TOPIC SIX - BREATHING APPARATUS

CONTENTS

SECTION ONE - GENERAL INFORMATION

CONTENTS

1 GENERAL INFORMATION

1.1 Introduction

The need for BA was initially realised by the Fire Service and the mining industry. Workers in these two occupations were faced with immediate severe respiratory trauma when exposed to hot, smoke-filled, toxic and oxygen-deficient atmospheres. Other industries that caused occupational respiratory diseases did not immediately recognise the need for BA, because the respiratory trauma was gradual, and it took time for an employee to develop the symptoms of respiratory diseases.

1.2 Self Contained Breathing Apparatus

The need for Self Contained Breathing Apparatus (SCBA) became evident in the Fire Service after the introduction of leather hose. Before the use of hose, bucket brigades and gooseneck pumpers were used for attack from the building exterior. Firefighters were able to stay out of the smoke. The introduction of hose put the firefighter closer to the toxic products of combustion that compose smoke. The hazards have increased to this day.

1.3 History of SCBA

SCBA can be dated back to Europe in the late 1700's. Most of the early apparatus consisted of inflated air bags and tubing for air to pass from the bags to the firefighter's mouth. Some early models had exhalation valves, others did not because of the belief that carbon dioxide readmitted to the air bag would automatically divide into carbon and oxygen. It was believed that the carbon would be collected and the oxygen could be rebreathed indefinitely. Other developments included smoke suits that were filled with air, pumped to the firefighter from the fire engine pump; masks that were connected to tubing that extended to the floor where there was less smoky breathing air; masks that used cool, wet sponges containing water and vinegar to neutralise and purify the air that was breathed; and smoke hoods, tightly woven masks used to filter out the larger smoke particles.

BA was used at fires in the USA after the 1860's. Many of the models used the same European methods with slight variations. A new method (that had a short life) was air supplied from a pumper through an air hose located inside the fire hose.

In another method, used by many cities around the turn of the century, firefighters were required to have six inch beards. The beard was dipped into water and then placed into the firefighter's mouth. The wet beard filtered the smoke-filled air supply similar to the way the wet sponges did. The beard, however, was not very effective, it would not stop the toxic gases and particles from being inhaled through the nose. The irritants would cause coughing, expelling the beard filter from the firefighter's mouth. Low oxygen levels or high carbon monoxide levels at fires were no less dangerous.

Oxygen deficiency and the presence of carbon monoxide limited the effectiveness of all the types of breathing protection mentioned above. Oxygen cylinder rebreathing equipment was designed to let the firefighter carry a small supply of breathable oxygen, and yet make it last longer for operation, by removing carbon dioxide from exhaled air so the air could be rebreathed. The exhaled air was still relatively high in oxygen and could be supplemented by only a small quantity from the oxygen cylinder. A scrubber chemical absorbed the carbon dioxide from the exhaled breath, and an automatic valve in the air storage mixing bay admitted oxygen as needed.

The oxygen-generating canister was developed on a Navy contract during World War II. The moisture from the wearer exhaled breath reacted with the chemicals in the canister, which produced oxygen and absorbed the carbon dioxide. The product of exchange was mixed well in the breathing bag, then inhaled by the wearer. A collapsible breathing bag

connected to the canister served as a reservoir to store the oxygen as it was generated. Since pure oxygen was involved, firefighters were warned to keep oil, grease, or open flame from entering the canister. Rapid oxidation or explosion of the canister could result. Oxygen-generating canisters were designed to last for 45 or 60 mins, but once the chemical process started there was no way to stop it.

The first practicable SCBA was developed by an English marine engineer, *Henry Fleuss* in the late 1870's. *Fleuss* patented his invention in 1879 and commercial manufacture was commenced by *Messrs. Siebe Gorman and Co.* the same year. *Siebe Gorman* were at the time engaged in the manufacture of submarine diving suits and equipment.

1.4 Current Equipment

Today's breathing equipment is an offshoot of the oxygen masks developed for high altitude flying in World War II. Continuous refinements have made the equipment more effective and efficient. The types of protective BA used in the NSWFB today include open-circuit demand positive-pressure systems, and closed systems that use compressed or liquid oxygen. Each of these types of systems will be dealt with in this Topic.

1.5 Future Equipment

It is extremely important that the respiratory devices provided to firefighters can withstand the severe environmental conditions firefighters might encounter. Because of reports of firefighters being overcome or even killed while wearing SCBA, laboratory tests are being conducted to investigate which key environmental factors affect SCBA, and what the effects are on the individual types of apparatus used today.

Factors such as radiant heat, superheated air, moisture, extinguishing agents, fire decomposition products and chemicals and mechanical stress are tested and the results recorded. These laboratory test results give BA manufacturer's guidelines, and new goals to strive for in designing new and safer apparatus. The new equipment being designed for fire fighting promises increased safety and utility.

SECTION TWO - RESPIRATION

CONTENTS

2 RESPIRATION

2.1 Elementary Physiology

Air is a mixture of gases approximately 21% oxygen and 79% nitrogen, with traces of carbon dioxide, water vapour and other gases. For normal body functions to continue, a person needs to inhale between 16 and 70 L of air every minute. The volume of air depends on a number of factors including age, general health, physical exertion and state of mental excitement. An adverse effect on the human body will occur if the quality of air is degraded by:

- toxic gases;
- oxygen deficiency;
- elevated temperatures; and
- smoke.

Any of the above conditions can be encountered by firefighters in the course of their duties. Therefore, to allow firefighters to effectively operate at incident grounds respiratory protection may be required.

2.2 Respiratory Protection

The lungs and respiratory tract are probably more vulnerable to injury than any other body area, and the gases encountered with fires are dangerous.

Standard Operating Guidelines (SOG's) state that no firefighter is permitted to enter a building that is charged with smoke or gas unless the firefighter is equipped with SCBA.

Firefighters should always assume that any smoke may be toxic. The firefighter, the victim and other crew members are best served when a firefighter uses correct respiratory protection. An atmosphere is considered hazardous if it contains:

- heat (greater than 48.9°);
- smoke;
- toxic gases;
- is oxygen deficient (less than 19.5°); or
- if flashover is likely.

Numerous research studies give graphic details of the dangerous contents of smoke and the damage they can cause in the human body.

Failure to use SCBA in hazardous atmospheres will incapacitate firefighters and could lead to the failure of rescue attempts. Having firefighters unnecessarily incapacitated from failure to use the equipment, can only hinder the functions of the NSWFB during an emergency. *Australian Standards* concerning SCBA have been approved and many fire departments have established policies requiring all personnel likely to enter, or work in hazardous atmospheres, to be equipped with SCBA and be trained in their use and maintenance. BA has been developed to aid in rescue and fire extinguishment by protecting the firefighter's life and health from hazardous atmospheres. The protection provided by the equipment can only be attained through correct training and mandatory use of SCBA.

2.3 When to Wear BA

It is important that every person who is required to wear BA is adequately trained and thoroughly understands the operation and procedures It is not only a question of the person's own safety, but also that of their colleagues with whom they may be working at the time or subsequently.

⚠ NOTE

The success of BA operations does not rest alone with those persons working inside the building. It is not sufficient for persons to be completely confident in their ability to work with BA in hazardous conditions; they must also have full confidence that the control and support arrangements outside

the buildings are beyond reproach. The whole success of any BA operation is team work and it is incumbent on all those engaged in the operation to ensure that they are competent and fully conversant with the BA and with the procedure for its use.

The general principle should be that: BA is worn whenever its use will facilitate the location and extinction of a fire or any other incident when, by wearing BA, discomfort and possible injury to a persons respiratory system and other body functions, can be avoided or eliminated.

The specific occasions when BA is to be worn are detailed in Standing Orders.

BA should not be removed until the OIC has established that the atmosphere in the working area has been rendered safe.

SECTION THREE - RESPIRATORY HAZARDS

CONTENTS

3 RESPIRATORY HAZARDS

3.1 Toxic Gases and Fumes

The firefighter should remember that a fire means exposure to combinations of the irritants and toxins that cannot be predicted accurately beforehand. In fact, the combination can have a synergistic effect in which the combined effect of two or more substances is more toxic or more irritating, than the total effect would be if each were inhaled separately. In terms of total effect, the firefighter can face a situation where one plus one equals three.

Inhaled toxic gases may have several harmful effects on the human body. Some of the gases directly cause disease of the lung tissue and impair its function. Other gases have no directly harmful effect on the lungs but pass into the bloodstream and to other parts of the body. In this second category are those gases that impair the oxygen-carrying capacity of the red blood cells.

3.2 Oxygen Deficiency

Combustion consumes oxygen while producing other products, including toxic gases, that are heavy enough and copious enough to exclude oxygen even in a partially opened room. Shown in Table 3A are the details of the physiological effects of reduced oxygen (hypoxia) at reduced percentages of oxygen in the atmosphere.

% OF OXYGEN IN AIR	SYMPTOMS
21	None - normal condition.
17	Some impairment of muscular co-ordination; increase in respiratory rate to compensate for lower oxygen content.
12	Dizziness, headache, rapid fatigue.
9	Unconsciousness.
6	Death within a few minutes from respiratory failure and concurrent heart failure.

Table 3A Physiological Effects of Reduced Oxygen

3.3 Elevated Temperatures

Exposure to heated air can also damage the respiratory tract and if the hot air is moist, the damage can be worse. Excessive heat conducted to the lungs quickly enough can cause a serious decrease in blood pressure and failure of the circulatory system. Inhaling heated gases can cause oedema, or fluid collection in the lungs, which can cause death from asphyxiation. If the heated air reaches the alveoli, there will be damage that can produce pulmonary oedema and interrupt the flow of oxygen to the blood. The tissue damage from inhaling hot air is not immediately reversible by introducing fresh, cool air. If death does not occur, pneumonia from the acute effect of respiratory injuries usually develops during recovery.

3.4 Smoke

The visible product of incomplete combustion, commonly called smoke, constitutes one of the greatest problems a firefighter has to solve when engaged in fire extinguishing operations. In the burning of nearly all flammable substances, there is never what

might be termed perfect combustion because much of the combustible matter escapes unconsumed in the form of smoke.

Smoke consists of exceedingly small particles of solid and liquid matter suspended in the atmosphere, the particles being composed principally of soot or carbon together with tarry substances which are mostly liquid hydrocarbons. As these rise from the fire they become cooler and condense in a cloud which is moved about, or cleared away by the current of hot air formed in the process.

When smoke is very black, as in the case of the burning of certain flammable liquids and oils, it denotes that the amount of carbon is greater than, and disproportionate to the other constituents.

The largest proportion of flammable substances consumed during a fire have carbon and nitrogen as their chief constituents, and during combustion the following principle compounds are produced:

- water vapour;
- nitrogen;
- carbon dioxide; and
- carbon monoxide.

3.5 Carbon Monoxide

Carbon monoxide is exceedingly asphyxiating or poisonous to breath because in the lungs it combines chemically with the haemoglobin in the blood for transporting oxygen (according to the amount of carbon monoxide absorbed). In fact, carbon monoxide combines with the haemoglobin about 200 times more readily than oxygen does. The result is oxygen starvation of the body tissues and finally asphyxiation because the tissues are unable to carry on the vital process without oxygen.

Carbon monoxide is colourless, odourless (except in high concentrations) and tasteless, so that a person cannot know by their senses whether or not it is present. In low concentrations, headache, nausea, or a feeling of weakness are symptoms but in higher concentrations a person may become unconscious without preliminary warning. It should be remembered that while an atmosphere containing 1% carbon monoxide would be almost immediately fatal if breathed, a very much smaller percentage would be equally fatal if breathed for a longer period of time e.g. 0.40% of carbon monoxide in air may kill a person within 1 hr of exposure. 0.04% is the maximum concentration that may be endured for 1 hr without noticeable effects. Thus, it will be realised how extremely dangerous this gas is and how small a percentage in the air may prove fatal. Table 3B details the toxic effects of carbon monoxide.

% CO IN AIR	SYMPTOMS
0.01	No symptoms - no damage
0.02	Mild headache; few other symptoms
0.04	Headache after 1 to 2 hrs
0.08	Headache after 45 mins; nausea, collapse and unconsciousness after 2 hrs
0.10	Dangerous - unconsciousness after 1 hr
0.16	Headache, dizziness, nausea after 20 mins
0.32	Headache, dizziness, nausea after 5 to 10 mins; unconsciousness after 30 mins
0.64	Headache, dizziness after 1 to 2 mins; unconsciousness after 10 to 15 mins
1.28	Immediate unconsciousness, danger of death in 1 to 3 mins

Table 3B The Toxic Effects of Carbon Monoxide

⚠ NOTE

The following three factors are to be noted with regard to the formation of carbon monoxide gas:

(1) When the quantity of incandescent matter is large and the amount of air is insufficient to complete the combustion, carbon monoxide is produced.

(2) With increase of temperature, the proportion of monoxide to dioxide increases with great rapidity.

(3) The playing of water onto the incandescent carbonaceous matter and the action of the steam, thus generated on the flowing carbon, yields carbon monoxide.

3.6 Carbon Dioxide

Carbon dioxide (CO_2) is not a poisonous gas but it has the effect of excluding oxygen from the lungs. It is present, in small amounts, in fresh air and is produced by fires and by breathing.

It may be breathed with impurity in concentrations up to 3% or 4% in air, the only noticeable effect being an increase in depth of breathing. Higher concentrations increase the rate as well as the depth of breathing; excess of 10% being dangerous to life. Table 3C details the effects of CO_2.

% OF CO_2 IN AIR	SYMPTOMS
0.5	No symptoms.
2.0	Breathing rate increases by 50%
3.0	Breathing rate increases by 100%
5.0	Vomiting, dizziness, disorientation after 30 mins.
8.0	Headache, vomiting, dizziness, breathing difficulties after short exposure
10.0	Death in a few minutes

Table 3C Effects of Carbon Dioxide

3.7 Working In Hot and Humid Conditions

When working in hot and humid conditions, particularly during periods of heavy physical activity, firefighters will begin to experience the effects of heat exhaustion. It is therefore, the ability of the firefighter to withstand these conditions that will determine the time that they can work without relief, rather than the working duration of a BA set. Even firefighters who are able to work the full duration of a set, should be rested before being required to carry out further work.

Heat exhaustion occurs when the body's core temperature rises and there is a loss of fluids (5% and above) due to perspiration. Typical symptoms are dizziness, lassitude, nausea, abdominal discomfort and/or a burning sensation of the skin. If these effects are not acted upon a more serious state known as heat stroke may occur. This will result in cyanosis (blue colouring of the skin), speech and walking difficulties, collapse and unconsciousness.

Prevention of heat exhaustion and heat stroke is possible if the body's fluid levels are maintained. This requires water to be taken frequently to prevent dehydration.

Firefighters in full turnout gear may lose up to 2 L/hr of fluid. It is possible for the body to absorb only about 1.5 L/hr. Firefighters must be given regular breaks if they are to maintain their fluid levels sufficiently to ward off the effects of heat exhaustion and heat stroke. It should also be noted that these effects are more apparent in areas where little or no air flow is available to assist in the cooling of the body. Personnel wearing protective clothing that does not allow airflow such as chemical protection clothing, are going to be more susceptible to these effects.

Fluid volume increase can be achieved by drinking cool water. Sugary soft drinks and electrolyte replacements should be avoided as they limit the intake of water into the system. Operational personnel must drink water frequently during hot periods, or when working in protective clothing. On hot days, prehydration must take place at the station by the regular intake of water, and as regularly as possible at the incident. Water should be consumed before a person enters a gas suit and after they have been released.

Officers must ensure that all crew members drink water frequently. This will minimise the effect of heat on the body and reduce the incidence of heat exhaustion and heat stroke, and the risks of injury that are the consequence of dehydration.

SECTION FOUR - BA TYPES AND WORKING DURATION

CONTENTS

4 BA TYPES AND WORKING DURATION

4.1 Safety

Whilst correct servicing and safety requirements are essential for operation of all NSWFB equipment this is particularly emphasised for BA and associated life safety equipment.

Attention is drawn to Clause 19 and 20 of the *Occupational Health and Safety Act 1983 No. 20* which makes employees of any organisation legally responsible to:

(a) take reasonable care for the health and safety of persons who are at his place of work and who may be affected by his acts or omissions at work; and

(b) shall, as regards to any requirements imposed in the interests of health, safety or welfare on an employer by the Act, co-operate with him so far as is necessary to enable that requirement to be complied with.

A person shall not intentionally or recklessly interfere with or misuse anything provided in the interest of health, safety and welfare in pursuance of the Act or the associated Occupational Health and Safety Legislation.

⚠ NOTE

There is a penalty for breach of any sections of the Act.

4.2 Types of BA

The types of BA manufactured can be grouped into three general categories:

- filtering equipment;
- open circuit BA (positive pressure); and
- closed Circuit BA (negative pressure).

4.2.1 Filtering Equipment

Respirators or other types of filtering devices are generally not considered suitable for fire fighting use because if there is deficiency of oxygen in the air, equipment of this type will not provide the wearer with oxygen. The major application of respirators is in specialised HazMat operations and in industry, where the filtering of known gases, vapours or dusts is required.

4.2.2 Open Circuit BA

Open Circuit BA supplies the wearer with air from a static source, mainly a cylinder. Once the air has been inhaled the exhaled breath passes from the apparatus to the outside atmosphere.

4.2.3 Closed Circuit BA

SCBA in which the exhaled air is recirculated, carbon dioxide is removed and a supplement of oxygen from an enclosed supply, is rebreathed again by the wearer e.g. Compressed Oxygen Breathing Aparatus or Rebreather.

4.2.4 Types of BA used by the NSWFB

The NSWFB use the following types of BA:

Open Circuit

- *Siebe Gorman (SG) Airmaster MKII* Positive Pressure;
- *SG* Firefighter Positive Pressure;
- *AUER BD88-AS* Positive Pressure; and

Closed Circuit

- *Drager BG174.*

4.2.5 Air Line Equipment

Air line equipment used in the NSWFB can be broken down into the following two groups:

- extension face mask; and
- portable trolley.

4.3 Working Duration of BA

4.3.1 Full Duration, Working Duration and Safety Margin

Mention has already been made of the duration of a BA set when in use, but it is not possible to determine this duration with accuracy because there are variable factors depending upon the circumstances in which the set is used. However, in the case of closed-circuit oxygen sets with a constant flow, the duration may be reduced by the use of the by-pass, although the effect is likely to be slight. In the case of compressed air open-circuit sets, the duration can be affected quite considerably by the lung capacity of the wearer and the degree of work undertaken. It is therefore necessary, to allow for wider variations in duration with compressed air sets than with oxygen sets.

Reference is made below to full duration, working duration and safety margin. These terms are defined as follows:

- **Full Duration** is the time BA is expected to last, from the moment it is started up until the moment the cylinder is exhausted;
- **Working Duration** is the time BA is expected to last, from the time it is started up until the cylinder pressure has reached a point at which the low cylinder pressure warning device i.e. the whistle starts to operate; and
- **Safety Margin** is the time from the moment the whistle starts to sound until the cylinder is exhausted.

Therefore, Working Duration = Full Duration - Safety Margin.

4.3.2 Calculating Working Duration

The formulae for determining the working duration of BA sets are as follows:

Oxygen $\frac{\text{Contents of cylinder in litres}}{\text{Constant flow (L/min)}} - 30 \text{ mins safe margin} = \text{minutes}$

Compressed Air $\frac{\text{Contents of cylinder in litres}}{40 \text{ L/min}} - 10 \text{ mins safe margin} = \text{minutes}$

SECTION FIVE - EQUIPMENT AND MAINTENANCE

CONTENTS

CONTENTS

5 EQUIPMENT AND MAINTENANCE

5.1 Introduction

This section of the Topic describes the various types of BA and other items of associated equipment.

5.2 Siebe Gorman Firefighter SCBA

The *Siebe Gorman* (*SG*) Firefighter is a positive pressure SCBA of the open circuit type, including a *Vistarama* ori-nasal mask or *Apollo* face mask (see Fig 5.1).

It comprises a single cylinder mounted on a backplate, together with a first stage pressure reducing valve and pressure outlets. Two stage pressure reduction is employed in which air from the pressure reducer is fed to a demand valve (second stage reducer) on the full face mask, which provides a regulated flow of air with each inhalation.

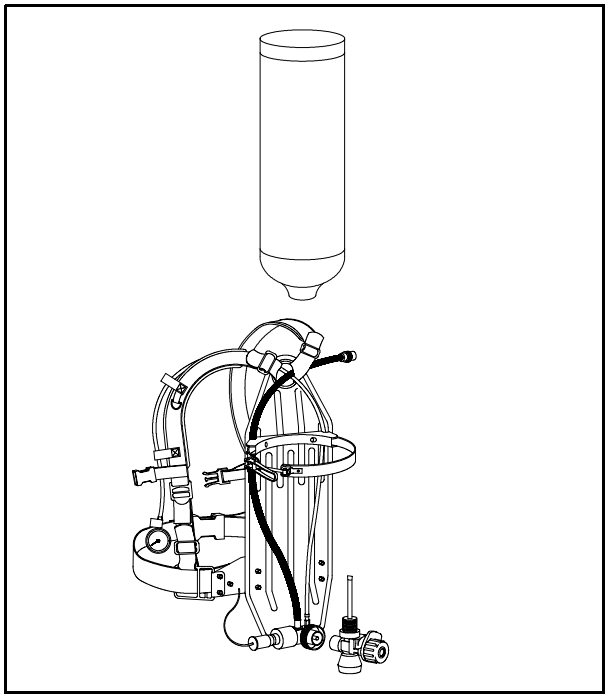

Fig 5.1 Siebe Gorman Firefighter SCBA

5.2.1 Components

High Pressure Reducing Valve

This is a **piston type** reducer of proven design, in which a spring loaded piston is balanced by the reduced pressure at which the reducer is set. The valve seal is an integral part of the piston and when the pressure at the back of the piston is reduced by operation of the demand valve, the spring pushes the piston and seals off the fixed seat, thus, allowing air to pass into the chamber surrounding the seat, and from there to the low pressure outlet.

The signal back pressure is generated by the air passing through the piston stem to the back of the piston. When the demand valve closes, the back pressure acting on the piston increases until it overcomes the spring pressure and the piston moves forward to shut off the main air supply from the cylinder. The reducing valve is set at a workable pressure (see Fig 5.2).

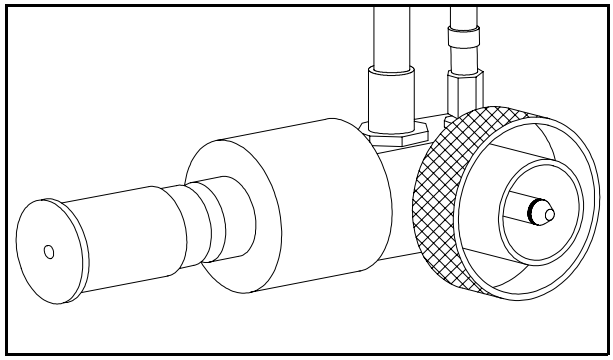

Fig 5.2 High Pressure Reducing Valve

The pressure reducing valve is divided into two sections:

- high pressure (cylinder pressure); and
- low pressure (working pressure).

The high pressure outlet on the reducing valve leads to the pressure gauge and warning whistle. The outlet is fitted with a choke to restrict loss of air in the event of hose or gauge failure.

On the low pressure side a supply line leads to the demand valve via a bayonet coupling. An additional low pressure outlet is provided for use with:

- an additional face mask attached;
- an extension face mask attached;
- an air blower nozzle; and
- an attachment when wearing fully encapsulated clothing.

