TOPIC FIVE - RESCUE

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SECTION ONE - CORDAGE

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1 CORDAGE

1.1 Introduction

In the NSWFB, cordage is a general term for all forms of fibre rope. The term includes reference to all of the ancillary equipment including hardware and software, used with fibre rope lines.

This section is about fibre rope lines, knots, combinations, ancillary equipment and vertical rescue techniques.

The NSWFB cordage equipment and methods are essential for:

- raising and lowering equipment;
- stabilising or securing objects;
- carrying out a vertical rescue, including self rescue;
- carrying out a rescue from heights, depths, and in trenches;
- hauling personnel or equipment across spaces; and
- conducting salvage operations.

1.2 Rope Types

1.2.1 General

Rope generally consists of three or more strands of material that is twisted, cabled, or plaited together. It may or may not have a core. Rope is a most versatile tool. The numerous ways in which it can be used depend on the knowledge and training of the firefighters who use it and the characteristics of the lines made from it.

Since its earliest years, the NSWFB has used natural fibre rope of three strand, hawser-laid construction. However, the availability of synthetic fibres has led to the manufacture of sophisticated ropes that can be tailored for specific purposes. These new materials and new kinds of ropes have encouraged the NSWFB to review its cordage practice. Now, we use ropes made of synthetic fibres.

Throughout this section, the term rope means rope in its unused manufactured state: uncut, coiled or wound on a reel, and measured in metres. A line is rope cut to a measured length for a specific purpose.

1.2.2 Natural Fibres for Rope Construction

The NSWFB no longer uses rope made of natural fibres, but this type of rope is still used extensively by other services and industry. As a firefighter, you should know the characteristics of ropes made of natural fibres.

The main disadvantage of natural fibres for rope making is that the fibres are short - from 0.5 to 2 m in length. They are not continuous throughout the entire length of the rope. Natural fibre is also subject to constant degeneration. Although preservatives such as ultra-violet light inhibitors and lubricants are often added during manufacture, natural fibre rope is still susceptible to chafing, rust, rot, mildew, fungi, and chemical attack.

Natural fibre ropes are made from basically two types of fibres:

- *Sisal fibre*. Sisal comes from the leaves of the Henequen plant, also called the Sisal plant. It originated in Yucatan in Central America but it is now grown mostly in Africa, Java, and Sumatra.
- *Manila fibre.* Manila comes from the leaf sheaths of the Abaca plant, a banana palm found in the Philippines.

1.2.3 Commercial Fibres for Rope Construction

Two kinds of synthetic fibres are currently used for the manufacture of the ropes in NSWFB lines:

- **Polyamide (for Life/Rescue Lines)**

poly:	many
amide:	compound formed in a reaction of hydrogen and ammonia
Chemical Name:	Polyamide
Trade Name:	nylon

- **Polyester (for general purpose lines)**

poly:	many
ester:	organic compound formed by a reaction between an organic acid and alcohol in water
Chemical Name:	Polyester
Trade Name:	Terylene and Dacron

Polyester and polyamide are made by a chemical process called *polymerisation*. In this process, the compounds are placed together in water and the water is boiled off to form a *polymer*. An *ester* links the molecules of the polymer. The manufacturing process then continues as the polymer is heated to a semi-liquid state and extruded, or drawn, through minute holes. This part of the process rearranges the molecules into a continuous fibre (filament). After extrusion, the filaments are cooled and then drawn or stretched to re-orient and re-align the molecules. This gives the fibre its strength and other characteristics.

Here is a list of some of the characteristics of synthetic fibre (multi-filament) ropes:

- they are made of continuous and unbroken length and uniform thickness;
- they are two or three times stronger than a rope of equal thickness made of natural fibres;
- they last five times longer than ropes made of natural fibres;
- they can withstand seven times the shock load of a natural fibre rope;
- they can resist most forms of chemical attack;
- they do not rust, rot or mildew;
- they can operate at relatively high temperature ranges; and
- they do not support combustion.

1.2.4 Yarn

Yarn is a generic term for a continuous strand of textile fibres, filaments, or materials in a form suitable for processing to form a textile fabric. Yarns can assume a number of forms including:

- a number of fibres twisted together;
- a number of filaments laid together with or without a twist; and
- a single filament with or without a twist.

1.2.5 Multifilament Yarn

Multifilament yarn is a simple continuous textile material. It is one of the smallest components of a rope. It is composed of more than one filament held together by twist.

1.3 Rope Construction

1.3.1 General

Here we discuss the three types of synthetic fibre construction rope in general use:

- three strand hawser-laid;
- plaited; and
- kernmantle.

1.3.2 Three Strand Hawser-laid Rope

Three strand hawser-laid rope is the traditional form of rope construction. It is made with either natural or commercial fibres. Its construction is a continuous mechanical twisting process and has three stages:

- the fibre is spun into yarns;
- the yarns are twisted into strands; and
- three strands are laid into rope.

In this method of construction, the twists are alternated so that the twists at each stage in the process are in the opposite direction to, and thus offset those in the preceding stage.

The *lay* of the rope is determined by the direction in which the strands are twisted at the third stage, either to the right or to the left. Rope is described as having *right hand (Z) lay* or *left hand (S) lay.* 95% of all manufactured three strand hawser-laid rope is right lay. The turn in the strands at the final stage must compensate for the turn in those strands already laid into the rope if the finished rope is to hold together and be in balance.

In three strand rope, every fibre used in its construction is exposed at the surface of the rope at some point. If three strand rope of synthetic fibre is coiled when stowing or making up lines, each coil distorts the rope around its longitudinal axis. The torsion causes loops or kinks to form. These create weak points when the line is under load. Flaking is therefore the preferred method when stowing three strand hawser-laid lines in bags.

1.3.3 Plaited and Braided Rope

Plaited and braided rope is constructed as illustrated in the Fig 1.1.

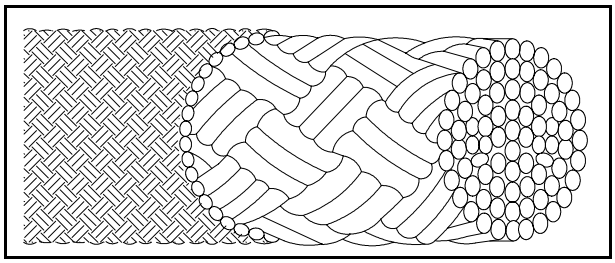

Fig 1.1 An Example of Braided Rope

In this construction,

- polyester (terylene) multifilaments are laid into yarns;
- those yarns are laid in pairs to form strands; and
- the strands are plaited into a rope.

Plaited rope has no core strands. While it is quite strong, it does not have the stability required for NSWFB rescue operations.

1.3.4 Kernmantle Rope

Kernmantle (*kern*: core) (*mantle*: sheath) rope construction is similar to braided construction in that a sheath covers a central core (see Fig 1.2). It is made from unbroken polyamide fibres and is free of knots and joints.

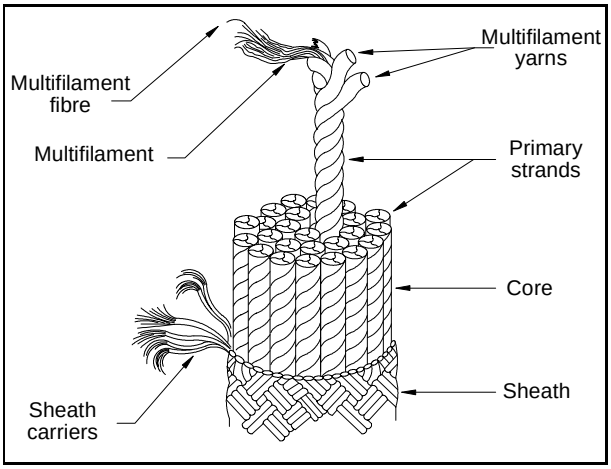

Fig 1.2 Kernmantle Rope

The kern. The kern is made from fibre that is spun into multifilaments. Here are the characteristics of the kern:

- these yarns are twisted into loose-lay strands;
- this type of construction is designed to eliminate spin during lifting and lowering operations;
- the kern of the rope makes up at least 50% of the total mass of the rope; and
- the kern provides 85% of its strength.

The Mantle. For the mantle, or sheath, a number of yarns, known as carriers, are plaited into a sheath by a cross-braiding machine. Here are some of the characteristics of the mantle:

- the mantle contributes only a small proportion of the breaking strength;
- it protects the core from dirt, grit, and ultra-violet light;
- it also provides resistance to abrasions and other external damage;
- it inhibits the absorption of liquids;
- a mantle made of synthetic fibres can absorb initial wear and abrasion that actually adds to its ability to resist further abrasion; and
- with the initial abrasion, the first fibres that are broken actually lay over and protect the undamaged fibres beneath them the next time the rope is abraded.

Kernmantle rope is torsionally neutral. This makes it as nearly free from kinking as is technically possible. This allows stowage by numerous methods.

Kernmantle Rope (Static Class)

Kernmantle static is designed to withstand stress while sustaining a load for an extended period of time. Here are some of the characteristics of static kernmantle rope:

- it is excellent for both descending and ascending applications;
- it works well for lifting or lowering systems;
- it may stretch no more than 3% under an 80 kg load with elongation at failure of not less than 20%.

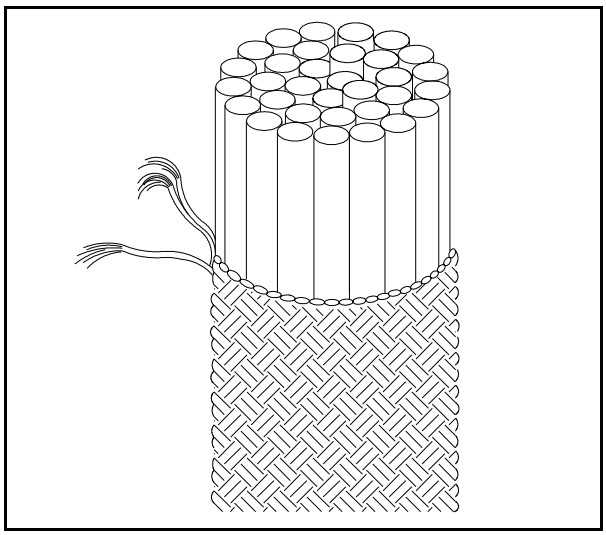

Fig 1.3 Kernmantle Static Construction

Kernmantle Rope (Dynamic Class)

A *dynamic kernmantle rope* is designed specifically for climbers. Here are some of the characteristics of dynamic kernmantle rope:

- it can survive large and repeated shock loads;
- it is well suited for safety lines for use in rescue work, it is used for little else;
- a dynamic rope usually stretches 3% to 6% under a load of 80 kg, and elongation at failure of greater than 40%.

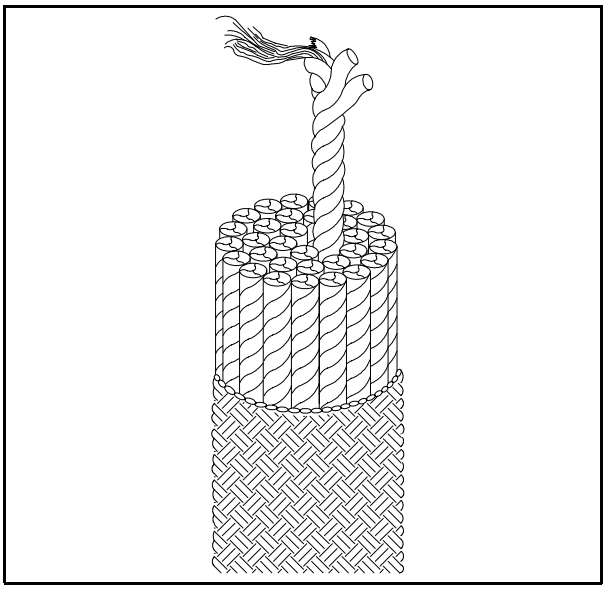

Fig 1.4 Kernmantle Dynamic Construction

1.4 Australian Standard

1.4.1 General

NSWFB specifications for Life/Rescue Lines reflect those developed by the Australian Standards Association (ASA), namely:

- *AS 4142 - Fibre ropes*; and
- *AS 4143 - Method of test for fibre ropes*.

However, these two standards are further sub-divided into numbered parts which describe different methods for testing and the care and safe usage of fibre ropes.

Firefighters should possess an understanding of the essential requirements of a Life/Rescue Line, to provide confidence and awareness of its strengths and limitations.

1.4.2 Construction

The rope shall be Kernmantle constructed with a plaited sheath over a core which shall be plaited, parallel or parallel and twisted plied yarns. The rope shall be of static class but must exhibit certain dynamic qualities. The construction shall minimise any tendency to spin.

There shall be no knots in any elements of the rope. Joins shall not be permitted in any element other than multifilament yarns where they shall be achieved by air splicing. Such joins shall be kept to a minimum. Loose ends shall not be permitted in multifilament yarns or larger elements of the rope.

Diameter

The diameter shall be in the range of 11 mm to 16 mm (inclusive) with a tolerance for any given diameter of plus or minus 5%.

Material

Man-made fibre rope for static Life/Rescue Lines shall be made of continuous filament, high tenacity, polyamide fibre or any continuous filament fibres for which no physical or performance characteristic shall be inferior to that of nylon 6:6.

Length Per Unit Mass

The length per unit mass of a 11 mm diameter rope shall be a minimum of 10.5 m/kg.

Colour

The core material shall be the natural colour of the fibre, with the sheath material contrasting sharply with the core, for the purpose of identifying cuts and contusions readily, and at a distance.

Markings

The rope shall contain a 3 mm wide marker type inside lay of core. It shall be repeated once every metre for the full length of the rope with the following information indelibly marked on it:

- the name, trade name or trademark of the manufacturer;
- the works FOR STATIC LIFE/ RESCUE LINES; and
- the rope diameter in millimetres.

1.4.3 Performance Requirements

Breaking Force

The breaking force when measured in accordance with *AS 4143.1* shall not be less than 3000 kg/f. This breaking force shall be adequate for a rope used to support a working load of 375 kg using a safety factor of eight.

⚠ NOTE

A safety factor of not less than eight is considered to be an appropriate margin of safety to reflect ageing, environmental effects, and less than ideal usage, including the tying of knots in the rope during its use.

Knotability

The rope used as a Life/Rescue Line should display good handling for which *AS 4143.2* defines not more than 1.1.

Knot Breaking Force

The knot breaking force, when measured in accordance with *AS 4143.2* shall be a minimum of 1500 kg/f.

Fall Factor Test

Also known as an Impact Strength Index. The rope when tested in accordance with *AS 4143.4* shall withstand two successive impacts from a falling block without breaking i.e. be capable of surviving two factor two falls. Further explanation of this test is provided at Para 1.6.2.

Sheath Slippage

The sheath slippage, when measured in accordance with *AS 4143.3* shall not be greater than 40 mm.

Elongation

The rope elongation, when measured in accordance with *AS 4143.1* shall be:

- not more than 3% under a load of 80 kg;
- not more than 10% under a load of 375 kg; and
- not less than 20% when the load causes the rope to break.

1.4.4 Other Tests

Other specifications and detailed explanations of standard test procedures are contained in the following *Australian Standards* for static Life/ Rescue Lines:

- *AS 4142.1 - Part 1: Care and safe usage*;
- *AS 4143.1 - Method 1: Dimensions, linear density, breaking force and elongation*;

- *AS 4143.2 - Method 2: Knotability and knot breaking force*;
- *AS 4143.3 - Method 3: Sheath slippage*; and
- *AS 4143.4 - Method 4: Impact strength index*.

The relevance of these standards is more for use by manufacturers and those involved in purchasing. However, firefighters using Life/Rescue Lines should understand the technology of the line they attach their life to.

Two particular manufacturers (*Eldelrid* and *Bluewater*) have been involved in the supply of kernmantle Life/Rescue Lines to the NSWFB and both satisfy *Australian Standards*. The particular lines they supply are:

- 13 mm *ELDELRID STATIC*
  Rated strength: 3000 kg
- 13 mm *BLUEWATER SUPERLINE PLUS*
  Rated strength: 4100 kg
- 13 mm *BLUEWATER II*
  Rated strength: 3500 kg

⚠ NOTE

Many other brands now meet the requirements of *Australian Standards*, but as yet have not been purchased by the NSWFB.

1.5 Safe Working Load

1.5.1 General

The *Safe Working Load* (SWL) is the maximum permitted working load for a rope. It is calculated by dividing the minimum breaking force of a rope by a safety factor appropriate for the conditions under which the rope or the line is used.

$$SWL = \frac{\text{Minimum Breaking Force}}{\text{Safety Factor}}$$

All Life/Rescue Lines used by the NSWFB must have a minimum SWL of 375 kg, giving a safety factor of 8 to 1.

1.5.2 Minimum Breaking Force

The minimum breaking force of a rope is the lowest force in kilograms that breaks the rope when the rope is subjected to a break force test. The *AS 4143.3* specifies a minimum breaking force of 3000 kg.

1.5.3 Safety Factor

The *ASA* has established a range of numerical values as safety factors for the purposes and conditions of the use of rope. Detailed in Table 1A are some examples of the safety factors and their specified use.

SAFETY FACTOR	SPECIFIED USE
5	Ropes not subject to flexing or twisting (standard rigging)
6	Ropes subject to occasional flexing or twisting (made up for use as slings)
8	Ropes used to support personnel either directly or indirectly (for securing bosuns chairs, stages - Life/Rescue Lines)
9	Ropes in continuous use where the load frequently approaches the SWL or is continuously exposed to flexing or twisting (ropes to heavy loads such as those on capstans and endless belt to drive machinery)

Table 1A Examples of Safety Factors

⚠ NOTE

NSWFB specifications state that all Life/ Rescue Lines comply with the requirement of the *AS 4143.3* for synthetic Life/Rescue Lines. This is equal to a SWL of 375 kg based on a safety factor of 8.

The following criteria are used to determine the safety factor of the line:

- intended working life of the rope;
- intended use and purpose of the rope;
- the kinds of knots/bends/hitches/ pulleys that may be used in the rope;
- modifications to the rope: these include a splice, used to form a loop or to join two ropes, that reduces the rope's breaking force by approximately 10%; or
- knots: these can reduce the breaking force of the rope from 40% to 75%.

The safety factor does not take into account the effects of abrasion, dirt, or inappropriate loads. The SWL is not valid for deteriorated rope.

1.6 Rope Tests

1.6.1 General

Rope manufacturers test the ropes to ensure that the ropes meet *AS 4143* (Parts 1 to 4 inclusive).

These tests simulate the stress likely to be encountered in actual use. To be confident in the use of the Life/Rescue Lines we use, you should be aware of some of these tests.

⚠ NOTE

You are not required to test rope. This is done at the supply stage. Assurance of the line safety is in the *Inspection and Maintenance Routines.*

Manufacturers' tests measure the effects of the following:

- load fall;
- abrasion;
- water absorption;
- breaking strength over edges; and
- minimum breaking force.

1.6.2 The Fall Test

A fall test simulates a severe fall. This test exceeds the stress to which a line would be subjected in actual service conditions. The test measures energy absorption, the impact force, and the number of falls that a rope can withstand before it breaks.

To pass the fall test, a rope must sustain at least two falls without breaking. The test fall simulates an extremely severe fall. A solid iron weight of 80 kg is attached to approximately 2.5 m of rope and dropped to fall 5 m. It is stopped by the rope length: this is a fall factor of two. The final speed of the weight at the time it stops is approximately 36 km/h or 15 mph. Time of the fall is about 1 sec. The impact force recorded is approximately 900 kg.

1.6.3 Using the Fall Factor

You can use the fall factor to estimate an impact force on a rope. The fall factor is a standard measurement and reference. The fall factor is calculated by dividing the distance the load falls by the length of the rope between the anchor point and the load.

$$\text{Fall Factor} = \frac{\text{Distance Fallen}}{\text{Length of Rope}}$$

The distance fallen in the example diagram (see Fig 1.5), from A to C position is 5 m. The rope length is 10 m. By dividing 5 m by 10 m,

the fall factor is 0.5. If the distance fallen from B to C is 2 m (see Fig 1.6) divided by the rope length of 10 m, the fall factor is 0.2.

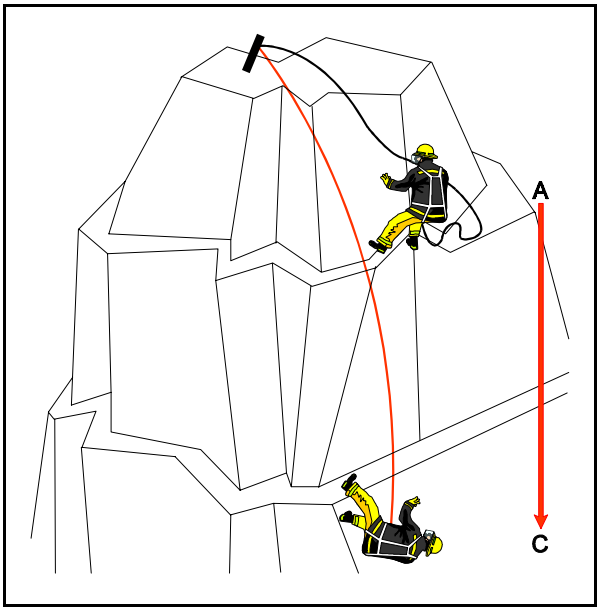

Fig 1.5 Fall Factor of 0.5

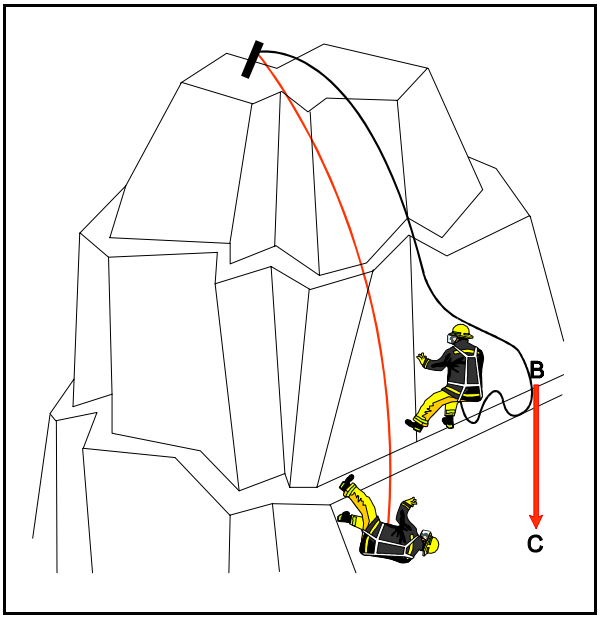

Fig 1.6 Fall Factor of 0.2

NOTE

Any fall or shock loading of a Life/Rescue Line should be brought to the attention of the Rescue Section.

1.6.4 Maximum Breaking Strength

The tensile test checks a rope for breaking strength and elongation under various strains. In this test, the rope is placed between two posts and stretched until it breaks. The posts have a large radius and the rope does not twist during the test. The rope should break between the posts, at greater than 3000 kgs.

1.7 Line Identification

1.7.1 Colour

In the NSWFB, we identify the various ropes we use by coloured fibres twisted or plaited by the manufacturers into the entire length of the ropes. These fibres identify each line as the property of the NSWFB.

Life/Rescue Line

On the Life/Rescue Line, the entire mantle is coloured rescue orange. On this orange background, the entire length of the line has a sequence of one red square then two blue squares.

All other NSWFB Lines

All other lines used in NSWFB are white and have one blue strand and one red strand of marker yarn. These marker strands give the lines a flecked appearance.

1.7.2 Termination of a Line

Each end of a line is finished off and heat sealed so that the strands of the line do not fray or become unlaid. The lines are finished off by different methods to enable the end of the line to be used for different purposes. In this section we describe the different termination methods used for NSWFB lines.

Whipping

The end of a line is whipped with coloured twines that bind the end of the line to prevent the strands from unlaying. The colour of twine

in the whipping also indicates the line's date of issue according to a colour code. Coloured whipping appears also at the mid-point of a general purpose line to indicate the mid-point of the line. This mid-point colour is the same as the issue date colour code.

Splicing

Splicing is a method of making an eye or loop in the end of a line by unlaying the strands for a short distance. These unlaid strands are then interlocked into one another in another length of line. The splice can have a thimble that replaces a knot. Kernmantle rope, and some other rope constructions, are not suitable for splicing. They can be swaged instead.

Thimble

A thimble is a grooved, pear-shaped, metal or nylon fitting used to terminate a rope or line. A thimble termination can prolong the life of the line by preventing wear on the end of the line. A thimble is used in place of an eye splice. An eye splice is used to increase the curve of the rope and reduce the stress on the rope when the rope is used with small attachments.

Swaging

Swaging is a method of line termination that uses a pair of metal tubular-shaped clamps that are pressed onto the end of a line. These clamps form an eye or loop that holds a thimble. For Life/Rescue Lines, kernmantle rope is double-swaged and fitted with a thimble at each end of the line length by the manufacturer. Swaging removes the need to tie a knot if you need to form a loop. This preserves the total line strength when a terminal loop is required. The metal swaging is marked to indicate the following:

- line length;
- line number or station number;
- date of manufacture; and
- date of issue.

Snap hook

A snap hook is a metal hook with a spring-loaded gate. It has a rated strength the same as the work load of the line. When a snap hook is attached to an eye splice, you do not need a terminal knot. A snap hook allows the line to be attached quickly and easily to another object.

1.7.3 Year of Make up of Lines

The year a line is made up is indicated by the colour of the whipping at or near each end of the line.

⚠ NOTE

This does not apply to Life/Rescue Lines.

Table 1B shows the year of make up of a line by the colour indicated.

YEAR	COLOUR	YEAR	COLOUR
1986	blue	1993	black/white
1987	yellow	1994	red/blue
1988	green	1995	red/black
1989	red	1996	yellow/green
1990	black	1997	black/green
1991	blue/yellow	1998	white/blue
1992	green/red	1999	black/yellow

Table 1B Make up of Lines

1.7.4 Record of Lines Issued to Stations

When a line is issued to a station, the Station Officer or Captain records the receipt of the line in the station register. This register is available for inspection, and the results of each inspection are kept for all lines in service.

Each station also keeps a record of the use of each Life/Rescue Line. This record is kept in the history books in each cordage pack and training line container. If a line is used, the entry records the number of descents and the load borne by the line.

Here are some examples of entries showing use-history:

Lowered patient, approximately 70 kg, from roof using harness through 4 m.

Dated: 17 August 1993. # 1 movement

Used to belay a stokes litter up an embankment through 25 m.

Dated: 7 October 1994. #2 movement

⚠ NOTE

When a training line has been used for 400 movements, it should be returned to the rescue section for a detailed inspection.

1.7.5 Lines Used by the NSWFB

In NSWFB cordage, a line is rope cut to a measured length. The ends of the line are terminated by one or more of the methods described earlier in this section. Each line has a specific purpose in NSWFB operations. Table 1C shows the uses for the various types of lines.

LINE TITLE	LENGTH (M)	DIAMETER (MM)	CONSTRUCTION	COLOUR	TERMINATION	FIBRE TYPE	MINIMUM BREAK FORCE & SWL	USES
Life/Rescue Line	50 100 200	13	Kernmantle	bright orange	Swage & Thimble **both ends**	polyamide *(nylon)*	3000 kg 375 kg	Life/Rescue Operations Self Rescue
General Purpose Line	30	12	3 strand Hawser Laid	white	Eye spliced & Snap Hook **one end** Whipped **one end**	polyester	2500 kg 312 kg	Hauling Equipment Suction Hose Substitution Guy or Guide Line
Pocket Line	4	8	3 strand Hawser Laid	white	Eye Spliced **one end** Whipped **one end**	polyester	1000 kg 125 kg	Search & Rescue BA Lashing Equipment Support Lashing Hose Lines
Guide Line	50 (aerials) 25 (aerials)	6	3 strand Hawser Laid	white	Eye Spliced & Snap Hook **one end** Whipped **one end**	polyester	600 kg 75 kg	Stabilise Line For moving objects in Lowering or Hauling
Guy Line	50	10	3 strand Hawser Laid	white	Eye Spliced & Snap Hook **one end** Whipped **one end**	polyester	1700 kg 212 kg	Assist/Stabilise Head Turntable Ladder
Lashing Lines	12	8 12	3 strand Hawser Laid	white	Heat Sealed **only**	polyester	as 8 & 12 mm 3 strand Hawser Laid	Lashing Work or where a Short Rope is required

Table 1C Lines Used by the NSWFB

1.7.6 Training Lines

The NSWFB has lines dedicated solely for training. These lines are assigned to stations in groups of three to five, and are shared on a monthly basis within the allotted stations.

⚠ NOTE

The Life/Rescue Lines contained in cordage packs and carried on operative appliances are not to be used for drill or training.

The use of training lines is important for your safety. Life/Rescue Lines are preserved for actual rescue operations. The use of training lines **for training** ensures that the Life/Rescue Lines will be ready for rescue operations when they are needed. Life/Rescue Lines should not be exposed to the stresses of training activities. The use of dedicated training lines also ensures that a Life/Rescue Line is ready to be deployed should an accident or mishap occur during training exercises.

Most Life/Rescue Lines have a minor history of actual rescue use. If a Life/Rescue Line has been properly stowed and maintained **and has not been used for training**, it will have a longer useful life. The training lines require frequent replacement because of the stress placed on them during training activities.

1.8 Line Inspections and Defects

1.8.1 Inspection of Lines

All lines in use by the NSWFB are inspected regularly, and the results of the inspections are recorded. You are expected to conduct inspections of the lines you use.

Regular inspection. All lines *except life support lines* are inspected at least once a month. The cordage pack is inspected regularly to ensure that all required items are present in the pack. At permanently attended stations, this inspection is conducted on the first day shift. At stations with part-time personnel, the inspection is conducted at the first drill of the month.

Any line that is used to support human life is inspected before and after it is used. In each emergency, you should conduct a touch and sight inspection as the line is set up for the operation. If the emergency is at night, you may have to forgo the sight inspection, but even at night you can conduct a touch inspection.

To conduct an inspection, pull about 300 mm of the line through your hand while your hand is lightly closed around the line. You can determine the general conditions of the line and detect any defects through your **touch**. Now go over the same length of line again, this time **look** at it carefully for defects. Continue this procedure for the whole length of the line.

If you find a defect in a line, you should report the defect immediately to the OIC of the station. A defective line is withdrawn from service and replaced by a new line (see 1.9.2).

Hawser Laid lines should be inspected by slightly untwisting them to reveal the inner surface of the strands.

Kernmantle lines are more difficult to inspect. You cannot actually see the load-bearing core unless the sheath is already so abraded that the line must be withdrawn from service. However, you should still inspect this line carefully by sight and touch. In your inspection, look for:

- cuts;
- contusions;
- fusing of the sheath;
- soft spots; and
- narrowing (an indication of damage to the core).

1.8.2 Causes of Defects in Lines

Most defects in lines are due to either mechanical causes or chemical reactions. Here is a summary of the usual causes of defects in lines.

Mechanical causes

Mechanical defects in the lines are most often due to:

- repeated normal use of the line;
- misuse or lack of care;
- abrasion caused by the line going over edges and surfaces;
- grit forced into the line by normal use, particularly when the line is wet;
- contact with sharp-edged tools;
- passage over sharp objects;
- exposure to a loading beyond the SWL;
- shock loading;
- improper stowage;
- tight knots left in the line after use;
- the line being stepped on by boots containing gravel or glass; and
- the line being struck by a heavy or falling object.

Chemical causes

Chemical defects in the lines are most often due to:

- ultra-violet light: the line can be damaged from prolonged exposure to sunlight;
- heat: the line can be damaged by either direct flame or by high temperature due to friction from the line running over a surface:

⚠ NOTE

The critical temperature for both fibres is 150° C. This is the temperature at which both nylon and polyester lines begin to weaken.

  - Nylon softens and melts between 230 - 260° C;
  - Polyester softens at 229° C and melts at 250° C.

- Mildew: *natural fibre* lines can be damaged by prolonged stowage in damp or wet conditions, but lines made of *synthetic fibres* are not damaged by mildew or mould in that the lines can be effectively washed and dried;
- Contact with chemicals: lines made from synthetic fibres may be stained if a chemical affects the colouring agent manufactured into the fibre. Synthetic fibres resist the effects of most chemicals, however the lines can be damaged by the following chemicals:
  - some strong oxidising agents;
  - hot formic acid;
  - sulphuric acid concentrate;
  - phenolic compounds; and
  - hot alkalis.

Table 1D shows a comparison of the various defects in lines, their causes, and the actions you can take to correct the defects.

DEFECT	CAUSE	FIBRE		ROPE		REMEDIAL ACTION					COMMENTS
		NATURAL	MAN MADE	HAWSER LAID	KERNMANTLE	MINOR DEFECT MORE CARE RETURN TO SERVICE	SEVERE WITHDRAW FROM SERVICE	WASH	DRY	CONTACT RESCUE SECTION IF DOUBT EXISTS	
general external wear	use	*	*	*	*	*	*			*	kernmantle rope with minor fibre breakage/disarrangement to the sheath surface is unavoidable and harmless if not extensive
local abrasion as distinct from general wear	misuse or lack of care over sharp edges or coarse surfaces	*	*	*	*	*	*			*	
cuts contusions hernias	misuse or accident	* 	 *	* 	 *	*	* *	 *	 *	* *	Life/Rescue Line to be withdrawn
internal wear	repeated flexing when wet	*		*		*	*		*	*	
mildew fungus rot	prolonged stowage in damp/wet conditions	*		*		*	*		*	*	has characteristic smell, degrades strength of natural fibre considerably, does not effect man made fibres
staining	contact with various chemicals	 *	*	* *	*	*	 *	*	*	* *	if stains do not wash out Life/Rescue Lines, are to be withdrawn
local weakening softening fibres powdering fibres	contact with acids	*	 *	* *	 *	*	* *	*	*	* *	resistive to most acids man made fibre lines must be thoroughly washed/dried/inspected. Life/Rescue Lines to be withdrawn

Table 1D Comparison of Line Defects

DEFECT	CAUSE	FIBRE		ROPE		REMEDIAL ACTION					COMMENTS
		NATURAL	MAN MADE	HAWSER LAID	KERNMANTLE	MINOR DEFECT MORE CARE RETURN TO SERVICE	SEVERE WITHDRAW FROM SERVICE	WASH	DRY	CONTACT RESCUE SECTION IF DOUBT EXISTS	
charring/ singeing of fibres	heat exposure	*		*		*	*			*	
melting/fusing of fibres	heat exposure		*	*	*	*	*			*	crucial temperature for Life/Rescue Lines weakening begins at 150° C
bleaching/fading	prolonged sunlight	*	*	*	*	*	*			*	see washing instructions ultraviolet light affects man made fibre more than it does natural fibre
line narrows at any point	broken internal fibres/yarns/strands		*		*		*			*	Life/Rescue Lines to be withdrawn
core is visible at any part of life/rescue line	cutting or rupture of the sheath or mantle		*		*		*			*	Life/Rescue Lines to be withdrawn
line is in a dirty condition	general use or misuse	*	*	* *	*	* *	*	*	*	* *	after washing check again for all defects natural fibre lines are not to be washed
condition of whipping splicing swaging thimbles	normal use or accident	*	*	*	*					*	damage to any of these areas means that repairs are necessary and will require replacement

Table 1D Comparison of Line Defects

1.8.3 Instructions for Washing Lines

Each line is to be washed if it is dirty after use at fires, rescues, drills, or other incidents.

Here is a list of steps to follow for washing the lines:

- fill a BA sink with **lukewarm** water and dissolve pure soap in the water: use **only** pure soap as it contains none of the chemicals normally found in washing powders;
- agitate the water to create suds;
- immerse entire line to be washed - you can *chain* the line to help you immerse it;
- agitate for 10 min by hand - **do not leave the line to soak**;
- use a soft cloth to rub one section of line at a time until the entire line is clean;
- rinse the line thoroughly in clean, cold water: Remove all residual soap so that it will not change the handling characteristics of the line, residual soap can make the line slippery when the line is next used in wet conditions;
- loosely flake and drape the wet line in a well-aired place within the station. Keep the line away from direct heat, sunlight and up off the floor; and
- allow the line to dry naturally. Do not hang the wet line on station whips or dry the lines in station driers or clothes driers.

⚠ NOTE

If you need to use the line while it is still wet immediately after washing it, there will be little noticeable decrease in its performance, but it may be slippery to handle.

1.9 Use of Lines

1.9.1 General Use

Here is a list of general instructions for the use of lines:

- **always wear gloves** when carrying out top, bottom, and self-belay operations;
- **never leave a line** knotted or tightly stretched for longer than is necessary;
- **do not drag** a line along the ground;
- **always carry out an inspection of a training line before training commences**. This inspection is to be supervised by a safety officer or an instructor, at their discretion, and at least every twenty evolutions. During this inspection pay particular attention to any wear at the line's points of contact;
- **do not stretch-test** a line. This can be damaging to the line;
- **always use rope protectors or bagging** when Life/Rescue Lines are in use. This avoids abrasion at points of contact with concrete, stone, or rough edges;
- **avoid stepping on lines**. Your boots can pick up stones, glass, and small objects that can become embedded in the line or cut the line;
- **always dry a wet line** after use at an incident before you return it to the cordage pack. Dry the line on return to the station in a cool place out of the sunlight;
- **always place the line on a ground sheet or debris sheet** when inspecting the line or when setting it up for use;

- **never use a line** for a load in excess of its SWL;
- **always flake a** three strand hawser-laid rope when stowing it in a bag. **Do not coil it**;
- **keep a record** of the date of issue of all lines by reference to the colour of the whipping or to the marking on its swaging;
- **keep lines** separated from each other during use, this prevents tangles;
- **never remove a line stowed on a reel by taking it off over the end of a reel**: this can distort the line and cause kinks that can then become hocks when the line is under load;
- **never use a line** that has been frozen;
- **always use a pulley** to redirect a line away from corners or edges when you are hauling with the line;
- **avoid unnecessary exposure** of the line to sunlight;
- **keep a record of the use of** each Life/Rescue Line in service;
- **use only Life/Rescue Lines** for the purpose of supporting human life; and
- **do not use** Life/Rescue Lines carried in cordage packs for drill or training exercises.

1.9.2 Withdrawal of Life/Rescue Lines from Use

Here is a list of conditions that determine when a Life/Rescue Line is to be withdrawn from service and brought to the notice of the Rescue Section:

- the line has been subject to shock loading: body weight;
- the line has staining which will not wash out;
- the line has been subjected to direct shock i.e. a heavy object has fallen on it;
- the line narrows at any point. This can indicate internal damage;
- the kern is visible at some point. This is due to a *hernia* in the mantle;
- the mantle is worn or abraded to less than 50% of its original thickness;
- any part of the line has been subjected to heat greater than 150° C;
- the visible end of the line has slipped within the swage; and
- the thimble is damaged.

1.9.3 Storage of a Life/Rescue Line

Chaining a line makes it easier to store, pack, transport, and wash the line. To chain a line, double it at the mid-point then loop it through itself to form the chain. The chain starts at the swaged end of the line. This method of storage prevents twists in the line.

Stuffing a line is a storage method that enables a line to be deployed quickly. To stuff a line, simply pile the whole length of the line into a rope bag. As you stuff the line, settle the contents occasionally by shaking or jerking the bag. The line is then ready to be deployed straight from the pack.

1.10 Tying and Using Knots

1.10.1 General

All knots are made up of turns and tucks in a line or a rope. A knot is held together in a line or a rope by friction. A rope's construction and the material from which it is made can affect the suitability and safety of knots. Some knots

work well only with certain materials i.e. a knot that works well in coarse material, such as manila, may not be secure in a more slippery synthetic fibre like nylon. Most knots developed for use with laid rope do not maintain their efficiency when tied in kernmantle.

The use of knots requires great skill. That skill is not only knowing how to tie a knot but also in recognising where to tie a knot, how to combine knots to safely anchor a line, and how to dress and pack knots. This skill is not acquired just by studying the illustrations in a manual. To be proficient in the use of knots, you must get to know the three-dimensional nature of the process and the behaviour of the different kinds of ropes. Probably the best help you can get in the skill of using knots comes from an experienced instructor. After you have learned how to tie a knot, practice tying it under difficult conditions, such as in darkness, until you have mastered it.

Firefighters all over the world maintain a tradition of proficiency with knots and rope. An old traditional knot, the *fireman's knot*, was developed to help with evacuations. This knot is tied by forming a *clove-hitch* in the middle of the line and following it with a succession of *half-hitches* throughout the length of the line. Then you pass the end of the line back through the loop. The result is a line with thumb knots along the entire length. This provides *hand-holds* for someone being evacuated by climbing down the line, hand-over-hand.

Many knots such as the *fireman's knot* have been *lost* because of the use of more modern methods of recovering persons in danger. Some of these include modern synthetic rope fibres, the use of BA, fire isolated stairwells, and aerial appliances. We now have a new system of knots especially for use with modern rope fibres. Out of the hundreds of knots, bends, and hitches developed over the years by firefighters for use in the NSWFB, only a few remain in use.

It is possible to deploy the line at a rescue without the need to tie a knot, and therefore has been referred to as a *no knot line rescue* system. In the following pages we discuss the knots currently in use in the NSWFB. All of these knots are used in general rope work. Some of them are used exclusively on kernmantle rope for Life/Rescue work.

1.10.2 Strength Reduction

When you put a knot in a line, the knot reduces the strength of the line. When a line breaks, if a knot is tied in the line, the break will usually occur at the point where the line enters the knot.

The *relative breaking strength* of a knot is defined as the *load required to break the same line with no knot on it.* e.g. if the breaking strength of a line is 1000 kg without a knot, and the breaking strength of a line is 500 kg when a knot is placed in the line, the relative breaking strength of the knot is 50%.

Here is a list of factors that can affect the breaking strength of a knotted line:

- the way in which tension is applied, that is, whether the tension is applied as a gradually increasing strain or a series of jerks;
- the method of tying the knot, that is, whether the knot is tied *with* or *against* the lay of the rope;
- the condition of the rope;
- the type of construction of the rope;
- the type of fibre from which the rope is made;
- the *dressing* and *packing* of the knot, that is, whether the knot was *correctly* dressed or packed; and

- the selection of the knot, i.e.whether the knot used was correctly selected and applied.

1.10.3 Requirements of Knots

In rescue work and other life support operations, a knot used in a line or a rope must fulfil certain requirements and do so at a high level of efficiency. In particular, the knot must pack tighter than for general rope work so that there is no slippage when the line or rope is in use.

Here is a list of the requirements for a knot to be effective. The knot should:

- safely carry out the purpose for which it is used;
- not damage the line;
- be tied quickly and easily;
- be untied easily; and
- reduce the breaking strength of the rope by the least amount.

1.10.4 Terminology of Knots

A knot is a method of making a fastening in a rope or a line to secure it to an object, another line, or part of itself. Knot is a generic term. The following terms are more specific names for knots. The use of these terms is determined by how a knot is to be used and the object to which it is to be fastened.

- *bend*: a knot which fastens a line to an object or another line;
- *bight*: that part of a line between the *running part* and the *standing part* with which a knot can be formed, the line does not cross itself;
- *hitch*: a simple fastening of a line to an object by passing the line around it and crossing one part of the line over the other;
- *loop*: a closed curve in a rope or a line;
- *overhand loop*: a loop made by crossing the end over the *standing part*;
- *round turn*: two turns or loops of the line around an object;
- *running-end*: the free end of the line which can be used for operations;
- *standing part* or *standing end*: the inactive part of the line, or that part of a *bight* nearest the *eye*, *bend* or *hitch*, in contrast to the *running end*;
- *tuck*: end or bight of the line which passes through a loop after a turn around the standing part;
- *turn*: a loop of the line around an object or around another section of the line itself;
- *underhand loop*: made by crossing the end under the standing part.

1.10.5 Types of Knots

Here is a list of the types of knots used in the NSWFB:

Alpine Butterfly: this knot is used with Kernmantle Rope (see Fig 1.7) and has the following characteristics:

- it is used as a midline loop designed to take a three way load;
- it can be used to form a load-carrying loop in a line;

- this is a very safe knot for kernmantle rope and can be used where an in-line figure of 8 loop is used.

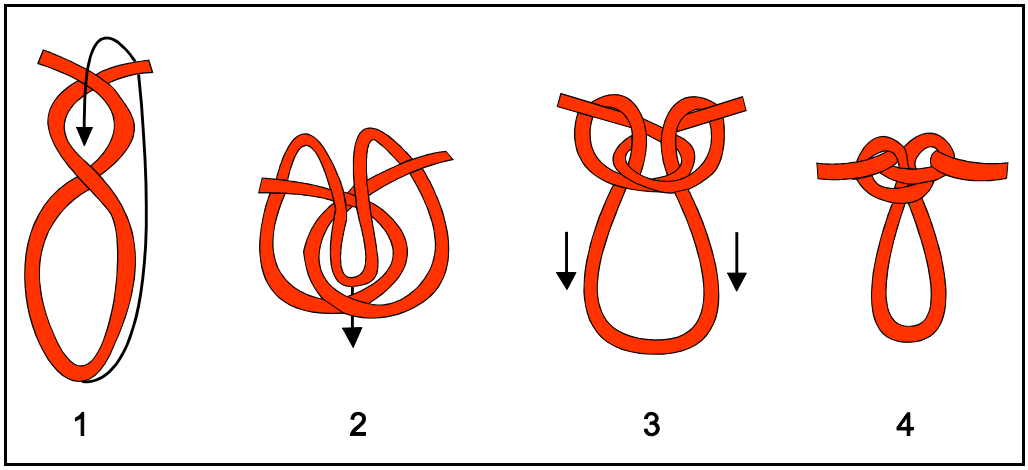

Fig 1.7 Alpine Butterfly Knot

Bowline: this knot is used with Hawser Laid rope (see Fig 1.8) and has the following characteristics:

- it is used to secure a hawser laid line to the head of a stokes litter;
- it is used to attach a hawser laid line to an anchor point.

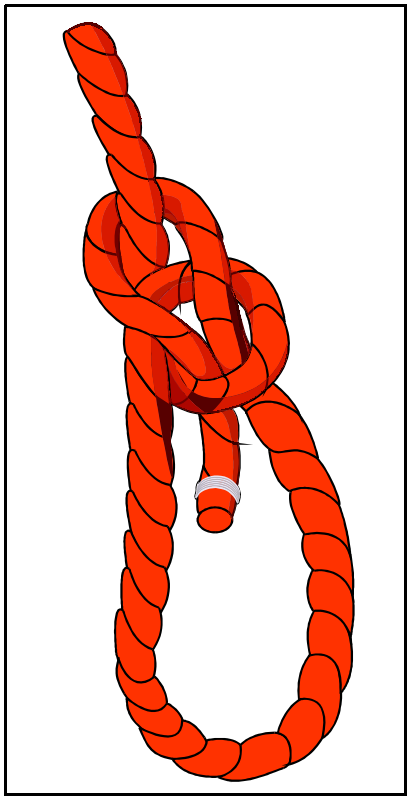

Fig 1.8 Bowline Knot

Clove Hitch: this knot is used with Hawser Laid rope (see Fig 1.9) and has the following characteristics:

- it is used to attach a line to a rail or beam to support a charged hose line;
- it can be used to attach a ladder hauling line to the rung of a ladder;
- it is used to start or attach a lashing;

⚠ NOTE

This knot is not used for life support. Where safety is important, the clove hitch must be finished with half hitches.

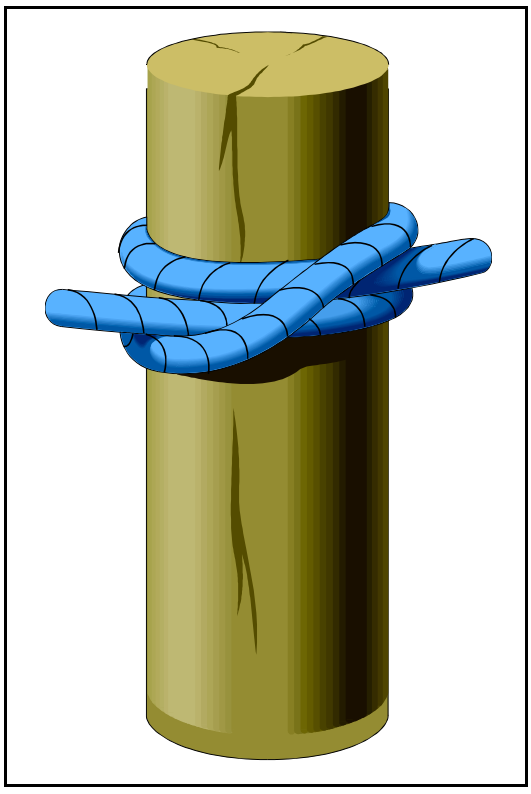

Fig 1.9 Clove Hitch Knot

Clove Hitch Middle of Line: this knot (see Fig 1.10) is used for Hawser Laid Rope and has the following characteristics:

- this is a secure but easily untied hitch;
- it is formed in the middle of the line or by forming two loops, one overhand, one underhand, and then placing them over the end or top of an object i.e. it can be placed over the top of a post or onto a suction hose strainer.

⚠ NOTE

This knot is not used for life support.

