards in a smouldering fire come from the materials that are burning.

Here are some points to consider regarding these materials:

- building materials are often exposed to temperatures above their ignition point but are not burning due to either lack of oxygen or a short exposure period;
- pre-heated materials can burst into flames with explosive force when oxygen is introduced in the ventilation operation; and
- heated materials give off vaporised fuel elements and compounds that combine with combustion gases and further increase the flammability of the atmosphere: this is evident in charred woodwork after a fire even if the flames have not made contact with the woodwork.

Thus, smouldering fires present dangers of:

- back-draught;
- flashover; and
- burns and loss of life.

| STEPS | ACTIONS |
|---|---|
| **Rescue** | • establish whether or not all occupants are accounted for; and<br>• initiate search procedures if necessary. |
| **Fire Protection** | • ensure that all exposures are protected;<br>• ensure that charged lines of hose are in place; and<br>• ensure that communications are established. |
| **Ventilation** | • determine where to ventilate;<br>• determine when to ventilate; and<br>• determine how to ventilate e.g. vertical, by opening roofs/skylights; horizontal, by opening windows/doors and mechanical with smoke extractors and water fog. |
| **Extinguishment** | • decide on points of entry; and<br>• decide on the method of fire fighting to be used. |

**Table 14A Steps for a Combined Fire Attack and Ventilation**

## 14.7 Rescue Work During Ventilation

Your first priority during both the attack and the ventilation is the rescue of the building's occupants from the fire and other dangers.

Each phase in the process of fighting a fire requires different procedures for rescue. In some instances, you may need to rescue and ventilate simultaneously during the second phase of the fire. However, rescue may not be possible during the third phase of the operation because of the lack of oxygen, poor visibility, high temperatures, the danger of back-draught, or the presence of toxic gases.

### 14.7.1 Combined Fire Attack and Ventilation

Whenever you combine fire attack with ventilation, you should follow the four steps detailed in Table 14A.

## 14.8 Implications of Construction Factors

### 14.8.1 Introduction

The construction of a building affects the behaviour of a fire and the by-products of the fire. Your knowledge of the construction of a building and the behaviour of fire in various buildings can help you resolve the various problems you face in fighting the fire.

A knowledge of these factors also helps you decide how to ventilate a building and what precautions you must take during the ventilation operation.

Most buildings have concrete foundations with double brick exterior walls. However, some buildings have timber floors, walls, or timber frames clad with brick, timber, metal, *fibro* or a combination of these materials.

To appreciate how a fire and the products of combustion can spread throughout a building, you must have a basic understanding of the different types of building construction and the characteristics of fire spread associated with each of these types of construction.

### 14.8.2 General Building Construction Features

#### Brick and Concrete Buildings

For purposes of fire prevention and fire fighting, buildings with double brick or concrete exterior wall constructions are the most desirable. These types of buildings inhibit fire spread both from within and from outside of the building.

**Timber and Brick Veneer Buildings**

Buildings constructed of timber or brick veneer have upright wooden or metal supporting members in the walls. This type of construction has hollow spaces in the walls through which fire can spread.

Some buildings of this construction have fire walls. If fire walls are constructed properly, you need to ventilate only the area on the side of the fire wall where the fire occurs; it is generally not necessary to ventilate the areas on the other side of the fire walls.

**Steel Buildings**

Steel buildings pose a special danger to fire fighting in that once the internal temperature of a steel building reaches 540° C or higher, the steel can soften, lose its strength, and can no longer be able to bear its designed load. The intense heat also causes steel components to expand and move. The heat also affects the integrity of steel structures. These factors can cause the building to collapse.

### 14.8.3 Precautions When Working on a Steel Roof

Whenever you work on a roof in the ventilating operation, you should consider the use of aerial appliances. These appliances can prevent the danger of falling through a weakened roof. You should watch for signs of discolouration or sagging in the roof. These can indicate that the structure has been weakened.

When you are working on a roof, you should walk on the areas that are nailed or screwed. The position of the nails or screws shows where the roofing is attached to a support underneath the sheeting. If the roof appears weakened, you can place a short extension ladder on the roof to distribute your weight over a larger area.

## 14.9 Smoke Spread in Multi-Storey Buildings

### 14.9.1 Dangers

A fire in high rise buildings carries a danger to occupants from heat and smoke.

Smoke issuing from lift shafts, air conditioning ducts, stairwells, (see Fig 14.1) and service shafts (plumbing or electrical) that are not properly sealed, can severely disrupt evacuation and ventilation in high rise buildings because of the smoke issuing from these areas.

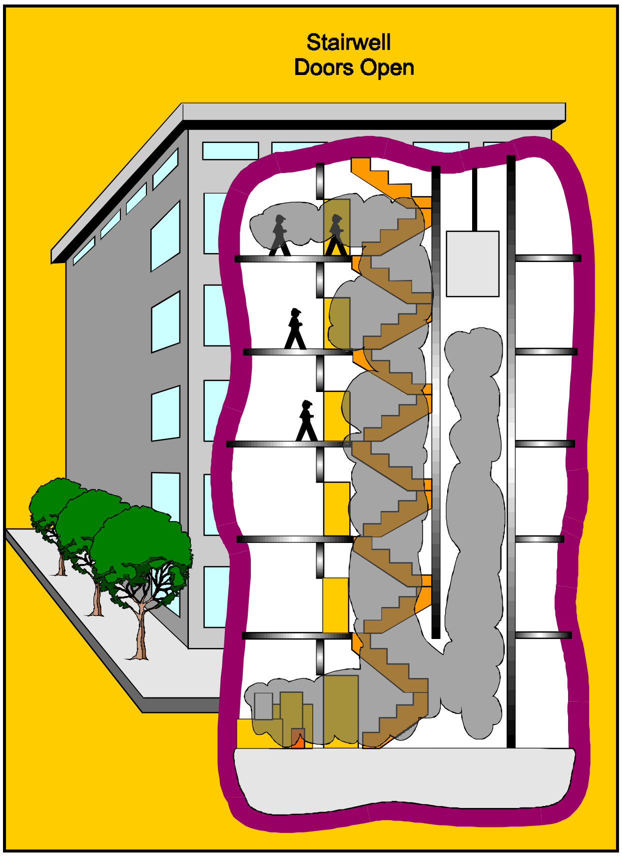


**Fig 14.1 Fire and Smoke Spreading Through a Stairwell**

These shafts can create an upward draft of smoke. This causes a phenomenon known as the *stack effect*. (See Fig 14.2)

