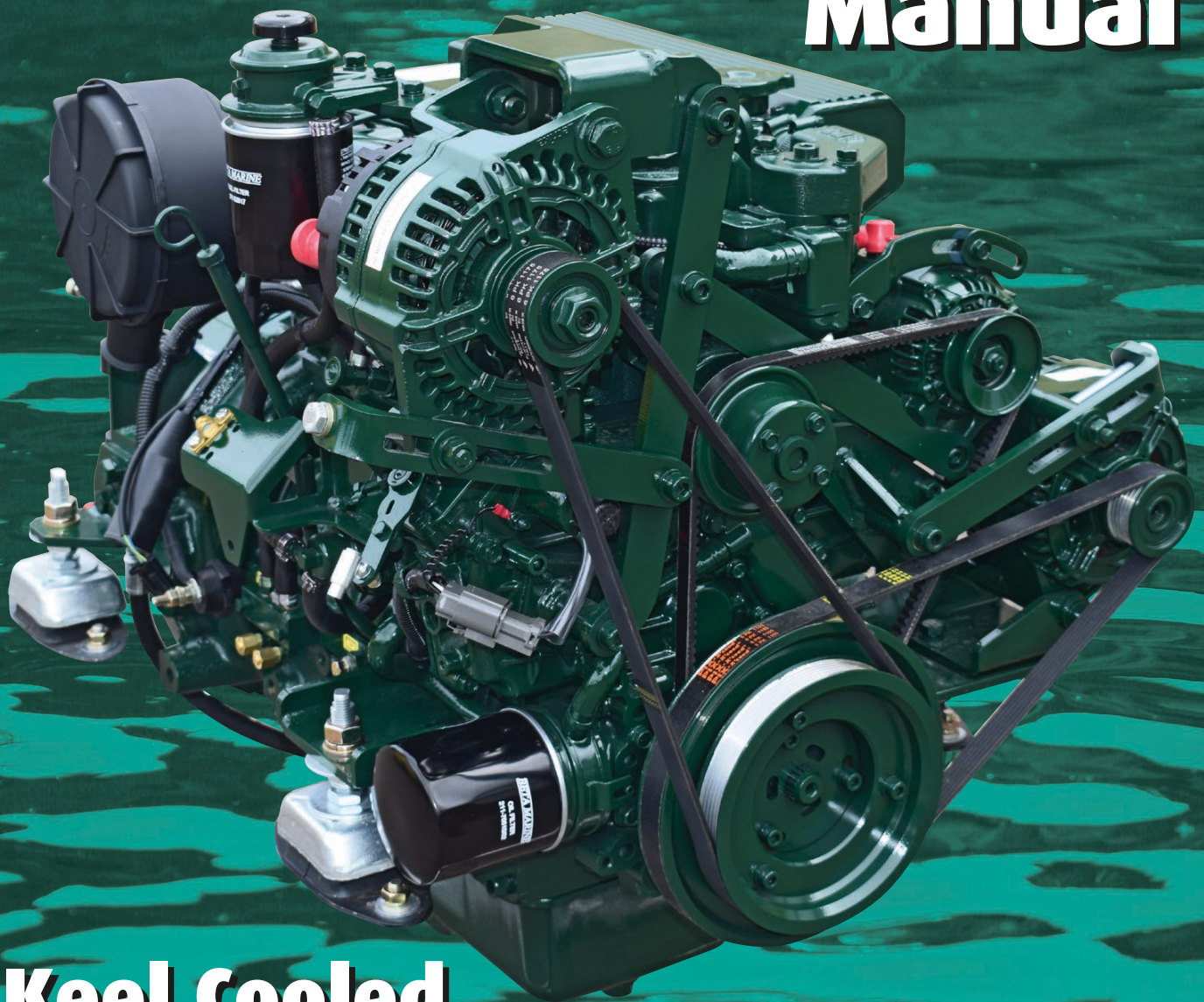