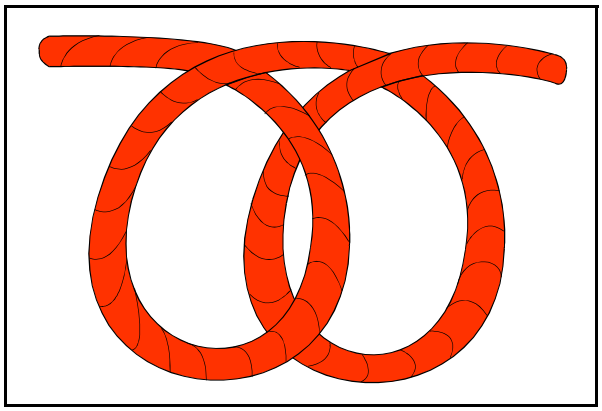

Fig 1.10 Clove Hitch Middle of the Line Knot

Double Fisherman's Bend: this knot (see Fig 1.11) is used with Kernmantle Rope and has the following characteristics:

- it is used to connect synthetic fibre ropes of equal or unequal diameters;
- it is often used to form slings or loops from short rope cord.

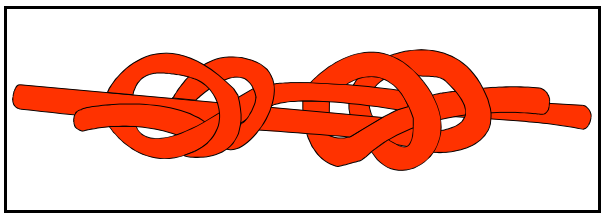

Fig 1.11 Double Fisherman's Bend Knot

Figure of Eight Knot: also known as the *stopper knot*: this knot (see Fig 1.12) is used with both Hawser Laid and Kernmantle Rope, and has the following characteristics:

- it is used to prevent the end of a line unravelling when whipping is damaged;
- it is used to prevent the end of a line passing through an eye or pulley block.

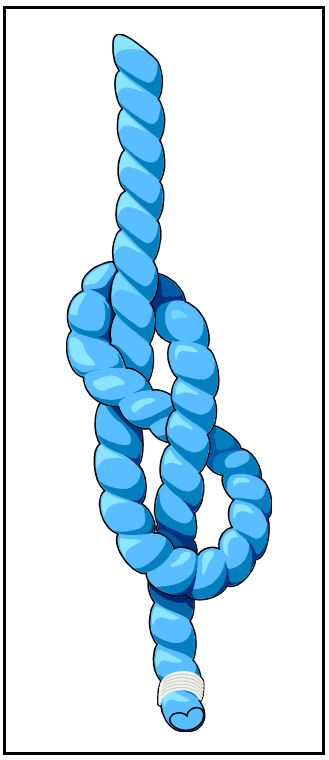

Fig 1.12 Figure of Eight Knot

Figure of Eight Loop: also known as *follow through figure of eight knot*: this knot (see Fig 1.13) is used with Kernmantle Rope and has the following characteristics:

- it is used to secure a line around one or more fixed objects that cannot accept a loop;
- it is tied at the end of a Life/Rescue Line for life support.

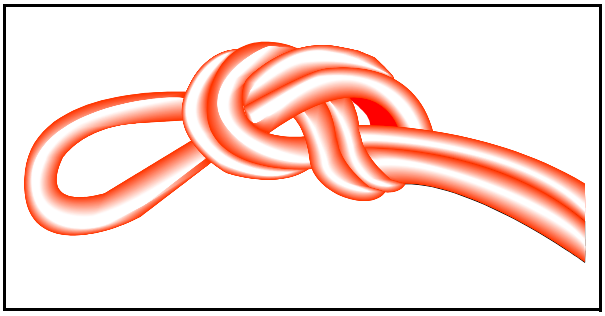

Fig 1.13 Figure of Eight Loop Knot

Half Hitch: this knot (see Fig 1.14) is used with Hawser Laid Rope and has the following characteristics:

- it is used to fasten a line to an object for a right angle pull;
- it is often used in conjunction with other knots.

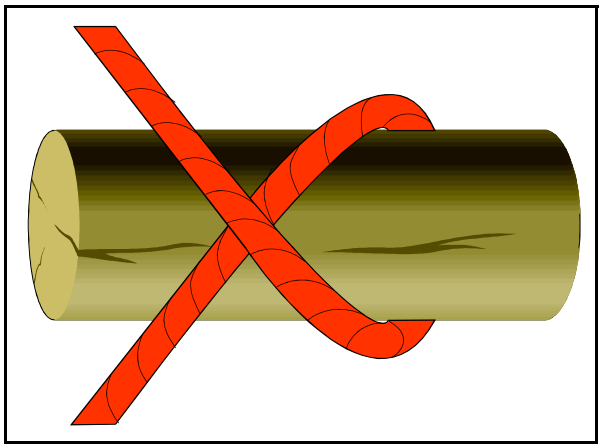

Fig 1.14 Half Hitch Knot

Half-Sheepshank: this knot (see Fig 1.15) is used with Hawser Laid Rope and has the following characteristics:

- it is used to form a loop in a line to provide a Mechanical Advantage (MA) when using the line for tensioning purposes, i.e. when you are using a line to tension a general purpose line while it supports a suction hose;

CAUTION

Consistently tying a half-sheepshank in a line or a rope can weaken it and cause the running part to cut through the standing part of the line.

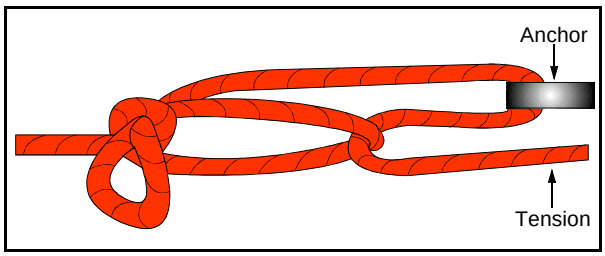

Fig 1.15 Half-Sheepshank Knot

Overhand Knot: also known as *thumb knot*: this knot (see Fig 1.16) is used primarily with Hawser Laid Rope and has the following characteristics:

- it is used to prevent the end of a line unravelling when whipping is damaged;
- it is used to prevent the end of a line passing through an eye or pulley block;
- it is often tied in a length of hose or hose-strap to indicate that the hose is damaged;
- it can be used to secure the tail of a knot.

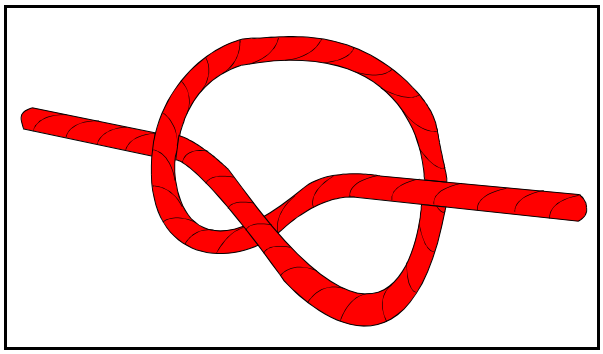

Fig 1.16 Overhand Knot

Rolling Hitch: this knot (see Fig 1.17) is used with Hawser Laid Rope and has the following characteristics:

- it is used to form a hitch which resists slipping along a tubular object in the direction (lateral right or vertical left) of the strain;
- it can be used for hauling tubular objects;
- it can be attached to a post rail or cylinder;
- it can be used for pulling out pickets.

NOTE

This knot is not used for life support.

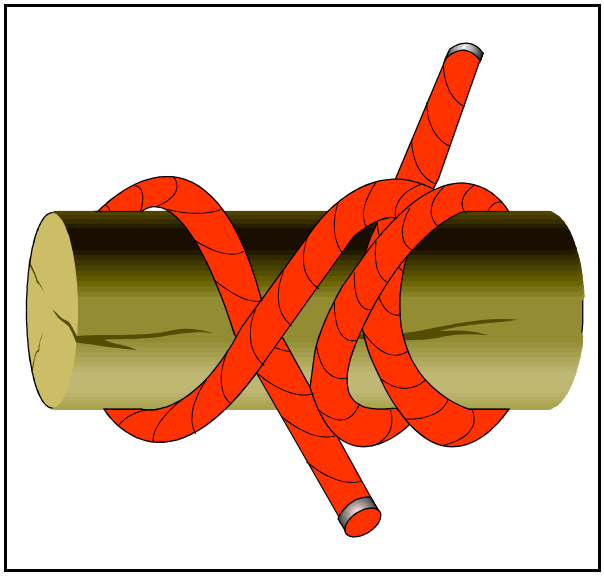

Fig 1.17 Rolling Hitch Knot

Round turn and 2½ Hitches: this knot (see Fig 1.18) is used with Hawser Laid Rope and has the following characteristics:

- it is used to tension and secure a line without mechanical advantage;
- it can be used to secure a line to an object particularly a round object;

- it is an excellent knot for anchoring objects such as guy ropes;
- this knot will not jam no matter how much load is applied;
- it is easy to adjust under load and is easily untied when the load is released.

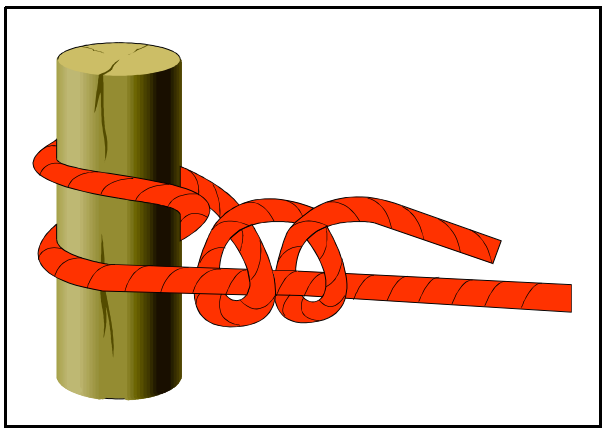

Fig 1.18 Round Turn and 2½ Hitches Knot

1.10.6 Dressing and Packing Knots

After you have tied a knot, you must then pack it and dress it before you can place a load on it. Here is a description of this packing and dressing operation:

- first, firm the knot, arrange each part of the knot so that it travels only the shortest practical distance through the knot;
- then, hold the knot firmly and tighten each part of it in turn. To simply pull the rope without holding the knot will not adequately pack the knot;
- leave a tail of at least 150 mm between the knot and the end of the line;
- tie an overhand knot in the tail to secure the end of the line as close as possible to the knot itself. Although this is not a component of the knot itself, it can help to make the knot more effective.

1.11 Cordage Bag

1.11.1 General

The Cordage Bag (see Fig 1.19) is made of heavy duty cordura. This material is extremely durable. It is twenty times more resistant to abrasion than 10 oz canvas, and it is more puncture proof than vinyl. High quality nylon zippers with pull tabs attached provide maximum durability and easy opening of the pockets.

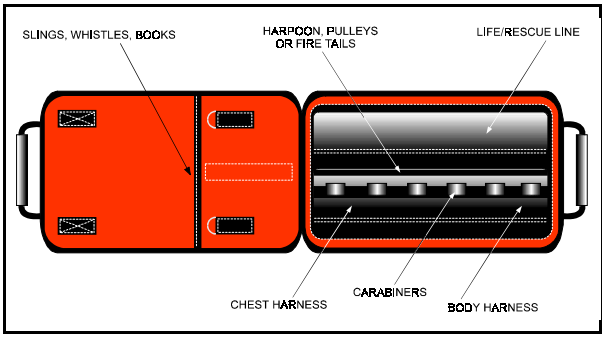

Fig 1.19 Cordage Bag

1.11.2 Features

The cordage bag has the following features:

- two compartments with independent double zippers:

  - the small outside compartment holds the hauling line;

  - the large main compartment holds the Life/Rescue Line and accessories including:

- two vertical dividers, one pocket with loops for up to eight Karabiners and one pocket with velcro closure for pulleys and friction device;

- one main compartment flap pocket with velcro closures for log books and pen/pencil, two fixed rings for attachment of Life/Rescue Line terminations with Karabiners;
- the outside of the bag has three riveted drag handles with internal gussets for strength to aid in removal from the appliance. Two handles are on the top and one is on the side;
- robust carry handles run the length of the bag so the load places no strain on the bag. You can use the top grab handles along with the carry handles; and
- the leather reinforced packaway padded shoulder straps have quick release *Fastex* buckles.

1.11.3 Inventory of Equipment

The cordage bag weighs 14.5 kg when full. Here is an inventory of the equipment carried in the standard Cordage Bag:

- Karabiners 4;
- edge protection, hession bag;
- friction device, 1;
- general purpose line, 1 x 30 m;
- gloves, 2 pairs;
- harness: 1 x full body harness and 1 x chest harness;
- Life/Rescue Line, 1 x 50 m;
- 2 log books (1 x Line Use Record, 1 x Record of Use of Pack);
- pulleys, 2;
- tape slings, 2; and
- whistles, 2.

1.11.4 Equipment Description

Full Body Harness

The full-body harness (see Fig 1.20) is:

- fully adjustable and fits any firefighter;
- synthetic webbing tape. Consisting of a body strap, thigh straps, and shoulder straps designed to prevent the wearer from falling out if inverted;
- fitted to accept a Life/Rescue Line at loops midway in the front of the torso;
- fitted at the five adjusting points with buckles that are spring-loaded for quick release but designed to prevent complete release of straps while the harness is being worn;
- equipped with adjusting straps that have stops sewn into the ends to prevent withdrawal from the buckles and to prevent the harness being assembled improperly;
- finished with stitching that is safety stitched box-gate and complies with the minimum requirements of the *AS*; and
- fully adjustable so that it can be worn over the fire fighting turnout coat: the harness can also be worn under CABA sets.

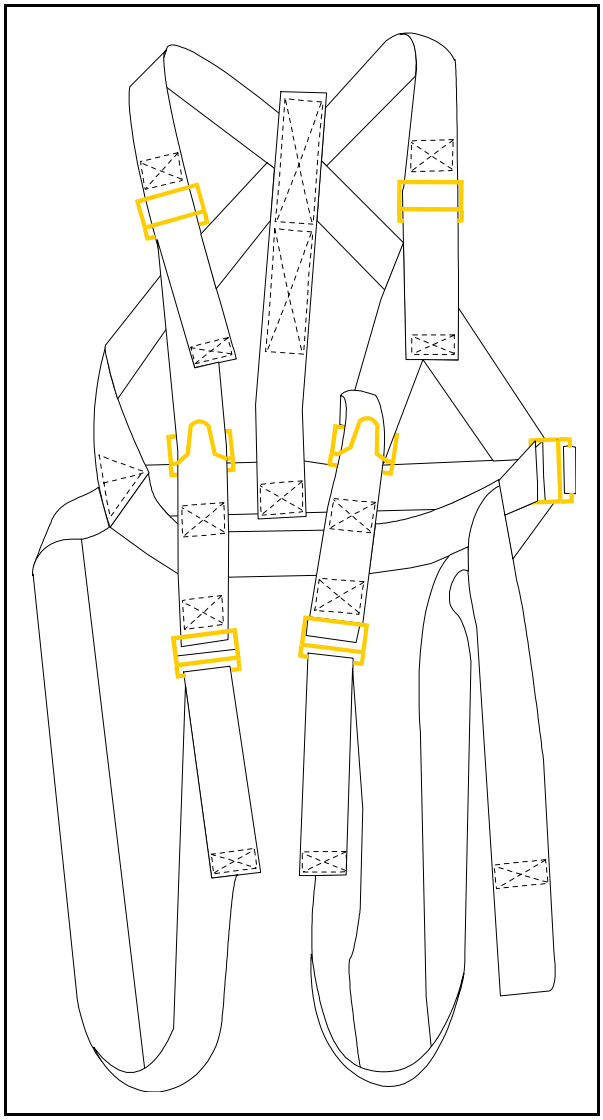

Fig 1.20 Full Body Harness

Wearing the Full Body Harness.

Before you put on the harness, take hold of the spinal strap and view the harness from the back. In this way, you can identify the various components of the harness. You put the harness on in the same way that you would put on a pair of overalls:

- you hold the front of the shoulder straps and then step into the body belt and leg assemblies;
- place each leg in turn through the leg loops and pull the harness up the body;
- then you place each arm in turn through the relevant shoulder straps; and
- then adjust the harness in the following sequence;
- waist strap; then
- shoulder straps; and finally
- leg straps.

⚠ NOTE

The harness is not very comfortable to wear. You can increase the comfort if you hook both thumbs under the leg straps at the buttocks, lift each leg in turn, and push these straps forward to the thighs. This will reduce some of the excess pressure in the crotch area whilst on rope.

Precautions for Use

When you are wearing this harness, observe the following precautions:

- **do not use** the **D-ring** (where fitted) on the back of the harness;
- **use** the **buddy check system** whenever you wear the full-body harness for rescue, training, or any purpose i.e. one person checks another to ensure the harness is correctly fitted and adjusted; and
- **attach** the Life/Rescue Line or Safety Line only to the loops provided at the front of the harness and attach Guide Lines only to the loop provided on the spinal strap that is central to the harness, thus, when you wear the harness, you will not be pulled off balance.

Inspection, Care, and Maintenance

The harness should be inspected at regular intervals, and it should be inspected before and after any training exercises. The inspection is to be carried out as follows:

- examine the stitching for wear or breakage, particularly where two or more layers of webbing are stitched together in its construction;
- check all webbing straps carefully for damage, particularly at attachment points and loops;
- check all straps for stain. When staining is evident and the substance is unknown, the harness must be withdrawn from service for evaluation. Wash the harness in warm water using pure soap only, not washing powders, and if the stain does not wash out of the webbing strap after thorough washing, then remove the harness from service, pending possible replacement of the effected part by the manufacturer or qualified persons;
- check all buckles and securing attachments. Ensure that the buckle spring (where fitted) is in place and operative;
- **do not spray buckles** with oil or *WD40* solutions. If there is any rust or corrosion on the buckle, it is faulty and you should remove it from service and bring it to the notice of the manufacturer; and
- stow the harness only in an approved bag or container on aerial appliances, or in the Cordage Pack on Pumpers and Salvage/Rescue Units. **Do not** stow the harness loosely in pockets with heavy or oil-operated equipment.

Chest Harness

Features

The chest harness (see Fig 1.21) is designed for the rescue of persons under emergency conditions. Although it is designed for lowering or lifting persons around the upper torso, you can also use it as a safety harness. To use it in this manner, place the harness around the waist of the person and attach a line. When fitted in this manner, the chest harness can prevent a person from falling when they approach an edge or a drop. You can also use the chest harness as a third sling provided that the anchor point does not damage the vinyl cover.

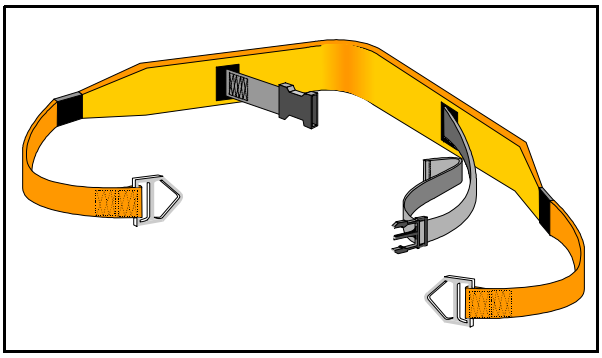

Fig 1.21 Chest Harness

⚠ NOTE

The chest harness can be used in this manner only for single person loads.

You can use the chest harness also for water rescue, the padding material in the harness is closed cell latex foam rubber and will not water log or sink.

⚠ NOTE

The chest harness is *not* a buoyancy vest or device, it will not keep an adult person afloat.

Construction of the Chest Harness

The chest harness is constructed from nylon and polyester webbing. The main webbing strap of the harness is made of orange-coloured nylon. This strap is continuous from one **D**-ring through the padded section to the other **D**-ring, and all other components are attached to it. The end of the keeper strap is fitted with a stopper loop to prevent it from completely withdrawing. All stitching is safety stitched and complies with the *AS*. The harness can be adjusted to fit all sizes.

Wearing the Chest Harness

The chest harness is worn by placing it under your arms and around the upper torso. Place the **D**-rings to the front. The blue straps are *keeper straps* that prevent the harness from slipping if you raise your arms above your head. Later issue chest harnesses have *black* keeper straps with plastic buckles. This later model is longer overall from **D**-ring to **D**-ring, providing extra length padding.

⚠ NOTE

Unconscious patients may need to have their hands tied at their waist as a precautionary measure.

Inspection, Care, and Maintenance

The harness should be inspected before and after use and at regular intervals. The inspection is to be carried out as follows:

- examine the stitching for wear or breakage, particularly where two layers of webbing are stitched together in its construction;
- check the straps for stains: when the straps are stained and the substance is unknown, withdraw the harness from service for evaluation. Wash the harness in warm water using pure soap only, not washing powders; and
- stow the harness only in an approved bag or container on aerial appliances, or in the Cordage Pack on Pumpers and Salvage/Rescue Units. **Do not** stow the harness loosely in pockets with heavy or oil-operated equipment.

Karabiners

The Karabiner is a common item used in most modern cordage systems (see Fig 1.22). The large **D**-shape Karabiner is a universal model and is compatible with other cordage hardware, software, and stretchers.

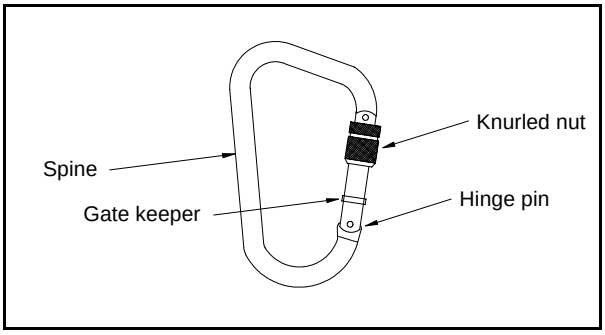

Fig 1.22 A Typical Karabiner

The NSWFB currently uses three types of steel and two types of alloy Karabiners:

Steel

- *Stubai* with a rated strength of 3000 kg;
- *Kong-Bonaiti* with a rated strength of 3500 kg; and
- *Bluewater* with a rated strength of 4000 and 4100 kg.

Alloy

- *HB Wales* with a rated strength of 2500 kg (used only on *Stokes* Litter lifting slings); and
- *SRT* with a rated strength of 3750 kg (issued **only** to black level operators).

Precautions for Use

When you are using Karabiners, you should observe the following precautions:

- ensure that the Karabiner is locked by the screw-gate **before** weight is placed on it;
- if a Karabiner is dropped onto concrete or otherwise abused, consider it suspect and inspect it closely before using it again;
- do not load a Karabiner across (see Fig 1.23) its latitude (that is, across the gate) as this is less than one third its rated strength;
- do not load a Karabiner simultaneously three or four ways;
- if the gate spring or pin won't open, withdraw the Karabiner from use; and
- do not use oils or grease on Karabiners. If the gate or knurled nut sticks or binds, use a small amount of *WD40* type fluid.

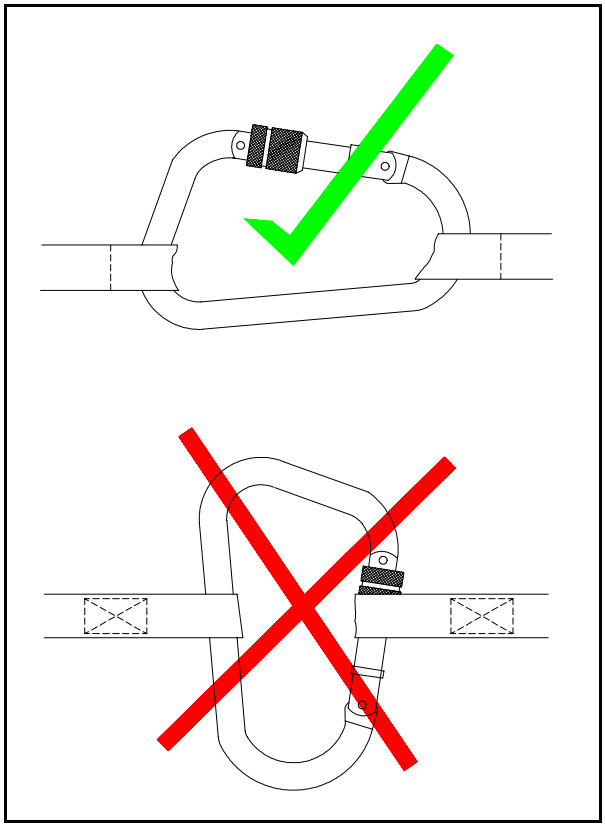

Fig 1.23 Loading a Karabiner

Harpoon Friction Device

The *Harpoon* friction device (see Fig 1.24) is a *figure eight* class of descending device. It is designed to allow a firefighter to be lowered safely by line.

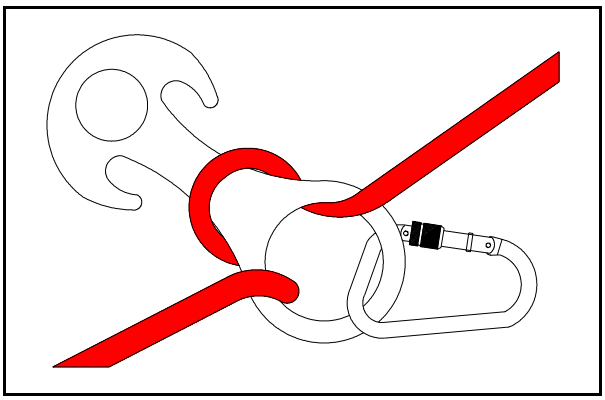

Fig 1.24 The Harpoon Friction Device

Characteristics

- the device is made from high grade drop-forged aluminium alloy or, from extruded aluminium that is polished to smooth any surface imperfections that can damage a rope;
- being made of aluminium, the device has a greater capacity than steel to disperse heat caused by friction;
- this device has been tested. It will destruct at approximately a 10 000 kg load and it distorts at a 4500 kg load;
- the *Harpoon* can be inserted at any point on a line by passing a bight of rope through the large rigging eye and over the smaller end that has the barbs. Then routing up around the mid-shaft between the larger and smaller rigging eyes;

Uses

You can use the *Harpoon* as:

- a lowering device from above or below;
- a device to secure a rope without knotting the rope;
- a self rescue device; and
- a device in belay or safety line brake.

NOTE

A belay operator may require assistance when the load of a second person is placed on the line.

Care and Safe Use of the *Harpoon*:

- when you use the device, be careful that the line does not run through the device above the critical temperature of the rope as this can cause damage to the rope by fibre fusion;
- if you drop the device from body height onto a solid surface, you should consider it suspect and it should be inspected thoroughly;
- if you drop the device from above shoulder height, you should consider it suspect and withdraw it from service pending a thorough evaluation. You must adopt the philosophy *if in doubt, do not use*;
- avoid constant wear to one side of the device by the rope. When this wear is excessive, i.e. 10% dia, withdraw the device from service;
- if the rope used with the device is dirty, the rope can cause excessive wear to the device. This is especially true when the rope is wet, as this will have the effect of wet and dry rubbing paper;

NOTE

Never subject a *Harpoon* friction device to stamping with metal stamps, engraving by means of vibrating electric or electric arc marking, or painting.

- use good lowering techniques to minimise the load placed on friction devices, rope, tape slings, Karabiners and harnesses. Make a steady even descent free of sudden jerks or stops.

Side Gate Rescue Pulley

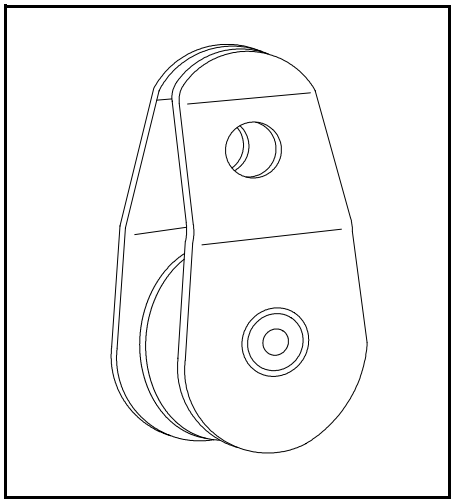

Fig 1.25 A Typical Side Gate Rescue Pulley

A side gate rescue pulley can be used:

- to redirect a rope line;
- to clear a rope line from abrasion on rough surfaces; and
- to offer a mechanical advantage.

Specification

Care of Pulleys

- never oil or grease a pulley;
- withdraw the pulley from service if the sheave will not turn or if the free moving cheek jams; and
- do not exceed the maximum mass lift equivalent to a two-person load.

Synthetic Webbing Tape Slings

Construction

The tape sling is 2 m long. It is made of 45 mm wide synthetic webbing, with a minimum tensile strength of 3000 kg, after stitching. The ends are terminated with folded formed eyes, sewn with either double gate or four point stitching minimum (see Fig 1.26).

Use

The tape sling is designed to serve a variety of needs including:

- to eliminate the need for tying knots in Life/Rescue Lines when attaching them to anchor points or other equipment;
- to offer a larger surface area of contact than a rope, this increases the safety aspect, particularly on sharp or abrasive objects;
- to allow attachment to objects that are too small for use with a Life/Rescue Line or too large to use with direct attachment of a Karabiner.

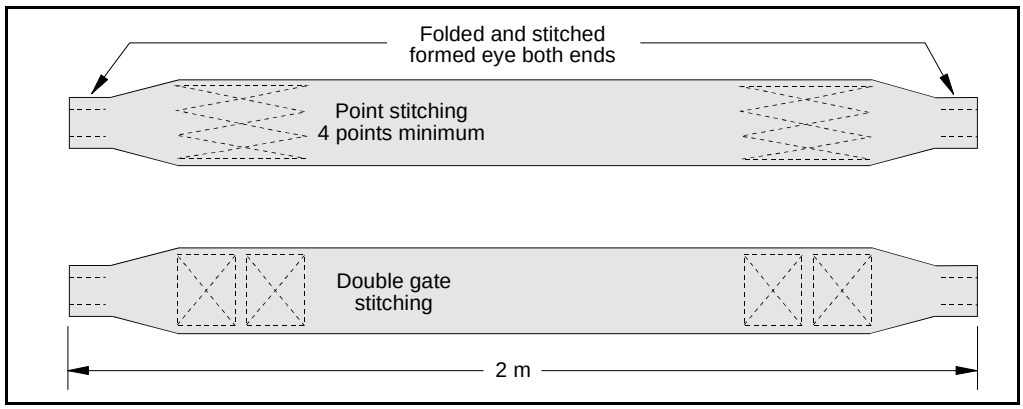

Fig 1.26 Synthetic Webbing Tape Slings

Care and Safe Use of the Sling.

- do not use the tape sling for any purposes other than those in the instructions;
- do not use the tape sling with any equipment other than that contained in the Cordage Pack.

Inspection

When you inspect the tape sling, look for the following:

- staining;
- burring of the edges;
- damaged stitching;
- excessive wear at the formed eye or any other damage that causes you to doubt the safety of the sling;
- dirt: if the tape sling is dirty, you can rinse it under cold water or wash it in warm water using pure soap only;
- proper stowage: stow the tape sling in the cordage pack by tightly rolling it with elastic bands. Do not fold the tape sling.

⚠ **NOTE**

Before and after using the tape sling, inspect it along with other life support equipment and inspect the stitching of all slings whilst they are under load.

1.12 Anchors

1.12.1 Introduction

When you rescue someone with a Life/Rescue Line, you must select:

- the best and safest **method** by which to access the person;
- in a fire situation the most appropriate **place** from which to work is as close as possible to a point above where the victim is located. You may however have to operate from off to one side in other evnvironments to avoid displacing debris onto a victim below, or if there is a danger of fire or heat damaging your line; and
- the best **equipment** to enable you to do the job.

1.12.2 General

To use your Life/Rescue Line effectively, you must select the best method of **anchoring** the line to gain access to the victim in a vertical environment.

There are three categories of anchors you can use:

- natural;
- structural; and
- constructed.

Rescue activities with ropes and lines can be life-threatening. Your selection of a quality anchor point is paramount. Even the strongest equipment becomes weak unless it is well anchored.

1.12.3 Natural Anchors

Nature provides us with many items that can serve well as anchors. However, you must be careful in your selection of natural anchors. Trees, rocks and natural formations can often be less reliable than you might think at first.

1.12.4 Structural Anchors

Structural anchors are those that attach to existing structures that are sufficiently stable to hold the line securely. These can include architectural items such as:

- columns;
- walls;
- beams;
- roofs;
- floor and wall sub-structures; and
- purpose-built anchor points.

As a result of your training as a firefighter, you have a good knowledge of building construction, you need to use this knowledge to make sound judgements about anchor selection.

⚠ NOTE

When you consider choosing a structural anchor, be sure and consider the possibility of rust, fatigue and weathering in the structure.

A vehicle can make a good anchor if you anchor your line to the most appropriate part of the vehicle: that is, the most secure structural component. This is probably the chassis rail. It is also best to place the vehicle at a right angle to the load.

Before you use a vehicle as an anchor, be sure to:

- put the brakes on;
- engage the gear;
- chock the wheels; and
- remove the keys from the ignition.

1.12.5 Constructed Anchors

If you cannot find a strong natural anchor or a secure structural anchor for your line, you may have to construct an anchor. To construct an anchor, you may use pickets (hydrant bars). The constructed anchor must be as stable as you can make it, and it is very important to check and recheck the security of a constructed anchor. You can also use constructed anchors as back-up anchors for existing natural or structural anchors.

Many accidents are due to human error. When you construct an anchor, it must be capable of doing the task you expect of it. To ensure success, you must consider soil type and the anticipated load. Also, place a safety observer to monitor the anchor while it is under load.

Equipment

Pickets and ground plates are equipment components of the Primary Rescue Unit. These items of equipment can offer an excellent primary or back-up anchor if you use them correctly. The standard issue includes the following equipment:

- 2 x ground plates;
- 8 x pickets;
- 2 x bow shackles (large).

The picket and ground plate anchor system can provide a strong and versatile constructed anchor. It can be used where a suitable natural or artificial anchor is not readily available.

This anchor has four possible configurations:

- single-plate anchor with a capacity of approximately 2 t;
- 3:2:1 picket holdfast with a capacity of approximately 2 t;
- vee with a capacity of approximately 3 t;

- in line with a capacity of approximately 3.25 t.

The NSWFB has performed tests on all four systems in firm ground. The various configurations were loaded to the specified tonnages. Security of these anchors can obviously vary greatly depending on the type and compactness of the soil into which the anchor is placed.

1.12.6 Safe Working Practice

Whenever the ground plates and picket system is being used, you must place a firefighter to observe the system throughout the operation. Drive each picket into the ground as far as possible and leave a minimum of 100 mm above the plate.

CAUTION

When you construct an anchor, beware of underground services.

When you remove the pickets, tap the base of the picket back and forth until you can pull it loose. If it still sticks, tie a rolling hitch with a pocket line around the picket and tie the other end of the line to the middle of a spare picket. With a firefighter on each side, pull together while the base of the picket is tapped.

1.12.7 Load Sharing Anchors

You can share the load between two or more anchors. To do this, you locate two, or more points of attachment and anchor the line to each.

This technique is borrowed from rock climbing and mountaineering where anchors are often only a Piton jammed into an available crevice. In such a precarious situation, load sharing is obviously the best method to make the points of attachment safer. In rescue work, always try to select a bomb-proof anchor in the first instance. If it isn't worth using by itself, **don't use it!**

Always consider the primary anchor as being able to support the entire load adequately. You can back up the primary anchor with a secondary anchor, and this is considered good practice. But you should use the secondary anchor only as security insurance.

You can use load sharing also to redirect the position or lay of the line. Once you have chosen the anchors, you can use one of the anchor points to redirect the lay of the line for the most appropriate line position.

You can use load sharing to reduce the stretch or elongation of the line while it is in use. This can be useful if the anchor site is positioned some distance from the edge. Practically, this also has the added advantage of reducing abrasion to the line.

1.12.8 Sling Load Angles

When you load a sling, the angle at which it is loaded can reduce the sling's rated strength. **You must consider this every time a sling is used.** At certain angles, the compromise or reduction in strength may cause complete failure of the sling.

CAUTION

When two legs of a sling system form an angle of 120°, each leg is supporting 100% of the load. This is because the legs start to pull against one another as the angle increases (see Fig 1.27). Above 120°, the tension begins to increase at an alarming rate, at 150°, the load is 200% of the original load on each leg of the sling.

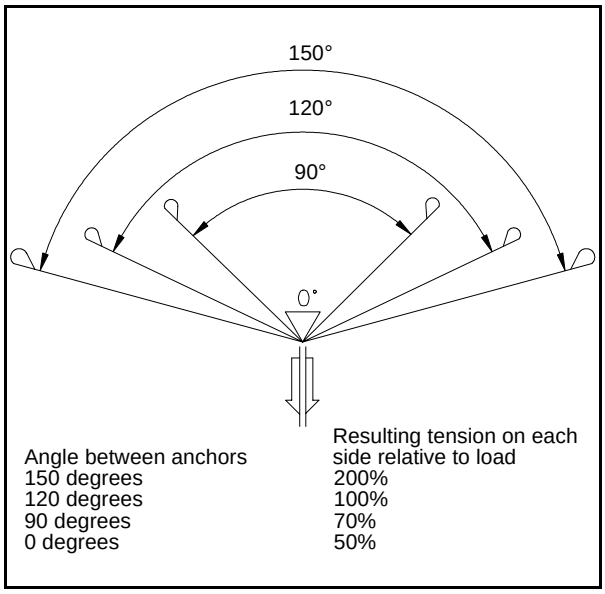

Fig 1.27 Result of Tension from Anchor Angles

Ideal - Yes - Trouble*:* this little slogan can help you remember the principle of correct sling load angles:

- **I for ideal**: at close to I, or zero degrees such as when a rope is taken around a block in a tackle or in a sling around a slim anchor such as a picket, the load on each leg is around 50% of the original load;
- **Y for yes**: at 90° and below, you have a safe sling angle; and
- **T for trouble**: you should exercise great care when the angles exceed 120°.

1.13 Constructing a Mechanical Advantage System

1.13.1 General

Pulleys are very useful in Life/Rescue work. You can use a pulley or a system of pulleys to:

- enable you to redirect a line to avoid abrasion or clear an edge; or
- gain a MA in a lifting situation.

Modern materials and technology now provide you with a much lighter alternative to the old wooden and iron blocks and pulleys that we used in years past.

1.13.2 Safety

To help you use pulleys and related mechanical equipment safely, here is a list of safety considerations:

- you determine your MA by the number of pulleys available and the configuration of the system when a pulley is added to a tackle (see Fig 1.28);
- each time you add a pulley, add a Karabiner so you avoid the damage that would occur if two pulleys were attached and loaded on a single Karabiner;
- whenever you use a MA lifting system, incorporate a belay device into the system to avoid the possibility of the load dropping;
- **do not** use the Life/Rescue Line to support any load other than a person;
- calculate the amount of line you need prior to assembling the tackle;
- assemble the tackle within arms reach, on the ground, and then place it in the required position;
- take care when the system is approaching *chock-a-block* (where top and bottom pulleys meet), damage may occur if the swaged ends contact the cheeks of the pulleys in the tackle;
- ensure that the SWL of the line, the pulleys, the Karabiners, and the slings are not exceeded.

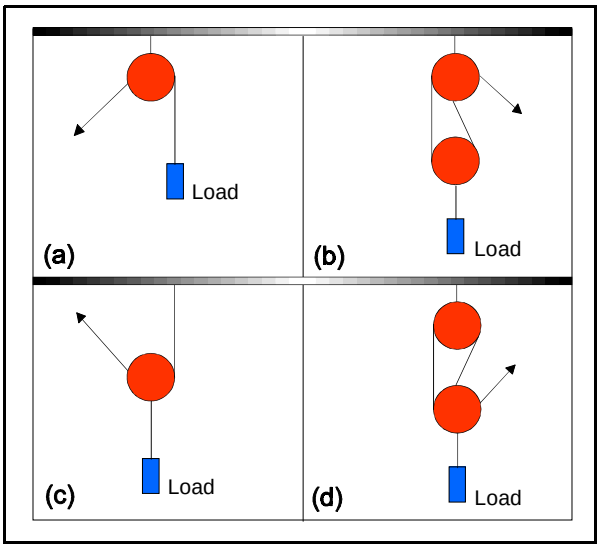

Fig 1.28 Calculation of Mechanical Advantage

(a) no MA (whip) 1:1;

(b) MA of 2:1;

(c) MA of 2:1; and

(d) MA of 3:1

⚠ NOTE

A separate Karabiner must be used with each pulley added to the system.

1.14 Rescue Techniques

1.14.1 Types of Rescues

The information in this section so far provides you with knowledge to perform specific tasks. Now we examine the basic techniques that enable you to perform a rescue operation to recover someone from a height such as a building, tower, or silo or from a depth such as a well, a pit, a trench, or an embankment.

There are five basic rescue techniques. They are:

- the top belay;
- the top belay pick-up;
- the haul belay;
- the self rescue; and
- the leaning ladder belay.

1.14.2 The Top Belay

In the top belay, you:

- reach the high point;
- anchor the friction device;
- lower the victim and/or the rescuer to base level; and
- walk out.

Procedure

The top belay is the most common rescue operation that you can perform with the equipment included in the cordage pack.

During the top belay, a firefighter wears a full body harness and is lowered by a friction device to access a position or rescue someone or something. In this operation, you attach a Life/Rescue Line to the firefighter's harness with a screw-gate Karabiner. The line passes through a *Harpoon* friction device attached to a suitable anchor (see Fig 1.27).

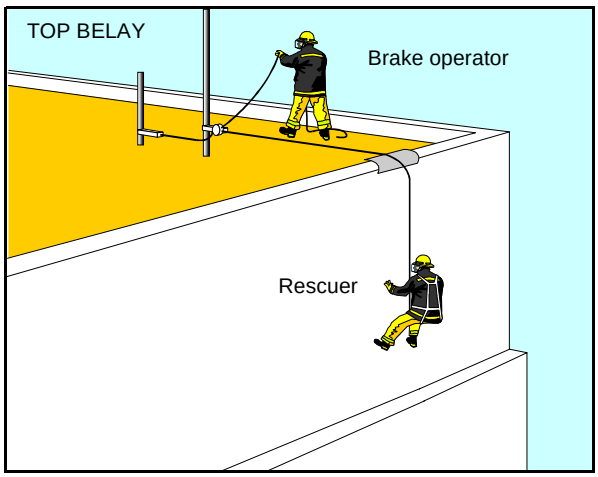

Fig 1.29 Top Belay Technique

The firefighter controlling the descent is referred to as the *brake operator*; the firefighter being lowered is referred to as the *rescuer.*

Protocol and Terminology

The brake operator first puts on gloves and takes up a position at the friction device. Taking the line in hand, they call loudly: *on belay.*

The rescuer on hearing this call, attaches to the Life/Rescue Line and when attached calls loudly *on rope*.

CAUTION

You must use these basic communications as they are absolutely critical to safety. They inform both operators of the status of the line.

Before the rescuer is lowered over the edge, they are checked thoroughly: helmet, harness, whistle, Karabiners (locked), anchor, and abrasion protection.

Other communications are *lower* and *stop*.

When the line is at *stop* or the Rescuer is at the bottom of the drop and still on the line, the *Harpoon* can be *locked off* or *locked off securely* (see Fig 1.30).

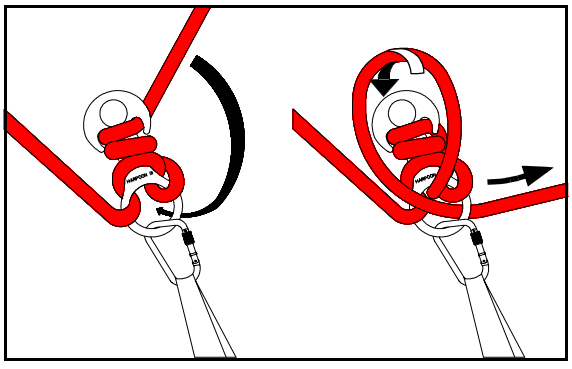

Fig 1.30 Harpoon Locked Off

When the rescuer is detached from the line, they call *off rope*. This line status call tells the brake operator to *lock off securely* the Life/ Rescue Line and call *off belay.*

1.14.3 The Top Belay Pick-Up

In the top belay pick-up, you:

- reach the high point;
- anchor the friction device;
- lower the rescuer to midpoint;
- pick up the victim;
- lower to the base level; and
- walk out.

Procedure

The top belay pick-up is an extension of the top belay. In the top belay pick-up, you, as the rescuer, collect a conscious or unconscious person and continue to the bottom of the drop. The operation is the same as the top belay except that you carry a chest harness for the victim. Fig 1.31 shows the top belay arrangement.

NOTE

The chest harness is attached to the Life/ Rescue Line using a separate Karabiner to an alpine butterfly knot tied approximately 0.5 m.

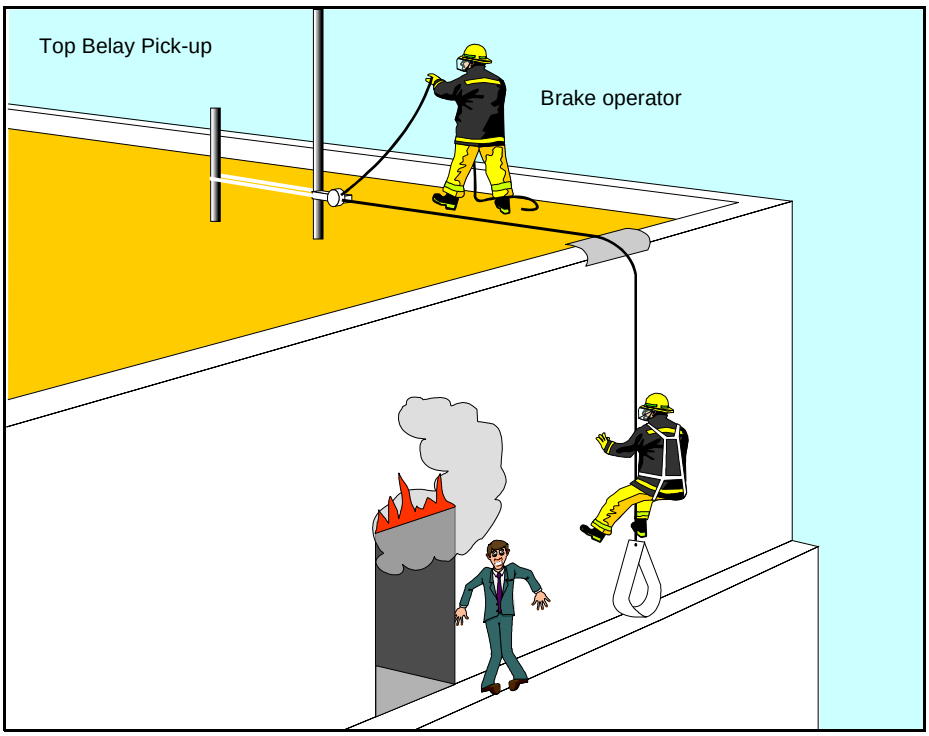

Fig 1.31 The Top Belay Pick-up Technique

When you reach the victim, you detach and fit the chest harness to the victim (where available). Persons at the top of the drop may need to haul slightly to enable you and the victim to clear any obstructions from where the victim may be positioned i.e. on a window or a ledge.

CAUTION

The added weight may cause some extra strain to the brake operator.

1.14.4 The Haul Belay

In the haul belay, you:

- start at the high point;
- place the line over the edge;
- reach the bottom of the drop; and
- haul the Life/Rescue Line to recover the victim and/or rescuer to the high point.

Procedure

Whenever you are performing a belay and the line needs to be hauled, you must maintain the security of the end of the line. To achieve this, the brake operator is assigned to *belay-in* the slack. The haul party consists of a minimum of:

- six team members for a one person load; and
- eleven team members for a two person load.

Hauling Methods

In some situations, available space is at a premium. When your area of movement is restricted, the **hand-over-hand** method of hauling is the only practical method of recovery.

At other times, when you have enough room, the **walk-away** method is the best to use. When you use the walk-away method, members of the haul team are positioned on alternate sides of the Life/Rescue Line (see Fig

1.32). Each member of a haul team rotates to the front of the group as they reach a predetermined mark or point. This method must be closely co-ordinated to ensure that **all** members of the hauling party remain **on line** throughout the haul.

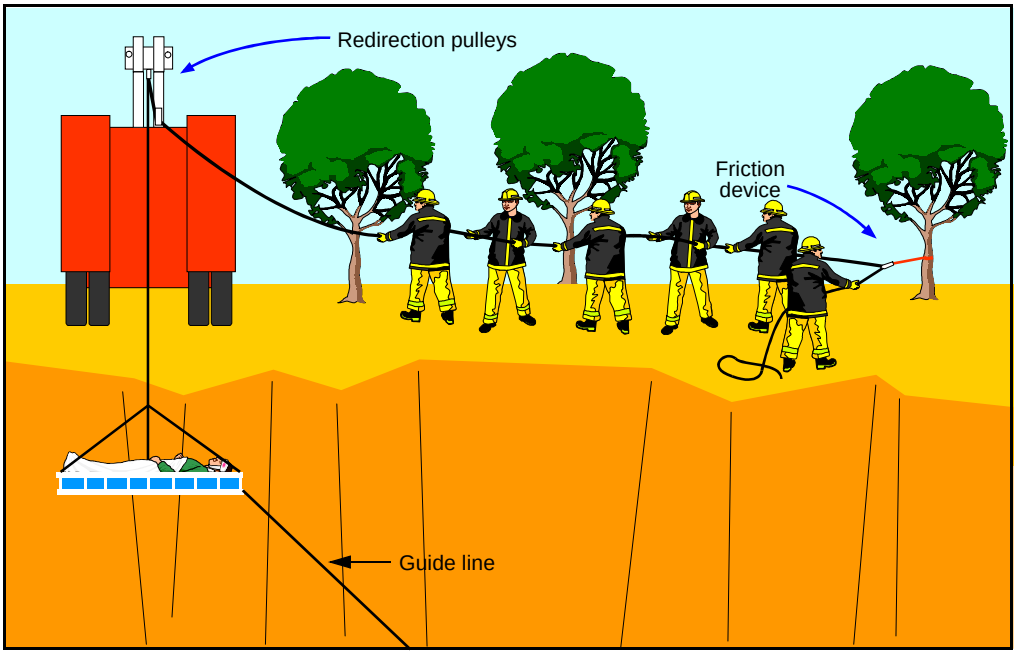

Fig 1.32 The Haul Belay Technique

1.14.5 The Self Rescue

In the self rescue, you:

- start at the high point;
- attach a friction device to the harness; and
- descend to the low point.

