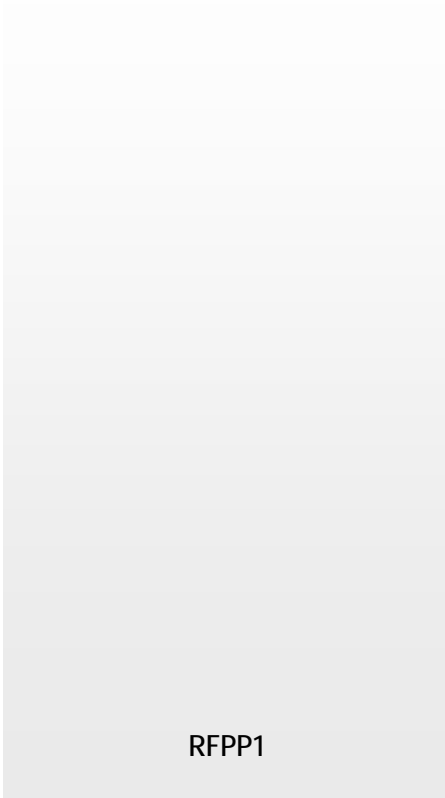




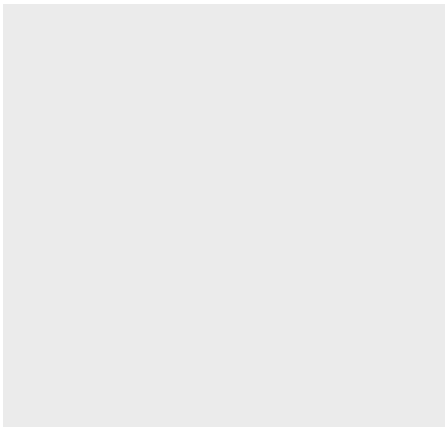
Rural Firefighting

Study Guide

# Operate Portable Pumps



RFPP1



## **Status of this Document**

This document is issued by the National Rural Fire Authority.

### **What This Means**

It is written to comply with:

- other National Training material
- National Rural Fire Authority best practice
- Forest and Rural Fires Act 1977
- Fire Service Act 1975
- Health and Safety and other relevant legislation
- New Zealand Qualifications Authority requirements
- Fire and Rescue Services Industry Training Organisation (FRSITO) requirements.

The document, its content and specified processes are not to be altered, except through National Rural Fire Authority training processes.

### **Recommendations for Change**

National Rural Fire Authority welcomes feedback on all its products and processes to ensure currency and continuous improvement.

Recommendations for changes to this material should be sent to National Rural Fire Authority.

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# Contents

- Acknowledgements..... i
- Study Guide Introduction ..... 1
- Section 1: Basic Hydraulics ..... 3
  - Introduction..... 3
  - Principles of Pressure..... 6
  - Flow in Hose Lines ..... 12
- Section 2: Knowledge of Portable Pumps..... 14
  - Pump Types ..... 14
  - Summary ..... 20
- Section 3: Set up Portable Pumps ..... 21
  - Types of Water Supplies ..... 21
  - Suitability of Water Supply..... 23
  - Assessment of Water Supply ..... 23
- Section 4: Operate Portable Pumps ..... 28
  - Engine Troubleshooting..... 33
  - Relay Pumping ..... 36
  - Communication..... 45
- Section 5: Recommissioning and Site Restoration..... 47
  - Retrieving and Recommissioning Equipment ..... 47
  - Maintaining After Use ..... 48
  - Restoring the Site ..... 49



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## Study Guide Introduction

### Overview

Welcome to Operate portable pumps. The course is made up of theory and practical training.

During the course, you will learn about:

- basic hydraulics
- knowledge of portable pumps
- set up portable pump
- operate portable pump
- recommissioning and site restoration.

Read through this study guide and complete the workbook before your practical training date. This will ensure you are familiar with the subject and can highlight any questions for the training session.

### Course Objectives

The general objectives for this course are to demonstrate knowledge of portable pumps and how to set up, operate and recommission a portable pump appropriate to your firefighting working environment. After studying this material, you should be able to demonstrate knowledge of:

- basic hydraulics; properties and characteristics of water
- portable pumps used in firefighting
- setting up a portable pump
- operating a portable pump
- recommissioning a portable pump and restoring a site.

This course provides evidence towards the achievement of Unit Standard 20386 (version 2) Operate portable pumps for fire fighting.

### Assessment and Evidence

Because practical experience differs you will need to check with an approved assessor and discuss the requirements for you to achieve the unit standard. This could include attestation of previous practical experience and/or practical assessment.

A properly maintained work record will support your portfolio of evidence for use as evidence for assessment against unit standards. You'll need to maintain a record of relevant work experience, together with an evaluation of tasks completed at an incident by the relevant supervisor.



## Practical Training

The practical training session is made up of two parts:

1. The instructor provides leadership in the use of firefighting portable pumps and the trainees practice using each item.
2. Participants work in a crew to set up and use firefighting portable pumps and practice these skills.

## Gaining the Unit Standard

For the unit standard assessment participants may submit a portfolio of evidence to a designated assessor. To support the evidence, maintain a workbook and records of relevant work experience, together with an evaluation by the relevant supervisor of tasks completed at an incident.

## Section 1: Basic Hydraulics

### Introduction

#### Basic Hydraulics

Hydraulics deal with the physical characteristics displayed by fluids at rest and in motion.

Hydraulics = *hydro* (water) *aulos* (a pipe) (Greek)

In firefighting, hydraulics is generally used to describe the study and behaviour of water. Every time you work with water you are employing hydraulics. Understanding the application of hydraulics in your role as pump operator is essential.

As a firefighter you will already be aware that water is the most commonly used fire-extinguishing agent. For water to be used effectively, it needs to be applied in a suitable form and at a rate high enough to overcome the heat of a fire. To achieve this knowledge you need to know about hydraulics and pump operation.

#### Water Hammer

When the flow of water through fire hose or pipe is suddenly stopped, the resulting surge is referred to as water hammer.

Water hammer can often be heard as distinct sharp clank, very much like a hammer striking a pipe. This sudden stoppage results in a change in direction of energy and this energy is instantaneously multiplied many times. These excessive pressures can cause considerable damage to water mains, plumbing, fire hose and fire pumps.

#### Jet Reaction

When water is projected from the nozzle, a reaction of equal and opposite force to the force of the water jet takes place. This causes the nozzle to recoil in a direction opposite to the flow.

Jet reaction is the force generated by the moving jet of water exiting a nozzle. As a pump operator, you need to be aware that a nozzle and hose under control will whip around at high speed if not under control, and can cause serious injuries and damage if it strikes people or objects.

Sudden variations in pressure at the nozzle can also unbalance the firefighter holding it if the jet reaction takes them by surprise. Opening valves too quickly is the most common way of rapidly altering the jet reaction.

This reaction takes place as the water leaves the nozzle and is not affected by the jet striking, or not striking, a nearby object.



### Safety Note:

While operating a pump, you need to be ready to react to an out-of-control hose by shutting off the water

### Characteristics of nozzle discharge

Water is usually applied in the form of either a jet or a fog/spray. Sometimes it is mixed with a foam concentrate and air and applied as foam.

An open-ended fire hose may be able to supply a sufficient rate of water flow, but unless a nozzle is added and water is supplied at an appropriate pressure, it may not be in a suitable form (jet or spray) to apply to a fire.



Figure 1.1 – Hose with Jet



Figure 1.2 – Hose with Spray

**Function of the nozzle**      The nozzle controls the flow and pattern of the water being discharged.

**Discharge through the nozzle**      Each nozzle will operate at an optimum pressure. These pressures cannot always be adopted during firefighting operations. They depend on the condition of the hose, the length of hose lines, the height of the nozzle above or below the pump, the capacity of the pump, and many other factors.

Optimum nozzle pressure is the pressure at which the nozzle delivers the best volume of water, usually in the 500 – 700 kPa range.

The advantages of using optimum nozzle pressures are:

- greater striking power and reach
- larger volumes of water
- less turbulence in the water jet
- less jet reaction.

Exceeding the optimum nozzle pressure, does not usually create any advantage.

