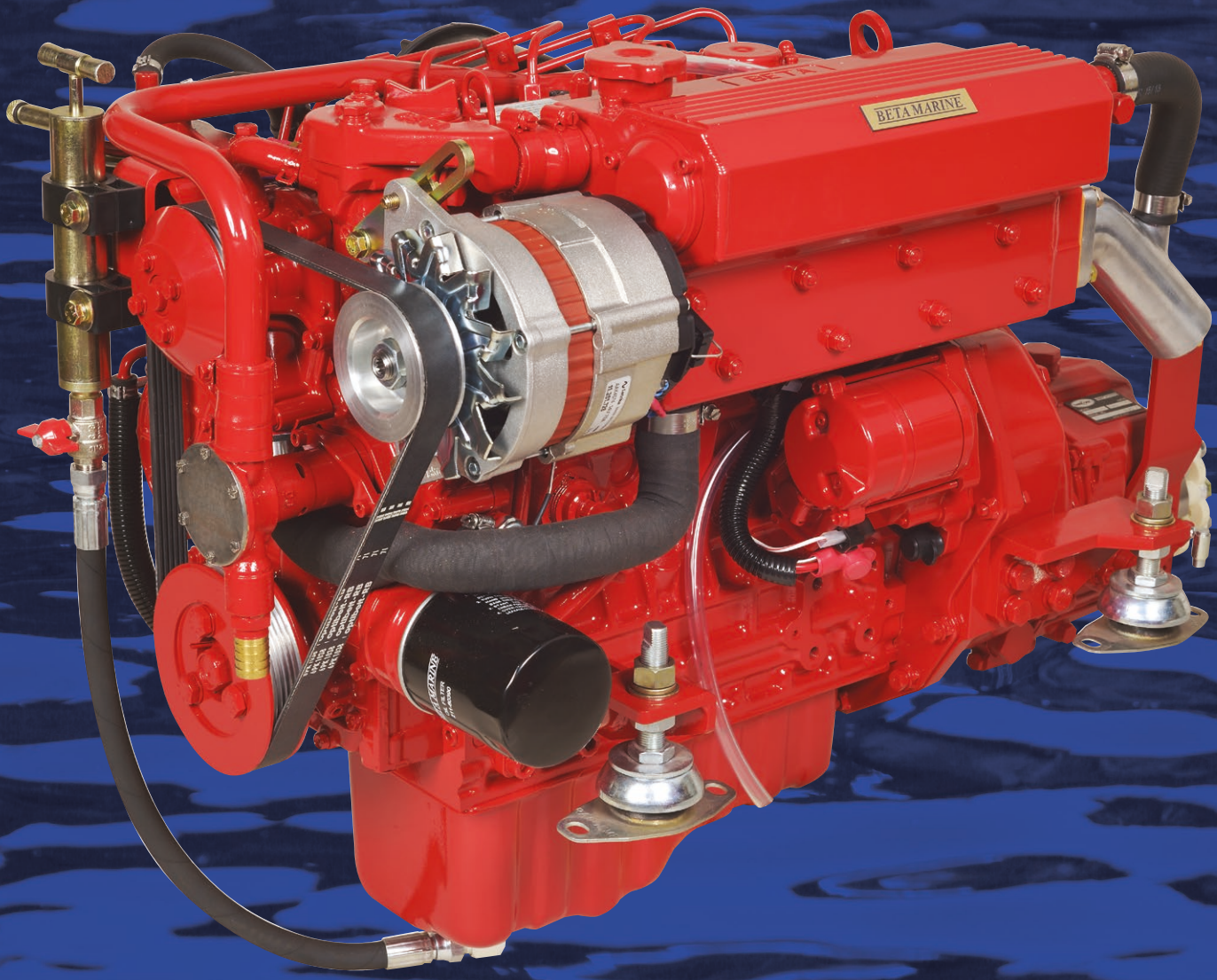
BETA MARINE

Marine Engine Installation Guide



Safety Precautions!

A Keep the engine, gearbox and surrounding area clean, including the area immediately below the engine.

B Drives - Power Take Off Areas

i) Gearbox Output Flange

The purpose of a marine diesel propulsion engine is to provide motive power to propel a vessel. Accordingly the gearbox output shaft rotates at between 280 and 2400 rev/min. This flange is designed to be coupled to a propeller shaft by the installer and steps must be taken to ensure adequate guarding.

ii) Forward End Drive

Engines are supplied with unguarded belt drives to power the fresh water pump and battery charging alternator. The installer must ensure that it is not possible for injury to occur by allowing access to this area of the engine. The three pulleys run at high speed and can cause injury if personnel or clothing come in contact with the belts or pulleys, when the engine is running.

iii) Power Take Off Shaft (Engine Mounted Option)

Shaft extensions are available as an option and rotate at between 850 and 3600 rev/min. If contact is made with this shaft when the engine is running, injury can occur.

C Exhaust Outlet

Diesel marine propulsion engines emit exhaust gases at very high temperatures - around 400 - 500°C. Engines are supplied with either wet exhaust outlet (water injection bend) or dry outlet (dry exhaust stub) - see option list. At the outlet next to the heat exchanger/header tank, the exhaust outlet can become very hot and if touched, can injure. This must be lagged or avoided by ensuring adequate guarding. It is the responsibility of the installer to lag the exhaust system if a dry system is used. Exhaust gases are harmful if ingested, the installer must therefore ensure that exhaust pipes are led overboard and that leakage in the vessel does not occur.

D Fuel

i) Fuel Lines

Diesel engines are equipped with high pressure fuel injection pumps, if leakages occur, or if pipes fracture, fuel at a high pressure can harm personnel. Skin must be thoroughly cleaned in the event of contact with diesel fuel.

ii) Fuel Supply Connections

Engines are supplied with 8mm compression fittings. The installer must ensure that when connections are made, they are clean and free of leaks.

E Oil

The Beta propulsion unit is supplied with 2 dipsticks, one for the engine and one for the gearbox. Ensure dipsticks are returned and secure after checking, if not oil leaks can cause infection when touched. All oil must be removed from the skin to prevent infection.

F Scalding

An engine running under load will have a closed circuit fresh water temperature of 85° to 95°C. **The pressure cap on the top of the heat exchanger must not be removed when the engine is running**. It can only be removed when the engine is stopped and has cooled down.

G Transportation / Lifting

Engines are supplied on transportable pallets. Lifting eyes on engines are used for lifting engine and gearbox assembly only, not the pallet and associated kit.

GENERAL DECLARATION

This machinery is not intended to be put into service until it has been incorporated into or with other machinery. It is the responsibility of the purchaser / installer / owner, to ensure that the machinery is properly guarded and that all necessary health and safety requirements, in accordance with the laws of the relevant country, are met before it is put into service.

Signed:

J A Growcoot, C.E.O, Beta Marine Limited.

***NOTE:* Recreational Craft**

Where applicable, the purchaser / installer / owner and operator must be responsible for making sure that the Recreational Craft Directive 94/25/EC is complied with.

Section 1

INSTALLATION RECOMMENDATIONS

The installation details are basic guidelines to assist installation, however due to the great diversity of marine craft it is impossible to give definitive instructions. Therefore Beta Marine can accept no responsibility for any damage or injury incurred during the installation of a Beta Marine Engine whilst following these guidelines.

- All engines shall be placed within an enclosure separated from living quarters and installed so as to minimise the risk of fires or spread of fires as well as hazards from toxic fumes, heat, noise or vibrations in the living quarters.
- Unless the engine is protected by a cover or its own enclosure, exposed moving or hot parts of the engine that could cause personal injury shall be effectively shielded.
- Engine parts and accessories that require frequent inspection and / or servicing must be readily accessible.
- The insulating materials inside engine spaces shall be non-combustible.

VENTILATION

The engine compartment needs air.

a) as air (oxygen) to burn the diesel fuel, and

b) as air to keep the engine cool (still hot at 100°C) by ventilation.

It is important that the engine compartment has adequate ventilation, and **this is your responsibility**. If there is no ventilation the engine can overheat and damage can be caused. As a general statement an engine will produce radiated heat - approximately equal to $^1/_3$ of the engine output power. Also the larger battery charging alternators create lots of heat. (A symptom of overheating problems is often black belt dust). If you have any doubts about the temperature of your engine compartment please check with a thermometer on a hot day, the maximum temperature in the engine compartment should be less than 70°C - the cooler the better!

Engine compartment ventilation is normally best with two holes; an **inlet** allowing colder air to enter below to the alternator and drive belts and a second **outlet** (about the same size) for the hot air to rise and ventilate out from the top of the engine compartment. Adequate ventilation must be included with all installations. Installations require a good quality reliable electric ventilation fan wired into the ignition switch to remove the hot air. The required air flow volumes in m^3/min = 0.05 x engine power in hp.

Typical ventilation sizes

	10hp	20hp	30hp	40hp	50hp	75hp	100hp	150hp
Combustion	14 cm^2	28 cm^2	43 cm^2	57 cm^2	71 cm^2	106 cm^2	142 cm^2	213 cm^2
Ventilation	13 cm^2	25 cm^2	37 cm^2	50 cm^2	62 cm^2	92 cm^2	123 cm^2	185 cm^2
Inlet / Outlet dia.	6 cm	9 cm	11 cm	12 cm	13 cm	16 cm	19 cm	22 cm

INSTALLATION RECOMMENDATIONS FOR KEEL COOLED ENGINES

Keel cooled engine, overheating is sometimes caused by:

a) Not fully venting the engine cooling system of air. It is necessary to remove all air from the cooling system - including the “skin” tanks and (if fitted) the Calorifier and associated piping.

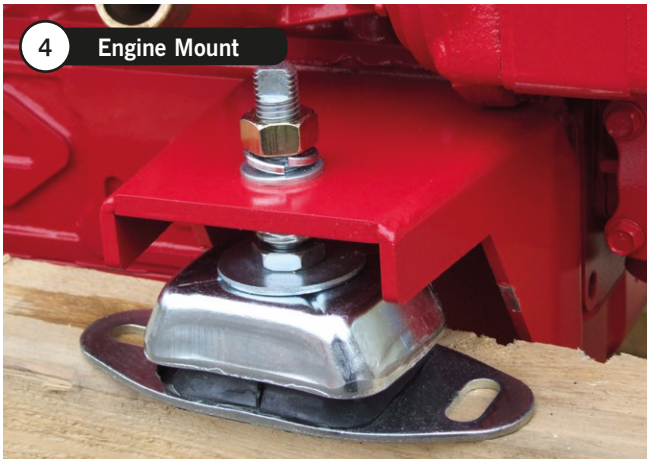
b) Incorrectly sized “skin” tanks that have been sized for ‘usual’ canal use, rather than maximum engine output that can sometimes be required on fast flowing rivers. An additional “skin” tank may need to be fitted; please refer to our website: Inland waterways - guidelines: keel cooling tank sizes.

ENGINE MOUNTING

To ensure vibration free operation, the engine must be installed and correctly aligned on substantial engine bearers, extending as far forward and aft as possible, well braced and securely fastened to form an integral part of the hull.

The engine must be installed as low as possible on the flexible mount pillar stud. This will limit vibration and extend the life of the flexible mount. To assist with engine replacement we offer 'Special Engine Feet' manufactured to your dimensions, as an optional extra to suit your existing engine bearers and shaft alignment / installation.