NOTE

This technique is for emergency use only and not for the rescue of other persons.

Procedure

In the self rescue technique, you lower yourself with the Life/Rescue Line. The line passes through a friction device attached to the full body harness, and you, in effect, abseil (see Fig 1.33). The term self rescue technique is used to reinforce the reason for the technique. If you experience a problem during the descent, you have no means of recovery, as at this level of training, ascending a line is not necessary nor practical. The self rescue technique is taught to enable you to know how to evacuate yourself from an emergency situation.

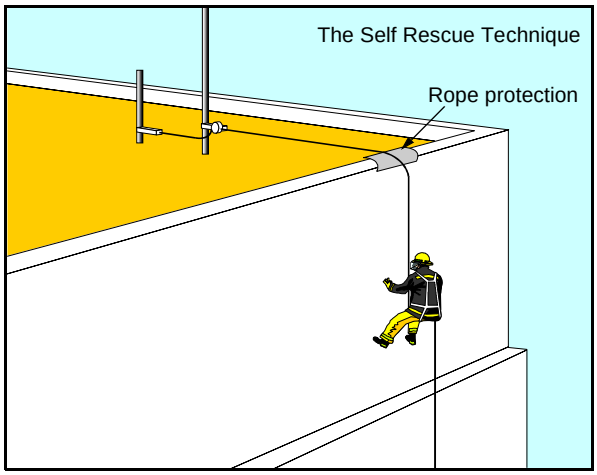

Fig 1.33 The Self Rescue Technique

The Bottom Belay and Safety

When you are training in the self rescue technique, it is important that you use the training line. If a mishap does occur, the Life/ Rescue Line may be used by the rest of the team to recover you. The bottom belay method can increase the friction on the line from the bottom of the drop. The bottom belayer stands ready at the bottom of the drop to increase the tension on the line if required.

The Operation

As the person performing the descent in this method, you should do the following:

- use *on-rope* and *off-rope* calls when they are required;
- call *abseil* when you are ready to descend the line;
- descend the line slowly. Avoid fast-friction or shock-loading jerks;
- keep your thighs at approximately 90° to the vertical;
- position your braking hand near the centre of your backside; and
- keep your feet apart to maintain stability.

⚠ NOTE

In training, do not descend the line until the bottom belayer calls *OK*;

CAUTION

Do not stop or pause on ledges during the descent.

1.14.6 The Leaning Ladder Belay

In the leaning ladder belay, you:

- use a standard NSWFB extension ladder from the low point;
- reach the high point;
- recover the victim and/or rescuer; and
- return to the low point.

Procedure

The leaning ladder belay technique is used to recover a casualty from a height such as a second level window or an area not otherwise readily accessible. First, you attain initial access with the ladder. You, as rescuer, take a chest harness and full body harness to the required level while the casualty is being accessed and prepared.

When you are ready to descend, the ground crew prepares the Life/Rescue Line for attachment to the ladder. A web tape sling is attached to the head of the ladder where the strings attached to the top rung. A pulley is attached to the sling on an upper rung of the ladder and a *Harpoon*/sling is attached to usually the bottom rung. The ladder is then positioned so that the top pulley is **above** the position of the victim (see Fig 1.34). Where possible, secure the head of the ladder to the wall. The end of the line is then attached. The brake operator can now easily lower the victim to the ground. If required, the line can be hauled slightly between the top pulley and the *Harpoon* to lift the victim clear of any obstructions.

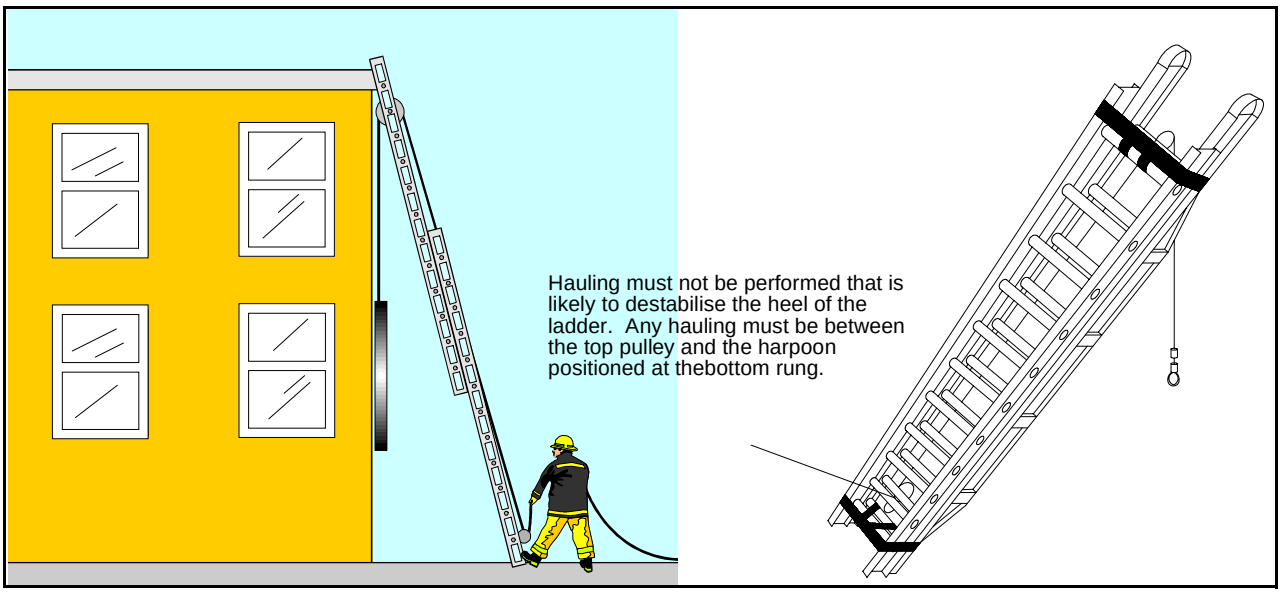

Fig 1.34 The Leaning Ladder Belay Technique

CAUTION

If you use hauling, you must be careful not to destabilise the heel of the ladder. Any hauling must be between the *top pulley* and the *Harpoon* positioned at the bottom rung. The use of guide lines, unless used directly under the ladder, may cause the head of the ladder to be de-stabilised.

1.15 Communications

1.15.1 General

When you use the basic techniques, success can often depend on effective communication. Whenever it is possible, it is best to use voice communication.

However, sometimes you need other means of communication because the length of the Life/ Rescue Line in the cordage pack can put you in a position where voice communication is not effective. For these situations, we have radio communications and whistle and hand signals. These are more effective in difficult situations such as darkness, noise, and bad weather.

Here we discuss each of these means of communication.

1.15.2 Voice Communications

Table 1F details the various voice communications that we use and the message they carry:

VOICE COMMUNICATIONS	MESSAGE (MEANING)
On belay	During a top belay or a top belay haul, the brake operator gives the on belay call after they have positioned themselves with the Life/Rescue Line in the correct manner and are ready to take control of the descent
Request gear and rigging check	When you, as a rescuer, give this call, another person checks your gear and rigging
Check complete	This is the call given by the person who has carried out the gear and rigging check to inform the rescuer when the check is complete and satisfactory
On rope	When all the gear and rigging checks have been carried out, you, as the rescuer, call out loudly on rope to tell everyone present that you are about to commence your descent. If a bottom belay is being used, they respond with ok to tell you that they have readied themselves in an appropriate position
Off rope	When you have completed your descent, you disconnect from the line and move to a safe area. You then call loudly off rope to inform personnel above that you have safely complete your descent. The brake operator or observer acknowledges by calling OK
Lower	You make this call if you require the brake operator to lower you slowly
Stop	You make this call if you require the brake operator to stop the descent immediately
Haul	You make this call if you require the haul team to raise you up
Help	You make this call if you require immediate assistance
Below	This call alerts all persons below if falling objects may pose a danger to them. Anyone below, on hearing this call, does not look up but moves to the face of the wall or cliff away from the fall zone
Lock off	This call informs everyone that the friction device is locked off
Lock off securely	This call informs everyone that the friction device is locked off securely
Silence	When you hear this call everyone must remain silent except when communicating commands or acknowledging commands
OK	When you receive a command from the Leader, you must repeat the command and reply OK to indicate that you have received the instruction, and that the command is being carried out, or has been carried out

Table 1E Voice Communications used in Rescue Operations

Here is an example of the dialogue that might take place during an operation:

leader:	*brake operator lock off*
brake operator (reply):	*ok, locked off*
leader:	*take the strain*
	(the haul team takes the strain.)
leader:	*ease the strain*
	(the haul team eases the strain.)

1.15.3 Whistle Signals

If you are unable to use voice communication, you can use whistle signals. Here is a list of the various whistle signals and the message they convey:

- one short blast: *stop*
- two short blasts: *haul*
- one long blast: *lower*
- continuous blasts: *help*

If the distance over which you are sending a whistle signal is so great that the whistle signal may not be heard, you can position another operator at a midpoint in the line. This second operator can relay the whistle signal. All whistle signals should then be echoed by all operators down the line. This ensures that the operator has made a clear communication.

1.15.4 Visual Signals

If voice communication is not possible, and whistle signals are not practical, you may have to use hand signals. When you use hand signals, make the signal with your arm fully extended from your body.

Here are some illustrations of the hand signals we use:

Stop

Hand and arm extended with palm towards the *Cliff Master.*

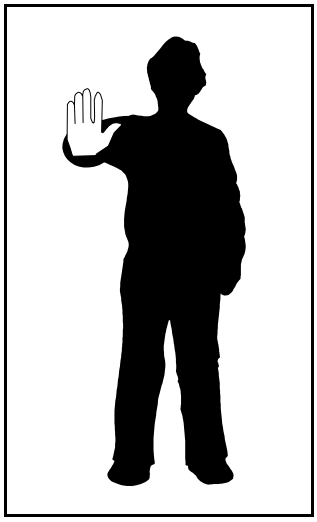

Fig 1.35 STOP Signal

Haul

Finger pointed upwards with forearm positioned at head height, moving in circular motion during upwards movement.

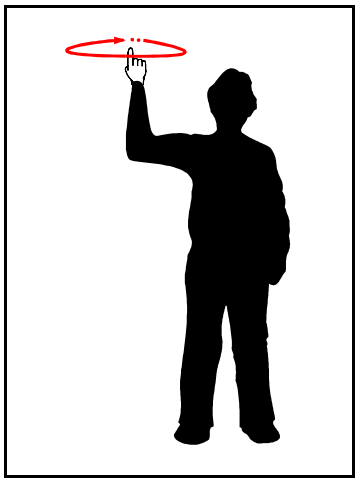

Fig 1.36 HAUL Signal

Lower

Hand fully extended, palm down, motioning a downwards direction.

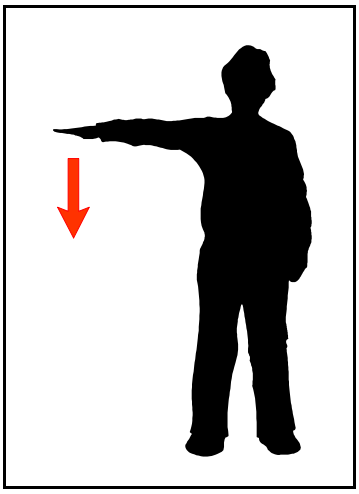

Fig 1.37 LOWER Signal

1.15.5 Advance Notice of the Need for Helicopter Assistance

If you are considering the use of a helicopter to assist in a rescue, you should make this decision as early as possible. Further, you should try to complete any planned operation with a helicopter during daylight hours. Nightfall brings certain dangers and restrictions to all helicopter operations.

While you are determining whether to use the helicopter, you are advised to give some advance notice to helicopter operations. This notice helps to reduce the response time that it takes to get the helicopter to the scene.

In your advance notice, you should inform the helicopter control centre of the following:

- the nature of the accident;
- the number of persons involved;
- a grid reference or UBD reference; and
- possible landing areas.

This information enables the helicopter operator to inform the emergency organisation at the earliest possible time as to whether the task required of the helicopter is possible or not. If the helicopter cannot assist you, the organisation can then look at alternative means of assistance.

1.16 Cliff and Vertical Rescue

1.16.1 Safety

Because of the hazards involved, cliff and vertical rescue operations require special attention to safety and approved techniques.

Here is a list of some points to consider relating to safety in cliff and vertical rescue:

- **common sense**: use a common sense approach to adopt the most practical and straightforward means of recovery;
- **communication**: use standard terminology that is practiced at training exercises to ensure good communication between crew members for a smooth operation;
- **control**: enable the crew leader to direct a successful rescue by supporting their control and direction of the operation, including the secondment of personnel to assist in the operation;
- **equipment maintenance**: maintain your equipment in a serviceable condition to ensure top performance from your cordage pack and ancillary equipment;
- **leadership**: appoint a team leader to ensure that the team is used to its full potential and as safely and as effectively as possible;

- **local knowledge**: be familiar with high risk areas within your unit's boundaries and conduct regular training exercises to maintain familiarity;

- **safe assessment**: use methods of assessment that maintain a high standard of safety for all involved in the operation even in the face of adverse conditions or panic; and

- **skills maintenance**: hold regular training exercises to ensure that each individual crew member can fulfil their function.

⚠ NOTE

Training must be moderated, extended training exercises can be taxing on concentration.

1.16.2 Assessment

Correct assessment of the rescue situation is the first essential step in a successful operation. Each rescue operation is different; each one has its own unique characteristics; each requires careful thought, planning, and ingenuity. In this section, we look at some of the initial considerations and then we consider each step in the assessment process in more detail.

When you assess a rescue operation, you must consider many factors and take into account at least the following:

- the physical nature of the incident site;

- prevailing weather conditions;

- available resources; and

- the time of the day.

Practising the assessment process begins with your next training exercise. In each training session, you improve your skills in the use of your equipment, but you can also improve your skills in the assessment process. Watch for the intricacies of each operation, and seek to build an innovative approach to assessment.

The rescue operation leader should be the person in your crew who is most qualified and experienced in vertical rescue. If you are the leader, you use the assessment process to develop a plan for the most practical and straightforward method of recovery. For instance, as leader, you would place priority on finding a suitable and safe stretcher access to the bottom of the drop so that you can *walk* a victim to safety. You would refrain from a flamboyant display of rescue equipment. Vertical rescues are risky, your main considerations are the safety of the victim/s and your crew.

1.16.3 Step One: The Call

When you receive a call to respond to an incident that may require vertical rescue, you must gain certain important details in the initial conversation. It will help if you know what you want to find out. In addition to the standard emergency information, you want to know at least the following:

- exact location of the casualty;

- suitable access for responding vehicles;

- contact person on-site and how you can contact them; and

- assistance available on-site, including a hauling party.

1.16.4 Step Two: Arrival at the Scene

When you arrive at the scene, transmit a short informative message to the State Communication Centre

- confirm the presence of other Services in attendance at the scene;

- give details of the exact location of the scene and the most suitable access;

- provide as much appropriate information as you can for other responding vehicles; and

- find out if there are any witnesses to the incident who are familiar with the area. Witnesses can provide useful information regarding the casualty's exact location, and local people may know how to gain access to the bottom of the drop.

1.16.5 Step Three: Obtain a History

When you are trying to piece together the history of the incident in the assessment process, you will need to determine the following information:

- how long the victim has been at the present position;

- if the victim fell to their present position, when the fall occurred and the time that has elapsed since the emergency began and prior to your arrival may determine some immediate priorities that are crucial for the survival of the casualty;

- what the victim was doing at the time i.e. some mishaps in recreational activities, such as hang-gliding, abseiling, rock climbing, and rock fishing, are more likely than others to create a cliff rescue situation, so the type of activity can help you to make some general assumptions about possible injuries, access, and position on the cliff face;

- how old the victim is. Knowing the victim's age can help you plan for the anticipated load and help you determine how well equipped the victim is psychologically to cope with the trauma of the injury and the stress of the situation;

- whether the incident was a suicide that ended in a fatality. If this is a successful suicide, you must respect the responsibilities of the coroner and the police at any fatality including the following:

  - police requirement to view the body *in-situ* prior to removal;

  - the need to maintain a record of your actions at the scene; and

  - preservation of physical evidence.

- whether the victim was attempting suicide but survived the attempt. This can substantially affect the victim's psychological state; and

- whether the victim is emotionally stable. Co-operation with police to deal with these situations is essential.

1.16.6 Control of the Incident Scene

When you arrive at the incident site, you will have completed your initial assessment from the information you received prior to arrival.

Your first action at the site is **to take control of the area**. For this you need the assistance of police, emergency personnel, and other responsible people who are present. If you are working at the edge of a vertical precipice, first move any crowds of people present back from the edge. You can use barrier tape to cordon off areas. It may be impractical for you to attempt to evacuate the area as you may need to enlist the help of some of the bystanders in the actual rescue operation.

In this initial stage of the operation, you must plan your actions calmly. Consider and use any reliable information you have available

from your initial assessment. Here is a list of some of the important first steps you should take at this stage:

- try to establish communication with the victim. See if you can find a vantage point where you can look back at the drop and make visual and voice contact with the victim;
- be careful if you place your operating position immediately above the victim;
- be careful in your approach. Soft edges or loose rocks may be responsible for the accident; and
- consult any witnesses present to find out where the victim fell.

1.16.7 Planning a Safe Approach

If loose or dangerous objects at the edge pose a hazard, stabilise this condition or remove the hazard. This step in your approach can be extremely hazardous, so use good careful judgement.

In some locations, you may need to assemble a top belay to overcome a heavily vegetated cliff edge (see Fig 1.38). The top belay allows a *hands-free* approach and the safe use of a full body harness. You can then make a thorough search of the vertical approach and formulate a plan to remove the victim. After you are sure that the edge is safe, declare a 2 m safety line zone and restrict access to this zone to persons who are wearing a safety line/harness.

Fig 1.38 A Safe Approach

When you look over the edge of the precipice, stay about 1 m back from the edge. Place your body weight on your forward foot and leg. If you don't feel safe in this position, place yourself about half a body length from the edge and then lie down just so your head can clear the edge and give you a good view to the bottom of the drop (see Fig 1.39).

Fig 1.39 Safe Positions for Viewing

1.16.8 Initial Access

When you have made visual contact with the victim, make the following determinations before you decide what to do next:

- whether there are signs of movement;
- whether there are signs of severe trauma;
- whether you can make communication with the victim; and
- whether the victim is in a stable condition.

⚠ NOTE

During this initial stage, and until you actually achieve access to the victim, you assume that the victim is still *alive* even if they appear to be lifeless.

If you decide that you must gain immediate access **urgently** to attend to the victim or give first aid, set up a top belay. This enables the first aider to remain *on-rope* while they attend to the victim. While they work, you can set up the retrieval/hauling systems at the top of the drop.

As you gain access to the victim, you should take equipment that includes the necessary items to cater for the basic first aid requirements. The items may include:

- oxygen resuscitator;
- blankets, both woollen and thermal;
- first aid equipment;
- cervical collars and splints;
- lights, torches;
- helmet and goggles for casualty protection;
- stokes litter;
- restraint straps; and
- wet weather clothing.

1.16.9 Time of Day

The amount of light remaining in the day is a major consideration. Vertical Rescue Incidents can become prolonged or protracted operations. When conditions change, and they often do during the operation, even straight forward situations can become complicated and problematical.

If you arrive at the scene of the incident in the afternoon, you must prepare to take lights over the edge. Begin to prepare these lights while you still have plenty of natural light available. **Don't wait until the lack of natural light begins to cause a problem**.

If you must work at night, everyone must be more careful. For a night operation, be sure that each crew member has a light source of their own and set up and maintain a good communications network.

1.16.10 Weather Considerations

As rescue operators, you may be well experienced and secure in your work. You may be comfortable with conditions at the top of the drop especially if the weather is good. But conditions at the drop can become worse very quickly if bad weather sets in. Rain and high winds can cause poor visibility, and this affects communications. Bad weather can also eliminate the possibility of using a helicopter to retrieve a victim.

A victim at the bottom of the drop may feel considerably less secure and comfortable. They may be injured, and they are probably frightened. Cold conditions and rain can cause or accelerate hypothermia. Hot and oppressive heat may force you to consider asking for more help if you are considering a stretcher walk over an extended distance or through rugged terrain.

1.16.11 The Incident Site

The physical features of the site are a major influence on the way you conduct the rescue operation. Table 1G details considerations relating to both natural topographic features and industrial features.

TOPOGRAPHICAL FEATURES	INDUSTRIAL FEATURES
Walking access to the bottom or top of the drop	Exposed or hazardous electrical connectors
Physical features: sloping, shear or overhung	Mooring machinery
Stability of the ground, particularly at the edge: is it shale, soil, rock or fill	Fuels and chemicals in the area
Position of the casualty on the vertical plane	Greasy or oily surfaces
Available anchor points: natural and constructed	Hot surfaces or extremely cold pipes, naked flames or convected heat
Suitable clear area to set up retrieval systems	Unstable structures
Clear areas at the bottom of the drop	Exhaust or steam outlets
Movement of tides, waves and surf	Irrespirable air or dusty atmosphere
High concentrations of naturally occurring foul air such as carbon dioxide	Noise that may hinder communication

Table 1F Actions Determined by the Incident Site

1.16.12 Safe Working Practices

Here is list of safe working practices for cliff and vertical rescue:

- perform equipment and inventory checks regularly as well as before and after use;
- at the site, set up a staging area to provide safe and free access to equipment;
- in the staging area, place the equipment on a salvage sheet;
- keep working areas and cliff edges clear of non-emergency personnel. Consider the use of barrier tape;
- for anyone approaching within 2 m of the edge, provide a harness and a line attached;
- observe strictly the directions of the leader who is also the safety officer;
- if you are the *litter attendant* i.e. the person being belayed, re-check the rigging prior to proceeding;
- choose your anchors with due regard for the loads to be placed upon them: always consider back-up support;
- use edge rollers or corn sacks where sharp edges may cause rope abrasion;
- use *on rope and off rope/on belay and off belay* calls. They are crucial for safe operations in the cliff and vertical rescue environment, and they indicate

the status and security of the Life/ Rescue Line and form the most basic communications;

- if you use the top belay, you probably won't need to throw a rope from above. However, if you need to throw a rope off the cliff top, use the call *rope below* to warn persons below;
- if a rock or loose object is dislodged and falls from the cliff, shout *below* to warn persons below to take cover;
- if you are a brake operator or litter attendant, you must wear gloves during operations;
- if you are a brake operator using a friction device, you should, whenever practical, adopt a body belay;
- if you are a litter attendant or a person being belayed, carry a whistle as a reserve communication device;
- if you are using untrained persons in the hauling party, alert them to the rule of **No Standing On Ropes**;
- if a fault develops during an operation, shout ***STOP***;
- observe **silence** during all training or rescue operations;
- in drills and training exercises, always use training lines so that you preserve the condition and efficiency of all Life/Rescue Lines;
- **do not use the self-rescue technique** to gain access to a victim unless you have advanced training in the use of this technique;
- use **live patient stretcher training** only when authorised instructors are in attendance;
- when you use a Karabiner, orient it:

  - so that the screw gate is protected from abrasion, away from the rockface; and

  - so that vibration will not cause it to become unlocked.
- when you are lowered to a position at the bottom of a drop and you are *off rope*, keep your Karabiners attached to your harness; and
- do not drop or toss ancillary equipment carelessly to the ground, it is life supporting hardware and it must be handled with care.

SECTION TWO - MOTOR VEHICLE EXTRICATION

CONTENTS

CONTENTS

2 MOTOR VEHICLE EXTRICATION

2.1 Introduction

The NSWFB has a long history of involvement in releasing victims of motor vehicle accidents who are trapped in their vehicles. We can respond rapidly, we have the fire protection capability, and we have a wide inventory of tools. We are ideally suited to provide road accident rescue service to the community.

Prior to 1960, motor vehicles were heavy, rigidly constructed, and relatively slow. The volume of traffic was far less than it is today. Serious and fatal accidents did occur, but it was rare for a person to be trapped in a wrecked vehicle. When a person did get trapped in this way, the extrication could take several hours.

The mid-1960's brought a new design of motor vehicle. These new vehicles had stylish bodies, more features, powerful engines, and greater speed. The cars were designed to crumple progressively on impact. More frequently, people were being trapped in their motor vehicles when they were involved in an accident. This presented a challenge to rescue agencies. The NSWFB met this challenge by increasing the equipment inventory, the training, and the number of Salvage Rescue Appliances.

In 1979, the Board of Fire Commissioners and the Minister for Emergency Services agreed to legislate an expanded role for NSWFB in rescue operations. *The Fire Brigades Act 1979 (Amendment)* gave the NSWFB the power to undertake rescues that were not associated with fire.

A training program and an equipment upgrade installation program were introduced that eventually gave a light rescue capability to all Brigades. The main purpose of the new training and equipment was to provide all Brigades with the ability to be effective in releasing persons trapped in motor vehicle accidents (MVA). The wide geographic spread of the NSWFB, our training, our modern equipment, and our rapid response time enabled us to develop an efficient and effective rescue service.

The State Rescue & Emergency Services Act 1989 further rationalised the rescue services throughout the State. NSWFB now has metropolitan and country primary and secondary rescue units.

In the service of rescue of persons in MVA, the NSWFB is now second to none. Our equipment and our advanced extrication techniques, coupled with our ongoing training, ensure that the NSWFB provides a world class rescue service.

2.2 A Motor Vehicle's Structure

2.2.1 Introduction

It is important for you to know and to use accurate terminology when you describe the particular parts of motor vehicles.

Figs 2.1 and 2.2 identify the main structural components of a motor vehicles.

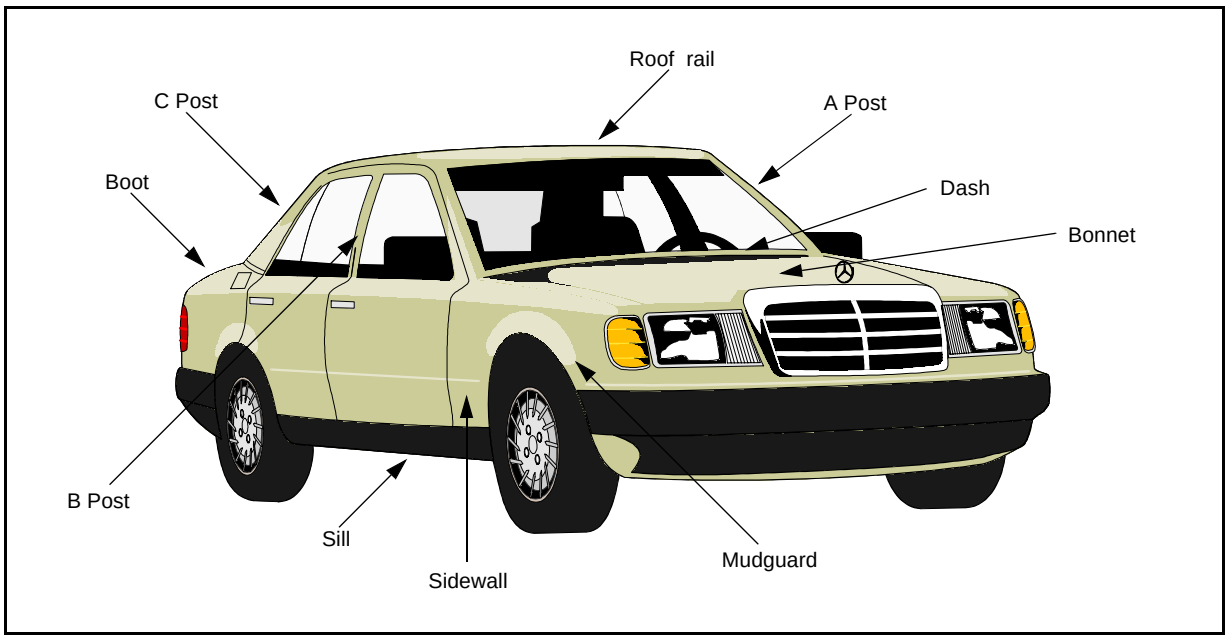

Fig 2.1 Structure of a Four Door Sedan

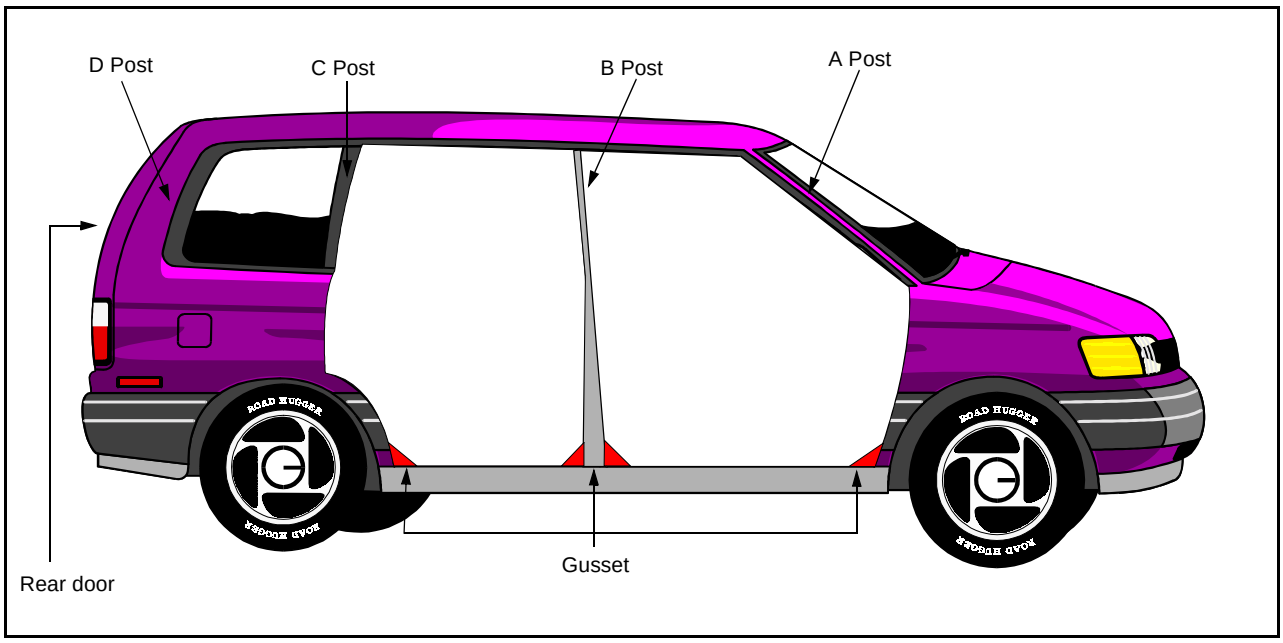

Fig 2.2 Structure of a Four Wheel Drive Vehicle

2.3 Hazards at a Motor Vehicle Accident

2.3.1 Introduction

When you attend a MVA, it is essential that you appreciate the hazards that can exist for firefighters, for the victims and for the general public. The information that follows in this section will assist you to reduce these hazards and in some cases, eliminate them altogether. To be effective in rescue operations, you should be aware of and follow the NSWFB Standard Operating Procedures (SOP's). This section covers those aspects of the SOP's that relate to MVA's and motor vehicle rescue and extrication.

2.3.2 Protecting the Accident Scene

When you arrive at the accident scene, you should place NSWFB vehicles in the **fend off** position (at an angle of 30°). This position helps protect the accident scene from oncoming or following traffic. You should also:

- place warning signs and signals in both directions to provide advanced warning to motorists; and
- request police assistance for traffic control.

2.3.3 Fuel Spills

Fuel spills at the scene of a motor vehicle accident pose special hazards. Here is a list of actions and precautions you should take when you arrive at the accident scene:

- deal with spilled fuel immediately upon arrival;
- cover any pools of flammable liquid with a foam blanket to prevent the escape of vapours. Keep the foam blankets in place throughout the operation;
- carefully plug leaking fuel. Do this under the protection of a hoseline;
- remove all unnecessary personnel from the area until the fuel hazard has passed;
- be aware that a very small amount of fuel can present a high risk; and
- request fire protection if there is none present when you arrive e.g. salvage rescue vehicle.

2.3.4 Fire Protection

When you arrive at the scene of the MVA, it may be your responsibility to request fire protection. Here are some points to cover when you request this protection:

- the minimum fire protection required is a 38 mm hoseline, charged to 400 kPa with an *Akron* spray branch;
- the branch must be hand-held by a firefighter in full turnout gear;
- the firefighter holding the branch must be positioned close to the risk ready to provide immediate water protection should a fire ignite;
- if the hoseline is used, the pump should be operated to 800 kPa with a minimum 90° angle of spray. The pump cooling valve must be operated; and
- the pumper must be positioned in a fire safe area at least 15-30 m from the incident unless circumstances dictate otherwise.

2.3.5 Electricity

Adhere to SOP's. Check for damaged or weakened power lines or poles.

2.3.6 Car Batteries

Car batteries can cause various hazards in a MVA, especially where the accident involves an overturned vehicle or a very severe head-on collision. Battery acid is particularly dangerous, and it can leak out of an upturned or fractured battery. You can use a fine water spray to ensure that both casualties and rescuers are protected from this hazard. Wear eye protection when you are working in the vicinity of a leaking battery.

Here are some actions you can take to minimise the dangers caused by car batteries at a MVA scene:

- turn off the ignition and remove the key. The wiring looms of the vehicle's electrical system often run through the sills and posts of the battery and can cause an electrical short when cut;
- **do not** disconnect the battery of a damaged car unless the battery is creating a problem;
- if you must disconnect the battery, do so under the protection of a water spray. Disconnect the earth terminal first and then disconnect the active terminal.

2.3.7 Liquid Petroleum Gas

Liquid Petroleum Gas (LPG) can cause particular problems. The problems associated with LPG are described in *Topic 3*. If LPG is involved, follow the SOP described in that section. You can avoid some of the problems by merely being aware that LPG may be involved in the accident.

Here is a list of some of the signs you can look for that might indicate if LPG is used by a vehicle in the accident:

- red square fitted in a diamond shape on number plate;
- two fuel filler inlets;
- changeover switch on dashboard;
- the presence of an LPG odour; and
- the hiss of escaping gas.

2.3.8 Load Hazards

When you arrive at the scene of an MVA, you should check whether any of the vehicles involved are carrying hazardous goods. You should pay special attention to small panel vans, utes, and forward control vehicles, as these are often used by commercial couriers to carry hazardous materials.

If you suspect that a hazardous material may be involved, take into account the wind direction when you plan your attack on the accident scene. The wind can carry dangerous fumes and gases away from the accident scene, and further complicate rescue efforts.

⚠ NOTE

If you suspect that a hazard exists, request the attendance of BA/Hazmat Section.

2.3.9 Catalytic Converters

A catalytic converter looks like a large muffler. It operates at extremely high temperatures (1000° C) and can cause serious burns if it makes contact with the skin.

Check for the presence of catalytic converters in the damaged vehicles. These converters are installed in vehicles manufactured after 1986. They are positioned in the exhaust system and are part of the pollution control system.

If a catalytic converter is present, it is very important that both high and low pressure airbags do not come in contact with the converter.

2.3.10 Supplementary Restraint System - Airbags

It is becoming increasingly

for later model cars to be fitted with supplementary restraint systems (SRS), more commonly known as airbags.

Airbags are a safety device designed to provide additional protection to the occupants of a motor vehicle involved in a collision. When two sensors in the front of the vehicle detect a deceleration in excess of a preset limit, the airbags inflate to cushion the impact of the impending collision.

The airbag inflation system is powered from the vehicle's battery by way of a capacitor. This capacitor is designed to hold sufficient power to deploy the airbag if the battery is damaged in the initial impact. The power in the capacitor ignites the propellant (sodium azide) to produce a gas (nitrogen), and this gas inflates the bag.

Identification of SRS Vehicles

Many luxury cars have airbags as a standard feature. However, lower priced cars are also now being fitted with the safety system.

To identify a vehicle that has airbags, look at the centre of the steering wheel. If the car has an airbag fitted, the steering column may be enlarged to contain the component parts of the airbag system. Also, most cars fitted with airbags have the words *airbag* or *SRS* embossed on the steering wheel and glove box (see Fig 2.3).

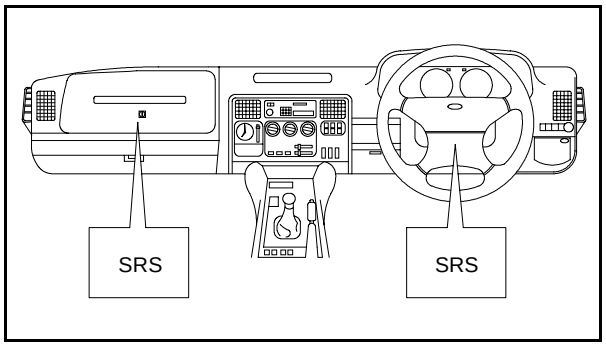

Fig 2.3 Location of Airbags

In many cars, airbags are now also being fitted to the passenger side. These are generally located in the dashboard above the glove box. In the near future, airbags will also be fitted to the doors for passenger protection in side impact collision. These are called *Side Impact Protection Systems* (SIPS).

Deployed Airbags

If an airbag has deployed at a MVA (see Fig 2.4), it does not pose a threat or danger. You can remove the bag by cutting it away with a knife or scissors. You may notice some white powder in or on the bag, this is most likely either talc or corn starch and is used as a lubricant during the deployment of the bag. It may cause a slight skin irritation but otherwise it is quite harmless.

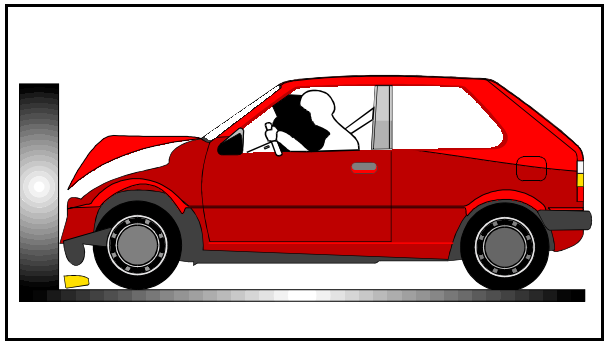

Fig 2.4 Airbag Operation

Non-Deployed Airbags

An airbag does not deploy in a side impact, rollover or rear end collision. Therefore you will attend many MVA's where the airbag is still intact or non-deployed. You must be aware of the potential hazards of an intact airbag at a MVA. Do not delay the rescue due to an intact or non-deployed airbag, but take special precautions.

CAUTION

Do not use a radio transmitter or cellular phone within 15 m of a non-deployed airbag

Here is a description of the safe working practices you should follow at an incident involving a non-deployed airbag:

- treat a non-deployed airbag as a **safety hazard**. Ensure that no part of your body or equipment gets in the way of the possible deployment path of the airbag;
- take particular care when conducting steering column pulls and when cutting into the **A** Post and floor sills;
- adjust the seat of an injured person back as far as possible, so long as the person's injuries permit movement in the seat;this will reduce the possibility of injury if the airbag suddenly deploys;
- **never** cut or drill into the airbag assembly;
- **never** attempt to dismantle the airbag assembly;
- **never** apply a heat source in the vicinity of the airbag assembly; and
- disconnect the battery in the approved manner.

CAUTION

Even with the battery disconnected, remember that there may be enough power left in the capacitor to deploy the airbag.

2.3.11 Miscellaneous

Here is a checklist of some of the miscellaneous hazards you may find at the scene of an MVA:

- broken glass in the working area can present a hazard to rescuers, especially if you kneel down on it. If broken glass is present, cover it with a salvage sheet;
- if you find sharp or jagged metal, cover it over with canvas sheets or heavy tape;
- a vehicle that has been in an accident and has then come to rest in contact with a wire fence may have caused extra tension in the wire. If you cut the wire, it may **whip** violently and cause injury to you or someone standing near you. Clear the accident area and drape a salvage sheet over the wire. Then cut the wire close to the vehicle and allow it to **whip** away safely;
- watch for debris that may present a **tripping hazard** and remove it from the area as soon as possible; and
- some luxury vehicles have shock absorbing bumpers. These bumpers can become **loaded** or compressed, as a result of accident damage. If you accidentally release one of these loaded bumpers, it can suddenly spring away from the vehicle and injure anyone who is close to it. If you identify one of these bumpers or suspect that one is on a damaged vehicle, advise anyone in the area to move across the front or rear of the vehicle carefully, and at a safe distance.

2.4 Safety at the MVA Scene

2.4.1 Introduction

When you attend a MVA, you may find a scene of confusion, panic, and chaos. To serve everyone in the best possible way, you must keep your priorities in order. Here is a list of those priorities in their order of importance:

- **first, you** are the first priority. You must protect yourself and your fellow rescuers, and keep yourselves safe;

- **second, those not involved in the accident** are your second priority; these include residents, other motorists and bystanders. Clear them from the scene of the accident so that they do not interfere and they are out of harm's way; and

- **third, the injured persons** are your third priority. Take care of the casualties, and ensure that their condition is not made worse by the extrication process.

2.4.2 Safety of Rescue Operators

Your first responsibility is to yourself and your fellow rescuers. Here is a list of precautions and actions you should observe if you are the rescuer at a MVA:

- wear protective clothing, a minimum standard includes eye protection, long sleeved workshirts, trousers, boots, gloves, and overtrousers;

- use care when operating tools and hydraulic equipment, your body position is important. Hydraulic equipment tends to turn while being operated as it seeks the path of least resistance. This movement can pin your body or limbs;

- anticipate the movement of the tools: do not stand between the tool and the vehicle, and always watch your hands and fingers when operating hydraulic equipment and other tools. Beware of a tool reaction should it slip during the operation;

- assemble and operate tools according to NSWFB instructions;

- sweep broken glass and other sharp objects clear of the immediate scene*:* these items can cause injury if you kneel on them. Sweep them clear or cover them with a canvas sheet;

- stabilise a vehicle before you work on or under it; and

- lift and carry according to *Occupational Health & Safety* guidelines e.g. use the **two-person lift**.

2.4.3 Safety of Other Personnel

As a rescuer, your second responsibility is to watch out for the care and safety of others at the scene. These include motorists, residents, bystanders, and other service officers. You should also keep other service officers informed of safety hazards as the hazards are identified. Here are some precautions you can observe and actions you can take to keep those at the scene safe:

- provide safety clothing and eye wear when required for firefighters and injured persons;

- provide traffic warning signs as required;

- keep traffic clear of the incident and redirect it around the scene. It is important for the traffic to keep moving as delays may be caused to emergency vehicles enroute;

- close the road if a hazard does exist: safety is the main concern;

- remove all unnecessary bystanders from the area. Utilise the Police Service for this duty;

- use barrier tape to cordon off the area; and

- consider the position of your own vehicle and provide for those of other emergency services. They may have a higher priority and need to be closer to the incident than you.

2.4.4 Safety of the Injured

Your third responsibility is to care for the injured persons; the casualties. Here is a list of points to keep in mind while caring for them:

- protect the injured. Keep them sheltered from moving metal, tools, broken glass, and inclement weather, using patient protection shields (where available) or rescue boards as an alternative;
- use both the full and half-size rescue boards as a barrier when cutting or spreading in the vicinity of the injured;
- determine exactly how the injured person is trapped, take care not to increase the pain or the injury, try to position all parts of their body correctly prior to beginning the extrication process;
- use debris and salvage sheets to protect the injured person from breaking glass, splintering plastic, etc; and
- use eye and ear protection as required for firefighters and injured persons.

2.4.5 Preservation of the Accident Scene

After a serious or fatal MVA, the Physical Evidence Section of the Police Service conducts an investigation to establish the cause of the accident. Their role is to provide corroborating physical evidence in court, or in administrative proceedings. Their evidence is offered to substantiate or refute statements of witnesses. They take photographs of skid marks, blood stains, impact points, and so on. They then prepare a report on the incident for the Coroner.

At the scene, be aware of the need to preserve the evidence for this investigation. Try to prevent the destruction of the scene and of evidence in and around the scene of the accident.

To ensure that the investigating service can do an effective job, it is imperative that the incident site, and crash vehicle or vehicles, remain undisturbed and intact. However, your preservation of this evidence should not interfere with your primary objective of safety at the scene and casualty extrication.

General Investigation

Here is a list of items that are essential to the investigation of the general scene of the accident:

- any witness accounts of the events leading up to or directly proceeding the impact;
- location of all vehicles involved;
- location of deceased persons;
- accident damage to vehicles;
- location of debris;
- location/size/path of all tyre or gouge marks;
- location of blood or oil; and
- possible point of impact.

Specific Investigation

Here is a list of items that are essential to the investigation of the specific matters at the scene of the accident:

- paint deposits on vehicles/pedestrians/ objects/roads;
- glass (windscreens & headlights);

- headlight globe or filament to determine if the lights were on or off;
- headlight switch on or off;
- vehicle parts (panels/mirrors/aerials);
- tyre skid marks;
- bloodstains; and
- tyre pressures.

2.5 Principles of Motor Vehicle Extrication

2.5.1 Introduction

It is well accepted that no two accidents are the same in all respects. However, rescue procedures are flexible enough to allow you sufficient latitude to deal with the different scenarios you are likely to face at the rescue scene. The rescue effort must revolve around the injured person. The skills of the rescuers and the medical personnel are linked together to ensure that the injured person has the best possible chance of making a full recovery.

This section discusses the principles of motor vehicle extrication with that end in mind.

2.5.2 Accident Scene Assessment

Scene assessment begins with the arrival of the first rescue vehicle.

Placement of Vehicle

When you arrive, position your unit in a safe location so that you can assess the scene of the accident. At a minimum, your rescue vehicle should remain a distance of **15 m** from the involved vehicles. You should increase this minimum distance as necessary, depending on the hazards you encounter such as fire, chemicals, fuel leaks etc. Place all additional emergency vehicles so that they do not block other units at the scene.

Hazards at the Scene

When you arrive at the scene, some of the hazards will be obvious to you immediately. These include a vehicle on fire or a vehicle that is unstable. Some of the other hazards may be difficult to see immediately. You should approach the scene cautiously until you can complete an adequate assessment of all hazards. Never let **tunnel vision** interfere with your total scene assessment.

Assessment is a continuous process that goes on constantly throughout the extrication.

Information you should gather at this initial stage includes:

- the number of casualties involved;
- any life threatening injuries;
- severity of the accident damage;
- obvious injuries; and
- the presence of SRS airbags.

2.5.3 Accident Scene Setup

Your initial setup of the accident scene (see Fig 2.5) ensures a safe and efficient extrication. You should setup the scene with the following areas in place.

The Inner Circle

This inner circle comprises an area immediately surrounding the vehicles involved in the accident. Only essential emergency services personnel are permitted to enter this area. Keep it free of all non-essential equipment.

The Outer Circle

This outer circle encompasses the entire accident site. Keep it free of unnecessary civilians and emergency services personnel.

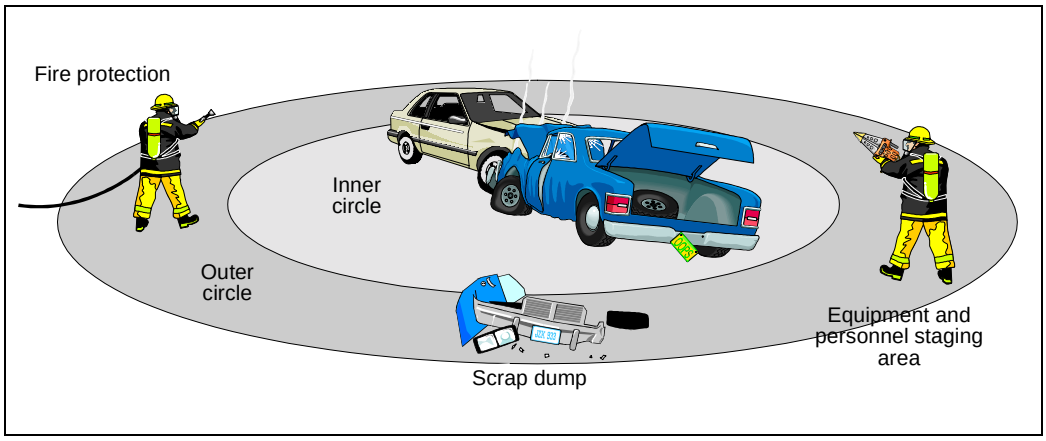

Fig 2.5 Accident Scene Control

Equipment and Personnel Staging Area

This is the area from which all equipment should be assembled and staged. Equipment that is no longer to be used, or that is no longer needed at the inner circle should be promptly returned to this area. **Spare** personnel should also be staged here awaiting further orders. This enables them to be given their tasks quickly and efficiently so that they can help during the extrication.

Scrap Dump

This is where all dismantled wreckage is placed, it also serves as an integral part of evidence preservation. Placing the wreckage here ensures that the work circle stays free of tripping hazards and items that could cause other injuries. A convenient position for the scrap dump is adjacent to the equipment staging area.

2.5.4 Gaining Access

Once the hazards, including vehicle stabilisation, have been eliminated, the next step is to gain access to the trapped casualty/ casualties. This access enables medical personnel to enter the vehicle and begin patient assessment and life support activities. Gaining access is different from the actual extrication of the injured person/s. You should gain access entry by the obvious routes. The doors and windows should be the first possibilities.