Excessive turbulence in a water jet at a higher pressure, may lead to it breaking up prematurely and reduce its effective range.

Excessive pressure also creates an unnecessarily high jet reaction, making the delivery more difficult for firefighters to use and control.



### Safety Note

Nozzle controls, hydrants, valves and hose clamps should be operated slowly to prevent water hammer.

## Physical Properties of Water

Water when pure is colourless, odourless and tasteless. It exists as a fluid between 0°C and 100°C and for all practical purposes it is considered incompressible. Water is incapable of resisting change of shape, always assuming the shape of the vessel in which it is contained, and will come to rest with a level surface.

**One cubic metre (m<sup>3</sup>) of water = one tonne (t) = 1,000 litres (l)**

**1 litre of water has a mass of 1 kilogram (kg)**

Force is the amount of energy to shift water (kilowatt - kW) and is related to the size and power of the pump.

Mass is the weight of water.

### Expansion

Expansion is when water expands by either heating to steam or cooling to ice. This water expansion can damage the pump.

## Principles of Pressure

### Pressure

Pressure is the force acting on a given surface area. It is usually measured in kilopascals (kPa).

Energy is needed to provide a flow of water to the nozzle with sufficient pressure to form an effective jet, fog/spray or foam stream. Usually this energy is imparted to the water by a pump. Pump operators control the flow and pressure of water being supplied to firefighters at the nozzle.

As the water travels through the hose on its way to the nozzle, there is a loss of energy due to:

- the height of the nozzle above the pump
- friction in the hose.

Pump operators need to provide the correct pressure at the pump to overcome both these losses so the pressure delivered at the nozzle(s) is sufficient to form an effective jet, fog, spray or foam stream. To achieve this, a good understanding of the principles of pressure is required.

**Head loss (or gain)**

Water flowing uphill from the pump to the nozzle needs more pressure to overcome the effect of gravity. The opposite happens if the nozzle is lower than the pump – less pressure is needed to send water downhill.

Head is defined as the difference in height (in metres) between the nozzle and pump.

**Suction Lift**

Suction lift is the distance from the pump to the level of water that you are drafting from.

**Ejector Pumps**

Ejector pumps are special pumps with no moving parts.

This type of pump is particularly suitable where it would otherwise not be possible to place a normal pump. They are used away from the appliance, as an extension to the appliance pump. They can pump dirty water without causing any damage to the ejector pump.

Ejector pumps are light and easy to handle. Once set up, they require little or no attention, except any removal of debris that may have collected in the suction strainer.

There are three common ejector pumps:

1. A Type
2. B Type
3. Water Dragon.

Only A and B types will be discussed below.

**‘A’ Type ejector pumps**

The ‘A’ type ejector pump is a salvage ejector pump only. It uses 100 mm suction to move large volumes of water.

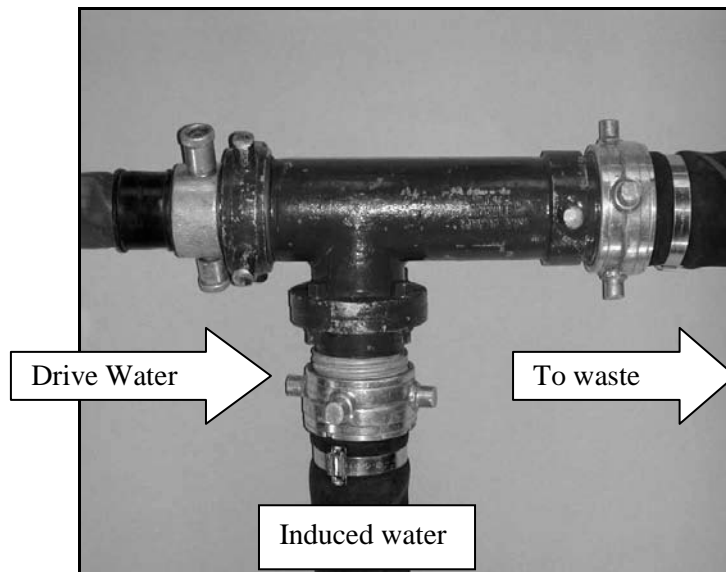


Figure 1.3 – 'A' Type ejector pump

### Barrier Height

Barrier height is the maximum height a pump is capable of delivering to, particularly in reference to the operation of B Type ejector pumps.

Caution: do not restrict flow by running over obstacles or obstructions to flow, particularly with discharge line from ejector pumps.

You need to add 10 kPa for every metre the nozzle is higher than the pump. This is particularly important for ejector pumps.

If the nozzle is below the pump then you need to subtract 10 kPa for each metre. This is particularly relevant in low pressure pumping situations, for example when using a 'B' type ejector pump.

### Head

Head is the height from the outlet of the pump to where the water is being delivered.

### 'B' Type ejector pumps

The 'B' Type ejector pump (see Figure 1.5) can be used as a salvage pump for minor flooding as well as providing water supply in non-reticulated areas. It has three connections. The pump is designed for use with a 70 mm delivery hose, so the connections are:

- 70 mm male on the inlet side
- 70 mm female outlet.

The pump incorporates a strainer, so no suction connection is required.

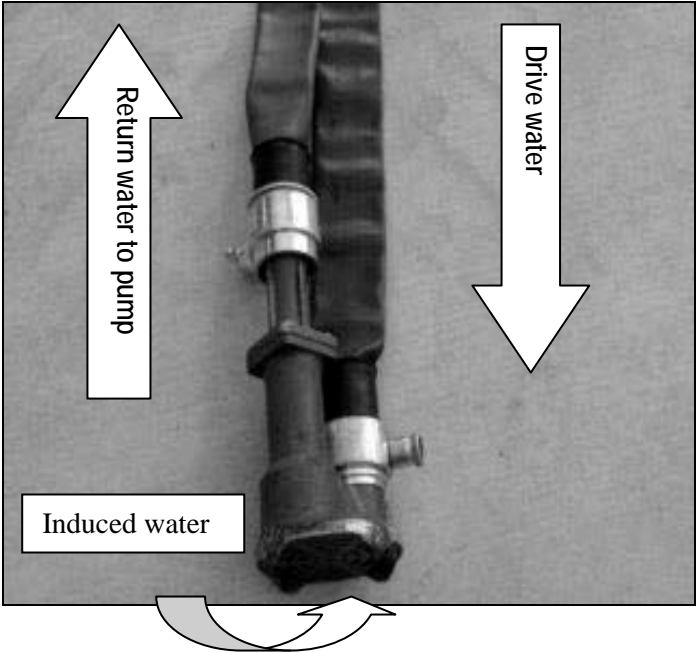


Figure 1.4 - 'B' Type Ejector Pump



## Characteristics of Suction Lift

When using suction, water cannot rise to a vertical height of more than 10 m. Water rises because it is forced up by atmospheric pressure.

To aid pump operators in recalling the factors the word '**CRESTA**' is can be used to help you remember.

<b>C</b> <b>Creation of flow</b>	A proportion of atmospheric pressure is used in creating flow. This varies in proportion to the velocity of water in the suction hose.
<b>R</b> <b>Resistance to friction</b>	Overcoming frictional resistance to the water, both on entering and on passing through strainers and suction hose. Frictional loss in suction hose is governed by the same factors as apply with delivery hose: <i>Length, Interior Surface, Diameter and Speed of flow</i>
<b>E</b> <b>Entry loss</b>	Due to changes of direction as the water enters the pump impeller.
<b>S</b> <b>Size of suction hose</b>	The larger the diameter of the suction hose the greater the flow.
<b>T</b> <b>Temperature</b>	Water boils at 100°C at normal atmospheric pressure. At pressures less than atmospheric, as in suction hose, water will boil and vaporise at lower temperatures. When it vaporises in suction hose, the column of water becomes broken and the pump loses its prime.  Approximate heights to which water can be lifted in suction hose at temperatures above normal are shown in Figure 1.7.
<b>A</b> <b>Atmospheric pressure</b>	Atmospheric pressure is the only pressure available to lift water in a suction hose. The primer of a pump only extracts air so atmospheric pressure may induce water to enter the pump.