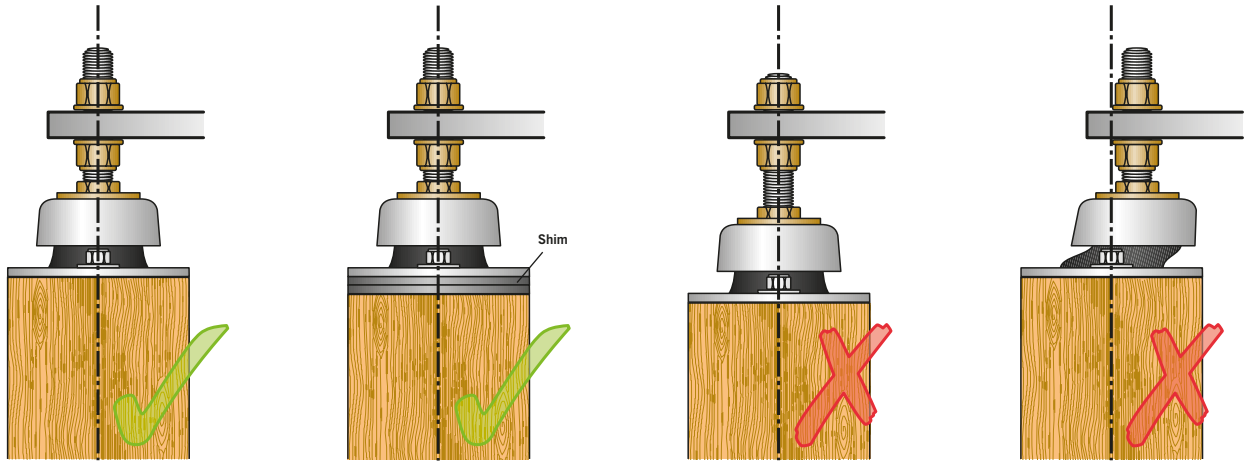
4 Engine Mount



⚠ WARNING!

- Do not set the engine feet high up the flexible mount pillar stud. This will cause excessive engine movement and vibration. Pack steel shims under the flexible mount and ensure that the flexible mounting is securely bolted to the engine bearer.
- The pillar stud on the flexible mount is secured into position by the lower locknut, do not forget to tighten this. **Also ensure that the stud is not screwed too far through the mounting body so that it can touch the bearer. This will cause vibration and knocking noises which are very hard to find!** If the flexible mounting is too far offset then the loading on the flexible mounting will cause premature failure, modifications are needed.

5 Engine Mount Alignment



Recommended
Correct height and positioning

Acceptable
Shim(s) required to achieve correct height and positioning

NOT Recommended
Positioning too high on the pillar stud - requires shims

NOT Acceptable
NOT aligned - requires bearer modifications to correct

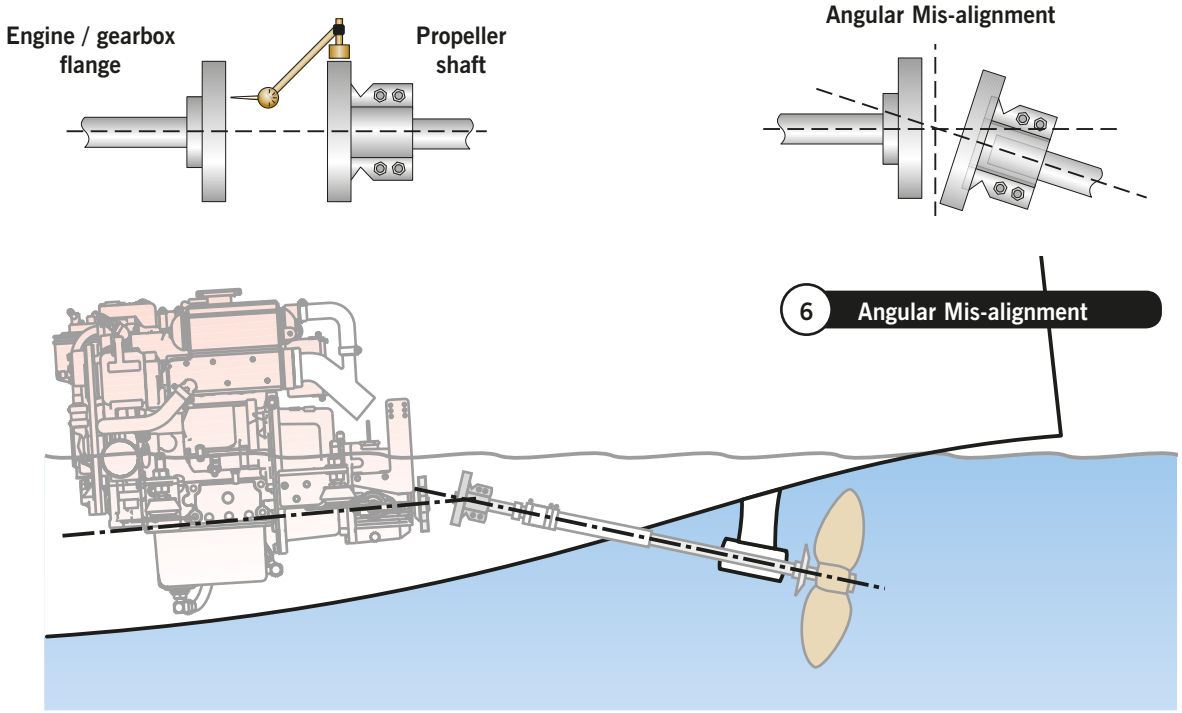
ENGINE INSTALLATION AT AN ANGLE

Beta Marine propulsion engines can be installed at angles up to a maximum of 15° flywheel up or flywheel down when static, and can be run at up to 25° when heeling. However if you are considering installing above 12° please contact Beta Marine or alternatively consider the 7° down angle gearbox. When our engines are installed at varying angles of inclination the normal markings on the dipstick should be disregarded. It is probably better to totally drain the sump, and completely refill the engine sump with the recommended quantity / volume of lubricating oil - noting its position on the dipstick - and then marking the dipstick accordingly (don't forget to replace the oil filter). **If in doubt ask Beta Marine!**

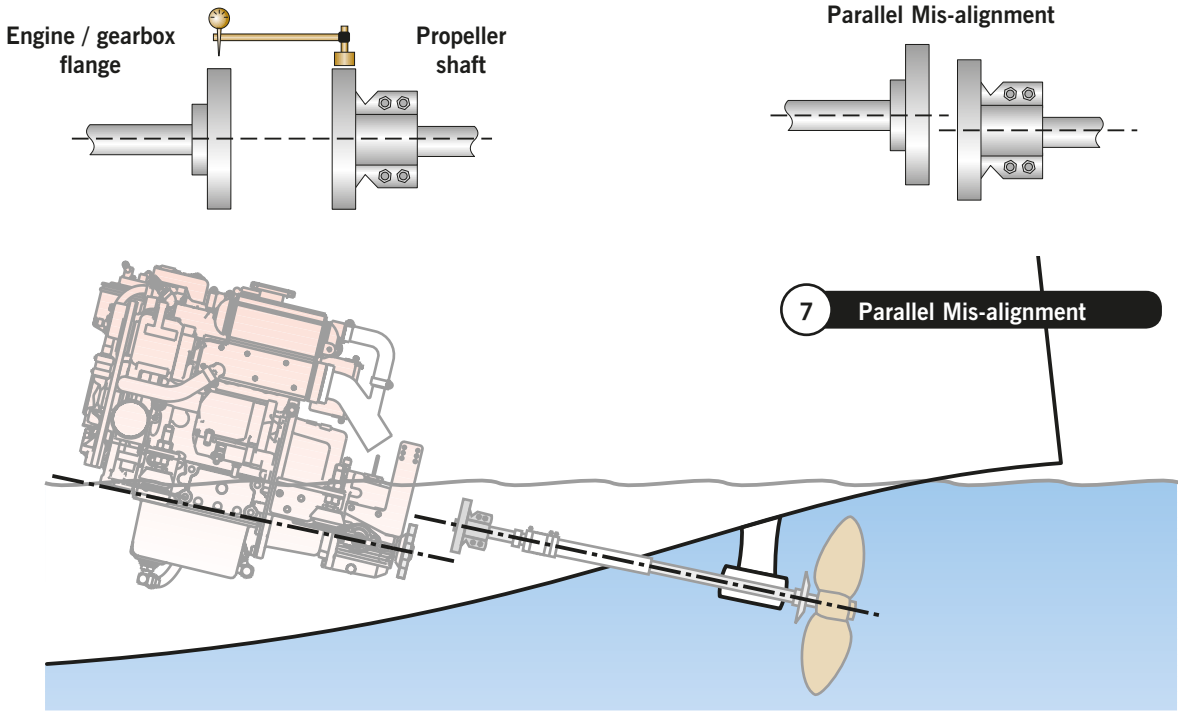
ALIGNMENT

To obtain accurate alignment the flexible mountings must be adjusted until alignment is attained, and the mountings must be locked in position. The engine / gearbox unit has to be aligned with the propeller shaft in two ways. The traditional engine alignment method involves measuring with either feeler gauges or a DTI (Dial Test Indicator) mounted on a magnetic foot so that they are aligned within 0.125mm (0.005”). (Obviously the propeller shaft must be centered in the stern tube and running true - through the cutless bearing; if the propeller shaft is not correctly centered you will experience vibration).

ANGULAR ALIGNMENT



PARALLEL ALIGNMENT



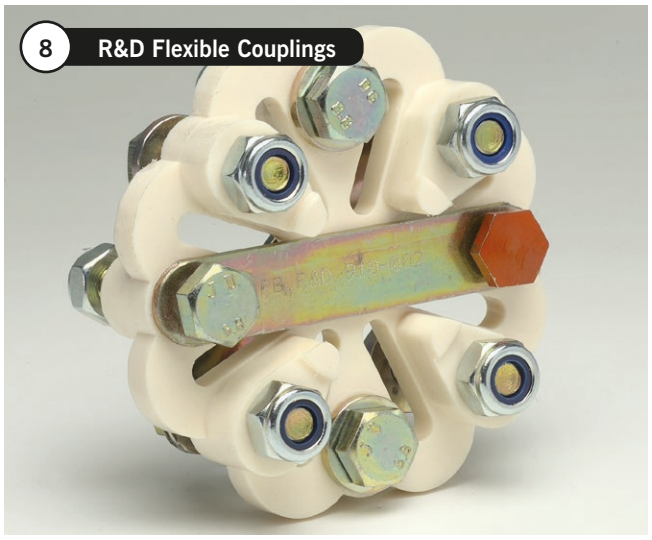
The engine mountings and the couplings must now be tightened in position and the alignment re-checked.

FLEXIBLE OUTPUT COUPLINGS

A flexible coupling is mounted on the gearbox output flange and is strongly recommended in almost every case. Flexible couplings do not resolve bad alignment, they are designed to absorb torsional vibrations from the propeller (transmitted along the propeller shaft).