Warning Whistle

The warning whistle is pre-set to sound when the pressure in the cylinder has fallen to 43 Bar. This gives approximately 10 mins duration at moderate work rate before the cylinder is exhausted.

Pressure Gauge

A braided hose connects the gauge to the high pressure connection on the reducer. The dial is calibrated in Bars which indicates the pressure in the cylinder (see Fig 5.3).

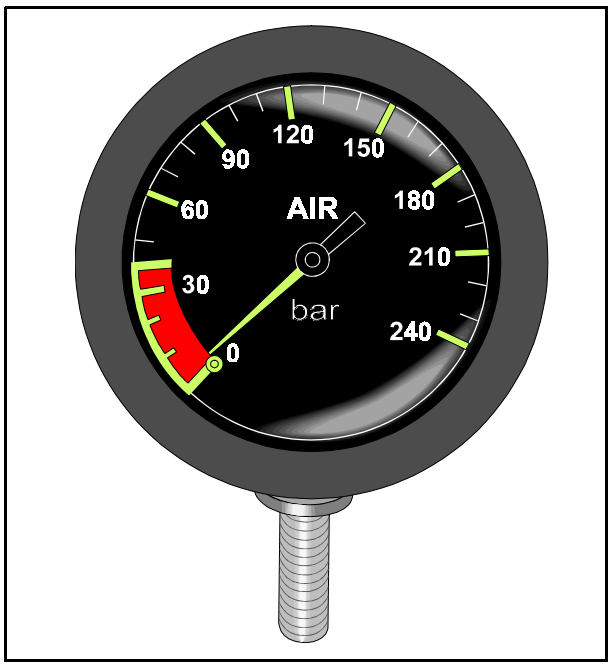

Fig 5.3 Pressure Gauge

Positive Pressure Demand Valve

The demand valve is of the positive pressure type, giving assurance that any mask leak will be outwards. This does not imply that leaks should be tolerated and every effort must be made to fit the face mask properly (see Fig 5.4).

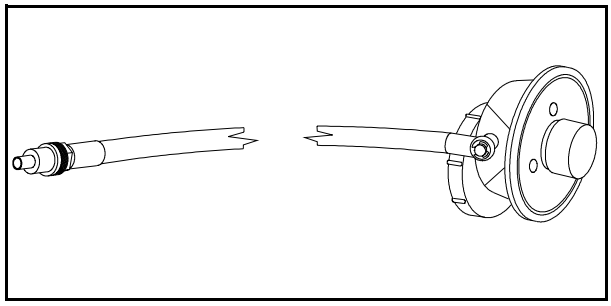

Fig 5.4 Positive Pressure Demand Valve

Having no springs in its basic form and requiring no adjustment, the demand valve is of the type which opens when its outlet is unrestricted. When air flow is stopped (respiration arrested, or during exhalation), pressure builds up in the face mask cavity and acting through the diaphragm/lever mechanism described below, counteracts the supply pressure to the demand valve causing it to close. Respiration takes place safely between these two limits.

The demand valve is of the downstream type, which will automatically vent excess pressure if for any reason the pressure in the supply hose should increase. The demand valve is connected to one end of the supply hose by means of a swivel banjo which is retained by a small circlip. The other end of the supply hose terminated with a male bayonet fitting for connection to the main supply hose from the reducer.

The demand valve incorporates a purge button fitted to the front of the valve. When the button is depressed it opens the valve, overriding its normal operation, to provide a supplementary flow of not less than 60 L/min and not more than 300 L/min.

The parking mode pressure facility comprises a knob on the demand valve lid. The knob is pulled and turned to engage this facility.

First Breath Activated Positive Pressure Demand Valve

Designed for use with the *SG* Firefighter airset, this demand valve may be attached to either the *Apollo* face mask (directly) or to the *Vistarama* ori-nasal mask (if modified) - see Fig 5.5.

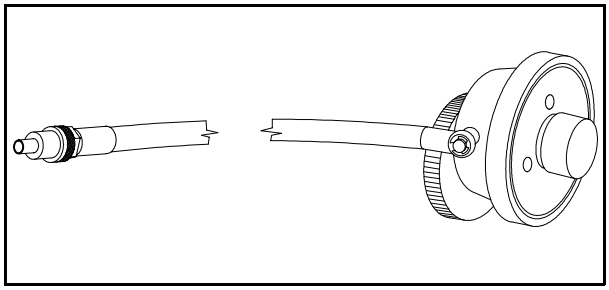

Fig 5.5 First Breath Activated Positive Pressure Demand Valve

The thread on the face mask attachment of the demand valve being larger that of the positive pressure demand valve. The First Breath Activated (FBA) demand valve is also distinguished by having a solid black plastic body with metal front.

The knob on the front of the demand valve is pulled fully out to click into park mode. When the wearer takes a deep breath the demand valve will automatically move into positive pressure mode.

A purge facility is also available by depressing the centre of the control knob whilst in positive pressure mode.

⚠ NOTE

The demand valve is non-serviceable by the wearer, servicing to be carried out by BA technicians only.

Vistarama Ori-Nasal Face Mask

The mask assembly consists of an outer rubber mask having an air cushion seal designed to adapt to a variety of facial contours, into which is fitted an ori-nasal mask (or nose cup) - see Fig 5.6.

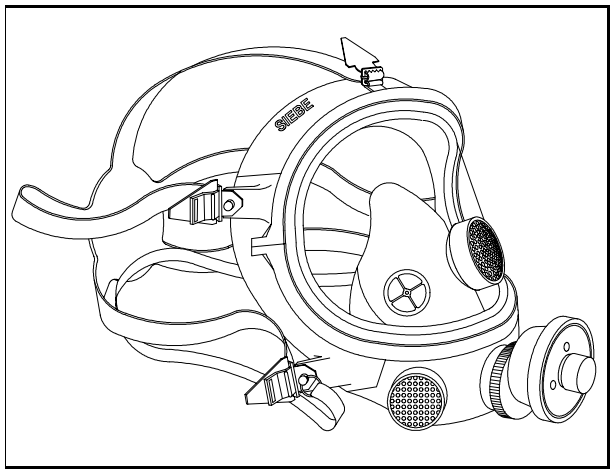

Fig 5.6 Vistarama Ori-Nasal Face Mask

The mask assembly is held firmly in place by a rubber harness consisting of five straps. Four of these straps are ribbed and have quick release buckles, the fifth is permanently connected to the top of the mask.

A moulded polycarbonate visor, giving panoramic vision, is retained in position by two metal clamping bands; the visor also provides the mounting for the exhalation valve and the ori-nasal mask. A speech diaphragm is also provided.

In operation, clean dry air is supplied to the mask from the demand valve, entering the outer cavity of the mask. The ori-nasal mask minimises carbon dioxide retention by reducing dead space and also prevents misting of the visor. The exhalation valve is spring loaded.

Apollo Face mask

The *Apollo* face mask can be used with either the positive pressure demand valve or the first breath activated demand valve in conjunction with the *SG* Firefighter air set (see Fig 5.7).

The mask consists of a rubber body with moulded polycarbonate visor with a single flap face mask seal and incorporating an ori-nasal cup.

The mask is held in place by a rubber harness consisting of five straps, all of which are adjustable and have quick release tabs.

A spring loaded exhalation valve and a speech diaphragm are attached to the mask body, one either side of the demand valve connection.

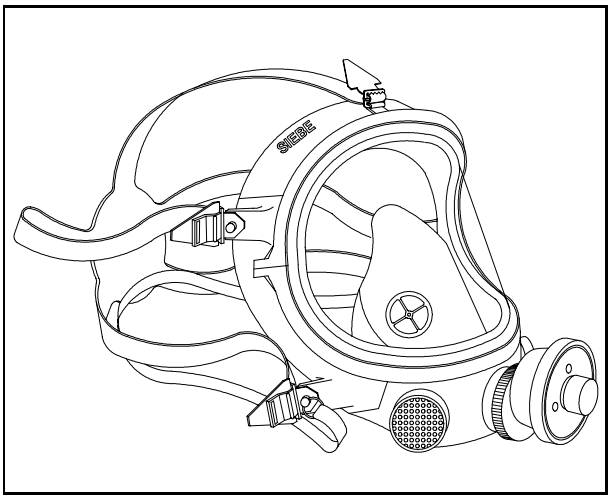

Fig 5.7 Apollo Face Mask

Frame and Harness

The frame comprises a stainless steel backplate with harness attachments and cylinder cradle. The cylinder and the first stage reducer are mounted directly on the frame, together with a high pressure hose for the gauge and warning whistle and an low pressure hose for the demand valve.

A nylon harness, designed for rapid adjustment, is attached to the frame. It consists of a waist strap, chest strap and shoulder straps.

Retention loops on the shoulder straps prevent the pressure gauge and demand valve falling out of reach (see Fig 5.8).

D rings are provided on the shoulder straps for rapid adjustment of the shoulder straps and also for the attachment of the *Sabrelite* 2000 torch and accessories.

The *SG* Firefighter Positive Pressure SCBA can be fitted with standard NSWFB cylinders, details of which are listed in Table 5A.

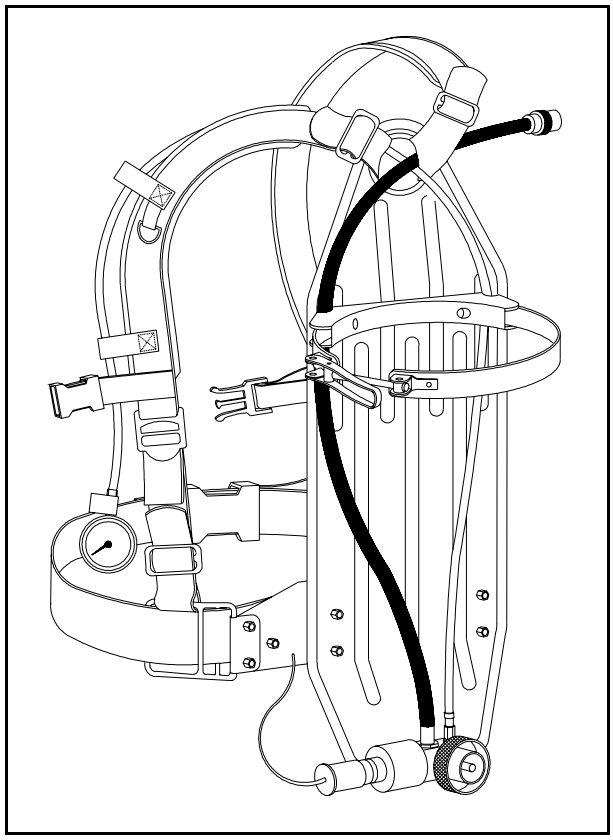

Fig 5.8 Frame and Harness

SPECIFICATIONS	CYLINDER TYPE		
	ALUMINIUM	STEEL	STEEL
Cylinder Capacity	1800 L	1800 L	1200 L
Cylinder Pressure Testing	3 Yrs	5 Yrs	5 Yrs
Cylinder Weight	10.5 kg	14.80 kg	10.5 kg
Cylinder Length	600 mm	575 mm	560 mm
Cylinder Width	325 mm	325 mm	325 mm
Cylinder Depth	200 mm	200 mm	200 mm
Working Pressure	207 Bar	207 Bar	137 Bar
Water Capacity	9 L	9 L	9 L
Full Duration IAW *AS 1716* at 40 L/Min	45 Min	45 Min	30 Min
Working Duration IAW *AS 1716* at 40 L/Min	35 Min	35 Min	20 Min
Harness	Nylon	Nylon	Nylon
Reducing Valve Type	Piston	Piston	Piston
Reducing Valve Service	5 Yrs	5 Yrs	5 Yrs
Warning Whistle	43 Bar	43 Bar	43 Bar
Demand Valve Flow	60 L/Min to 300 L/Min	60 L/Min to 300 L/Min	60 L/Min to 300 L/Min
Weight of Set	4.60 kg	4.60 kg	4.60 kg
Weight of Set with Cylinder	15.1 kg	19.4 kg	15.1 kg

Table 5A Siebe Gorman Firefighter Set and Cylinder Specifications

5.2.2 SCBA Accessories

Accessories that are provided with the SCBA are:

- 3 m and 15 m extension hose;
- face mask in a calico bag;
- gas suit adaptor hoses;
- SCBA record book; and
- air blower nozzle.

These items are retained in either a canvas bag or box.

Generally, not more than three 15 m lengths of hose should be joined together. However, tests indicate satisfactory operation of the equipment is possible with a line 90 m in length.

⚠ NOTE

This practice would only be used if absolutely necessary, as hazards increase by having the face mask so far from the air supply.

An extension hose and mask is used:

- where wearing a complete SCBA set is impracticable because of limited access, space or other circumstances;
- to provide respiratory protection for persons trapped or being rescued;
- to provide specialist advisers with respiratory protection from the SCBA of an accompanying firefighter when entering hazardous atmospheres; and
- to provide external air supply to Fully Encapsulated Suits as required.

NOTE

Always use the shortest practical extension hose.

CAUTION

When two persons are supplied from one SCBA set the wearing duration of the equipment is at least halved.

5.2.3 Pre-Operational Checks

Prior to operating the SCBA set, the following pre-operational checks are to be carried out:

- open main wheel valve **slowly** (full on and back ½ a turn;
- check cylinder pressure on gauge. The lowest pressure acceptable is 180 bar;
- check for audible defects or leaks;
- close main wheel valve;
- check acceptable pressure drop for 30 secs;
- check the audible warning device (43 on gauge) by turning docking switch to positive pressure;
- remove key to arm distress unit;
- check LED operates;
- use key to switch off if required; and
- enter name, rank and cylinder pressure on tally.

CAUTION

Do not twist or pull the mask components including straps in any direction or with a force other than would normally be applied when the mask is being fitted, worn or removed.

If any component is suspected of being defective following the pre-operational check, the set is not to be worn until the fault is rectified.

NOTE

Replace small (1200 L) capacity cylinders when pressure is below 110 Bar.

Replace large (1800 L) capacity cylinders when pressure is below 180 Bar.

5.2.4 Frequency of Pre-Operational Check

Permanent Staff: At the commencement of each shift, each officer and firefighter is responsible to carry out the pre-operational check on the SCBA set allocated to them.

Retained Staff: At wholly retained stations, the Captain is to ensure a pre-operational check is carried out at least once each week, and the results of the inspections recorded.

5.2.5 Start-Up, Donning & Removal

Start-up

To start-up the SCBA set carry out the following:

- ensure docking switch is in parking mode;
- **slowly** turn on main wheel valve (full on, back ¼ turn; and
- check gauge for pressure reading (minimum 180 Bar).

Donning

To don the SCBA, carry out the following:

- place face mask strap around neck;
- put set on (coat style, right arm first);
- adjust shoulder straps and body belt;
- arm distress unit; and
- fill in tally and place on control board.

Donning Face Mask

To don the face mask carry out the following:

- place chin into mask and place straps over head;
- adjust straps;
- pull straps to rear (45°), bottom pair first; and
- hold breath and listen for leaks.

Removal

To remove the face mask and SCBA carry out the following:

- return docking switch to parking mode;
- release face mask head harness and remove mask;
- turn off cylinder;
- de-pressurise system using docking switch;
- release chest and body harness;
- release shoulder harness and remove set coat style;
- return all harnesses to full extent; and
- leave demand valve in positive pressure mode.

CAUTION

Masks with a pneumatic seal will provide a satisfactory face seal with only light adjustment of the head straps. Initially, pulling hard on the straps will not give a better seal, but may cause failure of the head straps or the attachment points.

5.2.6 Maintenance of *SG* Firefighter SCBA

The full service is detailed in Table 5B.

ITEM	ACTIONS
Strip face mask	(1) Disconnect demand valve from mask and examine. (2) Wipe demand valve with cloth. (3) Rinse face mask in running water. (4) Remove and inspect Ori-Nasal mask. (5) Clean and sterilise as per *In-orders*. **NOTE** **Face mask is not to be disassembled. Demand valve is never to be immersed in water or have anything sprayed into it.**
Clean frame	(1) Clean frame, belts and harness.
Dry and assemble face mask	(1) Attach blower line to auxiliary fitting. (2) Shake excess water from face mask and components. (3) Open main wheel valve (slowly back half turn) and blow dry components. (4) Turn off main wheel valve. (5) De-pressurise blower line and remove. (6) Remove cylinder. (7) Check and replace ori-nasal mask. (check inlet valves). (8) Check washer and attach face mask, crack new cylinder and attach.
NOTE **A pre-operational check is an integral part of the full service.** **CAUTION** **High pressure jets of air can injure, do not direct air jets at other personnel.**	

Table 5B SG Firefighter SCBA Full Service

5.3 Airmaster MkII Positive Pressure (Converted)

This apparatus was originally a negative pressure BA. In line with the NSWFB policy on BA, this unit has been converted to a positive pressure type unit. The unit is for all intended purposes the same as the positive pressure Firefighter unit. They are mainly kept in rural areas (see Fig 5.9).

The following differences from the *SG* SCBA should be noted:

- the set has a bypass valve which gives full cylinder pressure to the face mask;
- the warning whistle is located on the backplate;
- the backplate is of a different design to the Firefighter set; and
- the gauge line has an automatic shut-off valve near the gauge.

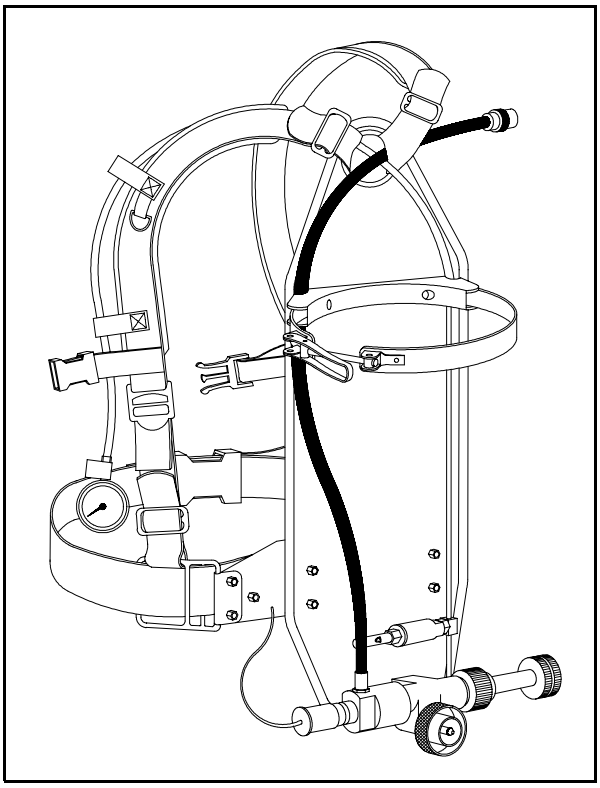

Fig 5.9 Airmaster MkII Positive Pressure (Converted)

⚠ NOTE

Only under distress conditions is the bypass valve to be used and then with extreme care. When using the air blower ensure it's connected to the auxilary adaptor and the demand valve is correctly connected.

5.4 AUER BD88AS SCBA

5.4.1 General Description

The *AUER* BD88AS SCBA is a self-contained, open circuit, automatic, positive pressure BA. In common with most compressed air sets, it has a two stage pressure reduction system and is lung governed, i.e. the duration of the set depends on the breathing rate of the wearer, which is related to the amount of work being performed and the amount of air in the cylinder (see Fig 5.10).

⚠ NOTE

***AUER* is the manufacturer of the BD88AS SCBA and the name should not be taken to indicate that the SCBA has an *hour* duration.**

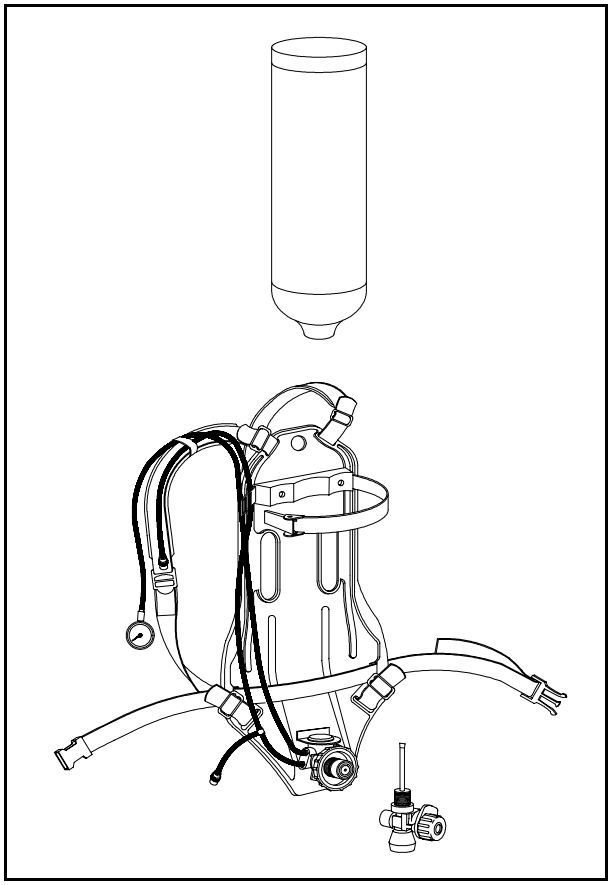

Fig 5.10 AUER BD88AS SCBA

5.4.2 Components

Backpack and Harness

The carrying frame is an anatomically designed plastic backpack. It is manufactured from *Duroplast*, glass reinforced fibre, and is permanently anti-static. It has two carrying handles and a hole at the top for ease of storage. Attached to the backpack is the harness, comprising two padded shoulder straps and a waist belt. The straps and belt are made from polyester fabric with the shoulder pads being made from non-flammable anti-static materials. The shoulder straps have self-arresting slide buckles and the waist belt has a quick release type buckle (see Fig 5.11). The cylinders are connected to the reducer with a hand tight connection.

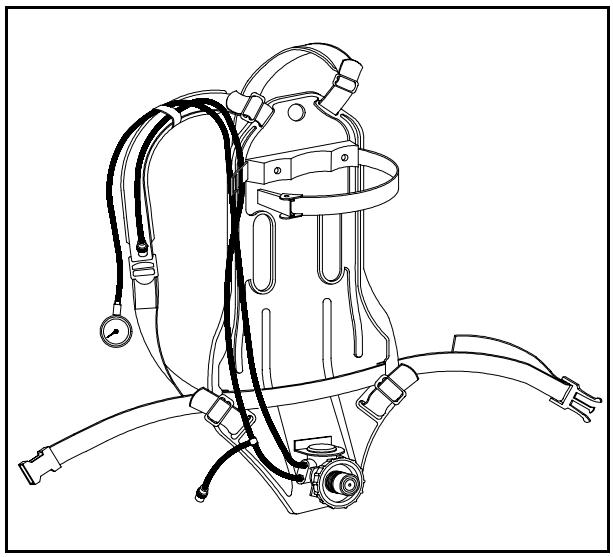

Fig 5.11 AUER BD88AS Backpack and Harness

Pressure Reducer

The pressure reducer is a piston type reducer of brass construction, fixed to the bottom of the backplate, it reduces cylinder pressure to a medium pressure. An audible warning device is located on the high pressure side, this indicates low cylinder pressure and operates at a pressure of 55 + or - 5 Bar. Located above the whistle is a safety valve. In the event of a reducer malfunction, this prevents the medium pressure from exceeding safe reducer

pressure. An auxiliary air line connection is connected to the medium pressure side of the reducer (see Fig 5.12).