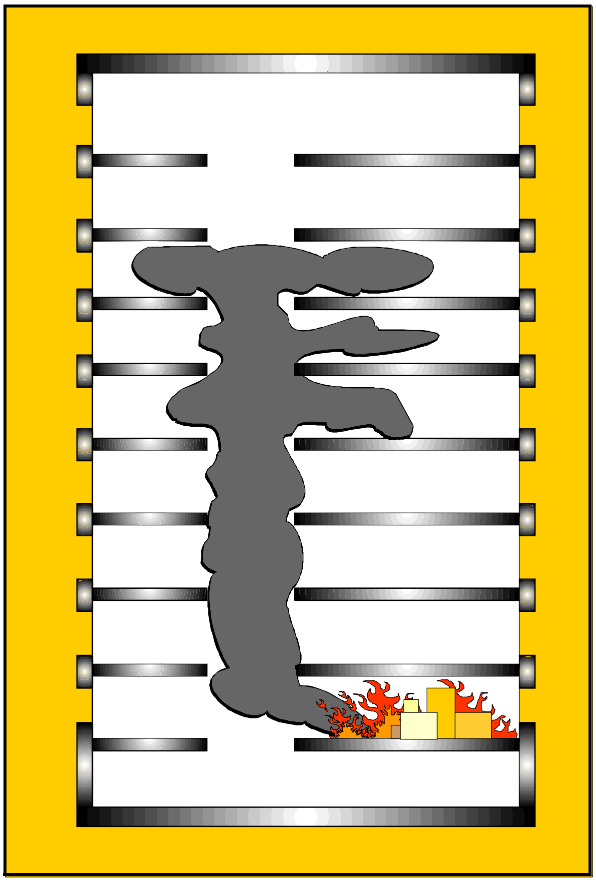

**Fig 14.2 The Stack Effect in a High Rise Building**

In these buildings, the doors to fire escapes or fire isolated stairs must be self-closing, and the doors must be kept closed. This prevents the entry of heat and smoke into the stairwells. When you conduct a building inspection, if you notice that the fire doors are propped open, you should close these doors and impress on the occupants the importance of keeping the doors closed.

### 14.9.2 Ventilating Multi-Storey Buildings

The ventilation operation of a high rise building must be carefully and specifically planned. These plans must include the following:

- the location of personnel;
- the fire fighting equipment available;
- how you use the fire fighting equipment;
- how ventilation is to be achieved;
- when to ventilate; and
- the communication of plans to all personnel within the building.

An unplanned or unco-ordinated ventilation attempt can be disastrous and highly dangerous.

### 14.9.3 Stratification of Smoke and Gases

Stratification of smoke and combustion products is a condition created above the fire floor in multi-storey buildings, which, by nature are sealed to the top floor.

Heat, smoke, and fire gases rise gradually through any vertical openings. They spread to the floors above the fire. As the heat dissipates into the surrounding atmosphere, the smoke and fire gases form layers within the building. The more heat produced by the fire, the higher these layers will penetrate.

Other factors affecting the levels reached by these stratified layers include:

- the type of fuel in the fire;
- size of the fire;
- size of the internal openings;
- height of the building; and
- the weather.

Smoke hinders the fire fighting operations, the search and rescue operations, and evacuation. The dangers remain until the building is ventilated.

In your pre-planning of the ventilation operation, you should take this stratification of smoke and fire gases into consideration. You should design your ventilation procedure to address these dangers. When you plan your method of attack, you should also consider carefully the risk to life associated with the layers of stratified smoke and toxic fire gases within the building.

## 14.10 Mushrooming Effect in Tall Buildings

If smoke and gases are free to spread throughout a building but cannot escape from the building, they will fill the entire building from the top down.

*Mushrooming* (see Fig 14.3) usually occurs in the upper parts of a building on fire. However, it does not occur in high rise buildings unless, the heat build up within the building is sufficient to move the stratified smoke and fire gases upwards, to a barrier from which they cannot escape.

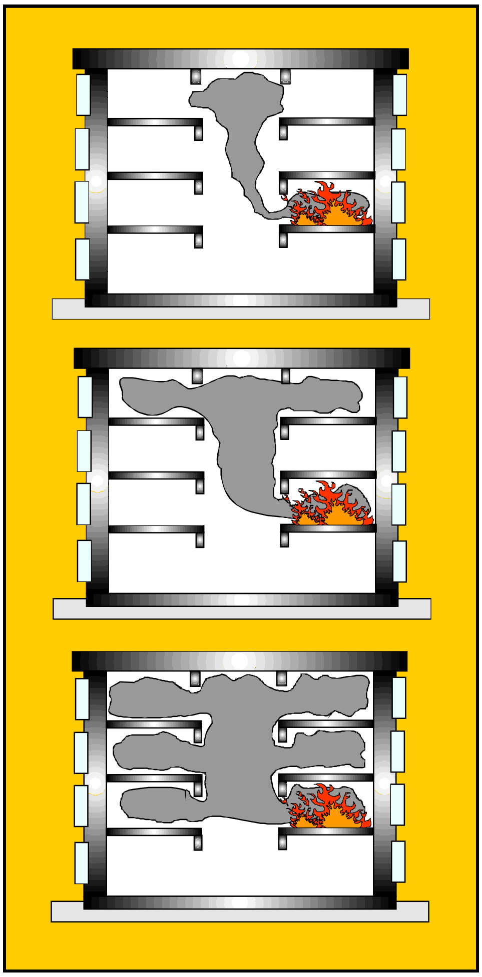

**Fig 14.3 The Mushrooming Effect in an Unventilated Structure**

If the mushrooming effect is advanced, you need to ventilate by creating an opening (ventilation) at the top of the building to safeguard against back-draught and flashover.