## Vertical Lift

The primer creates a vacuum in the pump and suction hose. The lifting of water to the pump inlet and the flow into the pump is then achieved only by atmospheric pressure.

The practical maximum lift applies only to cold pure water at sea level.

Water Temperature	Approximate lift height
25°C	8 m
55°C	6 m
72°C	4 m
82°C	2 m
Above 88°C	Nil

Figure 1.5 – Approximate lift heights of water above normal temperatures

When operating a pump, the height of the pump inlet above the water surface needs to be considered. This is called vertical lift.

An example of this is when the pump inlet is 3.0 metres or less above the surface of the water. In this example your pump will be running at its full capacity. By the time the pump is 7.0 metres above the water, you only have half of the rated capacity of the pump.

## Air Leak in Suction

If an air leak were to occur, the suction hose would not maintain a vacuum and the pressure in the suction hose means you lose the prime in the pump. Losing the prime in the pump will result in damage to the pump, and of losing water at the nozzle.

## Negative Pressure (pump inlet)

Firefighters usually refer to pressure above atmospheric pressure as positive pressure, and pressure below atmospheric pressure as negative pressure.

When the pump is using water from a static supply, there is a negative pressure on the inlet side of the pump. The amount of negative pressure normally corresponds to the lift of water being achieved.

If the suction hose or pump inlet were to become blocked the pump would work harder to lift water against the blockage. If the blockage is not cleared the pump flow is reduced or the prime can be lost.

## Flow in Hose Lines

### Friction Loss

Pressure is lost because of friction in the hoses. Several things cause friction, including the size of hose being used and the water flow.

The diameter of a hose affects the amount of pressure lost due to friction. Small hoses generate more friction than bigger hoses, so they need more pressure to push water through them. Larger hoses reduce the friction loss, which in turn reduces the pressure required to push water through them.

The table below shows the approximate friction loss for different hose types per length. These amounts are for low flow rate and will differ depending on type of inner lining in the hose. High and low flow rates are discussed next.

Hose Diameter	Friction loss (kPa)	Hose Length
25	350	30
41	200	30
45	150	25
70	60	25
90	50	30

Figure 1.6 – Effects of friction loss

**Friction loss due to flow rate**

The flow rate of water is governed by the pump rated output and restrictions in waterway fittings i.e. nozzle fitted or open ended hoses. A low flow rate is anything under 475 litres per minute. A high flow rate is anything higher than that. Some pieces of waterway equipment, like large nozzles and ground monitors require a high flow rate.

The higher the rate, the more pressure is lost due to friction.

High flow rate = more water pressure lost

Low flow rate = less water pressure lost

For example, for a 70 mm hose, the pressure loss per length is:

<b>Flow Rate</b>	<b>Length of hose section</b>	<b>Pressure loss per length</b>
Low flow rate	25 m	15 kPa
High Flow rate	25 m	50 kPa

A high flow rate should only be used with larger hoses, like 90 mm hoses. Smaller hoses, like 41 and 45 mm hoses should only be used with a low flow rate. Both rates can be used with 70 mm hose.

Friction loss decreases when running two hoses in parallel.

For example, if water is being delivered through one hose line at a particular rate of flow, and a second parallel hose line (same diameter) is brought into operation. Each of the parallel hoses will only need to flow half as fast to deliver the same total flow rate. However, the friction loss in each will be reduced to a quarter of its original value in the single hose line.

Friction loss increases with the roughness of the interior of the hose.

All other factors being equal, a hose that has a rough interior (an unlined hose) will have greater friction loss than will a hose with a smooth interior (a rubber lined hose).

**General Rules**

1. The general rule for pumping water over a significant distance is that using larger diameter hose reduces friction loss.
2. The general rule when already using a larger diameter hose is that in order to reduce friction loss in the hose line you need to 'twin' the hose line.
3. The pump operator should know the flow and pressure required at the end of the hose line to then set the pump output. Delivery requirements plus hose lengths (friction loss) equals required pump output.

## Section 2: Knowledge of Portable Pumps

### Pump Types

#### Portable Pumps

An effective pump operator must be able to operate portable pumps from both open water and pressure-fed supplies.

Portable pumps are independent pumping units that can be carried by one or several firefighters. They are usually centrifugal pumps powered by a small diesel engine or two-stroke or four-stroke petrol engines.

Portable pumps may be stand-alone units for use away from an appliance, fixed to the deck of an appliance or trailer, or carried as part of a firefighting unit designed to be carried on a utility or trailer.

Portable pumps have lower outputs than appliance-mounted-and-driven pumps. They are smaller and may not incorporate the usual pump gauges. Some portable pumps may also be designed as floating units, with an integral suction inlet.

#### Pump Classification

The National Rural Fire Authority pump categories are listed below, along with their abbreviations and examples of the pumps that meet each classification.

Type	Abbreviation	Capacity	Examples
High Pressure / Low Volume	HP/LV	100 l/min at 1700 kPa (light portable pump)	Wajax MK3 and MK 5 Wick 375
Low Pressure / Medium Volume	LP/MV	300 l/min at 200 kPa	Firemaster HP50, HP80 Waterous Floto STD Aqualite
Medium Pressure / Medium Volume	MP/MV	500 l/min at 500 kPa	Firemaster 10, 18 Waterous PB18 2515 Tohatsu V30 Millienium
High Pressure / High Volume	HP/HV	900 l/min at 700 kPa 1100-1500 l/min at 400 kPa	Firemaster 15, 20, 35 Waterous E603 Tohatsu V40

**Figure 2.1 - Pump types**

## Pump Components

The following are components of portable pumps:

- starter
  - manual or electric
- fuel types
  - 4 stroke, 2 stroke or diesel

**Note:** Each pump has different components. You will need to be able to identify and explain your agencies or organisations pump types.

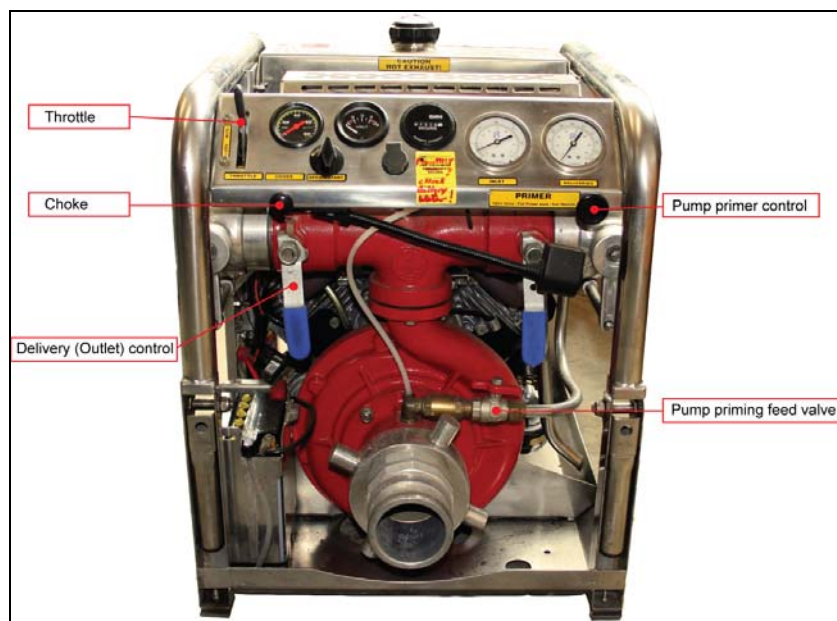


Figure 2.2 – Millenium (HP/HV)