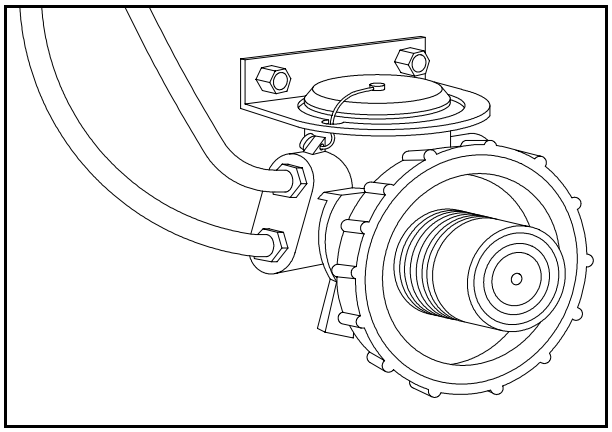

Fig 5.12 AUER BD88AS Pressure Reducer

Pressure Gauge

A bourdon tube type pressure gauge is connected to the high pressure side of the reducer by a high pressure hose. The gauge is water tight, encapsulated and shock proof with luminous figures, graduated from 0-350 Bar, and red lined at 55 Bar. To control air loss in the event of a line or gauge failure, a restrictor is placed in the reducer at the gauge tube connection (see Fig 5.13).

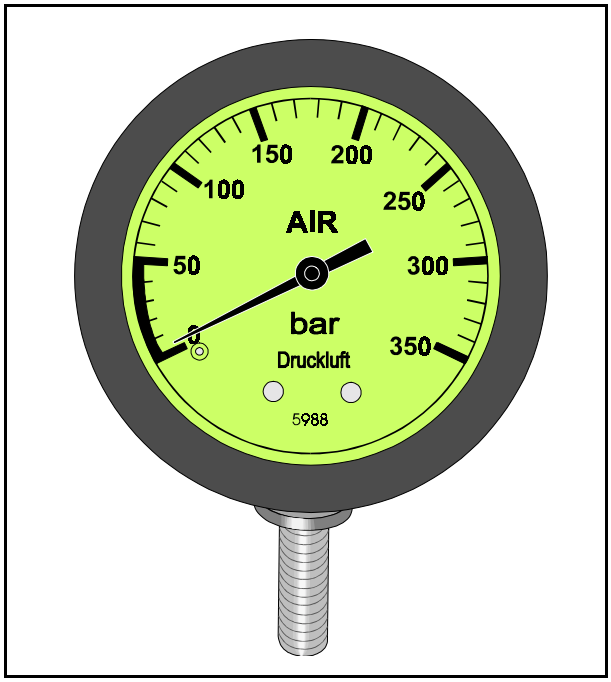

Fig 5.13 AUER BD88AS Pressure Gauge

Demand Valve

The demand valve is a lung governed, automatic, positive pressure, servo-assisted type. It is connected to the face mask with a plug type connector. Connection to the reducer is via a quick release hose coupling and a pivoting medium pressure line. In the positive pressure mode, pressure is maintained inside the face piece. A purge valve allows the face mask to be flushed with a constant flow of air if required (see Fig 5.14).

⚠ NOTE

The demand valve is non-serviceable by the wearer. Servicing to be carried out by BA technicians only.

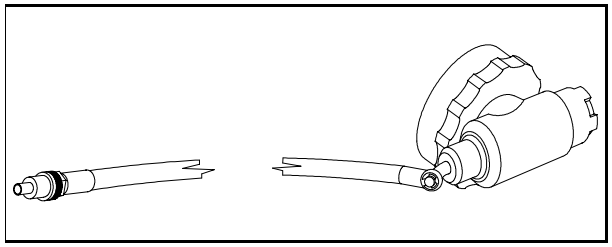

Fig 5.14 AUER BD88AS Demand Valve

Face Mask

The face mask is a lightweight, single flap seal mask giving good visibility with an integral ori-nasal cup and spring type exhalation valve. It is held in place on the head with a rubber harness with five adjustable straps. A plug type connector is provided for the demand valve. In operation, the inhaled air is directed over the inside of the face mask visor, effectively demisting it before flowing through the inhalation valves in the ori-nasal cup, then into the lungs. Exhaled air is released into the atmosphere through the spring type exhalation valve, this is designed to maintain a positive pressure in the face mask (see Fig 5.15).

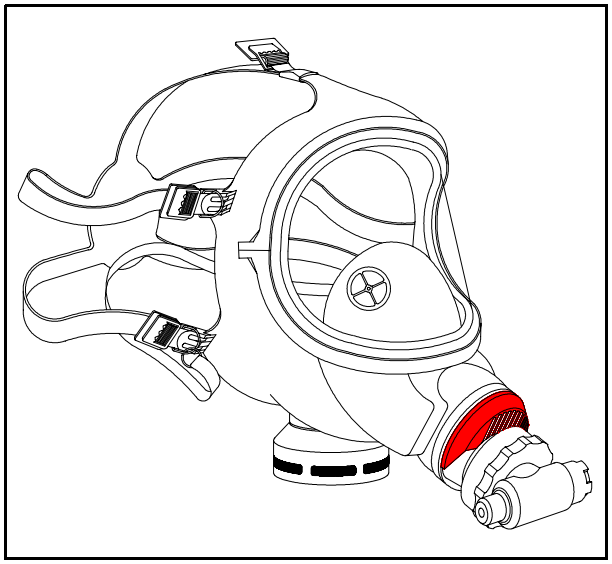

Fig 5.15 AUER BD88AS Face Mask

5.4.3 Flow of Air

When the cylinder valve is opened, high pressure air leaves the cylinder, flowing through the inlet connection into the pressure reducer. Some of the air makes its way into the pressure gauge line via the flow restrictor and registers on the pressure gauge. Air also flows into the warning whistle, which gives a momentary signal before shutting off. It flows into the high pressure side of the reducer, past the piston seat into the medium pressure side, then to the demand valve where the pressure is held. As the pressure increases it overcomes the spring tension on the piston and shuts off flow. When the wearer inhales, or there is a break in the facial seal, the medium pressure is reduced, allowing spring tension to open the piston, thus allowing air to flow according to the demands of the wearer. Hence the description lung governed.

5.4.4 Automatic Positive Pressure Principle

Positive pressure ensures that the internal pressure in the face mask never falls below the pressure of the surrounding atmosphere, thus alleviating the danger of inward leaks past the face mask seal.

To achieve this principle, the apparatus must have an exhalation valve capable of withstanding a low static pressure from within the face mask.

When the face mask is fitted and a facial seal is obtained, the first inhalation releases the diaphragm from the purge valve switch. Spring pressure depresses the diaphragm, allowing air to flow into the face mask. As the face mask is sealed around the wearer's face, and the exhalation valve can withstand a pressure above atmospheric, a static positive pressure is held in the face mask.

On inhalation, the static pressure is removed, enabling spring pressure to depress the diaphragm further to allow sufficient air (as demanded by the wearer), to flow into the face mask and lungs.

A break in the facial seal will have the same effect as the wearer inhaling, with the escape of air to atmosphere proportionate to the size of the leak. This does not imply that leaks should be tolerated and every effort should be made to fit the mask properly.

On exhalation, or when a full facial seal is required, the static pressure is reimposed in the face mask.

SPECIFICATIONS	CYLINDER TYPE		
	ALUMINIUM	STEEL	STEEL
Cylinder Capacity	1800 L	1800 L	1200 L
Cylinder Pressure Testing	3 Yrs	5 Yrs	5 Yrs
Cylinder Weight	10.5 kg	14.80 kg	10.5 kg
Cylinder Length	670 mm	600 mm	600 mm
Cylinder Width	290 mm	290 mm	290 mm
Cylinder Depth	230 mm	230 mm	230 mm
Working Pressure	207 Bar	207 Bar	137 Bar
Water Capacity	9 L	9 L	9 L
Full Duration IAW *AS 1716* at 40 L/Min	45 Min	45 Min	30 Min
Working Durations IAW *AS 1716* AT 40 L/Min	35 Min	35 Min	20 Min
Harness	Polyester	Polyester	Polyester
Reducing Valve Type	Piston	Piston	Piston
Reducing Valve Service	6 Yrs	6 Yrs	6 Yrs
Warning Whistle	55 Bar	55 Bar	55 Bar
Demand Valve Flow	450 L/Min	450 L/Min	450 L/Min
Weight of Set	4.50 kg	4.50 kg	4.50 kg
Weight of Set with Cylinder	15.1 kg	19.3 kg	15 kg

Table 5C AUER BD88AS SCBA Set and Cylinder Specifications

5.4.5 SCBA Cylinders

The *AUER* BD88AS SCBA can be fitted with standard NSWFB cylinders, details of which can be found in Table 5C.

5.4.6 Pre-Operational Checks

Prior to operating the SCBA set, the following pre-operational checks are to be carried out:

- visually check for damage and that straps are correct;
- visually check face mask;
- check connections for tightness;
- check that the exhalation valve is seated correctly;
- ensure ori-nasal mask and inlet valves are correct;
- ensure red selector button is in the park mode (pressed in);
- open main wheel valve **slowly**;
- check cylinder pressure on gauge, (lowest pressure acceptable 180 Bar);

- listen for audible defects or leaks;
- close main wheel valve;
- check acceptable pressure drop for 30 secs;
- check that the low pressure warning whistle operates at 55 + or -5 Bar, by pressing the red selector button and bleeding pressure slowly;
- remove key to arm distress unit;
- check LED operates;
- use key to switch off if required; and
- enter name, rank and cylinder pressure on tally.

5.4.7 Start-Up

To start up the *AUER* BD88AS SCBA carry out the following:

- ensure red selector button is in the park mode;
- slowly turn on main wheel valve; and
- check gauge for pressure reading.

5.4.8 Donning

To don the *AUER* BD88AS SCBA carry out the following:

- place face mask strap around neck;
- put set on (coat style, left arm first);
- adjust shoulder straps and body belt;
- arm distress unit; and
- fill in tally and place on control board.

5.4.9 Donning of Face Mask

To don the SCBA face mask carry out the following:

- place chin into mask and pull straps over head;
- adjust straps, bottom, centre and top;
- pull straps to rear (45°); and
- take a deep breath to engage demand valve and listen for leaks;

5.4.10 Removal of SCBA

To remove the SCBA set, carry out the following:

- collect tally from control board;
- inhale and select park mode;
- release face mask head harness and remove mask;
- turn off cylinder;
- de-pressurise system using red selector button;
- release body harness;
- release shoulder harness and remove SCBA set coat style;
- return all harness to full extent including face mask; and
- place in a safe position.

5.4.11 Frequency of Pre-Operational Checks

The frequency of the pre-operation checks are as follows:

Permanently Staffed Fire Stations

- commencement of each shift;
- immediately prior to fitting; and
- after full service.

Retained Fire Stations

- once a week;
- immediately prior to fitting; and
- after full service.

5.4.12 Maintenance of BD88AS SCBA

The full service of this SCBA set is detailed in Table 5D.

ITEM	ACTIONS
Preparation	(1) Use only 100% BA disinfectant.
Prepare face mask	(1) Disconnect face mask from demand valve. (2) Rinse face mask in running water. (3) Clean and sterilise mask in solution as per the following directions: • rinse in clean water (not hot); • spray liberally with BA disinfectant; • leave for 10 mins; • rinse in clean water; and • dry thoroughly. **NOTE** **Face mask is not to be disassembled. Demand valve is never to be immersed in water or have anything sprayed into it.**
Clean frame	(1) Clean frame, belts and harness.
Dry and assemble face mask	(1) Attach blower line to auxiliary fitting. (2) Shake excess water from face mask. and components. (3) Ensure red selector button is in. (4) Open main wheel valve and blow dry components. (5) Turn off main wheel valve. (6) De-pressurise blower line by means of the red selector button. (7) Ensure exhalation is correctly sealed. (8) Crack new cylinder, check **O** ring and attach.
NOTE **A pre-operational check is an integral part of the full service.**	

Table 5D AUER BD88AS SCBA Full Service

5.5 Dräger BG174

5.5.1 Introduction

The *Dräger BG174* is a closed circuit oxygen regenerative BA set with a wearing time of up to 4 hrs. The BA set is worn on the operator's back. A light metal cover protects all major components of the apparatus from damage.

The major components of the BA set are:

- the carrying frame;
- carrying harness;
- oxygen cylinder;
- oxygen distributor;
- pressure gauge line and pressure gauge;
- breathing bag;
- valve box;
- breathing hoses;
- face mask;
- regenerating cartridge; and
- cover.

5.5.2 Carrying Frame

The carrying frame is made of light alloy and has two side walls to which are attached the oxygen distributor and the valve box. Dished plates at the top and bottom are rigidly fixed to the side walls and form a cradle for the regenerating cartridge and oxygen cylinder respectively. A thin metal plate attached to the frame forms a central compartment which houses the breathing bag.

Fig 5.16 Dräger BG174

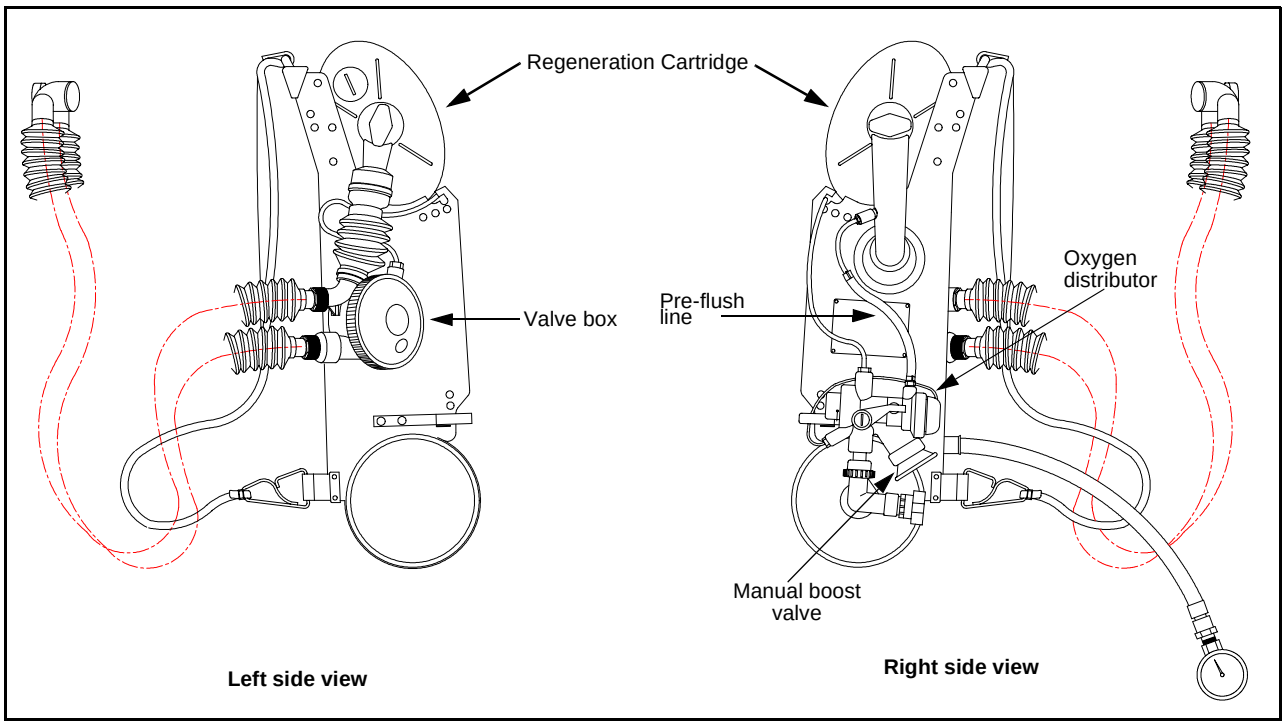

Fig 5.17 Side Views of the Dräger BG174

The back of the carrying frame has a rubber back support reinforced with steel. This ensures comfort to the wearer and provides an air space between the apparatus and the wearer's back.

5.5.3 Carrying Harness

The carrying harness consists of webbing shoulder straps and a body belt fitted with buckles which allow rapid adjustment.

5.5.4 Oxygen Cylinder

The steel oxygen cylinder when fully charged contains 400 L of oxygen compressed to 20 000 kPa. It is fitted with a main wheel valve which is fully opened when the set is in operation.

CAUTION

To prevent any strain being place on the thread of the main wheel valve, always back the valve off ¼ turn after fully opening.

5.5.5 Oxygen Distributor

The oxygen distributor (see Fig 5.17) is fixed to the right side wall of the carrying frame. It is connected to the oxygen cylinder by an internally threaded nut with a rubber finger grip. An **O** ring provides a gas tight seal between the oxygen cylinder and oxygen distributor when the nut is hand tightened.

The oxygen distributor is comprised of the following parts:

- reducing valve;
- pre-flushing device;
- manual booster valve; and
- pressure gauge shut-off valve.

The reducing valve reduces pressure from the oxygen cylinder to approximately 400 kPa for use in the BA set.

The pre-flushing device operates automatically when the main wheel valve is opened. It allows approximately 6 L of oxygen to flow into the BA set through a pre-flush line to initially flush the BA set with oxygen and inflate the breathing bag.

The manual booster valve is provided for the emergency supply of oxygen directly from the cylinder through the pre-flush line. This valve provides oxygen in the event of failure of the reducing valve or the lung demand valve. It is also used to flush and cool the contents of the BA set during prolonged operation. The valve is kept closed by spring pressure and is operated by depressing with the thumb.

The pressure gauge shut-off valve normally remains open. It is used to isolate the pressure gauge and pressure gauge line should leakage of oxygen occur with either of these components.

5.5.6 Pressure Gauge Line and Pressure Gauge

The pressure gauge line is a reinforced high pressure hose with an external rubber covering. It is connected to the pressure gauge shut-off valve and conveys oxygen from below the reducing valve to the pressure gauge.

The pressure gauge is graduated in *Bars* and indicates the pressure of oxygen in the cylinder. Oxygen cylinders are replaced on stowed sets if the pressure gauge reading is less than 150 Bar.

5.5.7 Breathing Bag

The breathing bag is made from rubberised fabric and is housed within the carrying frame. It is connected to the valve box by a threaded connector and to the regenerating cartridge by an elbow connector.

5.5.8 Valve Box

The valve box (see Fig 5.17) is secured to the left side wall of the carrying frame. It consists of a diaphragm box with a protective cover and has connections for the inhalation breathing hose, breathing bag and oxygen supply line. Housed within the valve box are:

- constant dosage jet;
- lung demand valve;
- pressure relief valve;
- audible warning device; and
- inhalation valve.

The constant dosage jet is located within the demand valve. This non-adjustable jet allows 1.5 L/min of oxygen to flow into the valve box.

The lung demand valve automatically provides additional oxygen if the wearer's oxygen consumption is in excess of the combined capacity of the breathing bag and the constant dosage jet. This may occur as a result of prolonged physical exertion.

The pressure relief valve is located in the centre of the lung demand valve diaphragm and is kept closed by a light spring. If all the oxygen supplied by the constant dosage jet is not used, pressure develops in the breathing bag and valve box. The excess pressure acting on the diaphragm opens the relief valve and vents to the atmosphere. When the pressure is vented the valve is reclosed.

The audible warning device only operates when no oxygen is being supplied to the breathing circuit. If no oxygen is being supplied a signal flap closes the aperture between the breathing bag and the valve box. As the wearer inhales, oxygen from the breathing bag is drawn through two slots in the signal flap which are covered by tuning reeds. This produces an audible warning signal which

indicates to the wearer either the oxygen cylinder is empty, or the main wheel valve is closed.

The rubber inhalation valve is fitted to the valve box. This valve remains closed until the wearer inhales, it then opens allowing oxygen from the valve box to pass to the wearer through the inhalation breathing tube.

5.5.9 Breathing Tubes

The double breathing tube consists of two flexible corrugated rubber hoses. The inhalation hose is fitted with a saliva and moisture trap. A screw cap enables the trap to be emptied after use. A webbing strap secures both breathing hoses together and has a metal ring which attaches to the right hand shoulder strap to provide support for the hoses. Both hoses terminate in a metal **U** piece which connects to the face mask and is secured by a central hand-tightened bolt.

5.5.10 Face Mask

The face mask (see Fig 5.18) is made from moulded rubber and incorporates a double reverse seal, ori-nasal cup, full width visor and speech diaphragm. The mask is also provided with a manually operated wiping device which, when operated, will remove condensation from inside the visor. The mask has five adjustable head straps so that it can be adjusted to provide a gas-tight seal against the wearer's face. In addition, a neck strap is fitted to support the mask when it is not being worn.

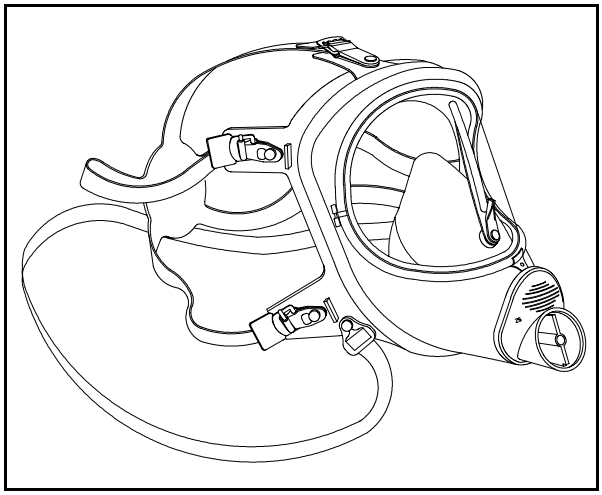

Fig 5.18 Dräger BG174 Face Mask

5.5.11 Regenerating Cartridge

The regenerating cartridge is located in a cradle at the top of the carrying frame and is held in place by two spring clips. The cartridge contains approximately 2.8 - 2.9 kg of soda-lime for removal of carbon dioxide from the exhaled breath. A screwed cap at the end of the cartridge allows the cartridge to be recharged following each wearing.

The exhalation tube from the face mask is connected to the inlet end of the cartridge by a lower elbow fitting, flexible rubber tubing and an upper elbow. The upper elbow contains a spring loaded mica exhalation valve and is secured to the canister inlet by a central hand-tightened bolt.

The outlet from the cartridge is connected to the breathing bag by a metal elbow secured to the cartridge by a central securing bolt.

5.5.12 Cover

All major components of the BA set are protected by a light alloy cover. The cover is removable and is located at the top by two metal brackets and held in place at the bottom by two spring catches.

5.5.13 Oxygen Circulation

Expired breath flows from the face mask via the exhalation hose, through the exhalation valve and into the regenerating cartridge. The carbon dioxide in the exhaled breath reacts with the soda-lime in the cartridge and is absorbed, allowing the remaining oxygen from the breath to flow into the breathing bag.

On inhalation, oxygen passes from the breathing bag into the valve box where it mixes with fresh oxygen from the cylinder. It then passes through the inhalation valve and inhalation hose to the face mask.

5.5.14 Inspection

The *Dräger BG174* is only to be visually inspected at the commencement of each shift by a NSWFB member qualified to wear oxygen BA. Any defects or damage detected are to be reported to the OIC and the BA Section immediately. The BA set is to be withdrawn from service pending examination by the BA Section.

The BA set is to be regularly inspected and tested once each week.

CAUTION

Should any joint or connection on the *Dräger BG174* be disconnected or loosened, or the equipment otherwise interfered with, the apparatus is not to be worn until a full pressure and leak test is carried out.

NOTE

Use of the *BG174* set is confined to those NSWFB members who have been trained and qualified on the equipment. Further information is available on this equipment in the Oxygen Training Manual.