We normally offer two types:

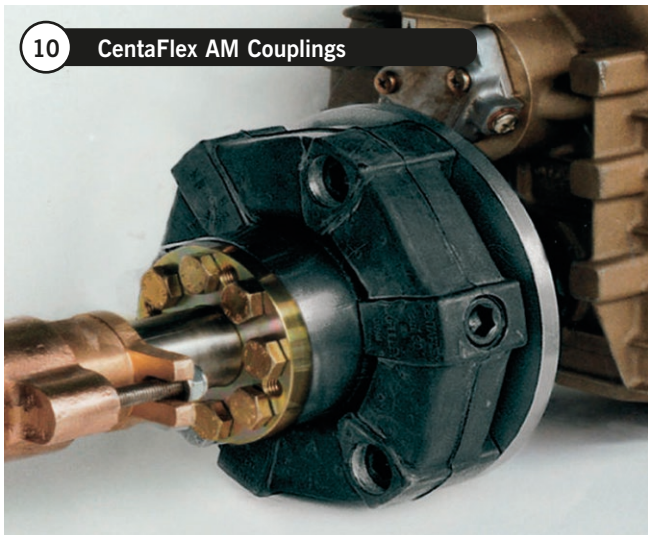
R&D with a flexible nylon disc and optional Clamp Coupling – a very good economical solution.



8 R&D Flexible Couplings

9 R&D Clamp Couplings - Optional

The excellent 'CentaFlex' coupling design includes lots of rubber to absorb torsional shocks and loads. The 'CentaFlex' coupling is complete, replacing both the R&D flexible and the R&D clamp couplings above.



10 CentaFlex AM Couplings

EXHAUST SYSTEMS

There are two main types of exhaust system:

1) **Standard yacht - wet exhaust system with a water injection bend and waterlock silencer**
2) **Dry exhaust system (see page 17)**

We recommend care when designing your exhaust system. The most important aspect is to ensure that water cannot enter the engine's combustion chamber from the exhaust system (this applies to both wet and dry exhaust systems).

STANDARD YACHT - WET EXHAUST INSTALLATION

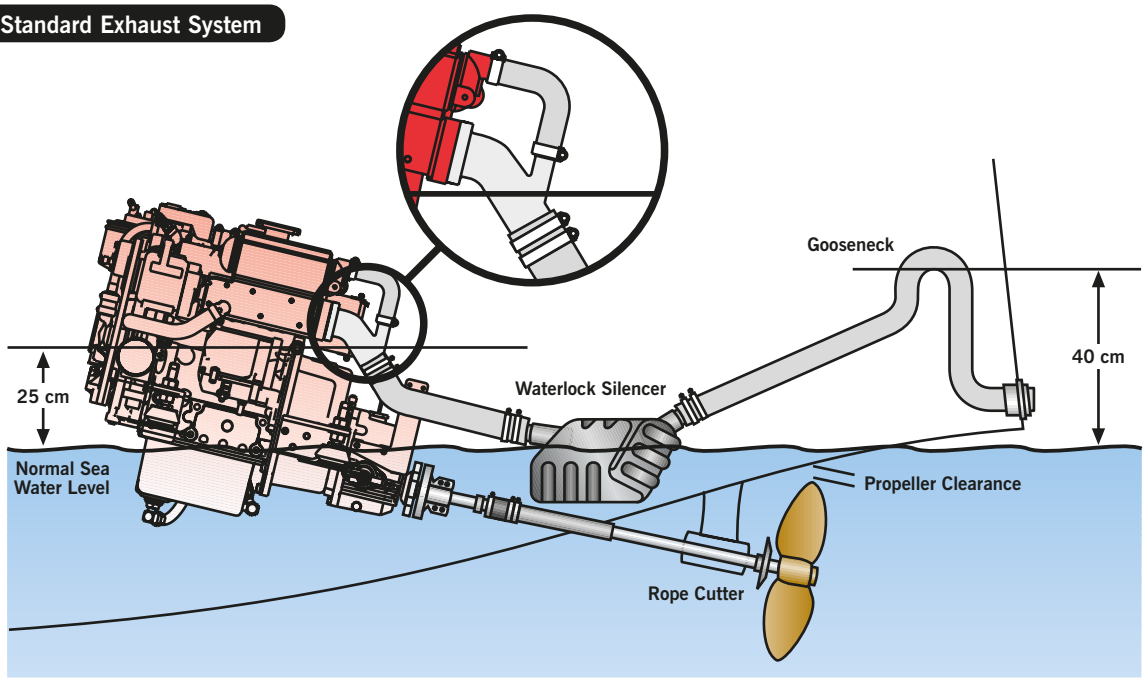
Owners need to be aware of three major problems that can easily occur when installing an engine in a sailing yacht or motor boat and allowing the engine to 'hydraulic lock'.

- Seawater syphoning past worn impellors in the seawater pump, flooding the exhaust system, and back filling into the combustion chamber when the engine is stopped.
- Seawater washing into the combustion chamber from the exhaust system due to either a very shallow exhaust run from the injection bend to the waterlock silencer, or because the waterlock silencer is too small to accept the total amount of cooling water in the exhaust hoses, or both. This can happen when the yacht is sailing into a big sea and a surge is set up in exhaust system as the yacht pitches - with the engine switched off.
- Waves forcing water up the exhaust due a poorly designed system with no 'gooseneck'. Small work boats moored on exposed beaches are very vulnerable to this as waves hit the stern before the boat can swing into the wind on a rising tide.

It is therefore very important to ensure that the engine will not 'hydraulic lock'. This can be a problem with engine installations. When water enters the combustion chamber and 'hydraulics' against the rising piston, a bent con rod, emulsified engine oil and a wrecked fuel pump can be the result. It's best avoided!

If your engine is installed below the water line, the potential for water entering the engine is considerably increased. The important dimension that must be measured is from the normal 'static' sea level to the point at where the cooling water is injected into the exhaust - this should be a minimum of 25 cms. If this can not be achieved the following options must be taken (see 11, 12 and 13).

11 **Standard Exhaust System**



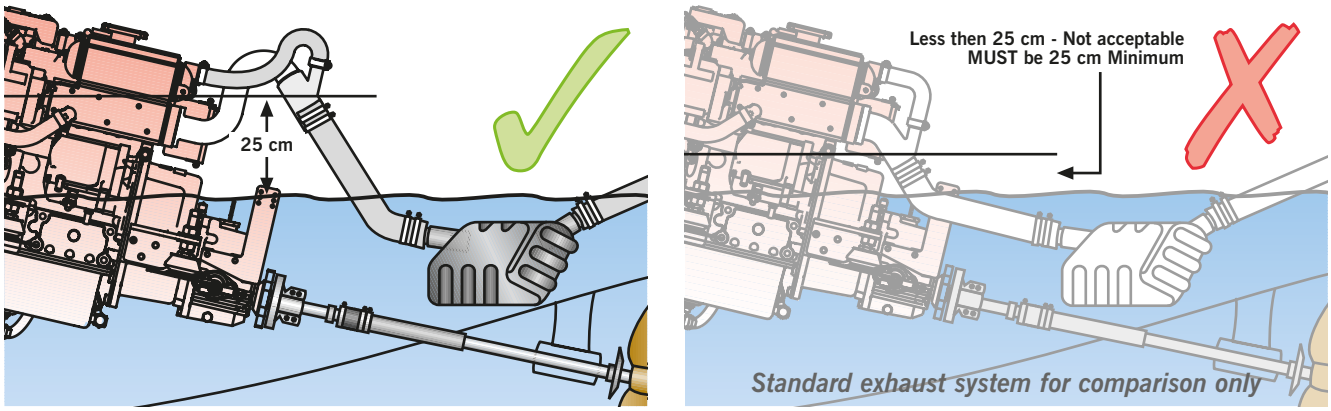
HIGH-RISE EXHAUST

In yachts, engines are mostly installed low down and often below the water line. There are several ways to avoid cooling water entering the engine.

Syphoning of cooling water can occur when the rubber impellor of the sea water pump becomes worn. If our standard injection bend is too low then we can offer a high-rise injection bend that adds 15 cms to the height.

If this is still not enough then you have to fit an 'antisyphon' / vacuum valve 50 cms above the 'loaded' water line sea level (see 13 below).

12 Exhaust with High Rise



EXHAUST WITH ANTI-SYPHON VALVE

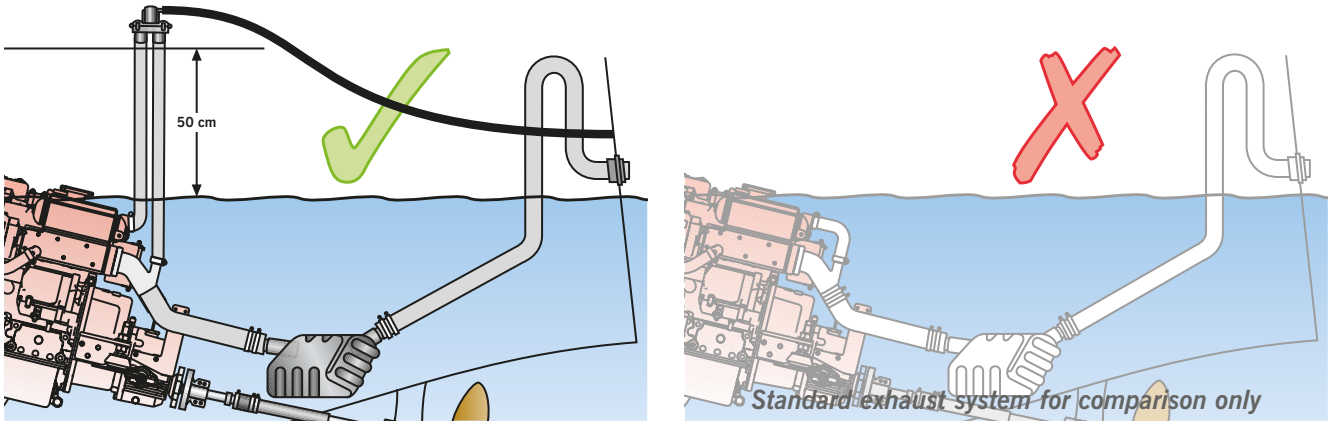
When the engine is installed with the standard injection bend - and the water injection point is still less than 25 cms above the 'static' seawater level or is below it, then you should either install a high rise injection bend adding 15 cms to the height or an anti-syphon valve to resolve the problem.

Some installers will always fit an 'Anti-Syphon' valve in yachts, regardless of the position of the injection bend - just to be as safe as possible. When fitting an anti-syphon valve to a yacht, it must be mounted as near as possible to the centerline so that there is no possibility that the valve goes under the water line when the yacht heels over.

⚠ IMPORTANT!

These valves need to be checked regularly as they have been known to block up with salt crystals over time.

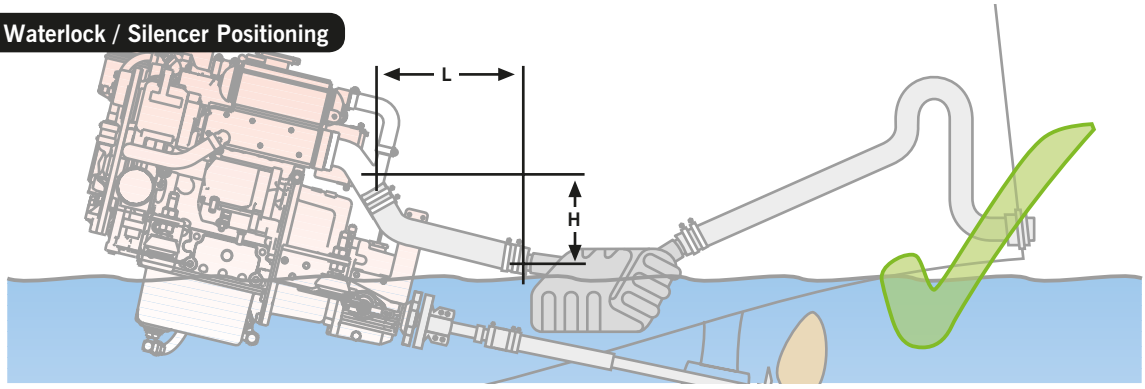
13 Exhaust with Anti-syphon Valve



WATERLOCK / SILENCER

You must always fit a waterlock / silencer to stop any water in the exhaust system back filling the engine. The water lock should always be fitted at least 30 cms away from the injection bend and at least 30 cms below the injection bend, being as low as reasonably possible, so that all the water can drain down into it. The waterlock should have sufficient capacity to hold an exhaust system full of water - draining into it.