## 14.11 Basements and Windowless Buildings

When you must ventilate the areas of a building below ground level, the procedure is different from ventilation in the above ground levels. Below ground, you face some different problems. You cannot use normal ventilation procedures because basements rarely have openings. Because of this, you may need to use mechanical ventilation.

You can use mechanical ventilation also in buildings that have no windows or that have windows that are fixed. Most buildings of this type usually have reverse cycle air conditioning, and you can use this air conditioning system to ventilate.

## 14.12 Pitched and Flat Roofs

### 14.12.1 Roof Construction

Roofs come in many and various designs. The two most common roof types are pitched or flat roofs. The materials used in construction of roofs also vary, but usually the materials include steel or timber support members with various materials being used for the actual roofing.

On normal residences, you can generally remove the tiles or metal sheeting quite easily for ventilation purposes. However, on factories and warehouses, you may have trouble removing the roof because the actual roofing material may be long lengths of sheet metal.

### 14.12.2 Ventilating a Roof

To ensure that the maximum amounts of heat and smoke are released in your ventilating operation, you should ventilate a roof at the highest point possible.

Factories and warehouses usually have large flat roofs, and ventilation may be difficult on the roofs of these buildings. You may have to use other methods of ventilation. For instance, you can consider the use of natural openings in the roof such as skylights, vents, or doors to roof areas.

## 14.13 Vertical Ventilation

### 14.13.1 Introduction

We use different methods to ventilate a structure. For the ventilation operation to be most effective, you must be aware of the different methods we use and the differences between them.

If you use a method that is not appropriate to the particular situation at hand, you may cause unnecessary risks to the occupants, other firefighters, and to the building. To ensure success, you must have the knowledge and experience to be able to translate the method into the appropriate actions. In this section we look at one method - vertical ventilation.

Vertical ventilation removes the smoke, gases, and accumulated heat through the top of the building by the introduction of cooler air at ground or fire level. Vertical ventilation reduces the chance of a back-draught occurring. (See Fig 14.4)

**Fig 14.4 Vertical Ventilation Reduces the Chance of Back-draught Occurring**

When you ventilate from the top, you must provide adequate inlets for cold air lower down in the building, otherwise the vents will not be effective.

The construction of the roof affects the point of entry. Make maximum use of doors, skylights, and covers. If these are not available, you need to create a hole in the roof.

### 14.13.2 Locating the Fire

In the previous section, we discussed how you should not begin ventilation until you have located the seat of the fire. If smoke issues from high within a building, this does not necessarily mean that the fire is in that area.

Before you arrived at the scene, the fire may have spread throughout the building. This can make the extent and location of the fire a major consideration in your decision on how to ventilate the building.

You should not start your ventilation operation until you have located the fire. You may be able to do this by feeling the walls, windows, or roof to determine the heat conditions. If you start ventilating too early, areas that are not involved in the fire may start burning.

### 14.13.3 Vertical Ventilation Considerations

**Primary Considerations**

The primary considerations when you consider ventilation are the following:

- the phase of the fire;
- the amount and type of fuel; and
- the length of time that the fire has been burning.

The fire can spread vertically if the following occur:

- direct burning or convection up stairwells and lift shafts;
- direct burning or convection through partitions and upwards between the walls;
- flame extending through windows and heating upper floors;

- conduction of heat through beams and pipes passing through walls and floors;
- direct burning upward through ceilings;
- through openings downward in floors;
- burning materials down through the building; and
- total collapse of floors and roofs.

## Positioning Personnel

You can gain access to the roof by using extension ladders or by using specialised aerial appliances. When you are on the roof, you must then select the right tool with which to ventilate.

When you approach the roof, you should take with you at least the following tools:

- an axe;
- a pinch bar;
- a hammer;
- a ceiling hook; and
- any other tools available.

You can use the ceiling hook to punch a hole in the ceiling once the roof has been penetrated. The hole must be large enough to allow the heat and smoke to vent. (See Fig 14.5)

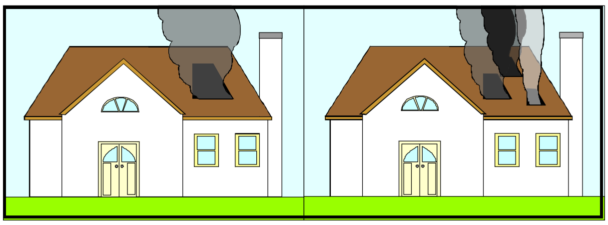

**Fig 14.5 One Large Hole in Preference to Several Small Holes**

## Selecting the Place to Ventilate

When you are deciding where to ventilate, make the opening at the highest part of the roof and directly over the fire if possible, otherwise the fire will be pulled through the structure toward the hole, thus increasing fire damage. (See Fig 14.6)

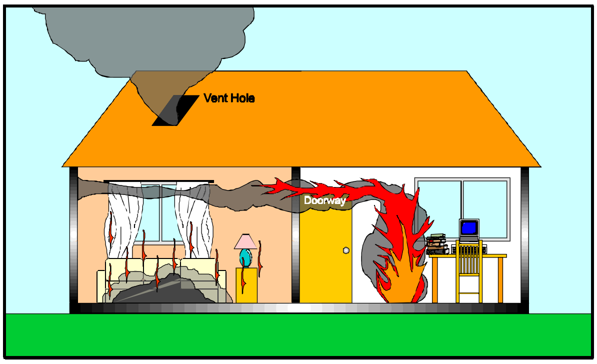


**Fig 14.6 Incorrect Positioning of Vent Hole**

The following factors will also have a bearing on where to ventilate.