5.6 Disinfection of BA

5.6.1 At the Incident Ground

To disinfect BA at the incident ground, carry out the following:

- replace cylinder if below operational pressure;
- ensure apparatus harnesses are returned to full extent e.g. face mask, shoulder straps and waist strap;
- ensure apparatus is operational; and
- use BA disinfectant to clean face mask.

5.6.2 At Stations

To disinfect BA at the fire station, carry out the following:

- remove demand valve and place in a safe dry area;

⚠ NOTE

Do not interfere with any part of the demand valve.

- rinse face mask in cold water;
- liberally spray BA disinfectant onto all surfaces and leave for 10 mins. Where necessary immerse and leave for 10 mins;
- rinse thoroughly in cold water; and
- dry equipment thoroughly.

5.6.3 Disinfection of SCBA Equipment

Where there is no alternative but to transfer a BA face mask from one firefighter to another at an incident, the following procedures are to be carried out:

- remove the demand valve and place in safe, dry, clean area;
- completely flush the face mask with cold water. Shake excess water from mask;
- liberally spray BA disinfectant, and leave for 10 mins;
- rinse thoroughly in cold water;
- dry face mask;
- attach demand valve; and

⚠ NOTE

The face mask is not to be disassembled, with the exception of removing the cover of the exhalation valve.

- it is the responsibility of the relieving firefighter to change the cylinder whilst the initial wearer carries out the disinfecting.

5.6.4 Blood Spillage

BA disinfectant can be used on blood spillages. Pour directly onto blood or other soiled areas. Apply liberally around the soil first and work towards centre. Leave for 10 mins to soak up, using fresh disposable towelling, which is to be disposed of in a suitable receptacle. Rinse well with cold water.

5.7 Big Ben/Firefly Distress Unit

5.7.1 Introduction

Big Ben/Firefly is an automatic personal distress alarm designed to sound if the wearer is rendered motionless for more than 20 secs. The unit is worn vertically on the waist belt and may be sounded manually by pressing the yellow button from the side. *Big Ben/Firefly* has virtually no moving parts, is intrinsically safe and is totally sealed within a waterproof and shock-resistant moulded case (see Fig 5.19).

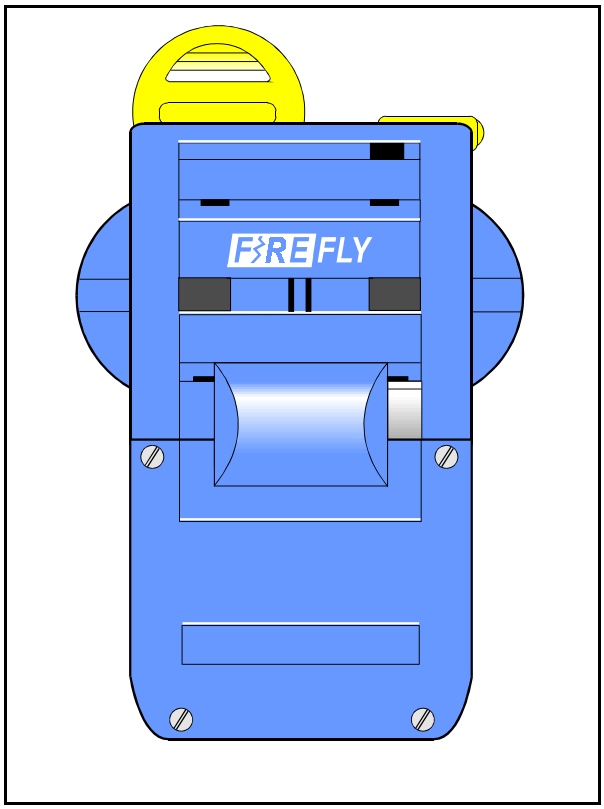

Fig 5.19 Big Ben/Firefly Distress Unit

5.7.2 Technical Specification

Technical specifications for the distress unit are detailed in Table 5E.

SPECIFICATION	DETAIL
Weight	285 g (including battery)
Output	98 dBA at 3 m
Battery type	9 V Alkaline (MN 1604)
Battery life	500 hrs (standby) 6 hrs (full alarm)
Dimensions	63 mm x 120 mm x 39 mm
Alarm audio frequency range	2.5 kHz - 3.0 kHz
Pre-Alarm	Intermittent 2 Hz (reduced volume)
Low battery warning	Short beep every 2 secs

NOTE

When fitted with a *Duracell* alkaline battery type MN1604 Big Ben/Firefly meets the requirements of *BASEEFA EEx 1a II BT3.*

Table 5E Big Ben/Firefly Technical Specification

5.7.3 Preparation for Use

Big Ben/Firefly is supplied ready for use, and all that is required is to attach the *Big Ben/ Firefly* in a suitable position to your waist belt on the left hand side (refer to *In-Orders*).

5.7.4 Mode of Operation

Automatic

Remove the key by turning anti clockwise one quarter turn. The unit will emit a 2 sec self test alarm. *Big Ben* is now in standby mode.

CAUTION

Should the self-test fail to sound before entering any hazardous area, check the system for faults. In the event of any malfunction return *Big Ben/Firefly* to the HazMat Response Unit.

NOTE

(1) The unit will remain in standby unless body movement stops. In the event of the unit remaining stationary for approximately 20 secs it will emit an intermittent low level pre-alarm warning. Movement of the unit will cancel this pre-alarm and return it to the standby condition.

(2) If no movement occurs during the pre-alarm period of 7 secs, the full alarm will sound. This alarm can only be cancelled by re-inserting the ON/OFF key.

5.7.5 Manual

Big Ben/Firefly may be operated manually by pressing the yellow alarm button located next to the **ON/OFF** key. The alarm should sound immediately after the button is pressed.

NOTE

(1) Manual operation is only possible when the unit is in the standby mode i.e. the key has been removed.

(2) The key is designed to be attached to a tally as part of the BA control system. It must not be taken into an incident with the wearer. The system may be turned off at any time by re-inserting the ON/OFF key.

5.7.6 Maintenance After Use

There are no serviceable parts inside *Big Ben/ Firefly.* Removing the back cover will invalidate the warranty.

In order to maintain the unit in prime condition it should be kept clean using only a mild solution of soap and water.

CAUTION

Cleaning must be done in a safe area. Under no circumstances should petrol, chlorinate degreasing fluids, such as, trichloroethylene, organic solvents or abrasive cleaners be used to clean any part of the unit.

5.7.7 Low Battery Warning

When the battery is near the end of its life, a **low battery warning** will sound. This is a short beep every 2 secs. Replace only with the specified battery. See Table 5E.

5.7.8 Battery Replacement

To replace the battery carry out the following actions:

- remove the screws, from the battery cover (lower front panel), remove the old battery and dispose of it in a suitable manner;
- insert and connect the new battery; and
- replace the battery cover ensuring the rubber seal is correctly located.

NOTE

To meet *BASEEFA EEx ia II T3* requirements, the battery must be a *Duracell*, 9 volt.

CAUTION

Any attempt to modify *Big Ben/Firefly*, or the fitting of replacement parts/batteries not approved by *Racal Panorama* Limited, may seriously reduce the protection afforded to the user, and can invalidate the warranty. *Big Ben/Firefly* is a sealed unit. No attempt should be made to repair the unit and in the event of a failure it should be replaced complete.

NOTE

Keys from the *Big Ben* Unit are not interchangeable with the *Firefly* Unit.

5.8 Firefly II

5.8.1 General

The Big Ben/Firefly PDU is gradually being discontinued and is to be replaced with the Firefly II (see Fig 5.20).

Fig 5.20 Firefly II

The Firefly II PDU offers the following features:

- a motion sensor that virtually eliminates the possibility of false alarms and unintentional re-sets;
- multiple LED indicators positioned on three sides of the unit which flash in sequence every 0.3 sec to verify the unit is functioning correctly;
- operates on a single 9 V alkaline battery providing a minimum of 100 hrs service in the Auto mode and 5 hrs in the Full Alarm mode;
- a durable, slide-type three position (OFF-ON-AUTO) switch. Fully operable with one hand, even when wearing thick gloves;
- for situations when a wearer is not unconscious but may be disabled, an override switch that can be used to summon attention manually is provided; and
- a lightweight (210 g) impact resistant construction that will withstand harsh treatment.

5.8.2 Technical Specifications

Technical specifications for the Firefly II PDU are detailed in Table 5F.

SPECIFICATION	DETAIL
Weight	210 g (including batteries)
Output	98 dBA at 3 m
Battery type	9 V Alkaline
Battery life	100 hrs (min in Auto mode) 5 hrs (full alarm)
Dimensions	58 mm x 50 mm x 96 mm
Alarm audio frequency range	2.6 kHz - 3.0 kHz
Pre-Alarm	Intermittent 2 Hz (low volume)
Low battery warning	Short beep every 5 secs

Table 5F Firefly II Technical Specification

5.8.3 Mode of Operation

Automatic

To activate the unit simply move the slide switch to **AUTO**.

⚠ NOTE

There is no self test on start-up of this unit.

In operation, the Firefly II PDU sounds a 7 sec pre-alarm warning whenever motion goes undetected for 20 secs. Body movement automatically silences the pre-alarm and resets the unit to the automatic mode.

If no motion is detected after the pre-alarm warning, the PDU emits a 98 dBa alarm.

Manual

Firefly II may be operated manually by moving the slide switch to the **ON** mode.

This then allows the wearer to activate the alarm on demand in one simple motion.

5.8.4 Low Battery Warning

When the battery is near the end of its life, a low battery warning is activated. This is a short beep every 5 secs.

⚠ NOTE

Even after the low battery warning is activated, the unit can operate under the Full Alarm mode for 5 hrs.

5.9 Oxy-Viva 3 Portable Resuscitator

5.9.1 Introduction

The saving of lives threatened by asphyxiation depends not only on the skill of the rescuer but on effective equipment for resuscitation. Although lives may be saved by expired air resuscitation methods, many cases require the application of 100% oxygen under pressure, as well as aspiration such as that provided by the *Oxy-Viva* 3 Resuscitator.

5.9.2 General description

The main features of the *Oxy-Viva* 3 are a gas powered demand resuscitator, a suction attachment with collection jar, a fixed flow oxygen therapy attachment and an auxiliary inlet/outlet. It also contains adult and child resuscitation masks, adult and child therapy masks, airways, therapy tubing, suction tubing and a *Yankauer* suction unit.

The three treatment systems may be used simultaneously with three different patients or exclusively with the one patient (see Fig 5.21).

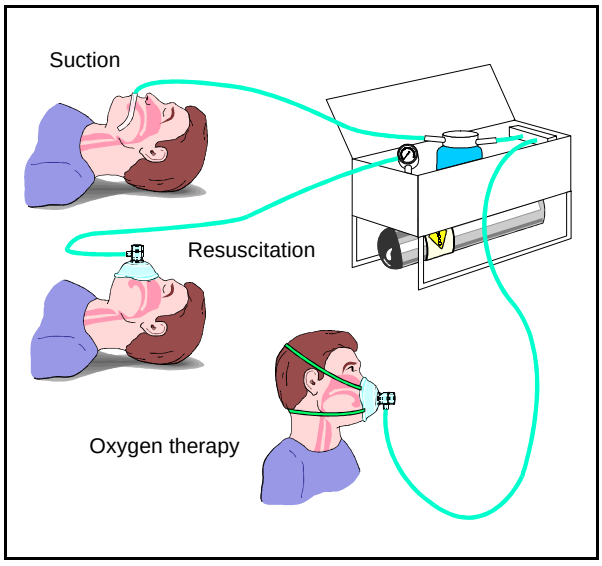

Fig 5.21 Treatment Systems

Two models are currently in use in the NSWFB:

- *Robert Shaw* Demand Resuscitator (see Fig 5.22); and
- *OTWO* Demand Resuscitator (see Fig 5.23).

5.9.3 Safety Precautions

An *Oxy-Viva* 3 resuscitator operates using oxygen. When using the resuscitator the following precautions should be observed:

- no smoking, naked flames or sources of ignition nearby;
- use no oil or greases;
- open cylinder valves slowly and fully;
- turn off cylinder valve when not in use;
- keep cylinder cool; and
- do not dump or drop cylinders.

Prolonged use of the suction unit will quickly deplete the oxygen supply.

No repairs should be undertaken by personnel not trained in servicing procedures for medical equipment.

Use only manufacturer approved spare parts when servicing.

CAUTION

The resuscitator may be used in toxic atmospheres provided the operator is wearing suitable respiratory protective equipment. There is an increased risk of fire or explosion when oxygen is used in flammable or explosive atmospheres and extra care must be taken.

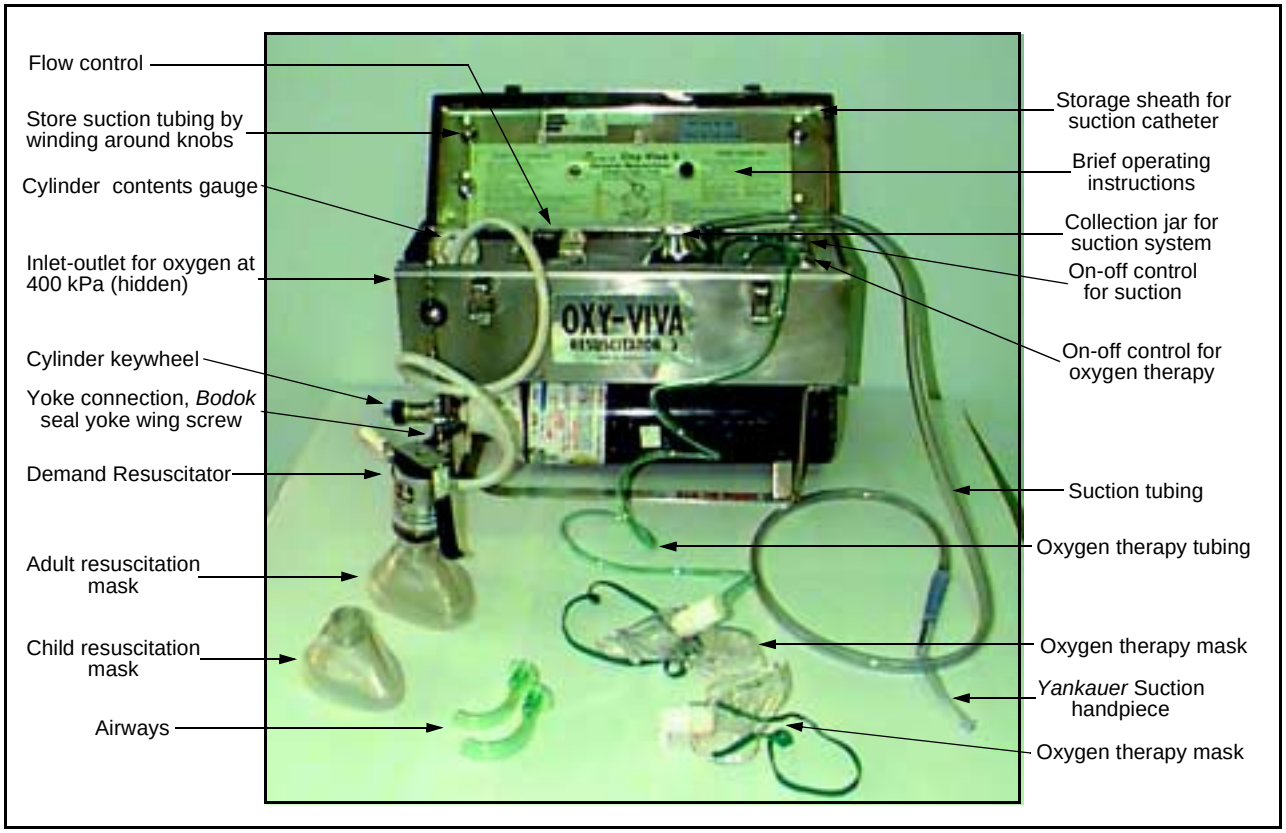

Fig 5.22 Robert Shaw Resuscitator

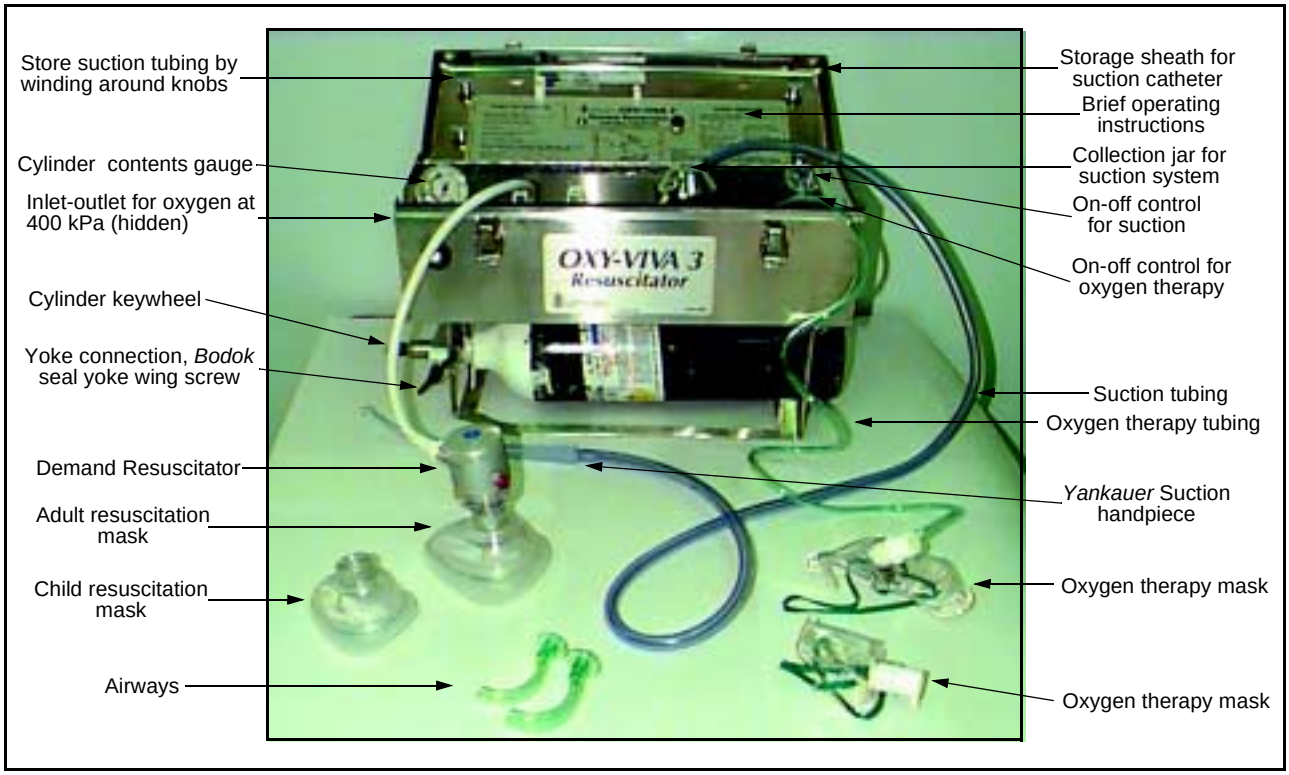

Fig 5.23 OTWO Resuscitator

5.9.4 Pre-Operational Check

It is recommended that the *Oxy-Viva* 3 undergo the following simple functional tests to ensure that the unit is in readiness for use in an emergency.

- tighten the oxygen cylinder in the yoke, making sure that the *Bodok* seal is in good condition and is in position. Turn **ON** the oxygen cylinder valve (anti-clockwise) to ensure that adequate contents are registered on the gauge;

- the suction trap jar must be located in the housing provided, and connected to the venturi outlet;

- check that the suction attachment operates by turning the **Suction** control **ON**, and confirm that suction is generated at the suction outlet;

- ensure that the Demand Resuscitator functions when the cylinder valve is open and the actuating button is pressed. When released, the plunger must return fully to the **OFF** position and completely shut off the gas flow. Block off the mask connection on the Demand Resuscitator and press the manual ventilation button. The pressure relief valve should open and gas should be heard venting to the atmosphere;

- check that the oxygen therapy attachment functions by turning the **Therapy** control **ON** and confirm that gas flows;

- check that both airways are present;

- check that the cylinder keywheel and yoke plug are securely attached to the case by their chains;

- check the condition of the resuscitation masks. Ensure that they fit the Demand Resuscitator, that they are free from damage, and the cuffs are soft and pliable; and

- turn **OFF** the cylinder valve (clockwise) and place the keywheel in the case. Note the pressure gauge reading, wait 3 mins and check the reading again. The maximum permissible leak is 2 widths of the gauge pointer. Depressurise the unit by turning **ON** the therapy flow control until the flow stops. Turn **OFF** the therapy flow control.

The lid can now be closed and the *Oxy-Viva* is ready for immediate application should an emergency arise.

5.9.5 Equipment Use

Oxygen Supply

The *Oxy-Viva* 3 has two oxygen supply inlets, a pin indexed yoke inlet for connection to oxygen cylinders, and an auxiliary inlet/outlet sleeve indexed system (SIS) inlet, for connection to a regulated 400 kPa external supply source.

Cylinder Supply

To fit a **C** size cylinder to an *Oxy-Viva* 3 first check that the *Bodok* seal is fitted to the pin indexed yoke connection and that the yoke wing screw is backed off. Remove any protective cover on the cylinder valve outlet. Crack the cylinder by briefly opening then closing the cylinder valve.

Slide the cylinder into the frame at the base of the case. Locate the pin index holes on the cylinder valve with the corresponding pins on the yoke. Secure the cylinder valve in position by tightening the yoke wing screw.

Fit the keywheel to the cylinder valve and slowly open (anti-clockwise). Ensure that the cylinder valve has made a leak-tight seal and the cylinder pressure registers on the contents gauge. Close the cylinder valve and release pressure from the unit by turning **ON** the therapy flow control until the pressure gauge reads zero. Turn **OFF** therapy flow control. Leave cylinder fitted and turned **OFF** until it is required for use.

Auxiliary Inlet/Outlet Supply

Located externally is a self-sealing annulus, for connection of a bulk oxygen supply. This is not currently used by the NSWFB.

NOTE

Leaks may develop from this annulus. As a rectification, simply unscrew the dust cover until the valve reseats. If it doesn't reseat automatically, depress the valve slightly. This will clear the seat.

5.9.6 Demand Resuscitator - General Description

With the oxygen supply turned **ON**, there will be no flow from the Demand Resuscitator until either the manual ventilation button is depressed or the patient inhales. A very slight inhalation effort produces an oxygen flow. The oxygen flow varies according to the inhalation effort and stops flowing during exhalation. An integral part of the Demand Resuscitator is an exhalation or non-rebreathing diaphragm and patient valve which allows gases from the lungs to be expelled during exhalation.

To resuscitate a non-breathing patient the Demand Resuscitator has been designed to supply oxygen to the patient's lungs by means of a mask. When the manual ventilation button is depressed, oxygen will flow and inflate the lungs.

When the manual ventilation button is released the gases are passively expelled from the lungs via the exhalation diaphragm and patient valve.

Use on a Non-Breathing Patient

To use the resuscitator on a non-breathing patient carry out the following:

- turn **ON** the oxygen cylinder valve (the keywheel is located inside the case). Turn anti-clockwise. Open the valve slowly and fully. Check the contents gauge for adequate supply;
- clear the patient's mouth and throat, use suction if required. Insert airway if necessary;
- tilt the head back, lift jaw;
- attach the mask to the Demand Resuscitator. Select the child or adult size mask as necessary;
- apply the mask firmly to the patient's face. Maintain an airtight seal over the nose and mouth;
- press the manual ventilation button on the Demand Resuscitator until the chest rises - then release. Wait until the lungs deflate, then repeat the operation continuously; and
- when the patient begins to breathe, stop pressing the manual ventilation button. Keep the mask on the face. The patient will automatically receive 100% oxygen with each breath on demand.

