11 EMERGENCY REPAIRS (Damage Control)

Overview

The primary objective of search and rescue is to preserve life not property, however saving property (which in Coastguards case is almost invariably a vessel of some description) sometimes goes hand in hand with preserving life. Towing can often be part of a SAROP (Search & Rescue Operation) or a precautionary SAR (Good Samaritan) action, so too can temporary repairs to vessels. Coastguard crew will inevitably deal with situations on the water where the simple delivery of tools or assistance may forestall serious SAR action later.

Your own CRV is not immune to suffering damage, fire, or failure. Many aspects of this module apply as much to CRV crew in their own vessel as it does to assisting other vessels.

Maintenance – Prevention is better than Cure

In the case of a CRV (or any other vessel), the process of getting home safely begins even before the vessel has put to sea. Ensuring the vessel is well maintained, equipped with the essential emergency / repair tools, and the crew trained in their use is essential.

Every CRV must be subject to a comprehensive and regular maintenance programme. Crew must know the regular pre and post operation checks on the CRV, and the system for recording (and rectifying) faults, failures, or the suspicion of a potential problem.
The maintenance schedules for the CRV and procedures for reporting faults or potential faults should be detailed in the Units Standard Operating Procedures (SOPs), and / or the CRV's Safe Ship Management Manual. (See Module Legal Considerations)

Be prepared – the old adage of ***'if it can go wrong it will'*** is very true. Even with a sound maintenance programme any vessel can suffer unexpected equipment failure, and an essential part of training for just such a failure is recognising its potential in the first place (at sea a tendency to paranoia is not a bad thing).

Its essential that the crew of the CRV 'know the boat' - meaning that they are able to recognise **any** unusual noises, vibrations, smells, flickering or dimming lights, loss of propulsion, power, or steering.

Anything out of the ordinary should be investigated as this could be an indicator of a potential fault. Possible faults should be recorded in the vessels log or dedicated maintenance log and reported to the relevant Unit Officer.

As an example - the colour of the engine exhaust is a good indicator of general engine performance, and recognising the significance of different exhaust colour is the type of basic fault recognition that crew should be capable of.

It isn't required (or expected) that crew be able to identify or fix the actual engine fault, but they should be able to recognise that something is potentially wrong.

Grey to White Exhaust Smoke: Indicates that part of the fuel injected into the cylinders is not igniting. Possible causes include:

- Low compression.
- Broken rings.
- Valve leaking.
- Faulty injectors.
- Coolant leak into combustion chamber.

Black Exhaust Smoke: Indicates unburnt fuel (over-fuelling) or not enough air for combustion. Possible causes include:

- Faulty injector.
- Pump timing.
- Incorrect rack settings.
- Dirty / blocked air filter.
- Choke / cold start prime not disengaged.
- Excessive use of the throttle or overloaded engine.

Blue Exhaust Smoke: Indicates that the engine is burning lubricating oil. Possible causes include:

- Worn rings.
- Worn bores.
- Overfilled crankcase.
- Blocked breather.
- Excess oil getting into valve gear.

Operating manuals provide a wealth of information on the workings of equipment on board, spare parts required, and various troubleshooting procedures. Manuals (or copies of) should be kept onboard for ready reference.

Repair Equipment on Board

Lengthy tows tie up valuable resources. Being able to effect minor emergency repairs at sea can avoid towing unnecessarily. Often attempting the repair of another vessel is not practical or desirable, as the tools and spares necessary for the repair are not available. The repair itself may be potentially complex, time consuming, or beyond the experience of the CRV crew, and it would be easier to tow the vessel.

Unless the repair is very obvious and simple it would normally be best left for a professional to deal with - in many cases trying to affect a repair may invalidate the owner's warranty.

Under no circumstances should any repair be attempted without the Skippers' knowledge and agreement. (See Module Legal considerations)

The best way to approach the subject of what to carry is to concentrate on the repair equipment and tools for the CRV first, and then look at what additional gear might be of use for other vessels, given the remaining space available.

The following items could be found on board a CRV.

- A portable pump with suction and delivery hoses, for de-watering or fire fighting.
- Jumper leads or quick start pack.
- Spare filters belts and impellors for CRV engine(s) if applicable.
- A general tool kit containing such basics as;
    - Assorted screwdrivers.
    - Spanners.
    - Pliers.
    - Allen Keys.
    - Adjustable spanners.
    - Socket set(s) (principally of a size suitable for the CRV).
    - Vice Grips.
    - Assorted tapes – electrical, plumbers, duct etc, and cable (pull) ties.
    - Hacksaw & blades.
    - Repair kit / plugs for CRV sponsons and or hull.

Basic Engine Repairs

Engine Problems

Coastguard is commonly called to assist when a vessel's engine stops, will not restart, or has been stopped because it has developed a problem.

There can be many causes for any of these scenarios, and many of the causes will not be something that can be rectified at sea. Sometimes however fixing the problem can be a very simple and quick 'repair'.

The following is a list of the possible **simple** causes for a particular engine problem, and the sort of repair that coastguard crew might be able to help with. The same list is not dissimilar to the checks and possible repairs that Coastguard crews will be able to carry out on their own CRV.

In the first example of an Outboard motor that won't start, the causes of the problem could include a faulty starter motor, fuel pump, or faulty ignition switch / coil – not things you will be able to fix at sea. There could equally be some very simple reasons for the problem such as;

Outboard Motor – will not start

- Fuel tank empty.
- Fuel tank vent closed or restricted.
- Engine stop (kill cord) engaged or faulty.
- Fuel supply hose incorrectly fitted.
- Fuel supply hose crushed or kinked.
- Fuel supply hose has small hole / puncture.
- Fuel filter clogged.
- Spark plugs fouled.
- Spark plug leads interchanged.
- Battery undercharged (electric start).

Outboard Motor – starts, runs for a while then stops

- Fuel tank empty.
- Fuel tank vent closed or restricted.
- Engine stop engaged (kill cord).
- Fuel supply hose incorrectly fitted.
- Fuel supply hose crushed or kinked.
- Choke still on.

The list of simple checks and possible simple repairs (providing the vessels has the necessary spares in some cases) to an inboard motor are not dissimilar.

Inboard Motor – will not start

- Flat battery or poor connections between battery and engine (engine won't turn).
- Fuel tank empty.
- Fuel tank valve closed.
- Engine stop engaged.
- Air filter clogged (filter will need to be changed).
- Fuel filter clogged (filter will need to be changed).
- Air in the system (evidence of any leaks in the fuel system would indicate this possibility).