2.5.5 Extrication Plan

As you begin to formulate your plan of extrication, you need to determine exactly how and by what the person or persons are trapped. Read the accident, see what the damage is and see what the types of injury are. Read the accident with the help of your hands as well as with your eyes. With this information, you can formulate an effective plan of extrication. This is the sequence of procedures that will enable you to release the casualty/casualties.

We use two types of release procedure: controlled release and immediate release.

Controlled Release

Controlled release means that you control the pace and the procedure of the extrication plan. It is slower, more controlled, and more systematic than immediate release.

Controlled release is the systematic dismantling of the wrecked motor vehicle with the casualty/casualties inside.

⚠ NOTE

This has become the accepted world standard of extrication of an injured person from a damaged motor vehicle.

Controlled release caters for the seriously injured casualty. This procedure permits their release and removal from the wreckage without causing any deterioration in their condition as a result of the extrication process.

The objective of controlled release is to make space. We do this using well practiced, systematic procedures. **This enables us to remove the vehicle from around the casualty and not the casualty from the vehicle**.

There are two recognised forms of entrapment of a person in a motor vehicle:

- **physical entrapment** occurs when the casualty is physically pinned by a deformity in the structure of the motor vehicle.

- **restricted space entrapment** occurs when the casualty is trapped in the interior of the motor vehicle. In this type of entrapment, to move the casualty without dismantling sections of the vehicle would cause further injury.

Immediate Release

In some MVA's, the condition of an injured person can deteriorate very rapidly. Medical personnel at the scene may request the urgent immediate release of the victim.

The Brigade Rescue Operator (BRO) must be prepared for this situation. You, as rescuer, may need to effect the immediate release of the injured person in the shortest period of time with the equipment that is immediately available.

When you undertake an immediate release, you use whatever tools you have to create enough access space to free the injured from the wreckage.

⚠ NOTE

***Immediate release* is contrary to the normal NSWFB practice of *controlled release*. The *immediate release* decision is taken only under the direction of medical personnel.**

Tool Setup for Immediate Release

Standard procedure at all serious MVA's requires the initial setup of the petrol hydraulic pump, spreaders and shears, and a second hydraulic pump and power ram. This setup is done upon arrival by one member of the rescue team. The double-acting hydraulic equipment used in this procedure has both the power plus the speed of operation to produce an immediate and effective release. When this equipment is properly set up, you can then ensure that the equipment is available for instant use if you are called upon to conduct an immediate release.

Standard Techniques

Standard techniques of extrication are used to effect immediate release. However, the following are especially applicable to an emergency situation:

- forced door opening;
- roof flap;
- dash roll;
- cross ramming and spreading;
- inverted door opening; and
- inverted ramming.

2.5.6 Concluding the Extrication

In both the controlled release and the immediate release procedures, you must make plans for the removal and transfer of the injured person/s from the vehicle to the Ambulance. Depending upon the nature of the incident, this can be a simple or a complex procedure.

In the easier situation, this removal may involve only a simple transfer from a rescue board to the ambulance.

In the more complicated situation, the removal may involve a laboured stretcher walk up a steep slope. Whatever the circumstances, it is important that you make sure that the required equipment is immediately available at the accident site. Also, be sure that sufficient personnel are available to carry out the task. If you are the rescue team leader, these matters are your responsibility.

2.5.7 Final Check

When you have finished with the extrication procedure, carry out a final check of both the vehicle and surrounding area. This final check helps to ensure that you have not overlooked any further casualties such as small children and to gather any further information pertaining to the incident.

2.5.8 Incident Debriefing

You are encouraged to debrief every incident. You should do this immediately upon your return to the station. All members who took part in the extrication operation should participate. This debriefing provides a valuable learning forum.

In your debriefing, consider the following questions:

- What went right?
- What went wrong?
- How could we improve on the extrication?

2.5.9 Incident Report

The Station Officers should record all details of the incident with specific attention to details in the *comments* section of the report. This section includes information on casualty details, techniques, and equipment used.

2.5.10 Critical Incident Stress Debriefing

Attention should also be paid to members of the crew after serious incidents and arrangements should be made for Critical Incident Stress debriefing if it is required.

Refer to Topic 14.

2.6 Common MVA Configurations

MVA's in which persons are trapped in their vehicles are categorised under five accident types.

- the Head-On collision;
- the Off-set Head-on collision: front quarter oblique impact;
- the Side Impact: T-bone;
- the Roll-over; and
- the Vehicle-Under Ride.

The Head-On Collision. In this type of collision, the motor vehicle strikes a static object such as a tree, a pole, an abutment, or another vehicle. The impact is relatively square-on to the front of the vehicle. This impact causes the rearward movement of the engine, transmission, firewall, and dash, towards the passenger compartment. This movement then traps the driver and/or passenger in the front seats.

The Off-Set Head-On Collision: Front Quarter Oblique Impact. This type of accident is similar to the head-on collision, but the impact is taken at an oblique angle to the front of the vehicle. The impact can trap the passengers in the front seats as in the head-on collision. However, the impact may be compounded by the rearward movement of the road wheel, suspension components, and footwell. This type of collision is referred to as a *front quarter oblique impact*.

The Side Impact: T-Bone. This type of accident occurs when a motor vehicle has been in a side-impact collision with an object such as another vehicle, a tree, or a pole. In this type of accident, the side of the vehicle collapses inward in varying degrees. The **A** Post can trap the casualty's legs against the transmission tunnel. This type of collision is referred to as a *T-Bone*.

The Roll-Over. This type of accident occurs when a driver loses control of the vehicle and it overturns. The roof structure may collapse to some degree. The *roll-over* will probably cause the fuel to spill and the battery acid to leak, and these will present hazards. The roll-over may be further complicated by impact with a solid object before or during the roll-over. If this additional impact occurs, then the roll-over will be combined with one of the accident types already mentioned.

The Vehicle-Under Ride. This type of collision usually results from a motor vehicle impacting on the rear of a truck. Also, in some head-on collisions, a truck may ride up onto and come to rest on top of another vehicle. This type of accident can cause the *rearward* movement of the engine, dash, or transmission as in a head-on collision. It can also cause the *downward* movement of the firewall, dash and steering wheel column. The stability of the truck on top of the motor vehicle is also a major concern in this type of accident.

2.7 The Team Concept

When we attend an incident involving a person trapped inside a motor vehicle, our mission is to extricate the casualty rapidly and efficiently. To accomplish this mission, our rescue operators work together as a team implementing a complex sequence of routines designed to maximise the injured person's chance of making a full recovery.

In this type of rescue operation, time is of the essence. The co-ordinated team approach maximises our efficiency. Any equipment likely to be needed should be assembled on arrival ready for immediate use.

The *team concept* requires training together as a team. In the training, we simulate accident scenarios to provide realistic experience within a specified time frame. It is essential that, as a team member, you be well trained in extrication techniques and the use of the proper tools. Some tasks require several rescuers whereas others require only one. Pre-planning is essential. Each crew member must be pre-tasked with specific procedures. This ensures that the initial stages of the rescue operation proceed quickly and efficiently.

The team concept is an integral part of the work of all firefighters. It means working together as a crew, co-ordinating tasks in difficult, dangerous, and stressful conditions, and assisting each other to succeed together, where one of us might not succeed alone.

2.7.1 Policy

When receiving a call, the NSWFB instruction allows all Station Commanders at accredited rescue stations to attend rescue incidents with the pump and crew, at their discretion. Here are some factors that may affect this decision:

- if the incident involves more than one vehicle or injured person and where more equipment or rescue operators are needed;
- if the incident involves heavy vehicles; and
- if the incident requires local knowledge of accident *black spots*.

2.7.2 The Team Leader

The State Rescue Board (SRB) registered Station Commander fills the role of Team Leader when in attendance at an incident. This

requires a balance of judgement, detachment, and initiative. When acting in this capacity as a Team Leader, the Commander avoids *hands-on* involvement unless absolutely necessary.

The Team Leader's duties include:

- to command and control the incident scene;
- to liaise with the Police Co-ordinator;
- to liaise with Police/Ambulance/other Emergency Service workers as required;
- to establish the plan of extrication (in conjunction with Rescue Operator #1);
- to maintain incident scene safety; and
- to utilise crew members with special skills and training as and when required.

2.7.3 The Rescue Crew

The Rescue Crew concentrates on the primary task of making space in the vehicle. This procedure prepares for the controlled release of the casualty in the shortest possible time with the least complication and without compounding any injuries already sustained. Controlled release involves systematically dismantling the vehicle before the injured person is removed.

⚠ NOTE

Once patient care has commenced it must be continued for the duration of the incident. The patient must never be left unattended from that point on.

Here is a description of the duties of the individual Rescue Crew operators:

Rescue Operator #1

Duties of Rescue Operator #1 include:

- administer initial first aid as required;
- check and control any hazards;
- gain access to the casualty;
- determine plan of extrication (in conjunction with Station Commander);
- conduct controlled release of the casualty; and
- assist with patient packaging and removal.

Rescue Operator #2

Duties of Rescue Operator #2 include:

- administer initial first aid as required;
- check and control hazards;
- stabilise the vehicle;
- gain access to the casualty;
- conduct controlled release of the casualty; and
- assist with patient packaging and removal.

The Pump Crew

Upon arrival at the incident scene, the main priority of the Pump Crew is to provide fire protection in the Combat Zone for emergency service workers. Additional activities that may be required of the Pump Crew include providing foam-making equipment or a Dry Chemical Powder (DCP) extinguisher. If fire protection is supplied by another station or agency, the Team Leader ensures that the

protection is adequate. The Team Leader will advise the Pump Crew of any other additional duties.

Rescue Medical Technician (as available)

Duties of the Rescue Medical Technician include:

- administer initial basic life support until more qualified personnel are available;
- assist paramedics as required; and
- package and remove patient if required.

Equipment Staging Operator

Duties of the Equipment Staging Operator include:

- establish Equipment Staging Area;
- organise Personnel Staging Area;
- prepare designated equipment for use;
- ensure immediate availability of equipment; and
- establish Scrap Dump.

As additional accredited personnel become available, they should be tasked as required from the Personnel Staging Area.

Tool Staging Area

Here is a prioritised list of suggested equipment. These items should be assembled for attendance at all serious motor vehicle accidents:

- latex gloves, eye protection;
- hydraulic pump No 1, shears, spreaders;
- 4 x step blocks, 2 x block sets;
- hard protection - leather gloves, soft protection - rubber gloves, hand tool kit, glass management tools, crowbar;
- hydraulic pump No 2 (hand/air/petrol), power rams;
- first aid kit, *Oxy Viva*, cervical collars, initial access pack, *Kendricks* Extrication Device (KED), long rescue board;
- air tools including chisel/airfile/air hacksaw; and
- lighting (as required).

⚠ NOTE

This is a minimum guide, additional equipment may be staged as the situation dictates.

2.7.4 The Combat Zone

The Rescue Crew has responsibility for their actions within the Combat Zone. The Team Leader has responsibility for managing the NSWFB personnel at the scene and for ensuring their safety.

The Ambulance Officers can prescribe a certain procedure for the removal of the casualty. Other personnel should follow Ambulance Officer's directions. The Ambulance Officers have the ultimate responsibility for managing the removal of injured persons. However, you should not hesitate to offer suggestions or discuss preferred techniques that have proven successful through training and experience.

The Team Leader needs the support of all Emergency Services at the scene. The leader liaises amongst the Services. A co-ordinated approach as a team ensures that everyone fully supports any suggested variations in tactics.

The Team Leader must prevent disputes from developing, for disputes have an effect on future extrications as well as the current one.

2.7.5 Training Responsibilities

All NSWFB Rescue Operators have an obligation to train and drill regularly in all aspects of motor vehicle rescue. To be a skilled and competent operator, it is essential that you become totally conversant with, and practiced in, the techniques described in this manual. There is no substitute for well rehearsed practical and theoretical knowledge and experience.

The key to success is training. During training sessions, you should allocate time to train as a team. Consider strategies that would involve the Pump and Rescue Crews.

Plan with the following considerations:

- practice the team concept;
- have the vehicle on its side or roof;
- use more than one vehicle to limit access;
- position a *live patient* within the vehicle;
- invite Ambulance Officers to participate in training;
- arrange night exercises;
- work within a realistic time frame; and
- invite firefighters from neighbouring stations to attend.

The advantages of training will soon become evident. For instance:

- removing a door or **B** Post from a wrecked car becomes a challenging exercise when some reality is added to the operation;
- a debriefing report from a *live patient* can give the team valuable information on stabilisation and tool handling;
- combined training sessions with Ambulance Officers gives you the opportunity to demonstrate new techniques and equipment. These sessions also allow the Ambulance Officers to discuss and indicate their priorities involving the patient. The result of this combined exercise is that we gain an understanding of their concerns and they become more aware of our ability and professionalism.

2.8 Stabilisation

2.8.1 Introduction

When a motor vehicle is involved in an accident, the damage that can occur to the vehicle can be devastating as it collides with objects in its path, rolls over, and comes to rest. The final resting position can be precarious at best. Sometimes the slightest movement can unexpectedly increase the damage to the vehicle and place the occupants in grave, or even mortal, danger. To minimise the chance of further injury, the vehicle needs to be stabilised as quickly and as firmly as possible.

Stabilisation involves providing additional support at key points between the vehicle and the ground or other solid anchor points. The purpose of stabilisation is to maximise the area of contact between the vehicle and the ground. This helps to prevent any further movement of the vehicle. Stabilisation is vital

to prevent further harm to the occupants and to protect the rescuers during the extrication operation.

Horizontal Movement: Chocking the Wheels

After an accident occurs, if the motor vehicle has come to rest in an upright position, your first priority in preparing for extrication of the occupants is to chock the wheels. This ensures that the vehicle cannot move horizontally: forwards or backwards. If the vehicle is on flat ground, place chocks on **both sides** of all of the wheels. As chocks, you should use doubled wooden wedges or rubber wheel chocks.

Vertical Movement: Blocking the Contact Points

The next step is to block the vehicle at four points of ground contact. This prevents further vertical movement of the vehicle. The purpose of the blocks is to hold the vehicle in a firm position, hence, you should not place blocks under suspension components such as shock absorbers. If you block the vehicle properly, this prevents the floorpan from flexing. It also prevents the vehicle from falling or rocking.

CAUTION

When you are blocking the vehicle, do not place any part of your body under the vehicle.

Even after you have chocked and blocked the vehicle, it can still shift. During the extrication operation, check periodically to ensure that the vehicle has remained secure.

Step Blocks

Step Blocks can help to secure the vehicle. Only one person is required to put step blocks in place. While you are stabilising the vehicle, slide the step block under the vehicle until the appropriate step is the shortest distance below the floorpan.

Then place a large timber wedge under the block and push it home until the vehicle is firmly supported (see Fig 2.6). You can also use a 2 m bar as a lever to gently lift the car as you are placing the step block into position.

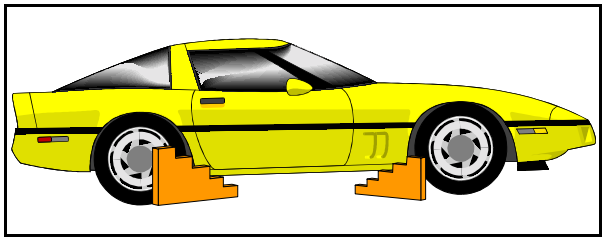

Fig 2.6 Positioning of Step Blocks

The Overturned Vehicle

If the vehicle has rolled or overturned and has come to rest on its roof, you must stabilise the vehicle to ensure that it does not roll further. This is a delicate operation because the vehicle can roll in almost any direction. As you stabilise an overturned vehicle, you must also take steps to prevent the collapse of the roof structure. To do this, you must support both ends of the vehicle (see Fig 2.7).

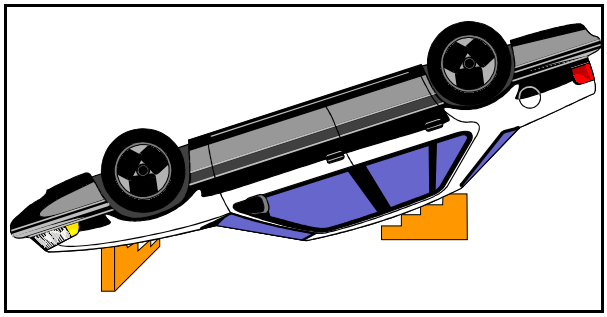

Fig 2.7 Stabilising an Overturned Vehicle

Generally, an overturned vehicle will rest in a *nose-down* position because the weight of the engine will tip the vehicle forward.

To stabilise an overturned vehicle, you will need the following tools:

- wooden blocks;
- *Enerpac* and extension tubes;

- low and high pressure airbags;
- high-lift jack;
- power ram; and
- 2 m bar.

The Vehicle on its Side

If the vehicle has come to rest on its side, it is in a particularly precarious position. In this situation, you should stabilise the vehicle with wooden blocks. These blocks increase the surface area of the vehicle in contact with the ground. Additionally, use other equipment such as the *Tirfor* winch to secure the vehicle. Here are some other points to remember:

- resist the temptation to *test* the stability of the vehicle. The vehicle may fail the test;
- avoid the use of rope lines to secure a vehicle. They can stretch, especially if they become wet;
- chock the vehicle at as many points as possible;
- avoid the top side of the vehicle if at all possible. Anything placed on top of the vehicle increases the height of the centre of gravity.

A vehicle can come to rest on its side in two positions (see Fig 2.8):

- flat on its side; or
- tilted towards the roof. In this position, the vehicle is extremely unstable, and sloping ground can further complicate the situation.

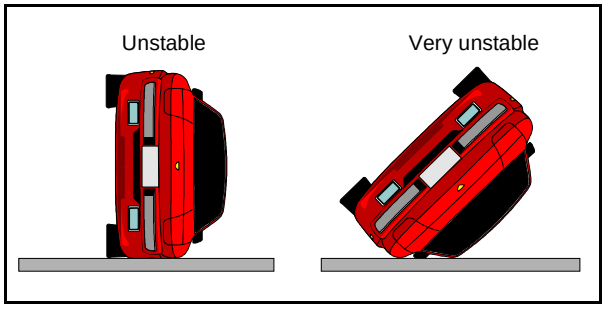

Fig 2.8 Examples of Unstable/Very Unstable Positions

Collision with Heavy Vehicles

If the vehicle has collided with a large truck, or other type of heavy vehicle, the smaller vehicle may be in an *under-ride* position (see Fig 2.9). The truck may have *ridden up* and come to rest on top of the smaller vehicle.

Fig 2.9 Collision with a Heavy Vehicle

In this type of accident, your priorities are to:

- prevent any further movement of the top vehicle, the truck; and
- take as much pressure as possible off the bottom vehicle. To accomplish this, you should crib the top vehicle.

CAUTION

This operation must be performed with extreme caution.

You may need the following equipment to *crib* the top vehicle:

- low pressure airbags;
- power rams;
- crib blocks;
- *Enerpac* rams and extensions.

2.9 Windscreens and Window Glass

2.9.1 Introduction

First steps. Upon your arrival at the scene of the incident, your first priority is to organise the area and stabilise the vehicle. When you have completed these steps, you are ready to begin the actual extrication procedure. You begin this procedure by gaining access to the vehicle by the removal of the doors and the roof.

Either before or during this part of the operation, but before you actually begin to work with the casualties, you must remove the glass in the doors and the windscreens. This prevents broken glass from becoming an uncontrolled hazard to both rescuers and casualties during the extrication process.

2.9.2 Preferred Procedure

The preferred method of glass removal is to control and manage the breakage and removal of windscreens and window glass prior to beginning your work with the doors and roof.

At all times, when you are dealing with glass, you must wear gloves and eye protection. All casualties, medical personnel, and rescue workers must be provided with eye protection. You should cover the casualties with a canvas sheet or blanket to protect them from breaking glass.

2.9.3 Common Sense Approach

When you have gained initial access into the vehicle, you should wind the windows down into the door as far as possible. This ensures that much of the breaking glass will fall inside the doors. As you work, keep the exposed glass covered with soft protection.

2.9.4 Glass Removal

Windscreens and windows in motor vehicles are made of two types of glass:

- tempered; and
- laminated.

Tempered Glass

Tempered glass is usually installed in the side and rear windows of the modern motor vehicle. It is manufactured by a process where molten glass is poured onto a mould. It is chilled rapidly causing it to be in tension across its outer surface. When broken it shatters into chunks of glass. If it is contained within a window frame it will generally remain in this frame. If the window is partially open the glass will explode outwards, parallel to the pane of glass.

Laminated Glass

In most modern vehicles the front windscreen is constructed of laminated glass. This consists of an inner and outer layer of glass with a sheet of plastic sandwiched between. In a collision, laminated glass is designed to crack into large section with the plastic sheet holding it together.

2.9.5 Windscreen Removal (Tempered Glass)

Intact Removal

In the windscreen removal operation, you should try to remove all glass intact. This prevents shards of glass from becoming a danger to both rescuers and casualties. The careful use of tools such as screwdrivers, lino knives, and windscreen cut out tools helps in this removal. After you have cut the glass loose, you can use the suction lifter to remove the sheets of glass.

Controlled Breakage

If you cannot remove the windscreen intact, you can use the controlled breakage technique on tempered glass. When you use controlled breakage, you must first cover the glass completely with a soft protection cover to prevent flying glass. Also, cover the casualty with a protective sheet.

In the controlled breakage technique, you use the automatic centre punch. You can also use hydraulic shears or spreaders to crush a section of glass and shatter the entire panel. After the glass is broken, you can then break out the pieces with gloved hands.

2.9.6 Windscreen Removal (Laminated Glass)

Intact Removal

In older vehicles, you can probably remove the laminated windscreen intact by using the windscreen cut out tool, suction tool, lino knife, and screwdrivers. To remove the windscreen intact, first prise off the chrome cover strip and then remove the rubber or bonding with the cut out tool or knife. You can then remove the windscreen by levering it out with the suction tool.

2.9.7 Bonded Windscreens

On later model vehicles, the windscreen is bonded to the bodywork of the vehicle. It forms an integral part of the vehicle's structure and adds to the strength of the structure. You can use the windscreen cut out tool to cut through the bonding. Use the suction lifter to provide leverage while cutting the bonding.

⚠ NOTE

A bonded windscreen is very difficult to remove.

2.9.8 Alternative Method

An alternative method of removal of the bonded windscreen is to cut a forward roof flap. After you cut the flap you can then remove the front windscreen as you fold the flap forward. When you use this technique, ensure that the casualty is protected from the splintering of windscreen glass. Use soft protection over the inside of the windscreen.

2.10 Seat Removal and Adjustment

2.10.1 Introduction

It is important for you to know and understand some of the techniques of seat adjustment and removal to help you extricate a trapped victim.

Motor vehicles have a wide variety of seat types and features. Some of these features can be used to make the casualty more accessible to you for extrication. If the features, such as forward-rearward and reclining seat adjustments are electrically operated, you will not be able to use them if the electrical system of the vehicle has been damaged in the accident. When adjusting or moving the seat of an injured person you **must** ensure that the casualty is well supported so that their condition remains as stable as possible.

2.10.2 Front Seat Removal

In most MVA's where a casualty is trapped in the vehicle, they will be sat in the front seat.

If the in-built adjustment features of the front seat are still in working order, you can use these features to relieve some of the restrictions on the casualty. To do this:

- support the casualty and release the seat belt;
- remove the rear seat cushion;
- operate the height adjustment lever (if fitted) and lower the seat;
- operate the seat slide adjusting lever; and
- operate the seat reclining knob/lever, and lay the seat back.

If the rear seat area is vacant, one rescuer can work from this area and help to support the front-seat casualty as the front seat is adjusted.

You can greatly enlarge the working area behind the front seat by removing the rear seat cushion early in the extrication (see Fig 2.10). This also allows you to recline the front seat fully into the horizontal position. The method of releasing the rear seat cushion varies from one vehicle type to another. Usually you can unbolt or unscrew the cushion. If this does not work, you may have to shear the hinges or clips.

Fig 2.10 Rear Seat Cushion Removal

Sometimes occupants in the rear seat may have their legs trapped under the front seat from the force of the impact. If this happens, you will probably have to raise the front seat to release the casualty's legs (see Fig 2.11). To do this, follow these steps:

- adjust the seat backs of the front seats so they do not obstruct each other as spreading takes place, remove the seat back if necessary;
- spread between the sill and the seat rail at the rear seat securing point (block between the floorpan and rail, before removing the super spreaders);
- support the seat and spread at the front securing point, if required; and
- release the casualty's legs.

Fig 2.11 Forced Seat Removal

2.11 Door Opening

2.11.1 Introduction

First steps. Upon your arrival at the scene of the accident, your first priority is to organise the area and stabilise the vehicle. Once you have completed these steps, you are ready to begin the actual extrication procedure. You begin this procedure by gaining access to the vehicle by removal of the doors and the roof.

Opening the doors of a motor vehicle that has been in an accident requires a considered approach and certain skills in the use of tools. You need to assess the quickest and safest way to accomplish this task.

If you can open the doors, open them; if you cannot open the doors, remove them. In this section, we look at the different ways we can do this. First, consider the *Common Sense Approach.*

2.11.2 Common Sense Approach

The best methods for accomplishing this task are often also the easiest. Here are some suggestions:

- try to open the doors by unlocking and operating the door handles;
- try to wind down all windows;
- try to open the rear hatchback;
- see if the keys are still in the ignition, you can use them to unlock and open the doors or the rear hatch; and
- support the casualty when you open a door next to them.

2.11.3 Opening Doors

If you cannot open the doors using the handles, you may have to force them open. You have access to two tools that can help you open the doors by force:

- single action spreaders; and
- super-spreaders.

2.11.4 Opening Doors with Single-acting Spreaders

The strongest part of a door is within the limits of an imaginary triangle drawn between the hinges and lock mechanism. If you must use force or leverage techniques to open the door, you might be successful using the single-action spreaders. Start at the top or the bottom of the door. These are the weakest points of the door as they are the points farthest away from the triangle.

The single-action spreader arms apply force by bedding on the door pillar and forcing the door to open through its natural arc (see Fig 2.12).

Here are some suggestions for the most effective use of the single-action spreader:

- create access for the spreader tips by using a buster bar and/or *WR4* wedgie;
- use wooden blocks or wedges to hold the gap open while you reposition the spreader;
- use a series of *spreads* up or down towards the door lock until the door is opened;
- if the door is too strong to be opened by one spreader, try introducing a second spreader as this increases the available force e.g. a *WR4* increases the force by 0.75 t;

Fig 2.12 Opening Doors Using Single Action Spreaders

- as an alternative method, use the spreaders to expose and unbolt the hinges and force the door open from the hinge side with the spreaders;
- **do not** place your body on or adjacent to the door being forced. Use your pocket line to secure the door in a loose position; and
- use a rescue board as a hard barrier to protect the injured person.

2.11.5 Opening Doors with Super Spreaders

The door of a motor vehicle consists of an inner skin and an outer skin. The inner skin is the one you concentrate on when you use the hydraulic spreaders to force open a jammed door. If you can get the spreader tips between the inner skin and the door jam, you can usually open the door by spreading open the gap (see Fig 2.13).

You can create access for the tips of the spreader by:

- using the buster bar;
- holding the spreader vertically and crushing the top of the window sill;
- opening the spreader horizontally between the window sill and the edge of the roof; and
- using the spreader tips to grasp the door skin and lever it back.

Here are some points to consider when you must force a door:

- be careful that the door does not fold in on the casualty;
- reposition the spreader if the outer door skin begins to separate;

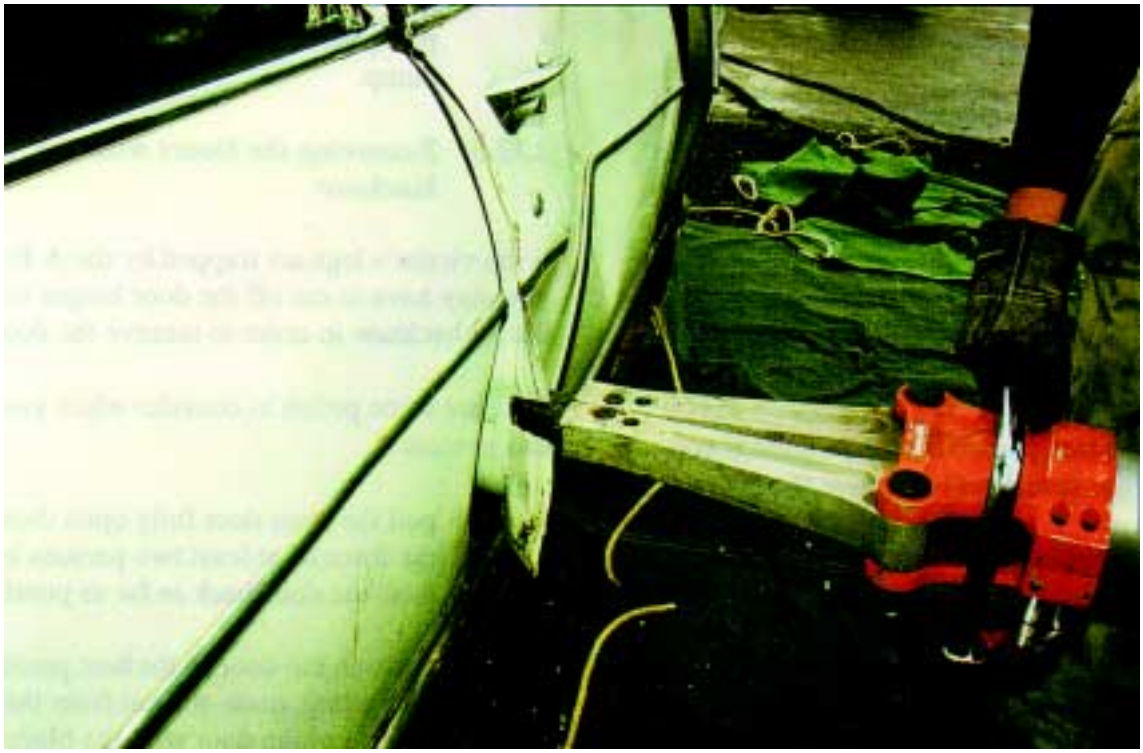

Fig 2.13 Opening Doors Using Super Spreaders

- once the door has been opened, secure it or completely remove it;

- use your pocket line to secure the door in a loose position to prevent a *jarring* effect when you force the door open; and

- ensure all persons are a safe distance from the line where the door will open.

2.12 Door Removal

You may need to remove the front doors of the vehicle to gain the additional space necessary to free the front seat passengers. The easiest way to remove the doors is to unbolt the hinges if they are accessible.

2.12.1 Removing the Doors with the Hand Tool Kit

The easiest way to remove the door is to unbolt the hinges using the socket set from the hand tool kit. This has the considerable advantage of not jarring or moving the car.

In some cases, the accident damage exposes the heads of the bolts. If they are not exposed, you can use the spreaders to spread the mudguard and door apart. This allows access to the bolts.

2.12.2 Removing the Doors with the Spreaders

Here are some points to keep in mind if you need to use spreaders to remove the doors:

- spread the doors from outside the vehicle;

- gain additional access space by:

  - pulling the door forward: lack of space can cause the spreader to turn inward on the operator or victim as the spreading progresses;

  - gripping the edge of the door skin with the spreader tips and levering the edge back;

  - crushing the mudguard with the spreaders above the wheel arch;

- take great care to avoid any movement of the vehicle that is in contact with the victim;

- place the spreaders at the strongest points on the door - the strongest points are the posts above the top hinge and below the bottom hinge;

- if the victim is actually trapped by the door pillar, avoid using the spreaders to remove the doors;

- if the hinge is too strong, place one tip on a hinge flap and the other on the metal of the door or pillar. The hinge will then be torn free of its surrounds; and

- place the removed door in a scrap dump.

2.12.3 Removing the Doors with the Air Hacksaw

It the victim's legs are trapped by the **A** Post, you may have to cut off the door hinges with the air hacksaw in order to remove the door.

Here are some points to consider when you use this process:

- pull the front door fully open then use the force of at least two persons to push the door back as far as possible;

- position the door in the best position for cutting, make the cut from the outside of the door with the blade protruding in towards the vehicle;

- use spreaders to increase space: use gravity - cut and spread from the top hinge downward;
- use a solution of detergent and water from a spray bottle to lubricate and cool the saw blade;
- make your cut on the smallest part of the hinge to reduce the duration of the cut; and
- take care not to cause further injury to the patient with the hacksaw blade.

2.12.4 Removing the Doors with Shears

NOTE

Use shears to remove the doors of a vehicle only when no other method is available.

The use of shears is not a standard method of door removal. **The cast door hinge** can cause damage to the blades of the shears. You can, however, safely and effectively use shears to cut some of the lighter types of steel hinges.

NOTE

This technique is not to be attempted on the training ground. It is considered acceptable only when no other method is available.

Here are some points to remember if you must use shears to remove doors:

- **do not** use the *Holmatro 1412* Shears to cut hinges;
- you may use the *Holmatro 2011* Shears to cut lightweight hinges;
- you may use the *Holmatro 2001* Shears to cut most kinds of hinges, if necessary.

2.13 Side Removal

2.13.1 Introduction

You can remove the side of the vehicle if you need to make more space to remove a seriously injured casualty. Removing the side exposes the interior of the vehicle and gives you better access for casualty handling.

Here we consider five different methods of removing the side of the vehicle. These include:

- **B** Post removal;
- **B** Post removal plus removal of the front door;
- third door entry;
- third door entry plus front door entry; and
- folding down the sill.

2.13.2 Removing the B Post

The removal of the **B** Post is a standard technique used on the four door vehicle (see Fig 2.14).

Fig 2.14 B Post Removal

Table 2A details the technique and a list of points to consider.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Whenever possible, the rear door and **B** Post should be **removed**. It is an unacceptable risk to try to remove a seriously injured casualty over a tripping hazard such as this
2. Open the front door and secure it, (if necessary, remove it completely)	
3. Open the rear door and cut the seat belts	2. Do not open the rear door if you can see that you will have to ram the dash. You may need to use the base of the **B** Post as a ramming point
4. Shear off the top of the **B** Post	
5. Shear the gusset of the **B** Post (you may have to lever it down first)	3. If possible, wind down windows
6. Remove the debris from the area	4. Be aware of hardened seat belt anchoring components when shearing the **B** Post

Table 2A Removing the B Post Technique

2.13.3 Removing the B Post Plus the Front Door

You can use this method on a four door vehicle when the damage prevents you from forcing open the front door. You might use this method when a severely injured casualty is close to the accident damage or when the accident caused a severe side collapse (see Fig 2.15).

Fig 2.15 B Post Plus Front Door Removal

Table 2B details the technique and a list of points to consider.

TECHNIQUE	POINTS TO CONSIDER
1. Secure and stabilise the vehicle	1. You might not want to use this method if it appears that you need to cross ram to ease the restrictions on the casualty; you would then need both **B** Posts in place
2. Open the rear door and cut the seat belts	
3. Cut the top of the **B** Post	
4. Cut the gusset of the **B** Post	2. When the accident damage has separated the front door from its hinges, the easiest method may be to open the rear door, cut the **B** Post at the top then fold the front door/**B** Post.rear door downward as an integrated *unit*. In this case, it would be advisable to weaken the structure first by cutting into the sill.
5. Open the rear door and front door as one: both doors will ride open on the front door hinges	

Table 2B Removing the B Post Plus the Front Door Technique

2.13.4 Third Door Entry

You can use this technique when you need to gain side access to the interior of a two door motor vehicle. You might use this method when either the driver or the front passenger is severely trapped or when a casualty is trapped in the rear seat (see Fig 2.16).

Fig 2.16 Third Door Entry

Table 2C details the technique and a list of points to consider. **2.13.5**

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Prepare the ramming points **before** you use this technique e.g. if you need to use the dash roll ram, you may need the posts as ramming points
2. Open the door nearest to the casualty and remove the rear quarter panel window	
3. Remove the rear quarter panel trim and rear seat cushion (if possible)	2. If you need to ram, then you should cut the **B** Post above the gusset and leave a suitable base for the ram
4. Use the air chisel and shears to cut out and weaken the rear quarter panel	
5. Shear the window line adjacent to the **C** Post and at the top and gusset of the **B** Post	
6. Remove cut out section or crush with spreaders and lever it downward to give access to the casualty	

Table 2C Third Door Entry Technique

2.13.6 Third Door Entry Plus Front Door

You might use this technique when the accident has severely damaged the side of the two door vehicle. In this case, you might not be able to spread the door because it has collapsed so deeply that the **B** Post and/or the door are close to or in contact with the casualty.

Here is a list of steps you should take if you use this technique:

- stabilise and secure the vehicle;
- remove the rear quarter panel window and interior trim, if possible;
- remove the rear seat cushion, if possible, and cut the seatbelts;
- cut out the rear quarter panel and inner skin with the air chisel and shears;
- shear the rear quarter panel window line next to the **C** Post;
- shear the top and the gusset of the **B** Post; and
- open out the rear quarter panel/**B** Post/ door unit fully on the hinges of the door.

If you are going to cut the base of the **B** Post, first use the air chisel to remove a section of the front door outer skin. You will then have better access to the base of the **B** Post when you use the shears to cut the **B** Post.

2.13.7 Folding Down the Sill

After you remove the side of the vehicle, you may find that the wrapping of the sill and floorpan are still trapping the feet of the casualty in the rear seat and that you do not have adequate access to the base of the front seat (see Fig 2.17).

Fig 2.17 Folding Down the Sill

In this case, Table 2D details the technique and points to be considered:

TECHNIQUE	POINTS TO REMEMBER
1. Cut the sill on either side of the entrapment	1. If the cross sectional area of the sill is too large for the jaws of the shears, then crush it first with the spreaders
2. Cut the seat cross member, if it is in the section to be folded	
3. Crush the cut-away section with the spreaders and lever down the sill and floorpan	2. Use great care if a casualty's leg is trapped between the seat and the sill
	3. Block securely the floorpan around the areas to be cut to prevent movement when cutting and spreading

Table 2D Folding Down the Sill Technique

2.14 Roof Techniques

2.14.1 Introduction

You can gain maximum access to the casualty by removing the roof and the sides of the vehicle. This also allows more light and fresh air to reach the casualty and gives access for the administration of medical care (see Fig 2.18). Removing the roof and sides also weakens the structural strength of the vehicle: this can help you in using other techniques as well.

Fig 2.18 Roof Removal

With the roof and the sides out of the way, it is much easier for you to remove the casualty in a far safer manner, and you can more easily fit the KED unit to the casualty. Rescuers can assist in the removal operation. By removing the roof early in the extrication process, you also provide an *emergency exit* for removal of the casualty if their condition deteriorates.

2.14.2 Roof Removal

Table 2E details the technique for roof removal and points to be considered.

TECHNIQUE	POINTS TO REMEMBER
1. Block the underside of the vehicle in the middle to support it and prevent it from flexing in the floorpan, as rescuers climb in and out	1. If you remove the roof first, you may have difficulty opening the doors
2. Open all necessary doors. In most instances, you remove the sides of the vehicle first	2. You may find the air chisel or air saw helpful when you cut the **C** Posts, as some **C** Posts are difficult and time consuming to cut
3. Remove the windscreens and cut the seatbelts	3. When you cut the **A**, **B** and **C** Posts be sure that the window frames do not fall into the interior of the vehicle
4. Cut both **B** Posts close to the roof, and cut close to the door if you do not need to remove the door. This gives leverage when you pull the sides down	
5. Cut the **A** Posts above dash level	
6. Cut the **C** Posts and support the weight of the roof to prevent it collapsing	
7. Remove the roof and place in the scrap dump	

Table 2E Roof Removal Technique

2.15 Roof Flapbacks

C Posts are strong, and sometimes they are hard to cut. If it appears that cutting the **C** Post is too time consuming, you may find it faster and more effective to cut the roof rail just in front of the **C** Posts and *flap* the roof back (see Fig 2.19).

Fig 2.19 Roof Flapback Technique

Table 2F details the technique and points to be considered.

TECHNIQUE	POINTS TO REMEMBER
1. Remove the windscreen and the window glass	1. To crease the roof when *flapping* it back, you can use a crowbar and lay it across the roof between the cutting points
2. Cut the **A** Posts above the dash level	
3. Cut the **B** Posts and cut the seatbelts	2. If damage from the accident causes resistance in the roof when you try to flap it back, use the air chisel to cut from the cutting points towards the centre of the roof: be sure to leave an area of the roof to act as a *hinge*
4. Cut the roof rail in front of the **C** Post	
5. *Flap* the roof back	
	3. You may need to *flap* the roof back at an early stage to provide for rapid casualty access, then, as the operation progresses, you can cut the **C** Posts for total roof removal
	4. If the car has a sunroof, or certain kind of roof rack, you should place your cutting points behind where the steel sides finish. However, if the sunroof is open, this method may not work
	5. You can secure the flapped-back roof with a pocket line

Table 2F Roof Flapbacks Technique

2.15.1 Forward Roof Flap

You may need to use this method if the rear of the car is embedded under an obstacle or other vehicle. With this technique, you will also find it easier to remove a *bonded* windscreen.

Table 2G details the technique and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. Remove the windscreens and windows	1. You may need to air chisel across the roof in front of the **C** Posts and then cut the roof rail to fold the roof forward
2. Cut the **A** Posts above the dash level	
3. Cut the **B** Posts and cut the seatbelts	2. Remember to protect the casualty from breaking glass if the windscreen is still intact when you start the procedure
4. Shear the **C** Posts and fold the roof forward; use the roof as a lever	
	3. When you *flap* a large roof structure, you may find it easier to cut at the top of the **A** Posts, then you can flap the roof forward, cut the **A** Posts above the dash, and fold the windscreen forward

Table 2G Forward Roof Flap Removal Technique

2.15.2 Side Roof Flap

You can use this method if you find that access is restricted to one side of the vehicle.

Here is a list of steps for this technique:

- remove windscreens and windows;
- cut **A**, **B**, and **C** Posts on one side of vehicle; and
- fold the roof sideways over the top (see Fig 2.20): to do this you will probably have to weaken the intact posts by crushing them so you can make the *fold*.

Fig 2.20 Side Roof Flapback Technique

2.16 Trapped in the Front Seat/ Footwell

2.16.1 Introduction

When a person is a casualty in a MVA, they are, in most instances, trapped in the front seat or front seat footwell. As a NSWFB Rescue Operator, you must be aware of the most effective techniques to extricate a casualty from this position.

Here we consider several of these techniques, including:

- a common sense approach;
- pulling the steering column;
- lifting the dash;
- rolling the dash;
- winching the dash;
- exposing the footwell;
- removing the road wheel; and
- hot cutting.

2.16.2 Common Sense Approach

When you attend a MVA and a casualty is trapped in the front seat or footwell, the simple methods of extrication are often the best and most effective.

Here is a list of some common sense approaches to help the casualty:

- use your hands to determine exactly how the victim is trapped;
- remove any debris that is causing a hazard or discomfort to the casualty;
- operate the adjusting knob or lever on the seat carefully to tilt the seat backwards;
- operate the seat slide lever and slide the seat backwards;

- if the steering column is adjustable, tilt the steering wheel upwards;
- unfasten or cut the casualty's seatbelt;
- if the front seat has a vertical adjustment and it is operable, lower the front seat; and
- remove or cut away the casualty's shoes to release their feet.

2.16.3 Pulling the Steering Column

When a casualty is trapped in the front seat or front seat footwell, they may well be pinned in by the steering column and/or the dash. You may need to pull the steering column up and off the casualty to free them for extrication (see Fig 2.21).

Fig 2.21 Steering Column Pull

Table 2H details the technique and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. If the steering column is adjustable and the adjustment is operable, adjust the steering column upward to create more space for the casualty
2. Attach the pulling chain around the steering column - 1½ turns of the chain	
3. Place a puller on the bonnet - ensure that the chain is fully extended	2. If you can cut the steering wheel spokes and remove the wheel, do so as this will create more space. However, note that this operation requires two rescuers
4. Attach the securing chains to a suitable anchor under the car. On small to medium cars, use the 3m chain	3. Ensure that the hook is secure and that the slack in the chain is fully taken up, so that the pulling chain does not slip during the initial stage of the pull. If it slips, the steering wheel may fall back and cause further injury to the casualty
5. Operate the puller until the steering column and wheel are clear of the casualty: *pack as you jack*	4. Position the hook so that the load is taken in the centre of the hook
	5. Insert support blocks under the chain on the front bonnet, the grille, the bumper, in front of the dash, and underneath the check pull itself
	6. If you have a *chain-pull* set available, use it rather than tying up the spreaders

Table 2H Pulling the Steering Column Technique

2.16.4 Lifting the Dash

When the motor vehicle accident involves a car in collision with a truck, the car may *ride under* the truck or the truck may *ride up* onto the car. This can happen in either a rear-end accident or in a head-on collision. This type of accident can cause the dash to collapse downwards and trap a front seat casualty by the legs. In this case, you may need to lift the dash to free the casualty for extrication (see Fig 2.22).

Fig 2.22 The Dash Lift Technique

Table 2I details the technique and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. If the truck is on top of the other vehicle, stabilise and secure the truck	1. If the dash has been forced down and/or backwards (towards the back of the lower vehicle), you should cut the **A** Post at or above the top hinge
2. Stabilise and secure the other vehicle	
3. Use a ram or spreader to create more space by creating a vertical separation between either of the following • sills and dash; • transmission tunnel and dash; • seat cross member and dash	2. If the dash still does not move after you cut the **A** Post, remove the mudguard and use the air chisel or shears to weaken the footwell structure
	3. Position the ram and adjust to the proper tension before you make any cuts
4. To help with this procedure, use the shears to make strategic cuts to the **A** Post gusset	4. Reduce the weight of the truck on the other vehicle with the jack or the rescue airbag
	5. Before you lift the dash, place a flat horizontal block under the dash to spread the load when you ram the dash to lift it.
	6. You may be able to create additional space if you do not block below the ram: the ram will force the floorpan downwards and this will create more space

Table 2I Lifting the Dash Technique

2.16.5 Rolling the Dash

When the collision involves a motor vehicle and a truck, as described in the previous section, the **A** Post as well as the dash can collapse and trap the casualty. You can use the *dash-roll* technique to push the **A** Post and dash off the trapped front seat casualty. In the dash-roll, you can use the hydraulic power ram between the base of the **B** Post and the **A** Post at dash level (see Fig 2.23).

Fig 2.23 The Dash Roll Technique

Table 2J details the technique and points to be considered of you use the technique.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. You must place the ram into position and adjust to a light tension before you make the strategic cuts in the **A** Post. This relieves the pressure on the casualty and ensures that you will not increase the pressure when you make the cuts
2. Open the door nearest to the trapped front seat casualty	
3. Position the ram between the base of the **B** Post and the top of the **A** Post, where it meets the dash: a good ramming point is on or near the top hinge	2. If the power rams are not available, use back to back *Enerpac* Rams - RC106 + RC104 or RC106 + RC102
4. Adjust to a light tension on the ram	
5. Cut the **A** Post at windscreen level and at the gusset	3. If you use the base of the **B** Post as a ramming point: • place support blocks under the **B** Post; and • do not open the rear door prior to operating the ram. Opening the door weakens the support to the **B** Post
6. Operate the ram to push the **A** Post/dash/ footwell off the trapped casualty	
	4. Place support blocks under the sill and maintain the support as the floorpan rises. This reduces further collapse if the ram slips during the operation
	5. You must free the casualty's legs first, and you may not be able to use this technique if the victim's legs are trapped by the folded **A** Post or footwell
	6. You can also roll the dash by placing a ram between the centre of the rear seat cross beam and dash. If you use this technique, place a timber support block under the dash to spread the load of the ram
	7. You can roll the dash by using two rams, one on each side of the vehicle: this helps you to remove the casualty as you can remove one ram after you have rolled the dash

Table 2J Rolling the Dash Technique

2.16.6 Winching the Dash

Although you should first consider using the hydraulic rams to roll back the dash, you can use a winch to remove the dash (see Fig 2.24).

This technique is an effective alternative to the power ram.

Fig 2.24 Winching the Dash Technique

You may want to consider using this technique in the following situations:

- in an accident involving two or more vehicles where the hydraulic equipment is fully committed;
- in a vehicle where access to the casualty is restricted so as to prevent the safe and effective use of hydraulic tools;
- in a vehicle where you want access to the casualty through the side of the vehicle;
- in a vehicle where you want to provide added security when ramming and spreading with hydraulic equipment: that is, a *pack as you jack* operation; and
- in an accident where a vehicle is locked into a solid object such as a tree, you can use this technique if it appears that a dash roll might be unsuccessful because the object, the tree, is too close to the vehicle. Here, you may want to use a *reverse-dash winch*.

Table 2K details the technique and a list of points to consider if you use this technique.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Place a soft protective cover over the dash to protect the casualty
2. Remove the side and the roof. Do not remove the front door on the driver's side	2. Be sure that the anchors and anchor points are in line
3. Identify suitable remote anchor in the front and at the rear of the vehicle	3. Use a split block to obtain a ratio of 2:1 mechanical advantage (MA), if required
4. Attach chains or a Steel Wire Rope (SWR) sling to the rear of the vehicle	4. If space at the front of the vehicle is restricted, you can operate the winch from the rear of the vehicle: this is a *reverse-dash* winch operation
5. Take up all the slack in the sling	5. You can also use this technique with a chain-pull set
6. Attach chains or a SWR sling under the steering column and under the top door hinge	
7. Attach the winch and adjust the tension	
8. Attach the winch and adjust the tension	6. Place support blocks under the sill and maintain them there as the floorpan rises
9. Remove stabilising blocks	
10. Cut the gusset of the **A** Posts on both sides of the vehicle	7. Place wedges into the strategic cuts: *pack as you jack*
11. Carefully use the winch to move the dash clear of the casualty	
12. Replace the stabilising blocks	

Table 2K Winching the Dash Technique

2.16.7 Exposing the Footwell

When a motor vehicle has been damaged by a side impact or when an accident has caused a rearwards movement of the **A** Post, the casualty's legs or feet may be trapped in the footwell. In this event, a dash roll or steering-column pull could cause additional injury or pain to the casualty. If these techniques are not available or if there is insufficient space to spread or ram, you may need to expose the footwell. Two different methods are available for this technique. Table 2L details Method One and Table 2M details Method Two.