CAUTION

Over-inflation of the lungs can occur if an excessive tidal volume is delivered, particularly in the case of children. Inflation of the stomach can occur if an excessive tidal volume is delivered or if inflation is performed in the presence of a partially obstructed airway. If the stomach becomes distended, check the airway again but do not try to empty the stomach.

Use on a Breathing Patient

- turn **ON** the oxygen cylinder valve. Turn anti-clockwise. Open the valve slowly and fully. Check the contents gauge for adequate supply;
- attach the child or adult mask to the Demand Resuscitator;
- apply the mask firmly over the nose and mouth ensuring an airtight seal. When the patient breathes, the resuscitator will automatically supply 100% oxygen; and
- if breathing stops, immediately proceed with the steps listed under *Use on a Non-Breathing Patient*.

⚠ NOTE

The Demand Resuscitator, when delivering a tidal volume of 600 ml, 12 times a minute to a patient, would deplete a C size cylinder (contents approximately 400 L) in approximately 45 mins.

5.9.7 Suction Attachment

To ensure clear airways before or during resuscitation, suction may be applied via the flexible suction tubing and *Yankauer* suction unit:

- fit the suction handpiece to the suction tubing;
- turn the **Suction** control to **ON**. This produces a continuous vacuum in the plastic reservoir jar and enables blood and other fluids to be sucked from airways; and
- if necessary, empty the reservoir jar during use to prevent overfilling.

⚠ NOTE

Turn suction OFF after use to prevent oxygen cylinder depletion.

Trouble Shooting

When the suction is turned **ON**, there is no aspiration of fluids:

- check that the sealing washer is in place and the jar is tight; and
- check that there is no blockage in the suction tubing.

⚠ NOTE

Operation of the suction attachment uses oxygen. When suction is in use the suction attachment would empty a full C size cylinder (approximate contents 400 L) in approximately 8 mins.

5.9.8 Therapy Attachment

When necessary oxygen therapy can be used. To use the oxygen therapy attachment:

- connect one end of the therapy tubing to the therapy outlet under the **ON**/**OFF** lever;
- turn the **Therapy** control to **ON**;
- fit the therapy mask to the patient's face and form an effective seal. The elastic bands should pass just above the ears and the soft metal strip should be bent over the nose to form a seal.
- the oxygen concentration delivered to the patient is approximately 60%; and
- turn therapy **OFF** when finished.

⚠ NOTE

Retain therapy mask and tubing in its sealed bag until required for use.

5.9.9 Cleaning

The *Oxy-Viva* 3 and its accessories **must** be thoroughly cleaned after each use. When cleaning use only BA disinfectant.

The recommended cleaning method for various *Oxy-Viva* 3 accessories is detailed below.

Case

The *Oxy-Viva* 3 case may be cleaned using a mild soap solution, or BA disinfectant.

Demand Resuscitator

Operate the Manual Ventilation Button to blow out any loose contaminant.

Ensure that the oxygen supply is turned **OFF**. Bleed the remaining pressure out of the system by depressing the Manual Ventilation Button. Remove any mask fitted to the Demand Resuscitator and disconnect it from the supply hose.

OTWO Demand Resuscitator

To clean the *OTWO* Demand Resuscitator (see Fig 5.24) carry out the following:

- unscrew the mask connector (1) from the Demand Resuscitator body (3). Remove the exhalation disc (5) from the mask connector. Remove diaphragm (2);
- all components, except the body, can be cleaned using BA disinfectant. The resuscitator body should be wiped over with a soft cloth and a mild soap solution.
- after cleaning dry all components thoroughly;
- using a cloth lightly moistened with BA disinfectant, gently wipe inside of lip of body assembly (3). Wipe off with a clean moistened cloth and dry;
- re-assemble the exhalation disc (5) to the mask connector (1). The exhalation disc must be centralised and it should freely rotate when lightly moved with a finger;
- insert the diaphragm (2) into the body of the resuscitator (3) and smooth it into position with a finger;
- place the mask connector diaphragm and screw it hand tight in a clockwise direction onto the body (3); and
- check the operation of the Demand Resuscitator as per Pre-Operational Check.

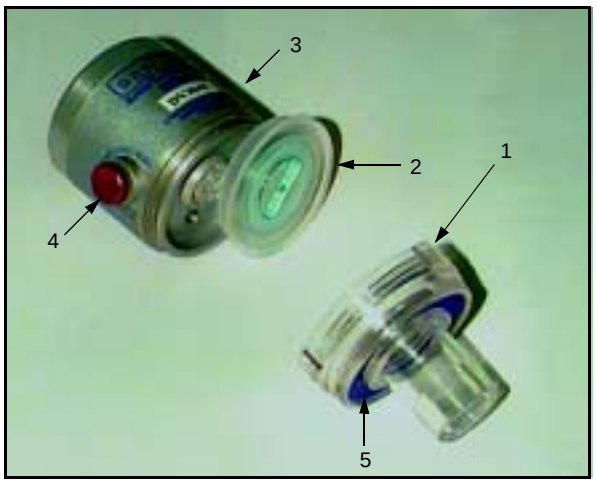

Fig 5.24 OTWO Demand Resuscitator

***Robert Shaw* Head**

To clean the *Robert Shaw* Demand Resuscitator (see Fig 5.25) carry out the following:

- remove the outlet adaptor (1), and valve assembly (2), from the body assembly (3);
- all components, except the body, can be cleaned using BA disinfectant. The resuscitator body should be wiped over with a soft cloth and a mild soap solution.
- after cleaning dry all components thoroughly;

- using a cloth lightly moistened with BA disinfectant, gently wipe inside of lip of body assembly (3). Wipe off with a clean moistened cloth and dry;
- after cleaning, dry all components thoroughly; and
- carefully examine parts, reassemble, and return to use.

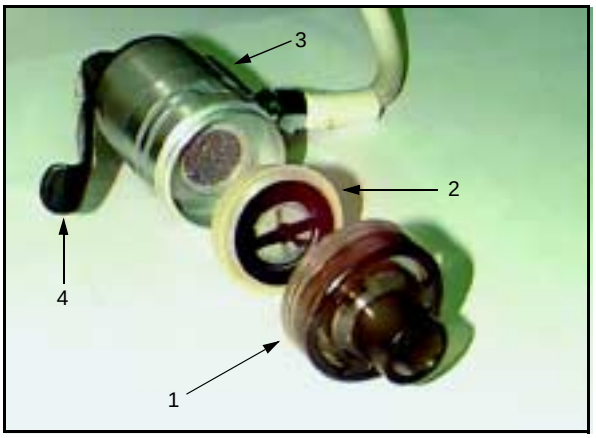

Fig 5.25 Robert Shaw Demand Resuscitator

Suction Jar, Suction Handpiece and Tubing

The suction trap jar is cleaned with BA disinfectant. Tubing is disposable.

Resuscitation Masks

The adult and child resuscitation masks supplied with an *Oxy-Viva* 3 are cleaned with BA disinfectant, dried and placed in a resealable bag.

Therapy Masks

The therapy masks supplied with an *Oxy-Viva* 3 are for single use only. They **must not** be cleaned and re-used.

Guedel Airways

The airways supplied with an *Oxy-Viva* 3 are for single use only. They **must not** be cleaned and re-used.

Yankauer Suction Unit

The suction units supplied with an *Oxy-Viva* 3 are for single use only. They **must not** be cleaned and re-used.

5.10 Mars Portable Resuscitator

5.10.1 Introduction

The *Mars* Resuscitator is an automatic gas powered time cycled system with patient trigger and manual override. The unit (see Fig 5.26) provides both an effective means of artificial respiratory ventilation, and a breathing-on-demand system allowing the conscious patient to establish his/her own respiratory pattern.

⚠ NOTE

Within the NSWFB this resuscitator is only used on patients during vertical lift rescue extractions or where access cannot be gained using the *Oxy-viva* 3 resuscitator.

The unit provides an inbuilt patient monitoring and override system. The system automatically shuts off artificial ventilation, should spontaneous ventilation occur, while at the same time continuing oxygen therapy. The system also covers the reverse situation where, should the respiratory rate drop below the pre-set level, the unit will automatically cut-in and recommence artificial ventilation.

Once the operator has established an effective seal between the patient's face and mask, the unit is ideally suited for resuscitation in a toxic environment, because the system is totally sealed from the external environment.

5.10.2 Alarm System

The resuscitator unit features an audible alarm system warning the operator of either an airway blockage or over-inflation of the casualty's lungs.

The audible alarm operates at approximately 44 mb, with any excess pressure being automatically *dumped* by the system. This feature protects the casualty from over-inflation of the lungs or inadequate ventilation in the case of airway blockage.

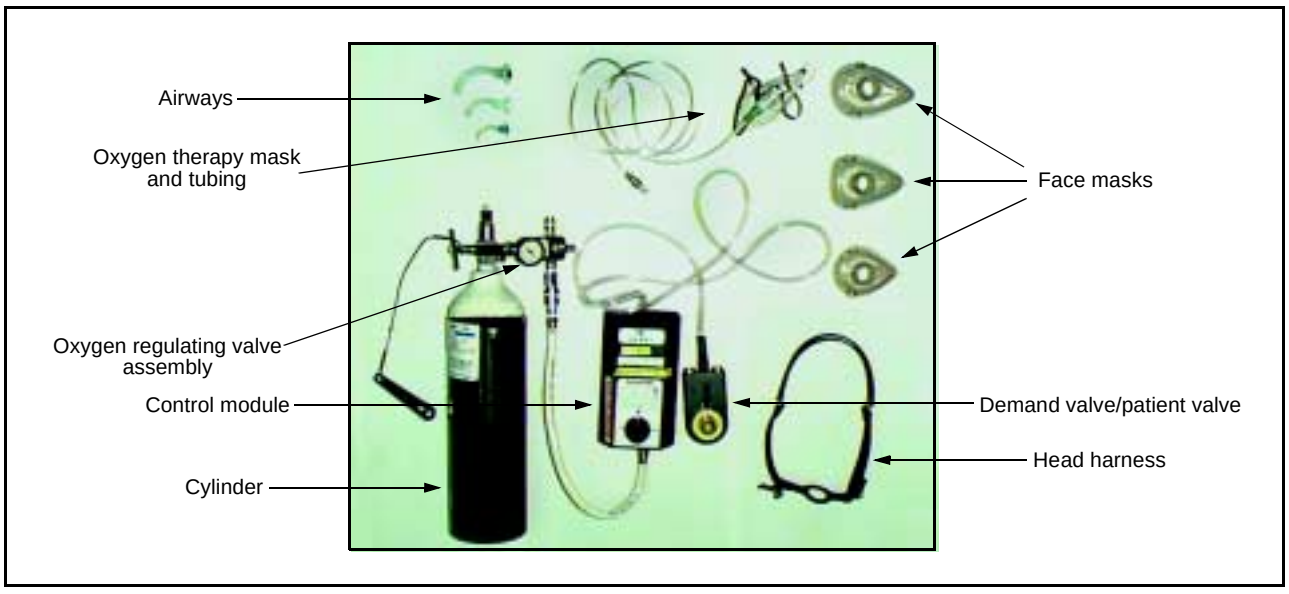

Fig 5.26 Mars Portable Resuscitator

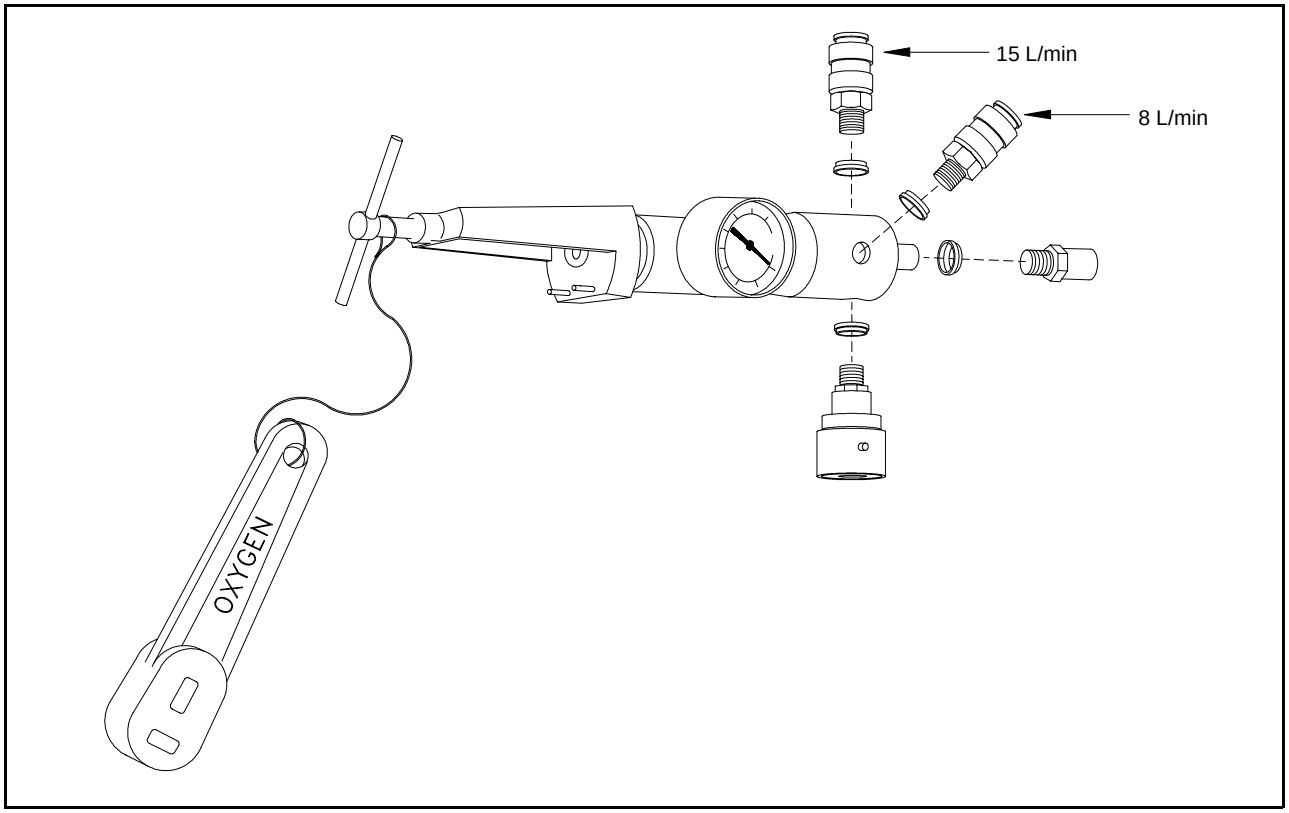

Fig 5.27 Oxygen Regulator Assembly

5.10.3 Multi-functions

The unit has the facility to ventilate one casualty whilst providing oxygen therapy to another two casualties at either 8 or 15 L/min (see Fig 5.27).

The 100% oxygen not only improves the quality of resuscitation but also provides treatment to patients with specific ailments, including Carbon Monoxide poisoning and decompression sickness.

5.10.4 Warnings on Use

The following warnings should be adhered to strictly:

- the resuscitator **must only** be used by firefighters who have received adequate training in Cardio Pulmonary Resuscitation (CPR) and the correct use of this resuscitation apparatus;
- if ventilation is not achieved with the resuscitator, Expired Air Resuscitation should be used, and the airway re-checked;
- over-inflation can occur, especially in children, if inflation is prolonged, sustained or as a direct result of an inadequate airway;
- throughout resuscitation, continuously monitor the casualty's pulse, pallor and pupils. Frequently monitor the cylinder contents gauge. When children under 20 kg require resuscitation, operate the unit by **gently** depressing the manual trigger, whilst watching the chest rise and fall. **DO NOT** prolong or sustain trigger operation because over-inflation may occur in extreme circumstances;

- if too large a face mask is used for spontaneously breathing children, the dead air space will be excessive, which will adversely affect the performance of the unit; and

- the resuscitator may be used in toxic atmospheres provided the operator is wearing suitable respiratory protective equipment. There is an increased risk of fire or explosion when oxygen is used in flammable or explosive atmospheres and extra care **must** be taken.

5.10.5 Dangers

The following are real dangers associated with the use of this equipment:

- there **must** be no smoking, naked flames or other sources of ignition near the system when in use or in storage;

- **do not** use oil or grease when maintaining the equipment;

- **do not** drop or mishandle the cylinder;

- cylinders **must** be stored at temperatures below 40° C;

- turn **OFF** cylinders when not in use; and

- use **only** brass or non-spark producing keys to turn **ON** the cylinder.

5.10.6 Pre-Operational Checks

To prepare the unit for use carry out the following with reference to Fig 5.28 and Fig 5.29:

- open bag by releasing fasteners;

- plug probe (G) into the cylinder outlet (H);

- ensure that the *Bodok* seal (B) within the yoke is in place and undamaged;

- locate the regulator yoke assembly (A) over the cylinder pin index valve and secure by screwing the T-bar clockwise;

- ensure T-bar is fully tightened by hand;

- turn **ON** the cylinder valve fully anti-clockwise, with the key (E) provided;

- check pressure gauge for cylinder contents (F); and

- the unit is now ready for use.

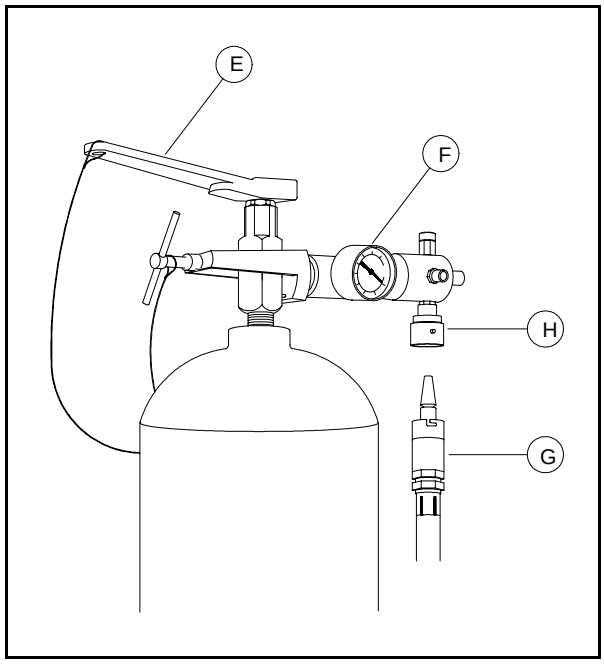

Fig 5.28 Resuscitator Components

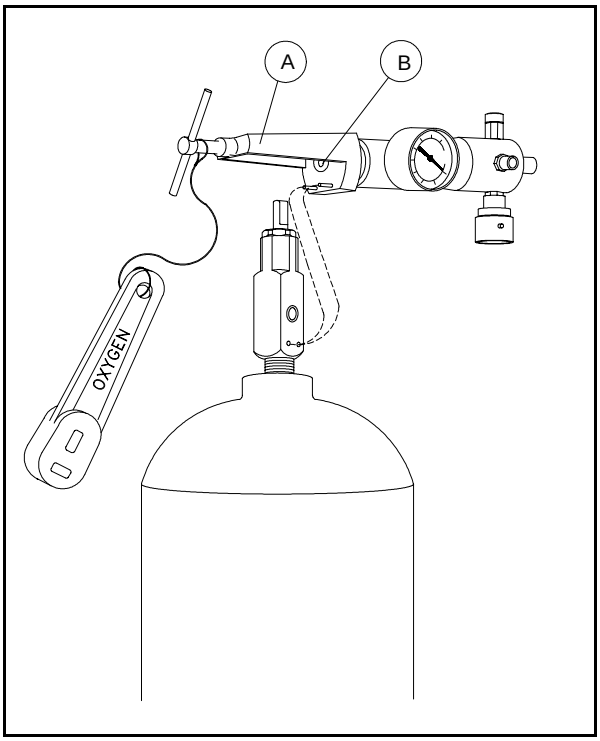

Fig 5.29 Cylinder Connection

Storage

The system can be stored in the *Ready for Use* condition, but with the gas supply turned **OFF**.

NOTE

The NSWFB *Mars* Resuscitators are carried in an Initial Access Pack, which is also equipped with first aid items.

Changing the Cylinder

CAUTION

While a cylinder is being changed, Expired Air Resuscitation must commence if the casualty is not breathing spontaneously. This MUST NOT be attempted within a toxic atmosphere.

It is important to monitor the cylinder contents when using the resuscitator. When the contents fall below 20 Bar it can be quickly changed as detailed below:

- turn **OFF** the cylinder valve clockwise with the key (E) provided. Depress the trigger on the demand valve to release any internal gas pressure;
- unscrew the regulator T-bar anti-clockwise until the regulator clears the pin index valve. **DO NOT** remove the T-bar from the regulator;
- ensure that the *Bodok* seal (B) within the regulator yoke is in place and undamaged;
- locate the regulator assembly (A) over the **FULL** cylinder's pin index valve and secure by turning the T-bar clockwise until hand-tight;
- turn **ON** the supply fully anti-clockwise using the cylinder key provided. Check the contents gauge to ensure that the new cylinder is **FULL**; and
- recommence treatment.

5.10.7 Operating Instructions

Using Resuscitator in Respiratory Arrest

In this situation carry out the following:

- bring the resuscitator to the casualty as soon as possible;
- in normal non-toxic breathable air, Expired Air Resuscitation should be commenced immediately if no breathing is detected, and continued until the resuscitator is ready for use;
- upon arrival at the scene of the incident, assess the situation for danger to yourself and the casualty;
- ensure that the mouth is clear of debris, vomit, and loose dentures;

- open and maintain the airway by extending the head and neck;
- check the casualty's breathing, pulse, pallor and pupils. Listen, feel and look for signs of respiration;
- loosen restrictive clothing at the neck, chest and waist;
- ensure the cylinder is turned **ON**;
- select the appropriate face mask and connect to the demand valve and place adjacent to the casualty;
- check the airway and place the mask over the casualty's face ensuring a tight seal around the nose and mouth (as shown in Fig 5.30);
- give five inflations to saturate the lungs with oxygen using the manual trigger as shown in Fig 5.30, watching the rise and fall of the chest at the same time;

CAUTION

Excess pressure caused by blockage of the airway through incorrect position or vomit will be indicated by an audible alarm on the demand valve. RECTIFY IMMEDIATELY BY ESTABLISHING THE AIRWAY.

- re-check breathing, pulse, pallor and pupils. If no pulse is found, carry out Full Cardio Pulmonary Resuscitation (CPR);
- if a pulse is present, but no breathing detected, select the required mode on the ventilation unit i.e. large or small adult or child. The unit will now ventilate automatically;

NOTE

Whilst on automatic mode, ensure that the airway is maintained and frequently monitor the casualty's pulse, pallor and pupils.

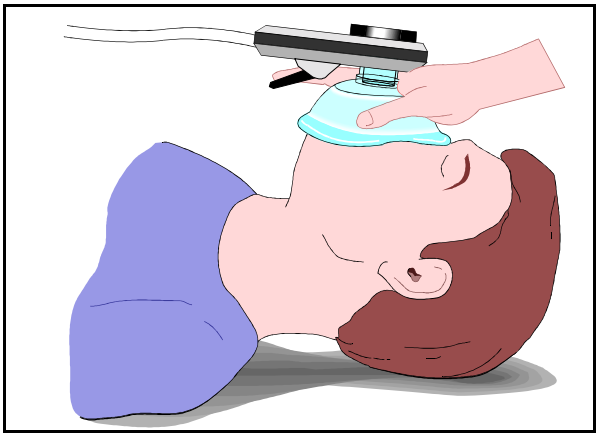

Fig 5.30 Correct Positioning of Mask

- when the casualty commences breathing, the unit will automatically switch to demand flow, allowing the casualty to breath unassisted through the unit. Should the casualty's respiratory rate drop below the pre-set levels, the unit will automatically recommence ventilation; and
- if breathing and/or circulation cease, recommence resuscitation.