- number and location (if any) of natural openings; (See Fig 14.7)
- seat and size of the fire;
- building construction;
- weather and wind direction; (See Fig 14.8)
- length of time that the fire has been burning;
- the size of the fire; and
- the age of the building and fire loading.

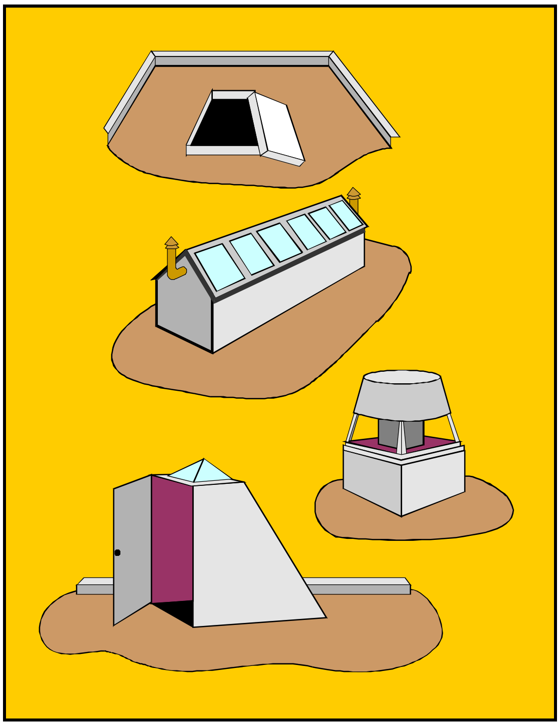

Fig 14.7 Types of Roof Opening

Keep uppermost in your mind **the effect** that ventilation will have on the fire. Consider also the need to protect exposures, the rest of the building, and the contents of the building.

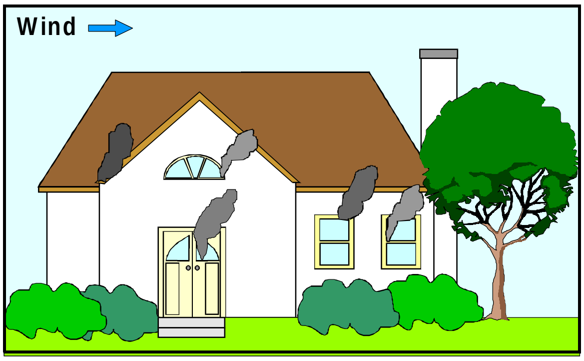


Fig 14.8 The Effect of Wind on Where to Ventilate

### Opening the roof

When you have made the decision to open the roof, and you find that natural openings do not exist or are not sufficient to release the accumulated heat and smoke, the OIC may order the roof to be ventilated. Timing is most important: you must cut the hole large enough **at the first attempt** to establish adequate ventilation.

⚠ **NOTE**

**When you cut the hole in the roof, consider also that this hole must be repaired; make it as easy as possible to repair.**

### 14.13.4 Procedures

The determinations that the OIC makes initially include:

- assessing the building involved;
- determining the location and extent of the fire;
- moving fire crews and tools to the roof;
- observing safety precautions; and
- selecting the place to ventilate.

Prior to, and during the actual opening of the roof, the OIC should give consideration to the following items:

- communications with crews that are not involved in ventilation;
- other exposures in relation to the wind direction;
- the type of construction and weight on the roof;
- use of natural openings where possible;
- use of one large hole rather than several small ones;
- location of hot spots to help locate the seat of the fire;
- condition of the roof covering to indicate if roof collapse is imminent;
- location of the hole (flat roofs ventilate more effectively when the hole is cut 1 - 1.5 m from hot spot);

- ensuring that structural members are not cut when the hole is cut;
- cutting from an upwind position; (See Fig 14.9)
- attending the opening after it has been cut so that others don't fall through the hole;
- using a ceiling hook to make a hole in the ceiling equal to that in the roof;
- using a hose line for protection; and
- establishing two exit routes.

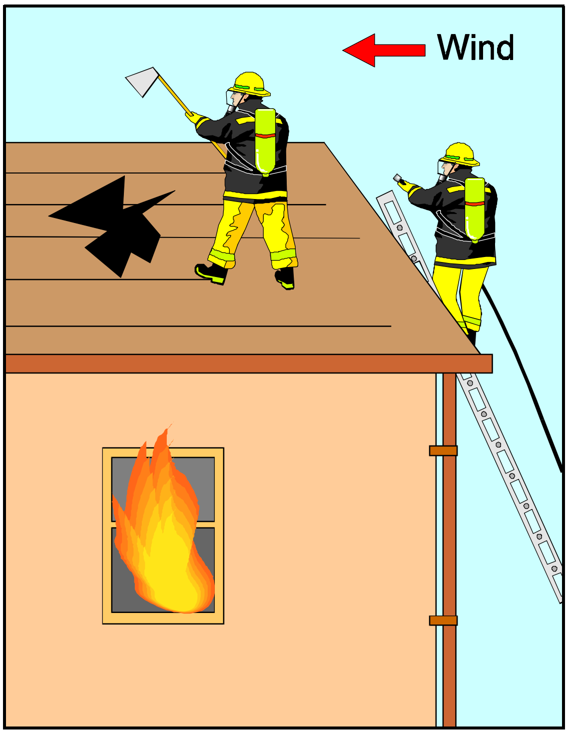


**Fig 14.9 Always Work Upwind of the Vent Hole**

### 14.13.5 Factors That Destroy Established Vertical Ventilation

If you use the correct type of ventilation at the proper time, firefighters in the building should not have to leave the building due to heat or smoke. When firefighters have been forced from the burning building, investigation usually shows they were forced from the building due to some factor that was destroying the well established ventilation in progress.