Both of the last two problems will entail bleeding the system to remove any air. As with any other repair, this is a procedure that should only be followed if the Coastguard crew involved are completely confident in their ability to do so.

On no account are injectors to be loosened if the engine has a common rail (high pressure) fuel system. Serious injuries and even fatalities have resulted attempted repairs to common rail systems. (Refer CBES Inboard Diesel Maintenance Course)

If you don't know the difference between common rail and in line injection systems – you probably don't have the experience and knowledge to confidently bleed the system.

Inboard Motor – overheats

- Air filter clogged (filter will need to be changed).
- Raw water filter clogged.
- Raw water sea cock shut or partially closed.
- Raw water pump impellor damaged.
- Raw water pump belt drive broken or loose.
- Engine oil / gearbox oil levels low.
- Coolant level low.

Always allow an overheated engine to cool before restarting.

General Safety Tips (fuel & electrical systems)

- If working on a fuel system keep a fire extinguisher handy.
- Do not start a motor if petrol fumes are present – ventilate the area thoroughly.
- Be extremely careful when checking fuel lines on a hot engine, especially around the carburettor – allow the engine to cool before working on the fuel system.
- Care is required when working around high-voltage areas such as the battery. Batteries when being charged produce Hydrogen gas which is highly explosive, and bridging the battery terminals will produce a spark.
- If necessary isolate the battery – Do not attempt to disconnect the battery, you are just as likely to create a spark removing terminals. If the system has no isolator, cover the terminals with a non conductive material to prevent arcing which will result if terminals are bridged by conductive materials (metal watch straps, tools etc can all 'arc' on battery terminals).

Jumper leads / start packs must be used with caution if the battery is located near fuel areas.

Whether using heavy jumper leads or a Start Pack, the same basic principles apply;

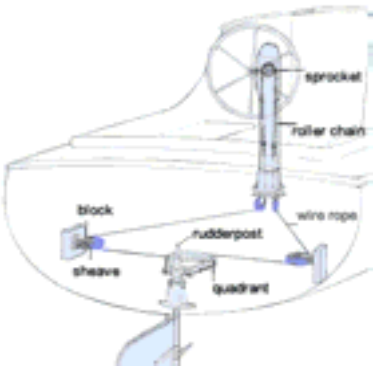
- Check for vapours, and ventilate area if possible.
- Check whether it is a 12 or 24 volt system.
- Connect leads to starter motor if possible – positive first.
- Or onto the battery terminals – positive first.
- Disconnect in the reverse order – negative first.

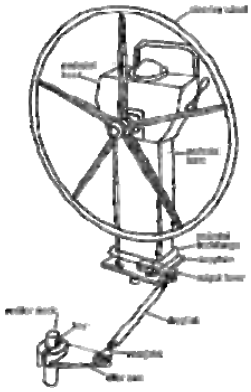
Steering Systems

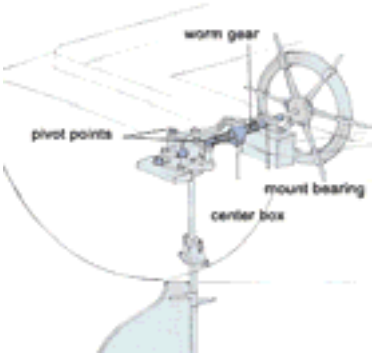
Mechanical systems

Many steering systems use mechanical linkages of wire, cable, chain or steel rod to transfer the motion of the vessels wheel to its rudder or drive unit. An actual breakage in any of these component parts is not something which a Coastguard crew are likely to be able to repair even temporarily.

What can sometimes happen is a simple disconnection of part of the steering system such as a nut & bolt that has worked loose. Many systems employing wire as a component part have rigging screws to tighten the wire. These can work loose allowing the wire to drop out of any pulley they are normally held in. These sorts of problems can often be repaired quickly and easily, so it's worth checking over the system for any obvious problems before engaging in a possibly lengthy tow.







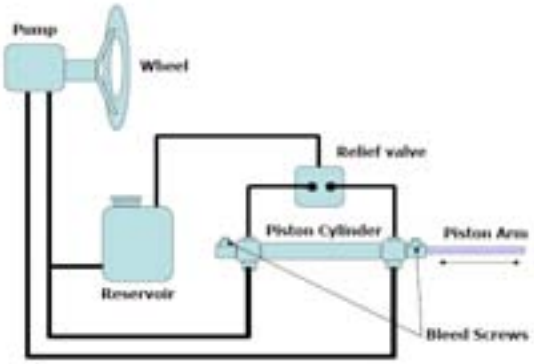
Hydraulic Systems

A complete failure of a hydraulic steering system such as a ruptured pipe or fractured fitting is unlikely to be repairable unless adequate spares and sufficient replacement fluid are available. Often hydraulic systems can suffer small leaks from corroded or even loose fittings (such as bleed screws) and these problems can be repaired - especially if it as simple as tightening a loose fitting.

Duct tape or similar may reduce a hydraulic leak temporarily, but is unlikely to completely stop the loss of fluid. Any fluid however will suffice as a replacement in an emergency (oil or water). Fresh water preferably as salt water it is corrosive, however once safely home, a full system flush, and replacement hydraulic fluid will be required anyway.

Most small boat hydraulic steering systems have a hydraulic reservoir, filler cap, and vent at or near the steering wheel which can be filled with a replacement fluid if necessary. If steering is a little 'spongy' this is an indication of air in the system.

Bleeding a hydraulic system to fully expel any air in the system may not be something that will be fully successful on another vessel while at sea, but for any Coastguard CRV that has hydraulic steering the crew should able to bleed their own system if necessary. The basic procedure is the same regardless of the actual system;



- Fill the hydraulic reservoir.
- Fit two lengths of clear plastic tubing to the bleed nipples on the piston cylinder, and place the free ends into containers with a little oil in them. Keep the ends of the tubes immersed in the oil to prevent air being sucked back into the cylinder.
- Turn the wheel slowly one way – oil (and hopefully air) will be vented from the bleed nipple at one end of the cylinder (keep topping up the reservoir). When no more air is vented, tighten the bleed screw, and repeat the process turning the wheel the other way while venting the other end of the cylinder.
- If the steering is still spongy repeat the process.

Many hydraulic systems (especially those that have two steering positions) have a bypass valve that when opened allow hydraulic fluid to circulate freely around the system, and hence have no effect on the rudder(s) or drive gear.