14 Waterlock / Silencer Positioning



You should always create a 'gooseneck' with the exhaust hose (or purchase a propriety one) by raising the exhaust hose 40 cms above the waterline before exiting the transom at least 5 cms above the waterline. This will stop any waves pushing seawater down the exhaust.

Position of silencer in relation to exhaust hose length:

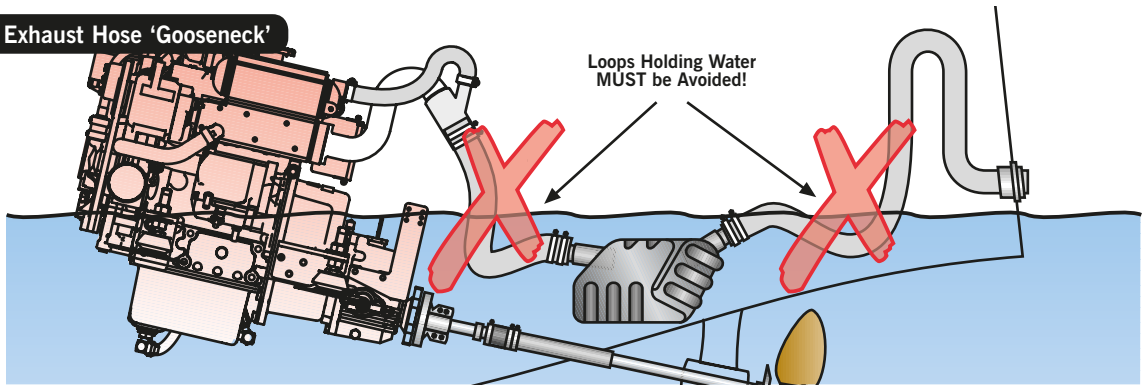
Length (L)	Height (H)
30 cm	30 cm
120 cm	40 cm

IMPORTANT!

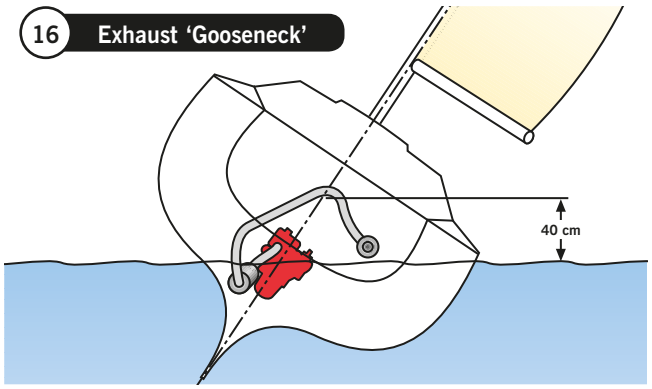
If measurement **'H'** cannot be met, a high rise exhaust injection bend must be installed so that any residual water flows / drains into the waterlock / silencer or overboard.

With longer lengths of exhaust hose you may need to support the hose to avoid a drooping hose and water build up.

15 Exhaust Hose 'Gooseneck'



16 Exhaust 'Gooseneck'



SEA WATER INLET FOR HEAT EXCHANGER COOLED ENGINES

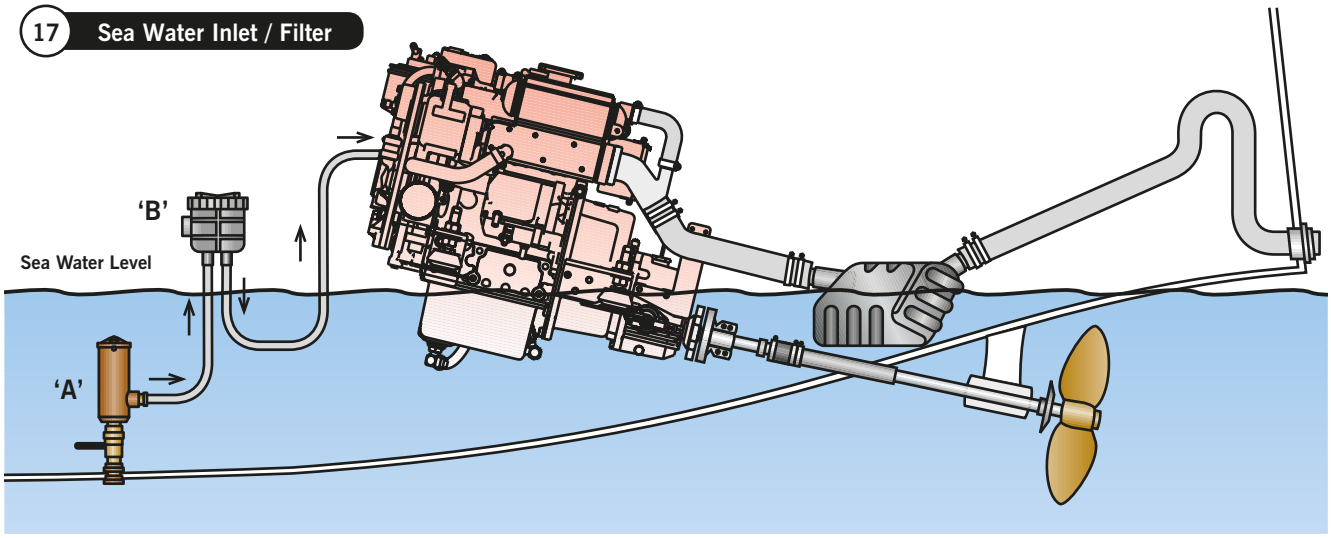
Your engine is fitted with a gear driven sea water pump which sucks in seawater (raw water) to cool the closed circuit system via the heat exchanger.

Engine	Seacock Inlet / Seawater Pump Hose I.D.
Beta 10 to Beta 38	19 mm ($^3/_4$“) min.
Beta 43 to Beta 60	25 mm (1“) min.
Beta 75 to Beta 105	28 mm ($1^1/_4$”) min.

1. It is very important that the seawater inlet should have a strainer system either **‘A’** built into the sea cock, or **‘B’** a high level system with visual inspection glass (as shown) mounted just above the water line.
2. Good access to the inlet sea cock from inside your boat is essential so that plastic bags or seaweed trapped in the intake can be poked out.
3. All pipe work should have approved marine grade stainless steel hose clips. Any loose clamps or bad connections can cause flooding and sinking of the vessel. It is accepted practice that two stainless steel clips should be used at each end of raw water pipes for security. Ensure that you use the correct grade of hose.

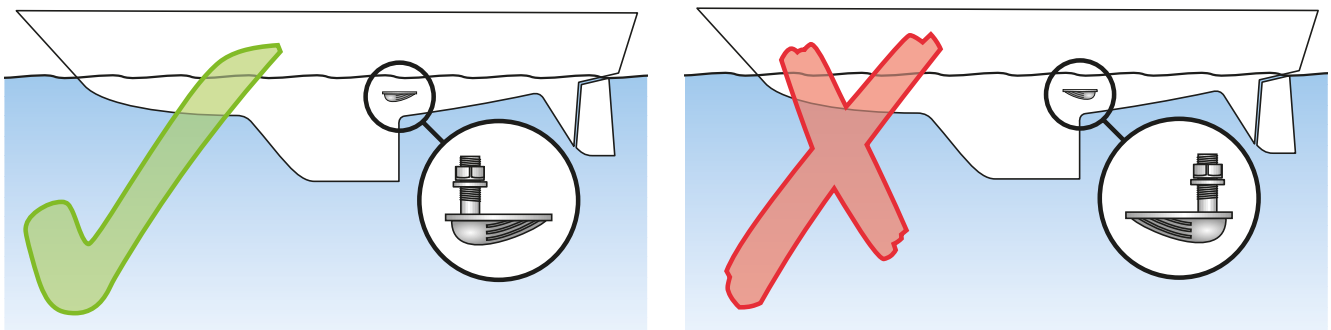
Note: The maximum lift of the sea water pump is 2m when primed.

17 Sea Water Inlet / Filter

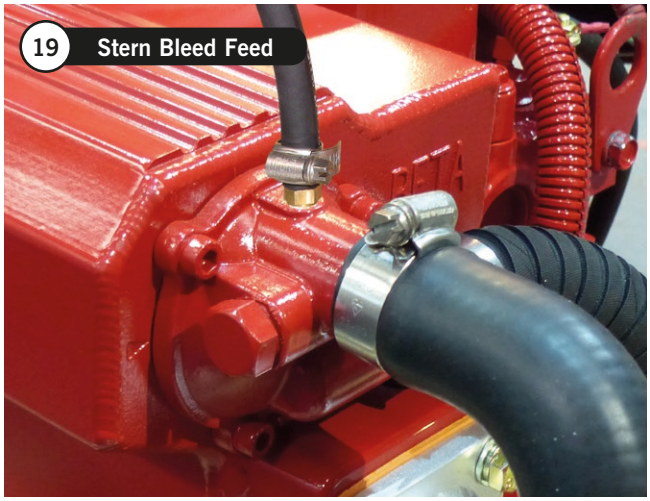


4. A normal inlet sea cock type **‘A’** (as shown in 17 above) is recommended as this can be ‘rodded out’ to remove blockages. We do not recommend the use of ‘Scoop’ type water pickups, because if fitted the wrong way around the water will be forced through the pump and into the exhaust system whilst the vessel is sailing. This is very dangerous as the exhaust will eventually fill and sea / raw water will back up into the engine through the exhaust valve. Catastrophic failure will result as soon as the engine is restarted.

18 Sea Water Inlet - Scoop



STERN GEAR LUBRICATION



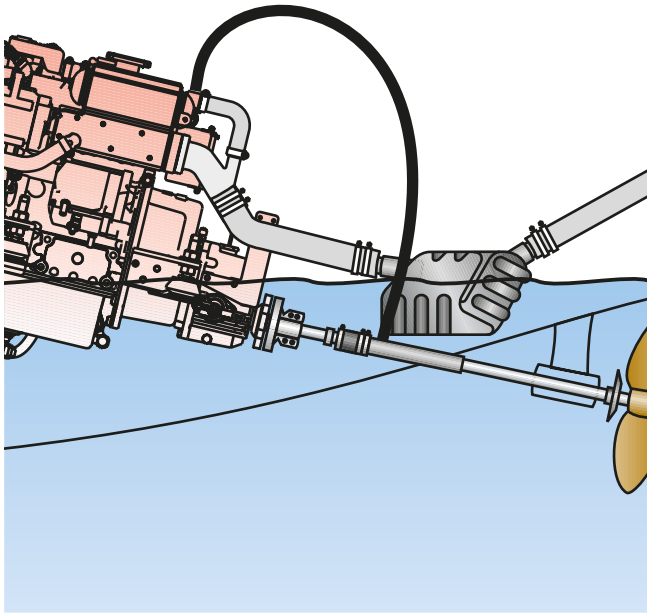
19 Stern Bleed Feed

⚠ IMPORTANT! - ENGINE COOLING

If a 'water feed take off' is required for stern gear lubrication of the cutlass bearing or if you have an anti-syphon valve with 'continuous bleed', then the connection must be taken **after** the heat exchanger (**not** before) and the maximum size should be an 1/8 inch BSP fitting with a 5mm hose.