If the ventilation procedure is interrupted, heat and smoke will remain and increase. They hamper rescue operations and extinguishment of the fire.

Factors that may destroy established ventilation include:

- using the wrong type of ventilation, such as mechanical;
- breaking of windows;
- aiming hose streams into the building;
- using natural openings incorrectly;
- explosions; and
- placing too many openings.

### 14.13.6 Elevated Hose Streams

You can use elevated hose stream jets to cut down sparks, embers, and the volume of heat over the building. When these jets are aimed downwards through a ventilation hole to a point where ventilation is no longer effective, they can destroy and upset the natural flow of heated gases from the building.

This kind of disruption in ventilation hampers the efforts of firefighters within the building. However, you can use elevated jets if you angle them slightly above the horizontal to help cool the sparks, embers, and heated gases. (See Fig 14.10) The movement of the jet across an opening can even increase the rate of ventilation.

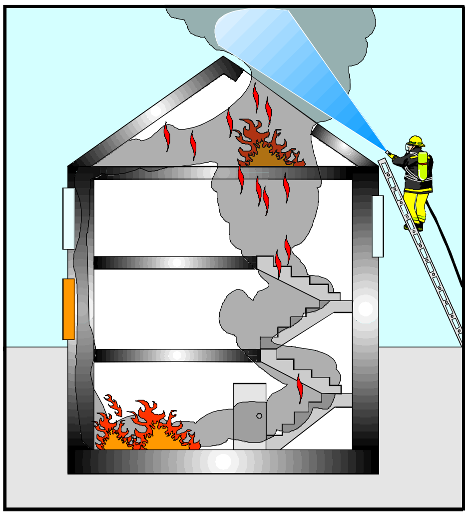

**Fig 14.10 A Stream Directed Above the Vent can Aid the Ventilation Process**

### Trench Ventilation

*Trench ventilation* is a form of vertical ventilation. When trench ventilation is used correctly, it prevents the horizontal spread of the smoke and fire through a large building. This type of ventilation has proved very effective in controlling fires in schools, motels, and factories that have large open and undivided roof spaces.

*Trenching* is carried out by cutting a 1 - 1.5 m wide opening across the entire width of the roof. (See Fig 14.11) After you have cut the hole in the roof, you should then open the ceiling below to the same degree.

**⚠ NOTE**

**It is important that the trench be located, cut, and finished before the fire reaches the area where the ventilation is located.**

**CAUTION**

**Flames may reach the trench area, but you should never direct jets of water from aerial appliances into the opening. Streams directed into the opening push heat, smoke, and flames back into the building.**

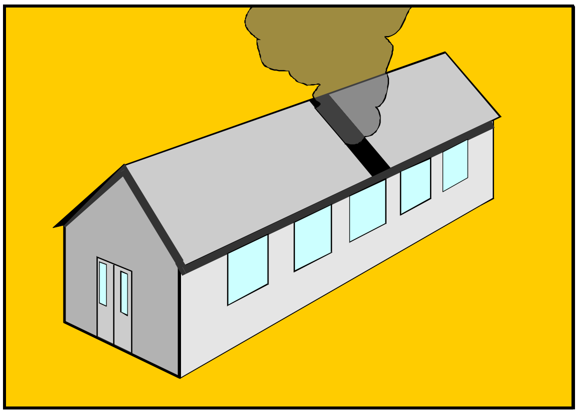

**Fig 14.11 A Trench Cut Across the Entire Width of a Roof**

### 14.13.7 Safety Precautions

Here is a list of safety precautions that you should practice during vertical or trench ventilation:

- don't walk on spongy roofs. Sponginess in the roof is usually a sign that structural members have been weakened;
- take care to prevent firefighters from sliding and falling;
- exercise caution when working near electric wires;
- ensure that firefighters making the opening are standing to the windward side of the cut and wearing the correct protective equipment;
- watch for indications of weakening structure or other hazards;
- apply extreme caution when using power tools;
- keep a firm footing;
- always have a means of retreat.

## 14.14 Horizontal Ventilation

### 14.14.1 Introduction

Ventilation of a building is a very important part of the fire fighting operation.

We have several types of ventilation that we use. We have discussed vertical ventilation at some length. Vertical ventilation is not the solution to all ventilation problems. In some instances, vertical ventilation is impractical or impossible because of conditions and considerations previously discussed in this module.

In some situations, horizontal ventilation is the more appropriate ventilation method. You can use horizontal ventilation by opening windows and doors. This allows the ventilation to travel laterally through the building. Smoke, gases, and accumulated heat are removed by the movement of cooler air introduced at the ground or fire level.

### 14.14.2 Structural Characteristics of a Building

The building design, construction, and occupancy are the main factors that determine whether you should use horizontal or vertical ventilation.

The design features that can affect the decision to use horizontal ventilation include:

- exterior fire escapes;
- nearest exposures;
- number of floors; and
- number and size of any wall or roof openings.

Here is a list of buildings for which horizontal ventilation is best suited:

- homes where the roof is not involved in the fire;
- buildings where the windows are close under the eaves;
- high rise buildings where each involved floor has operable windows; and
- warehouses with large under-roof spaces that may have been weakened by fire.

### Using Windows for Horizontal Ventilation

The windows of a building provide the best openings for horizontal ventilation. When you use windows for ventilation, it is most effective to open the higher parts of windows on the downwind side and to open the lower parts on the upwind side. (See Fig 14.12) This allows smoke and gases to escape. To get maximum use of window openings, you should remove any curtains or blinds.