In the event of a seizure or breakage in another part of the system this by pass valve may need to be opened to allow the rudder / drive systems to move freely. This would be preferable to a steering system effectively jammed at an angle. With the rudder / drive system working freely an alternative method of controlling steering might be employed, such as emergency tiller (if the vessels has one) or the rudder(s) secured amidships by lashing / clamping the rudders stock, quadrant or rack.

Alternative Steering

If a vessels steering system is inoperable there may be alterative methods of steering that can be employed. In most cases this will be to assist in a tow back to shore, but they may on occasions be effective enough to allow a vessel to continue under its own power.

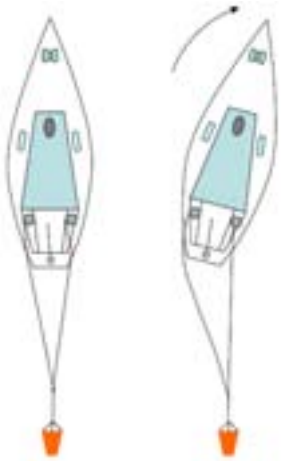
In a twin engine vessel varying the speed of the individual engines can be an effective method of steering the vessel (a method that is very relevant to a lot of Coastguard CRV's).

On small vessels an oar / paddle lashed to the stern of the vessel can made an effective makeshift rudder. It will need to be well secured as the forward motion of the vessel will naturally try to lift the 'rudder' upwards, but while secured allow enough lateral movement to be effective for steering.

For a vessel with working outboard motor(s) but broken steering system, lashing an oar / paddle, boat hook or similar to the outboard motor, can give enough leverage to become tiller and hence an alternative steering method.

With larger vessels where an oar or similar will not be sufficient, rigging an effective alternative steering method can be a difficult, complex, and time consuming problem.. Essentially what is required is sufficient drag to be employed on either side of the vessel to steer in a particular direction. The amount or angle of drag must also be adjustable - the speed and ease of that adjustment is the main problem to overcome. Often the only sensible solution is a tow unless the vessel has available a powerful winch or winches to help with the steering (as in the case with many sailing yachts).

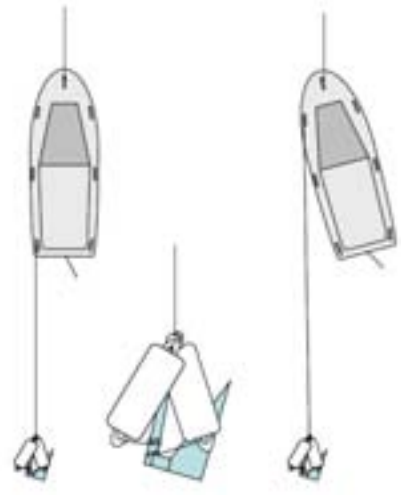
In the picture opposite the yacht has a drogue deployed on a bridle from its stern. Each end of the bridle is taken to one of its winches in the cockpit. By easing away on one end, and winching in on the other the drogue can be hauled from one side of the stern to the other. This uneven drag will help to steer the vessel in a particular direction.



The problem can arise however that the steering is not simply broken (in which case the rudder / drive systems can often be secured in a central / midships position), but that the steering is actually jammed at an angle. This may be due to damage incurred when hitting and object, or if a rope / fishing gear has become entangled in the rudder.

To tow a vessel in such a condition it may be necessary to induce drag on one side of the vessel to counteract its tendency to steer in one particular direction.

Trailing a drogue, suitable strong bucket (steel or canvas), anchor and fenders lashed together, or any combination of materials (even another vessel) that are robust enough, and can create enough drag to help counteract a jammed steering system may be the solution.



In extreme cases where the towed vessel is very difficult to control the ‘drag device’ may need to be attached forward of the vessels stern – the further forward it is the more turning motion it will create to counteract the jammed steering.

Damage Control

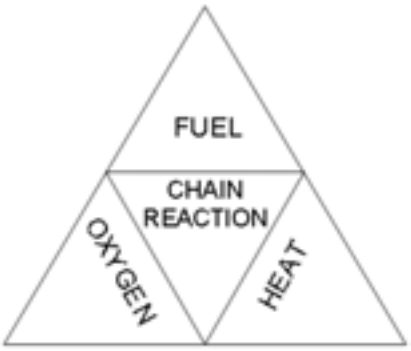
Damage control as the name would suggest is essentially about ensuring that any damage or failure is contained, and at the very least not allowed to get any worse. Damage control is normally an operation to combat fire, water ingress and / or structural failure.

Fire Fighting

Fire is one of the most potentially dangerous emergencies to be encountered at sea. It is also an emergency that requires quick action to contain or eliminate the emergency. Crew training should include fire drills aboard the vessel, so that the actions required for preventing, containing, and extinguishing a fire have been thoroughly rehearsed.

Fire needs three components

- Fuel to vaporise and burn.
- Oxygen to combine with the fuel.
- Heat to raise the temperature of the fuel vapour to ignition point.



If any of these three are missing a fire will not start.
If any of these three are removed a fire will go out.

Removing the Fuel

- Turn off the supply – gas, petrol, or diesel.
- Physically remove near by materials that may combust.

Removing the Oxygen

- Fire blanket.
- Smothering agents – i.e. foam and CO2.
- Close down hatches and vents.

Removing the Heat

- Cool - i.e. use water.
- Turn off electrical supply.

The fourth component of a fire is the chain reaction that supports and sustains combustion. Some agents such as Halon and dry chemical extinguishers directly attack the molecular structure of compounds formed in the chain reaction.

Basic Generic Safety Rules

- Upon discovery of a fire, call out / sound the alarm to summon help.
- Never pass the fire to get an extinguisher.
- If you enter a compartment to fight a fire, keep an escape path open.
- Never let the fire get between you and the escape path.
- **Always keep as low down as possible to prevent inhaling fumes.**
- If you enter a compartment, and fail to extinguish the fire with a portable fire extinguisher, get out immediately and close the door or hatch to confine the fire.

Standard Fire Fighting Procedures

The procedures described below should be part of every fire-fighting operation.

Alarm

The crew member that discovers the fire, or an indication of fire, must raise the alarm and give the location.

Reaction

- With a fire forward turn stern to wind if possible.
- With a fire aft turn head to wind if possible.
- If practical - anchoring or using a sea anchor may be a viable option.
- Make a distress call (it can always be cancelled if the fire is contained).

Assessment

- What is burning & where?
- How advanced is the fire?
- Can its spread be prevented?
- What type of extinguishing agent is suitable for the type of fire?

Are you able to secure or isolate other vulnerable areas of the boat, such as;

- Electrical circuits.
- Engine and fuel supply.
- Air intakes doors or hatches.