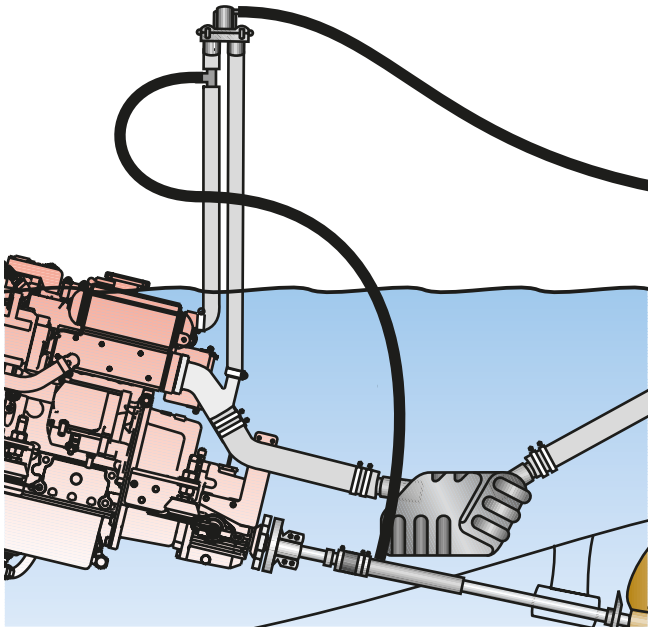
(Installations that have excessive water 'bleed' will effect combustion temperatures and exhaust emissions; and taken to the extreme could either seize the engine and/or melt the exhaust system).

20 Standard Exhaust with Stern Bleed



Beta 10 to Beta 60 - can be connected to the heat exchanger end cap using our 'Stern Bleed kit' and drilling and tapping the end cap.

21 Stern Bleed with Anti-syphon Valve



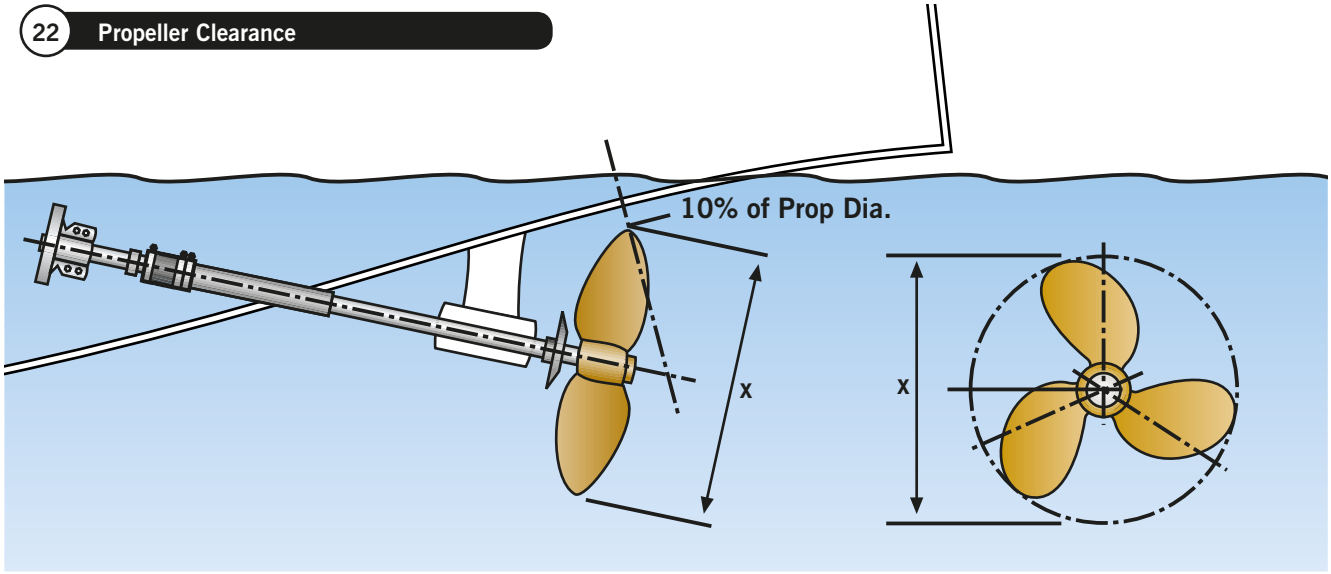
Beta 75 upwards - need a 'T' piece with an 1/8" BSP connection fitted just after the heat exchanger as shown in the drawing. It is important that this 'feed' is taken from the engine side of an anti-syphon valve or you can 'hydraulic' the engine with catastrophic results.

PROPELLER CLEARANCE

There must be a propeller clearance between the tip of the propeller blade and the underside of the hull.

This should be a minimum of 10% of the diameter of the propeller (some say 15%) to reduce 'tip noise'.

22 Propeller Clearance



EXHAUST HOSE

Wet exhaust hose should be matched to the injection bend diameter. An engine correctly installed in accordance with this handbook will meet the emission requirements of the RCD (Recreational Craft Directive).

Engine	Exhaust Hose I.D.
Beta 10 to Beta 60	50 mm
Beta 75 & Beta 90	60 mm
Beta 105	75 mm

EXHAUST BACK PRESSURE

Keep exhaust systems to a minimum length and have gradual bends (NOT right angle elbows). Exhaust back pressure should be as low as possible; it is increased by long exhaust length and sharp bends. Back pressure should be measured with the complete exhaust system connected and the engine running at full speed. The correct measuring point is before the injection bend (at the manifold flange). We can supply a Manometer kit for testing 'Back Pressure'.

Engine	Exhaust Back Pressure
Beta 10 to Beta 25	Max. 70 mm Hg
Beta 30 to Beta 60	Max. 80 mm Hg
Beta 75 & Beta 90	Max. 90 mm Hg
Beta 105	85 to 115 mmHg

DRY EXHAUST INSTALLATION

a) An engine correctly installed in accordance with this handbook will meet the emission requirements of the RCD (see back of manual).

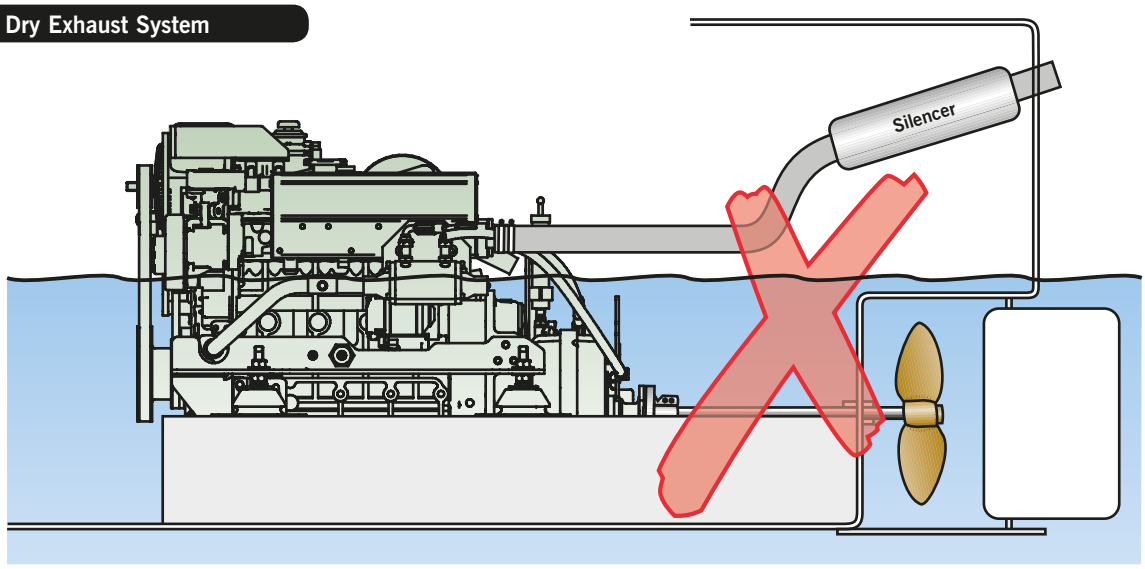
b) Keep exhaust systems to a minimum length and have gradual bends, refer to 'exhaust back pressure' bottom of page 16 for futher information.

c) The dry exhaust system installed in a canal boat or work boat should be $1^1/_2$" minimum internal diameter.

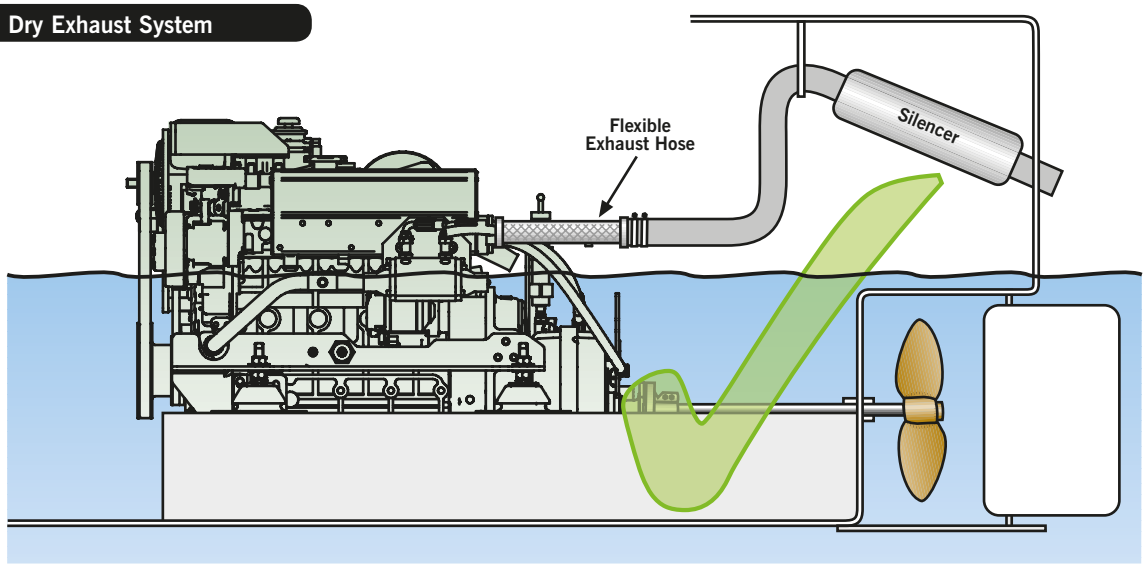
The engine is fitted with a $1^1/_2$" BSP male connector stub as standard - Valid for exhaust systems up to 3 metres in length. A flexible exhaust bellows and dry exhaust silencer should be used. It is up to the installer to work out his own pipe run but care should be taken as follows:

- Never use a flexible exhaust bellow as a bend, it will crack, always keep them straight.
- Ensure that rain water (or any other water - say from the side of the loch) cannot enter the exhaust port and run back down the system, flooding the silencer and eventually the engine (see drawings below).
- The system should be lagged if there is any danger of the crew getting near it.
- A dry exhaust system will give off considerable heat and suitable insulation and ventilation must be provided.