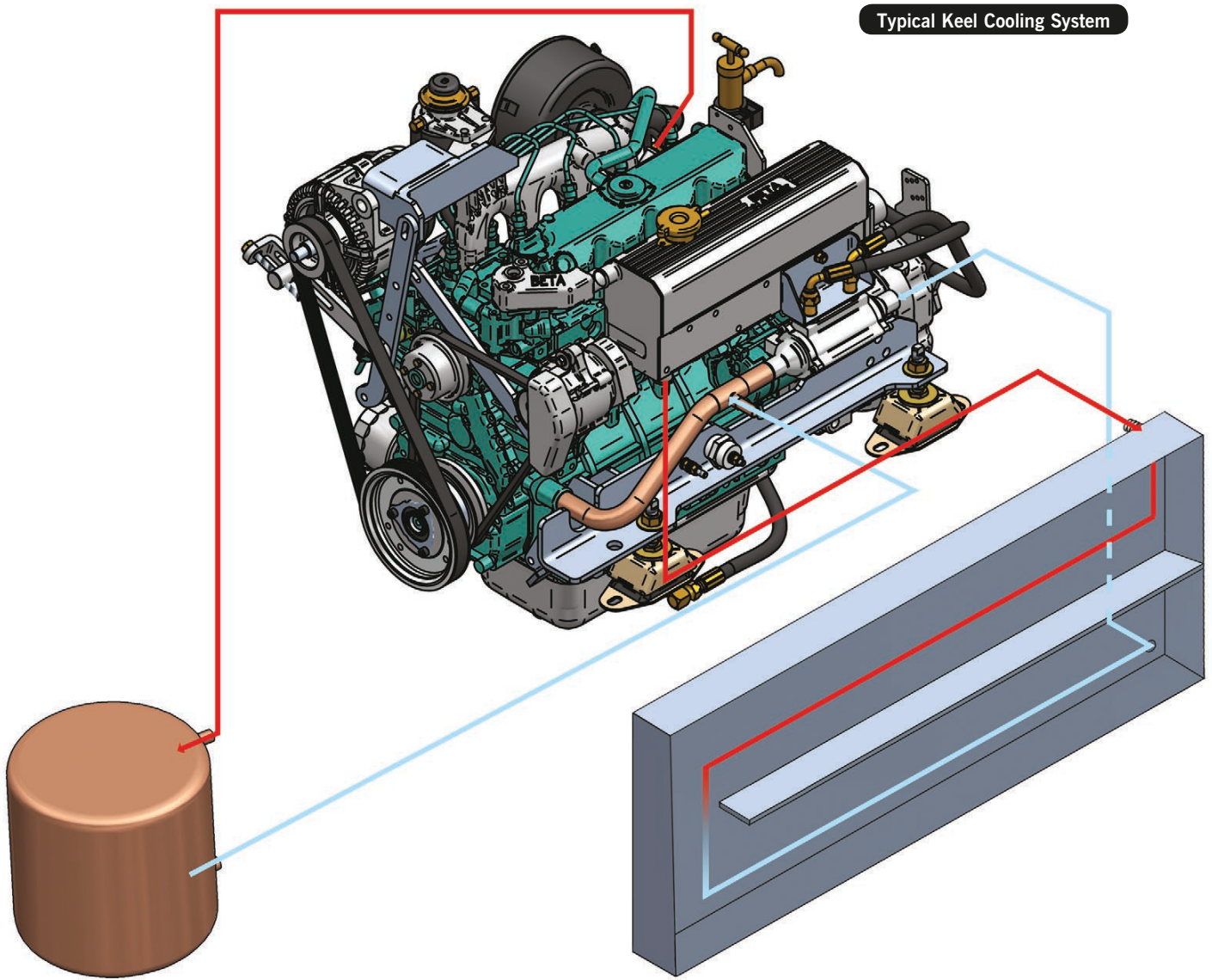