NOTE

When resuscitation is successful, the carotid pulse will return. Look at the casualty's face and lips, their colour will improve as oxygenated blood begins to circulate. If the casualty is not breathing, their normal colour will turn to blue, cyanosis.

DO NOT LEAVE the casualty until the arrival of the medical services.

5.10.8 Dismantling and Cleaning

To dismantle and clean parts of the unit carry out the following using Fig 5.31 for reference:

- unscrew the patient valve housing (3) and the rubber non-return, flap valve (2) from the demand valve body (1);
- disinfect the components (2, 3 and 4 only) by immersing them in a BA disinfectant solution for a minimum of 10 mins;
- rinse thoroughly in clean running water to remove all traces of disinfecting solution;
- clean the face mask by immersing in a solution of BA disinfectant, followed by a thorough rinse in clean running water;
- wipe off all excess water with clean lint-free materials;
- allow the individual parts to dry thoroughly. **DO NOT** use direct heat. Assemble once dry; and
- check cylinder contents, recharge or replace cylinder if the gauge is reading less than $^1/_3$ or 50 Bar.

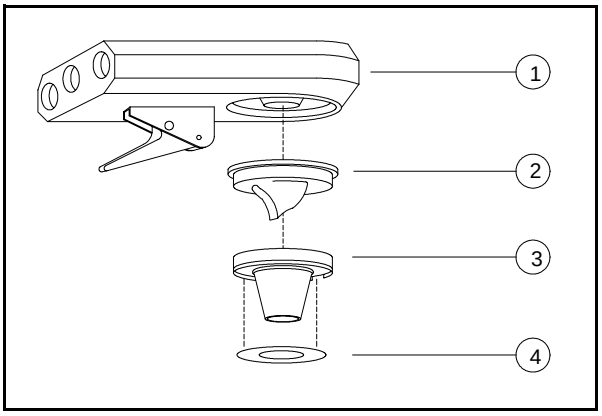

Fig 5.31 Demand Valve/Patient Valve Assembly

5.10.9 Testing

After Use and Monthly

The following tests are to be carried out after use and at monthly intervals:

- ensure that the pin yoke is fully tightened and the *Bodok* seal is correctly positioned;
- turn **ON** the cylinder valve fully, with the key provided;
- check the pressure to ensure that the cylinder is **FULL**. If the pressure gauge reading is less than $^1/_3$ or 50 Bar, refill or replace with a full cylinder;
- plug the probe into the oxygen reducer outlet;
- place finger over the patient port. Flick the trigger and note that the reed valve sound simulates an airway blockage;
- flick the trigger several times and ensure that there is a free flow of gas;
- turn **OFF** the cylinder and operate the trigger to discharge pressurised gas;
- carefully pack the unit with all accessories ready for use; and
- record details of the test

Annual

The resuscitator unit should be serviced at least once a year in accordance with the *Mars* Servicing Instructions.

⚠ NOTE

The annual servicing must only be carried out by persons trained to undertake the servicing of the resuscitator apparatus.

5.10.10 Fault Finding

The most common faults along with the possible causes and remedies associated with the *Mars* Portable Resuscitator are detailed in Table 5G.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Leak from connection with pin index cylinder	Incorrect position of regulator on P1 valve	Turn **OFF** cylinder valve. Adjust position of regulator.
	T-screw loose	Turn **OFF** cylinder valve. Tighten light hand pressure only.
	Damaged P1 valve face or damaged regulator seal	Turn **OFF** cylinder valve. Remove regulator. Check valve sealing face for scratches or dents. Renew cylinder if necessary. Check seal for damage, renew if necessary.
Equipment does not function	Cylinder not turned **ON**	Open cylinder valve.
	Cylinder empty	Check regulator gauge. Replace cylinder if empty.
	Hose incorrectly fitted	Turn **OFF** cylinder valve. Remove hose and refit, ensuring that it *clicks* into position.
Reduced gas flow/pressure	Filter partially blocked	Check and clean filter inlet.
	Cylinder valve not fully open	Open cylinder valve fully.
Demand valve does not provide flow or patient cannot obtain oxygen supply	Missing inhale or exhale valve	Turn **OFF** cylinder valve. Check to ensure inhale and exhale valves are fitted. Replace if necessary.
Unit does not pulse	Set on **CPR**	Turn knob to correct setting.
	Knob between settings	Turn knob to correct setting.
	Gas **OFF**	Open cylinder valve.
	Gas pressure low	Check regulator gauge. Replace cylinder if empty

Table 5G Mars Portable Resuscitator Fault Finding Chart

5.11 Sabrelite 2000

The Pelican Super *Sabrelite* 2000 is intrinsically safe and waterproof. It has been tested by the *Standards Association of Australia* and the *Workcover Authority* in an explosive atmosphere (Class 1 Zone 0) and complies with *AS 1826, 1983*.

The torch (see Fig 5.32) is 190 mm in length and has a body made from lightweight, high impact Cyclolac resin which is yellow in colour. The lens of the torch is made from polycarbonate Lexan.

The Laser Spot Xenon lamp module produces a tightly focused white beam of light, and is powered by three 1.5 v *C* cell batteries.

The *Sabrelite* has a three-way attachment system consisting of:

- a belt spring clip;
- a stainless steel split ring; and
- a lanyard.

The unit is to be affixed to the right hand side shoulder harness of each BA set by means of a snap hook. This will allow easy identification when inventory audits are made. The torch must be tested each time a pre-operational BA check is performed.

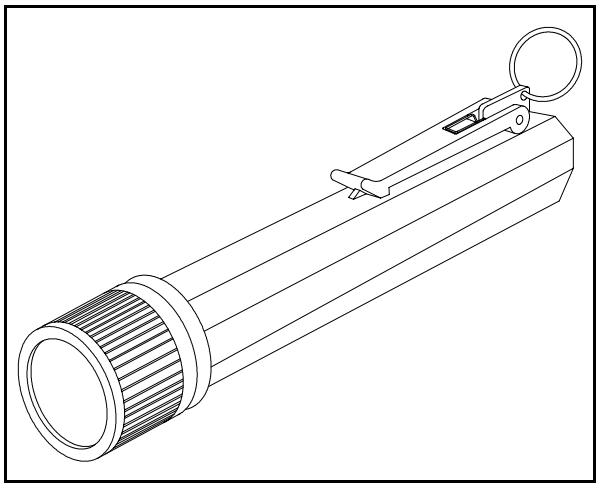

Fig 5.32 Sabrelite 2000 Torch

The *Sabrelite* is to be maintained in accordance with *In-Orders*.

SECTION SIX - INCIDENT GROUND PROCEDURES

CONTENTS

6 INCIDENT GROUND PROCEDURES

6.1 Introduction

Each year, the NSWFB attends a large number of incident grounds where members are required to use BA to assist them in the performance of their duties, and to protect them from breathing in smoke and toxic fumes which occurs as a by-product of combustion.

The BA is a specialised piece of equipment that relies on the contents of a cylinder for its operation, and therefore it has a limited operating time. Because of this, and the dangers involved in entering a smoke filled environment such as a burning building, it is essential to have in place a system that monitors the use of BA by members.

6.2 BA Control System

The BA Control System is designed to safeguard members wearing BA at any incident ground, and to initiate search and rescue operations should a member wearing BA fail to report back to a control point, at, or before the time the contents of the members BA cylinder is exhausted.

As with all safety systems, it can only function correctly if **all** personnel associated with the system, know and fulfil the obligations and requirements the system imposes on them. It is therefore **essential** that all members of the NSWFB strictly adhere to the instructions contained within the system when using BA.

6.2.1 Control System Components

The BA Control System utilises:

- a tally for each BA set;
- Stage One, Stage Two Control Boards;
- a 24 hr digital clock; and
- a Main Control.

6.2.2 Tallies

A plastic tally is provided for each BA. It is used to identify each BA operator, to record the cylinder pressure of the BA being worn, and to record the time entry was made to the contaminated atmosphere.

Provision is made on each tally for the following information to be written by the operator, after completion of the pre-operational check of the BA:

- station number;
- rank of wearer;
- name of wearer;
- cylinder pressure; and
- time in (to be recorded immediately before placing tally in a Control Board).

6.2.3 Regenerative Oxygen Tally

A white tally with red lettering is used for regenerative oxygen BA (see Fig 6.1).

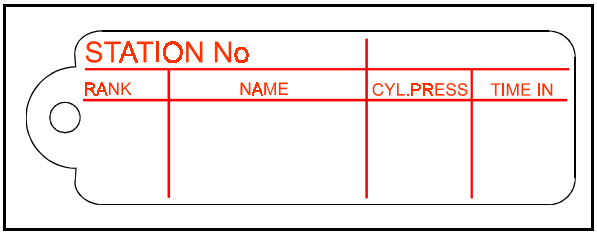

Fig 6.1 Regenerative Oxygen Tally

6.2.4 SCBA Tally

A yellow tally with black lettering is used for SCBA (see Fig 6.2). The tally is attached to a key which activates a PDU.

⚠ NOTE

Removal of the key from the PDU and its retention by a firefighter, other than its use in a Stage One or Stage Two Control Board, could endanger the safety of BA teams.

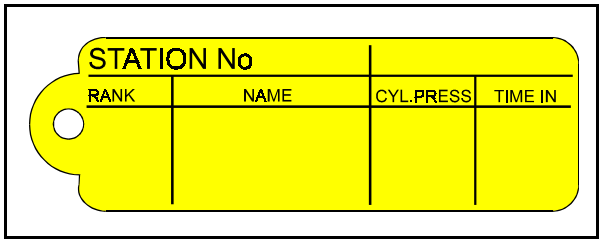

Fig 6.2 SCBA Tally

6.3 Stage One Control Board

Stage One Control Boards are fitted to Pumpers, Salvage Rescue Appliances and the CO_2 Tender. The purpose of the board is to hold the tallies of operators wearing BA and provide information regarding their location and exit time (see Fig 6.3).

The board is designed so that six tallies can be inserted into the slots provided. Included on each board are three columns, headed:

- location;
- remarks; and
- exit time.

Tables at the top of the board allow the wearing time for either regenerative oxygen or SCBA to be calculated. The tables are compiled on the basis of moderately hard work and include a safety margin.

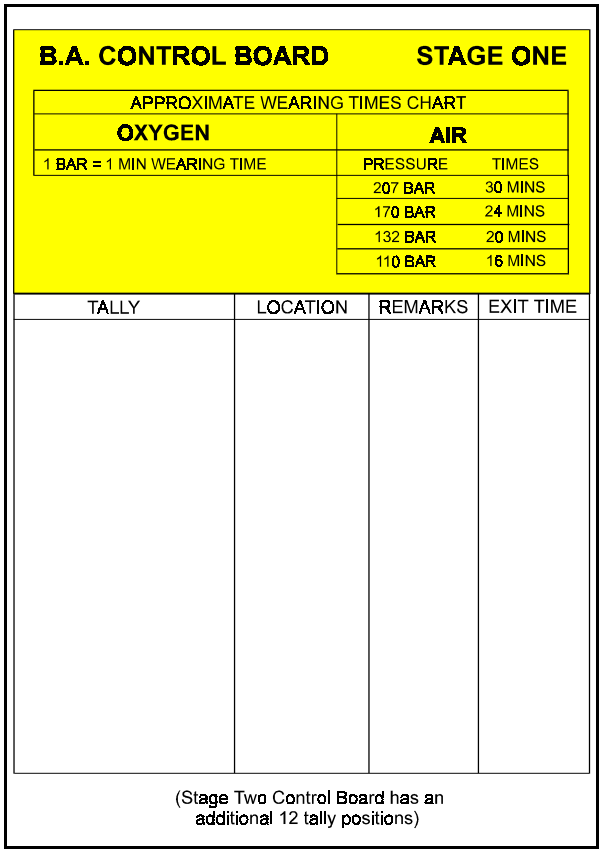

Fig 6.3 Stage One Control Board

6.4 Stage Two Control Board

A Stage Two Control Board is carried on Hazardous Materials Response Unit vehicles, Salvage Rescue Appliances and Operational Commanders' vehicles. The layout of the board is identical to the Stage One board except that it has provision to accept 18 tallies. The Stage Two Control Board is used to centralise BA tallies when a number of Stage One BA Control Boards are to be consolidated.

⚠ NOTE

The setting up of a Stage Two Control is not dependant upon a Stage Two Control Board being available. If necessary, one or more Stage One Control Boards can be used to set up a Stage Two Control.

6.5 24 Hour Digital Clock

Installed on each appliance in close proximity to the Stage One Control Board, is a 24 hr digital clock. All times recorded on BA tallies are obtained from this clock on the appliance.

It is essential that the clocks be maintained to indicate a uniform time. The clocks are to be checked and if necessary adjusted to the correct time on the following basis:

- permanently staffed stations - daily at 0800 hrs;
- retained stations with permanent staff - daily at 0800 hrs; and
- retained stations with no permanent staff - at least once per week in conjunction with the pre-operational check of BA.

⚠ NOTE

The digital clock is powered by the appliance's 12V battery. Should the battery be disconnected or power to the clock be interrupted for any reason, the digital display of the clock will flash when power is restored. The clock is to be readjusted to the correct time following any interruption of the power supply.

6.6 Main Control

A Main Control is to be established when more than one Stage Two control is in operation. The purpose of the Main Control is to:

- supervise all BA operations at an incident;
- arrange and deploy relief and rescue teams to Stage Two Controls; and
- arrange availability of sufficient personnel and equipment for BA operations and manning of controls.

6.7 Pre-Operational Procedure

On completion of the pre-operational check for BA the following information is to be entered on the tally by the operator, in the space provided, (using a chinagraph pencil):

- the station number;
- the rank of the wearer;
- the wearer's name; and
- the cylinder pressure of the BA.

6.8 Stage One Control

6.8.1 BA Operators Responsibilities

Having donned the BA, the key and tally is to be removed from the Personal Distress Unit (PDU), thereby arming the unit. The BA wearer will then:

- check the BA cylinder pressure against the pressure recorded on the tally. Amend the pressure on the tally if necessary;
- enter the **Time In** on the tally from the digital clock;
- place the tally on the Stage One Control Board;
- on exiting from the contaminated atmosphere, immediately report back to the Stage One Control Board, inform the Controller that exit has occurred; replace the BA tally from the Board onto the BA PDU that was worn; erase all irrelevant information (old cylinder pressure reading) from the tally.

6.8.2 Controllers Responsibilities

The OIC of the incident shall designate members to act as Stage One Controllers for one or two appliances. If necessary, appliance

drivers are to be detailed for this duty pending arrival of more personnel. The OIC is to arrange for any **pump operator with pumping responsibilities** to be immediately relieved of a Stage One Controllers responsibilities as soon as sufficient personnel are available.

Any member who has been detailed to relieve a Stage One Controller, shall obtain from that member all details concerning the BA operation before taking charge.

Where members are operating with BA from two appliances in close proximity, one Stage One Controller is to be designated. If the appliances are remote from each other e.g. another street, then additional Stage One Controllers are to be designated for such appliances. Wherever practicable, each Stage One Controller is to be responsible for two appliances.

The Stage One Controller is responsible for:

- ensuring all members wearing BA have entered their name and station number as well as the correct time on their tally and inserted the tally into the Stage One Control Board before entering the contaminated atmosphere;
- calculating the **exit time** of each wearer and together with the **reported location**, enter this information on the Stage One Control Board;
- monitoring the Stage One Control Boards to ensure all BA wearers exit at the due time; and
- removing the tally from the Stage One Control Board and handing the tally to BA operators exiting from the contaminated atmosphere.

CAUTION

Should any BA wearer exceed the due exit time, immediately report this information to an Officer and notify State Fire Command.

Take any other practical action to commence search and rescue for any overdue BA wearer.

NOTE

When tallies are removed from a Stage One Control Board for the purpose of establishing a Stage Two Control, the location of the Stage Two Control is to be entered in the remarks section on the Stage One Control Board.

6.9 Stage Two Control

The purpose of a Stage Two Control is to:

- consolidate a number of Stage One Controls to rationalise the use of fire fighting personnel.
- provide an assembly point for relief BA teams;
- maintain a rescue team ready for immediate rescue operations;

NOTE

In the context of this topic, rescue team means a BA team assigned for rescue of any firefighters who may be in difficulties. This instruction is not to be confused with the responsibilities of Salvage/Rescue and Pump/Rescue crews as detailed in *In Orders 1994/25.*

The OIC of the incident will be responsible to order Stage Two Controls to be implemented. **This OIC will also designate personnel to take charge of each Stage Two Control**. The complexity of the incident may require more than one Stage Two Control to be established.

A single Stage Two Control will be established in any of the following circumstances:

- when there is a **single entry/exit** point to the hostile environment remote from existing Stage One Controls;

- when amalgamation of a number of Stage One Controls will achieve more efficient control of BA teams and release Stage One Controllers for other duties;

- where a number of BA teams which will require a relief, are operating at the incident; and

- when the circumstances at the incident indicate that a rescue team should be immediately available.

Additional Stage Two Controls are to be implemented in the following circumstances:

- where the total number of BA wearers operating from one Stage Two Control exceeds 18; or

- where BA teams are operating at large incidents and access and egress is required at points remote from each other.

6.9.1 BA Operators Responsibilities

BA Operators working from a Stage Two Control will adopt the same procedure as laid down for the Stage One Control, except that the tally will be placed in the Stage Two Control Board.

If a Stage Two Control has been established during a period in which BA operators were engaged in operational duties, they are to report to the Stage Two Control on exiting, instead of the Stage One Control.

Relief BA teams are to report to the Stage Two Controller and stand by until directed to relieve another specific BA team.

6.9.2 BA Controllers Responsibilities

Personnel designated to establish and take charge of a Stage Two Control must:

- establish the Control as close as practical to the entry/exit point of the hostile atmosphere;

- transfer tallies, exit times, location and remarks from Stage One Control Boards to the Stage Two Control Board;

- inform the Stage One Controllers that a Stage Two Control is being established, indicating the location of the Stage Two Control so that this information can be displayed on the Stage One Control Board;

- arrange for one BA team (a minimum of two operators) to be dressed and ready to don their face masks. This team is to stand by at the Stage Two Control and should the need arise, be used as a rescue team;

- ensure that a rescue team of two operators is maintained at the Stage Two Control while it is in operation;

- arrange for a second BA team (a minimum of two operators) to be dressed and ready to don their face masks. This team is also to stand by at the Stage Two Control to be used as a relief team; and

- ensure that when a relief or rescue team is committed they are immediately replaced by a new team.

In addition, the Stage Two Controller is to establish a communication point at the control using a hand held transceiver. This is to provide communication between the Stage Two Control and the following:

- working BA teams;

- the incident ground command point if only one Stage Two Control is in operation; and

- the Main BA Control when more than one Stage Two Control has been established.

⚠ NOTE

Should any BA team working from a Stage Two Control fail to exit at their due time or report a distress situation, the rescue team is to be immediately despatched to search or assist, and the OIC of the incident notified.

6.10 Main BA Control

A Main BA Control is to be established whenever more than one Stage Two Control is in operation. It should be established in close proximity to the HazMat/BA unit or Command Vehicle. It will be under the control of the BA Officer or other Officer, designated by the OIC of the incident.

6.10.1 Controllers Responsibilities

The Main BA Controller will:

- liaise with the OIC of the incident concerning all BA operations;
- supervise and co-ordinate all BA operations at the incident;
- arrange, organise and deploy relief and rescue teams as required to Stage Two Controls;
- organise the availability of sufficient personnel and equipment for BA operators and manning of Stage Two Controls;
- maintain communications to all Stage Two Controls as well as receiving and transmitting information and necessary instructions for effective BA operations; and
- maintain communications to the incident ground Command Point and inform the OIC of the incident of all relevant information concerning BA operations and requirements.

SECTION SEVEN - SEARCH AND RESCUE

CONTENTS

7 SEARCH AND RESCUE

7.1 Introduction

Of all the facets of fire protection, search and rescue may be the most important task the firefighter performs. Due to the critical nature of search and rescue and because it is such a demanding task, both physically and mentally, firefighters must practice the techniques frequently.

When searching for victims in a fire, rescuers must always be concerned with safety. Personnel should be properly trained and equipped with the necessary tools to accomplish the search in the minimum of time. Unsafe, hurried rescue attempts could be fatal to rescuers and victims.

Because of the high risk associated with search and rescue, it is always done in teams. All search and rescue teams should wear SCBA. In some cases, the search and rescue team will also be the fire suppression team. It is important to remember that the primary objective of the team is to locate and remove any victims. This function takes priority over fire suppression. If fire suppression or ventilation is needed first, initiate a search and rescue as soon as it is safe. If resources permit, search and rescue should be done by a different team than the team doing fire suppression or ventilation. It may be necessary for suppression, support, or relief of search teams.

7.1.1 Pre-Fire Planning

The search and rescue system begins with pre-fire planning. The pre-fire plan should include such items as the locations of occupied areas, mantraps, means of egress, routes fire and/or smoke is likely to travel, the location of utilities and fire suppression equipment, and a floor plan of the building.

Each jurisdiction has its own specific search and rescue problems. Pre-fire planning can help identify these hazards so the responding firefighters will be aware of the specific occupancies located in their jurisdiction.

Examples of specific hazards that should be pre-fire planned are:

Health Care Facilities

- what are each facility's plans for day time and night time evacuation?;
- where are the persons most likely to need immediate assistance?;
- what kinds of patients are there?; and
- where are the non-ambulatory/ ambulatory patients?

Factories

- what are the hours of operation?;
- how many employees and where are they usually located?;
- are there any employees who will need special assistance?;
- is there a watchman or security guard?;
- is there an area where persons will be isolated from knowing there is an emergency?;
- where are the utility shut-offs?; and
- where are the fire suppression systems?

To aid in the size-up process, the Officer can review the pre-fire plan en route to the scene of the emergency. Once on the scene, the Officer can direct the team to the point of entry, as

indicated on the pre-fire plan. When sizing-up the building, items that must be considered include:

- how much of the building can be searched by the crews on hand; and
- is there enough air on the scene for SCBA use.

7.1.2 Size Up

The person in charge of the first-arriving station has the responsibility of determining whether search and rescue is necessary, where the searches should be made, and the number of personnel needed for the search. To make these decisions the person in charge sizes up the situation as follows:

- what is the occupancy?;
- have escaped occupants or other people reported persons being inside?;
- how many persons are inside and where are they? Above the fire? In the path of fire and smoke extension?;
- are the persons inside bedridden, handicapped, elderly or children?;
- does pre-fire information indicate probable necessity for search and rescue?;
- where is the fire?;
- what stage is it in?;
- where is it likely to spread?;
- has it ventilated itself or is the interior charged with smoke and combustion gases?;
- are exits cut off by fire or smoke?;
- are persons trapped?; and
- will ventilation be needed before the search can begin?

The answers to these questions will give the person in charge a good idea of the need for search and rescue. Other factors to consider include:

- occupants of dwellings are usually sleeping at night. They are often overcome in their beds;
- a vacant building isn't necessarily so, children play in them, derelicts sleep in them;
- attics and basements of dwellings are sometimes remodelled and used as bedrooms for the young or the elderly; and
- has smoke spread made search and rescue necessary in adjoining structures? Ventilation systems can carry smoke to remote areas of the fire building.