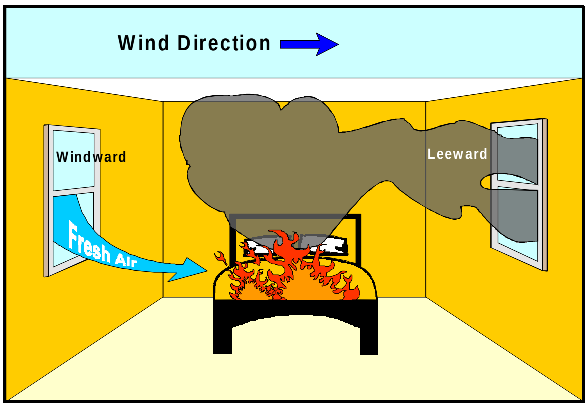


**Fig 14.12 Correct Use of Windows for Horizontal Ventilation**

### Building Configuration

Some buildings do not lend themselves well to the use of horizontal ventilation. If you know the layout and the contents of the buildings, this will help you to find the seat of the fire i.e. buildings with a large number of rooms or with partitioning can be very difficult to ventilate horizontally.

Smoke and gases can build up over a long period of time and filter throughout the building through cracks and other conduits. This can make it difficult to locate the seat of the fire. The contents of the rooms and the presence of partitioning can cause horizontal ventilation to be ineffective.

### 14.14.3 Horizontal Spread of Fire

Many of the procedures that we use in vertical ventilation also apply to horizontal ventilation. However, we sometimes need a different procedure to ventilate a room, a floor, or a basement. The procedure that we follow is influenced by the location and extent of a fire.

It is also affected by the way in which the fire spreads, especially if the fire is spreading horizontally. Some of the ways by which horizontal fire spread occurs are as follows:

- by direct burning or convection through wall openings;
- by direct burning, convection, or radiated heat through halls and passageways;
- by direct burning or radiated heat across open space;
- by explosion, flammable vapours, gases, and dust in any direction;
- by direct burning through walls;
- through beams and pipes by conduction; and
- through air conditioning ducts and vents.

### 14.14.4 Exposures

When you fight a fire, you should be aware of internal and external exposures. Horizontal ventilation does not normally release the heat and smoke above the fire. Horizontal ventilation removes these hazards by the same routes by which any occupants may have to evacuate the building.

It is important to protect outside exposures from the effect of released heated gases because the gases have the potential to ignite some of these exposures such as the eaves of nearby buildings.

As well, the smoke removed by horizontal ventilation may also be drawn into adjacent buildings through their air conditioning ducts. This can cause causing smoke damage and endanger the occupants.

### 14.14.5 Weather Conditions

When you are considering which ventilation procedure to use, you must consider the weather conditions.

#### Wind

The wind conditions are a major influence in determining the proper ventilation procedure. (See Fig 14.13)

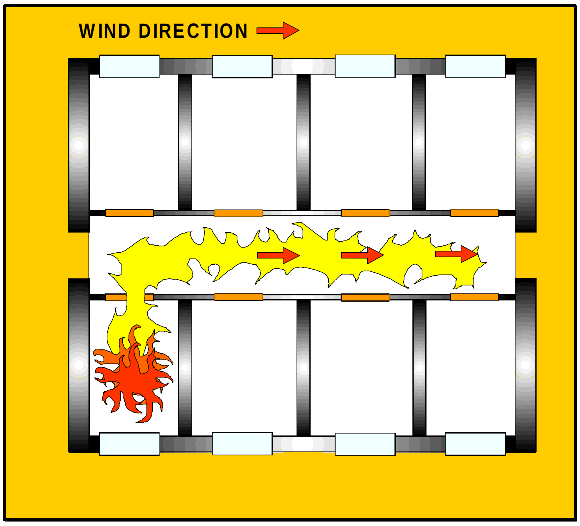


**Fig 14.13 Fire can Spread when the Wind Aids the Process**

If there is no wind, horizontal ventilation is not very effective. However, if the wind is too strong, the wind can blow the heated gases and smoke onto and into nearby exposures.

#### Humidity

High humidity can severely hinder horizontal ventilation because humidity tends to keep the smoke and gases from rising into the air.

#### 14.14.6 Factors That Destroy Established Horizontal Ventilation

When you initiate a ventilating operation, it is important that the areas and openings that you are using for ventilation are not blocked by fire crews extinguishing the fire. Any extra openings that are made in the building can upset the flow of air currents that are moving the smoke and gases from the initial ventilation. (See Fig 14.14)

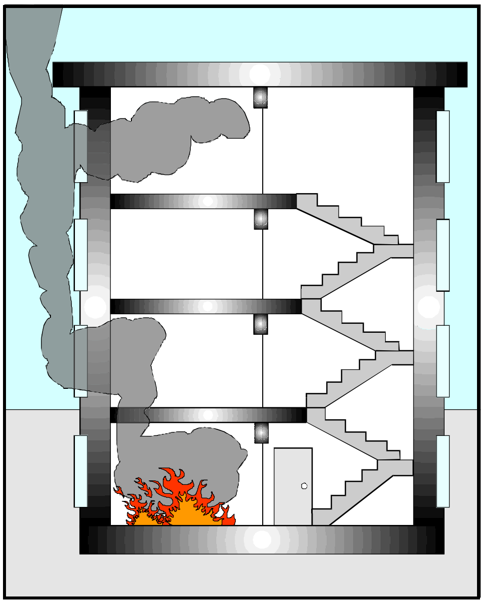

**Fig 14.14 Extra Openings can Draw Smoke in at Higher Points**

Here are some of the factors that can impair horizontal ventilation:

- improper use of mechanical ventilation, such as insufficient cold air intake and incorrect positioning of smoke extractor;
- incorrect use of hose streams, such as directing streams into ventilating openings;
- incorrect placement of salvaged contents left in a building so that the contents obstructs ventilation; and
- obstruction of air currents by partitions or contents blocking airflow.