BETA MARINE

Operators Maintenance Manual



**Keel Cooled
Mid Diesel Engine Range:
Beta 43, Beta 50 & Beta 60**



Engine Identification



IMPORTANT!

To ensure you receive the correct advice or parts we ask you to always provide the WOC (Works Order Card) number and/or the engine serial number. Please refer to page 4.

Engine Type:	Power: bhp	Speed: rpm
BETA WOC NO: K		
Gearbox Type:		
Purchased From:		
Invoice Number:		
Date Commissioned:		
Specification/Special Details:		

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OPERATION AND MAINTENANCE MANUAL FOR THE FOLLOWING BETA MARINE ENGINES BASED ON KUBOTA

Beta 43, Beta 50 & Beta 60

WELCOME TO BETA MARINE

Thank you for purchasing a Beta Marine Engine. We have produced this manual to provide you with important information and recommendations to ensure the most trouble free and economical operation of the engine possible.

As manufacturers, we have written this "Operators Maintenance Manual" from a technical viewpoint assuming a certain amount of understanding of marine engineering. We wish to help you, so if you do not fully understand any phrase or terminology or require any explanations please contact Beta Marine Limited or its distributors and we will be pleased to provide further advice or technical assistance.

All information and recommendations given in this publication are based on the latest information available at the time of publication, and are subject to alteration at any time.

The information given is subject to the company's current conditions of Tender and Sale, is for the assistance of users, and is based upon results obtained from tests carried out at the place of manufacture and in vessels used for development purposes. We do not guarantee the same results will be obtained elsewhere under different conditions.

▼ FREQUENTLY USED TOOLS

Useful tools when working on Beta 43, 50 & 60 engines are:



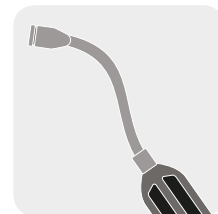
Sockets and/or spanners in sizes:

**10, 12, 13, 14,
17, 19, 22 & 24mm**



Allen key in sizes:

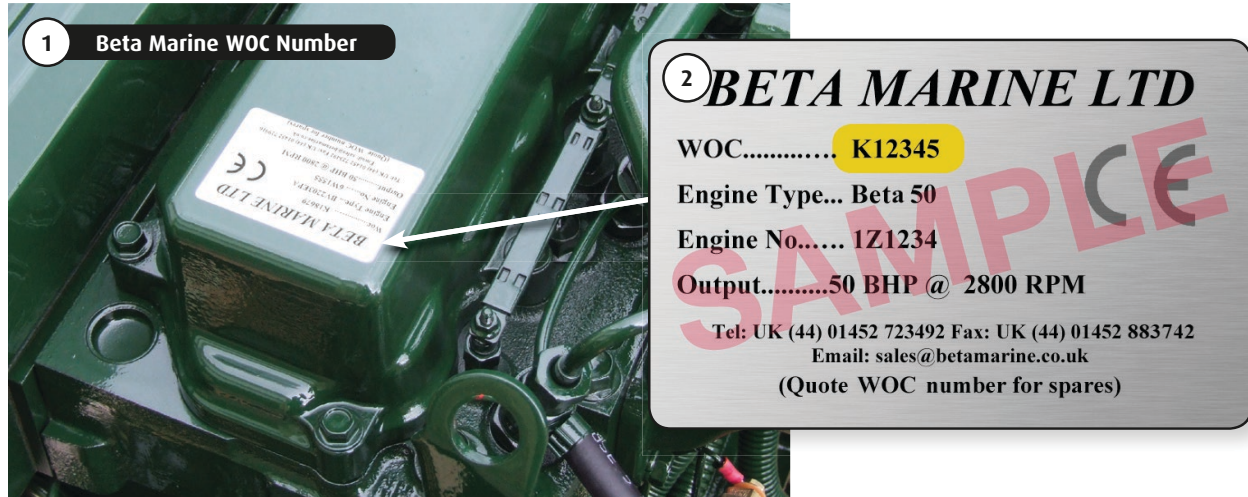
5, 6, 8 & 10mm



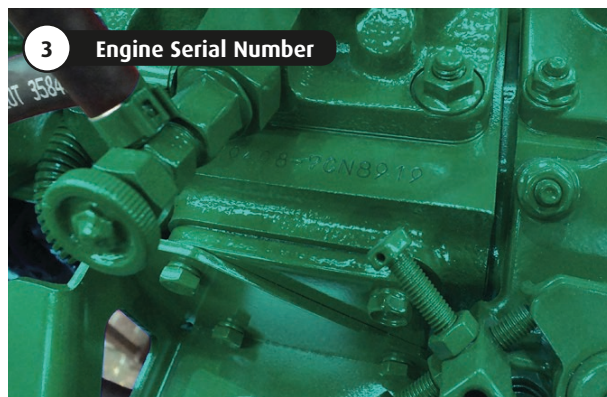
When working on jubilee clips on hoses in restricted or awkward positions a **7mm flex-drive socket** is highly recommended.