Figure 2.3 – Pumps with gauges

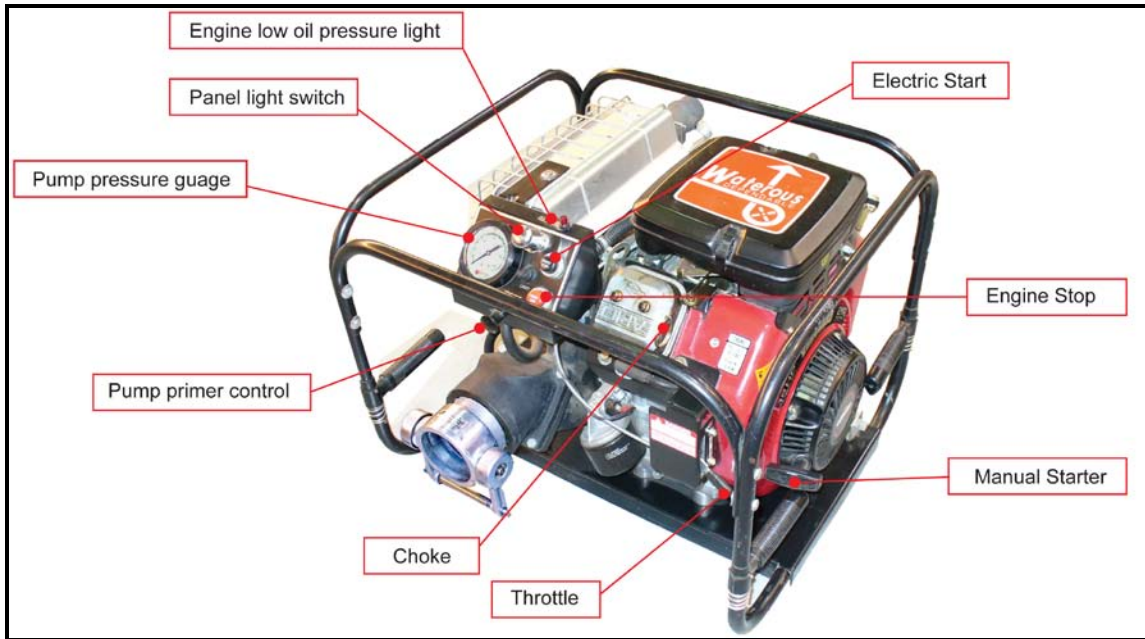


Figure 2.4 – Waterous (MP/MV)

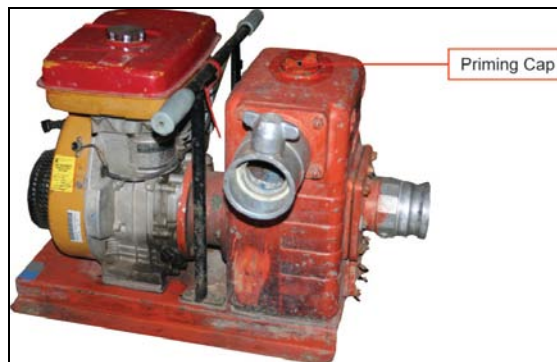


Figure 2.5 – Aqualite Pump



Figure 2.5a – Pump inlet



Figure 2.5b – Camlock suction hose 70 mm



Figure 2.6 – Screw thread



## Pump Specifications

NRFA Portable Pump Category	Minimum Capacity for NRFA Category	Max Pressure	Max Suction Lift	Inlet size & Type	Outlet size & Type	Fuel Type	Primer Type	Approx. Weight	Examples
High Pressure/ Low Volume (HPLV)	100 lts/min at 1700 kPa	2100 kPa	2 m	50 mm male Camlock	1 x 41 mm male screw (Forestry) thread	2- stroke	Hand primer or use of footvalve	35 - 40kg	Wajax
Low Pressure/ Medium Volume (LPMV)	300 lts/min at 200 kPa	350 - 450 kPa	4 m	75 mm male Camlock	1 x 70 mm female Instantaneous	4- stroke	Bucket fill	60 - 70kg	Aqualite Firemaster HP80
Medium Pressure/ Medium Volume (MP/MV)	500 lts/min at 500 kPa	700 - 800 kPa	6 m	75 mm male Camlock or 100 mm	1 x 70 mm female Instantaneous	2- stroke and 4- stroke	Mechanical primer	80 - 100kg	Millenium Waterous PB18
High Pressure / High Volume (HPHV)	900 lts/min at 700 kPa	1000 - 1100 kPa	8 m	100 mm male Round Thread	2 x 70 mm female Instantaneous	2- stroke and 4- stroke	Mechanical primer	120 - 135kg	Angus 1200 Firemaster 20

Figure 2.7 – Pump Specifications

This table is a general summary of the various portable fire pumps. Check your pump operator manual for specific details.



Figure 2.8 – HPHV Kit

## Routine Maintenance and Testing

A typical maintenance regime consists of checking the following:

- fuel level
- crank case oil level
- that all switches are off
- that valves operate freely and are set for priming
- that the pump is correctly stowed with its suction hose and strainer
- that intakes and strainers are clear
- the condition of the suction hose and strainer

Regular checks have been conducted:

- carrying out an inspection (monthly)
- the pump should be test run regularly (minimum 3 monthly)
- if pump is being used in salt water the pump will need to run from clean water for at least 20 minutes. Salt water is corrosive.
- ensure correct fuel type for portable pump engine
- annually, or if a fault is detected, servicing is to be carried out to the manufacturer's specifications by an approved service technician. (NRFA standard requirement)

**Note:** The frequency of testing will be specific to your agency or organisation.

Check the manufacturer's instructions regarding maintenance for specific portable pumps.

## Summary

- **Portable pumps** are independent pumping units that can be carried by one or several firefighters.
- Portable pumps have **lower outputs** than appliance-mounted-and-driven pumps.
- **Suction hose** for portable pumps is usually in a single length and fitted with a strainer and float (optional).
- Not all portable pumps have **gauges**.

## Section 3: Set up Portable Pumps

### Types of Water Supplies

**Types of Water Supplies**     Firefighting water supplies come in three basic groups:

- static water supply
- pressurised water supply
- mobile water supply.

**Static Water Supply**     Static water supplies can include:

- lakes
- rivers and streams
- ponds
- dams (fixed or portable)
- the sea
- swimming pools
- wells.

**Pressurised Water Supplies**     Pressurised water supplies are those in which water is distributed under pressure for example:

- urban water mains (reticulated supply)
- pressure fed from another pump
- gravity feed from an elevated tank.

**Mobile Water Supplies**     Mobile supplies are those by which water is transported to the fire ground from a distant source, for example:

- tankers
- fire appliances.

**Limited Water Supplies**     Limited water supplies often include:

- tanks
- wells
- portable dams
- natural and manmade dams
- swimming pools.

A limited supply must be used sparingly. If the supply is insufficient, water

may need to be brought to the fire ground, or dry firefighting techniques may need to be used.

### Portable Dams

Portable dams can be purpose-built or improvised, and they can be used for a number of purposes:

- to hold a water supply delivered by tanker
- as part of an open relay
- as large 'Dipping Dams' for filling helicopter buckets
- for the mixing of additives with water.

### Unlimited Water Supplies

An unlimited water supply has either a volume or a flow that is far in excess of your requirements, for example:

- the sea
- rivers
- lakes.

## Suitability of Water Supply

Pre-planning	Pre-planning identifies suitable water supplies in advance of an incident. This reduces the time and effort required to locate and establish a water supply when required.
Hidden Water Supplies	<p>Water supplies are not always apparent. They can be:</p> <ul style="list-style-type: none"> <li>• hidden from view behind or under vegetation</li> <li>• too low a flow to be useful.</li> </ul> <p>Hidden water supplies can be assessed and recorded as part of pre-planning.</p>
Access	<p>Access to a water supply can limit its usefulness. Potential solutions can include:</p> <ul style="list-style-type: none"> <li>• cutting an access track through vegetation</li> <li>• clearing and/or flattening out a space for a portable pump.</li> </ul>

## Assessment of Water Supply

	Not all water sources are suitable for firefighting use. You need to be able to assess a supply and decide upon its suitability for firefighting.
Location	<p>When assessing a water source for firefighting purposes, consider the following:</p> <ul style="list-style-type: none"> <li>• is it adjacent to the fire area?</li> <li>• will the location be threatened by the fire or smoke?</li> <li>• are there adequate communications at this point?</li> <li>• is there a safe escape route?</li> <li>• has a safety zone been identified?</li> </ul>
Access	<p>When assessing the accessibility of a water source for firefighting purposes, consider the following:</p> <ul style="list-style-type: none"> <li>• what type of pump will be used (portable, trailer or vehicle mounted)?</li> <li>• how close to the water can the pump be located?</li> <li>• is there firm ground on which to place the pump or park the appliance?</li> <li>• can the pump be safely carried or driven to the pump site?</li> <li>• is the site tidal or does the water level rise and fall (eg hydro-power</li> </ul>

rivers or irrigation canals) during the day?