Method One

In Method One of this technique, use the spreaders to crush the **A** Post and the side wall and then lever them away from the sill (see Fig 2.25).

Fig 2.25 The Footwell Exposure - Method One

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TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. You may need to use the shears or the chisel to further weaken the sidewall and footwell
2. Remove the front door	
3. Use shears to cut the **A** Post just below the dash level and near the sill. Ensure that the **A** Post is completely severed.	2. You may need to place a ram in position to support the dash when you cut the **A** Post. Place the ram as you would for a dash-roll
4. Crush the sidewall with spreaders, then use the spreaders as a lever to force the sidewall out and away from the footwell.	

Table 2L Exposing the Footwell - Method One

Method Two

In Method Two of this technique, use the spreaders to force the **A** Post and sidewall away from the sill. This is a very quick and effective method to obtain immediate release of the casualty (see Fig 2.26).

Fig 2.26 The Footwell Exposure - Method Two

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. As an alternative step in Method Two, you can partially open the spreaders and put one tip against the seat cross member and the other against the **A** Post
2. If possible, remove the door	
3. Cut the **A** Post just below the dash level and at the gusset	2. You should place the spreaders at a slight angle to ensure an outwards movement when spreading begins: however, it is crucial that you do not use an extremely wide angle as the spreaders may slip
4. Place the tips of the spreaders into the cut at the base of the **A** Post and spread the **A** Post and side wall outwards, until the footwell is fully exposed	
5. You may need to position a ram to support the dash when cutting takes place. Place the ram as you would for a dash-roll	3. If the casualty is in close proximity to the steering wheel, you may need to remove the steering wheel
	4. During the implementation of Method Two, you must watch the **A** Post closely to ensure that it does not move inwards and apply pressure on the casualty

Table 2M Exposing the Footwell - Method Two

2.16.8 Removing the Road Wheel

If you must use the technique of exposing the footwell, your access for cutting may be blocked by the road wheel. In this case, you must remove the road wheel.

Here is a list of steps you can use for this technique:

- block and wedge the underside of the vehicle to prevent any sudden movement of the vehicle when the wheel is removed;
- unbolt the wheel nuts; and
- remove the wheel and place it in a safe position:

  - you may need to use a crowbar to prise it free;

  - you may need to puncture the tyre to create enough space to remove it; and

  - you may need to use the air chisel to cut away the mudguard.

2.16.9 Moving the Suspension to Gain Access to the Footwell

In the accident, the force of the impact may have pushed the wheel and the suspension into the footwell. The vehicle may end up in a position that denies you access to the wheel nuts. This may mean that your access to the footwell is blocked by the road wheel and suspension. You may not be able to remove the wheel. If space is limited, and you cannot use the spreaders or the ram, then you may have to move the suspension. This should give you sufficient space to expose the footwell.

Removing the suspension is frustrating and time consuming. This technique can be carried out only by a crew that is well practiced and competent in this technique.

2.16.10 Moving the Independent Strut and the Road Wheel

If you need to move the independent strut suspension leg and the road wheel assembly, you need to cut the tie rod, the steering arm, and the anti-roll bar (the sway-bar).

Table 2N details the technique and points to be considered if you use this technique.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise the vehicle to prevent collapse of the vehicle when the wheel is removed. Block the underside of the vehicle	1. Make the hacksaw cuts at a slight angle to prevent the blade jamming
2. Use the air hacksaw and cut • the tie rod, cut this first while it is still held firmly in place; • the steering arm; then • the anti-roll bar	2. If the blade jams or if the saw begins to labour, use a crowbar or wooden block to relieve the tension on the component you are cutting
3. Use a crowbar and lever the strut and the road wheel forward	3. If you cannot gain access to these components, you may need to unbolt or cut the ball joint on the steering arm. If you do this, you must make the cut at the narrowest point of the ball joint
4. Cut the brake hose and clamp the end of the hose with vice grips	4. If the wheel or wheel suspension are held by the mudguard, use the air chisel to cut and release them
5. If you need additional space, unbolt the road wheel	5. Move the suspension forward: you may need to use the spreaders to push it forward or the hand winch (*Tirfor*) to pull it forward

Table 2N Moving the Independent Strut and the Road Wheel

2.16.11 Moving the Wishbone Suspension and Road Wheel

If you need to move the wishbone-type suspension and the road wheel, you may need to cut the components.

Table 2O details the technique and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise the vehicle to prevent collapse of the vehicle when the wheel and suspension are removed	1. On some suspensions, both arms are of the *wishbone* type. If these are present, you should cut them instead of the ball joint
2. Use the air hacksaw and cut • the tie rod; • the ball joint on the lower suspension arm: cut this at the narrowest point; • the top wishbone arm: cut the wishbone arm if you have enough space;	
3. Cut the brake hose	
4. Remove the road wheel complete with stub-axle, disc, and brake calliper	

Table 2O Moving the Wishbone Suspension and Road Wheel

2.16.12 Hot Cutting

You can use hot cutting where the casualty's legs are firmly trapped in the front footwell. But you should use hot cutting as a last resort when the only course of action available is to move the road wheel and suspension to gain access to the footwell.

If you are thinking about using the hot cutting technique, you should take into consideration the following:

- you may need to use hot cutting to move the road wheel and the suspension when the casualty cannot be released by any other means: for instance, when cold cutting is not possible because space is very limited;
- you should consider whether you can make the area sufficiently safe to conduct hot cutting;
- you cannot use hot cutting in the presence of a hazardous substance or gas and you cannot remove the risk in sufficient time or reduce the risk to an acceptable level; and
- you cannot use hot cutting if the accident has occurred in an unventilated area.

Table 2P details the technique and a list of points to consider if you use this technique.

TECHNIQUE	POINTS TO CONSIDER
1. If necessary, hose down the area with high pressure hose reels and lay a blanket of foam	1. Never cut a shock absorber or hydraulic line. Protect these items from over heating
2. While you are actually doing the hot cutting, protect the area close to the cut by water spray. You must prevent any fire involving the tyres, brake hose, rubber hose, or similar materials	2. Only an experienced crew can conduct a hot cutting operation. The operators must be fully competent in the use of this technique
	3. Before using the hot cutting technique, first consider the use of cold cutting
3. Be careful to prevent the water spray from interfering with the hot cutting operation and the blanket of foam	4. Use the hot cutting technique only after consultation with ambulance personnel

Table 2P Hot Cutting

2.17 Side Impact

2.17.1 Introduction

Side impact damage can occur to a motor vehicle when the vehicle has collided with another object such as a motor vehicle, a telegraph pole, or a tree. The side impact accident often causes the collapse of the **A** Post (see Fig 2.27). A person in the front seat may have their legs trapped against the transmission tunnel. You may find it impossible to remove the front door or cut the front door hinges.

Fig 2.27 Side Impact Collision

The first priority in the extrication process is to force the collapsed **A** Post and the side wall off the injured person's legs. For this operation, you will probably use cross-ramming or spreading. These may be the only solutions if the vehicle is locked against a tree, a pole, or some other stationary object.

2.17.2 Cross Ramming

You may be able to cross-ram between the **A** Posts or between the transmission tunnel and the **A** Post or the sill. However to do this, you may have to remove the centre console.

The side of the car may be severely collapsed by the side impact. Prior to opening or removing the door, you may need to cross-ram between the **B** Posts or diagonal-ram between the sill and the **B** Post on the side of the car where the accident damage has occurred (see Fig 2.28). Either of these will ease the entrapment of the victim.

Fig 2.28 Cross Ramming Technique

These procedures prevent the doors and the posts from moving inwards onto the victim. This helps you with the door opening and side removal operations. If you use the ram, support it so that it does not drop onto the victim when you remove the side of the car.

2.17.3 Spreading

You may have enough space to use the spreaders. You should use the spreaders in all cases when the road wheel or suspension are forced into the footwell or the **A** Post has collapsed onto the injured person's legs (see Fig 2.29).

Fig 2.29 Spreading Technique

Here is a list of steps to follow for this technique:

- if necessary, cut away the rim of the steering wheel or raise the steering column with the chain pull set;
- open the spreaders and place the tips on either side of the victim's knees between the transmission tunnel and the **A** Post; and
- open the spreaders to release the victim's legs.

⚠ NOTE

You may find it easier to release the victim's legs if you make several parallel air chisel cuts along the transmission tunnel.

2.17.4 Progressive Strategic Cutting

The **A** Post of a motor vehicle is very substantial. For a successful ramming and spreading operation, you will need to cut the **A** Post.

Here is a list of steps to follow for this technique:

- cut the **A** Post at the top and bottom, if possible;
- if you don't have enough space to make both cuts, concentrate on the top or the bottom of the **A** Post: you can use the air chisel and the shears to complete the cut; and
- continue ramming to release the victim.

Strategic cutting is used to make the damaged door post weaker than the ramming point on the opposite side of the vehicle.

2.18 The Overturned Vehicle

2.18.1 Introduction

Any motor vehicle accident can create several potential hazards. This is especially true when the vehicle has overturned in an accident.

- fire is one very real possibility: a fire can result from a burst fuel tank as the fuel leaks from the tank through the filler cap or when the tank has been ruptured, dislodged, or damaged;

- battery acid damage or injury is another possibility: an inverted or damaged battery will leak acid, possibly directly onto the injured occupant;

- even uncontrolled removal of the occupant from the vehicle can increase the risk of injury. The injured person may have an artificially maintained blood pressure level: the trauma of uncontrolled removal from the vehicle can add to the severity of their existing injuries.

It follows then, that stabilisation of the vehicle and controlled release are particularly important if you are dealing with an overturned vehicle.

2.18.2 Vehicle on its Side

If the motor vehicle has overturned and has come to rest on its side, the preferred method for access and extrication of the injured person is the side roof flap approach (see Fig 2.30).

Fig 2.30 Side Roof Flap Technique

Table 2Q details the technique and points to be considered if you use this technique.

TECHNIQUE	POINTS TO CONSIDER
1. Secure and stabilise the vehicle	1. Secure the window housings when you are making the cut to prevent the housings from falling into the car
2. Remove the windscreen glass for access to the injured person	
3. Cut the top of the **A**, **B**, and **C** Posts	2. If the vehicle is a hatchback or a station wagon, open the tailgate first: beware of the potential of gas being released from the gas-filled strut
4. Cut or crush the **A**, **B**, or **C** Post that is adjacent to the ground: this weakens the structure of the vehicle	
5. Force the roof structure to the ground	3. As a safety precaution, remove any protruding pillars
	4. Ensure that the injured person is supported when you fold down the roof

Table 2Q Vehicle on its Side

2.18.3 Inverted Side Removal

If the motor vehicle has overturned and come to rest on its top, the preferred method for access and extrication of the injured person is inverted side removal: this creates more space to remove the injured person safely. This procedure differs slightly depending on whether you are working with a four door vehicle or a two door vehicle.

Four Door Vehicle

Here is a list of steps to follow for this technique if you are working with a four door vehicle:

- stabilise and secure the vehicle;
- open the front door and secure it out of the way;
- open the rear door and cut the base of the **B** Post;
- force the rear door and **B** Post down and cut the seat belt; and
- cut the top of the **B** Post and remove it from the working area.

Two Door Vehicle

Here is a list of steps to follow for this technique if you are working with a two door vehicle:

- stabilise and secure the vehicle;
- open the front door and secure it out of the way;
- remove the window glass and the interior trim in the rear quarter panel;
- support the injured person and cut the seat belt;
- use the air chisel to cut out the rear quarter panel;
- cut the gusset of the **B** Post;
- cut the rear quarter panel window line;
- fold the rear quarter panel and the **B** Post to the ground; and
- cut the top of the **B** Post and remove it from the working area.

2.18.4 The Floorpan Flap

If the motor vehicle has overturned and the roof structure has collapsed, you can use inverted side removal and the floorpan flap to gain access to the injured person (see Fig 2.31). This procedure is very useful when you have access to only one side of the vehicle. This happens when the vehicle is jammed beneath another obstacle or vehicle.

Here is a list of steps to follow for this technique:

- stabilise and secure the vehicle;
- support the injured person and cut the seat belts;
- use the air chisel or air file saw and make a cut in the rear floorpan from the sill to the transmission tunnel: make this cut next to the point where the rear seat support is spot welded to the floorpan;
- use the air chisel or air file saw and make a cut in the front floorpan from the base of the **A** Post to the transmission tunnel;
- cut any cross members or longitudinals;
- position the power ram vertically between the roof rail and the floor sill;
- apply a light pressure to the ram;
- cut the sill close to the gusset of the **A** Post;
- cut the sill next to the rear seat panel;
- use a knife to cut the floor carpets;
- use the power ram to raise the floorpan and seat: ensure that the seat back does not impede the power ram; and
- if you need more access room, you can secure the floorpan in the flapped position and remove the power ram.

Fig 2.31 The Floorpan Flap Technique

2.18.5 The Front Floorpan Cut-Out

You can use the front floorpan cut-out if the vehicle has overturned, and if the injured person's feet are trapped in the front footwell. By cutting out the floorpan and by cutting the base of the **A** Post or door sill, you will weaken the structure of the vehicle. This will enable you to use the ram or spreaders to release the injured person's feet.

Here is a list of steps to follow for this technique:

- stabilise and secure the vehicle;
- remove the side of the vehicle and locate the position of the injured person's feet;
- use the air chisel or air file saw to cut the perimeter of the floorpan to the front footwell and remove the floorpan;
- cut the sill at the gusset of the **A** Post; and
- spread or ram between the base of the **A** Post and the transmission tunnel: support the injured person's legs while you are doing this.

2.18.6 Inverted Power Ramming

Sometimes, inverted side removal does not create sufficient space. You can use inverted power ramming when the roof of the overturned vehicle has collapsed and you don't have enough access to the injured person (see Fig 2.32).

Fig 2.32 Inverted Power Ramming Technique

Table 2R details the technique and points to consider if you use the technique.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Choose carefully the best side of the car on which to conduct this operation
2. Remove the side of the vehicle	
3. Place the ram between the sill and the roof	2. If you don't have enough space to insert a ram, use the spreaders until the ram will fit
4. Support the vehicle by blocking it fore and aft before you use the ram	3. Stabilise the vehicle by blocking it fore and aft: place the blocks between the ground and the dash/bonnet and between the ground and the boot lid/rear mudguard
5. Cut the roof pillars: this will help in the ramming process	
	4. If you are working with a station wagon or a hatchback, here are some options you can consider to help you stabilise the vehicle: • inflate a low pressure air bag in the rear compartment; • fit a ram and extensions between the roof and floor of the rear compartment; and • use a high-lift jack between the ground and the floor or between the ground and the bumper bar of the vehicle.

Table 2R Inverted Power Ramming

2.18.7 Inverted Winching

If you are using inverted-ramming, you can also use the winch to help in the operation. By using the two of these together, you *pack as you jack*. This lessens the need for you to block the car as it rises. Alternatively, if you use blocking, you can remove the power ram: this allows you clear access to the injured person.

Table 2S details the technique and points to consider if you use this technique.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Ensure that the vehicle remains below the obvious point of balance
2. Open both the front and the rear doors	
3. Flap down the side of the vehicle	2. If you are going to remove the power ram, block both the front and the rear of the vehicle
⚠ **NOTE** **Do NOT cut the B Post at the roof.**	3. Remove or secure the front door
4. Select suitable remote anchor points on opposite sides of the vehicle	
5. Secure SWR slings to the suspension components at the front and the rear of the vehicle and connect them to the winch	
6. Secure the folded **B** Post to the anchor with chains	
7. Remove all slack to prevent the car from moving	
8. Operate the winch until the weight of the vehicle is fully supported	
9. Position the power ram	
10. Cut the **A** and the **C** Posts	
11. Continue winching and ramming until you have created enough space to remove the injured person	

Table 2S Inverted Winching

2.19 Light Commercial Vehicles

2.19.1 Introduction

The Light Commercial Vehicle (LCV) class includes:

- light commercial vans; and
- light *people-mover* passenger vans.

Both of these light van vehicles feature the forward-control configuration with the engine located under or behind the front seat.

If these vehicles are involved in an accident, injuries to the occupants are likely to be severe (see Fig 2.33). The configuration of the vehicle increases the chances of the accident trapping a victim's legs. For the extrication process, you can use a *roof-flapback* or a *dash-roll* to release the victim.

Fig 2.33 Damage to a Light Commercial Vehicle

2.19.2 Roof Flap

You can flapback the roof of a LCV to allow clear access to a trapped and injured person (see Fig 2.34).

Fig 2.34 LCV Roof Flap Technique

Table 2T details the technique and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Use the 2 m bar to help you make a crease in the roof
2. Open the doors	
3. Cut the windscreen posts at the top	2. You may wish to unload the cargo from the van to gain rear access to the inside of the van: before you do this, consider if additional strain will be placed on the injured person as the springs rise
4. Cut the roof railing at the rear of the front doors opening	
5. Fold back the roof	
	3. A load hazard may exist in the vehicle as this type of vehicle is often used commercially
	4. You may have some difficulty in *creasing* the roof: it will help if you use the air chisel to cut to the centre of the roof and leave a *hinge* in the centre before you make the cuts with the shears

Table 2T Roof Flap

2.19.3 Dash Roll

You can use this standard technique at almost every incident where the occupant's legs are trapped by the rearwards movement of the dash and the **A** Post.

Fig 2.35 LCV Dash Roll Technique

Table 2U details the technique and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Be careful not to over extend the ram
2. Insert the ram in the doorway below the seat cushion level: use spreaders to make more space if you need it	2. If you have enough space available, you can use high pressure airbags between the engine housing and the dash
3. Shear the **A** Post at the top and at the gusset	3. Take care with the position of the injured person's feet: they may be tangled in the pedals
4. Extend the ram gradually to create space	

Table 2U Dash Roll

2.19.4 The Reverse Dash Winch

If the front of the vehicle is locked into a tree, a pole, or some other stationary object, you might be able to use the *reverse dash winch.* The reverse dash winch provides an effective - and sometimes the only method of release.

Table 2V details the technique and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. Place soft protection over the dash to protect the injured person
2. Open the doors, but don't remove them	
3. Remove the roof	2. Be sure that the anchors and anchor points are in line
4. Identify remote anchors in the front and at the rear of the vehicle	3. Use split blocks to obtain a 2:1 MA if you need it
5. Attach chains or SWR slings to the rear suspension of the vehicle	
6. Attach chains or SWR slings under the steering column and under the top door hinge	
7. Attach the winch at the rear of the vehicle and apply tension	
8. Remove the stabilising blocks and chocks	
9. Cut the gusset of the **A** Post on both sides of the vehicle	
10. Carefully winch the dash clear of the injured person	
11. Replace the blocks and chocks	

Table 2V Reverse Dash Winch

2.19.5 Forward Control Vans - Rear Access

In a serious accident involving a forward control van, the quickest and easiest method for access is through the rear hatch. However, you may have trouble gaining access to the rear of the vehicle. If you cannot gain access through the rear, you have two alternative techniques: forced opening of the side door and third door entry.

Forced Opening of the Side Door

To operate the sliding side door of a LCV, you normally would first pull the handle and move the door outwards and then slide it rearwards. In an accident, before you can open the door, you will still need to force the rear of the sliding door outwards. Once the door has moved outwards, you can use the spreaders at the front edge of the door to force the door rearwards. Alternatively, you can cut the sliding brackets with the shears and then remove the door.

Third Door Entry

Table 2W details the technique for third door entry and points to be considered.

TECHNIQUE	POINTS TO CONSIDER
1. Stabilise and secure the vehicle	1. If you do not need to use the dash-roll, you can remove the **B** Post completely to give you improved access to the interior of the vehicle
2. Remove the window and the window glass	
3. Remove the internal wall trim if possible	
4. Use the air chisel to make two vertical cuts at the extremities of the window opening and continue the cut to the floor level	2. Cover all exposed metal edges with soft protection
5. Use the air chisel to make a horizontal cut to join the vertical cuts	
6. Use the shears to make a cut at the top of the air chisel cuts on the window line	
7. Use the shears or air chisel to cut any internal frame work	
8. Remove the cutaway section	

Table 2W Third Door Entry

2.20 Heavy Vehicles

2.20.1 Introduction

A serious accident involving heavy vehicles such as prime movers or large trucks, tests the ingenuity and stamina of even the most accomplished rescue operator.

When one heavy vehicle collides with another heavy vehicle or a large object, such as a wall, the front of the vehicle is pushed backwards. If the force of impact is great enough, the trailer or load can move forwards. This can crush the occupant between the trailer or the load and the front object.

With heavy vehicles, you can use the techniques similar to those you use to release people who are trapped in smaller vehicle accidents. However, every aspect of the operation is *larger*. All bodywork and component parts of heavy vehicles are larger, and they are constructed of heavier gauge metal. The trucks are higher, and you will find them more difficult to work on. All of our techniques will require greater force when they are used on heavy vehicles. You must use tried and proven techniques to ensure a successful outcome when you are working at a heavy vehicle accident.

Here is a list of the standard techniques to use on heavy vehicles: **note the modifications** to these steps as they apply to heavy vehicles.

2.20.2 Stabilising Techniques

At heavy vehicle accidents, you must stabilise the heavy vehicle just as you do the lighter vehicles:

- use doubled wooden wedges to chock the wheels in both directions;
- operate the handbrake, if possible;
- use wooden blocks to pack up to the subframe of the vehicle;
- pack airbag suspension between the suspension and the subframe of the vehicle in case of possible collapse of the airbag;

- if the heavy vehicle is equipped with a tilt-cabin, you may have to secure it with chains if the locking mechanism has come apart from the force of the impact; and
- use low pressure airbags in the stabilisation procedure.

2.20.3 Door Opening and Removal

Because of the height of a heavy vehicle and the heavier gauge of the metals, opening or removing the door can be a difficult procedure. To overcome the height problem, you can use stepladders or short ladders. If you use these, be sure they are well *footed* for solid support.

Another solution is to work off the top of a flat top tow truck, ute, or another vehicle of a suitable height that provides a working platform. Once you have access to the door, you can use standard door opening techniques, but take into account the stronger construction. When you are trying to remove doors, the first method you should try is to unbolt the hinges.

2.20.4 Roof Flap

As with lighter vehicles, you can flap back the roof of the vehicle to allow the medical attendant clear access to the severely trapped person.

Here is a list of steps to follow for this technique:

- stabilise and secure the vehicle;
- remove the windscreen;
- use the air chisel to cut from the roof rail shearing points towards the centre of the roof: be sure to leave a *hinge*;
- cut the **A** post above the dash level;
- cut the roof rail in front of the **B** post; and
- flap back the roof.

2.20.5 Forward Roof Flap

You can use the forward roof flap as an alternative technique. It works particularly well for a heavy vehicle with the *cab-over* or the *forward-control* configuration.

Here is a list of steps to follow for this technique:

- stabilise and secure the vehicle;
- use the shears or air chisel to cut the **B** and **C** Posts at their narrowest points;
- partially sever the **A** Post at the dash level;
- carefully flap the roof forwards using the **A** Post as a pivot; and
- completely sever the **A** Post and remove the roof flap from the working area.

2.20.6 Dash Roll

You can use this standard technique at almost every incident when the person's legs are trapped by the rearwards movement of the dash and the **A** Post.

Here is a list of steps to follow for this technique:

- stabilise and secure the vehicle;
- open and remove the door;
- position the ram in the doorway below seat cushion level;
- use the shears to make strategic cuts at the dash level at the gusset of the **A** Post; and
- operate the ram slowly to release the occupant.

2.20.7 Third Door Entry

In some accidents, you may not be able to push the front of the vehicle forwards. In this case, you will have to create a third door to the side of and behind the trapped person.

Here is a list of steps to follow for this technique:

- stabilise and secure the vehicle;
- use the ram to force the front of the vehicle as far forwards as possible and to release the occupant's legs;
- remove the sheet metal and fibreglass panels to expose the framing of the cabin;
- use the shears to sever all framing and posts: this creates the third door opening; and
- lay back or remove the back of the seat and remove the person:

⚠ NOTE

You should remove the person only under medical supervision.

2.20.8 'Rear Axle Lift

In some accidents, a person may be trapped under the rear axle or wheel of the vehicle. You may have to raise the axle or wheel to release them. You can usually do this quite safely with high pressure airbags or hydraulic rams: which one you use will depend on the situation.

Here is a list of steps to follow for this technique:

- apply the handbrake to prevent the vehicle from moving horizontally;
- securely chock the front wheels;
- carefully and accurately centre and position the airbags; and
- *pack as you jack*.

You can use the *Enerpac* Rams (RC 506 and RC 256) in tandem to lift the axle or wheel up to 150 mm. Be sure to centre the rams on the lift point and to *pack as you jack*.

⚠ NOTE

With these methods, you can achieve a substantial lift of the rear wheel and axle. However, the suspension system, the springs or airbags, would have to bottom out prior to lifting the truck body.

SECTION THREE - AIR OPERATED TOOLS AND AIR BAGS

CONTENTS

3 AIR OPERATED TOOLS AND AIR BAGS

3.1 Air Angle Grinder

3.1.1 Introduction

The introduction of the air operated pneumatic, *Shinano* angle grinder is designed to compliment the existing cutting capability of the primary rescue inventory (see Fig 3.1).

It also enables an operator to work in a confined space, where size, noise and fumes associated with a power saw would be a hindering factor.

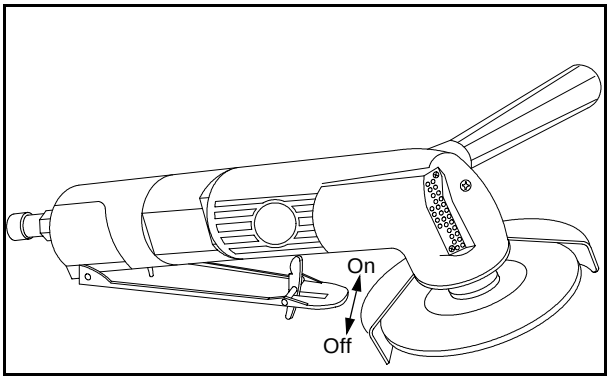


Fig 3.1 Air Angle Grinder

Table 3A details the technical specification of the grinder.

ITEM	SPECIFICATION
Disc Size	100 mm diameter
Free Speed	11 000 rpm
Air Consumption	200 L/min
Net Weight	1.80 kg
Duration	4 mins free spinning - 207 Bar cylinder
Disc Rated	15 000 rpm
Disc Specification	102 x 3, 4 x 26 mm Metal Cutting A30S 102 x 6, 0 x 16 mm Metal Grinding A30S 102 x 3, 2 x 16 mm Masonry Cutting - any reputable brand

Table 3A Air Grinder Specification

3.1.2 Operation

To operate the air angle grinder carry out the following actions:

- ensure that the **O** ring on the reducing valve spigot is intact. Obtain a CABA cylinder and crack to clear the airway. Hand tighten the reducing valve to the CABA cylinder;
- insert one drop of 3 in 1 oil into the male air hose connection at the base of the air angle grinder;
- connect the air hose to the angle grinder by sliding back the outer sheath of the female hose coupling as the connection is made;
- turn the CABA cylinder fully ON;
- push the lever on the trigger arm forward with thumb to operate the tool;

- maintain a firm pressure against the working surface; and
- Ensure air cylinders are laid down to prevent possible damage if knocked over.

NOTE

If sparks or heating of the surface present a problem, then a fine spray of water should be used and applied with the tool operating at full throttle.

3.1.3 Removal/Attachment of Discs

To either remove an old disc or attach a replacement disc, carry out the following actions:

- ensure CABA cylinder is turned **OFF**;
- ensure tool is disconnected from air supply;
- insert the U Shaped spanner behind the disc to *lock* the spindle;
- insert the pins of the other spanner into the holes of the spindle locking nut;
- remove the spindle locking nut by turning in an anti-clockwise motion;
- remove or attach the disc;
- replace the spindle locking nut;
- tighten by rotating spindle locking nut in a clockwise manner; and
- remove spanners.

CAUTION

Cutting operations should only be conducted with new discs. Discs that are worn, damaged or suspect should not be used with this tool.

3.1.4 After Use Action

The following actions should be taken after any use of the grinder:

- disconnect the air from the air angle grinder;
- turn the CABA cylinder **OFF**;
- insert one drop of 3 in 1 oil into the male air hose connection at the base of the tool; and
- reconnect the tool to the air hose and operate tool to purge the air line.

3.1.5 Mounting of Wheels

Grinder wheels of less than 178 mm dia are to be mounted as detailed in Fig 3.2.

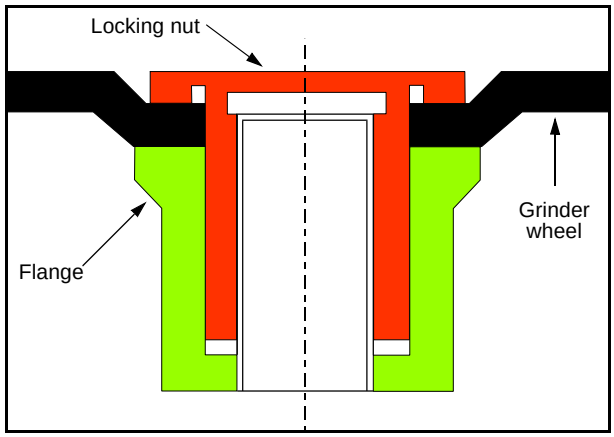


Fig 3.2 Correct Mounting of Wheel (less than 178 mm dia)

Grinder wheels of 178 mm dia plus are to be mounted as detailed in Fig 3.3.

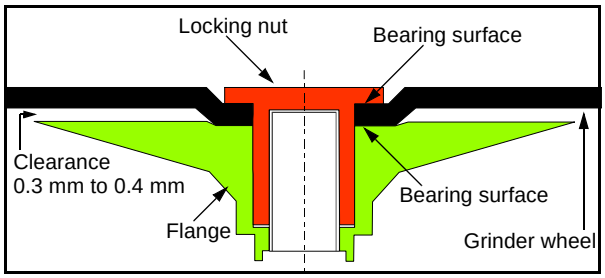


Fig 3.3 Correct Mounting of Wheel (in excess of 178 mm dia)

3.2 Air Chisel

The Air Chisel is an air operated (pneumatic) tool (see Fig 3.4). When fitted with an appropriate chisel, it is capable of cutting metal up to approximately 3 mm thick or severing the heads from mild steel bolts, screws and rivets. These tasks are all commonly encountered during rescue operations.

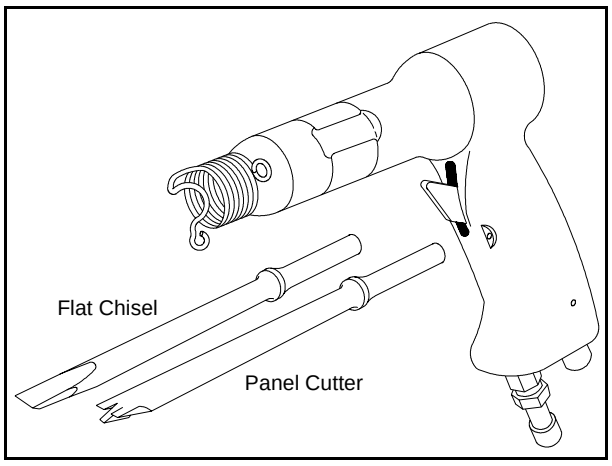


Fig 3.4 Air Chisel

Table 3B details the technical specification and inventory of the Air Chisel.

ITEM	SPECIFICATION
Air Operating Pressure	700 - 800 kPa
Air Consumption	110 L/min
Strokes Per Minute	Up to 1500
Speed Settings	2 or 4
Inventory	1 x pressure reducing valve (with high pressure hose length) 1 x flat chisel 1 x panel cutter 1 x container of lubricating oil spare **O** rings

Table 3B Air Chisel Specification

3.3 Air File Saw

The Air File Saw is a compact air powered tool that converts from hacksaw to file in minutes. The saw is lightweight and its sleek shape enables its use in confined spaces. The saw is particularly useful at domestic and industrial rescue work.

The NSWFB currently operates two models of air file saw:

- Model AF8 (see Fig 3.5); and
- Model AF 10 (see Fig 3.6).

3.3.1 Model AF8

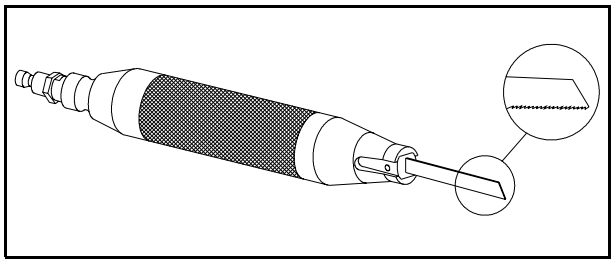


Fig 3.5 Air File Saw (Model AF8)

Table 3C details the technical specification and inventory of the air file saw (AF8).

ITEM	SPECIFICATION
Air Operating Pressure	700 - 800 kPa
Air Consumption	230 L/min
Stroke	8 mm
Speed	1500 rpm non-variable
Weight	950 g
Inventory	detachable head hacksaw blades 2 x allen keys 3 x files (flat/round/triangular)

Table 3C AF8 Specification

3.3.2 Model AF10

The AF10 (see Fig 3.6) is a later model and has the following additional features:

- sound muffler fitted to the air exhaust vent;
- new style head attachment.

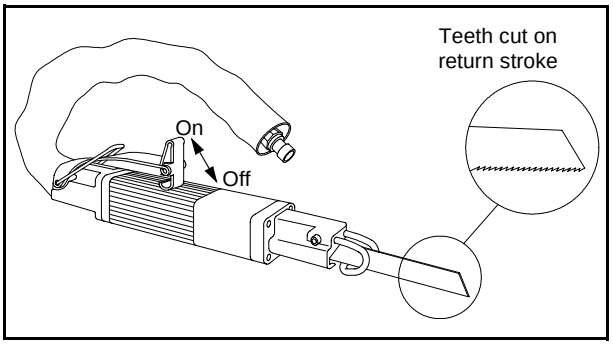


Fig 3.6 Air File Saw (Model AF 10)

Table 3D details the technical specification and inventory of the AF10 air file saw.

ITEM	SPECIFICATION
Air Operating Pressure	700 - 800 kPa
Air Consumption	230 L/min - variable
Stroke	8 mm - variable
Speed	1500 rpm - variable
Inventory	15 hacksaw blades (18-24-32 tpi) Allen keys 3 x machine files (flat/round/triangular) Saw

Table 3D AF10 Specification

3.4 Reciprocating Air Saw

The NSWFB currently use two types of reciprocating air saws:

- *Cengar*; and
- *Tigair.*

3.4.1 Cengar

The *Cengar* (see Fig 3.7) was one of the first pneumatic reciprocating tools of its kind to be developed.

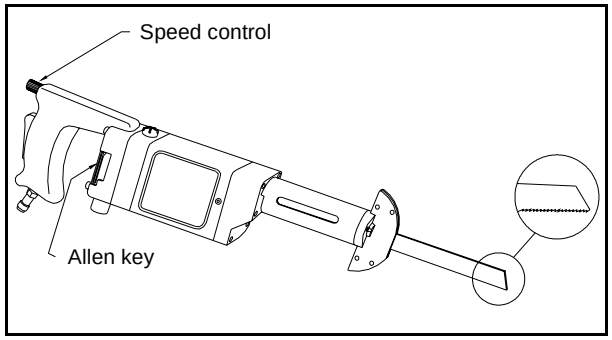


Fig 3.7 Reciprocating Air Saw (Cengar)

Table 3E details the technical specification for the *Cengar.*

ITEM	SPECIFICATIONS
Air Operating Pressure	700 - 800 kPa
Air Consumption	168 L/min
Stroke	20 mm
Speed	0 - 2000 strokes per min

Table 3E Cengar Specification

3.4.2 Tigair

The *Cengar* and the *Tigair* air saws (see Fig 3.8) are primarily used for cutting metals, plastics, laminates or similar materials, in situations where insufficient space exists, for operating other cutting tools. Both saws may also be used on barred windows or as a general entry tool.

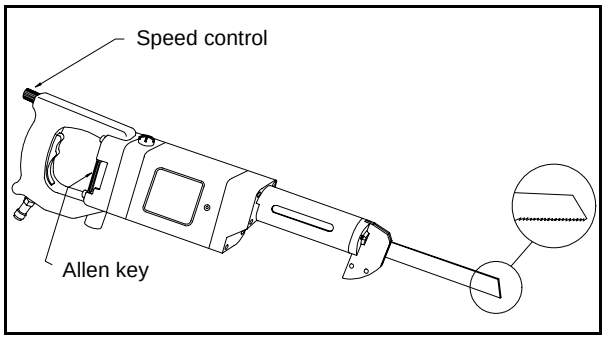


Fig 3.8 Reciprocating Air Saw (Tigair)

Table 3F details the technical specification for the *Tigair.*

ITEM	SPECIFICATIONS
Air Operating Pressure	700 - 800 kPa
Air Consumption	180 L/min
Stroke	40 - 50 mm
Speed	0 - 1200 strokes/min
Blades	Standard 18/24 or 32 tpi (teeth per inch - tpi)
Lubrication	Red oil in reservoir

Table 3F Tigair Air Saw Specification

3.5 Reversible Air Drill

3.5.1 Introduction

The NSWFB currently operate with the *Shinano* air operated reversible drill (see Fig 3.9), which is capable of drilling a variety of materials, including wood, plastic and metal.

Screwdriver bits e.g. *Phillips* head, *Torx*, straight etc can be used with this drill for removal or replacement of screws.

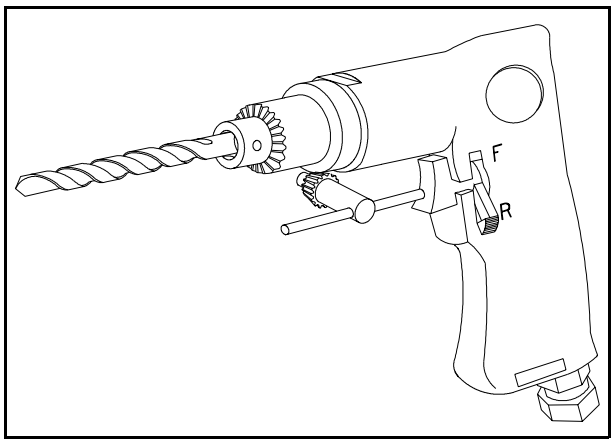


Fig 3.9 Reversible Air Drill (Shinano)

Table 3G details the technical specification and inventory of the *Shinano* air drill.

ITEM	SPECIFICATION
Air operating pressure	700 - 800 kPa
Air Consumption	300 L/min.
Capacity	11 mm
Free Speed	2200 rpm
Duration	A single 20 700 kPa cylinder - 5 mins not under load
Drills Bits	High speed drill bits ranging from 1 mm to 10 mm, a 5 mm masonry bit and chuck key.

Table 3G Shinano Air Drill Specification

3.5.2 Operation

To operate the *Shinano* Air Drill, carry out the following actions:

- insert required size and type of drill bit in chuck, tighten with chuck key;
- insert one drop of lubricating oil in airway of drill;
- obtain a CABA cylinder and *crack* to clear any dirt/debris from airway;
- ensure air cylinders are laid down to prevent possible damage if knocked over;
- attach pressure reducer to CABA cylinder, noting the condition of the **O** ring;
- turn cylinders fully on and back 1 turn; and
- operate as required.

3.5.3 After Use Actions (Make Up)

The following actions are required to be carried out after use of the drill:

- disconnect air supply;
- insert one drop of oil in airway of drill;
- re-connect air to drill and turn cylinder off;
- bleed air line (operate tool), this will oil working parts; and
- disconnect tool.

3.6 LAB Low Pressure Air Bag

3.6.1 Introduction

Low pressure air bags (see Fig 3.10) provide a means of applying force to lift or move objects. They are particularly useful when used on weak parts of large vehicles, like buses. Unlike high pressure air bags, they do not decrease in their capacity as the load rises.

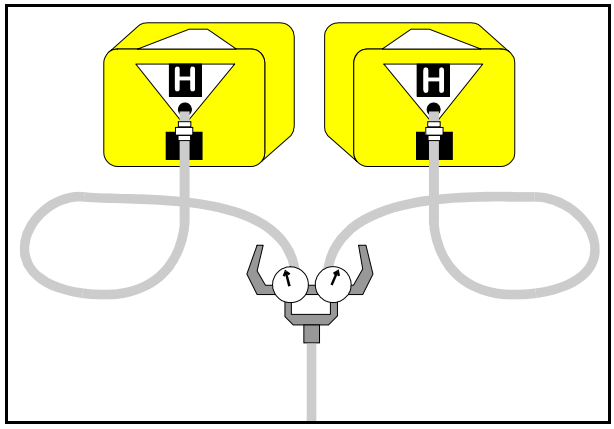


Fig 3.10 LAB Low Pressure Air Bag

3.6.2 Features

The LAB air bags have the following features:

- simple and quiet operation;
- ideal for use in restricted spaces;
- suitable for soft or boggy ground;
- suitable for irregular or rubble strewn ground;
- able to provide buoyancy to float vehicles etc;
- chemical resistant;
- reinforced, wear resistant, non slip top; and
- quick release valve (new model only).

⚠ NOTE

LAB's are to be used as a pair and not by themselves.

Table 3H details the technical specification and inventory of the LAB air bag.

ITEM	LAB 6U	LAB 9U	LAB 16U (EARLY)	LAB 16 (NEW)
Maximum operating pressure **⚠ NOTE** **Operating pressure of 50 kPa, pressure reducer setting to be 500 kPa**	50 kPa	50 kPa	50 kPa	50 kPa
Maximum lifting capacity	6 t (3 t per bag)	9 t (4.5 t per bag)	16 t (8 t per bag)	16 t (8 t per bag)
Dimensions (L x W x D)	76 x 76 x 6 mm	91 x 91 x 6 mm	122 x 122 x 6 mm	122 x 122 x 6 mm
Maximum inflated height	620 mm	620 mm	1000 mm	620 mm
Maximum air volume	716 L (358 L per bag)	1028 L (514 L per bag)	2976 L (1488 per bag)	1846 L (923 per bag)
Inventory	1 x pressure reducer; 1 x twin control valve/distributor; 2 x 5 m air hoses; 2 x low pressure lifting bags (equal capacity); 1 x storage bag; 3 x spare baby **O** rings;			

Table 3H LAB Low Pressure Air Bag Specification

3.7 HKB High Pressure Air Bag

3.7.1 Features

The HKB high pressure air bags have the following features:

- provides a safer lifting alternative in the presence of flammable liquids and vapours;
- suitable for use on soft or marshy ground;
- quiet operation and ideal for use in restricted spaces;
- constructed of *Kevlar* reinforced, non-slip neoprene rubber;
- resistant to continuous heat up to +80° C and temporary exposure to heat up to +110° C;
- resists cold to - 40° C; and
- tested to 20 Bar, minimum burst pressure is 32 Bar.

Table 3I details the technical specification and inventory of the HKB air bags.

ITEM	HKB 5	HKB 11	HKB 20	HKB 24	HKB 29	HKB 40	HKB 67
Maximum operating pressure	800 kPa	800 kPa	800 kPa	800 kPa	800 kPa	800 kPa	800 kPa
Maximum lifting capacity	4.8 t per bag	11 t per bag	20 t per bag	24 t per bag	29 t per bag	20 t per bag	67 t per bag
Dimensions in mm (L x W x D)	260 x 260 x 19	381 x 381 x 22	511 x 511 x 22	1000 x 320 x 22	611 x 611 x 25	714 x 714 x 25	917 x 917 x 25
Maximum inflated height	150 mm	210 mm	285 mm	210 mm	340 mm	400 mm	510 mm
Maximum air volume	20 L	76 L	188 L	217 L	350 L	550 L	1200 L
Inventory	1 x pressure reducer; 1 x twin control valve/distributor; 2 x 5 m air hoses (in two colours); 2 x high pressure lifting bags (equal capacity);						

Table 3I HKB High Pressure Air Bag Specification

3.8 HAB High Pressure Air Bag

3.8.1 Models

Three models of HAB air bag are currently in use with the NSWFB:

- HAB 20 (early model);
- HAB 20 (new model); and
- HAB 29.

The differences between models is identified clearly in Table 3J.

3.8.2 Features

The HAB and HKB air bags (see Fig 3.11) have the following features:

- they provide a safer alternative in the presence of flammable liquids/ vapours;
- they are suitable for use on soft or marshy ground;
- quiet operation ideal for use in restricted spaces;
- they are constructed of steel or kevlar reinforced, non slip neoprene rubber;
- they are resistant to continuous heat up to 105° C (short term) and 65° C (long term exposure); and
- they are tested to 16 Bar, with a minimum burst pressure of 40 Bar.

ITEM	SPECIFICATION FOR HAB 20 (EARLY)	SPECIFICATION FOR HAB 20 (NEW)	HAB 29
Operating pressure	800 kPa	800 kPa	800 kPa
Lifting capacity	20 t per bag	20 t per bag	29 t per bag
Dimensions (L x W x D)	508 x 508 x 18 mm	511 x 511 x 20 mm	611 x 611 x 20 mm
Maximum inflated height	282 mm	280 mm	333 mm
Maximum air volume	208 mm	188 mm	351 mm
Inventory	1 x pressure reducer; 1 x twin control valve/distributor; 2 x 5 m air hoses (in two colours); 2 x high pressure lifting bags (equal capacity);		

Table 3J HAB High Pressure Air Bag Specification

3.9 Air Bag Lifting Capacity

There is a direct relationship between the lifting height and the capacity of air bags. When the air bag is inflated, the effective pressure area becomes smaller and as a result, the lifting capacity of the bag decreases.

For this reason it is vital that:

- prior to bag inflation - as much space between load and bag is taken up; and
- wherever feasible - the maximum surface area of the bag/s is covered when lifting.

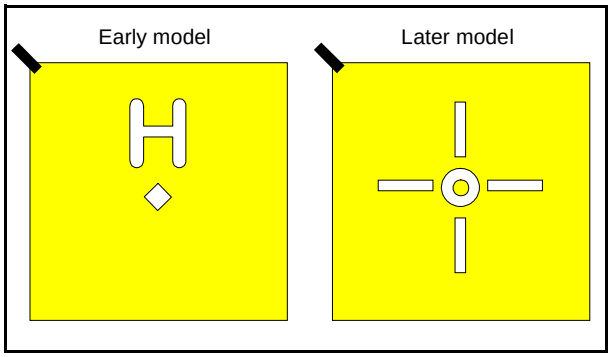


Fig 3.11 HAB High Pressure Air Bags

Table 3K details the remaining lifting capacity for a particular lifting height.

LIFT HEIGHT (MM)	20 T	29 T	40 T	67 T
20	19.2	26.5	35.0	62.8
40	14.8	22.0	33.5	60.0
60	12.0	20.0	32.0	58.4
80	10.4	17.2	29.2	53.5
100	8.8	14.8	27.0	50.3
120	7.2	13.2	23.5	43.2
140	6.0	10.8	21.5	41.5
160	4.6	9.2	19.0	39.2
180	3.4	7.2	16.2	36.0
200	2.6	6.0	14.2	32.0
220	1.8	4.8	12.1	28.0
240	1.2	3.6	10.3	25.5
260	0.9	2.8	9.0	23.0
280	-	1.8	7.1	20.0
300	-	1.2	6.0	18.0
320	-	0.8	4.6	16.0
340	-	-	3.8	13.5
360	-	-	2.4	11.2
380	-	-	1.8	9.5
400	-	-	0.9	8.0
420	-	-	-	6.0
440	-	-	-	5.0
460	-	-	-	4.0
480	-	-	-	3.0
500	-	-	-	1.8

Table 3K Remaining Lifting Capacity for a Particular Lifting Height

NOTE

Low Pressure Air Bags always produce the maximum lifting capacity at each height.

SECTION FOUR - HYDRAULIC PUMPS

CONTENTS

4 HYDRAULIC PUMPS

4.1 Motorised Hydraulic Pumps

4.1.1 General Information

The NSWFB currently use both the *Enerpac* PGR - 2041 (see Fig 4.1) and the *Holmatro* (see Fig 4.2) motorised pumps for rescue operations.

As with any motorised equipment, hydraulic pumps are to be fully maintained and ready for use. A unit should only be operated in a well ventilated area for efficient, safe operation, and on level ground to allow for adequate lubrication.