Combating the Fire

Having assessed the fire, an attack should be started immediately to gain control and to prevent or minimise the fire spreading. The attack will be either direct or indirect depending on the fire's situation.

- **Direct**

  If the fire is small and has not gained headway crew members can use an appropriate extinguisher(s) directly onto the fire.

- **Indirect**

  Indirect attack is used once a fire has gained headway, or when it is impossible for crew members to reach the fire. The success of an indirect attack depends on complete containment of the fire. All possible avenues allowing the fire to spread must be cut off by closing doors, hatches, and securing all ventilation systems.

The lack of 'containment areas' on most CRV's and the speed at which fire can spread, mean that if a direct attack with available extinguishers is not successful the crew will have to abandon ship.

Overhauling the Fire

Once the obvious signs of fire are extinguished, a careful examination of the vessel must take place to ensure that the fire is completely extinguished. One crew member should be assigned to do nothing but check for re-ignition.

Final Assessment

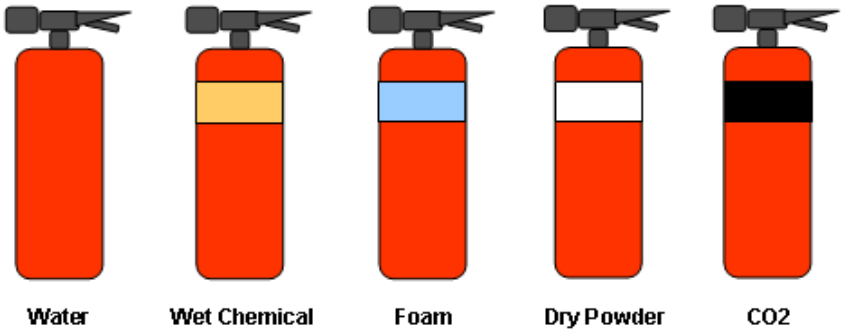
- Crew should now conduct a check of the vessel, and 'tidy up' as much as possible.
- Any necessary de-watering operations should be started.
- Re-stow all fire-fighting equipment.
- Portable fire extinguishers, whether partially or fully discharged, should be put aside and replaced as soon as possible upon arrival back at Unit.
- Complete all necessary Unit and Maritime NZ paperwork.

Types and uses of extinguishers

Extinguishers generally affect one or two sides of the fire triangle. They smother the fire to exclude or reduce oxygen, and some also have a cooling effect.

Type	Band Colour	Class A	Class B	Class C	Class E	Class F
		Wood Paper Plastics	Flammable Liquids	Flammable Gases	Electrical	Cooking Oils/Fats
Water	No Band	Yes	No	No	No	No
Wet chemical	Beige	Yes	No	No	No	Yes
Foam	Blue	Yes	Yes	No	No	Limited
Dry Powder	White	Yes	Yes	Yes	Yes	Limited
CO2	Black	Limited	Limited	Limited	Yes	Limited

Class D fires involve combustible metals and require special purpose extinguishers.



Extinguishers also have pictograms showing which class of fire they are suitable for, and which type of fire they should not be used on

Note –1kg of extinguisher (regardless of type) gives approx 10 seconds of use.

Water

Water is not usually carried on board CRV's in an extinguisher – but is more likely to be used in conjunction with a salvage / fire pump or bucket. Sea water is the most readily available and most effective extinguishing agents for Class A fires. Water is primarily a cooling agent; it absorbs heat and cools the burning material.

The effectiveness of water as a cooling agent can be greatly increased if it is delivered in a spray. The increase in surface area when the water is in droplets greatly increases its ability to absorb heat, and as a 'water wall' affords protection to the fire fighters from flames, heat, and smoke.

Alternatively when delivered as a jet, the fire can be fought from a greater distance than any hand held extinguisher.

Large amounts of water can however seriously affect the stability of a vessel – 1000 litres being roughly equivalent to 1 Tonne**. **There have been numerous cases of vessels capsized and sunk because excessive amounts of water were used in fire fighting.

The three most common types of extinguisher carried on small vessels are

- Dry powder.
- Foam.
- CO2.

Dry Powder

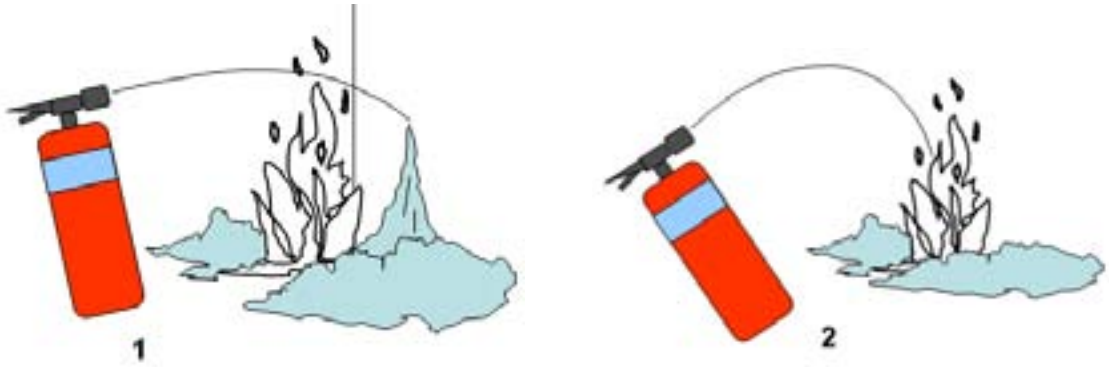
Aimed at the base of the fire, and applied with a sweeping motion.

Foam

Foam is used in the same way as dry powder for Class A fires, but needs a different method of application for Class B fires.

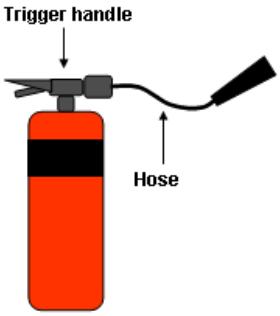
Applied directly onto a burning liquid the force of the extinguisher may spread the liquid and hence the fire. The foam needs to be allowed to spread over the surface of the burning liquid.

This can be done either by aiming the foam at an adjacent vertical surface and allowing it to drop down the surface and spread out (1). Alternatively the foam is aimed in an arc to fall vertically down onto the burning liquid (2).



CO2

Applied to the base of fire with a sweeping motion for a spill fire.
Applied downwards at the centre of a confined fire.