- what are the requirements of the pump/s being used?

## Quality

When assessing the quality of water available for firefighting purposes, consider the following:

- fresh water is better than stagnant water
- clear water is better than muddy water
- is it weedy or does it have floating debris?
- hard ground is better than soft ground
- when the pond level is lowered, will you be left with only mud?
- sea water is corrosive and hard on equipment.

## Quantity

When assessing the quantity of water available for firefighting purposes, consider the following:

- how much is there? how much will you need?
- is it a limited or unlimited supply?
- is there an in-flow of water to top up the supply?

## Depth and Flow

Suction hose in shallow water will tend to create a vortex (whirlpool) that allows air to be drawn into the pump. Air in the water entering the pump can:

- reduce performance
- cause the pump to lose its prime.

## Estimation of Volume

To calculate the capacity of a rectangular swimming pool or tank:

$$\text{Capacity (in litres)} = \text{length (m)} \times \text{breadth (m)} \times \text{depth (m)} \times 1000$$

If the container has an uneven depth, the average depth in the calculation is used:

$$\text{Capacity (in litres)} = \text{length (m)} \times \text{breadth (m)} \times \text{average depth (m)} \times 1000$$

For example:

A pond is approximately 5 metres by 10 metres and varies from 1 to 3 metres deep.

$$\text{Capacity (in litres)} = 5 \text{ (length)} \times 10 \text{ (breadth)} \times 2 \text{ (average depth)} \times 1000 = 100,000 \text{ litres}$$

Your estimations will have to take into account the practicalities of how much water you can actually use. You may not be able to use the bottom 300 mm of depth due to debris at the bottom of the pond or other limitations due to hose length etc. The section on improving water supplies deals with some of the possible limitations on supply and ways to counter them.

## Usage Rate

The usage rate is the volume of water that is used in a given period of time. By estimating the usage rate, you can estimate:

- how long a limited supply will last
- whether you can supply water fast enough to satisfy demand.

To estimate the usage rate, you need to know:

- how many pumps will be used
- the approximate output capacities of each pump.

To find the usage rate of one or more pumps, add the output capacities of all the pumps using the same supply.

For example:

1 × medium volume pump @ (900 litres per minute) 54,000 litres per hour and

2 × Wajax pumps @ (150 litres per minute) 9000 litres per hour, per pump.

$54,000 + 9000 + 9000 = 72,000$  litres per hour

## Duration Estimation

To estimate how long you will be able to supply water from a fixed supply, divide the capacity of the supply by the usage rate.

For example using an Aqualite pump in a 50,000 litre swimming pool:

$$\frac{50,000 \text{ litres}}{900 \text{ litres per minute}} = \text{approximately } 55 \text{ minutes}$$

Water supply	Volume	Pump	Pump output	Duration of supply (approx)
Large pond	50,000 lt	Aqualite	900 lt/min	55 mins
Large pond	50,000 lt	Wajax	150 lt/min	5 hrs 30 mins
Portable dam	2,000 lt	Wajax	150 lt/min	13 mins
Fire appliance	2,000-3,600 lt	Wajax	150 lt/min	24 mins
Fire appliance	3,600 lt	Darley or other PTO pump	1320 lt/min	3 mins

Figure 3.1 – Examples of duration of various supply and pump combinations



## Loose Material

Mud, silt, vegetation, stones and rubbish in the water supply can block the strainer on the suction hose, reducing the volume the pump can deliver.

There are ready-made suction trays and any number of improvisations that can minimise this problem.

**Note:** Place the suction hose in water with a depth of at least three times the diameter of the strainer to prevent a vortex forming.

## Selecting the Site

When you are considering your requirements and selection of the site you need to consider:

- access to the site for both pumps and people
- portable pump should be positioned on a flat, firm surface in an accessible place. A floating pump may need to be tethered. Hoses may need to be protected from chafing by pump vibrations.
- suction lift
- firm ground
- site drainage
- hazards including loose material uphill, passing traffic
- quality and quantity of water
- airflows (fumes and smoke)
- danger from fire.

## Safety and Hazards

When handling portable pumps, it is important to employ correct lifting techniques.

### **Always:**

- Use correct **lifting and carrying techniques** when handling portable pumps.
- size-up load and get help if necessary
- hold the pump firmly, keeping your arms close to your body
- keep your backs straight
- avoid twisting when lifting

- lift using your leg muscles, not your back muscles
- ensure that there are enough people for the task
- keep the load level and balanced.

**Other hazards include:**

1. **Exhaust fumes**  
Operate these pumps only in well-ventilated areas.
2. **Hot exhausts**  
Ensure that safety guards are adequate. Wet down the surrounding area or remove vegetation that is at risk of igniting and place out fire extinguishers.
3. **Fuel spillages**  
Make spillages safe: follow the procedures for refuelling hot engines.
4. **Engine seizure**  
Ensure that the pump is kept level when operating on an incline in order to maintain oil feed to the engine.
5. **Excessive noise**  
Ensure that adequate hearing protection (Class 4 earmuffs) is worn when you are operating portable pumps.
6. **Drowning**  
Take care near deep water sources.
7. **Hose burst**  
Take care when closing the delivery valve on a second or later pump in a closed relay line, as this may cause an over pressure in the pump and inlet fittings.

## Section 4: Operate Portable Pumps

### Operating a Portable Pump

#### Pump Kit

Ensure that you have all of the equipment required to operate the pump before you commence setting up to operate. A pump kit may include:



Figure 4.1 – Pump Kits

#### Suction Hose

Rural fire authorities commonly use 75 mm camlock suction couplings for the medium size portable pumps and 100 mm round thread for the large portable pumps. The NZFS has standardised on 100 mm suction hose for both medium and large portable pumps. Suction hoses are manufactured of either flexible wire bound composite hose (50 mm and 75 mm diameter) or the more rigid rubber compound (100 mm diameter). They are used to get water from a static water supply, such as a dam, pool, or river to portable pumps.



Figure 4.2 – 75 mm and 50 mm camlock with wire bound composite suction hose



Figure 4.3 –75 mm camlock coupling with strainer



Figure 4.4 –75 mm camlock to 100 mm round thread adaptor for pump inlet

### 100 mm Round Thread

They are connected with screw couplings. These couplings must be tightened with a suction hose spanner.

You will need two fire fighters to connect suction hoses together.



Figure 4.5 – Hand tighten suction hose couplings

Tighten the joints further using suction hose spanners. Tighten by turning the spanners clockwise.



Figure 4.6 –Tighten with spanners

Connect the suction hose to pump



Figure 4.7 –Connect to pump

Use a rope to support suction hose when lowering to water supply.



Figure 4.8– Supporting the suction hose

Tie off the suction hose by tying a clove hitch around the suction hose. This is to support the weight on the couplings. Creating a bend in the suction hose takes the weight of the hose when it is full of water, and takes the strain off the couplings.

Tie each set of couplings to the next set using a half hitch. Make sure you tie the knots around the strainer side of the suction hose.



Figure 4.9 –Tying off suction hose

## Priming

‘Prime’ refers to having the suction hose and pump case full of water. If they are not, the pump will not move water.

The pump will not pump water if there is air in the suction system. You must remove air from the intake side of the pump.

Light portable pumps are primed by a number of different methods.

There are two main forms of priming are:

1. Mechanical primer (exhaust, rotary)
2. Manual primer (diaphragm).

Each pump is primed differently and during your training you will be shown how to prime your organisations’ pumps.



Figure 4.10 –hand operated primer

## Issues with Priming

If the pump will not prime or loses prime check for:

- suction strainer not fully in water
- damaged / missing suction washers
- loose connections above water or hole in suction
- delivery valve open
- sharp bend in suction hose e.g. over bridge parapet
- blocked strainers
- faulty foot valve (if fitted)
- damaged suction hose
- water level dropped
- water too hot for drafting
- pump drain not closed.