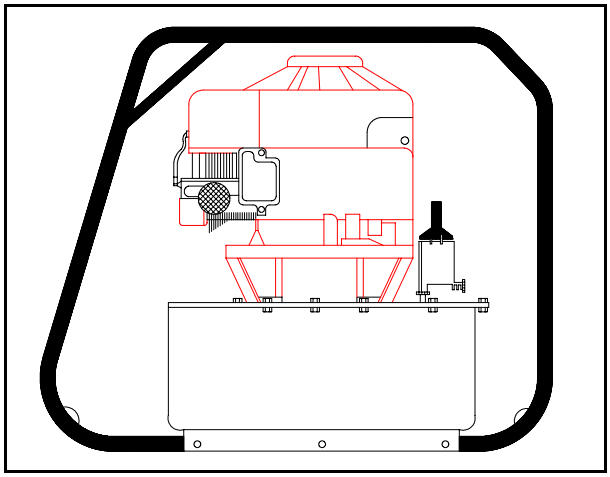


Fig 4.1 Motorised Hydraulic Pump (Enerpac PGR - 2041)

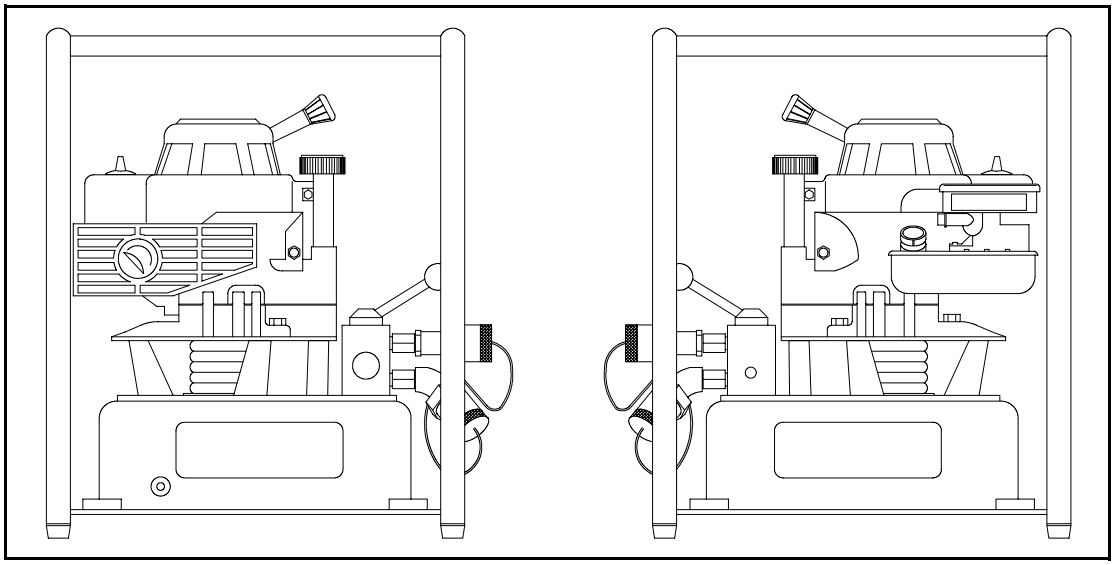


Fig 4.2 Motorised Hydraulic Pump (Holmatro)

4.1.2 Maintenance

All maintenance on a unit is to be recorded and key tags attached to the pump to indicate dates of last service to oil, air filter and spark plug (see Table 4A).

A common problem with air filters is that operators tend to over-saturate the foam elements. Once filters have been cleaned, lightly oil the foam and wrap it in a soft cloth. Stand on the element to squeeze out any excess oil. Unwrap and refit element.

To check hydraulic oil level on the *Enerpac*, remove filler plug and fill with *Enerpac* hydraulic fluid until only 1 cm of air space exists within the tank.

Refuelling should be done with clean, unleaded fuel and using a funnel, in a well ventilated area.

4.1.3 Fuel Tank Problems

Problems with fuel have occurred when over a period of time, particles have made their way into fuel tanks and have caused a small fuel filter inside the tank to become blocked.

Regularly flush the tank to keep unit free of this problem. If a problem occurs whilst connected to a tool (which is fully extended), complications will arise if the operator chooses to change the tool. The pump reservoir will overfill with oil and may not allow a full retraction of the ram.

To obviate this problem, a simple solution would be to turn the deadman's handle (see Fig 4.3) to close and pull the starter cord to crank pump over. This will slowly retract the ram.

⚠ NOTE

This action needs to be carried out while the tool is still connected and selected to the motorised pump.

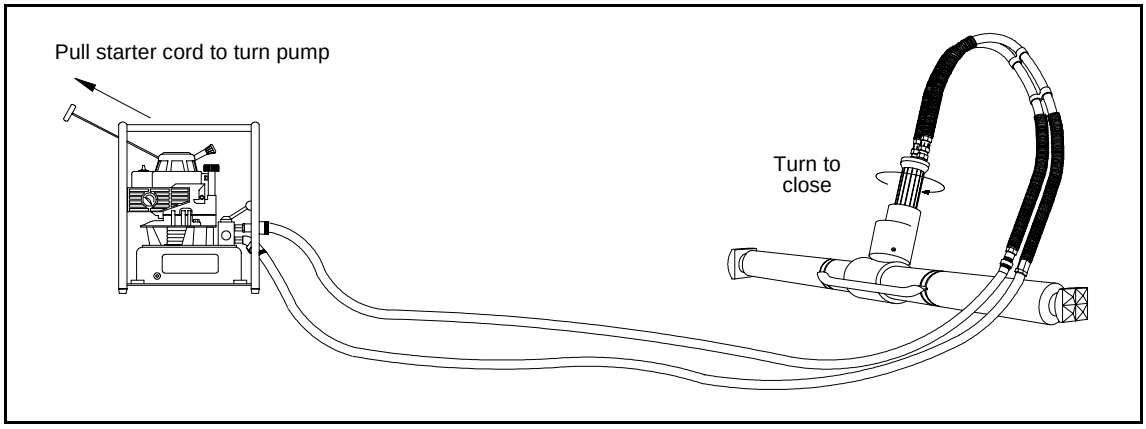


Fig 4.3 Operation of Deadman's Handle

ITEM	MAINTENANCE	PERIODICITY
Engine oil	Drain and replace with SAE 30 multigrade	Changed every 25 hrs or 6 mths
Air filter	Wash in kerosene, squeeze dry, saturate foam with oil then squeeze to remove excess completely	Every 25 hrs or 6 mths
Spark plug	Remove and clean	Reset gap every 100 hrs or 12 mths

Table 4A Motorised Hydraulic Pump Maintenance

Table 4B details the technical specification of the *Holmatro* hydraulic pump.

ITEM	SPECIFICATION
Pump type	Single stage (directly connected radial plunger pump)
Drive	3.5 hp *Briggs & Stratton* petrol motor, 3600 rpm air cooled
Fuel	Unleaded petrol
Weight	30 kgs (2 man lift)
Hydraulic tank	6 L capacity (to dipstick mark) *Enerpac* hydraulic oil
Crank case oil	600 mls multigrade motor oil
Spark plug type	*Champion* RCJ 8 at 0.76 mm (0.3 ") gap
Max. Relief valve setting	72 000 kPa
⚠ **NOTE** **Stowed with manual release valve CLOSED (where fitted)**	

Table 4B Holmatro Hydraulic Pump Specification

Table 4C details the technical specification of the *Enerpac* PGR - 2041 hydraulic pump.

ITEM	SPECIFICATION
Pump type	single stage twin radial piston pump
Drive	*Briggs & Stratton* petrol motor, 4 stroke
Fuel	Unleaded petrol 0.75 l capacity
Weight	30 kgs
Hydraulic tank	4.5 L *Enerpac* hydraulic oil
Crank case oil	600 mls Multigrade Engine Oil
Spark plug type	*Champion* RCJ8 gap set at 0.76 mm
Max. Relief valve setting	72 000 kPa

Table 4C Enerpac PGR - 2041 Hydraulic Pump Specification

4.2 Air Hydraulic Power Pump

4.2.1 Introduction

The NSWFB currently operate with the *Enerpac* PA 1150 air operated, hydraulic pump (see Fig 4.4).

The pump may be used in areas of confined space where exhaust fumes from a motorised pump would contribute to entrapment problems. The pump is also quieter and less likely to ignite a flammable environment however, **it is not intrinsically safe**.

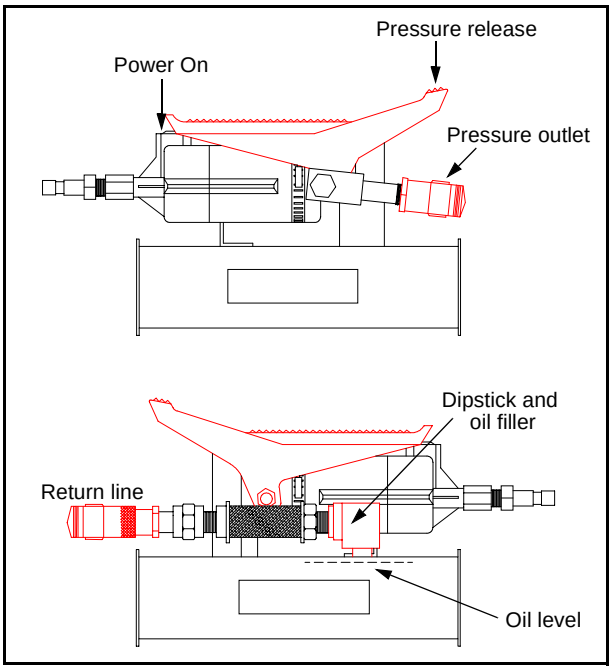


Fig 4.4 Air Hydraulic Power Pump

Table 4D details the technical specification of the power pump.

ITEM	SPECIFICATION
Oil Reservoir Capacity	1.3 L
Weight (kg)	8.2 kg
Max. Air Operating Pressure	700 - 800 kPa
Air Consumption	250 L/min
Relief Valve Setting	70 000 kPa

Table 4D PA1150 Power Pump Specification

4.2.2 Maintenance

A dipstick is located on the return line, that incorporates an allen screw. The reservoir is checked by placing the dipstick in the hole, but not screwing it in. The top mark on the dipstick indicates the correct level.

4.2.3 Operation

To operate the pump, the following actions are to be carried out:

- ensure that the pump has no pressure at outlets (prior to connecting hydraulic lines), by depressing the release on the treadle;
- connect both hydraulic lines to the unit ensuring that the lines are clean by wiping couplings with a clean cloth (if necessary);
- connect hydraulic line or lines to a tool, either single acting or double acting, ensuring that the lines are clean;

⚠ NOTE

WR4/WR5, 2005 and 2006 double acting power rams may not be suitable.

- obtain a CABA cylinder, and lay down the cylinder adjacent to where the pump is to be used;
- obtain a pressure reducer from the air tool kit and ensure **O** ring is intact, hand tighten the reducing valve to the CABA cylinder;
- connect hose to air/hydraulic pump; and
- turn CABA cylinder fully **ON**.

The unit may now be operated with the commands **power on**, **stop** and **power off** for single acting tools and the commands **power on** and **stop** for double acting tools.

⚠ NOTE

With double acting tools, the *stop* command is necessary for air conservation.

4.3 Double Acting Air/Hydraulic Turbo Pump

4.3.1 Introduction

This pump can be used with all NSWFB double acting tools and nearly all single acting tools. The only exception to the latter is the *Enerpac* WR4 (Wedge), because the speed of operation cannot be controlled with a sufficient degree of safety.

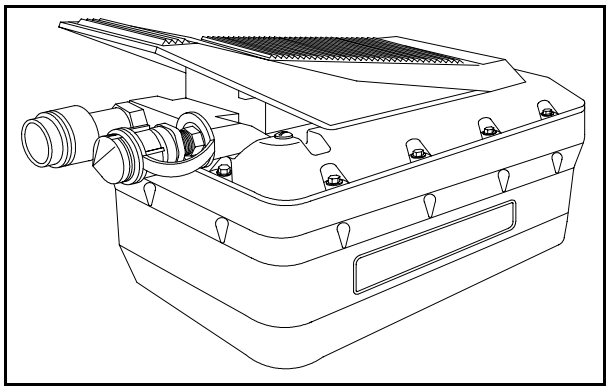


Fig 4.5 Double Acting Air/Hydraulic Turbo Pump (Enerpac)

4.3.2 Operation

To operate the pump, carry out the following actions:

- ensure that the pump has no pressure at outlets prior to connecting hydraulic lines, by depressing release on treadle;
- connect both hydraulic lines to unit ensuring that lines are clean by wiping couplings with a clean cloth (if required);
- connect hydraulic line or lines to tool, either single or double acting, ensuring that lines are clean;
- obtain a CABA cylinder, and lay down cylinder adjacent to where pump is to be used;
- safely crack open the cylinder. Ensure the cylinder is pointed away from any person;
- obtain a pressure reducer from the air tool kit, and ensure **O** ring is intact. Hand tighten the reducing valve to the CABA cylinder;
- connect the hose to the air/hydraulic pump; and
- turn the CABA cylinder fully **ON**.

⚠ NOTE

WR4/WR5 may not be suitable.

The unit may now be operated with the commands **power on**, **stop** and **power off** for single acting tools and the commands **power on** and **stop** for double acting tools.

Table 4E details the technical specification of the *Enerpac* Double Acting Air/Hydraulic pump.

ITEM	SPECIFICATION
Air operating pressure	600 - 800 kPa
Air consumption	5.6 min (20 700 kPa cylinder)
Useable oil capacity	2.1 L
Total oil capacity	2.5 L
Max. oil operating pressure	72 000 kPa
Weight	7.0 kg

Table 4E Enerpac Turbo Pump Specification

4.3.3 Maintenance

To carry out an oil level check, remove the oil filler plug and the oil should be level with the bottom of the skirt.

CAUTION

The vent screw must always be unscrewed 1-2 turns. Failure to observe this caution may result in the tool not operating or damage to the pump.

The pump casing is constructed of PVC plastic so handle with due care.

4.4 Single Speed/Single Acting Pump

The NSWFB currently use one type of single speed/single acting pump which is the *Enerpac* P39 model (see Fig 4.6).

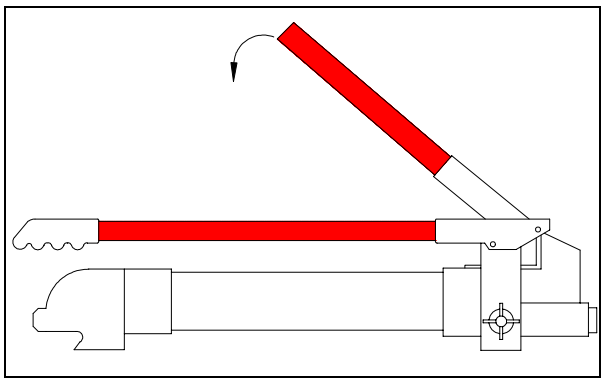


Fig 4.6 Single Speed/Single Acting Pump (Enerpac P39)

Table 4F details the technical specification of the P39 pump.

ITEM	SPECIFICATION
Max. operating pressure	72 000 kPa
Useable oil capacity	655 mls
Displacement per stroke	2.61 cm^2

Table 4F Enerpac P39 Specification

4.4.1 Single Speed Pump Operation

Fig 4.7 details a schematic of single speed pump operation and all items identified by alpha-numeric references are taken from this figure.

A small plunger (A1) is moved up and down by means of a handle/lever. As the plunger travels up, hydraulic fluid is drawn in from the reservoir and past a check (non-return) valve.

When the operator applies a force (F1) to the handle the plunger travels down, hydraulic fluid is pressurised past another check valve and on to the tool. As pumping continues these check valves will open and close automatically with the pressure differences that are created.

The manual release must be closed whilst pumping. Opening this valve will return fluid back to the reservoir. A spring is fitted to all single acting hydraulic tools ensuring that the fluid returns to the reservoir whether the tool is loaded or not.

An in-built pressure relief valve will operate if the pressure exceeds 72 000 kPa and relieve such fluid back to the reservoir.

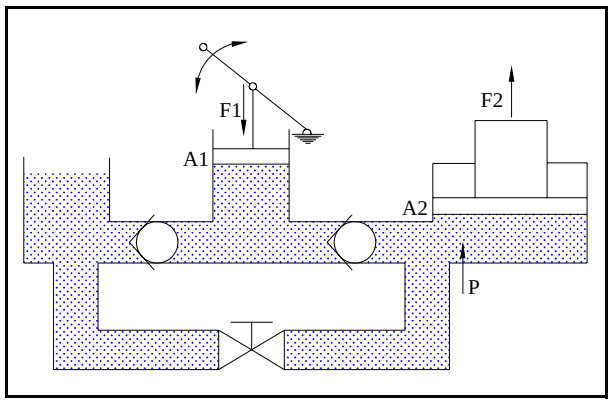


Fig 4.7 Single Speed Pump Operation

4.5 Two Speed/Single Acting Pump

4.5.1 Introduction

The NSWFB currently use the *Enerpac* P80 (see Fig 4.8) as the only type of two speed/ single acting pump.

The advantage of this pump is that when there is a small load on a tool, the pump can deliver a large volume of fluid and achieve greater efficiency.

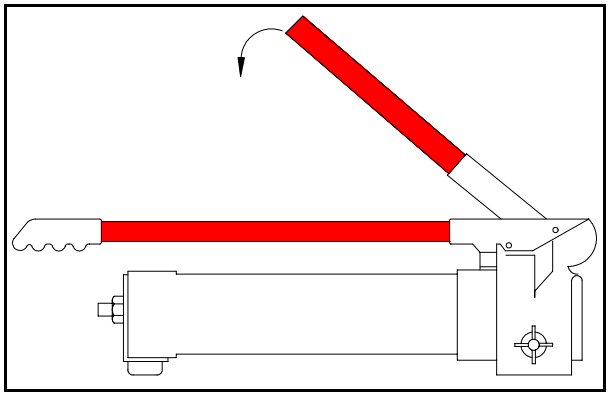


Fig 4.8 Two Speed/Single Acting Pump (Enerpac P80)

Table 4G details the technical specification for the *Enerpac* P80 pump.

ITEM	SPECIFICATION
Max. operating pressure	0 - 3000 kPa (1st stage) 3000 - 72 000 kPa (2nd stage)
Useable oil capacity	2200 ml
Displacement per stroke	1.6 cm^2 (1st stage) 2.4 cm^2 (2nd stage)

Table 4G Enerpac P80 Specification

4.5.2 Operation

Fig 4.9 details a schematic of the two speed/ single acting pump operation, and all items identified by alpha-numeric references are taken from the figure.

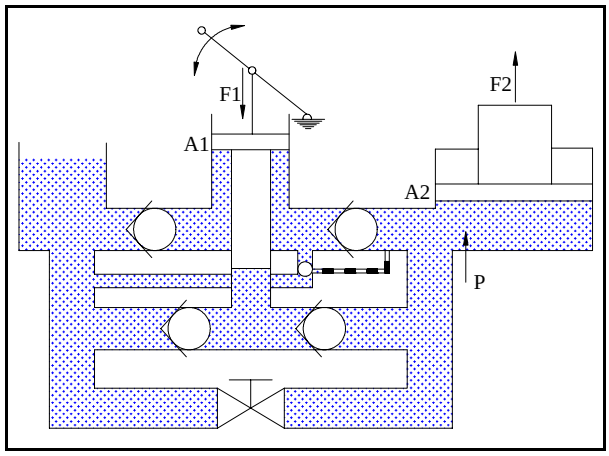


Fig 4.9 Two Speed/Single Acting Pump Operation

This pump has a two faced plunger working and pressurising separate chambers within the pump head. Acting in tandem, when the plunger travels up, hydraulic fluid is drawn in to the chambers from the reservoir past two check (non-return) valves.

As the operator applies a force (F1) on the lever/handle, the plunger travels down and the fluid is pressurised, passing through two check valves and on to the tool. In this first stage, the two chambers are hydraulically independent and the pump is moving a large quality of fluid at relatively low pressure.

⚠ NOTE

The manual release must be closed whilst pumping. Opening this valve will return fluid back to the reservoir.

A spring is fitted to all single acting hydraulic tools ensuring that the fluid returns to the reservoir whether the tool is loaded or not.

As the pumping continues, these check valves will open and close automatically with the differences in pressure that are created. On two speed pumps, at a pressure of approximately 3000 kPa the second stage engages and a valve operates that will cause the fluid under plunger face (A1) to return to the reservoir with every stroke.

An in-built pressure relief valve will operate if plunger (a) pressure exceeds 72 000 kPa and relieve such fluid back to the reservoir.

4.6 Two Speed/Double Acting Pump

4.6.1 Introduction

The NSWFB currently use both the *Enerpac* P82 pump (see Fig 4.10) and the *Holmatro* two speed/double acting pump for a variety of rescue operations.

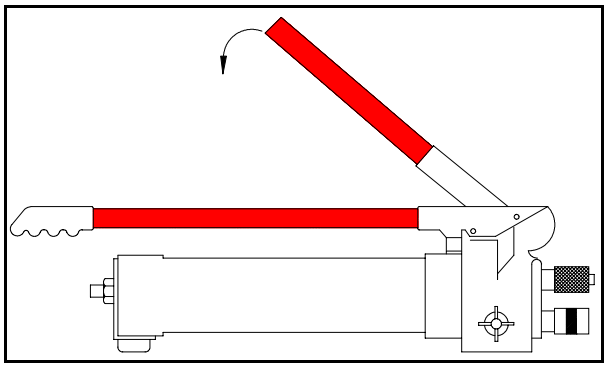


Fig 4.10 Two Speed/Double Acting Pump (Enerpac P82)

Table 4H details the technical specification of the *Enerpac* P82 pump.

ITEM	SPECIFICATION
Max. operating pressure	0 - 3000 kpa (1st stage) 3000 - 72 000 kpa (2nd stage)
Useable oil capacity	2200 ml
Max. relief valve setting	72 000 kpa

Table 4H Enerpac P82 Specification

Table 4I details the technical specification of the *Holmatro* two speed/double acting pump.

ITEM	SPECIFICATION
Max. operating pressure	0 - 3 000 kPa (1st stage) 3 000 - 72 000 kPa (2nd stage)
Useable oil capacity	1600 ml
Max. relief valve setting	72 000 kpa

Table 4I Holmatro Two Speed/Double Acting Pump Specification

⚠ NOTE

The pump is to be stowed with the relief valve in the open position.

4.6.2 Use of Double Acting Pump on Single Acting Tools

The P82 two speed pump functions in the same manner as the P80, but has been adapted for use with double acting tools. This pump, as well as the more commonplace *Holmatro* double acting manual pump may be used on single acting tools. This capacity along with its two speed function provides much more flexibility for operators in its application.

When operated with single acting tools (see Fig 4.11) the pumps are to be connected in the following manner:

- attach both male and female couplings to the pump;
- attach the male coupling of the double acting hose length to the tool in use; and
- use the commands - **power on**, **stop** and **power off** when operating single acting tools.

⚠ NOTE

On receiving the power off command, the manual release valve can be opened slowly causing the tool to retract/house.

When using double acting tools, the commands are **power on** and **stop**. The tool can be retracted by operation of the deadman's handle. The stop command is only necessary to *rest* the person operating the pump handle.

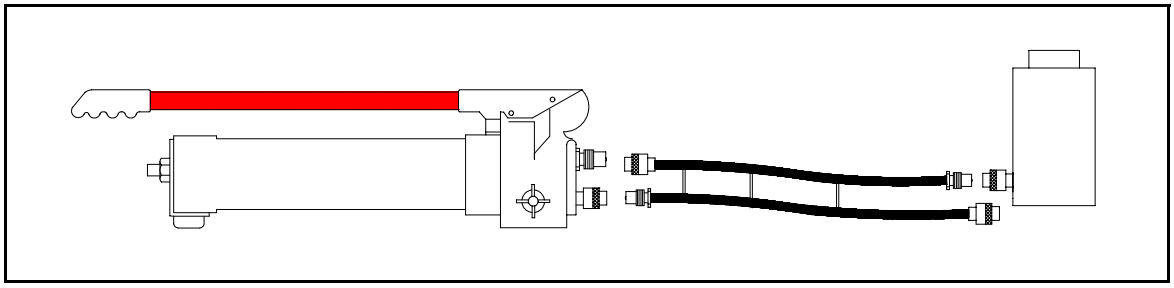


Fig 4.11 Connecting a Double Acting Pump to a Single Acting Tool

CAUTION

Beware of the reaction forces of hydraulic tools when cutting, spreading, pushing etc. Double acting tools, particularly when in use with petrol powered pumps can quickly *twist* with the following possible dangers:

- **damage to tool;**
- **injury to patient;**
- **injury to operator; or**
- **ineffective operation.**

SECTION FIVE - HYDRAULIC POWER RAMS

CONTENTS

5 HYDRAULIC POWER RAMS

5.1 General Information

The NSWFB currently use *Holmatro* hydraulic power rams (see Fig 5.1) for rescue incidents. The smooth action of the plungers in providing maximum stroke per pump action has superseded the ram effect of conventional rescue rams.

5.2 Holmatro Rams

The latest models of the *Holmatro* rams that are used by the NSWFB are:

- model 2004U (single plunger);
- model 2005U (double plunger); and
- model 2006U (double plunger).

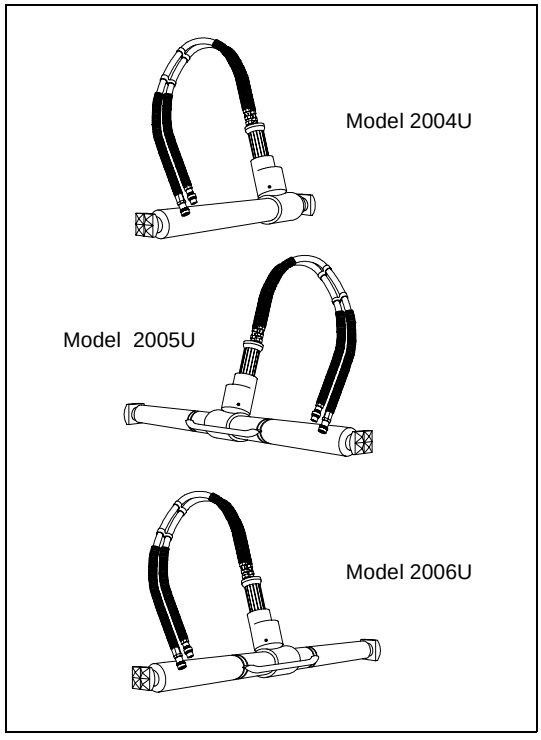


Fig 5.1 Hydraulic Power Rams (Holmatro)

The features of the *Holmatro* power rams are as follows:

- fitted with a deadman's handle with built-in check valves to hold the load;
- compatible in operation with the 2008U Super Spreaders;
- double acting plungers extend and retract hydraulically;
- suitable for use underwater;
- the handle incorporates a relief valve (set at 35 000 kPa) which operates automatically if the return hose is not connected. Fluid will then bleed from the rear of the handle; and
- has a 16 t capacity throughout stroke.

Table 5A details the technical specification for the *Holmatro* power rams.

ITEM	SPECIFICATION FOR 2004U	SPECIFICATION FOR 2005U	SPECIFICATION FOR 2006U
Maximum Operating pressure	72 000 kPa	72 000 kPa	72 000 kPa
Maximum spreading force	16 t	16 t	16 t
Minimum length (cross heads attached)	540 mm	770 mm	970 mm
Maximum length (cross heads attached)	790 mm	1270 mm	1670 mm
Weight	12 kg	15.5 kg	18.5 kg
Length of stroke	250 mm	500 mm (2 x 250 mm)	700 mm (2 x 350 mm)
NOTE **The air/hydraulic pump (PA 1150) may not fully extend the 2005U and 2006U rams**			

Table 5A Holmatro Hydraulic Power Rams Specification

5.3 Holmatro Power Ram 1040

The NSWFB also uses an earlier model *Holmatro* power ram which is designated as Ram 1040 (see Fig 5.2).

The ram has the following features:

- has a deadman's handle with built-in check valves to hold the load;
- double acting plungers extend and retract hydraulically; and
- the handle incorporates a relief valve (set at 35 000 kPa) which operates automatically if the return hose is not connected. Fluid will then bleed from the rear of the handle.

Table 5B details the technical specification for the *Holmatro* Model 1040 power ram.

ITEM	SPECIFICATION
Maximum Operating pressure	72 000 kPa
Maximum Spreading force	10 t
Minimum length (cross heads attached)	700 mm
Maximum length (cross heads attached)	1100 mm
Weight	12 kg
Length of stroke	400 mm (2 x 200 mm)

Table 5B Holmatro Power Ram 1040 Specification

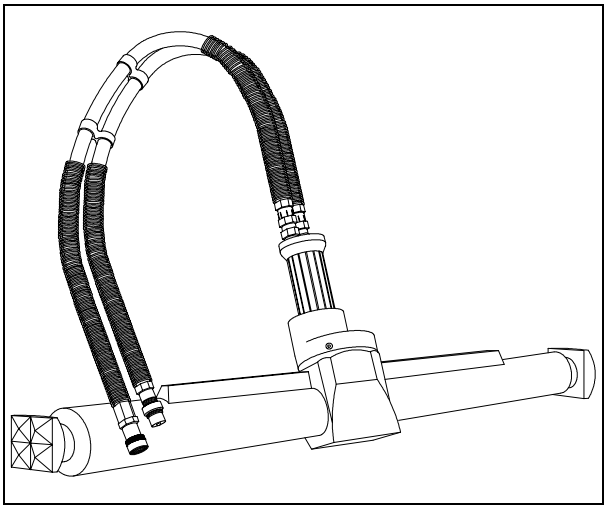


Fig 5.2 Power Ram (Holmatro 1040)

5.4 Cylinder Rams

The Cylinder Rams, used by the NSWFB within the respective *Enerpac* kits have a single acting, spring returned plunger which is either used independently or with attachments, for lifting, pushing or spreading (see Fig 5.3). The range of cylinder rams used by the NSWFB is as follows:

- model RC102;
- model RC104;
- model RC106;
- model RC256; and
- model RC506.

Table 5C details the technical specification for the Cylinder Rams.

MODEL	MANUAL/AIR PUMP COMPATIBILITY	CYLINDER STROKE	OIL CAPACITY	CYLINDER CAPACITY
RC102	all	50 mm	78 cm^3	10 t
RC104	all	100 mm (4")	152 cm^3	10 t
RC106	all	150 mm (6")	224 cm^3	10 t
RC256	all	150 mm (6")	528 cm^3	25 t
RC506	not P39	150 mm (6")	1127 cm^3	50 t

Table 5C Cylinder Rams Specification

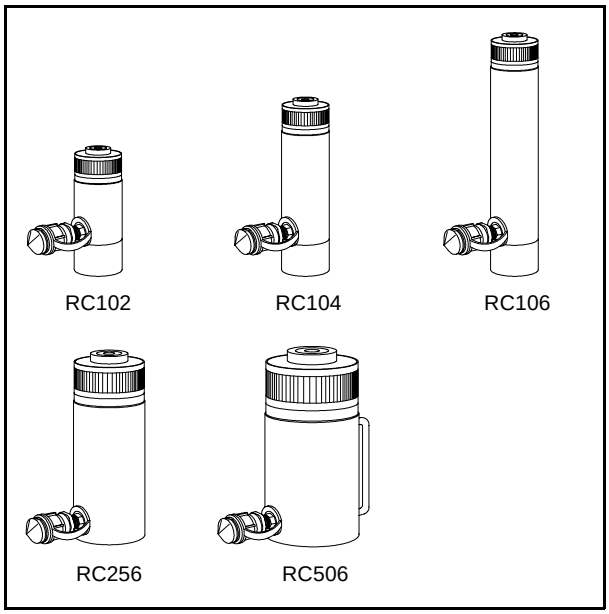


Fig 5.3 Cylinder Rams

5.5 Enerpac Attachments

The *Enerpac* attachments are used with cylinder rams to extend their operating capabilities as required for a given incident (see Fig 5.4). The attachments that are used by the NSWFB for rescue work are as follows:

- lock-on tube adaptors (male and female adaptors);
- lock-on tube connector;
- snap-in accessory saddle;
- serrated saddle;
- extension tubes;
- lock-on threaded adaptor;
- threaded male saddle;
- slip lock extension;
- threaded connector;
- 90° flex head;
- 90° V base;
- wedge head;
- cylinder plunger toe;
- cylinder collar toe;
- locking pin;
- flat base;
- screw extension;
- round flex head; and
- threaded connector.

NOTE

No attachments are supplied for use with the RC256 and RC506 cylinder rams. When an attachment is used on the RC102, RC104 and RC106, the maximum load capacity is 5 tonnes.

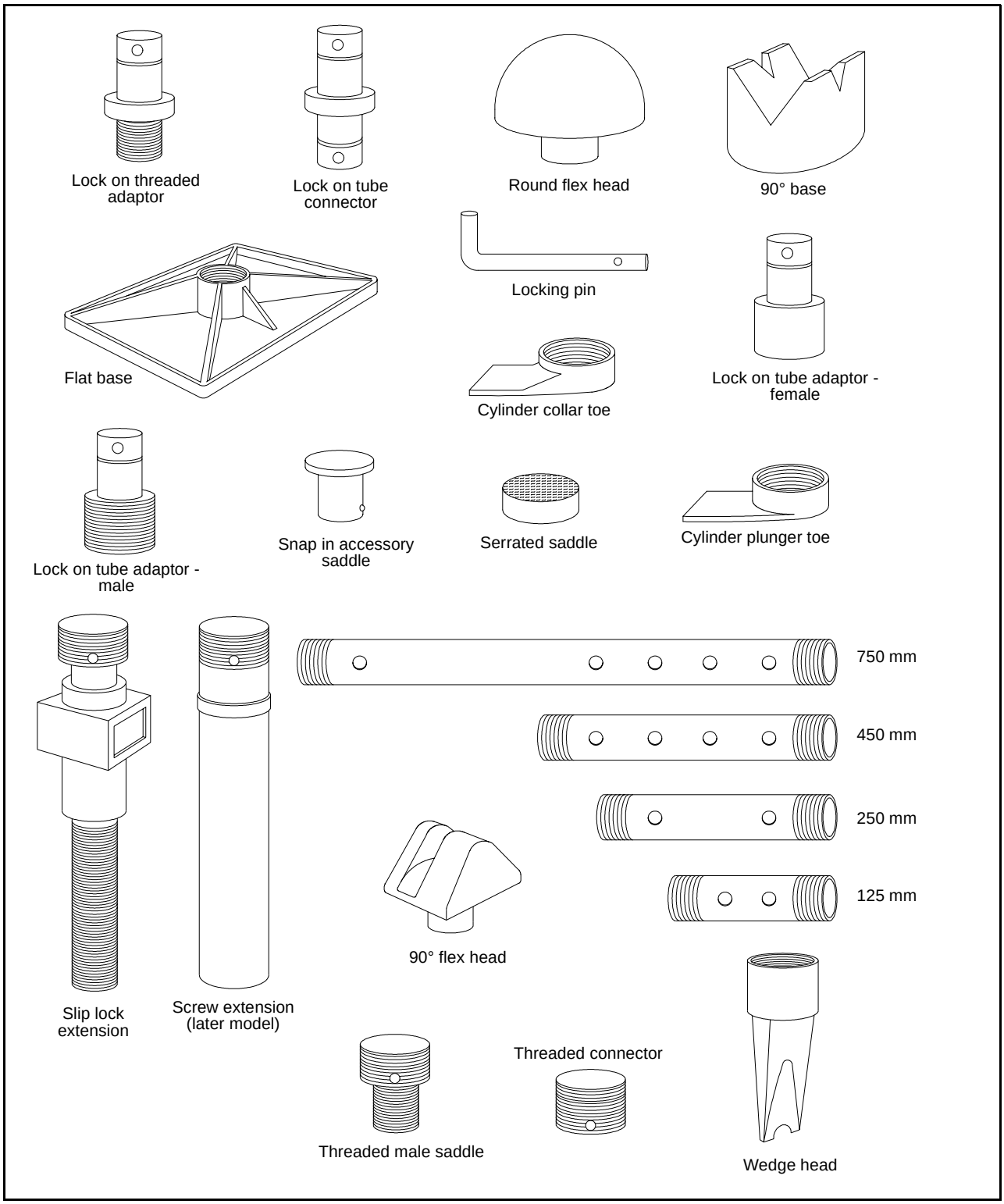


Fig 5.4 Enerpac Attachments

5.5.1 Cylinder Base Attachments

The base of all rams are designed to accept the attachment of various accessories to enhance their performance at a rescue incident. The attachments used by the NSWFB are as follows:

- 90° V base;
- flat base;
- RC102 - RC104;
- wedge head;

- 90° flex head; and
- round flex head.

⚠ NOTE

The RC256 and RC506 rams are not fitted with a cylinder base attachment, and no accessories are supplied for use with them.

The cylinder base attachment is firmly fixed to the base of the cylinder by two allen screws (see Fig 5.5). To remove the cylinder base attachment and replace it with another, use the three-in-one tool or a suitable allen key from the Hand Tool Kit.

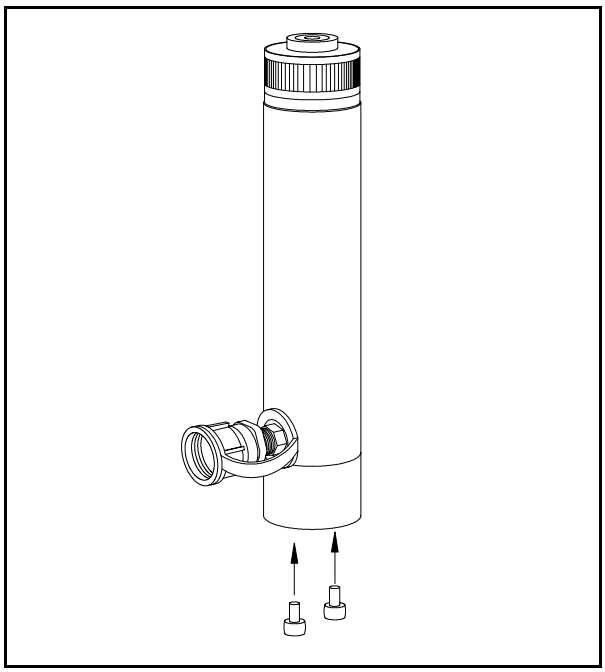


Fig 5.5 Method of Attachment of Cylinder Base

SECTION SIX - HYDRAULIC KITS

CONTENTS

6 HYDRAULIC KITS

6.1 General Information

The NSWFB currently uses *Enerpac* hydraulic kits for rescue incidents. Within the four different *Enerpac* hydraulic kits in use with the NSWFB is all the pushing and lifting equipment firefighters would require from single acting tools.

The *Enerpac* kits are housed in four boxes, and are issued to all NSWFB stations as follows:

- Box 1 and Box 2 to all NSWFB stations;
- Boxes 1, 2, and 3 to all primary rescue units; and
- Boxes 1, 2, 3 and 4 to all salvage appliances.

6.2 Enerpac Box 1

The *Enerpac* hydraulic kit Box 1 (see Fig 6.1) contains the following items of equipment:

- 1 x Metal box;
- 1 x Box 1 insert;
- 1 x 3 in 1 tool;
- 1 x P39 Single speed pump;
- 1 x WR15 Spreader;
- 1 x WR4 Wedge spreader or WR5;
- 1 x RC106 Ram;
- 1 x Cylinder base attachment;
- 1 x Thread protector;
- 1 x Snap-in accessory saddle;
- 1 x Threaded connector;
- 1 x Flat base;
- 1 x High flow pin adaptor;
- 1 x Pin high flow adaptor;
- 1 x Serrated saddle;
- 1 x Wedge head;
- 1 x Lynch pin; and
- 1 x RC102 (secondary rescue only).

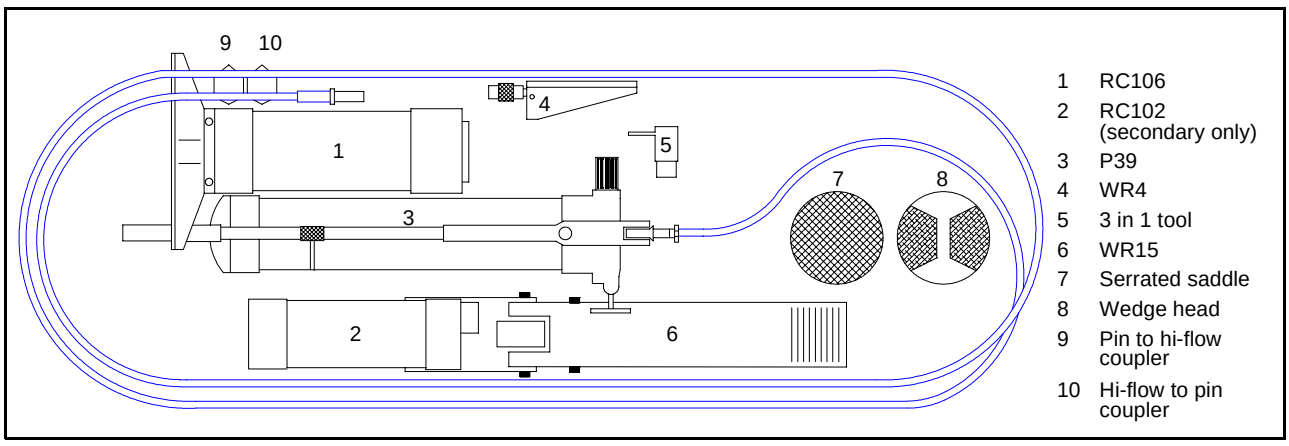


Fig 6.1 Enerpac Hydraulic Kit (Box 1)

6.3 Enerpac Box 2

The *Enerpac* hydraulic kit Box 2 (see Fig 6.2) contains the following items of equipment:

- 1 x Metal box;
- 1 x Box 2 insert;
- 1 x 125 mm Extension tube;
- 1 x 250 mm Extension tube;
- 1 x 450 mm Extension tube;
- 1 x 750 mm Extension tube;
- 4 x Lock-on tube connectors;
- 6 x Locking pins;
- 1 x Threaded male saddle;
- 1 x Lock-on tube adaptor male;
- 1 x Lock-on tube adaptor female;
- 1 x Round flex head;
- 1 x 90° Flex head;
- 1 x Slip-lock or screw extension;
- 1 x 90° V Base;
- 1 x Cylinder collar toe;
- 1 x Cylinder plunger toe;
- 1 x 1 L Hydraulic oil;
- 1 x Lynch pin; and
- 1 x Lock-on threaded adaptor.

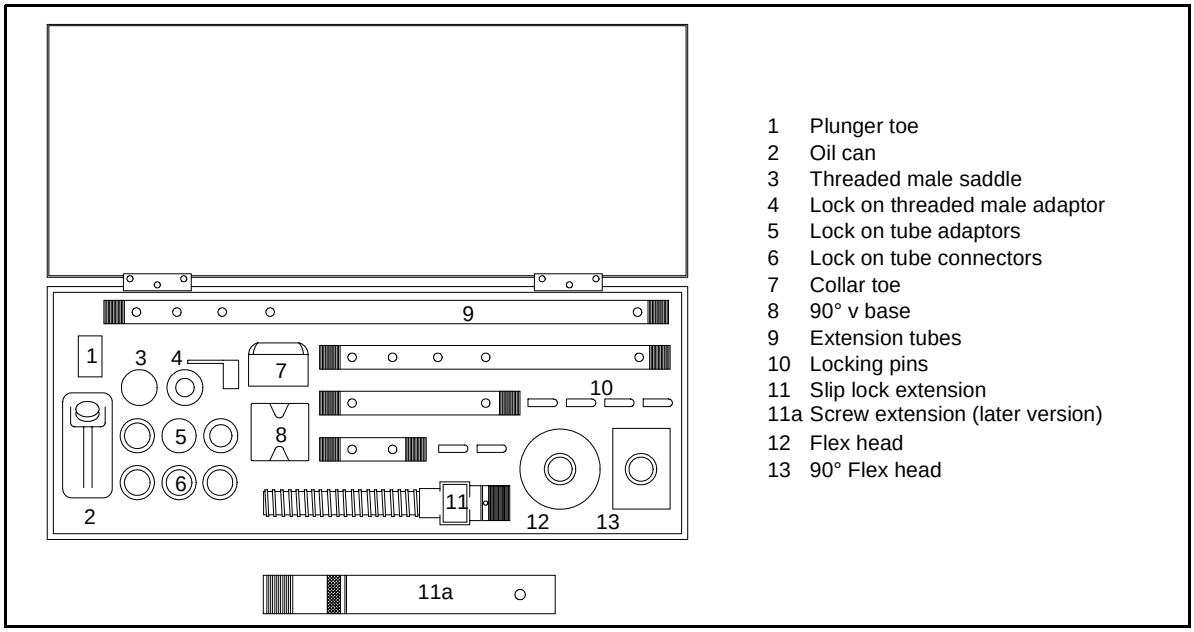


Fig 6.2 Enerpac Hydraulic Kit (Box 2)

6.4 Enerpac Box 3

Box 3 upgrades the lifting capacity to 25 t and provides additional ram sizes, and an extra P39 pump.

The *Enerpac* hydraulic kit Box 3 (see Fig 6.3) contains the following items of equipment:

- 1 x Metal box;
- 1 x P39 Single speed pump;
- 1 x RC256 Ram;
- 1 x Snap-in accessory saddle;
- 1 x Thread protector;
- 1 x RC104 Ram;
- 1 x RC102 Ram;
- 2 x Cylinder base attachments;
- 2 x Snap-in accessories;
- 2 x Threaded protectors;
- 1 x Threaded connector;
- 1 x Flat base;
- 1 x Serrated saddle;
- 1 x Lock-on threaded adaptor;
- 1 x WR15; and
- 1 x Lynch pin.

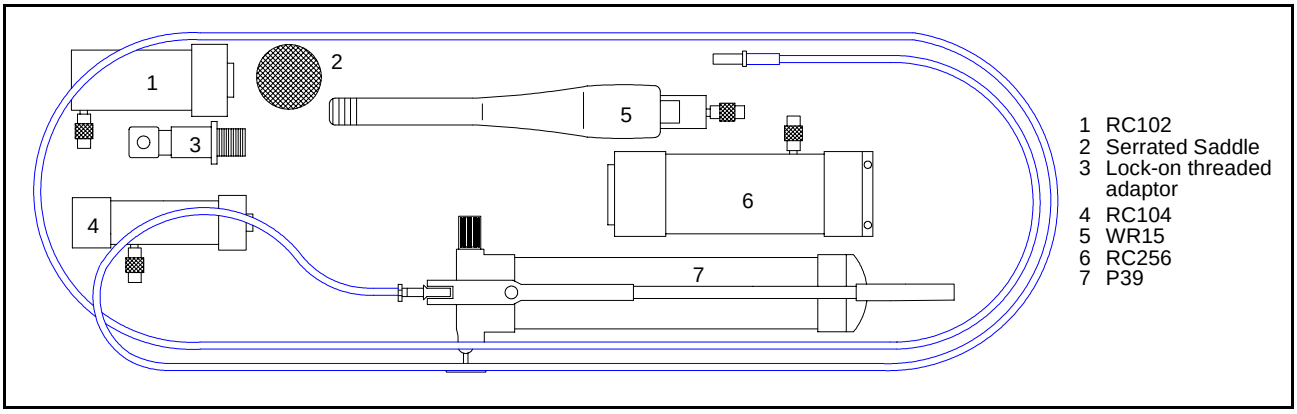


Fig 6.3 Enerpac Hydraulic Kit (Box 3)

6.5 Enerpac Box 4

Box 4 upgrades the lifting capacity to 50 t and provides additional ram sizes, and a P80 pump.

The *Enerpac* hydraulic kit Box 4 (see Fig 6.4) contains the following items of equipment:

- 1 x Metal box;
- 1 x P80 Two speed pump;
- 1 x RC506 Ram;
- 1 x RC102 Ram;
- 1 x Snap-in accessory saddle;
- 1 x Cylinder base attachment;
- 1 x Threaded connector;
- 1 x Thread protector;
- 1 x Flat base;
- 1 x Lock-on threaded adaptor;
- 4 x Lock-on connectors;
- 1 x Threaded male saddle;
- 1 x Serrated saddle;
- 2 x 450 mm Extension tubes;
- 2 x 750 mm Extension tubes; and
- 1 x Lynch pin.

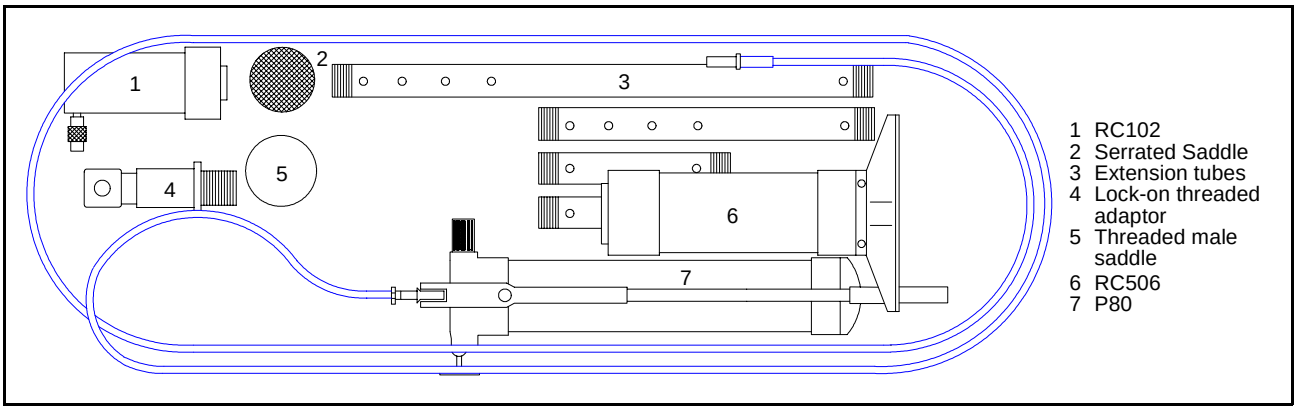


Fig 6.4 Enerpac Hydraulic Kit (Box 4)

SECTION SEVEN - SPREADERS

CONTENTS

7 SPREADERS

7.1 General Information

The NSWFB currently uses a variety of spreaders for rescue incidents. The types of spreaders that are used by firefighters consist of the following:

Single Acting

- WR4 Wedge Spreader;
- WR5 Wedge Spreader;
- WR8 Wedge Spreader;
- WR15 Wedge Spreader;

Double Acting

- Model 1434 Universal Spreader;
- Model 1436 Universal Spreader;
- Model 1445 Super Spreader; and
- Model 2008U Super Spreader.