The effective range for a portable CO2 extinguisher is about 1.5m. Care should be exercised when using CO2 extinguishers, the cylinder can get extremely cold – enough to induce cold burns. The extinguisher should only be held by the trigger handle and at the end of the hose (not the cone).

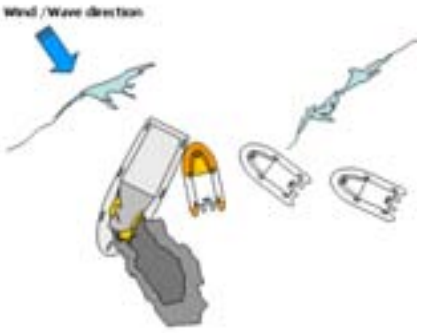
The cones usually found on the end of a CO2 extinguisher's hose have occasionally been known to blow off the end of the hose when the extinguisher is activated.

Rescue from Vessels on Fire (or chemical / gas situations)

In a fire it's the smoke, not the flames that are the biggest killer. One breath of toxic fumes may be all that is needed to inflict permanent lung damage.

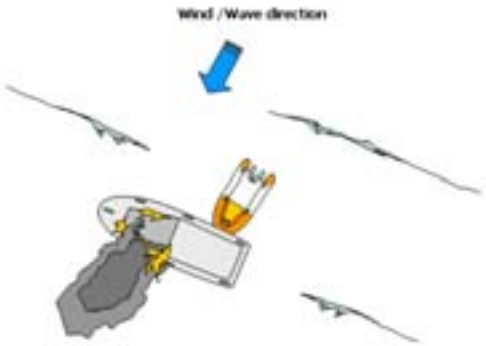
The CRV should assess the situation **(SAP – Stop Assess Plan)**, and come up with a plan that for safely evacuating survivors from the distressed vessel while at the same time minimising risk to the CRV and crew.

CRV crews are neither equipped nor trained to fight any but the smallest fires – the priority is to save lives not property.



The leeward side of the distressed vessel is most likely to be affected by flames, smoke or fumes. However there may be space on the lee side to affect a rescue depending on the size of the vessel and its orientation to the wind.

If coming alongside to windward, a bow on rather than parallel approach should be considered. This exposes less of the CRV and personnel to the danger of explosion from fuel or LPG. The other danger of coming alongside parallel to the other vessel is the CRV being 'pushed on' by wind and waves and subsequently having difficulty clearing away from the vessel in a hurry.



The merits of a bow on approach will have to be weighed against the increased difficulty in the transfer of people across the bow.

If coming alongside the distressed vessel is not considered a safe option, the only course of action is to request that the crew abandon ship to be subsequently recovered from the water.

If it is necessary to exchange lines its essential that a crew member tends them throughout and is prepared to release or cut loose should the need arise.

There have been occasions where a vessel has caught fire amongst other vessels. Using a grapple and chain / wire rope if there is a need to tow a burning vessel away from other vessels in an anchorage or marina / fuel jetty might be a viable (and safer) alternative than trying to attach a towline.



Water Ingress

Vessels taking on water usually have one of three possible problems.

- The hull itself or fittings such as rudder stock or propeller shaft have been damaged in a collision / grounding, or the vessel has suffered a structural failure such as a plank working loose on a wooden vessel allowing water ingress.
- A seal preventing water ingress (such as a stern gland) or a pipe attached to a skin fitting / sea cock has given way or become detached.
- The plumbing system on the vessel itself has managed to create a siphon sucking sea water into the vessel (marine toilets are a common cause of this particular problem).

The capacity of the pumps carried on most small vessels are not sufficient to deal with any large ingress of water – ***One of the top priorities is to locate the water ingress and try to stop it, or at least slow it down to the point where the pumps can cope .***

An example of the pump capacity needed to deal with a 'hole' in the vessel;


- The large hand pump pictured opposite is a "Whale Gusher 30'. At 70 strokes / min it displaces approx 115 litres / min.
- The smaller yellow pump (more the average size hand pump for small vessels) will displace approx 55 litres / min.
- A 1" Jabsco engine driven pump displaces approx 75 litres / min.
- A 1"Jabsco high output electric pump displaces approx 165 litres / min.

To put these figures in perspective - ***A 40mm diameter hole, 0.6m under the water will allow in approx 265 litres / min, and 40mm is the sort of size you would expect for a marine toilet outlet or the raw (salt water) engine cooling inlet for a large marine diesel.***

Salvage / Fire Pumps

Prior to arriving at the scene the CRV crew may have the opportunity to assemble their pump and hoses, prime and run it.

Having arrived on scene, accounted for the crew of the distressed vessel, and carried out an assessment (remember – find out where the water is coming from);

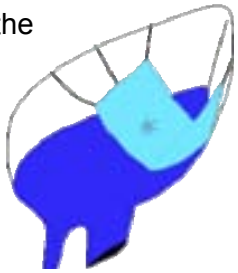
- The suction hose should be transferred into the water filled compartment on the distressed vessel.
- Start the pump ensuring that the outlet clearly discharges overboard.
- Take care to keep the suction from getting blocked – loose plastic bags, rags etc in the bilge can block the suction hose.
- Keep the pump secured on the CRV if at all possible, monitor fuel level, and provide ear muffs / plugs for crew.
- A crew member should standby any lines made fast to a vessel that may subsequently sink and be prepared to cut the CRV free.

If the source of the water ingress is accessible from inside the vessel, then it's often a case of initially stuffing rags / clothing or other suitable material into the hole to reduce the flow (or simply turning off the relevant sea cock).

Reducing the flow to the point where the pumps can cope, will allow you time to come up with a possibly more effective and permanent repair.

Pumps can and do fail or get blocked, so if every pump employed is only just containing the water ingress, you should be looking for ways to reduce the ingress still further if possible.

Fothering (collision mat)



The source of the water ingress may not be easily accessible from the interior of the vessel, in which case fothering may be an option. Fothering is when a sail, tarpaulin or similar is positioned over the hole and held in place on the outside of the hull. The water pressure will push the material used into the hole and reduce the flow.

Positioning the fothering / collision mat can be tricky, and any lines attached to the mat usually need to be weighted so they will drop under the vessels hull. A triangular shaped mat like the one shown opposite is often far easier to position and secure

Any movement through the water either by towing the distressed vessel, or them making way under their own power will probably displace the fothering / collision mat – but again it may buy you valuable time in which to come up with a more permanent fix.

Heel & Trim

Deliberately heeling or trimming the distressed vessel is also a tactic that can be employed. This may raise the hole out of the water, or at least getting it closer to the surface to reduce water pressure, and hence the flow.