23 Dry Exhaust System



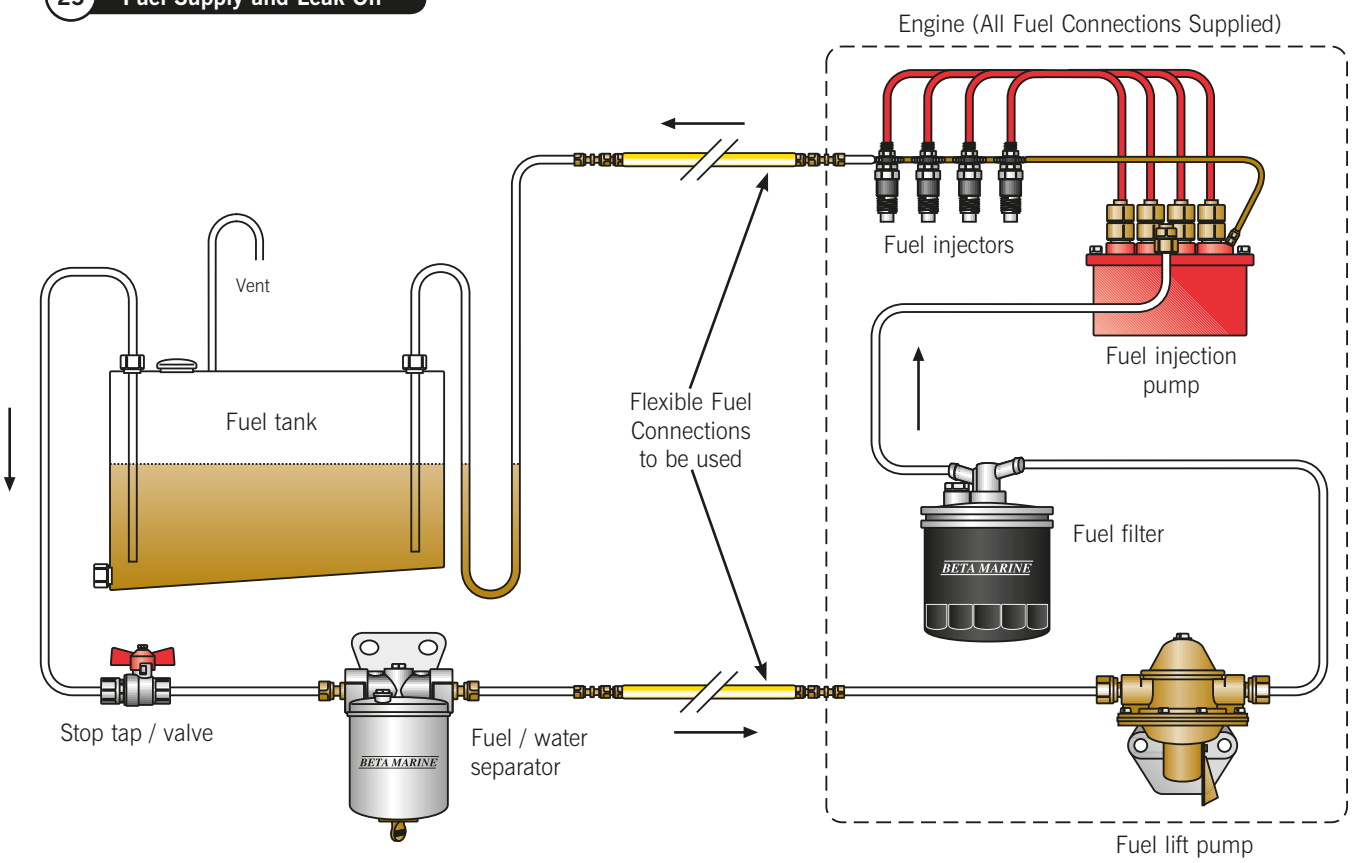
24 Dry Exhaust System



Ensure exhaust raises then falls to outlet

FUEL SUPPLY & LEAK OFF

25 Fuel Supply and Leak Off



NOTES:

1. **A fuel / water separator must be installed.**
2. The mechanical fuel lift pump is fitted to all engines as standard, but if a suction head of 0.25m or more is required, then an electric fuel lift pump must be fitted (ask your dealer or Beta Marine).
3. It is very important that the excess fuel from the injectors is fed back to the fuel tank and not back to any point in the supply line. This will help prevent air getting into the system.
4. The fuel return (leak off) pipe must loop down to be level with the bottom of the tank before it enters the top of the tank – see drawing. This prevents fuel 'drain down'.
5. Fuel lines and hoses connecting the fuel tank to the engine, must be secured, separated and protected from any source of significant heat. The filling, storage, venting, fuel supply arrangements and installation must be designed and installed so as to minimise the risk of fire. When connecting the engine to the fuel supply and return lines, flexible fuel hoses must be used (next to the engine) and must meet the requirements detailed in standard ISO7840:1995/ A1:2000 and/or as required by your surveyor / authority.
6. Any fuel leaks in the system when static are likely to cause poor starting and erratic running and must be corrected immediately. These leaks will allow air to be sucked in when the engine is running.

FUEL CONNECTIONS

Engine Connector	Hose O.D.
Fuel supply and leak-off connections are 8 mm conex with olives	8 mm O.D. piping for both, a flexible section is required

CALORIFIER SYSTEM

All Beta engines can be fitted with the calorifier connections to allow the coolant from the closed circuit cooling system to circulate through a calorifier tank, which in turn heats up domestic water. Calorifier connections on this range of engine are shown.

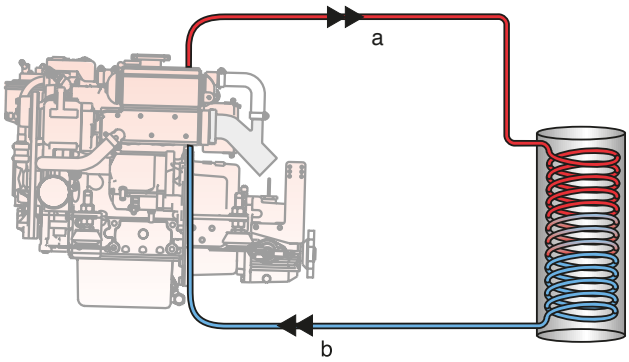
1. The big problem with a calorifier is to remove all the air from the system. If this is not achieved then they don't work!
2. Try and keep the supply and return pipes either horizontal or sloping down in a continuous fall towards the calorifier. This avoids air pockets being created.
3. Extra care must be taken when first connecting the calorifier circuit system to the engine as the coolant level in the heat exchanger may appear to be full but it soon disappears into the calorifier pipe work. Run the engine off load for 10 minutes then check the level as described in 'Filling The Fresh Water System'. Also check to see if the pipe going to the calorifier is getting warm. Top up the water level as required and run for another ten minutes then repeat.
4. If the water level is steady but no warm water is getting to the Calorifier then (with engine stopped) very carefully remove the pressure/filler cap using a large rag/cloth to protect you hand from scalding. Now very carefully open the Calorifier bleed valve (see manufacturers instructions) or if none is provided then very carefully loosen the jubilee clip securing the supply pipe to the Calorifier. Air should escape. Refasten securely when no further bubbles are seen.
5. If the calorifier tank is fitted above the heat exchanger / header tank then you will need to fit a remote header tank slightly above the calorifier tank.

⚠ CAUTION:

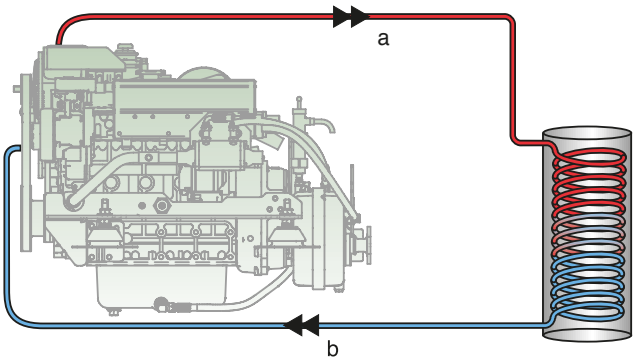
TO AVOID PERSONAL INJURY!

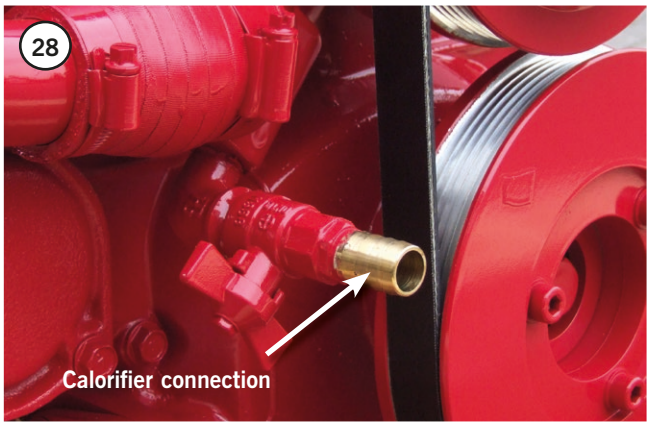
Do not do this when the engine is hot as scalding hot water may be forced out of the pipe under pressure.

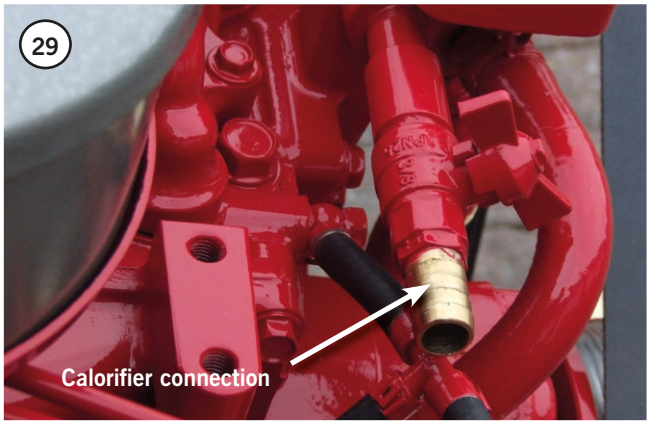
26 Heat Exchanger Calorifier System



27 Keel Cooled Calorifier System







CANAL BOATS WITH KEEL COOLERS

The majority of narrowboats on English canals have keel cooling, and this is our standard cooling arrangement for our 'Green Line' Narrowboats and 'Wide Beamers' (heat exchanger cooling is available as an option if required).

Narrowboats: These keel cooling 'skin' tanks are normally welded into the 'swim' of the narrowboat. They use the hulls' 8mm steel plate as one side of the keel cooling tank that transfers the engine heat into the canal water. The larger the engine / horse power the larger the 'skin' tank surface area that is required for keel cooling our engines. Keel cooling pipes under the hull of yachts or work boats, that achieve the same surface area can also be used.

Generally the keel cooling tank should have a surface area that is exposed to the canal or sea water of:
0.25 x the hp of the engine = the square feet of cooling tank area required (for steel hulls)

Engine (Narrowboats)	B14	B16	B20	B25	B30	B35	B38	B43	B50
Steel Tanks (Ft^2)	3.5	4.0	5.0	6.3	7.5	8.0	9.5	10.8	12.5
Steel Tanks (M^2)	0.33	0.38	0.46	0.59	0.70	0.82	0.88	1.00	1.16

Engine (Wide Beams)	B50	B60	B75	B90	B105	B110	B150
Steel Tanks (Ft^2)	12.5	15.5	18.8	22.5	25.0	27.5	37.5
Steel Tanks (M^2)	1.16	1.43	1.75	2.09	2.32	2.55	3.50

The ideal keel cooling tank should:

a) Efficient keel cooling tanks are side mounted, as detailed in the illustration.

b) The rubber hoses connecting the engine to the keel cooling tanks should be designed and manufactured as hot water heater hoses suitable for operation up to 100°C.

c) The 'baffle' must be continuously welded to the outer skin and to one end as shown, and should be close to the inner skin.