7.2 Wedge Spreaders

The NSWFB has a range of single acting spreaders (see Fig 7.1) which form part of the equipment supplied in the *Enerpac* hydraulic kits. The technical specification for these spreaders are detailed in Table 7A.

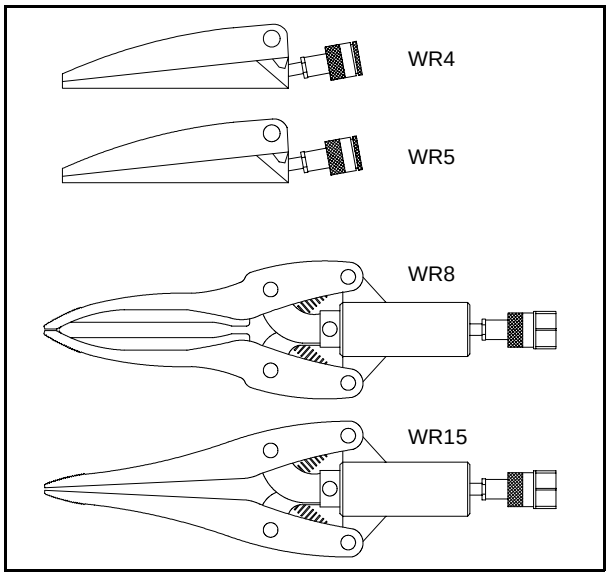


Fig 7.1 Wedge Spreaders (Models WR4, 5, 8 and 15)

7.3 Universal Spreader 1434

The NSWFB currently uses the Universal Spreader model 1434, (see Fig 7.2) which has the following features:

- double acting in its operation, arms open and close hydraulically;
- can be connected to hand, petrol powered and air/hydraulic pumps;
- adjustable handle;
- built in relief valve on deadman's handle operates if a return line is not connected, causing oil to discharge from the hole located between the couplings;
- operates with non-toxic mineral base *Enerpac* oil; and
- 1.5 t capacity from a closed arm position, opening to 200 mm.

MODEL	MANUAL AIR PUMP CAPABILITY	SPREAD WIDTH	MAXIMUM CAPACITY	LOCATED IN BOX NUMBER
WR4	all except air pumps	100 mm	3/4 t	box 1 only
WR5	all except air pumps	90 mm	1 t	box 1 only
WR8	all	300 mm	1 t	box 1 & 3
WR15	all	300 mm	1.5 t	box 1 & 3

Table 7A Wedge Spreader Specifications

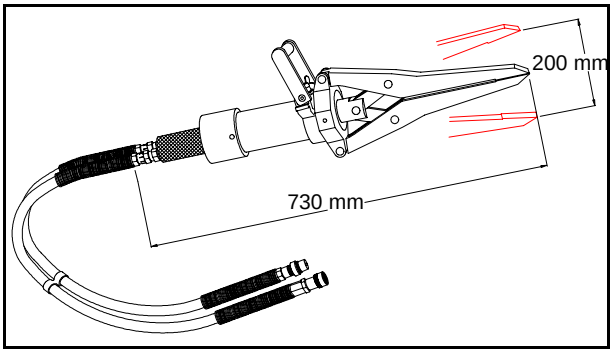


Fig 7.2 Universal Spreader (Model 1434)

The technical specification for the Universal Spreader 1434 is detailed in Table 7B.

ITEM	SPECIFICATION
Maximum operating pressure	72 000 kPa
Weight	17.5 kgs
Length	730 mm
Spread width	200 mm
Spread power arms closed	1.5 t
Spread power arms half open	3 t
Spread power arms fully open	5 t

Table 7B Universal Spreader 1434 Specification

7.4 Universal Spreader 1436

The NSWFB currently uses the new series Universal Spreader model 1436, (see Fig 7.3) which has the following features:

- greater spread width and power, than earlier model 1434;
- double acting in its operation, arms open and close hydraulically;
- can be connected to all double acting manual, petrol powered and air/ hydraulic pumps;
- the built in relief valve on the deadman's handle operates if a return line is not connected, causing oil to discharge from the hole located between the couplings; and
- operates with non-toxic mineral base *Enerpac* oil.

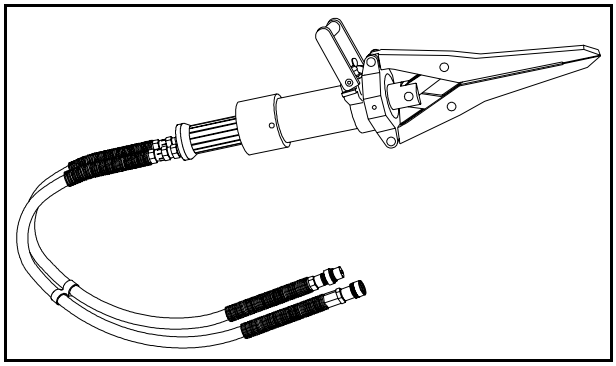


Fig 7.3 Universal Spreader (Model 1436)

The technical specification for the Universal Spreader 1436 is detailed in Table 7C.

ITEM	SPECIFICATION
Maximum operating pressure	72 000 kPa
Weight	18.5 kgs
Length	730 mm
Spread width	325 mm
Spread power arms closed	1.5 t
Spread power arms half open	8 t
Spread power arms fully open	15 t

Table 7C Universal Spreader 1436 Specification

NOTE

Some Universal Spreaders, in service currently, are fitted with non-return valves (check valves) that act so that the arms remain exactly in position and do not move when the pressure drops or handle is released. However, some early models do not have this feature.

CAUTION

If the spreader is under load and you need to open them further, DO NOT operate the deadman's handle in a slow manner as this WILL cause a momentary collapse which could produce problems. To avoid, this the deadman's handle should be operated smartly to gain full pressure. When the required spread has been reached, the deadman's handle should be smartly released back to the neutral position, again avoiding any possible collapse of the arms.

7.4.1 Check Valve

To identify a deadman's handle that offers check valve protection, refer to Fig 7.4 for details.

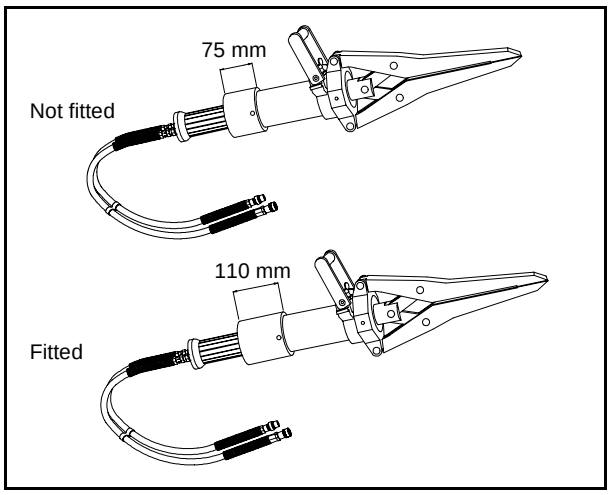


Fig 7.4 Identification of Check Valve Protection

7.5 Super Spreader Model 1445

The NSWFB currently uses the original series of *Holmatro* spreader. It's versatility and safe operation is combined with a tough and powerful construction (see Fig 7.5), with up to 4.7 t of spreading power. The features of the Super Spreader 1445 are as follows:

- can be connected to all double acting manual, petrol powered pump or air/ hydraulic pumps;
- double acting - the arms open and close hydraulically;
- built in non-return valve act so that the arms remain exactly in position, and do not move when the pressure drops or handle is released;
- arms are made of heat treated, high tensile chromium nickel steel;
- built in relief valve in deadman's handle, incorporating a valve that operates when a return line is not connected, detected when fluid *bleeds* from the handle;
- teeth inside arms will crush pipes - capacity 8 t;

- 3.7 t capacity from a closed arm position opening to 680 mm; and
- operates with non toxic mineral base *Enerpac* oil.

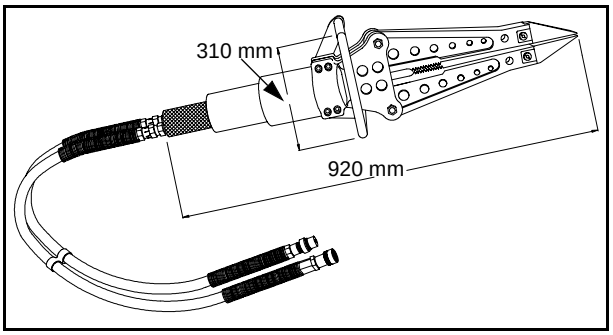


Fig 7.5 Super Spreader (Model 1445)

The technical specification for the Super Spreader 1445 is detailed in Table 7D.

ITEM	SPECIFICATION
Maximum working pressure	72 000 kPa
Spread distance	680 mm
Weight	26 kg
Length	920 mm
Width	310 mm
Spread force at tips: arms closed arms half open arms fully open	 3.7 t 4.2 t 4.7 t
Closing force at tips: arms closed arms half open arms fully open	 2.7 t 3.1 t 3.5 t

Table 7D Super Spreader 1445 Specification

7.6 Super Spreader Model 2008U

The NSWFB currently uses the new series *Holmatro* Super Spreader, which is lightweight and has more power, with a spread capacity of up to 6 t (see Fig 7.6).

The features of the Super Spreader Model 2008U are as follows:

- can be used on a hand, power or air/ hydraulic pump;
- chrome plated, **U** shaped carrying handle. Easy to handle in all situations;
- double acting - the arms open and close hydraulically;
- arms, cylinder housing and yoke are of high quality aluminium forgings;
- all aluminium parts are anodised;
- quick lock spreading tips, do not need to be removed to attach chain adaptors;
- spreading tips machined out of high quality tool steel and hardened;
- a relief valve fitted to the deadman's handle will **bleed** hydraulic fluid if a return line is not connected; and
- 3.2 t capacity from a closed arm position opening to 835 mm.

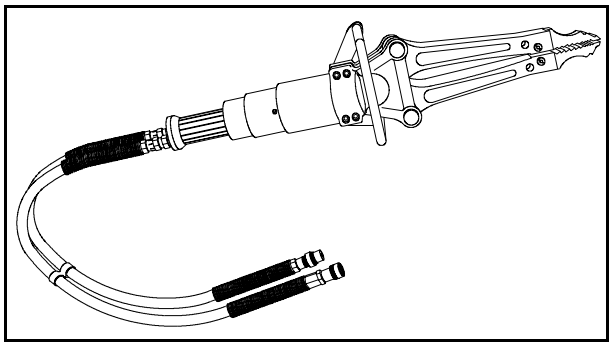


Fig 7.6 Super Spreader (Model 2008U)

The technical specification for the Super Spreader 2008U is detailed in Table 7E.

ITEM	SPECIFICATION
Maximum working pressure	72 000 kPa
Maximum spreading force	6.0 t
Spread force half open	5.4 t
Spread force from closed	3.2 t
Spread distance	835 mm
Maximum crushing force (at tips)	2.6 t
Weight	18.5 kg
Length	960 mm
Width	300 mm

Table 7E Super Spreader 2008U Specification

The specially hardened tips (see Fig 7.7) are easily exchangeable. Holes behind the tips allow attachment of chain adaptors, the tips need not be removed. The chain adaptors and chains for the super spreader are of a suitable length to facilitate a pulling action.

NOTE

In operation, locking pins should be inserted from the bottom pointing up. Hooks to face up, or keep engraved face (NSWFB) on top (see Fig 7.8).

CAUTION

Avoid aggressive use of arms during use and concentrate work on hardened steel tips.

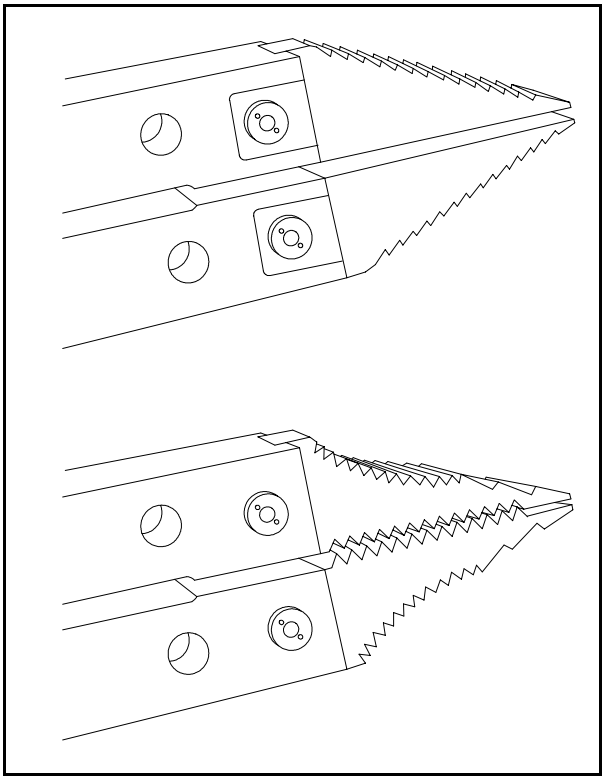


Fig 7.7 Hardened tips

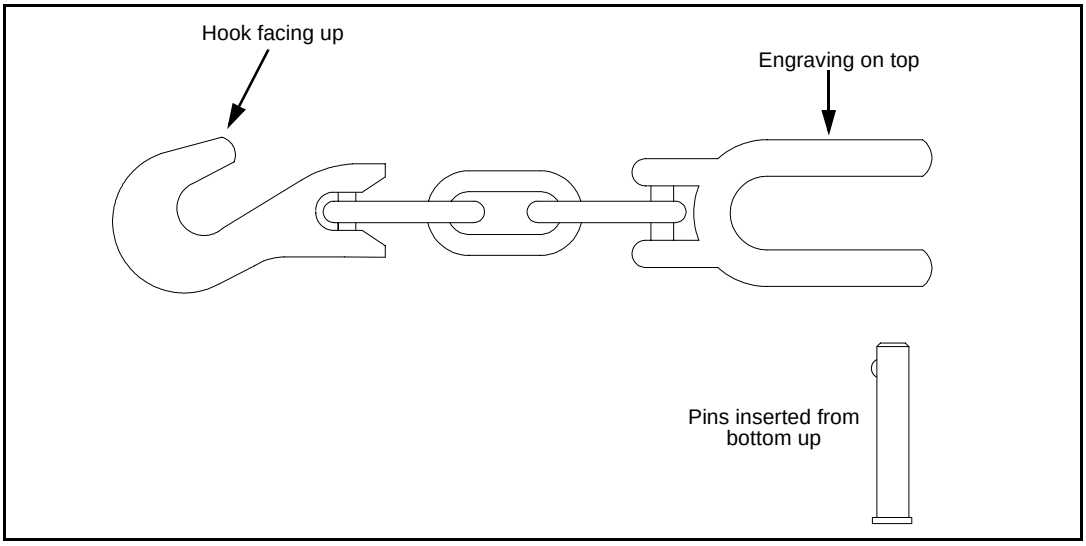


Fig 7.8 Chain Adaptor Locking Pin

7.7 Super Spreader Adaptors

7.8 Adaptors

Two chain adaptors with shortening hooks (see Fig 7.9) are provided for use with the two 2 m Chain Sets. The adaptors fit into holes behind the tips on the super spreader arms. Each adaptor has its own retaining pin. One chain length has only a clevis hook, the other chain set has a clevis hook and a shortening hook.

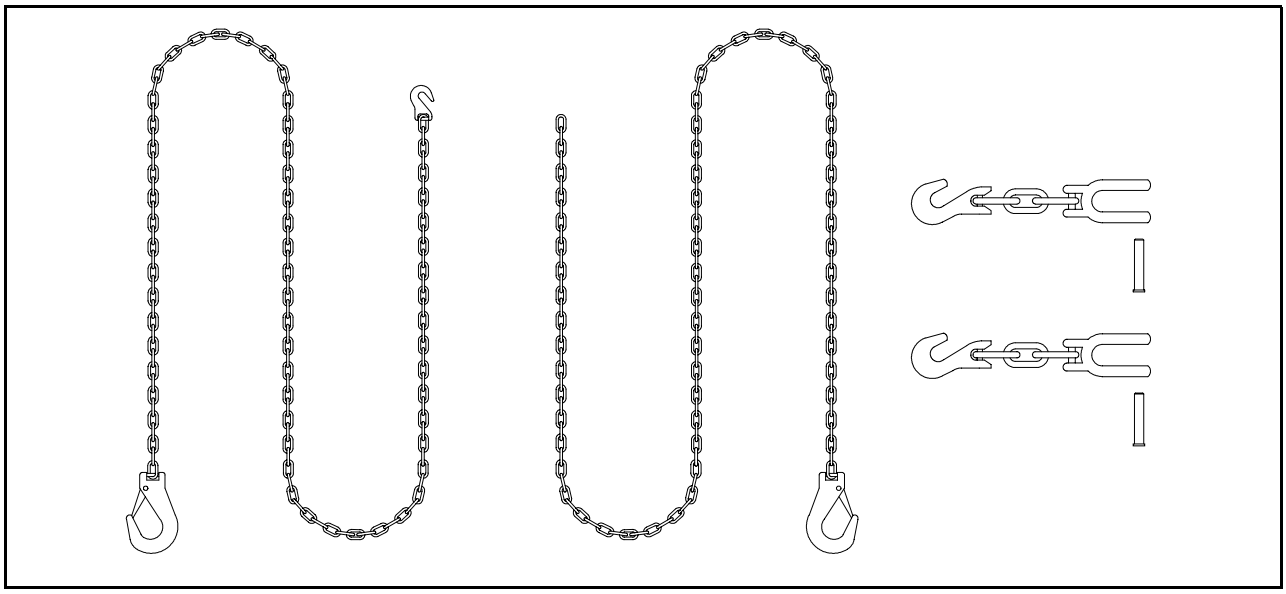


Fig 7.9 Chains and Adaptors

SECTION EIGHT - SHEARS

CONTENTS

8 SHEARS

8.1 General Information

The NSWFB currently uses 3 models of Shears as part of their hydraulic equipment that is used at incidents requiring rescue. The shears may be used to cut a wie variety of materials including:- door pillars, pipes, sheet metal, foot pedals etc, but are **not** designed to cut high tensile steel, spring steel, club locks, lock hasps, torsion bars etc.

The types of Shears that are used are detailed as follows:

- Double Acting Shears Model 2011;
- Double Acting Shears Model 1412; and
- Double Acting Shears Model 2001U.

8.2 Double Acting Shears Model 2011

The NSWFB uses model 2011 Shears (see Fig 8.1) fitted with the 1412 model blades. The new style Shears are lighter, slightly more compact and has the following features:

- deadman's handle with valve that relieves hydraulic pressure if return line not connected;
- chromium steel cutting edges that are re-grindable;
- **U** shaped carry handle;
- relief valve operates automatically when a return line is not connected, causing oil to discharge from the hole located between the couplings;
- used with double acting manual, power and air/hydraulic pumps; and
- recess will cut mild steel rod up to a maximum of 16 mm diameter.

The technical specification for model 2011 Shears is detailed in Table 8A.

ITEM	SPECIFICATION
Maximum working pressure	72 000 kPa
Weight	9.5 kgs
Length	600 mm
Blade opening	100 mm
Cutting force recess	19 t
Cutting force blade centre	11 t

Table 8A Shears Model 2011 Specification

NOTE

The Shears should be stowed on the appliance with the blades nearly closed (a gap of approximately 6 mm).

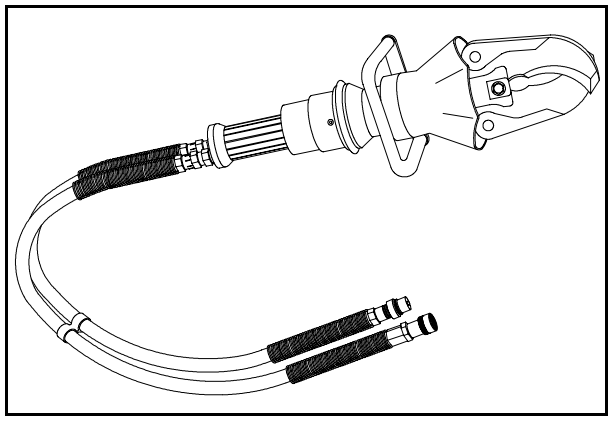


Fig 8.1 Double Acting Shears (Model 2011)

8.3 Double Acting Shears Model 1412

The NSWFB currently uses model 1412 Shears (see Fig 8.2) which are manufactured by *Holmatro*. The Rescue Shears have the following features:

- use *Enerpac* mineral base hydraulic oil;

- can be connected to double acting foot pump, power pump or air/hydraulic pump;
- cutting edges that are re-grindable and made of chromium steel, hardened in two phases;
- cutting jaws open and close hydraulically;
- safe operation with the deadman's handle;
- bleed valve operates automatically when a return line is not connected;
- recess will cut steel bars to a maximum diameter of 16 mm; and
- may be used underwater.

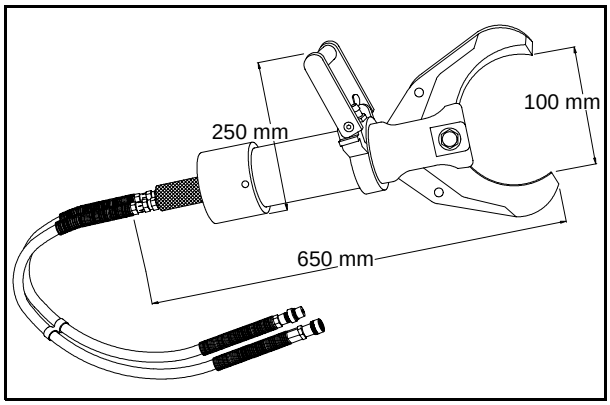


Fig 8.2 Double Acting Shears (Model 1412)

The technical specification for model 1412 Shears is detailed in Table 8B.

ITEM	SPECIFICATION
Maximum working pressure	72 000 kPa
Weight	14 kgs
Length	650 mm
Maximum width	250 mm
Blade opening	100 mm
Cutting force recess	18 t
Cutting force in middle of jaws	9 t

Table 8B Shears Model 1412 Specification

8.4 Double Acting Shears Model 2001U

The NSWFB currently uses the latest series of Double Acting Hydraulic Shears, model 2001U, (see Fig 8.3) and it has the following features:

- blades are made of high quality tool steel, dual hardened and re-grindable;
- can be connected to hand/foot pump, power pump and air/hydraulic pump;
- provided with a *quick lock* carrying handle;
- cuts 25 mm round bar in recess; and
- relief valve operates automatically when a return line is not connected.

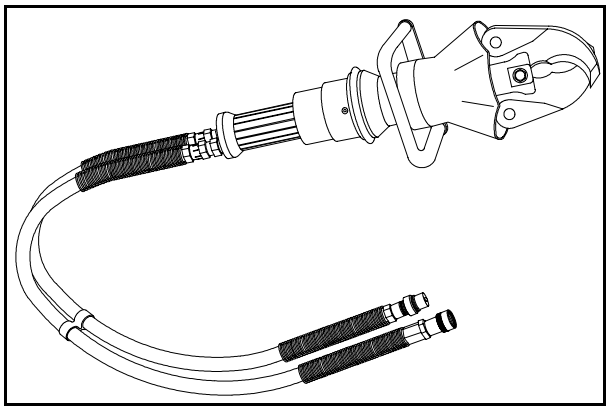


Fig 8.3 Double Acting Shears (Model 2001U)

The technical specification for model 2001U Shears is detailed in Table 8C.

ITEM	SPECIFICATION
Maximum working pressure	72 000 kPa
Weight	13 kgs
Length	830 mm
Maximum width	220 mm
Blade opening	125 mm
Cutting force recess	29 t
Cutting force in blade centre	18 t

Table 8C Shears Model 2001U Specification

8.5 Shear Operation

Shears should, where possible, cut at right angles to the work. This lessens the possibility of the blades *splaying* and minimises the amount of damage and unnecessary cutting.

SECTION NINE - CHAINS

CONTENTS

9 CHAINS

9.1 General Information

The Chain Pull Set, or Lever Ratchet Hoist, is a piece of equipment that can be used in any position for safe hauling and lowering of up to 1.5 t and 3 t, for the larger set. The model described below is made by *FUJI* and has been used by the NSWFB as part of their rescue equipment for many years. Both the 1.5 t and 3 t sets are identical in operation and have the following features:

- a braking device designed to hold the load, independent of the ratchet mechanism;
- designed with a handle length that excludes the possibility of one operator exceeding the safe working load; and
- a chain gauge fitted to the end of the chain to check chain stretch and hook opening deformation (this only applies to chain and hook on the machine).

9.2 Chain Pull Set

When using a Chain Pull Set, it may be necessary to place packing under the unit for even load distribution and increased purchase on the column. It is also permissible for the unit to be placed on its side so that the handle is more conveniently positioned for use.

The Chain Pull Set is shown in Fig 9.1.

9.2.1 Operation for a Column Pull

When using the adaptors and chains to move a steering column on a motor vehicle. The following actions are to be carried out:

- position the Chain Pull Unit with the fixed hook facing up and positioned towards the front of the vehicle;
- utilise wooden blocks (if required) to spread the load or lessen the crushing of panels;
- adjust the **reeved** chain length, by placing the directional lever in the neutral position and gently pulling the chain through the unit to allow for the operation to be completed in one movement;

⚠ NOTE

3 links should be left loose, prior to loading.

- place a full round turn of chain around the upper most section of the steering column, and position the hook so that the hook keeper faces the driver, and as such the keeper is protected from damage during the pull;
- position the alloy chain slings around a suitable anchorage on the sub-frame, and attach to the fixed hook of the unit. Shorten the chain sling length as required;
- position the handle as appropriate, however, the chain entering the unit under tension must not be fouled by the loose chain exiting the unit;
- engage the directional lever (and in turn the ratchet) in the **UP** position, and load the chain pull set until the desired displacement of the dash is achieved; and
- to unload, engage the directional lever in the **DOWN** position and unload.

When down loading, particularly where the unit has been loaded close to its rated capacity, the handle may be difficult to move. Sharply moving the handle in the down direction will enable the unit to be safely unloaded and the handle operated with more moderate force.

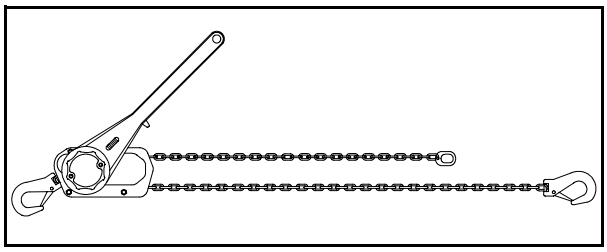


Fig 9.1 Chain Pull Set

9.2.2 Chain Pull Set Slings

These chains are made from Grade 80 alloy and are fitted with a shortening hook at both ends. There are two lengths of chain supplied with the kit, these are 1 x 5 m and 1 x 3 m.

CAUTION

When reeving chain slings, the nip angle should not exceed 120 degrees (see Fig 9.2)

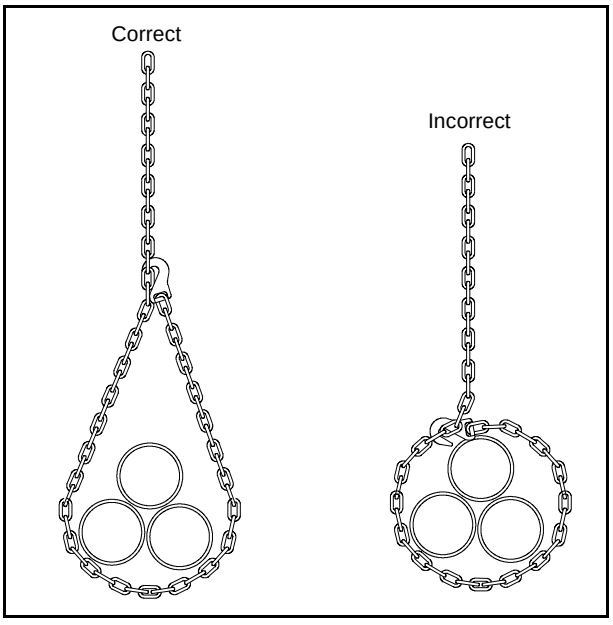


Fig 9.2 Chain Sling Reeving

The strength of the sling relative to its diameter is detailed in Table 9A.

9.2.3 End-To-End Attachment

When attaching slings to each other to achieve a greater length, it should **not** be done by creating two eyes and passing one through the other, it is recommended to use a *monkey grip* style of attachment (see Fig 9.3).

Fig 9.3 Monkey Grip Attachment

CHAIN PULL COMPATIBLE	LINK DIAMETER	SAFE WORKING LOAD TONNES STRAIGHT	SAFE WORKING LOAD TONNES REEVED
1.5 t	7.1 mm	1.6	1.2
3 t	10 mm	3.2	2.4

Table 9A Sling Strength

SECTION TEN - WINCHES

CONTENTS

10 WINCHES

10.1 General Information

Rescue situations often rely on the capability to lift or pull loads in various positions. The portable nature of the *Tirfor* Winch, used by the NSWFB makes it a particularly useful piece of equipment.

10.2 Tirfor Winches

The NSWFB currently uses 3 models of the *Tirfor* winch, these are:

- model TU16 (see Fig 10.1);
- model T516 (see Fig 10.2); and
- model T532 (see Fig 10.2).

The features of each winch model are identical and are as follows:

- operates in any direction and on an entire length of rope;
- precision of rope travel and portability;
- safe operation - shear pins indicate exceeded safe working load;
- safe *hand over hand* operating principle; and
- kit comprises of Bow shackles - split block pulley - 4 slings.

The technical specification for these winches are detailed in Table 10A.

SPECIFICATIONS			
CAPACITY	**TU16**	**T516**	**T532**
Capacity for safe lowering/lifting	1.6 t	1.6 t	3.2 t
Bow shackle capacity	3.25 t	3.25 t	6.5 t

Table 10A Winch Specifications

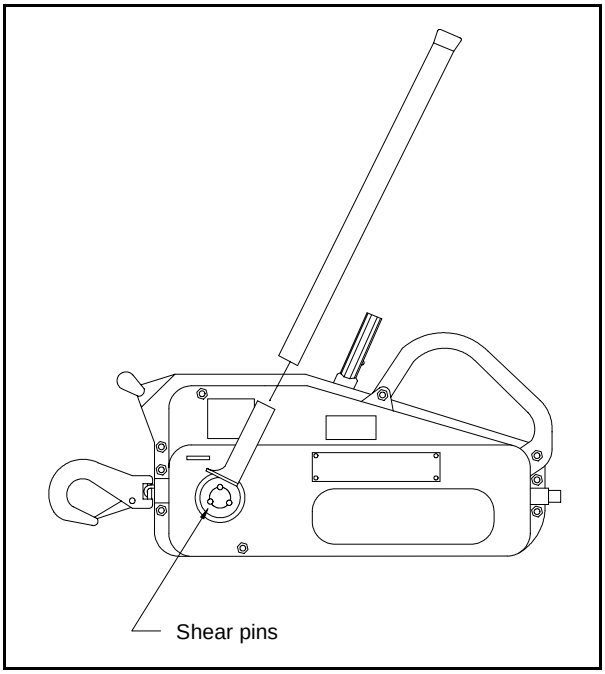


Fig 10.1 Winch (Model TU16)

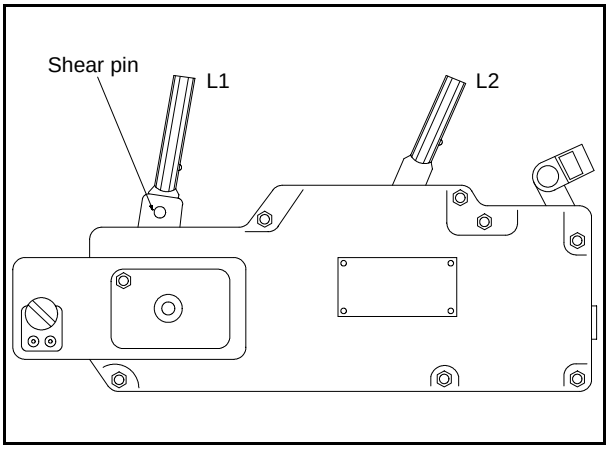


Fig 10.2 Winch (Models T516 and T532)

10.2.1 Operation

To operate the *Tirfor* Model T516 and T532, carry out the following actions:

- uncoil the wire rope in a straight line between the machine and the load;
- release the small lynch pin and then release the anchor pin;
- release the machine by pushing the rope release lever towards the anchor point until it locks into position;
- ensure that both operating levers, point in the same direction. Insert the fused and tapered end through the rope guide and push it through the machine;
- pull the slack wire rope through the machine by hand;
- put the sling into position and refit the anchor pin, ensuring that it passes above the machine wire rope. Refit the small lynch pin;
- to engage the machine on the rope, push the rope release lever downwards and allow the lever to travel back to its original position;
- place the telescopic operating lever on L1 and lock into position by twisting. The machine is now ready for forward;
- to reverse, simply place the telescopic operating lever on L2 and lock it into position, the load may now be lowered or backed off; and
- whilst the winch is to be stowed on the vehicle, the rope release lever with the rope removed, should be returned to the engaged position, this allows the machine to be stored without tension.

10.3 Associated Equipment

The following associated equipment is required to be used in conjunction with *Tirfor* winches:

- Superflex slings;
- shackles;
- pulley; and
- winch cable.

10.3.1 Superflex Slings

Superflex slings are constructed from galvanised steel and are configured into high tensile plaited cable, 12 ply in a 4 by 3 Sinnet lay (see Fig 10.3).

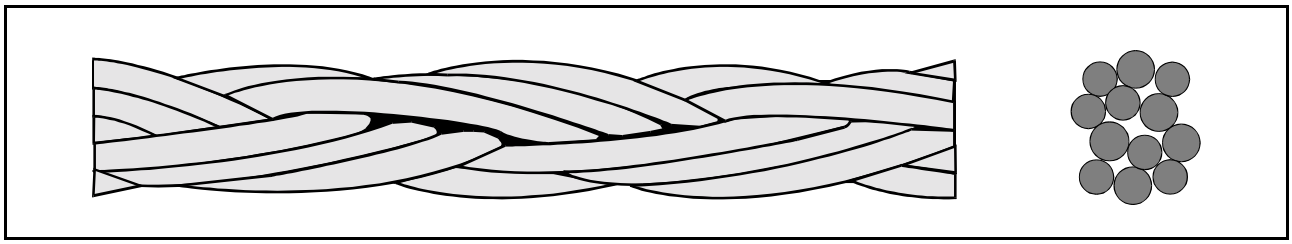


Fig 10.3 Superflex Sling Plaited Cable Configuration

Differing lengths and diameters of sling cable are available and Table 10B details the appropriate length and diameter compatible with the *Tirfor* models used by the NSWFB.

MODEL	LENGTH	DIAMETER
TU16/T516	1 m	13 mm
	3 m	15 mm
T532	3 m	28 mm
	5 m	28 mm

Table 10B Compatible Sling Measurements

The Superflex slings can be used in a variety of configurations, and the safe working load (SWL) will vary according to the configuration selected and the cable diameter used.

Table 10C details the sling configurations.

10.3.2 Shackles

The *Tirfor* winch kit incorporates Bow shackles. Table 10D details which type to use and the appropriate SWL.

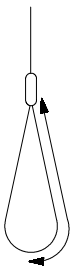
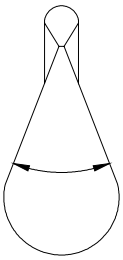
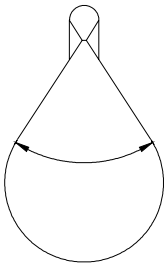
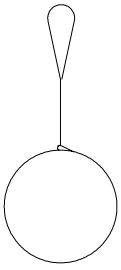
CABLE DIAMETER	STANDARD EYE LENGTH	SLING SINGLE FALL	SLING AS CRADELING LESS THAN 30°	SLING AS CRADELING LESS THAN 60°	SLING CHOCKED ONTO ROUND LOAD	SLING CHOCKED ONTO SQUARE LOAD
						
13 mm	200 mm	1.5 t	2.9 t	2.6 t	1.1 t	0.8 t
15 mm	230 mm	1.9 t	3.7 t	3.3 t	1.4 t	1.0 t
28 mm	400 mm	7.0 t	14.0 t	12.1 t	5.3 t	3.5 t

Table 10C Superflex Sling Configurations

TIRFOR COMPATIBLE	TYPES	CAPACITY SWL	PIN DIAMETER
TU16 and T516	Bow	3.25 t	19 mm
T532	Bow	6.5 t	25 mm

Table 10D Tirfor Compatible Shackles

10.3.3 Pulley

The TU16 and T516 winch kits are supplied with a split block pulley of 3 t capacity.

10.3.4 Winch Cable

Table 10E details the compatible winch cables that should be sued with the *Tirfor* winches used by the NSWFB.

TIRFOR COMPATIBLE	DIAMETER	LENGTH	TYPE	MINIMUM BREAK FORCE
TU16 and T516	11 mm	10 m and 20 m	6/25 IWRC	8.7 t
T532	16 mm	10 m and 30 m	6/25 IWRC	18.4 t

Table 10E Winch Cable Specification

SECTION ELEVEN - DRILLS

CONTENTS

11 DRILLS

11.1 General Information

The NSWFB currently uses the *Kango* 950 Rotary Hammer Drill and the *Bosch* GBA 24 VR Cordless Hammer Drill for rescue work.

11.2 Kango 950

The *Kango* 950 rotary hammer provides drilling capability in concrete, stone or brickwork from 16 mm to 50 mm solid drill or to 125 mm with core drill. The hammer also has attachments for points, chisels and spades (see Fig 11.1).

The technical specification and inventory for the *Kango* 950 is detailed in Table 11A.

ITEM	SPECIFICATION
Rated watts input	1020 compatible with 2 kVa generator
Drill rev/min	276 rpm (approximately)
Blows/min drilling	2000
Blows/min hammering	2200
Overall length	675 mm
Weight	11.4 kg
Voltage	240 V AC
Inventory	
1x 25 mm spiral carbide drill with taper shank 1 x 50 mm spiral carbide drill with taper shank 1 x Drilling handle 1 x Dust shield 1 x 38 mm Point 1 x 400 mm Drill extension 1 x 380 mm Chisel 2 x pair Ear muffs 1 x Lynch pin 1 x jar White paraffin	1 x 50 mm Wide chisel 1 x Drill holder 1 x Drill ejector 1 x 125 mm Core and pilot drill 1 x Pilot drill ejector 1 x 355 mm Drill shank 1 x 150 mm x 400 mm Spade 2 x pair Protective goggles 1 x Metal carry box 1 x Depth gauge rod 1 x **T** handle 8mm hex wrench 1 x **T** handle ¼ A\F hex wrench

Table 11A Kango 950 Specification

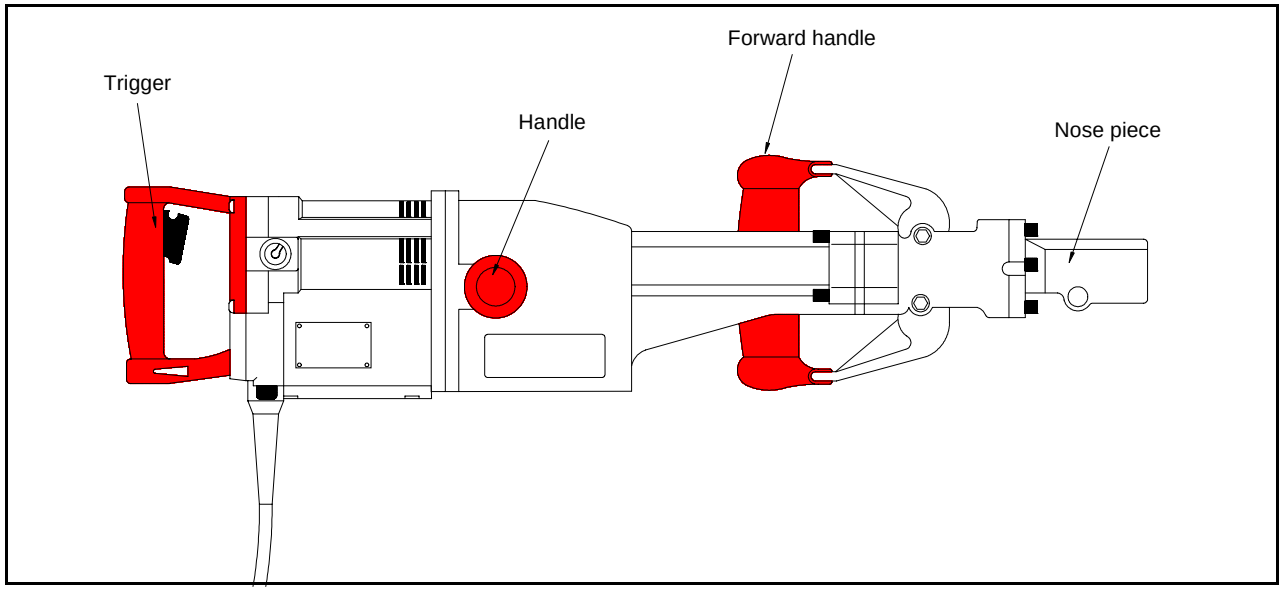


Fig 11.1 Rotary Hammer Drill (Kango 950)

11.2.1 Kango 950 Operation

To operate the *Kango* 950 rotary hammer drill, carry out the following actions:

- select drill holder and insert through dust shield;
- smear white paraffin on drill holder before inserting into the hammer/drill nose piece;
- push latch bar across to lock in position;
- select drill intended for use and insert taper into drill holder;
- attach drill handle into casing for either left or right handed operation;
- connect power lead into a suitable extension lead (if required) with weather proof couplings attached; and
- wearing eye, ear and suitable protective clothing, commence hammer drill operations by squeezing the trigger and grasping the side mounted drill handle.

CAUTION

Care must be taken whilst drilling concrete, especially when the core drill is in use, as a severe backlash may be experienced when the drill encounters any reinforcing.

11.2.2 Hammer Operation

To operate the *Kango* 950 in hammer mode, carry out the following actions:

- select either chisels, point or spade, dependant upon application;
- attach dust shield and smear white paraffin on shank before inserting into nosepiece;
- push latch bar across to lock in position;
- connect power lead into a suitable extension lead (if required) with weatherproof couplings attached; and
- wearing eye, ear and suitable protective clothing, commence hammer operations by squeezing tool trigger.

11.2.3 Safe Working Practices

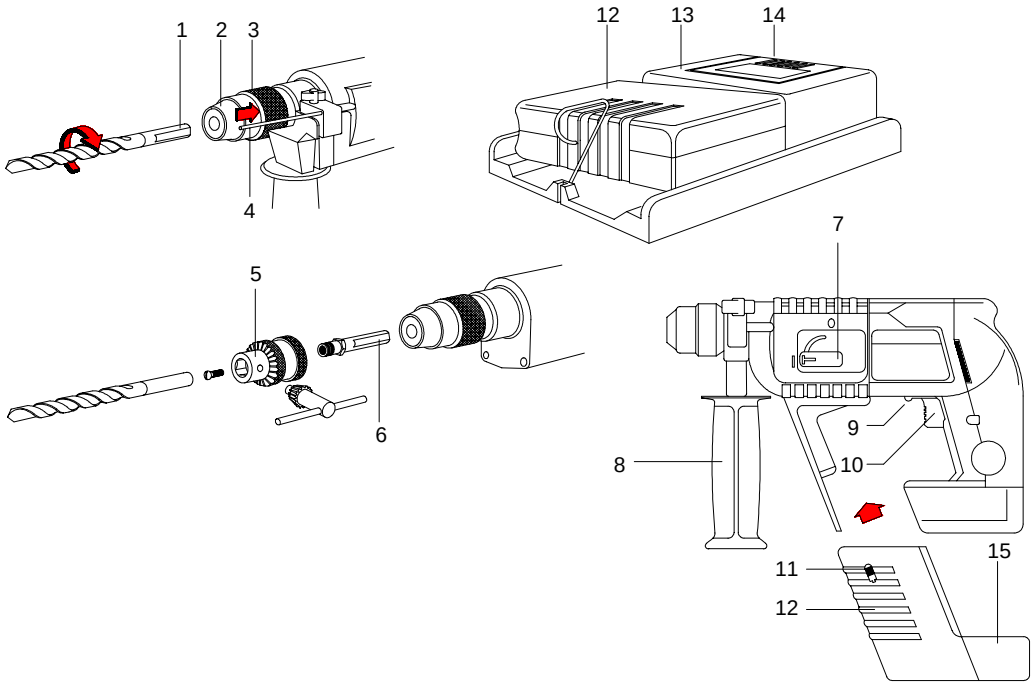
Always observe the following safe working practices:

- do not use tool in a flammable atmosphere;
- always wear eye protection;
- protective footwear is also important for operator safety;
- noise can constantly exceed acceptable safe levels - wear ear muffs;
- whilst drilling, backlash may occur, use drill handle and adopt a precautionary grip of the tool handles;
- do not use the trigger lock function whilst drilling; and
- do not operate tool, unless points, chisel, or drills, etc, are positioned on work surface.

11.3 Bosch GBA 24 VR Cordless Hammer Drill

The *Bosch* GBA 24 VR Cordless Hammer Drill (see Fig 11.2) operates from internal rechargeable batteries.

The technical specification for the *Bosch* GBA 24 VR Cordless Hammer Drill is detailed in Table 11B.



1	SDS - plus drill bit (Spline Drive System)	8	Auxilary handle
2	Dust protection cap	9	Reversing switch
3	Protection sleeve	10	On/Off switch
4	Depth stop	11	Holding clamp
5	Drill chuck	12	Battery
6	Chuck holder	13	Quick charge unit
7	Impact - type stop switch	14	Indicating lamp (LED)
		15	Contacts

Fig 11.2 Cordless Hammer Drill (Bosch GBA 24 VR)

ITEM	SPECIFICATION
Rotary hammer	GBH 24VR
Power input	270 W
Power output	180 W
Rated speed	650 rpm
Impact rate at no load	3000 rpm
Tool mount	SDS-plus (Spline Drive System)
Drill operation	Forward/Reverse
Weight with battery	3.5 kg
Maximum drill diameter	Concrete 14 mm Steel 13 mm Wood 20 mm
Inventory 2 x Batteries 1 x Instruction manual 1 x Charging unit 1 x 13 mm Chuck	 1 x 16 mm Masonry drill 1 x 13 mm Masonry drill 1 x 10 mm Masonry drill 1 x 6.5 mm Masonry drill

Table 11B Bosch GBA 24 VR Specification

11.3.1 Instructions & Safety Precautions

The cordless rotary hammer begins to operate as soon as it is switched on, so the following precautions should be observed:

- ensure that the battery is securely fixed on the housing;
- do not put such a load on the hammer that it stops moving;
- sharp bits ensure high-performance drilling and help to preserve the drill; and
- if the operating time decreases considerably each time the drill is used, this indicates that the battery needs changing.

11.3.2 Preparations for Use

If the drill is new, or has not been used for a long time, the battery must be charged. The battery and the charger have been designed to suit one another, so use only this type of charger. To operate the drill, carry out the following actions:

- switch on by pressing trigger;
- switch off by releasing trigger; and
- switch off the tool again when removing from working surface.

11.3.3 Tool Insertion

When impact drilling into concrete or stone, always use a drill bit with a SDS-plus shank. The following points should be observed:

- the drill is kept by one ball and driven by splines;

- insert drill **1** with a slight twist;
- the drill must have some play in the tool holder;
- to remove the drill, press sleeve **3** backwards and pull out the drill at the same time.

⚠ NOTE

Only use tools with clean, greased ends (slightly smear end with petroleum jelly).

11.3.4 Using Standard Twist Drills

Insert the adaptor in the SDS drill holder 13 mm (½") capacity chuck attached. Operate the drill only with impact mechanism in the **OFF** position.

11.3.5 Safety Clutch

If the drill bit happens to bind or catch, the safety clutch will operate. To re-engage the hammer, slightly tap the drill onto your work.

11.3.6 Quick Charge Unit

The red lamp indicates that charging is in progress. Red lamp off indicates charging is completed and prolonging the charging beyond this point will not damage the battery.

It is normal for the charger to become warm while charging is in progress.

If charging two batteries in succession, give the charger 15 mins to cool down between the two.

⚠ NOTE

Do not charge the battery if the room temperature is below 0° C or above 45° C.

11.3.7 Battery

For charging, remove the battery by pushing down the two holding clamps projecting on both sides while simultaneously pulling off the battery. The following points should be observed:

- do not use force;
- let the heated battery cool down prior to charging;
- a full charge requires approximately 2 hrs;
- the battery can be recharged more than 300 times;
- no special maintenance routine is necessary;
- store in a dry place shielded from frost; and
- the ambient temperature must not exceed 50° C.

11.3.8 Compensation Charging

The quick charging of the battery is completed after approximately 2 hrs, and the charger then switches to compensation charging.

Compensation charging serves the purpose of counteracting the natural automatic discharge of the battery. Your battery is therefore always charged and will suffer no damage, even if it is left in the charger for several days.

⚠ NOTE

The battery operates at full power only after approximately three charges. Never put empty batteries in storage, but recharge immediately or store in a connected charger.