## Emergency Priming

In practice emergency priming is extremely difficult to achieve. The best option is to replace the pump. If a trainer wishes to demonstrate a technique this is at the discretion of the trainer.

## Starting the Engine

You need to be able to start and operate your agency or organisations portable pump.

You need to be able to start each pump from a **cold** start or **hot** start.

### Guidelines

Do not run the pump if it is not fully primed.

Keep the pump as close to the water as possible.

Keep the suction hose as short as possible.

Keep all connections clean.

Keep all connections tight - use suction spanners to tighten connections.

Keep suction strainer clear of debris.

Keep pump strainer clean of debris.

Operate portable pump in a well ventilated area; take appropriate precautions to guard against the hazards created by hot exhausts and during refuelling.

Do not pump silty water.

## Engine Troubleshooting

### Troubleshooting Tips

If the engine fails to start or is not running properly, check the following:

1. Ignition switch, set to ON.
2. Fuel tap, turned to ON.
3. Fuel tank vent, set to OPEN.
4. Fuel level, tank full.
5. Choke - closed for cold starting or flooding, open for hot starting.
6. Air intake, clean and unobstructed.
7. Spark plug, is it clean?
8. Is the engine flooded?

### Engine Flooded

Repeated attempts to start an engine can cause excess fuel to 'flood' the engine. Different engines have different procedures for dealing with flooding.



### Safety Note:

If a fuel tap is fitted this should be turned off when the pump is stored on appliance or depot.



## Pumps with Gauges

Some pumps have gauges. These can be used for fault finding when using a pump. The most common gauges on pumps are compound gauges and pressure gauges.



Figure 4.11 – Example of Gauges

## Fault Finding using Gauges

The compound gauge shows an increase in vacuum. The pressure gauge will show a decrease in pressure.

An **increase in vacuum and/or a decrease in pressure** might be a result of:

- drop in water supply level
- blocked suction strainer
- blocked strainer
- suction strainer sinking in to mud
- burst delivery hose
- suction hose internally collapsing.

A **decrease in vacuum and/or a increase in pressure** might be a result of :

- rising water supply level
- loose suction couplings above the water
- open primer valve
- loose/open drain plug
- pin holes in suction.

A **sudden increase in pressure** could be caused by:

- a closed nozzle
- a badly kinked hose.

Engine revs constant but a **sudden decrease in pressure** could be caused by:

- an opened nozzle
- a burst delivery hose.

When a pump operator is attempting to deliver more water than is available this will show on the gauge as fluctuating pressure. This could result in a seriously damaged pump.

## Refuelling

### Before Refuelling

Stopping the pump to refuel needs to be carefully managed to minimise the disruption to the firefighters you are supplying with water.

To make the refuelling stoppage as short as possible, do the following:

1. Ensure you have enough fuel of the correct type. Check that the fuel container and its' label have the same colour code.
2. Notify the nozzle operator.
3. Ensure everyone relying on the hose lines you control has backed off to safe positions.
4. Close down the hose line supply.
5. Stop the engine.

### During Refuelling

1. Avoid spilling fuel by using a funnel and pour slowly.
2. In calm conditions, wait for a minute after refuelling to allow fuel fumes to clear.
3. Check the state of the soap capsules in the hydroblender, or foam supply.



### Safety Note:

Care must be taken while refuelling as the pump is hot and could cause a fire.

## Relay Pumping

### Water Relay

The provision of water at a fire where nearby water supplies are either inadequate or non-existent is at times a difficult operation and one that must be carried out with the equipment available at the time.

Where such situations arise, it will be necessary to implement a water relay. A water relay comprises a number of pumps spaced at intervals along the route between the water source and the point where the water is required. Each pump in the relay receives water and passes it along the next pump until the desired delivery is achieved. The additional pumps are, in such circumstances, referred to as relay pumps.

Largest capacity pump at the water source and then the spacing of the respective pumps will depend upon the capability of each individual pump, the task it has to perform and the terrain over which its performance is required.

There are two water relays in general use:

- the closed relay
- the open relay.

### Relay Types

A pump can be introduced into a relay system either by:

- using a relay adaptor, known as a closed relay or pressure-fed system
- using a portable dam/s, known as an open relay or static system.

### Reasons for Relay Pumping

If the distance or height over which water must be delivered is too great, a relay pumping system will be required.

### Closed Relay Pumping

In a closed relay, water is pumped by the first or base pump from the water source, which maybe a tank, hydrant or open water source through hose lines connected directly to the inlet of the second or booster pump. The second pump in turn may be connected to a third and subsequent pump until the final destinations is reached.

Connecting the delivery hose from one pump directly to the inlet of the next pump using a relay adaptor is called a closed relay system.

Each pump in the relay boosts the pressure, making up for the losses from friction and pumping uphill, to ensure there is adequate pressure at the nozzle.



Figure 4.13 – Relay Adaptor



Figure 4.12 – Pump in a closed relay being fed via a relay

#### Advantages

The closed relay is generally considered to be more suitable than the open relay for several reasons.

- there is economy in the equipment used.
- there is greater speed in setting up the system.

Closed relay results in a continuous flow of water from the base pump to the final discharge pump.

#### Disadvantages

To be fully effective, the closed relay demands a higher standard of pump operation than normal. The operator must carefully watch pump gauges, pump speed, and the hose lines supplying the pump, for fluctuations in the supply. Where the pumps have no gauges, the operator must rely on continually observing the hose line supplying the pump.

The term ‘soft suction’ refers to the process where water is supplied to a pump by a conventional ‘soft’ delivery hose as opposed to a ‘hard’ suction hose.

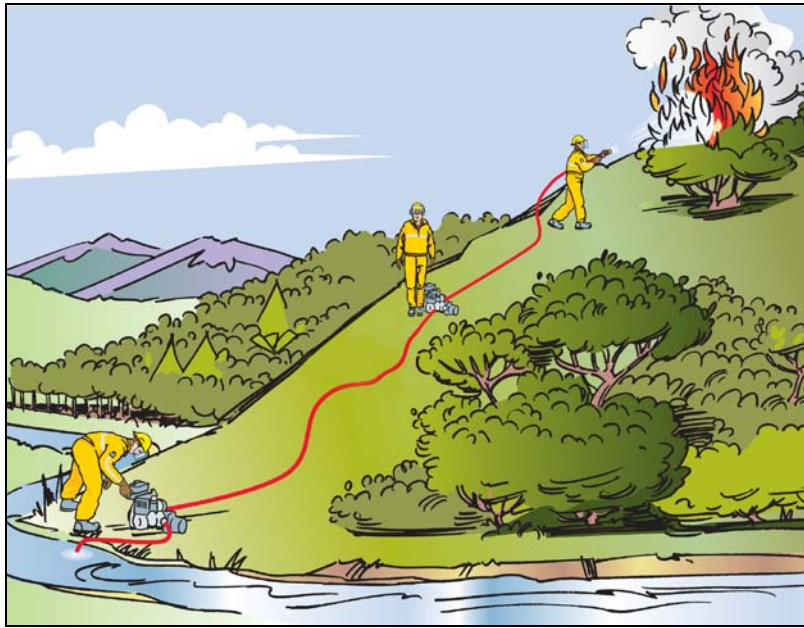


Figure 4.14 – Closed Relay

Delivery hoses are designed to resist internal pressure. If the supply cannot meet the demands of the relay pump there will be a tendency for the relay pump to draw more water from the line than the volume available. In such circumstances, the reduction in volume will collapse the hose.

Another disadvantage of the closed relay is that any problems with any unit in the system will affect the whole system. If the base pump fails it will result in a break in the water supply. However, if any other pump in a closed relay fails water will continue to flow although at a lower flow and pressure.



### Safety Note

When engaged in a closed relay pump operators must watch for any changes in the incoming hose line. When you see this the pump speed must be reduced until the incoming hose is firm again.

Failure to see changes in the incoming hose will result in total collapse of the hose line and a total cutting off of the water supply.

Open Relay Pumping

Delivering water from the first pump into a portable dam and taking water from the dam via the suction hose from the next pump is called an open system.