Tingles (patches)

A small hole in a wooden or fibreglass hull can be repaired with what is traditionally called a tingle. A tingle consists of a patch of soft metal or wood, tacked or screwed onto the hull from the outside often with a cloth gasket of the same size between it and the hull.

In an emergency a patch of any suitable material may be fashioned and secured (inside or outside the hull) from what is available – for example a plastic sheet / bag held in place with duct tape.

Beaching

Beaching is a deliberate attempt to put the boat ashore. Such a manoeuvre may be necessary if a boat has suffered serious damage, or is taking in water and is in danger of sinking.

Beaching may be the only option, and the Skipper of the damaged vessel may require help in selecting the most appropriate method. The CRV may itself suffer some damage and require beaching.

The nature of the emergency will probably not allow a particularly wide choice of suitable sites, or much opportunity to spend time in selection. The ideal beach for the purpose should be of sand, mud or light shingle. It should have a gentle slope and be free of off lying rocks, boulders, surf, and cross-currents. A weather shore (where the wind is blowing off the land) is almost always preferable to a lee shore (wind blowing onto the land).

If the distressed vessel still has steering and motive power, then it can beach itself – the main question being whether to go in head or stern first?

Bow or Stern First?

The advantages and disadvantages of a bow or stern first entry onto a beach should be considered before any attempt is made to beach a vessel.

Beaching the boat bow first will reduce the chance of damage to the propeller / drive system and rudder(s).

Beaching stern-first leaves the bow seawards. This part of the boat is better shaped to ride any waves and surf as the manoeuvre is carried out. For outboard-powered craft, tilting the engine(s) will reduce the chance of damage.

Use of an Anchor to Control Speed and Broach

When the wind and waves are blowing onto the beach, the vessel will try to broach (be pushed sideways onto the beach) in the surf or as it runs aground. For example as the bow touches bottom the waves pushing on the stern will tend to swing the vessel side onto the shore. In addition to the influence of the wind and waves, the beach may also be subject to a longshore current (a current running parallel with the beach which will also induce the vessel to broach. (See Module Boat handling and Heavy Weather)

Viewed from seaward the conditions on a beach can often look far more benign than they actually are. What can seem like only gentle surf can in reality be heavy and potentially dangerous surf, which may cause a vessel that beaches to broach violently or even roll.

The approach to the beach must be made at a speed slightly slower than the incoming waves. If this is not possible by reducing the vessel's motive power, a drogue can be used to reduce speed, however only an anchor will prevent the vessel broaching once it runs aground.

- The anchor is deployed from either the bow or stern (depending on how the approach is made).
- Adjusting the tension on the anchor rode and allowing it to drag if necessary will control the boat's speed, prevent it from surfing uncontrollably and, by keeping it end-on to the waves, will help prevent broaching as it approaches the beach.
- At a suitable distance from the beach the anchor is allowed to dig in and the anchor rode surged to control the vessels speed and direction.

If conditions on the chosen beach are such that there is a significant risk of injury to persons on board when beaching – it would be better to let the vessel beach unmanned.

Securing on Landing

Probably the moment of greatest danger is when the boat first touches the beach, especially when there is an undertow running, as it could easily swing around to lie broadside to the waves and subsequently be rolled up the beach.

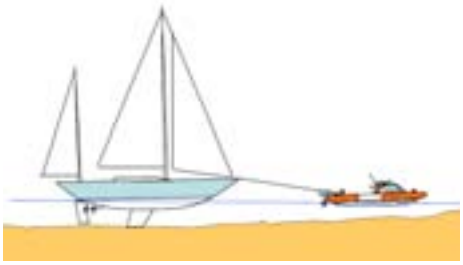
To minimise this risk;

- On touching the bottom all aboard should jump over the side, and the boat should be manhandled quickly as far up the beach as possible (if the size of the boat permits).
- A larger boat should be quickly secured in position. If possible lines should be run from each bow and quarter up the beach and secured ashore to brace the boat. Secure them to any suitable object; rocks, piles, trees, or posts driven into the sand.
- The anchor if used should be left to seaward; this will help hold the boat in position and may be useful later when trying to refloat.

Towing a vessel onto a beach

The distressed vessel may have lost steering, motive power, or conditions are such that beaching the vessel unmanned is the only safe option. In this case the vessel will need to be towed onto the beach. The principals remain the same, the problem is how to control the beaching when towing.

If the distressed vessel has a significantly deeper draft than the CRV (and the slope / gradient of the beach and conditions allow), then towing the vessel astern of the CRV onto the beach may be an option. As the vessels beaches it will obviously decelerate rapidly so the final approach should be made at slow speed and the towline ready to be surged or let go completely.



Alternatively if conditions and time allow the vessel might be towed alongside / barged onto the beach. Barging the distressed vessel should only be attempted if the vessel is not at any immediate risk of sinking – having to cast off several lines in a hurry is something to be avoided.

If none of these options are viable the distressed vessel will need to be towed into the shore, and left to beach under her remaining momentum once the towline is slackened or cast off.

Any vessel that has been beached comes under the authority of MNZ or the Local / Regional Harbour Master depending on the location.

It is primarily the responsibility of the Skipper of the distressed vessel to contact MNZ or the Harbour Authority, but it's unlikely that a recreational Skipper will be aware of this.

The relevant authority must be informed (by Coastguard if necessary) as they have responsibility for any subsequent pollution control.

Dismasting

Dismasting can pose a serious threat to the safety of a sailing vessel depending on the sea conditions, where the failure in the rig occurred, and how the damaged mast and rigging are now positioned relative to the vessels hull.

If the mast breaks completely at or near deck level, it will go overboard but still be attached to the vessel by the remaining standing rigging (usually wire) and running rigging (rope). In heavy weather a broken mast can easily punch a hole through a hull.

Sometimes the mast collapses (folds at a specific point) but does not break off completely.
If sea conditions are reasonably calm, a broken or collapsed mast might be pulled back on board or lashed in position. In rough conditions for the safety of the vessel it may need to be cut away – either completely or so that it can be towed behind the vessel.



Any assistance given to a dismasted vessel must be approached with caution. There may be ropes trailing from the damaged rig in the water. The damaged rig can become a tangle of moving wire & rope under tension, and any attempts to cut away or secure the broken rig must be made methodically and carefully.

The standing rigging is normally attached to the hull by rigging screws (pictured far right) made fast to chain plates (strong points) on the deck. The easiest way to detach them is to remove the split ring or pin from the clevis (retaining) pin, then remove or punch out the clevis pin.