11.3.9 Cleaning and Care of Tool

The cooling vents on the motor housing and the charger must always be kept clear and clean.

CAUTION

Replace a damaged dust protection cap without delay. Any dust entering the drill holder can cause a malfunction.

The drill holder can be dismantled for cleaning by pressing the sleeve backwards and removing the protective cap**.** The sleeve can now be removed from the shaft. **Beware of loose ball**. Clean the parts and slightly grease them before assembly.

SECTION TWELVE - HAND TOOL KIT

CONTENTS

12 HAND TOOL KIT

12.1 General Information

The hand tool kit currently used by the NSWFB has been compiled to provide rescue personnel with an immediate resource of simple hand tools. These tools compliment heavier rescue equipment, and provide the rescuer with significant flexibility when considering the methods and tools that can be best employed to ensure a quick, safe and effective rescue (see Fig 12.1).

12.2 Tool Kit

The Standard Hand Tool Kit comprises the tools detailed in Table 12A.

INVENTORY			
QTY	**ITEM**	**QTY**	**ITEM**
1	Tool box with lynch pin	1	pair Insulated pliers
1	pair Multi grips 250 mm (Bar type)	1	pair Universal scissors
1	300 mm Shifting Spanner	1	pair Right hand compound action tin snips
1	150 mm Shifting spanner	1	Combination AF and metric socket set
1	Metric ring and open end spanner set	1	pair Vice grips
1	AF ring and open spanner set	1	Imperial allen key set 1/16’ - 1/4’
1	Large phillips head screwdriver	1	Metric allen key set 1.5 mm - 6 mm
1	Medium phillips head screwdriver	1	Penetrating oil spray
1	Small phillips head screwdriver	1	450 mm Pipe wrench
1	90° Standard offset screwdriver	1	Ball pein hammer
1	90° Phillips head offset screwdriver	1	Marlin spike
1	Hacksaw frame	1	Lino knife
12	Hacksaw blades (18/24/32 tpi)	1	Impact driver set
1	19 mm Cold chisel	1	Lump hammer
1	25 mm Cold chisel		

Table 12A Standard Hand Tool Kit Inventory

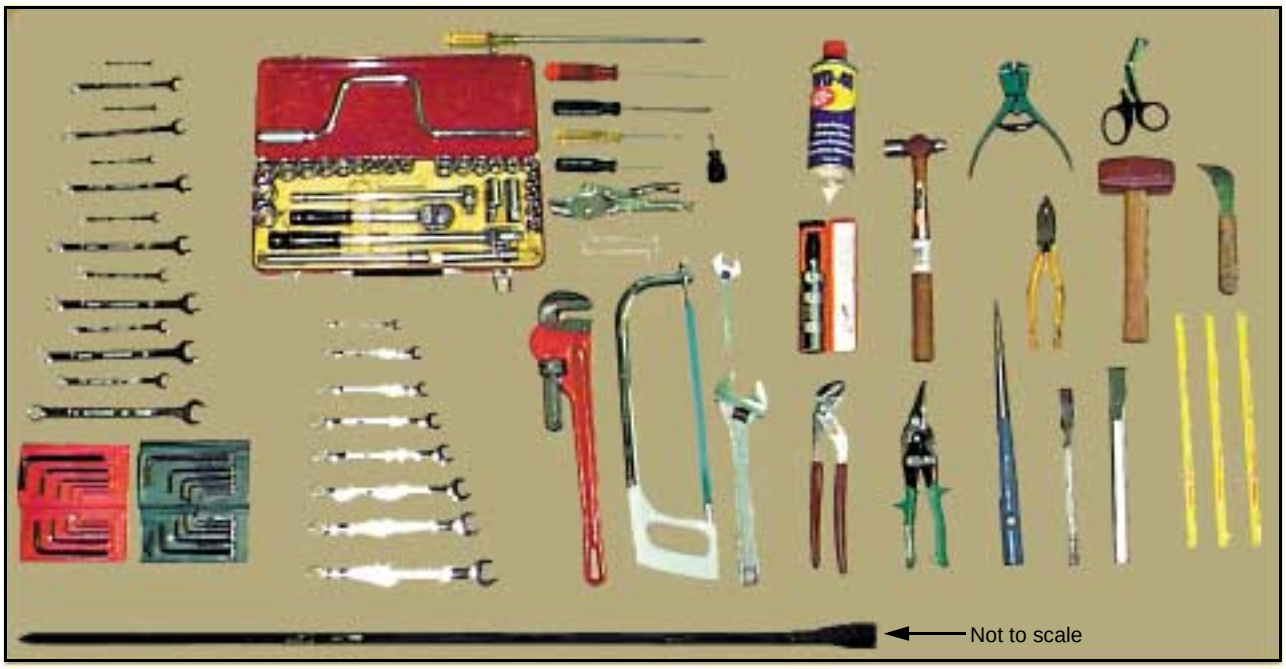


Fig 12.1 Hand Tool Kit

12.3 Finger Kit

The Finger Kit is specifically designed for the purpose of extricating trapped limbs and digits in industrial and domestic rescue situations.

It is a kit of precision tools which compliment the Hand Tool Kit.

12.3.1 Long Nose Pliers

The long nose is used to reach into tight places (see Fig 12.2). The jaw tips are serrated to give a firm grip and the cutters can be used for cutting steel wire.

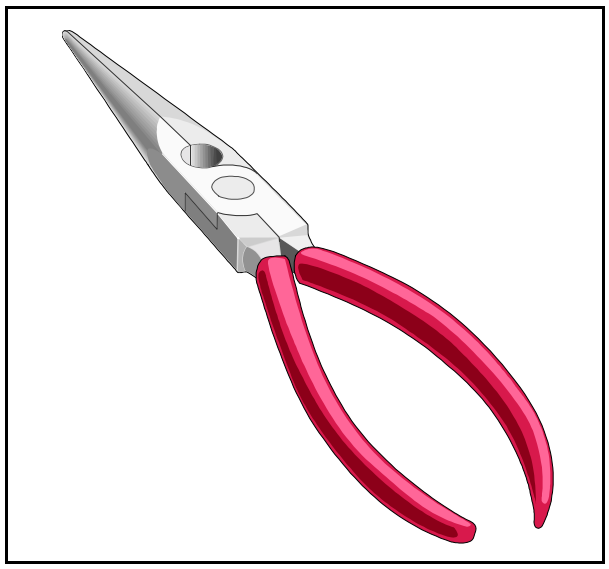


Fig 12.2 Long Nose Pliers

12.3.2 Side Cutters

The construction of this tool gives excellent leverage (see Fig 12.3). It is designed to cut piano wire.

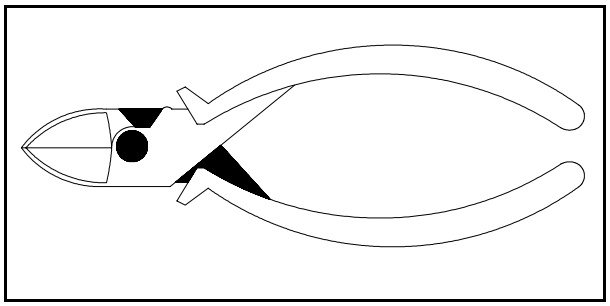


Fig 12.3 Side Cutters

12.3.3 End Cutters

The double acting, heavy duty end cutters are designed to give powerful leverage for efficient cutting (see Fig 12.4).

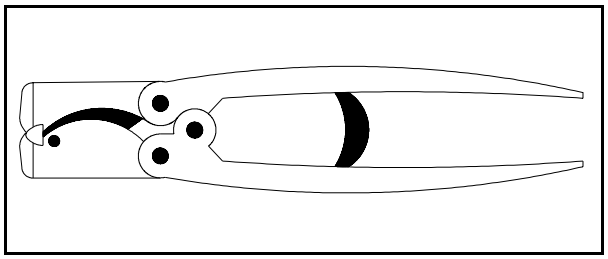


Fig 12.4 End Cutters

12.3.4 Jewellers Snips (straight or curved)

Intended use is primarily the straight or curved cutting of light gauge sheet metal.

12.3.5 Carbide Rod Saw

Used for cutting glass, ceramics, glazed tiles, alloy steel, etc. It fits a standard hacksaw frame.

12.3.6 Tool Handle or Pad Saw

Used to provide a secure handle for standard hacksaw blades and junior hacksaw blades. The newer style adjustable tool handle will also accept needle files.

12.3.7 Needle File Set

A set of six needle files are provided. The file shapes are round, half round, square, triangular, warding and flat.

12.3.8 Feeler Gauge

The thin metal feelers are used to provide protection when cutting to release digits or limbs at domestic or industrial incidents.

12.3.9 Junior Hacksaw

This can be used to cut metal, wood, plastics and many other materials (see Fig 12.5). Both wood and metal cutting blades are available. To replace a blade the front end of the frame is compressed against a solid surface.

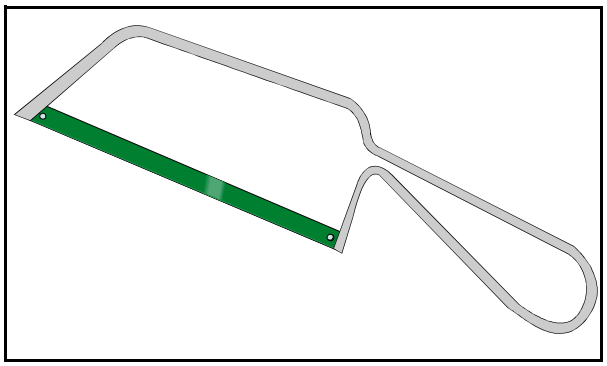


Fig 12.5 Junior Hacksaw

12.3.10 Hacksaw Blades

The 18 tpi is used for cutting soft metals, plastics, etc. The 24 tpi blade is used for general use and the 32 tpi blade for cutting very hard metals.

12.3.11 Dental Mirror

Used for the inspection of hidden areas (see Fig 12.6). The mirror magnifies the object being inspected.

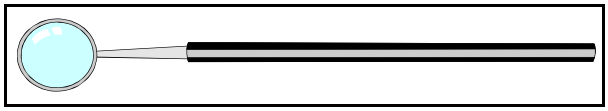


Fig 12.6 Dental Mirror

12.3.12 Retractable Knife

This has a very sharp blade for general purpose cutting (see Fig 12.7).

Fig 12.7 Retractable Knife

12.3.13 Additional Items

- small scissors;
- tweezers (1 pair rounded/1 pair pointed);
- tape measure;
- ring cutter;
- windscreen removal tool;
- splinter probe;
- paraffin jelly;
- insulation tape;
- penetrating oil; and
- string.

12.4 Ring Cutter

As a component part of the Finger Kit, the Ring Cutter compliments other means of removing rings from fingers (see Fig 12.8).

⚠ NOTE

This specialised implement is to be strictly confined to the removal of rings and soft metals generally used in jewellery. Replacement discs are available through any jewellery wholesaler.

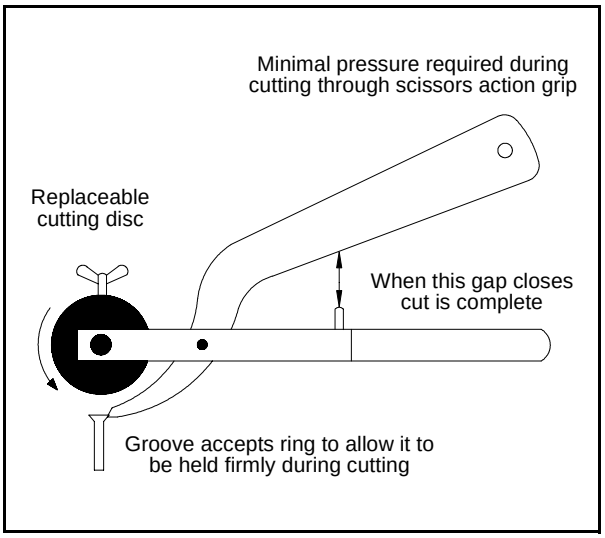


Fig 12.8 Ring Cutter

12.4.1 Ring Cutter Operation

The following procedure is provided as a guide for when the Ring Cutter is used:

- seat the patient comfortably with the hand resting on a table of similar flat surface;
- with the patients palm facing down (preferably), slide the grooved head of the pivot arm between the finger and the section of the ring to be cut;

- slide a feeler gauge, or place of piece of tape, in any area of possible skin contact with the cutting disc;
- engage the cutting disc on the surface of the ring by gently squeezing the scissor action grips. The ring should sit square against the end of the grooved section, to provide a right-angle cut;
- with minimal squeezing pressure, score the soft metal surface of the ring, by slowly turning the **T** piece clockwise;
- once the surface has been scored, maintain the position of the cutter, and with a gentle action, continue until the ring is completely severed; and
- remove the ring cutter and place 2 loops of string through the cut-gap of the ring. Pull the 2 loops in opposite directions - this will provide a gentle method of opening the ring sufficiently for it to be removed.

12.5 Windscreen Removal Tool

The windscreen removal tool is designed to cut the adhesive bonding when removing bonded windscreens in rescuing trapped persons at a motor vehicle accident. It consists of a plaited **L** shaped blade secured to a solid aluminium handle (see Fig 12.9).

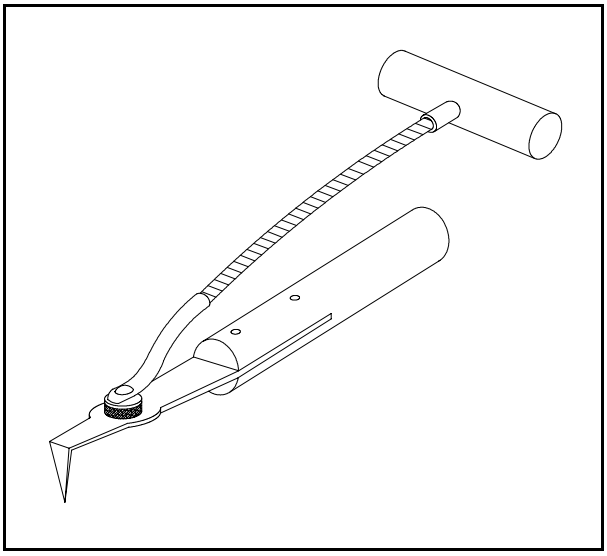


Fig 12.9 Windscreen Removal Tool

A pulling handle is affixed by means of a cable near to the base of the main handle. This is used to draw the tool when the blade is placed in position.

12.5.1 Features

The Windscreen Removal Tool is best suited to flexible adhesive bonding which is the most common form of windscreen fixing. It can also be used on other types of bonding such as soft bonding.

12.5.2 Safety

When using the Windscreen Removal Tool, the operator and assistant must wear gloves and eye protection.

12.5.3 Operation

To use the Windscreen Removal Tool, carry out the following procedure:

- the blade of the tool should be placed in line with the glass edge and used to pierce the bonding;
- the blade is then turned through 90° so that it penetrates the bonding between the glass and the car body; and

- hold the tool at a slight angle, away from the line of pull, the bonding can be cut by steadily drawing the tool by the pulling handle

NOTE

The tool is held at a slight angle to prevent the blade from snagging and water will enhance the cutting operation.

12.5.4 Service

The cutting edge of the blade should be kept free of nicks and dents. It should be sharpened with a fine file.

SECTION THIRTEEN - PORTABLE GENERATORS AND LIGHTS

CONTENTS

13 PORTABLE GENERATORS AND LIGHTS

13.1 General Information

There are two portable 240 V electrical generators currently in use with the NSWFB. These are the *Dunlite* 1000 W and the Powerlite 2000 W generator.

13.2 Dunlite 1000 W

The *Dunlite* 1000 W portable generator is used by the NSWFB at incident grounds to provide power for lighting (see Fig 13.1).

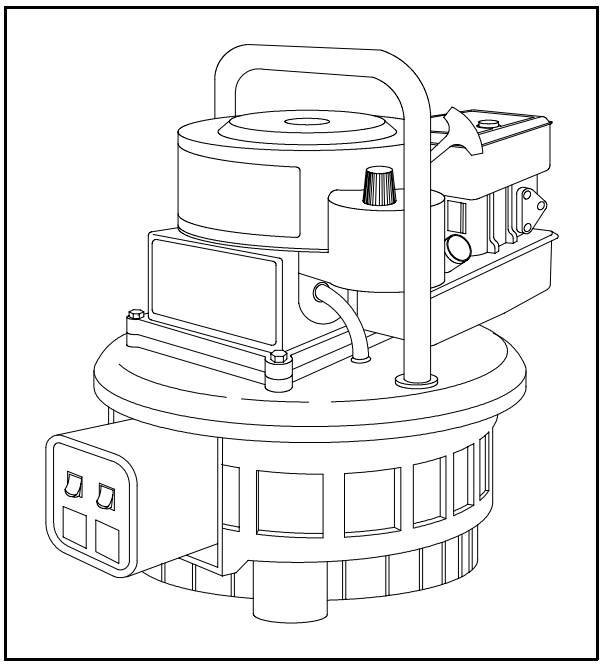


Fig 13.1 Portable 1000 W Generator (Dunlite)

The specification for the *Dunlite* 1000 W generator is detailed in Table 13A.

ITEM	SPECIFICATION
Generator	1000 W Alternator
Voltage	240 V
Amperage	Up to 4.2 A (do not exceed)
Drive	4 hp, 4 cycle *Briggs and Stratton* petrol Motor, 3600 rpm air cooled
Fuel	Unleaded 0.9 L capacity
Oil	0.6 L of SAE 30 or multigrade motor oil
Spark plug	*Champion* RCJ8 at 0.76 mm gap

Table 13A Dunlite 1000 W Generator Specification

13.2.1 Operation of Dunlite 1000 W

To operate the *Dunlite* 1000, use the following procedure:

- check petrol level;
- check oil level;
- connect electrical leads from the generator to the required equipment, ensuring that the weatherproof couplings enclosing the plugs are connected, and hand tightened;
- turn power switches **OFF**;
- move the choke control lever to the **CHOKE** position. A warm motor requires less or no choke than a cold motor;
- move the stop lever to the **ON** position;
- connect the earth lead. **Do not** use unless generator is correctly earthed;
- steady the generator with one hand and grasp the recoil starter grip in the other, then pull until resistance from

compression is felt. Pull the cord rapidly to overcome compression and to prevent kickback, and start the motor;

- return the starter grip slowly. Repeat if necessary with the choke opened slightly. When the engine starts, open the choke gradually;

⚠ NOTE

If the motor floods, move the choke lever to RUN and the stop switch to OFF, and pull the starter six times. Move the stop switch to ON and start the motor.

- when the motor is running smoothly the equipment can be switched **ON**, however, the load must be added gradually. It's a good practice to let the generator adjust to the load with approximately a 2-4 secs delay in switching on and off the second appliance; and

- once operations are complete, turn the electrical switch **OFF**. If a second appliance is in use, wait 5 secs before switching it off. Then move the stop switch to the **OFF** position.

13.3 Honda Powerlite 2300 W

The *Honda* Powerlite 2300 W portable generator is used by the NSWFB at incident grounds to provide 240 V power (see Fig 13.2).

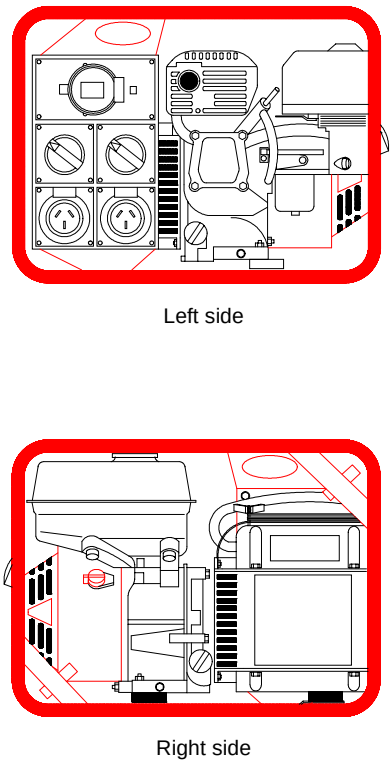


Fig 13.2 Portable 2300 W Generator (Honda Powerlite)

The specification for the *Honda* Powerlite 2300 W generator is detailed in Table 13B.

ITEM	SPECIFICATION
Power	2300 W
Voltage	240 V
Amperage	8.4 A (do not exceed)
Drive	5.5 hp, *Honda* petrol motor, 3250 rpm air cooled
Fuel	Unleaded 3.6 L capacity
Oil	0.6 L of SAE 30 or multigrade motor oil
Spark plug	ND W20 EPR-U at 0.76 mm gap

Table 13B Honda Powerlite 2300 W Generator Specification

NOTE

This motor has a low oil level sensor, which will shut the motor down should there be a low oil level, or if the unit is operated on a slope.

13.4 Operation of Honda Powerlite 2300

To operate the *Honda* Powerlite 2300, use the following procedure:

- check petrol level;
- check oil level;
- drive earth spike into the ground and connect the earth wire;
- connect electrical leads from the generator to the required equipment, ensuring that the weatherproof couplings enclosing the plugs are connected and hand tightened;
- turn power switches **OFF**;
- turn fuel valve to the **ON** position;
- turn the choke lever to the **CLOSE** position. A warm motor requires less or no choke than a cold motor;
- move the throttle control lever lightly to the left;
- turn the engine switch to the **ON** position;
- steady the generator with one hand and grasp the recoil starter grip in the other, then pull until resistance from compression is felt. Pull the cord rapidly to overcome compression and to prevent kickback and start the motor;
- return the starter grip slowly. Repeat if necessary with choke opened slightly. When engine starts, open the choke gradually;

NOTE

If motor floods, move the choke lever to open the throttle lever fully, the engine switch to off, and pull the starter six times.

- when the motor is running smoothly the equipment can be switched **ON,** however, the load must be added gradually. It's good practice to let the generator adjust to the load with approximately a 2-4 secs delay in switching on and off the second appliance; and
- once operations are complete turn the electrical switch **OFF**. If a second appliance is in use, gradually switch it off. Then move the stop switch to the **OFF** position.

NOTE

All these model generators are fitted with an earth leakage circuit breaker (ELCB), which will operate should a fault develop in a piece of equipment being used. The fault is to be located before the circuit breaker is reset. If no fault is located, the piece of equipment is to be withdrawn from service and checked by a licensed electrical contractor.

13.4.1 Service Checks

The oil is to be changed every 25 hrs, or 6 monthly. A key tag with date of last oil change/service is recommended.

To check oil level of the *Honda* Powerlite 2300 W Generator, remove and wipe the oil filler cap/dipstick, insert the dipstick but do not screw it in.

Remove and check the dipstick. The oil level on the *Powerlite* 2300 is considered to be full when the oil reaches the thread of the filler plug.

⚠ NOTE

Never wash paper cartridge air filters. Clean by tapping gently on a flat surface. Replace if excessively dirty.

13.5 500 W Flood Lights

500 W Q1 flood lights are currently being used by the NSWFB and are most frequently fitted to *Hella* tri-pods

An electrical connection is made to each light via a lead which has a male weatherproof coupling on it and is fitted with a 10 A plug.

13.6 150 W Caged Lights

The cage light that is used by the NSWFB has been designed to provide good illumination while protecting the globe from damage. If a bulb fails, a 120 W globe may be used with the cage light, if a 150 W replacement globe is not available.

Check that a rubber weatherproof ring exists between the globe and the socket. An electrical connection is made to each light via a lead which has a male weatherproof coupling on it, fitted with a 10 A plug.

13.7 Electrical Power Leads

Power leads of 20 m lengths are currently being used by the NSWFB. 15 A power leads are used which are fitted with 10 A plugs.

Weatherproof couplings are fitted to each power lead, but these fittings are not waterproof.

SECTION FOURTEEN - MISCELLANEOUS EQUIPMENT

CONTENTS

14 MISCELLANEOUS EQUIPMENT

14.1 STIHL TS 350 Power Saw (Cut Quick)

At factory fires, roller shutter door access is often required, for which this tool (see Fig 14.1) is ideally suited. However, the Power Saw has many rescue orientated purposes including industrial entrapments which are explored more fully in practical training sessions. A sound working knowledge of this tool is essential as some techniques will place great demand on your proficiency.

14.1.1 Features

The *STIHL* TS 350 Power Saw has the following features:

- adjustable wheel guard;
- centrifugal clutch;
- adjustable drive belt tensioner;
- flame arrester on muffler; and
- throttle trigger interlock (safety lock).

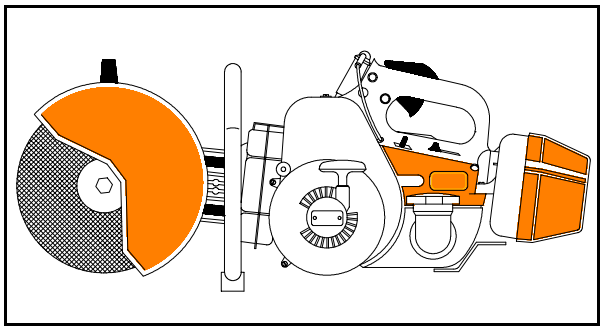


Fig 14.1 Power Saw (STIHL TS 350)

The technical specification for the *STIHL* TS 350 Power Saw is detailed in Table 14A.

ITEM	SPECIFICATION
Engine type	Single cylinder 2 stroke
Engine size	60 cc
Plug gap	0.5 mm
Weight	Approx 12 kg
Fuel type	2 stroke/unleaded mix 25:1 with Stihl 2 stroke oil 50:1
Cutting discs Type Size Speed rating	 Steel or masonry 300 mm diameter, 20 mm bore, 3.4 mm thickness 5460 rpm
Spindle speed	Maximum acceptable 5100 rpm (Wheel must be rated faster than spindle)

Table 14A STIHL TS 350 Power Saw Specification

14.1.2 Cutting Discs

Two types of abrasive cutting discs are used with this saw. The discs are similar in appearance, but are identified by the central labels (paper washers) which are necessary in the fitting of a disc. These washers bear the word *metal* or *masonry.*

The *metal* cutting abrasive disc is used for:

- cutting steel; and
- non ferrous metals.

The *masonry* cutting abrasive disc is used for:

- concrete;
- brick;
- stone; and
- earthenware pipes etc.

⚠ NOTE

When using this equipment an operator might bear in mind the following when at the scene of an incident:

(1) Should a *metal* disc continually clog when cutting soft non ferrous metals such as copper or aluminium, a *masonry* type disc may be used. Although the disc will rapidly reduce in diameter, less clogging will occur.

(2) It may also be found that a *masonry* disc is suitable for cutting fibreglass, although it is stressed that every precaution must be taken to protect the operator and those in the immediate vicinity from the considerable amount of fibreglass dust by the use of goggles, respirators etc.

14.2 Davey Pump

The NSWFB currently operate only one model of *Davey* pump - model 8187 (see Fig 14.2).

The *Davey* pump is a high pressure portable pump used to extract water from an external source such as a water tank, dam or swimming pool. The pump can also be used to provide pressure and pumping power for hosing, multiple sprinklers or pushing water up steep hills.

The pump is fitted with one 38 mm and two 25 mm *Storz* discharge outlets and one 38 mm suction inlet. It comes complete with a roll cage for storage on a fire appliance.

The technical specification for *Davey* pump model 8187 is detailed in Table 14B.

ITEM	SPECIFICATION
Engine type	*Honda* GX140 4 stroke air-cooled single cylinder
Engine size	144 cc
Max. power	5 HP @ 3600 rpm
Max. flow	3951 L/min
Max. head pressure	750 kPa

Table 14B Davey Pump Specification (Model 8187)

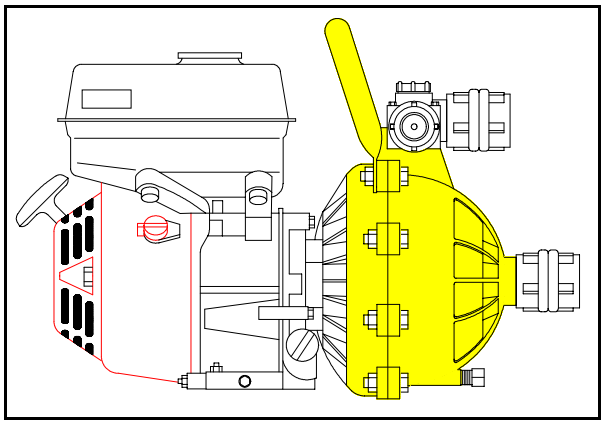


Fig 14.2 Davey Pump

14.3 Safety Lamps

14.3.1 Wolflite Safety Lamp

The *Wolflite* (see Fig 14.3) is a rechargeable battery powered safety hand lamp, which is approved and certified for safe use in a wide range of explosive atmospheres.

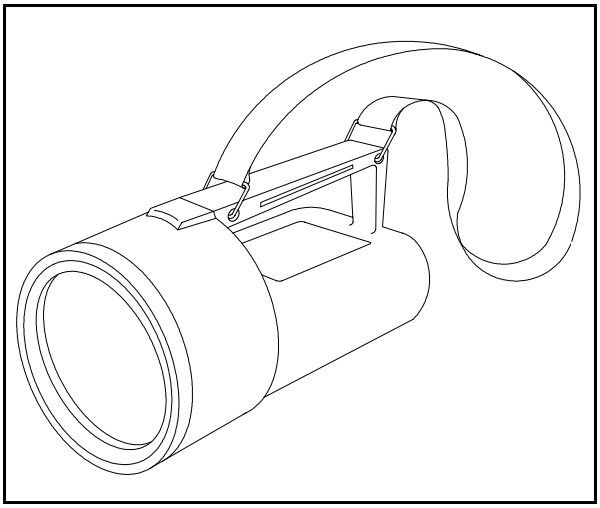


Fig 14.3 Safety Lamp (Wolflite)

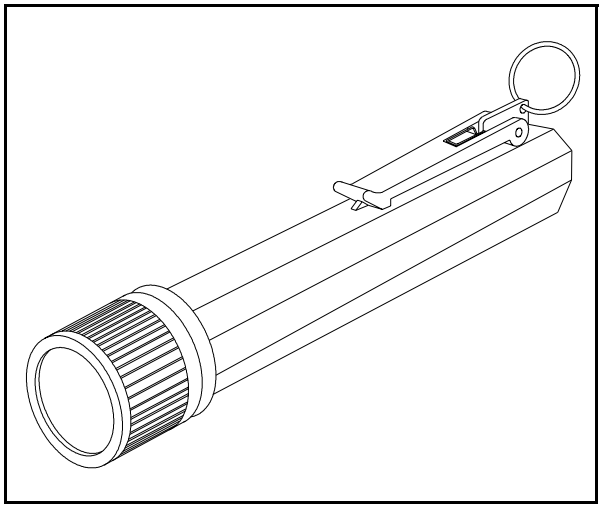


Fig 14.4 Safety Lamp (Sabrelite 2000)

14.3.2 Sabrelite 2000

The Pelican Super *Sabrelite* 2000 is intrinsically safe and completely 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 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 kit 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.

14.4 The Crib Block Set

The six piece Crib Block Set is carried on Salvage/Rescue Appliances, and is designed to compliment existing block sets (see Fig 14.5). This kit enables rescue operators further flexibility in stabilisation and extra packing in high lift operations. It enables crews to construct **pigsty** or **box cribs**.

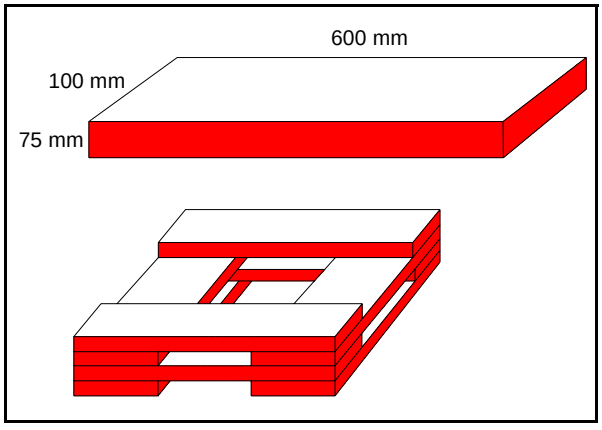


Fig 14.5 Crib Block Set

14.5 Patient Protection Shields

Primary Rescue Units carry two each of the three shields designed for patient protection. The shields are stowed flat (not rolled), preferably where rescue boards are located on the appliance. The shields are designed to give

maximum physical protection and psychological reassurance to the entrapped patient (see Fig 14.6).

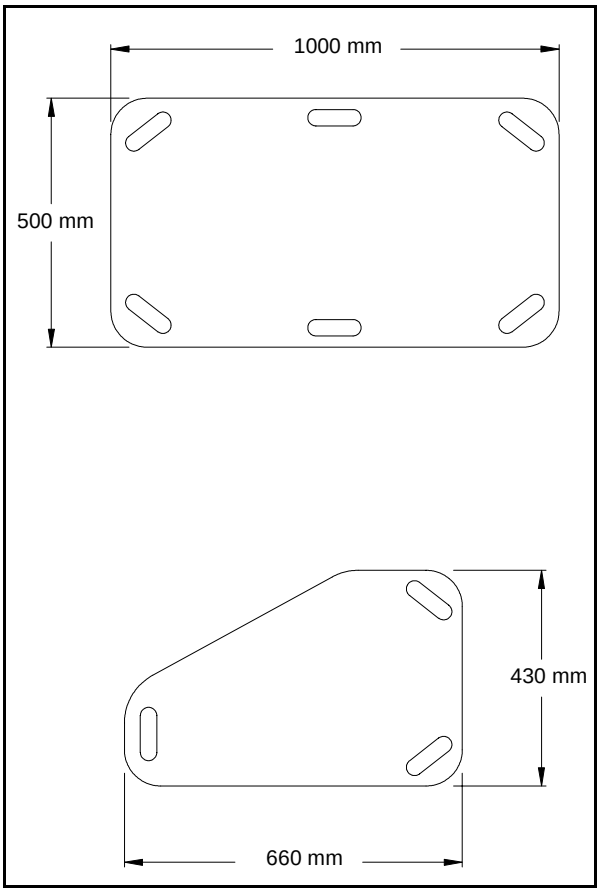


Fig 14.6 Patient Protection Shields

14.5.1 Small Rigid Shield

The small rigid shield is made from 3 mm *Lexan*. *Lexan* is a polycarbonate, similar to the face visor on firefighter's helmets. The shield is rigid, but may be flexed around a patient to suit the situation.

It has high impact strength and will not shatter. The shields should be positioned between the patient and any rescue tools being used during the extrication procedure. It will protect the patient from accidental contact with the rescue tool. Also, it will protect the patient from any part being cut, pushed, or pulled from impacting on them.

Transparent shields have many advantages over salvage sheets, blankets, etc. By being transparent, the patient does not feel isolated from his/her rescuers, and the rescuer always knows exactly where their patient is in relation to the rescue tool. Patient carers (NSWFB First Aiders and Ambulance Officers) are not restricted in their movements, and the shields do not block the vital light needed to tend to their patients.

⚠ NOTE

These shields are for patient protection, and are not to be used for spinal immobilisation or patient removal.

14.5.2 Large and Small Flexible Shields

The large and small flexible shields are both made from 5 mm flexible PVC (burn rate - slow to self extinguishing), and both can be used for the same purposes as the rigid shield, and have the same advantages over other forms of patient protection now used.

These shields can also be used in glass management, windscreen removal.

14.5.3 Maintenance

All shields should be cleaned with warm soapy water after use and allowed to dry in a shaded area before restowing. If the shields come in contact with blood products, they should be sterilised with BA disinfectant.

⚠ NOTE

Glass slivers tend to become embedded into the flexible PVC shields. If the shields are used against broken glass that face should not then be used against patients or rescuers. Flexible PVC shields should be inspected carefully for glass shards and any found should be removed and disposed of.

14.5.4 The Wooden Block Set

The 17 piece wooden block set is carried in a canvas bag and is an essential component of Rescue Kits (see Fig 14.7). There are 14 hardwood or laminated blocks as detailed in Table 14C.

ITEM	SPECIFICATION
No. 1	1 x Large base (750 mm x 200 mm x 75 mm)
No. 2	1 x Square base (200 mm x 200 mm x 75 mm)
No. 3	1 x Thin square base (200 mm x 200 mm x 50 mm)
No. 4	2 x Rectangular bases (200 mm x 100 mm x 75 mm)
No. 5	2 x Thin rectangular bases (200 mm x 100 mm x 50 mm)
No. 6	2 x Large half wedges (100 mm x 100 mm x 50 mm)
No. 7	1 x Small half wedge (150 mm x 50 mm x 25 mm)
No. 8	2 x Large wedges (100 mm x 75 mm x 300 mm)
No. 9	2 x Small wedges (75 mm x 50 mm x 200 mm)
Softwood plugs	No 1 (150 x 70 x 45 mm) No 2 (150 x 50 x 20 mm) No 3 (100 x 25 x 12 mm)

Table 14C Wooden Block Set

14.5.5 Soft Wood Plugs

Three soft wood plugs are also supplied with each block set. Softwood plugs on salvage appliances are stored in the Gas Repair Kit.

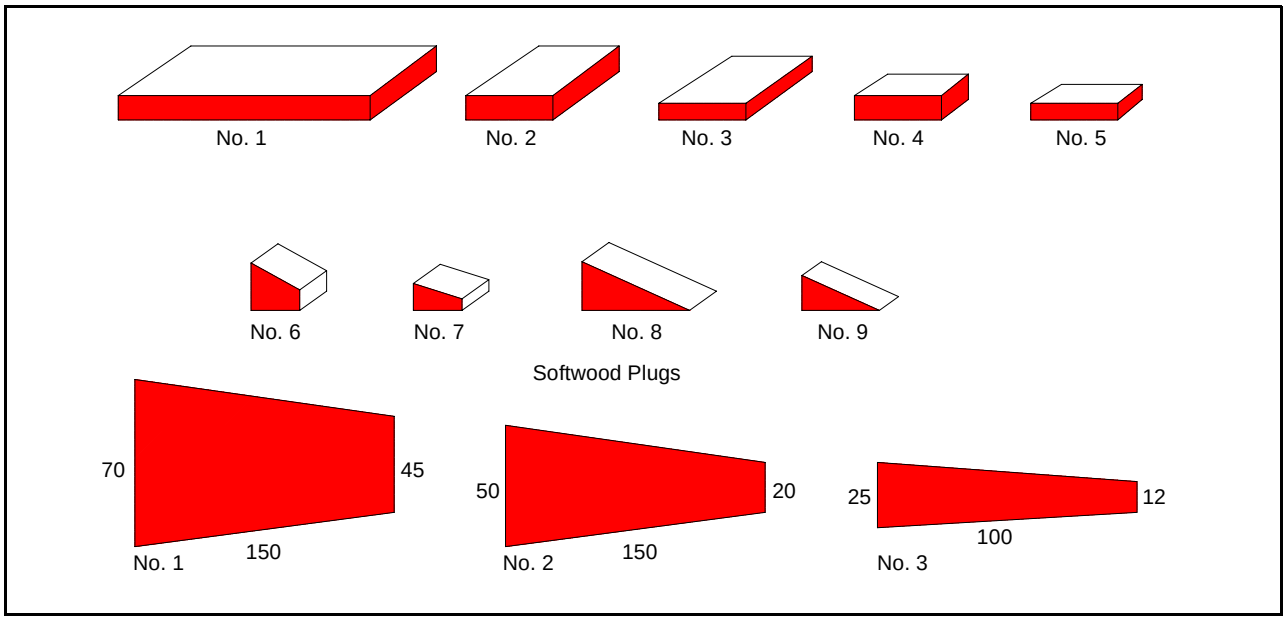


Fig 14.7 Wooden Block Set

14.6 Pickets and Groundplates

The picket and ground plate anchor system has been developed to provide a versatile and strongly constructed anchor. It may be used where a suitable natural or artificial anchor is not readily available. It can be used in four configurations:

- single plate;
- in line;
- vee; and
- picket holdfast.

14.6.1 Estimated Holding Capacity

The estimated holding capacity for each configuration is as follows:

- single plate holds approximately 2 t;
- in line holds approximately 3.25 t ;
- vee holds approximately 3 t; and
- 3:2:1 picket holdfast holds approximately 2 t (see Fig 14.8).

Tests have been carried out by the NSWFB on all four systems in firm ground. The various configurations were loaded to the specified tonnages, at which point the pickets began to bend slightly and move forward in the ground. It is obvious that these loadings will vary greatly depending on compactness and type of soil (see Fig 14.8).

14.6.2 Inventory

- 2 x Ground plates;
- 8 x Pickets; and
- 2 x Bow shackles (large).

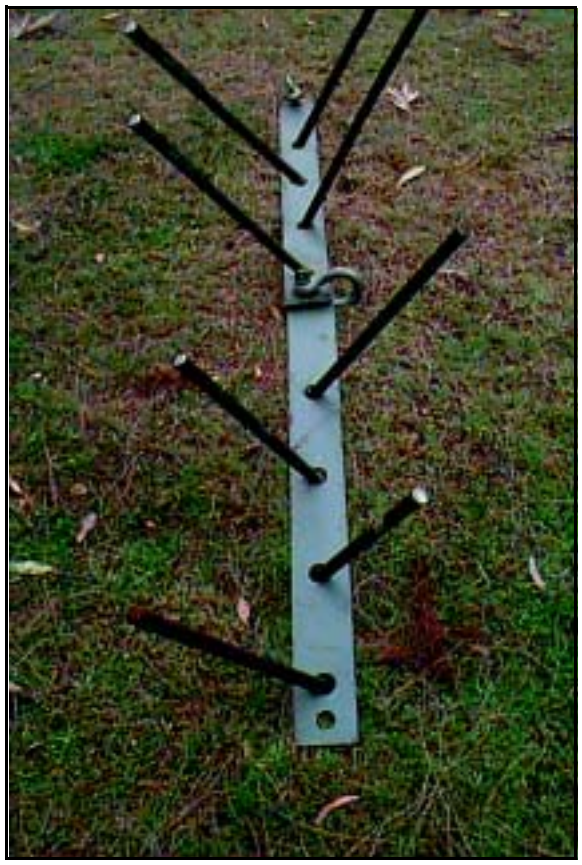
14.6.3 Safe Working Practice

Whenever the ground plate and picket system is being used, a firefighter must be placed so as to observe the system throughout the operation.

CAUTION

Beware of underground services when constructing an anchor.

Single ground plate with pickets



Two ground plates in-line with pickets

Two ground plates - V configuration

3:2:1 Picket configuration

Fig 14.8 Pickets and Groundplates

14.7 Harpoon Descender

The NSWFB currently uses the Harpoon (see Fig 14.9) which is a fixed friction descending device. It is drop forged from high grade aluminium alloy and polished or burnished to a smooth surface.

The Harpoon has been tested to destruction, which occurs at considerably greater than 5000 kg. However, distortion begins to occur at 4500 kg.

The Harpoon descending device can be used for the following functions:

- a lowering device from above and below;
- a way of securing a rope without knotting it;
- a self rescue device; and
- a belay or safety brake.

14.7.1 Inspection

The Harpoon should be inspected visually before and after use for damage and for deep grooving caused by continual usage. The device can be checked by suspending it from a piece of string, etc, and gently tapping it with a carabiner. If the device is in good structural condition, with no cracks, it should give a true lasting ringing sound. If the device is in unsound structural condition it will emit a short flat ring.

The Harpoon should be removed from service if one of the following has occurred:

- it has been dropped from greater than body height (if dropped from less than body height it should be tested in the manner described above);
- if it has been grooved to a depth of greater than 5 mm; and
- if the above test indicates that the device is damaged.

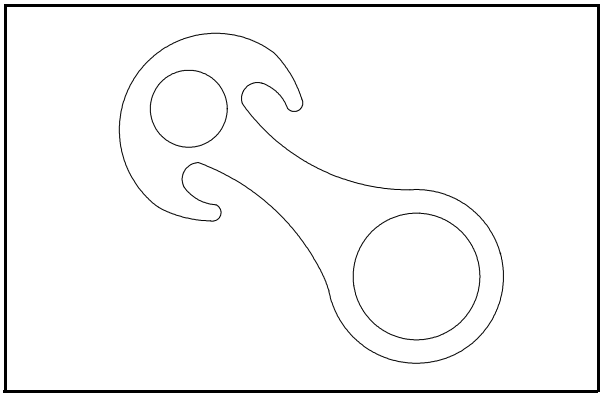


Fig 14.9 Descender (Harpoon)

14.8 Side Gate Rescue Pulley

A side gate rescue pulley can be used:

- to redirect a rope line;
- to clear a rope line from abrasion on rough surfaces; and
- to offer a mechanical advantage.

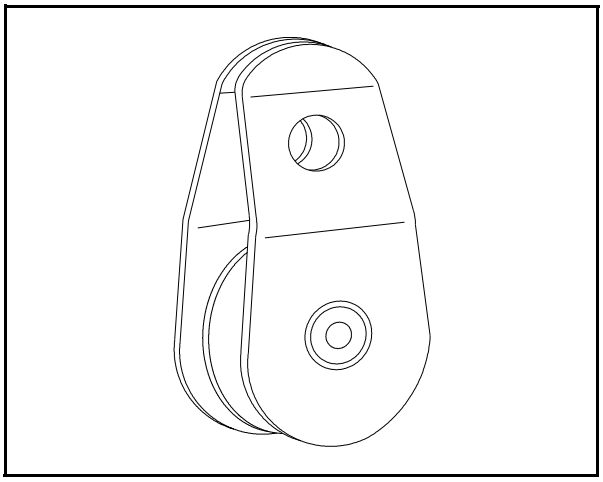


Fig 14.10 A Typical Side Gate Rescue Pulley

Table 14D details the specification of the Side Gate Rescue Pulley.

SPECIFICATION	DETAIL
Construction of *Riley* Side Gate	The cheeks are made from stainless steel with a Delrin Sheave
Sheave Diameter	50 mm
Capacity	up to 13 mm dia
Rated Strength	1500 kgs
SWL	250 kgs

Table 14D Side Gate Rescue Pulley Specifications

14.9 Stokes Litter

There are several types of *Stokes* Litters in common use by Rescue Services. The NSWFB uses a litter made by *DHS Pty Ltd*. It consists of an aluminium tubular frame with a cross linked yellow plastic pan, large enough to accommodate a spine board (see Fig 14.11).

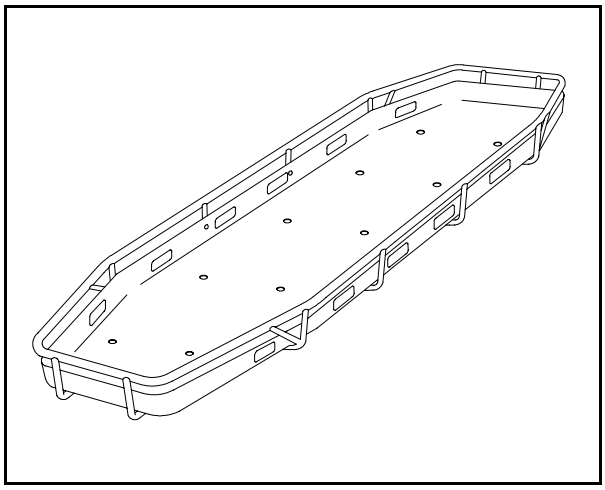


Fig 14.11 Stokes Litter

The overall dimensions are as follows:

Length: 2160 mm

Width: 650 mm

Height: 240 mm

Weight: 10 kg

The SWL for this item of equipment is 300 kg.

Accessories include four adjustable restraint straps and a four point lifting sling (see Fig 14.12).

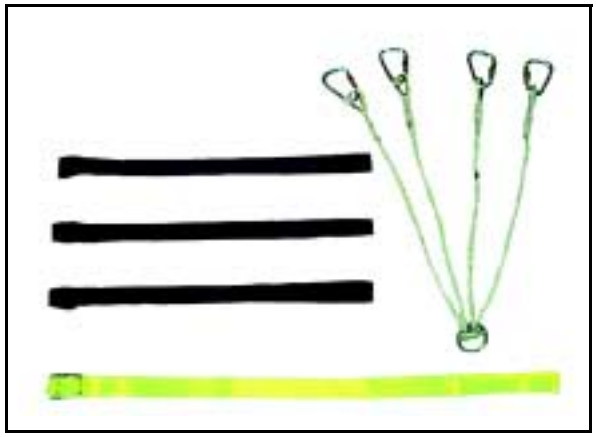


Fig 14.12 Stokes Litter Accessories

14.10 Safety Helmet

For rescue operations that involve any degree of climbing, NSWFB rescue operators wear the lightweight helmet (see Fig 14.13).

The helmet is constructed of fibreglass and can be fitted with a Petzl zoom light.

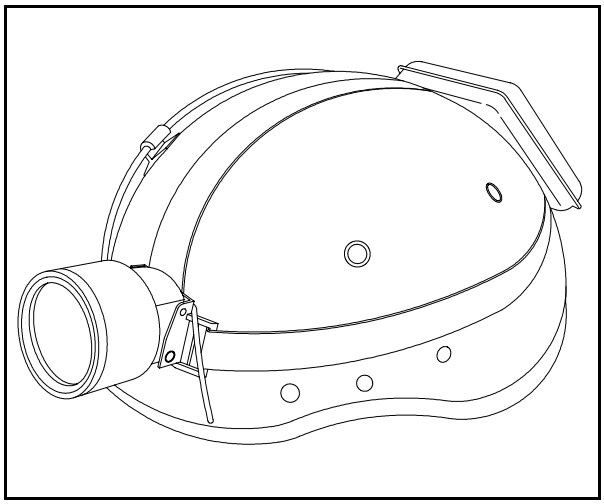


Fig 14.13 Safety Helmet