### 14.15 Pressurised Ventilation

#### 14.15.1 Introduction

Positive pressure ventilation is a forced ventilation technique that operates by creating pressure differentials.

Up to this point, ventilation has been considered using the natural flow of air currents and the currents created by fire. Pressurised ventilation is accomplished mechanically (with blowers and ejectors) or hydraulically (with fog streams).

#### 14.15.2 The Pressurised Method

When we use the pressurised method of ventilation, we **force** the contaminants to move. In this way, we can:

- cause the contaminants to exit through pre-selected and/or controlled openings;
- use ventilation openings that are remote from the contaminants to help us:

  - overcome the effects of humidity;
  - overcome interior/exterior temperature differentials;
  - move contaminants to the exterior of a contaminated area through areas or openings not normally used by natural ventilation; and
  - reduce the time necessary to ventilate a contaminated area when compared to natural ventilation.

### 14.15.3 Negative and Positive Pressure

#### Negative Pressure Ventilation

When you use negative pressure ventilation, open the door and place the blower **inside** the building to exhaust the contaminants. (See Fig 14.15) This method draws the contaminants **from** within the building through the blower and exhausts the contaminants **to** the exterior of the building by creating negative pressure, or suction, within the building. When you open a window, the exhausting contaminants are replaced with fresh incoming air.

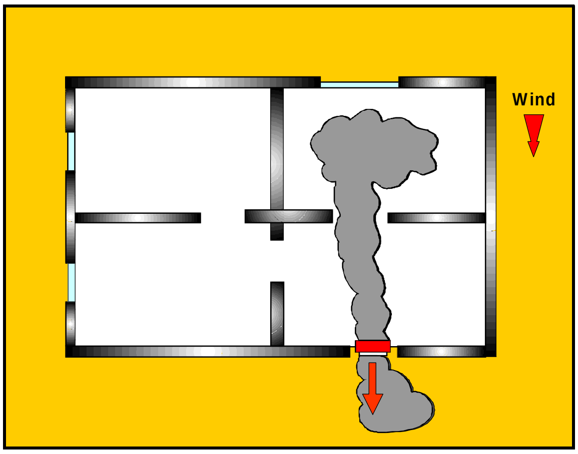


**Fig 14.15 Negative Pressure Ventilation Using a Blower Inside a Building**

#### Disadvantages of Negative Pressure Ventilation

Interior blowers are not efficient in removing contaminants from the top of an area or building. Air follows the path of least resistance. This path is normally a straight line from the fresh air inlet to the blower. This limits the flow of air at the top of the area to be ventilated.

Although this method performs satisfactorily, it has the following disadvantages:

- personnel are exposed to hazardous contaminants when they position the blower;
- blowers placed in doorways or hallways block entry and exit to the building;
- blowers placed inside a building add to the noise and confusion and hinder communications;
- to position the blower effectively, we must use straps, hooks, and other accessories to suspend the blower in doorways or windows; and
- contaminants are drawn through the blower, and this creates additional equipment clean-up and maintenance.

#### Positive Pressure Ventilation

When you use positive pressure ventilation, open the door and place the blower **outside** the building. This method forces clean, fresh, pressurised air into the building and creates a positive pressure, similar to the pressure you create when you blow up a balloon. The positive pressure is equal at the top, bottom, and corners of the building. When you open the window, the contaminants from all parts of the building exhaust to the exterior.

#### Advantages of Positive Pressure Ventilation

Compared to negative pressure ventilation, positive pressure ventilation has the following advantages:

- personnel are not exposed to hazardous interior contaminants while positioning exterior blowers;
- doorways, windows, and halls do not need to be blocked by blowers;
- exterior blowers do not depend on additional equipment or accessories for set-up and operation;
- the set-up operation requires less time and, in some instances, fewer personnel to put exterior blowers into operation as no other equipment or

accessories are necessary;

- exterior blowers do not add to the noise or hinder the flow of communications inside the fire area;
- exterior blowers are efficient in removing contaminants at the top, bottom, and corners of an area or building;
- contaminants are not drawn through the blowers and this minimises the clean-up and maintenance; and
- compared to negative pressure ventilation, positive pressure ventilation is at least twice as efficient at removing contaminants from the contaminated area.

## 14.15.4 Implementation of Positive Pressure ventilation

### Opening the Entrance

When you place the blower, you must ensure that the *cone* of pressurised air issued from the blower completely covers the entrance opening. (See Fig 14.16) This prevents the contaminants from being forced back through the unsealed portions of the entrance opening and being reintroduced into the pressurised area. You can ensure this by adjusting the distance from the blower to the entrance opening.

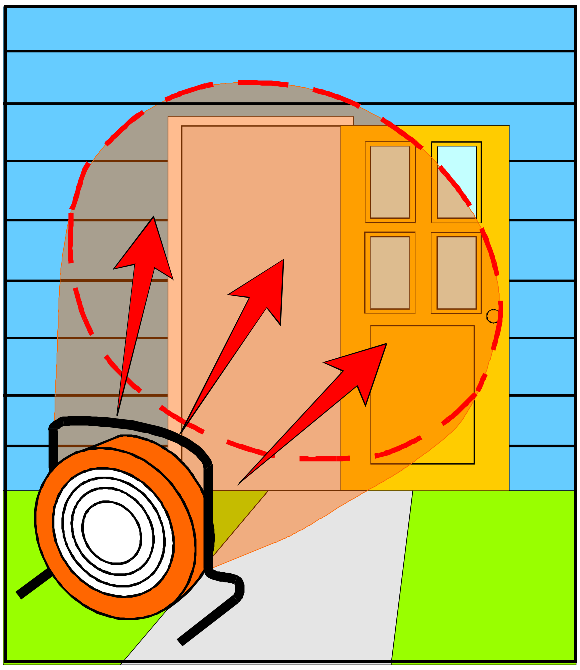

**Fig 14.16 Ensure the Cone of Air Covers the Entire Opening**

### Adjusting the Flow

It is very important that you control the flow or path of pressurised air between the entrance opening and the exhaust opening. (See Fig 14.17) This helps to achieve effective ventilation.