⚠ NOTE

Searching a building has two objectives: finding and removing victims and obtaining information on the extent of fire.

Upon arrival at the fire scene, check with building occupants who have escaped the fire for information about those who might still be inside and their possible location. Make sure the information is factual. Neighbours might know of the occupants' possible location.

Also, the victim might have been seen at the window just before your arrival. The only positive way to be sure that the building is totally evacuated is to search it. All buildings including abandoned buildings **must** be searched.

It takes only a few seconds to stop and look at a building, before entering, to gather facts that will be useful to you when you go inside. Look at the entire building you are about to enter and

at its surroundings. When gaining access, is there a chain on the inside of the door? This indicates that there is someone inside, or that they used a different exit when leaving. Is a television or radio on? Is there food on the table?

Other things that you should look for are:

- cars in the driveway;
- lights on; and
- smoke coming from the chimney.

Search and rescue is divided into two segments, and they are referred to as:

- the **primary search**; and
- the **secondary search**.

The **primary search** has the following characteristics:

- immediate;
- rapid; and
- systematic.

During the primary search, you may perform the following operation:

- additional size up;
- ventilation; and
- salvage.

The **secondary search** has the following characteristics:

- after the fire is under control;
- slow and deliberate; and
- systematic.

During the secondary search the following operations are performed:

- ventilation;
- salvage; and
- overhaul.

The secondary search is conducted after the fire is under control. The primary search team works under extreme conditions, with speed of search being of primary importance. The aim of a secondary search is thoroughness. Every corner of the building must be searched, beginning at the roof and working to the street.

Following is a list of common sense safety points of which rescuers should be aware before they attempt any type of search and rescue within a building:

- if fire conditions are so advanced or the condition of the building is so poor that rescuers have a good chance of losing their lives, rescue should not be attempted. Under such conditions it is unlikely the victim would be alive;
- when a backdraft is possible, attempt entry only after ventilation has begun. Entry before correct ventilation could result in a backdraft explosion, often causing serious injury to victims and firefighters;
- always wear full structural fire fighting turnout clothing including SCBA;
- keep track of each other by touch, sight, or sound. Sound is especially important when rescuers separate. The sound of the SCBA's regulator or the partner's voice will give a good indication of location. Visual contact can be maintained by staying within a distance close enough to see your partner's light. The best way to maintain contact with your partner is

to keep in physical contact. This limits the amount of area that the team can cover, however, response in the event of an emergency will be quicker;

- if entry is to be made through a window, be cautious when breaking glass, an unconscious person may be on the other side. First probe for possible victims and then check the floor for stability before entering;

- have a plan or objective (search plan). Do not wander aimlessly, but working systematically will reduce the possibility of disorientation. Continue to turn in one direction to ensure a systematic approach to the search. Look for a secondary means of egress. Ground crews should place ladders for a secondary egress for search teams;

⚠ NOTE

Always have a charged line of hose before opening doors.

- when operating on the floor above the fire, have a charged line ready. Hose lines can be used as lifelines in addition to their emergency fire fighting capability;

- mark entrances into rooms and make note of the direction turned while going into the room. To exit and return, turn in the opposite direction; and

- feel handles or knobs with the back of an ungloved hand before advancing through doors. A hot handle is a good indicator of fire on the other side of the door, open the door cautiously.

⚠ NOTE

Don't stand in front of the door. Stay to one side, keep low and open the door. If there is fire behind the door, this will allow the heat and combustion products to pass overhead.

If a door opens easily at first and then is stopped by something, reach around the door to determine whether the obstruction is an unconscious person. When probing with a tool use caution to avoid injuring the victim.

Because of the working angle, it may be difficult to move a victim away from the door. In some cases it may be necessary to break through a wall to gain access to the victim. Breaching a wall may also be necessary to escape when fire blocks the exit route.

When carrying out search and rescue within a building, use the following procedures:

- always remember to check behind all doors and drapes. Inform the person in charge if an entrance is blocked, or if a search cannot be made because of heat, smoke or fire;

- to help contain the fire, the doors of fire-involved rooms should be closed, call for a hose line and continue the search;

- crawl on hands and knees when visibility is poor;

- stop frequently and listen for evidence of victims who may be coughing, moaning, or crying;

- stay low and move cautiously;

- stay alert, use all senses;

- watch for hot spots, weakened structures, and other indications of fire extension;

- keep in contact with a wall. Ropes or straps can extend the coverage between two rescuers;

- as the rescuer moves around a room, windows may be opened to remove heat and smoke if such venting does not extend the fire;

- probe the floor ahead with a tool or by sweeping an arm or leg in front of you when crawling to discover victims, obstructions, or openings in the floor's surface;

- slide one foot forward to test the flooring before transferring full body weight when walking;

- trapped rescuers can obtain some protection by hiding behind a solid, well-hung door;

- children often try to hide when there is a fire. Ask parents where is their children's favourite place to hide. Look in every place where a child could hide:

  - under beds;

  - between bed and wall;

  - under, beside, or behind furniture;

  - in closets, cupboards or wardrobes;

- check cribs for infants, avoid confusing an infant for bed clothes;

- the elderly will sometimes be found in bathrooms, often in bathtubs or showers, where they have gone to try and protect themselves;

- check around all exits such as doors, windows, elevators, stairways and hallways. Adults will usually try to escape from a building by routes they normally take. They are often overcome in these areas; and

- stay calm if direction is lost. Follow the wall and it will return you to the door through which you entered or a door to another area. When coming across a hose line, crawl along this line. It will lead to the nozzle team or outside. If trapped, follow the wall to the nearest window and signal for assistance.

- once the search is complete, searchers should report back promptly to the OIC;

7.1.3 Establishing a Search Pattern

The buddy system of searching for victims should always be used. Two people using an efficient system can search an average residence in a short time.

The fire floor should be checked first, and the floor directly above the fire should be checked next (or at the same time if enough personnel are available). Rescuers on the floor above the fire should have a charged hose line with them. Initial size-up should have revealed if there could be an attic apartment.

When multiple rooms or apartments lead off a centre hallway, (see Fig 7.1) the rescuer's will need to search a series of rooms or apartments. When entering the first room, the pair of rescuers will turn right or left. Upon exiting the room, the rescuers should turn in the same direction they entered and continue their search for another room.

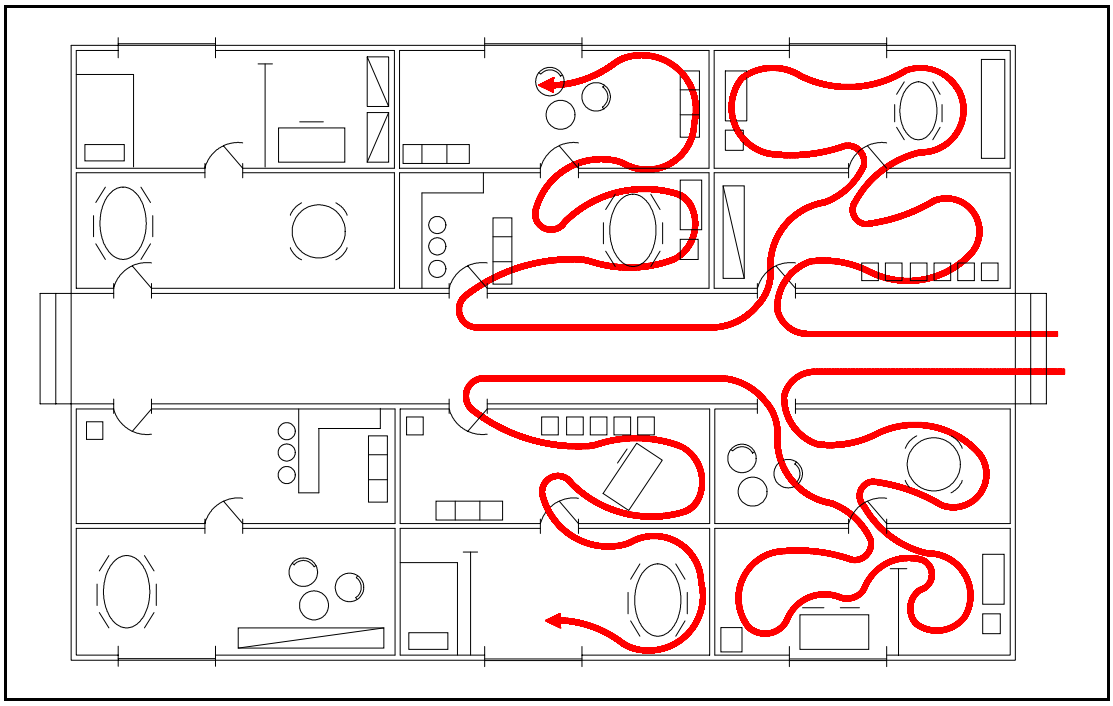

Fig 7.1 Searching Multiple Rooms or Apartments

It is important that rescuers exit a room or apartment where they entered to ensure a complete search. This search pattern may be used to search any building, from a one storey single family home to a large high-rise building.

Rooms that have been searched should be marked to avoid duplication of effort. Several methods of marking rooms searched are used by the NSWFB. Whichever method is used, it must be clearly known and understood by all personnel who are participating in the search.

If rescuers have to abort their search, or if a victim is located and is to be removed from the building, rescuers should leave the room by turning in the opposite direction to that used for entering e.g. if the room was entered using a left turn, use a right turn when leaving the room.

The following techniques will help rescuers search a building systematically and give them a quick exit if they have found a victim and want to return to their starting point:

- enter and exit in the same direction if the search is to be continued e.g. enter right, exit right;
- enter and exit in opposite directions to abort the search or to remove a located victim from the building e.g. enter right, exit left;
- if for any reason the search is aborted, this information should be reported immediately to the OIC;
- during a search for victims, negative information is just as important as positive information to co-ordinate a complete search;
- if rescuers become trapped in the building while making a search, they can go to the window and call for assistance;
- if a victim is located, they can use a window to get the victim to fresh air. Doors to rooms not involved in fire should be closed to delay the spread of fire into these rooms; and

- exit paths from the fire building should be kept as clear as possible to make the removal of occupants easier, and to prevent falls and possible injuries.

7.1.4 Room Search

If visibility is poor, crawl on your knees or stomach to search for victims. Visibility should be clearest closer to the floor. Heat and smoke tend to rise. Crawling will also let you locate holes, obstructions and other hazards. Follow the walls to keep from becoming disorientated. Windows may be opened for ventilation, but use good judgement or the fire could be extended. Feel for hot spots on the floors and walls and look for fire extension.

Rescuers should stay in constant communication with each other. Keep talking to keep track of each other's condition. Pause occasionally to listen for coughing, moaning or any sound that would indicate the location of a victim. There is also a chance of locating the fire by hearing its crackling.

Enter the room and follow the wall around the room. Keep in constant and direct contact with the wall, stretching out your hand, foot or tool to cover a greater area. This will bring you back to your starting point. Then search the centre of the room. Check the bed thoroughly, on top and underneath.

Thoroughly search all areas, (see Fig 7.2) including behind furniture and inside closets and bathrooms. Careful consideration **must** be given to the search pattern so that no areas are overlooked.

If smoke has reduced visibility, use the hand, leg, or tool to feel for a victim under beds. Victims are also found near windows, doorways, and other escape routes (see Fig 7.3).

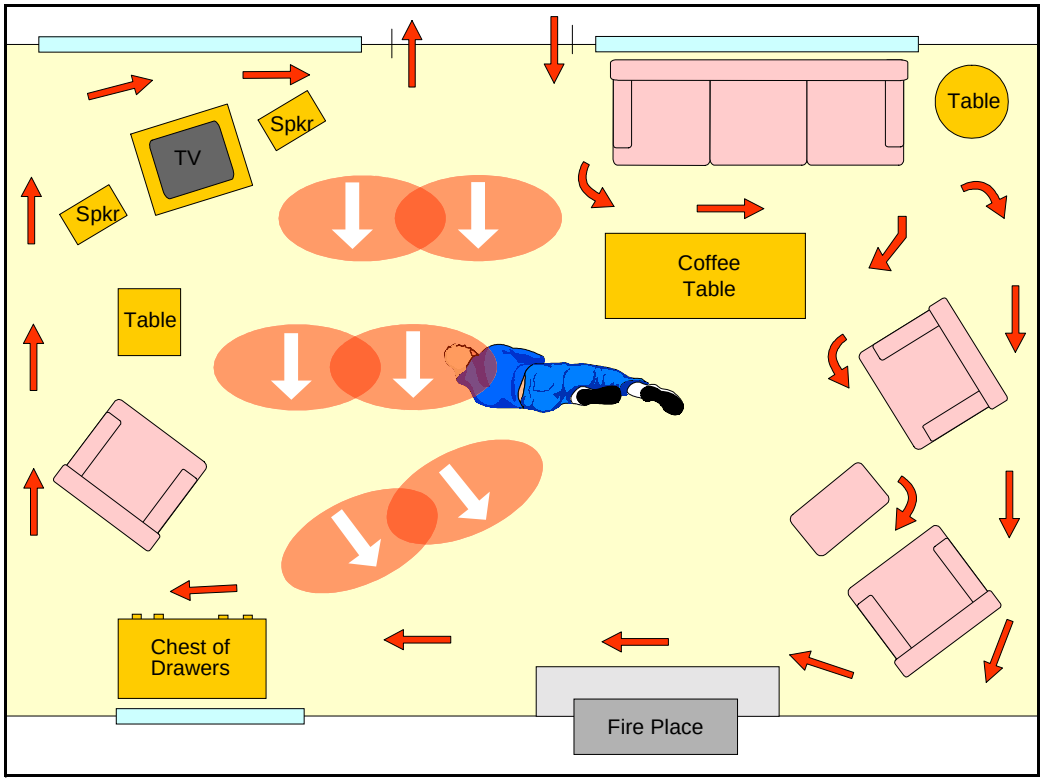

Fig 7.2 Room Search

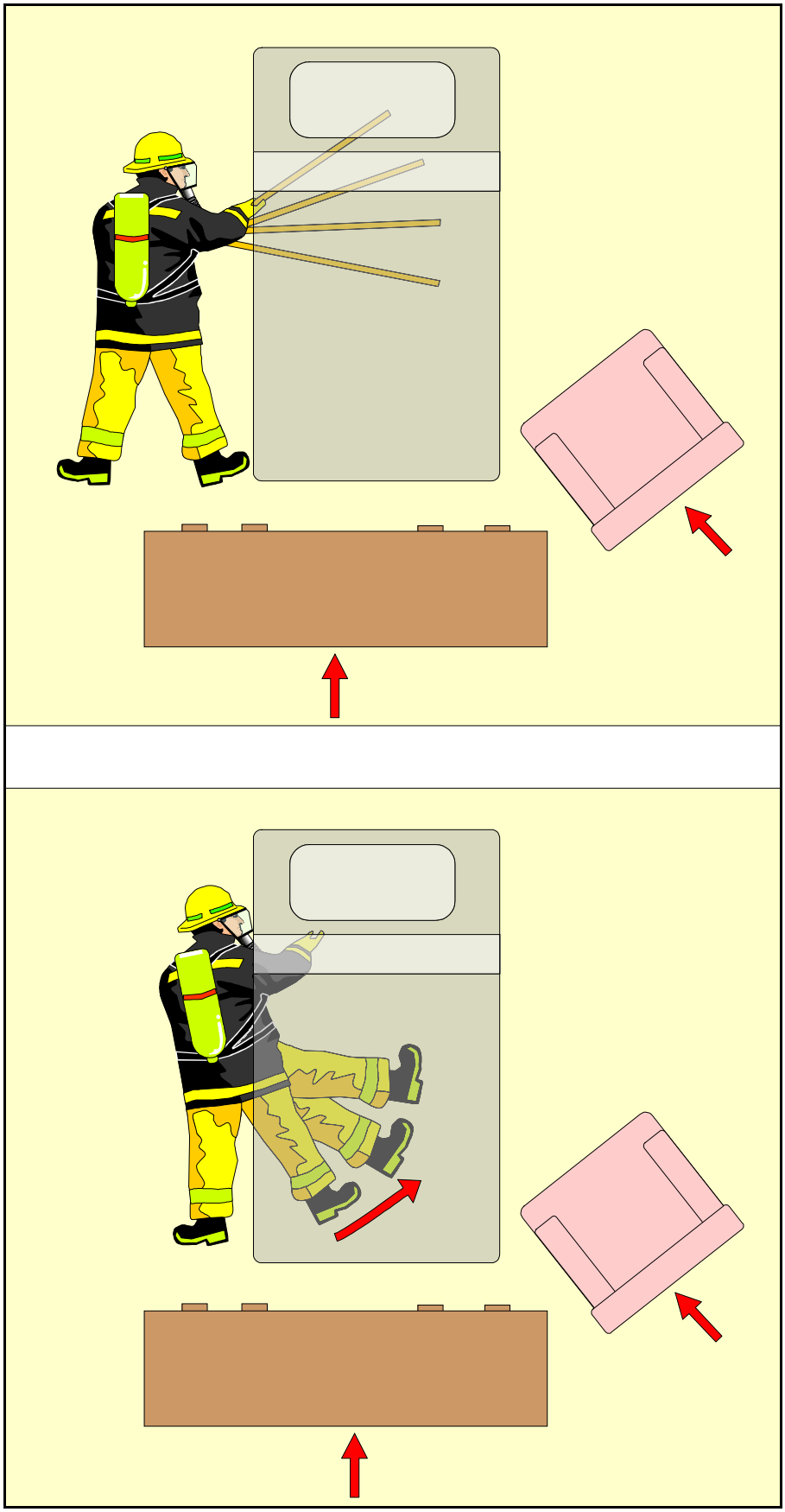

Fig 7.3 Probing Under Beds and Other Furniture

7.2 Marking Searched Rooms

All rooms that have been searched should be marked so there will be no duplication of effort. There are a number of methods to mark searched rooms. Any of them may be used as long as they are understood for what they are by other members of the NSWFB (see Fig 7.4). Some marking methods are:

- chalk a circle low on the door. This marks the point of entry, place a mark in the circle on leaving;

⚠ NOTE

This may not be able to be seen in smoke situations.

- mattress folded in **U** shape on bed; with many of the newer mattresses, this is not possible;
- strip of cloth closed in door near latch or tied to door handle. (Use table cloth, clothing, curtain, or other material found in room);
- furniture upside down, with legs pointing out, in doorway. (Could cause problems with smoke and fire spread; and
- special tags.

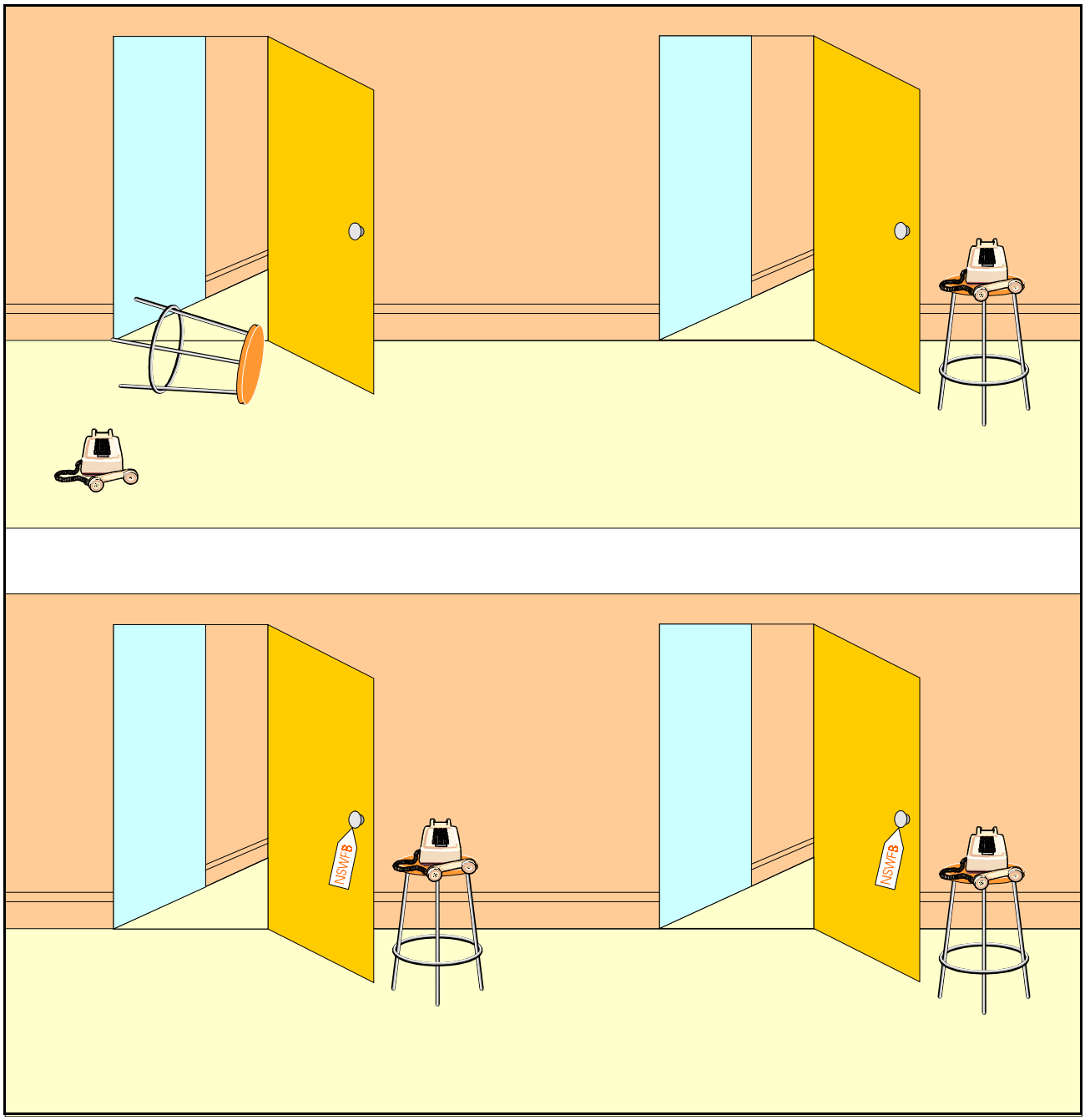

Fig 7.4 Room Marking Methods

7.3 High-Rise Search and Rescue

Rescue problems in a high-rise building above the reach of fire department aerial appliances is a challenge to all fire departments faced with the potential problem. As in other building fires, two ways to reach victims could be possible - exterior rescue and interior rescue. The high-rise problem or rescuing victims deserves much attention and thorough training for everyone concerned.

Rescue teams should assemble at the interior command post (sub-command post) two or more floors below the fire floor and check layout of floor, room numbers, exits to stairways and distance from elevators to exits. The only way to get a more accurate idea of the layout is by good pre-fire planning.

If information obtained on arrival indicated victims trapped in specific rooms on the twelfth floor, the layout of the eleventh floor should indicate on which end of the building

the rescue problem is located, what the distance is from the stairway and about how many rooms will have to be checked. Checking room numbers on the floor below and getting some idea of the distance to be travelled will save time and energy.

Even with this information the task will be difficult. With a great amount of heat and smoke, rescue from above can sometimes only be accomplished with the aid of a charged hoseline from the nearest standpipe to protect against fire spread and maintain the escape route.

The reasons why it may be impossible to evacuate occupants of high-rise buildings to street level are:

- egress may be cut off by products of combustion;
- manpower may not be available for this purpose;
- many persons are physically incapable of walking down numerous flights of stairs; and
- the time element will not permit evacuation of large numbers of people.

If a fire is located near the top of a high-rise building, safe refuge areas can usually be established in any location at least three floors below the fire floor or on the roof as illustrated (see Fig 7.5).