Any tension on the rigging screw will need to be relieved to make the job easier. If this isn't possible then using bolt / wire cutters or a hacksaw to sever the wire may be the only option.

Swamped / Capsized Vessels

Calls for assistance can involve vessels that have been swamped or capsized. As with all Coastguard operations the priority is people not property; however de watering a swamped vessel or righting a capsized vessel may become a post rescue operation.

If a swamped vessel can be dewatered, or a capsized vessel righted it will obviously make any subsequent tow quicker and easier, but both operations especially righting a capsized vessel should be approached with caution. The potential risks to the CRV, its crew and others involved must be carefully assessed.

Swamped Vessels

- Approach the swamped vessel cautiously, remaining clear of any lines.
- Attach towline - preferably to trailer eye if fitted as with normal towing operations.
- Any swamped vessel could be extremely unstable and may capsize easily - do not attempt to board the vessel, unless absolutely sure that it is still stable.
- The CRV should get underway. The forward movement of the vessel and the free flow effect of the water emptying over the stern will see significant proportion of the vessel de-watered.
- When the water ceases to flow over the vessels stern, the forward way can be taken off slowly, the vessel bought alongside, and a salvage pump used to finish off the de-watering process.

In the case of a swamped vessel, attempting to dewater it by towing is unlikely to make matters worse. If it was going to sink it would have done so already. Attempting to right a capsized vessel however could potentially result in the vessel sinking.

A vessel sinking while under tow, or attempting to establish a tow can have serious implications for the CRV Skipper and crew. (See Module Towing Techniques)

Righting Capsized Vessels

The decision to right the vessel must be made carefully.

Is it necessary?

Can the vessel be towed to a point of safety and secured while still capsized? Can it at least be towed into shallower / calmer water before any attempt to right it.

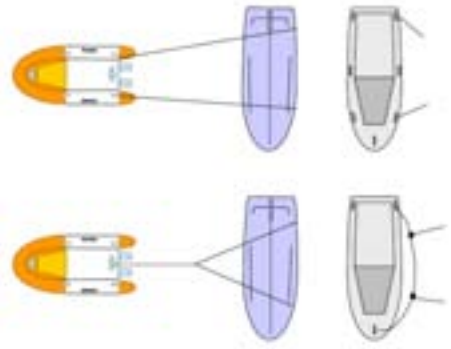
Will it make matters worse?

A capsized vessel may be still floating because of its fixed buoyancy which is part of the design of the vessel, or it may be air trapped inside the inverted hull that is keeping it afloat. When righting the vessel any air trapped inside the hull will escape, and there is the very real chance that attempting to right it will result in it sinking.

As with any Coastguard operation whether it is a simple tow or the offer of help with some basic repairs – attempting to right a capsized vessel should only be attempted with the full knowledge and consent of the distressed vessels Skipper.

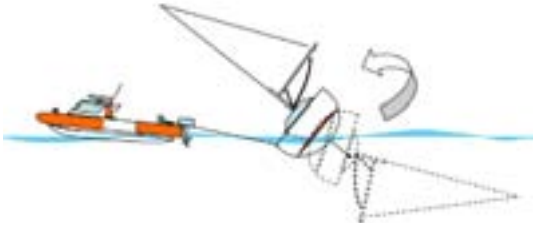
Parbuckling (rolling the vessel)

'Parbuckling' is the term used to describe righting a capsized vessel by passing ropes over its keel, and fastening them to one side of the vessel. The CRV then moves ahead, rolling the vessel over. As a swimmer is often required to position the lines, this method should not be attempted in anything but calm to moderate seas.



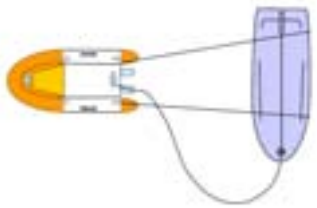
- Approach the capsized boat cautiously — downwind remaining clear of lines and debris.
- The CRV's stern should be positioned perpendicular to the length of the capsized vessel and lines made ready.
- A swimmer from the capsized vessel or a CRV crew member (wearing a PFD) should be tasked to position and attach the lines between the two vessels.
- The lines are then brought over the capsized vessel's keel, and attached on the side of the upturned vessel furthest from the CRV.
- Lines should be kept clear of all handrails, life lines and stanchions. A light grapple may also be of benefit if used carefully.

- Finally, adjust the length of both lines to prevent the righted boat from hitting the CRV, and make fast to the CRV's quarter cleats or bridle. In the case of righting a sailing vessel the CRV should be positioned far enough away that the vessels mast will not hit the CRV. The amount of water in the vessel could make it extremely unstable, with the very real chance that it will not just roll upright, but will continue to roll and capsize again.



- Recover the swimmer.
- The CRV moves ahead gently, and the force exerted on the lines should be sufficient for the capsized vessel to be righted.
- The righted boat should be brought alongside so that de-watering can begin and the appropriate recovery action taken.

If there is a risk of the vessel sinking once rolled upright, then a towline from its bow / trailer eye should already be attached and ready. As soon as the vessel rolls upright the lines used to parbuckle are cast off or slacked away so that the towline takes up the strain as per the operation for a swamped vessel.



Any risk of the vessel sinking also means that provision should be already made for buoying the vessel should it subsequently sink.

End over End Method

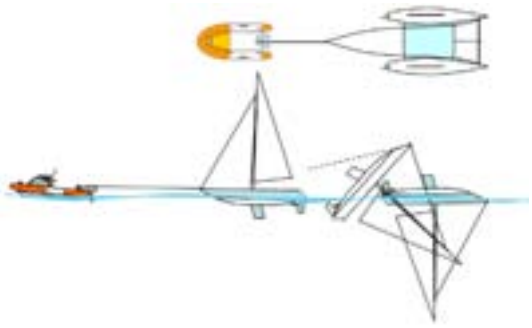
Almost all vessels can be righted by parbuckling as they will have far less transverse stability as compared to their longitudinal stability (see Module Boat handling & Heavy Weather). There is however an alternative method that can be employed particularly with catamarans where their transverse stability is far higher than that of an equivalent sized monohull.

This method for righting a capsized vessel uses two forces, one pulling on lines from the bow or stern of the vessel, and the other being water pressure on the opposite end of the hull(s).

Pulling the bow over

Attach ropes from each of the catamarans bows running aft along the inside of its hulls to the CRV's stern, either as separate lines to each quarter, or in a bridle arrangement. When the CRV moves ahead, the pressure along the rope will cause the catamaran to bury its stern in the water, and effectively flick the bow over.