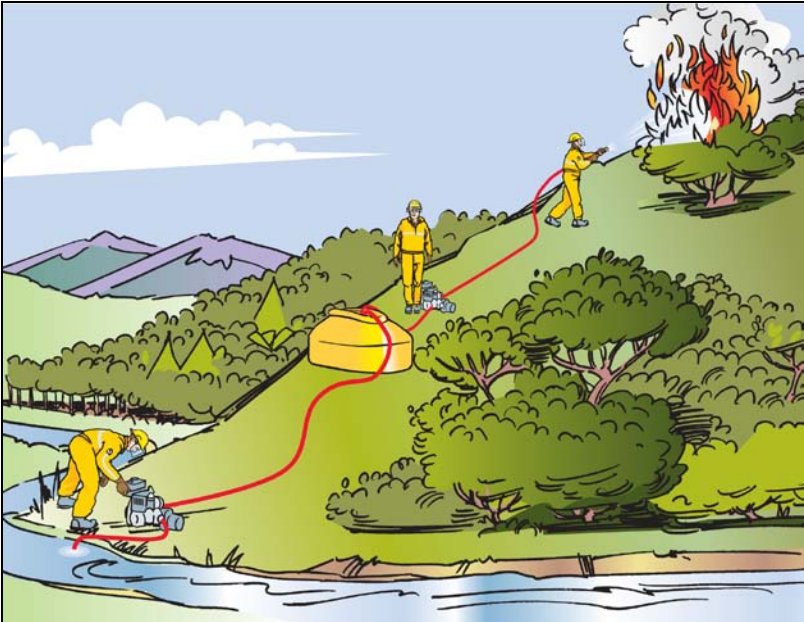


Figure 4.15 – Open Relay



Figure 4.16– Portable dam used as part of an open relay

With open relay the base pump takes water from a source and pumps it through hose lines into some form of reservoir. The second pump then draws water from this reservoir through its suction hose and delivers it through delivery hose to subsequent reservoirs and pumps until the final destination is reached.

#### **Advantages**

The open relay system offers the advantage that several pumps can draw their supply of water from any one reservoir provided that the supply to the reservoir is adequate. If any one of the pumping units requires replacement or supplementing, it can be achieved without interrupting the water supply.

No special skill is required of the pump operator as each portable pump operates under what could be described as normal operating conditions with each operator able to monitor the water level of the reservoir from which their pump is supplied.

#### **Disadvantages**

The main disadvantage with the open relay is the need to transport or construct the reservoir for each relay pump. This may also affect the available manpower. If any pump fails then the relay stops until remedy action is taken.

## Relay Pumping Tips

A relay pumping system is put in place when a single pump cannot supply sufficient water at sufficient pressure to the firefighters who require it. To maximise the performance of a relay:

- use lined hose (non-percolating) for water delivery over long distances, as lined hose produces less friction loss and provides more water
- use percolating hose where there is a risk of embers burning hose
- if using a mixture of hose to run the required distance, always use the largest diameter hose at the beginning of the system, using progressively smaller hose as it approaches the fire ground
- use the highest performance pump available at the water supply and use progressively smaller pumps as the hose line progresses
- if using a hydroblender, always move it to the last pump in a relay. This will avoid cavitations in the pumps from capsules emulsifying.

Class A foam proportioner may remain at the first pump as the foam solution, in a relay, will only foam on contact with air at the nozzle.

### Connecting Relay Adaptor

The following instructions are designed to get a relay adaptor connected quickly and with minimal disruption to the pumping operation.

1. Call for water off from the base pump.
2. Disconnect the hose line at the appropriate point.
3. Place relay pump in position.
4. Connect the relay adaptor to the pump inlet.
5. Connect delivery hose from the last pump in the system to relay adaptor.
6. Connect the hose line to the dividing breeching on the outlet side of the relay pump.
7. Call for water on from the base pump at full speed.
8. Start the relay pump when water arrives.

Adjust the engine speed of your pump to suit the pressure of water coming into the inlet, feel and observe the inlet hose:

- if the hose is hard, increase engine speed
- if the hose collapses, reduce engine speed
- at the correct engine speed, the hose will be just firm.

If the inlet hose is still collapsed at low engine speeds, check the water supply from the pumps below you in the system.



**Setting up Portable Dam** These instructions are designed to get a portable dam established and connected quickly, and with minimal disruption to the pumping operation.

- set up a portable dam in an appropriate position and next to a set of hose couplings in the hose line.
- disconnect the hose line.
- start filling the dam.
- place the pump in position and set it up with a suction hose as for an open water supply.
- wait until there is enough water in the dam to establish prime and maintain the required flow.
- start and run the pump.
- monitor the level of water in the dam and prevent the pump running dry.
- maintain communication with the base pump operator to control the water coming into the dam.

## Relay Capacity

When organising a relay, the aim is to deliver the maximum quantity of water according to the capacity of the available pumps and to use the minimum amount of equipment. This can only be achieved by utilising the full capacity of the pumps and maintaining the correct spacing between them.

With pumps of different capacity the pump with the lowest capacity should be at the end of the relay.

The best volume performance obtained from a pump when pumping through open ended hose may be only at half to three quarter throttle when pumping across flat ground. Pumping uphill will require an increase in pump throttle.

## Pressure energy

Pressure energy in a water relay circuit is expended in two ways:

- in overcoming the static head or height, against which the water has to be delivered
- in overcoming the friction loss in the hose through which the water has to pass.

In circumstances where the relay is crossing reasonably level ground any difference in level between the pumps positions in the relay may be estimated reasonable accurately and the distance between pumps determined.

The rule of thumb for how many lengths of hose you can have between two medium size pumps in a relay is:

- flat ground = 8 lengths (70 mm)
- steep terrain = 4 lengths (70 mm)

### Steep terrain

If steep terrain limits your choices for pump sites, place the pump lower in the system rather than higher.

When this occurs the static head will be of relatively little importance and the distance between pumps will depend primarily on frictional loss in the hose.

All hose is limited in the quantity of water that it can successfully carry. Above this hose limit frictional losses become excessive and operators must either increase hose diameter or increase the number of hose lines.

### Pump pressure

Pump pressure increases are only possible when the pump is operating below its designed maximum output. Any increase above the maximum output will result in a reduced flow.

## Fault Finding

### Problem Solving in the Field

There are many reasons that a pump may perform poorly or fail during operations. The following table identifies some common problems and solutions.

<b>Problem</b>	<b>Fault</b>	<b>Possible Solutions</b>
<b>Failure to prime, or prime lost</b>	Pump not primed correctly	Repeat priming to ensure the suction hose and pump case are full to overflowing.
	Air leaking into suction	Check that couplings are tight and undamaged.
		Check rubber washers in couplings to ensure they are in place and undamaged.
	Air entering via vortex	Increase the depth of the suction strainer – dig a hole or dam flow if necessary.
		Place flat object, e.g. the blade of a shovel, over the suction strainer.
<b>Poor pump output</b>	Blocked suction strainer or foot valve	Clean debris off strainer.
		Add a basket strainer to limit debris build-up.
		Place suction tray or blade of shovel under strainer.
	Water level dropping, increasing loss to suction lift	Reduce height of suction lift by moving pump closer to water level.
		Increase flow into a portable dam to maintain water level.
<b>Cavitation</b>	Pump running faster than available water available can support	Reduce throttle setting, and consider ways to improve the supply.

## Communication

When portable radios are not available when using portable pump using clear, commonly understood hand signals are less likely to be misunderstood than shouted instructions or improvised signals.