Roof-top evacuation of occupants by means of helicopters is not recommended unless the occupants are in imminent danger. Usually, occupants can safely remain on a roof for a long period of time if they are not exposed to smoke or severe weather conditions and are under the supervision of NSWFB personnel.

Time is the most important factor in any rescue operation. Most other incident ground operations can be postponed until people are safely out of danger areas. Studies in the USA and Canada have shown that the time required for fire department personnel to transport people to the ground floor by making long round trips from upper floors is too costly. Based on these studies, it becomes obvious that complete evacuation of buildings over a certain height is unreasonable. A shuttle service over shorter distances to safe refuge areas on floors below the fire and in some cases several floors above the fire, or on the roof must be established to save precious time.

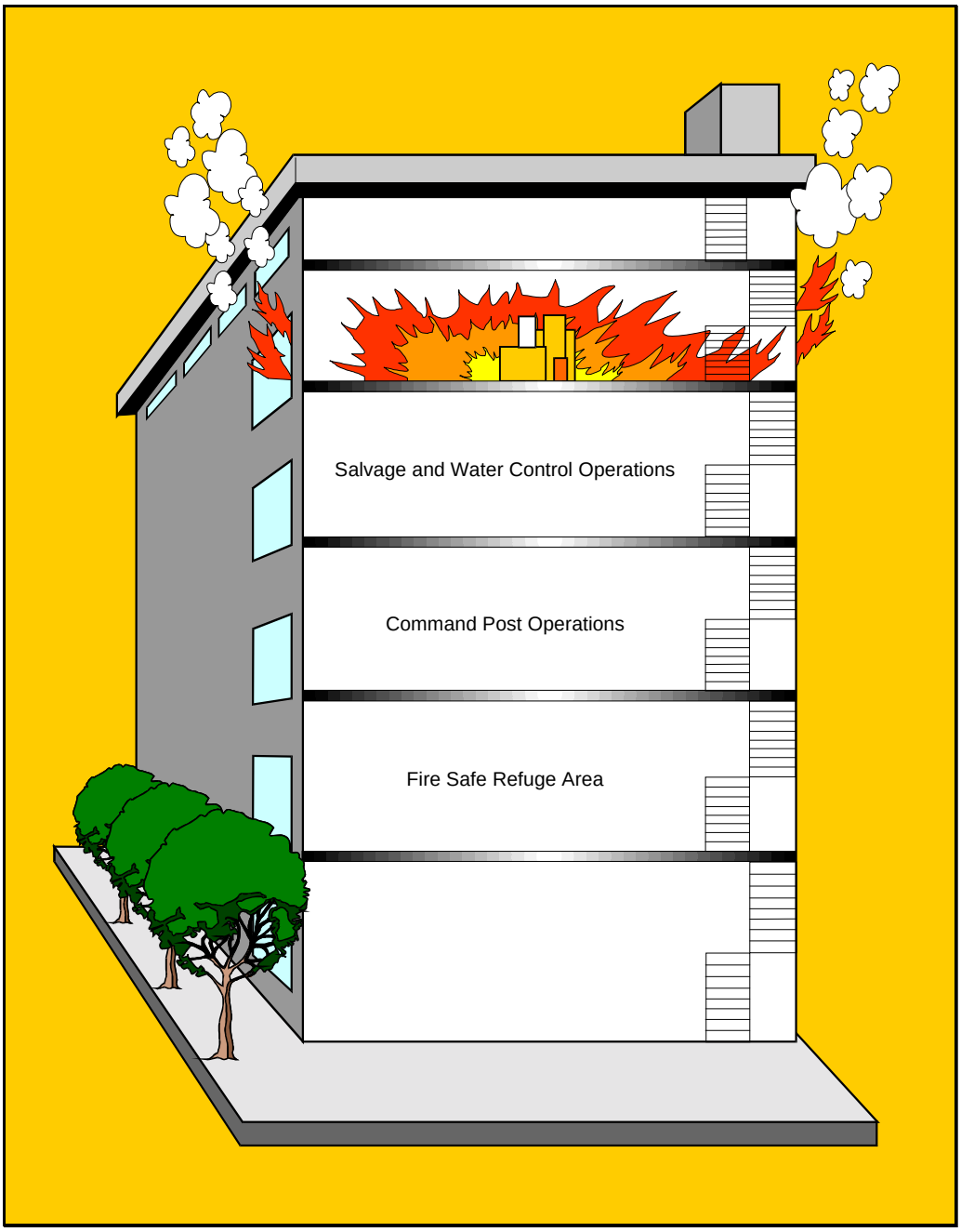

Fig 7.5 Safe Refuge Areas

7.3.1 Use of Exits

It should be remembered that most persons are unaware of the various exits available in a given building. Occupants frequently enter the elevator from the lobby, ride to a particular floor and walk along a known path to their apartment or office. They usually make no effort to discover other ways to get out of the building. If the elevator service is interrupted and the lights are out in any interior hallway, the occupants cannot be expected to find the exit stairways.

Smoke trapped in interior hallways creates a similar problem. The panic potential under these conditions is very real. Education of occupants regarding the types and locations of exits available is a necessary NSWFB function. Emphasis should be placed on the fact that doors leading from stair towers may all be locked above the first floor landing.

The exit capacity of a given floor may be divided into several stairways. Some stairways exit only on lower floors of a building. Some stairways do not reach the roof but stop at the top floor. Many stairway doors are unmarked and cannot be distinguished from other doors. During pre-fire planning surveys, efforts should be directed toward convincing owners and occupants of the necessity of marking all stairway doors.

7.3.2 Large Open Buildings

Pre-fire planning is critical for fire fighting operations in large open buildings. Large open buildings such as supermarkets, warehouses and manufacturing concerns have several common problems:

- expansive truss roofs that may fail under fire conditions;
- a limited number of exits, exit doors usually are security tight causing access/egress problem;
- long distances from walls to the centre of rooms;
- a limited number of windows and ventilation points;
- varied population, occupancy varies with time of day, day of week, and season of the year;
- a large number of obstacles;
- non-standard floor plan i.e. residences have a somewhat predictable floor plan; and
- easy to become disorientated.

In addition to the pre-fire plan, building occupants are a valuable resource when searching a large open building. It is important to contact a building manager, plant supervisor, maintenance person or other occupant. Occupants of the building can tell where trapped persons may be located.

Ventilation in a large open building may or may not be important to the rescue. In many situations the building ceiling is so high that it takes a long time for the smoke to back down. If this is the case, a visual-walking search may be made. SCBA is still a must.

For a walking search of a building where a pre-fire plan has been made, the primary search should be made of the known populated places first. The plan should indicate areas where people may be trapped. These should be checked on the primary search.

During the primary search, points of egress and ventilation points should be noted, if they are not known from checking the pre-fire plan. For a crawling search of a pre-fire planned building, ventilation and escape routes may be the first areas to be checked. Then move toward populated areas.

For an upper-fire planned building, a check of the outside of the building should be made before entry into the building. Check floors and windows for signs of the locations of the fire. Check for the quickest entry/exit point. Check for signs of occupancy i.e. cars in parking lot, lights on in building and where, windows, office wings.

When checking the building, it may be possible to drive the appliance around the building, this could save valuable time and effort. It may not always be best to park the apparatus at the front door.

Once access has been made, a perimeter search should be made. Open any outside doors or windows. If possible, make contact with someone on the outside at these points.

In most cases you will be able to see for some distance from the outside wall, move to this position to see further into the building. It is important that communication be maintained

with the outside, via radio, or natural openings in the building (doors and windows). In some cases, an interior phone may be used to call the dispatch centre to advise of interior conditions.

For a blacked out building, it is important that auxiliary lighting be on the scene as soon as possible. Begin the perimeter search while waiting for the lighting.

A systematic search may not be possible without lifelines and additional manpower. With extra manpower, one firefighter linked by voice communication or lifeline to another, the building can be amply covered.

7.3.3 Ways to Search the Centre of a Large Open Building

Place a light at the wall, and move to the centre of the room as far as the light can be seen. Several lights can be placed if greater distance into a room is necessary.

Using a light on a cord reel, move to the centre of the room, then follow the cord back. If searching a large room with no obstacles such as a gymnasium, use a rope. With firefighters along opposite walls, work rope down the gym floor.

7.3.4 Rescue of Firefighters

Firefighters working inside the building are sometimes injured or overcome and will also need rescuing. Depending on the circumstances, the rescue techniques described for occupants can be used. A firefighter wearing a SCBA can be dragged to safety by the SCBA straps, the air cylinder being used as a skid. Be sure that the firefighter's face piece is not dislodged.

There are several methods that a firefighter can use to indicate the need for help. Signals indicating that the firefighter is having a problem with a SCBA should be worked out in advance. The entire department should know these signals and be prepared to act immediately.

If at any time during the fire fighting operations a signal indicating a firefighter is in trouble is heard, all persons hearing the signal must go to assist immediately. If the signal is heard from the outside of the building, a crew should be assigned to aid immediately. Other indicators of a firefighter in trouble are, a helmet or other tool on the ground, clapping, SCBA whistle, pounding on wall or floor, any other noise making.

7.3.5 Conditions of Victims

Although many people can help themselves, some cannot co-operate in their own rescue due to infancy, advanced age, or a variety of predicaments. Whatever their plight, such persons must be rescued quickly. Every victim must be regarded as living.

Rescue workers, even though trained in providing first aid, are not medically competent to decide if death has occurred. Consider the following conditions of victims.

A Bed-Fast Victim

Those who, because of illness or injury, cannot leave their bed will be found in any kind of dwelling as in hospitals and institutions. Rescuers must take precautions to protect their physical condition. Incisions may be agitated and surgical treatments rendered ineffective by careless handling of a bed patient.

A Burn Victim

Burns are injuries requiring special attention. When moving a burn victim, even with second degree burns, improper handling will sometimes damage the skin. In the case of third degree burns destruction of the flesh may have occurred. Extreme care is necessary to prevent further damage to the body. A burn victim is also suffering from shock and should be dealt with accordingly.

An Unconscious Victim

A person is likely to become unconscious because of an injury, loss of blood, suffocation or asphyxiation. An electrical shock may also render a victim unconscious. Some people faint under the strain of an accident or an extremely exciting occurrence. Unconscious victims are absolutely helpless and must be rescued.

A Victim of Shock

Physical shock is a depressed state of body functions. Severe pain, extensive injury, exposure to extreme heat or cold, witnessing others in distress, sudden fright, anger or joy, being overcome by gas or contact with electric current, causes the nervous system to become unstable. A victim of shock becomes partially or totally unconscious and unless given proper treatment, may die.

A Sleeping Victim

A sleeping victim is actually unconscious, but may be wakened unless otherwise affected while sleeping. People may be found asleep in burning buildings where the disturbance is not enough to waken them. Such people need only to be awakened and led to safety. But sudden awakening to a dangerous situation may produce either shock or panic. Calmness and consideration on the part of the rescuer are essential.

An Intoxicated Victim

Intoxication causes either unconsciousness or irresponsibility. If unconscious, the victim must be carried to safety. If irresponsible, such people may not be able to help themselves. Intoxicated victims are often antagonistic and it is necessary to deal with them firmly.

Victims Without Sight

The blind have only their senses of touch and hearing to guide them. In an unfamiliar fire situation these may mislead and touch can be dangerous. The blind need to be taken in hand and guided through the evacuation procedures and even carried to safety.

7.4 Rescues from Buildings

The purpose of rescue work is the removal of victims from a building to a place of safety without further injury. Human life must be protected even if it is necessary to sacrifice the building.

7.4.1 The Rescuers

Trapped people require leadership prior to commencement of rescue operations. It is in this role that members of the NSWFB excel. Firm, positive directions have a calming effect on victims trapped in buildings and give firefighters a chance to rescue them. Rescuers too must display full confidence in their ability to carry out the task and this display will inspire confidence in those being rescued.

7.4.2 Rescued by Ordinary Means

The majority of rescues are made simply by firefighters reaching those who are awaiting help, reassuring and comforting them and then perhaps leading them to safety by a way they have forgotten or through light smoke which has temporarily made them lose confidence.

One of the effects of smoke is to cause loss of judgement. People who have been trapped in smoke are often unaware of ill effects and insist they are capable of rescuing themselves. Never rely on such statements. All rescued persons should be accompanied from the building if there is any doubt as to their condition. Instances have occurred in which people stated that they felt unaffected by the smoke, yet they collapsed while making their way to safety. Such collapses can have fatal results if they occur in a smoke-laden atmosphere, on an outside staircase or in other dangerous positions.

7.4.3 Rescue of Non-ambulant Victims

Evacuation will be required for people who cannot walk, for example in hospitals, where the patients are sick or recovering from operations. The non-ambulant victim may be encountered in nursing homes and similar institutions and even in residentials, flats and houses. The removal of a person from a room or hazardous area may become a task of even a solitary firefighter. Circumstances existing at the time will present the best method of rescue.

At fires in hospitals or nursing homes, the Senior Medical or Nursing Officer present will generally determine how each patient can be moved. This will normally be done by the nursing and attendance staff, who are versed in methods such as blanket removal. But due to shortage of staff, extreme urgency or other reasons, it may be necessary for firefighters to assist in the evacuation.

The following basic methods can be used to remove a non-ambulant victim. However, do not overlook means already at hand which may help in making a safe rescue. Stretchers, movable beds, wheelchairs.

Blanket Removal

Usually two attendants would remove a bed-fast patient using this method. The following steps are those of a lone rescuer. The victim is on the floor.

- gently turn the victim onto her or his back;
- kneeling to one side, on both knees, reach across and roll the victim up against your knees and hold the body securely;
- with one hand, slide the blanket up against the victim's back and very slightly gather it there;
- allow the victim to roll back gently off your knees. You can then straighten out the blanket; and
- holding two corners of the blanket, drag the victim to a place of safety. The person should be pulled head first, with head and shoulders only slightly raised off the floor.

Pick-a-back

Where practicable, raise the victim to a sitting position in bed with her or his legs down over the side of it. Part the legs and sit on the edge of the bed between them and direct the victim to place both arms over your shoulders. Grasping the legs behind the knees and leaning forward to ensure the weight is above you, carry the person away. This is the easiest method if there is no danger of the victim losing unconsciousness and is able to hang on. If you suspect that the victim may lose consciousness, hold the wrists rather than the legs.

Human Crutch

Where the victim can help, stand at the injured side where the support is needed, place the person's arm around your shoulder and grasp the wrist. At the same time grip her or his clothing at the hip with your other hand.

Fore-and-Aft Method

With the victim lying face upward, one firefighter raises the body in a sitting position. Then momentarily kneeling, passes her or his hands under the armpits from behind and grasps the armpits from behind and grasps the wrists to cross them slightly in front of the body. The second firefighter stands between the victim's legs facing the feet. Bending down she or he takes hold under the knees of the victim. Both firefighters lift carefully and march forward.

Crawl Method

Turn the victim face-up and tie the wrists together with a pocket line, handkerchief or similar materials. Facing the persons head, kneel astride and place your head through the loop formed by her or his arms and wrists. Taking the weight against the back of your head, crawl on your hands and knees. A person far heavier than the rescuer can be removed in this manner.

Bedside Chair Method

Place a chair alongside the bed and transfer the victim to a sitting position in it. Stand behind the chair. Place your hands over the armpits to grasp the sides of the chair and secure the body from falling. Tilt the chair back slightly and drag it backwards to the exit. To descend a stairway a second rescuer is needed to spread the victim's legs and grasp the front chair legs close to the seat. Both rescuers will then lift and carry the chair and its passenger forward.

Drag Method

With the victim face-up, raise the body to a sitting position. Kneeling down behind, pass your hands under the armpits and grasp the wrists, crossing them slightly in front of the body. Stand almost upright and raise the victim's buttocks off the floor. Moving backwards, drag the person away.

Hand Seats

A method of rescuing those who have to be carried rather than dragged and those whose weight is beyond the capacity of one person is the hand seat. It is used in hospitals and nursing homes when the staff are required to evacuate wards in an emergency and by firefighters who assist them.

Two-Hand Seat

Two rescuers stand side-by-side then turning together clasp those hands which have just been furthest from each other. The seat formed is placed under the thighs of the victim who is tilted back into the second pair of arms which cross behind the back and take a share of the weight.

Three-Hand Seat

This method is adopted when the bearers need one hand free to support (in this example) an injured right leg. The bearer on the left of the casualty grasps her or his own right hand, the other bearer then takes hold of the first bearer's left wrist and keeps a free right hand to support the injured limb. Instruct the casualty to place on arm around each bearer to help maintain position during the lifting and the transport.

Four-Hand Seat

Provides firmer support for a casualty especially if very heavy but the person must be able to hold on. Two bearers face each other and grasp their own left wrists with the right hands. Their hands are then brought together, the free left hand holding the right wrist of the other. The casualty places one or both arms around the necks of the bearers. The bearers should then rise together, lift the victim and step off with short cross-over steps to carry the person to safety.

7.5 BA Safe Working Practices

7.5.1 Introduction

Firefighters should always be aware that when wearing BA three of the normal senses should be considered ineffective as the wearer is completely isolated from the actual environment in which work is being performed. The true taste, smell, or pain to sensitive organs such as the respiratory passages which would normally be apparent, are lost when wearing BA.

7.5.2 BA Teams

Firefighters wearing BA are not to work alone, they are to work only in a team. A BA team is comprised of a minimum of two firefighters.

The senior member is to act as the leader. When a number of teams are required to work together the senior member of the group of teams is to be the leader.

7.5.3 Pre-Entry Safe Working

Should there be any doubt regarding the quality of the respirable atmosphere BA is to be worn. The following points should be observed when using BA:

- BA must be worn when entering any area protected by an inert gas fire suppression system and it is known or suspected that the system has operated;
- BA is not to be used under water;
- the BA rated wearing time, the distance of travel and the work to be performed are to be considered when choosing the type of BA (oxygen - SCBA) to be used;
- oxygen BA is not to be used in any area where there are concentrations of flammable hydrocarbon vapours. Flammable hydrocarbon vapours coming into contact with a high pressure oxygen leak can cause a seat ignition which could precipitate a major explosion;
- firefighters are to ensure that sufficient air is available in a SCBA cylinder before entering a dangerous atmosphere. They are not to enter if the 20 700 kPa (207 Bar) cylinder is below 18 000 kPa (180 Bar) or the 30 000 kPa (300 Bar) cylinder is below 27 000 kPa (270 Bar);
- each BA team is to work from the lowest cylinder pressure of the two person team, so that both members withdraw together;
- irrespective of the urgency, firefighters are not to neglect carrying out the pre-operational check on their BA before entering a dangerous atmosphere;
- the BA Control System is designed for the BA wearer's safety, neglect in conforming with the requirements of the system could jeopardise the wearer's life;
- the BA face mask is to always be donned in clear air before entering smoke or toxic atmospheres. This is particularly important when using regenerative oxygen BA; and
- helmets are always to be worn when wearing BA.

7.5.4 General Safe Working Practices

The BA pressure gauge is to be checked frequently so that the air/oxygen consumption can be closely monitored and sufficient time be allowed for exit:

- when calculating exit time, allow the time for exit as that required to make entry;
- remember, if a wearer is supplying air from the set being worn to an auxiliary face mask, the wearing duration of the BA will be approximately halved;
- when a warning whistle on a BA operates, all members of the BA team are to exit together to the BA control;
- BA teams are to maintain verbal contact at all times. When working in conditions where visibility is severely impaired physical contact should be maintained as much as possible;

- should team members become separated, both members are to continually call to each other so that the separated members can rejoin. If no response is obtained within a reasonable period the PDU is to be sounded;

- should a BA wearer become entrapped or a BA team become lost, the personal distress unit is to be immediately sounded. The team is to remain together until assistance arrives;

- when working in BA, team members are to be alert for signals from one another or from other teams working in the area;

- should a team member or any team hear a distress signal they are to respond to the signal and render immediate assistance;

- wherever practicable, and when a Stage II control is in operation the leader of a BA team or group of BA teams is to maintain contact with the outside control by using a hand radio transceiver;

- under no circumstances is a BA wearer to remove the face mask whilst in a dangerous atmosphere;

- wearers are not to remove their face masks to supply air/oxygen to persons in distress as it will expose the wearer to the dangerous atmosphere. Use an auxiliary air line and mask, or if necessary connect the distressed wearer's mask to the SCBA auxiliary outlet;

- if the BA face mask becomes dislodged, hold your breath, readjust the face mask. If unable to obtain a proper seal withdraw with your team mate to the BA control. With oxygen BA, immediately withdraw with your team mate, as toxic substances may have polluted the regenerative breathing circuit;

- in the event of the face mask being damaged or a malfunction occurring with the BA, the wearer is to seal the damaged face mask with the hand, immediately operate the PDU and together with the other team member exit to the BA control;

- when working in high expansion foam, BA is to be worn and guidelines are to be used;

- BA teams are to maintain physical contact whenever working in areas filled with high expansion foam. When working in these areas there is no visibility and the audibility of speech, the warning whistle and other devices is diminished;

- when handling or operating BA, extreme care is to be exercised to prevent any valve assembly being subject to bumps or knocks which could alter settings or damage valves;

- should it be necessary to use guidelines they are not to be attached to a BA wearer. They are to be laid out at waist height from the point of entry to wherever required;

- BA operators using guidelines are to maintain contact with the line and be able to identify the run of the line so that safe exit can be made; and

- once a BA operation has been instituted, the use of such equipment is not to be discontinued until the OIC has declared the area safe.

Safe Working in Smoke and Darkness

When working in smoke and darkness, the following actions should be taken:

- when feeling your way in smoke protect the face behind the crook of the arm with the back of the hand outwards. This will prevent you walking into obstructions and if live electrical wires are encountered will prevent the hand closing on the wire;

- obstructions or objects should not be unduly handled particularly when working in smoke or darkness. Injury could result from handling materials which are hot, sharp, corrosive or electrically alive;

- when moving across floors during fire fighting operations, particularly when visibility is limited, slide the leading foot forward to test the floor for holes or weakness before putting weight on it;

- provide lighting in darkened areas as soon as practicable to avoid the risk of accidents. In addition to lighting for general use, place lights at danger spots such as holes in floors or to indicate damaged or weakened structures;

- when floors are damaged keep close to the walls wherever possible. Joists for wooden floors and reinforcing in suspended concrete floors are housed into the walls making this area the safest section to walk on;

- on damaged stairways the wall string is less likely to be weakened than the outer string. Where the stairs are of centre spine construction, the centre of the tread is the area of greatest strength. If the strength of the staircase is suspect descend the stairs backwards. Grip the nosings of the tread above and test each tread with leading foot before applying full body weight; and

- if any doubt exists about the strength of a floor or staircase, bridge the damaged section with scaling or portable ladders. This distributes the weight over a larger area.

7.5.5 Procedures for Damaged or Faulty Equipment

Should any piece of BA or hazardous material equipment be found to be faulty or damaged, so that it is not fit for use, a pink serviceable/ repairable tag is to be filled out and attached to the equipment as near as possible to the area of the problem.

The equipment is then to be returned to the BA and HazMat Response Unit, Greenacre through normal NSWFB channels.

⚠ NOTE

In the case of a faulty or damaged air set, the entire unit i.e. face mask, backpack and demand valve are to be returned regardless of where the fault or damage is. This enables the air set to be tested as a complete unit before being returned to service.

7.5.6 Entrapped Procedure Guidelines for SCBA

If trapped while using SCBA, take the following actions:

- sound distress;

- conserve air usage by minimising all movement;

- adopt a shallow and slow rate of respiration; and

- remain calm.