Engine	B14 - B25	B30 - B60	B75 - B105	B150
Supply & Return Pipe	22mm	28mm	38mm	41mm
Baffle Gap Minimum	35mm	40mm	55mm	60mm
Baffle Gap Maximum	65mm	85mm	115mm	125mm

d) The tank should be thin in section (H = 30mm to 40mm) as it is the heat transfer to the canal or river water that is important.

e) The engine coolant for keel cooling (is the same 50:50 ratio of fresh water / antifreeze solution as heat exchanger cooling) and flows around the engine, then the keel cooling tanks, before returning to the engine.

f) The keel cooling tank must have air bleed valves fitted on the top at both ends of the tank.

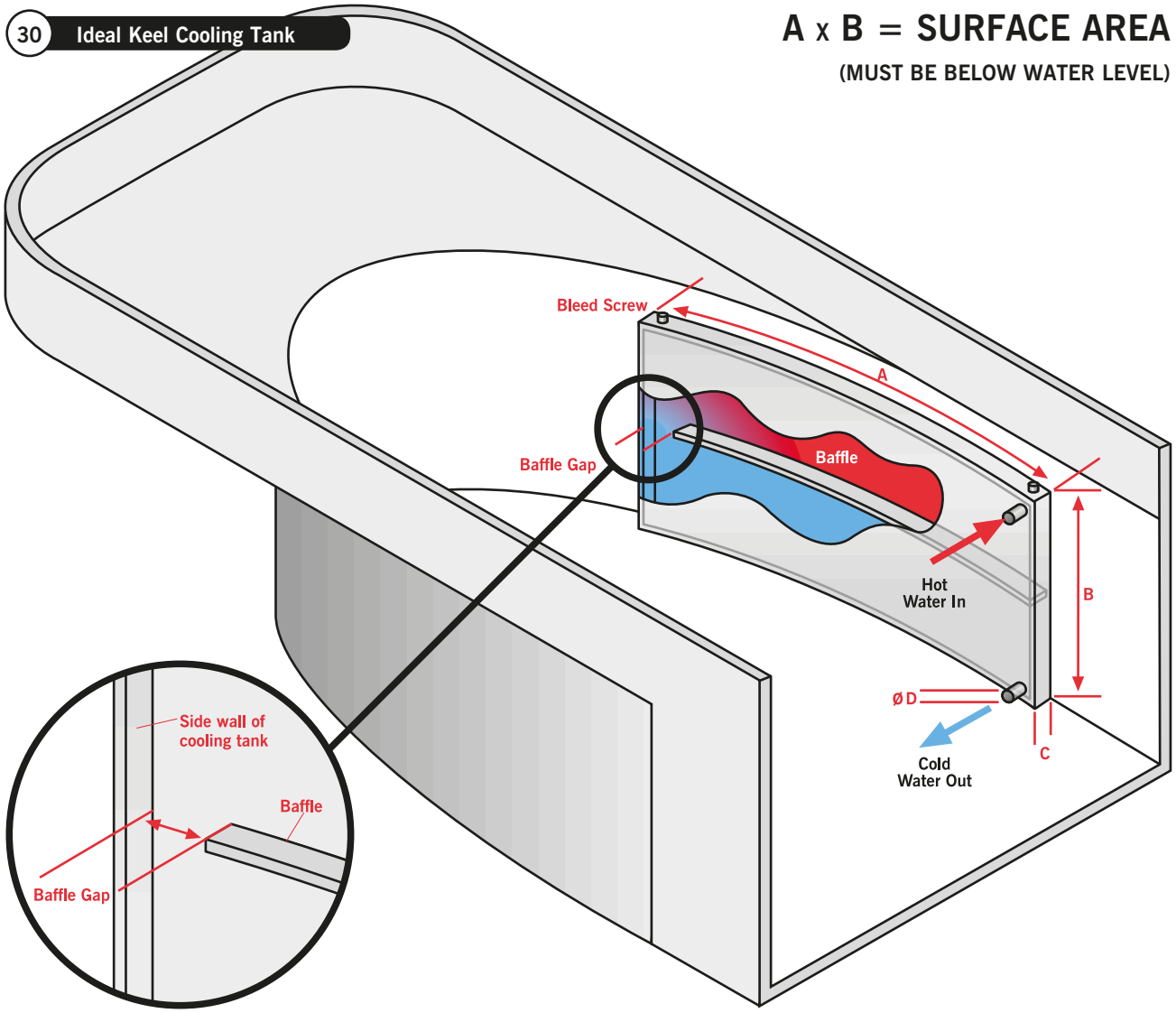
g) The hot water feed enters at the top of the tank and the colder engine return comes out of the bottom.

Note: If your boat has a hydraulic drive, you will need to increase the surface area of the keel cooling tanks by approximately 30% percent. If you have any questions about keel cooling please refer to our design guidelines detailed on our website, or ask us.

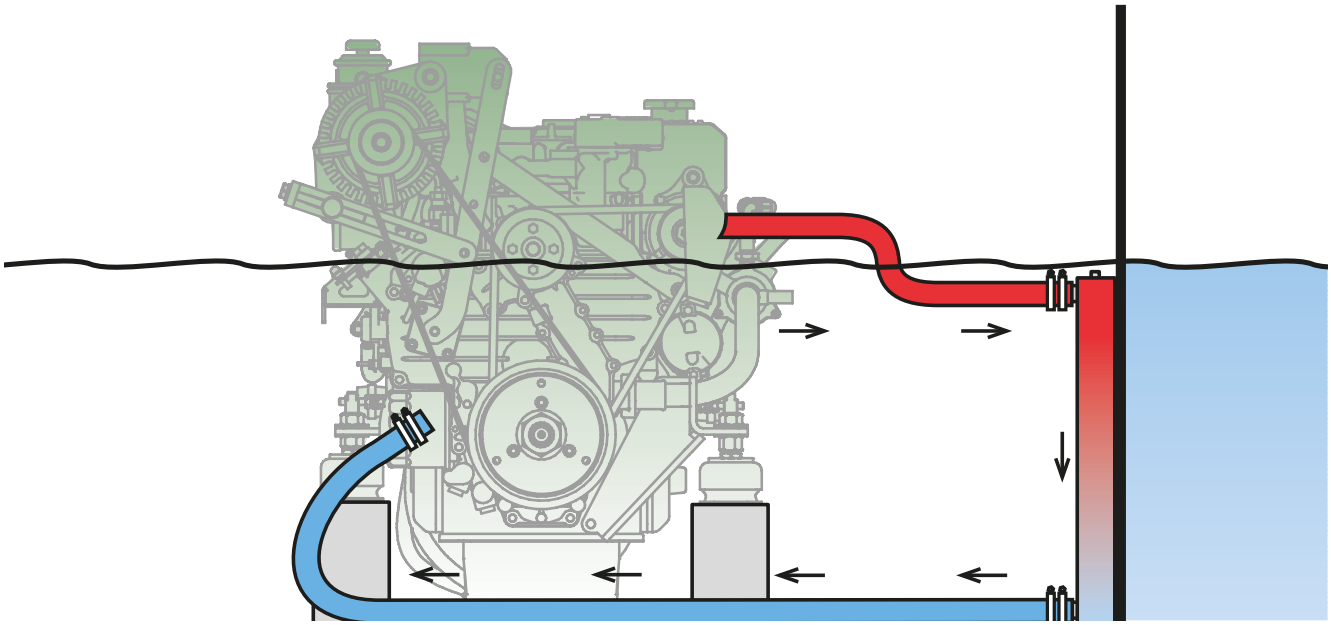
30 Ideal Keel Cooling Tank

A x B = SURFACE AREA

(MUST BE BELOW WATER LEVEL)



31 Ideal Keel Cooling Tank



ELECTRICAL INSTALLATIONS

All our engines are supplied with 12 volt electric starting as standard. We therefore supply the main components: starter motor, battery charging alternator, fuel control solenoid, glow plugs, engine temperature sensor, oil pressure sensor, control panel and a wiring loom connecting everything together. We do **not** supply as standard either the starter batteries or battery cables.

CONTROL PANELS

Heat Exchanger Cooled - We offer 5 control panels: the ABV is standard and the A, ABVW, B, C and D are optional. The engine harness is common to all. With our **Keel Cooled** Canal range the AB panel is standard or the 'C' panel is optional.

1. Control Panels must be fitted in a location where the helmsman can either see or hear the alarm system.
2. Our control panels are supplied as standard with a 3 metre multi-core cable for connection to the engine wiring loom. As an optional extra, Beta can provide various lengths of extension looms for runs of 5m or more, and this kit includes a start relay to overcome the voltage drop. (See drawing 300-58520).
3. For standard wiring diagrams see back of manual.
4. All electrical equipment must be protected from sea water. Sea water or rust in the starter motor will invalidate the warranty. Care must be taken when pushing the two halves of the plug together to ensure that individual pins do not fall out. To prevent corrosion and assist in assembly we recommend that the plug is packed with petroleum jelly (Vaseline) and then carefully pushed together. The plastic boots should cover both halves and overlap. A cable tie is then put around to hold the two halves in position and help prevent any ingression of water.
5. The control panels must not be installed where sea water spray can get at them. We recommend that a suitable flap or cover is fitted.
6. All cables must be adequately clipped and protected from abrasion.
7. Electrical systems shall be designed and installed so as to ensure proper operation of the craft under normal conditions of use and shall be such as to minimise risk of fire and electric shock.
8. Attention shall be paid to the provision of overload and short circuit protection of all circuits, except engine starting circuits, supplied from batteries.
9. Ventilation must be provided to prevent the accumulation of gases, which might be emitted from batteries. Batteries shall be firmly secured and protected from ingress of water.

BATTERY INSTALLATIONS - SOME CONSIDERATIONS

We would recommend keeping the electrical part of the engine installation as simple and as reliable as possible. We would suggest a dedicated battery for engine starting and if required, a domestic battery bank for other requirements.

Selecting the correct starter battery and battery cables is important as incorrect selection is a major cause of starting failure.

BATTERIES

1. **There are several different types of battery available to choose from:** a) Wet Lead Acid (invented in 1859); b) AGM (Absorbed Glass Mat - developed in 1972 as sealed Lead Acid); c) Gel (with a gelified electrolyte) developed in 1980; and d) Lithium-ion produced in 1991.

   With boats there are two different requirements: a) A battery to drive the starter motor and b) A battery bank to power your domestic / auxiliary needs such as GPS, navigation equipment, lighting, music etc... **We recommend that you talk to a battery specialist for guidance.**
2. Climatic conditions will affect power output from batteries and at low temperatures the battery capacity will need to be increased as performance will decrease. (At minus 10 degrees centigrade battery output would be under 50 percent of normal output). This needs to be considered when first selecting your batteries.

3. All our engines are supplied with one battery charging alternator, sometimes two. Our electric starting circuit is nominal 12 volts and we fit as standard a 40 amp battery charging alternator up to Beta 25, and a 70 amp alternator from the Beta 30.