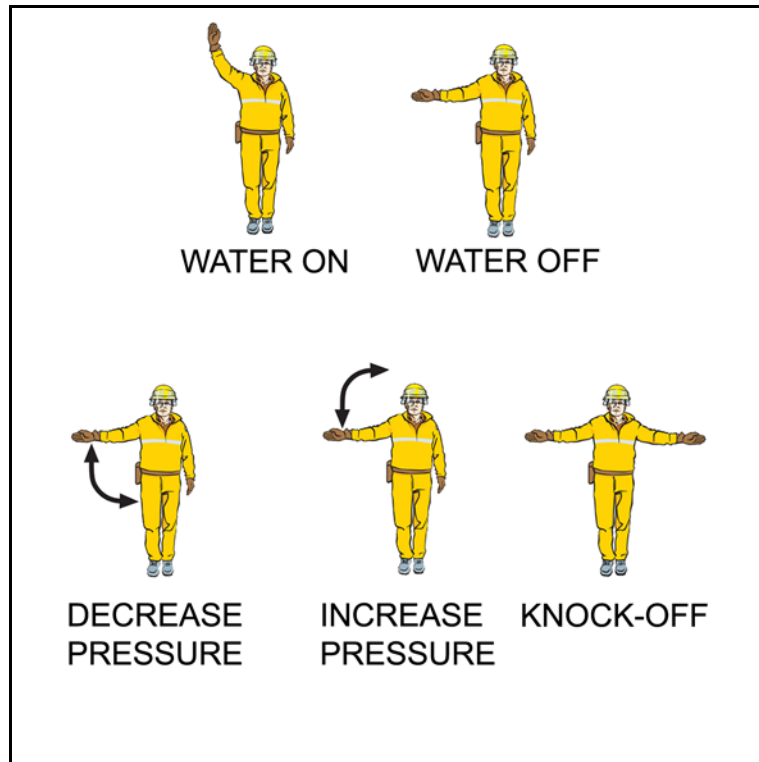


Figure 4.17 – Hand signals for hose lines

### Runners (Messengers)

When hand signals and portable radios cannot be used, messages can be sent by runner:

- a verbal message relying on the memory of the runner is sufficient for brief messages
- a written message will be necessary for messages that are too long or complex to be reliably held in memory, for example messages between crew leader and incident controller.

## Personal Safety

The minimum personal protection equipment includes;

1. Basic firefighting kit (boots, fire overalls, helmet)
2. Hearing protection.
3. Gloves.



## Section 5: Recommissioning and Site Restoration

### Retrieving and Recommissioning Equipment

#### Retrieving Equipment

If different organisations have provided equipment, you need to sort and return it to the correct organisation. It's easy to overlook some items of equipment and leave them behind.

Endeavour to retrieve equipment without causing damage to it or to the environment:

- do not drag equipment along the ground, as this may cause damage.
- if you have been using foam, soap capsules or retardants, don't flush the equipment into a waterway.
- take care when using vehicles to pick up equipment.
- see 'Water supply quality' section regarding Didymo.

#### Recommissioning

Recommissioning equipment ensures it remains in a serviceable and ready state. All equipment must be recommissioned before storing it. This is part of the role. Don't leave this task to someone else.

Recommissioning equipment includes checking and servicing to ensure that:

- all items are accounted for (use the check list/s)
- all items are in full working order (damaged items have been tagged and replaced)
- pumps have been flushed with clean fresh water and refuelled
- where used in salt or brackish water the suction hose needs to be flushed (internal wire binding in suction hose will corrode if not flushed)
- used hose is replaced as required (some hose types will require drying and repacking at a later time, while others can be rolled and re-stowed immediately after use)
- all equipment is re-stowed on vehicles as it usually is (or as close to as possible) on the assumption that it will be required again at short notice.

Even if it is not your equipment, if you have used it, then you are responsible for recommissioning it.

#### Labelling of Hoses and Pumps

You are more likely to have your equipment returned to you (and sooner) if you make sure it is clearly identified.

## Maintaining After Use

Maintenance consists of checks, inspections, tests, and servicing and should be managed in accordance to you agency or organisations maintenance plan.

### Check that the Pump Kit is Complete

With the aim of maintaining your equipment in a ready state:

- check the contents of the pump kit against the inventory
- check for damage to any part of the pump kit.

### Check that the Pump is in Working Condition

More than just checking the contents of the pump kit, the pump must also be proven to be in working order:

- perform a general visual check of the pump, looking for defects
- check the motor controls to see that they function correctly
- check the pump strainer and fittings
- check the suction hose couplings to ensure that they operate correctly and that the seals are in place and in good condition
- test run the pump.

At the end of the test running of two-stroke engines, turn the fuel tap off to run the carburettor out of fuel.

### Clean and Refuel

Cleaning the pump will prevent damage:

- if the pump has been used in brackish or contaminated water, flush the pump by pumping clean water through it
- drain the pump
- clean the top of the fuel tank and spare fuel container
- check engine and primer oil levels (where appropriate)
- wipe down the pump.

### Log Books and other Documentation

Complete a log book with the hours the pump has been used, the type of use and ensure that the book is signed. There also may be checklists for pump accessories that need to be completed.

**Store Correctly Ready for Use**

Once the pump and kit is tested and cleaned, it must be stored in a secure manner so that it can be transported and unloaded safely and effectively the next time it is needed.

To do this:

- store securely if kept on a vehicle
- for a long period of storage, use a fuel additive.

If a pump is stored for more than six months, the fuel will have to be replaced before use. The use of a fuel stabilizer is recommended.

## Restoring the Site

**Limiting your Impact**

When restoring a site you should:

- clean up damage to waterways and water points
- consult with the landowner over any damage. Sometimes damage to a scene may not be repairable.

You will avoid issues by being proactive and taking some basic precautions.

**Restoration**

Restoration of the site used during operations is an important part of your role. Failure to make reasonable attempts to restore a site may generate ill feeling with landowners.

Restoration involves returning the site, as far as possible, to its original condition.

Restoration can involve any or all of the following:

- notifying the landowner of the activities
- removing everything that was brought in
- cleaning up as required
- reinstating the area to its previous state
- advising the fire authority should refilling of the reservoir be required.

## Water Supply Quality

**Sea Water**

Sea water can be used but care needs to be taken near property, crops and in or near sensitive wetlands or reserves. This is due to the salinity of sea water potential killing plant life and invertebrates as well as changing the ph of soils and waterways that are dependent on fairly close (stable) tolerance in their environments.

Care is needed in flushing firefighting equipment with clean fresh water after operations due to sea waters corrosiveness.



<b>Contaminated water</b>	<p>Bacteria can be inhaled, ingested or enter even through the tear ducts in eyes.</p> <p>PPE commonly worn by Rural Firefighters is very insufficient for protecting these pathways especially given the fine water particle size generated by mist sprays and aerial drops. Examples of contaminated water includes:</p> <ul style="list-style-type: none"> <li>• settling ponds from timber treatment plants</li> <li>• water from diary farms</li> <li>• gravel extraction works</li> </ul> <p>Note: Didymo- this is any river, stream or creek – follow Biosecurity NZ or Department of Conservation protocols.</p>
<b>Decontamination recommendations</b>	<p>A staging area is required to hold and isolate and decontaminate equipment and personnel.</p> <p>PPE should be washed in a hot wash cycle with detergent</p> <p>Firefighters exposed to contaminated water should shower immediately following exposure using soap/shampoo.</p> <p>After using pumps and other equipment in contaminated water supplies i.e. didymo or setting ponds these need to be cleaned as explained below.</p>
<b>Vehicles</b>	<p>Vehicles should be cleaned thoroughly with a decontamination solution. Including spraying the underside of the vehicle that have had contact with river or lake water.</p>
<b>Tyres</b>	<p>Tyres which have been backed into streams or used for stream crossing must be carefully checked for clumps of algae and other debris within the treads and then scrubbed, soaked or sprayed and flushed with a cleaning solution for the required treatment times</p>
<b>Machinery</b>	<p>Machinery (e.g. pumps, hoses, tanks spray units) should be scrubbed soaked, sprayed or flushed with a decontamination solution,. Ensuring that there is a contact time of a t least one minute,</p> <p>Equipment may then be rinsed using water that has come from a town water supply.</p> <p>Drying is an acceptable alternative method, provided that all components are completely dry to the touch, inside and out, and then left dry for at least another 48 hours before entering a different waterway. Give particular attention to components where water might pool, such as sections of pipes and inside tanks and spillage trays.</p> <p>If you do not want to decontaminate your gear, you should restrict use to a single waterway.</p> <p>Further information can be found on the website:  <b><a href="http://www.biosecurity.govt.nz/didymo">www.biosecurity.govt.nz/didymo</a></b></p>