This method can risk damage to the rudders unless they have been secured amidships, and the vessel may try to yaw as it is being pulled over. The stern of the vessel is also more resistant to burying in the water than the bow. The advantage is that at least the vessel is the being towed bow first once it has been righted.

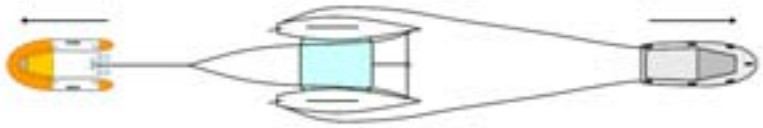


Pulling the stern over

Attach ropes from each of the catamarans sterns running forward along the inside of its hulls to the CRV's stern. This time when the CRV moves ahead, the pressure along the rope will cause the catamaran to bury its bow in the water. This method has the advantage that the bow is far more easily buried in the water than the stern. The disadvantage is that the vessel will be towed by the stern once it has been righted and if the rudders are not secured it will induce the vessel to yaw and risk damage to the rudders.

Larger catamarans

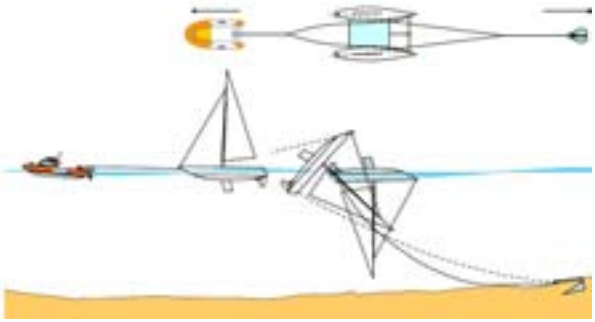
A variation on the same method is to increase the pulling power by employing two vessels in the operation.



- The two vessels are positioned with their stern to the capsized craft's bow and stern respectively. When pulling the bow over.
- Attach lies from each of the catamarans bows running aft along the inside of its hulls to the stern of one assisting vessel.
- Attach lines from the stern of the capsized vessel running forward outside the hulls to the stern of the other assisting vessel at its bow.
- The vessel attached to the bow(s) moves ahead while the other vessel holds station until the stern(s) bury. Then both assisting vessels move ahead, slowly increasing power until the catamaran flips over.

The vessel pulling on the distressed vessels stern must be ready to instantly cast off their tow line(s) if necessary to avoid becoming entangled with the mast.

A further variation is for one of the vessels to be substituted for an anchor and bridle (or preferably two anchors to avoid entanglement with the mast) from either the catamarans bow or stern.



Co coordinating two vessels or laying anchors from the capsized vessel can be a time consuming and complicated affair and run the risk of increased damage to the vessel – especially mast and rigging. Attempting this sort of recovery is probably best left to a professional salvage company and the vessels insurers / owner to organise.

Rope Work – Knots & Methods for Damage Control

The ability to tie ‘standard’ knots, bends and hitches such as the bowline, clove hitch, sheet bend, and round turn & two half hitches are basic core seamanship skills. When it comes to damage control there are a few other knots which can be extremely useful, particularly when it comes to securing things tightly (lashing a broken mast in position or providing support to a damaged section of the vessels structure).

Constrictor knot

The constrictor is essentially a variation of the clove hitch which is very secure. The constrictor will need to be undone with the aid of a marline spike or similar if it has been subject to heavy load.

The constrictor is formed by first tying a clove hitch (pictures 1 -3).

1

2

3

The bitter end is then tucked under its adjacent part (pictures 4 & 5). If when completing the clove hitch, the bitter end came up from the right as in the example, it is tucked under the adjacent standing part to its right. The hitch is then pulled tight - completed constrictor knot (picture 6).

4

5

6

Rolling hitch

A rolling hitch will enable a line to be tied onto another line, spar or similar, and pull exerted on that line in one particular direction. There are many slight variations on how to tie a rolling hitch, and the pictures below show just one particular version.

The bitter end is looped twice around the line / object working back towards the final direction of pull (pictures 1 & 2).

1

2

The bitter end is then crossed over the initial turns and secured with a half hitch (pictures 3 & 4). The completed rolling hitch (picture 5).

3

4

5

Some times a single rolling hitch is not sufficient for the load. In which case a second (or possibly third rolling hitch can be tied). The method is the same as described above only this time there must be sufficient length of line in the bitter end to tie a second rolling hitch above the first one (pictures 6 & 7). The completed double rolling hitch (picture 8).

6

7

8

Waggoner's hitch

The Waggoner's hitch (sometimes referred to as a truckers hitch) also has many variations. The essence of this knot is that it forms a crude but still effective 2:1 purchase similar to the 'whip' purchase shown opposite.

To form a Waggoner's hitch the line is first secured on the item that needs to be tensioned (picture 1). A loop is formed (same as would be done for a bowline) (picture 2). A bight is put through the loop (picture 3).

1

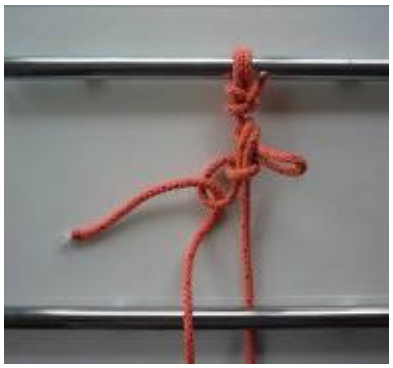
2

3

The loop is pulled down to hold the bight, which is then secured by a half hitch around the standing part (picture 4).

The bitter end is passed through or around a fastening / strong point (picture 5). The bitter end is passed through the loop formed previously and pulled tight - this is utilising the 'block & tackle 'effect of the hitch (picture 6). The fall is made fast either by tying around another strong point or by tying around the hitch itself.

4



5

6

Frapping

Frapping is more of a method of tightening lines rather than a knot in its self. If two or more lines are used to secure an object, frapping will increase the tension of those lines.

Once the securing lines are in place, another line (can be smaller / lighter line) is secured (picture 1). The frapping line is then progressively wrapped around and pulled tight between the main securing lines (pictures 2 & 3).

1

2

3

As the gap between the main lines is reduced their tension / loading will increase. Each 'frap' is like a small block and tackle being used – the cumulative effect is that by frapping with even a very small diameter line, the loading on the main line(s) can be increased many times more than by just hauling tight by hand or using a Waggoner's hitch.

The frapping line is then secured by tying onto one of the original securing lines, or by a couple of half hitches around the frappings (pictures 4 & 5).

4

5