4). Battery size depends upon your requirements. For starter motor batteries the battery size should be based upon the starter motor requirements - table below, and never be of less capacity than the battery manufacturers recommendation. (You could oversize your battery by up to 20% to allow for gradual loss of capacity due to age and temperature etc.) - **If in doubt - ask.**

Typical starter motor ratings with Kubota engines

			Suggested Minimum Battery Size		
Starter Capacity (kW)		**Engines**	**Typical AH @ 20 hour rate**	**Typical AH @ 5 hour rate**	**Typical CCA (Cold Cranking Amps)**
Less than 800cc	0.8 - 1.0	Beta 10 to 20	35 to 50 AH	28 to 40 AH	350 to 400
800 to 1,900cc	1.0 - 1.4	Beta 25 to 38	65 to 75 AH	53 to 62 AH	450 to 540
1,900 to 3,000cc	1.4 - 2.5	Beta 43 to 70	100 to 120 AH	80 to 96 AH	580 to 670
Over 3,000cc	2.5 - 3.0	Beta 75 to 105	150 to 180 AH	120 to 144 AH	1050 to 1200

5. If you require a domestic battery bank you will need to calculate your power requirements, and then multiply that by the number of hours you will need this power (before you are able to re-charge the batteries). To keep the installation simple and reliable we would recommend a second alternator for a domestic battery bank.

6. Battery charging alternators must be suitable for the battery bank size. With 'Lead Acid' batteries it is recommended that if you wish to achieve a long battery life of 5 years and more - your alternator should be charging in Amperes at about 10 to 20 percent of the battery bank in 'Ampere Hours' (20 Hr rate).

   Generally it is very easy to recharge to about 80 percent of battery capacity, but the last 20 percent is important if you wish to achieve a long battery life, and this can require an overnight charge. Battery life and recharging tends to be a compromise and it is generally recommended that the alternator output 'in amperes' is not more than 25 percent of the 'Ampere Hours' rating of the battery bank. The battery charging system must be a balanced solution; you must have enough battery capacity but bear in mind the recharge capability.

   Generally it will take as long to recharge a battery as it does to discharge a battery. I know that this is an obvious statement but you can only recharge your batteries when the engines is running, so if you only use the engine for entering and leaving a marina you may need an alternative solution for recharging your batteries. Solar panels can be a good solution for keeping batteries 'topped up'.

7. Batteries must be in good condition and must hold voltage. An idle standing battery would be expected to be at least 12.6 volts and we would like to see at least 12v on the starter motor terminals. (After a full charge the terminal voltage drops quickly to 13.2 V and then slowly to 12.6 Volts).

8. The maximum charging voltage for a Lead Acid battery is about 14.8 volts, above this voltage damage will occur. We would expect a maximum output voltage from our battery charging alternators of something like 14.8 volts at no load. At 50 percent load the voltage drops to 14.3 to 14.4 volts and at full output the voltage is 13.5.

9. Battery terminals and connections must always be kept clean, in good condition and tight. Faulty connections can lead to poor performance and even (in extreme conditions) explosion.

BATTERY CABLES

1. Starter batteries should be as close to the engine as practically possible. The reason for this is to ensure that the maximum voltage from the battery is available to the starter motor. The longer the cable run - the more will be the voltage drop. This is due to the resistance of the cables.
2. Generally speaking for smaller engines (say under 60hp) we recommend battery cables of 25mm^2 conductor cross sectional area with length up to 1.5m per cable. That equals a cable run of 3m total which would have a voltage drop in the region of 0.8v if the starter motor was using 160 amps when motoring. Battery cables that are too small will overheat and their insulation could catch fire.
3. When the supply is switched on to the starter motor there will be a massive inrush of power in the region of 5 times the motoring current. The battery will be expected to supply this inrush and then recover sufficiently to give the motoring or 'rolling' current. If the correct battery is selected but the engine will not crank at sufficient speed after the inrush then (assuming battery cables are the correct size) the battery is either discharged or faulty.
4. If the voltage at the starter motor terminals after the inrush is not at least 10.5 volts it is likely that the motor will either crawl at insufficient speed or not turn at all. Battery cables could overheat.
5. Battery cables are sized on the motoring or rolling current of the starter motor and the length of battery cable run. This length is the total distance of both the positive and negative cables added together. Under normal circumstances the voltage drop in the starter battery cable circuit should not exceed 0.8 volt and in any circuit should not exceed 1.2 volts.
6. Please note that cranking time should be no longer than 10 seconds, with at least a 10 second rest between attempts.

25mm^2 Cable

Engine	Cranking Amps	Cable Volt drop*	Max length, both cables added together
Up to Beta 38	100	0.0017V	4.7m
Up to Beta 50	120	0.0017V	3.9m
Up to Beta 60	170	0.0017V	2.8m
Up to Beta 105	210 / 250	0.0017V	Not suitable
Beta 150	333	0.0017V	Not suitable

35mm^2 Cable

Engine	Cranking Amps	Cable Volt drop*	Max length, both cables added together
Up to Beta 38	100	0.0013V	6.2m
Up to Beta 50	120	0.0013V	5.2m
Up to Beta 60	170	0.0013V	3.6m
Up to Beta 105	210 / 250	0.0013V	2.5m
Beta 150	333	0.0013V	1.8m (70mm^2 cable preferred)

70mm^2 Cable

Engine	Cranking Amps	Cable Volt drop*	Max length, both cables added together
Up to Beta 38	100	0.00063V	12.7m
Up to Beta 50	120	0.00063V	10.5m
Up to Beta 60	170	0.00063V	7.5m
Up to Beta 105	210 / 250	0.00063V	5.0m
Beta 150	333	0.00063V	3.8m

*Voltage drops for pvc insulated cables are ex table 9D1 of the IEE Wiring Regulations.

The above are based on a maximum conductor temperature of 70°C in an ambient temperature of 30°C.

Please note that it is not practical to use table 9D1 of the IEE Wiring Regulations for larger sizes. We are after all talking about short duration power flow not continuous ratings for the starter motor.

At the end of the day what matters is the voltage at the starter motor terminals before starting and whilst cranking, all without destroying the insulation on the cables.

KEYSWITCH TERMINATIONS

The standard panel keyswitch can be used to tap off a switched positive ignition feed to power additional gauges. In this way these gauges will only be live whilst the engine is running, the engine is starting or the heaters are being used.

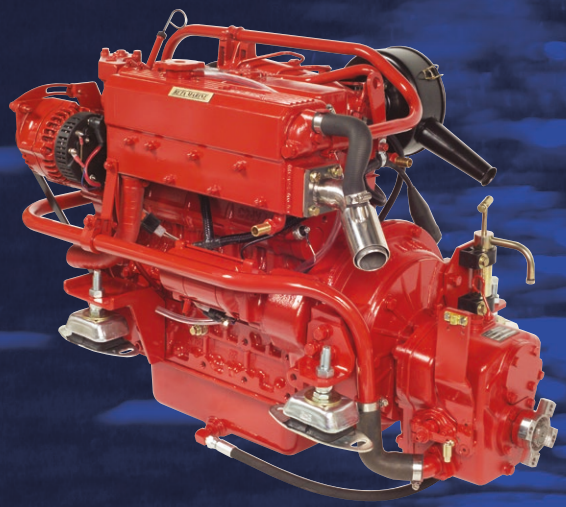
For silver keyswitches, the terminal to achieve this ignition switched positive is marked 'AC'.

For panels without any keyswitch, gauges can be driven from the 1mm^2 brown wire which terminates at 11 way connector terminal 4. This is a lower power switched positive, any additional power required from this connection must be feed through a relay, as noted below.

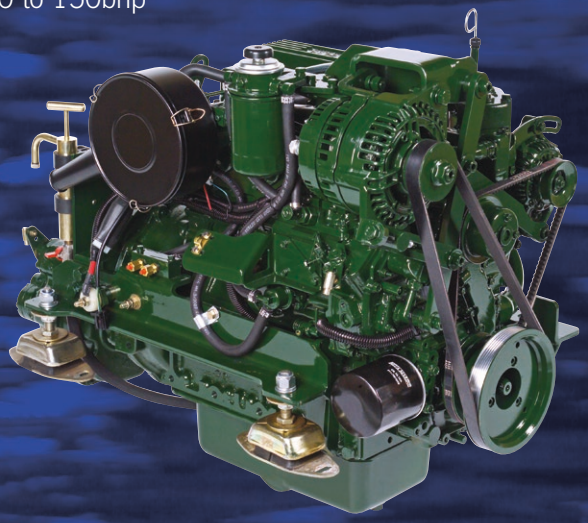
Note: these keyswitch terminals are rated at 10 amps maximum, since they are already utilised for panel and alternator feeds Beta Marine recommend any additional requirements from these terminals must be fed through a relay. This relay should then be connected to it's own fused positive supply directly from the engine battery.

Beta drawing 202-06421 illustrating the wiring of a typical electric fuel lift pump with ignition switched relay can be supplied upon request.

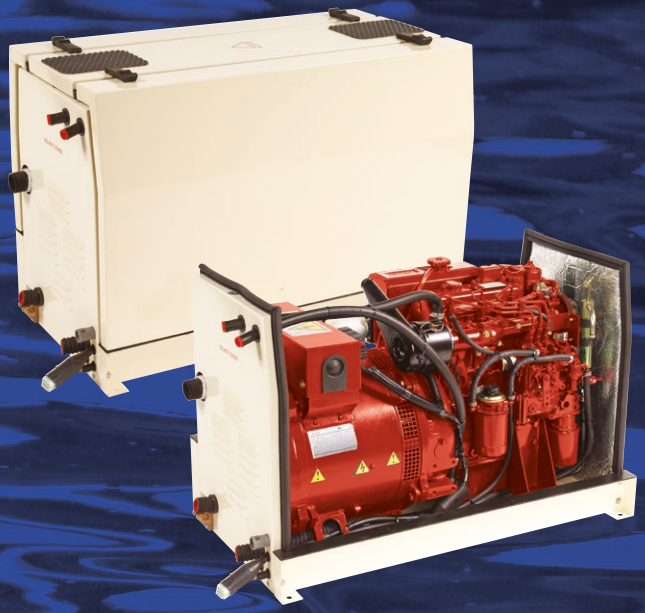
Heat Exchanger Cooled
10 to 150bhp



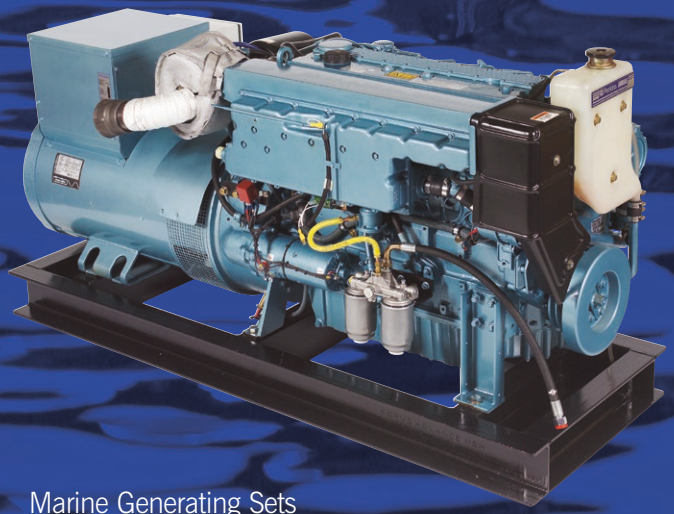
Keel Cooled
10 to 150bhp



Marine Generating Sets
4 to 40kVA



Sail Drives
13.5 to 56bhp



Marine Generating Sets
30 to 1000kVA

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