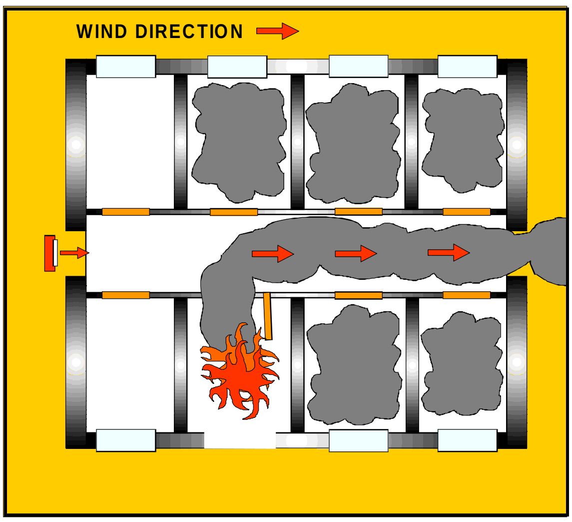


**Fig 14.17 Controlling the Flow of Pressurised Air**

If pressurised air is directed from an entrance opening to an exhaust opening without being diverted to other openings, contaminants are removed with the pressurised air in a minimum amount of time. If you open other windows or doors, this will not facilitate a successful positive (or negative pressure) ventilation operation.

**Selecting the Exhaust Opening**

Select the exhaust opening to provide horizontal or vertical ventilation of contaminants. The size of the exhaust opening depends on the capacity and number of blowers you are using.

### 14.15.5 Operational Considerations

**Single Blower**

If you are using a single blower, you should place it so that the cone of pressurised air just covers the entrance opening. If the blower is too close to the opening, the opening will not be completely covered by pressurised air. If the blower is too far from the opening, pressurised air will strike the area around the opening. This reduces the amount of pressurised air that is forced into the contaminated area. Optimum placement depends on the size of the entrance opening.

If you use a small blower, you should place it back from the entrance opening. If you use a larger blower, place it closer to the entrance opening so that it properly covers the opening with pressurised air. The difference in placement depends on the size of the pressurised cone of air that issues from the blower. You can increase the efficiency of the blower by tilting the blower back about 20 to 30°.

**Multiple Blowers**

If you use more than one blower, the volume of air flow is dramatically increased. For standard entrance openings, you can achieve the maximum effect by placing two blowers **in-line** with each other.

When you use this method, place the first blower approximately 0.5 m from the entrance opening. This ensures that all the pressurised air from the blower enters the contaminated area, yet it allows sufficient room for personnel to move in and out of the entrance. Place the second blower behind the first. The distance between them is determined by the size of the opening.

The second blower covers the entrance opening with pressurised air, forces pressurised air into the contaminated area, and increases the capacity of the first blower by approximately 10%. If the two blowers are of unequal size, place the one with the larger capacity in front of the smaller one.

When you must cover a larger entrance, place the blowers in parallel configuration, side by side. The size of the opening helps you to determine the number of blowers you should use to cover the opening. Remember that some openings, such as loading-dock doors, can be reduced in size by partially closing the door. This reduces the size of the entrance opening that you need to cover by pressurised air. Depending on the number of blowers that are available, you can effectively ventilate large areas by using a combination of **parallel** or **in-line** blowers.

If the areas that you must ventilate, such as storage rooms, do not have openings that you can use as exhaust openings, you can effectively ventilate them using multiple blowers. Use a blower to provide air **past** the opening. You can locate this blower outside the contaminated area.

Use the second blower to provide pressurised air **into** the area to be ventilated. Place this second blower in the bottom portion of the opening. This provides pressurised air and creates a positive pressure within the area to be ventilated. This pressure forces the contaminants out of the upper portion of the entrance opening. The air flowing past the entrance opening forces the exhausting contaminants to follow its path to the exterior of the building.

**Adjusting the Exhaust Opening**

Positive pressure is most efficient when the exhaust opening, such as a window or door, is between three quarters to one and three quarters the size of the entrance opening. This variance is due to the number and $m^3/s$ capacity of the blowers that you are using.

If you notice an exhaust odour inside the building or area to be ventilated, this indicates that the exhaust opening is not large enough. The exhaust odour should disappear when you increase the opening.

**Effect of the Weather**

Atmospheric conditions do not usually limit the ability of blowers to move the contaminants horizontally or, in most cases, vertically.

However, the wind can have an adverse effect on positive pressure ventilation, but its effect depends on the wind direction and velocity. As in any ventilation operation, you can achieve maximum efficiency by using the prevailing wind direction to your advantage. You will find it most advantageous to pressurise the contaminated area on the **windward** side so as to ventilate on the leeward side. Positive pressure has been effective on winds with a velocity of up to 50 kph, above that velocity, the efficiency will be reduced.

**Effect of the Size of the Blower**

Compared to smaller blowers up to 700 mm, the larger blowers offer the following advantages:

- higher $m^3/s$ ratings;
- larger cone of pressurised air for covering entrance openings; and
- increased versatility for various types of applications.

**Power used for Blowers**

Blowers are powered by electricity, water hydraulic pressure, or petrol engines. Petrol powered blowers offer increased performance and flexibility. They also offer increased versatility and portability compared to electric or water driven blowers.

**Points to Remember**

Here are some points to remember regarding your choice of blowers:

- petrol powered blowers add a small amount of carbon monoxide to the air when positive pressure ventilation is used; and
- tests indicate that two-stroke engines produce 30 ppm (parts per million) and four-stroke engines produce 60 ppm of carbon monoxide.