▼ ENGINE IDENTIFICATION

⚠ IMPORTANT! - To ensure you receive the correct advice or parts we ask you to always provide the **WOC (Works Order Card)** number and/or the **engine serial number**.



▼ BETA 43, BETA 50 & BETA 60



The engine serial number is shown on the rocker cover label. It is also stamped on the crank case just below the fuel injection pump on the starboard side of the engine.

▼ INITIAL RECEIPT OF THE ENGINE

A full inspection of the engine must be made **immediately on delivery** to confirm that there is no damage. If there is any damage then write this clearly on the delivery note and inform your dealer or Beta Marine within 24 hours. It would be appreciated for any claims to be supported by relevant photographs.

▼ ENGINE STORAGE

The engine must be stored in a dry, frost free area and this is best done in its packing case. If storage is to be more than six months then the engine must be inhibited (contact your dealer or Beta Marine). Failure to inhibit the engine may result in the formation of rust in the injection system and the engine bores, this could invalidate the warranty.



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 - 550°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 Growcoat, 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 2013/53/EU is complied with.

Technical Specifications

Standard Engines	Beta 43	Beta 50	Beta 60
Cylinders	4	4	4
Bore (mm)	83	87	87
Stroke (mm)	92.4	92.4	102.4
Displacement (cc)	1999	2197	2434
Combustion	Naturally aspirated*	Naturally aspirated*	Naturally aspirated*
Power Output EN ISO 8665 (kW)	32.6	36.0	41.0
Power Output EN ISO 8665 (at rev/min)	2,800	2,800	2,700
Maximum Torque (N m)	130.3	143.2	158.6
Maximum Torque (at rev/min)	1,600	1,600	1,600
Capacity of Standard Sump (litres)	9.5	9.5	9.5
Capacity of Shallow Sump (litres)	7.0	7.0	7.0
Nett Dry Weight with Gearbox (kg)	270	300	310
Fuel	Diesel Fuel Oil to EN 590 or ASTM D975		
Coolant	30 < 50% anti-freeze** : 70 > 50% water		
Coolant Capacity Approx. (H/E litres)	7.4	7.4	7.4
Plus Keel Cooling Tank Size (litres)	Capacity to be measured by Owner		
Electrical Starting - Standard	12 Volt		
Starter Motor Output (kW)	1.4	1.4	2.0
Alternator (Battery Charging) - Standard	70 Amps		
Min. Recommended Battery Capacity	12 Volt, 94 Ah (620 CCA Minimum)		

* Three vortex combustion, naturally aspirated with indirect injection.

** Always use a Mono Ethylene Glycol Based Extended Life Anti-freeze mixed 30 < 50% with water.

Maximum Angle of Installation: 15° flywheel up or flywheel down when static; and up to 25° when heeling.

Rotation: Anti-clockwise on flywheel, clockwise on output gearbox output flange - for use with right hand propeller in ahead, with mechanical gearboxes. Hydraulic gearboxes can be left or right handed.

Fuel: Diesel fuel must conform to EN590 or ASTM D975.

Engine Lubrication: Engine oil must meet API Classification CF (CD or CE have been superseded by CF).

Gearbox Lubrication: See gearbox operator's manual for the gearbox oil type and capacity. Please refer to page 35.

Oil Pressure: Minimum (tickover) 0.5 bar.

Power Outputs: These comply with EN ISO 8665 propeller-shaft power.

1. Declared powers are measured at the gearbox output flange (as coupled to the propeller shaft) as per EN ISO 8665, developed from our standard engine specification, including gearbox and accessories as detailed in our current price lists. Additional accessories or alternative gearboxes may affect the declared powers. Declared power outputs are subject to the stated tolerance band.
2. Operation at parameters outside the test parameters may affect the outputs/powers.

Section 1: Installation Guidelines

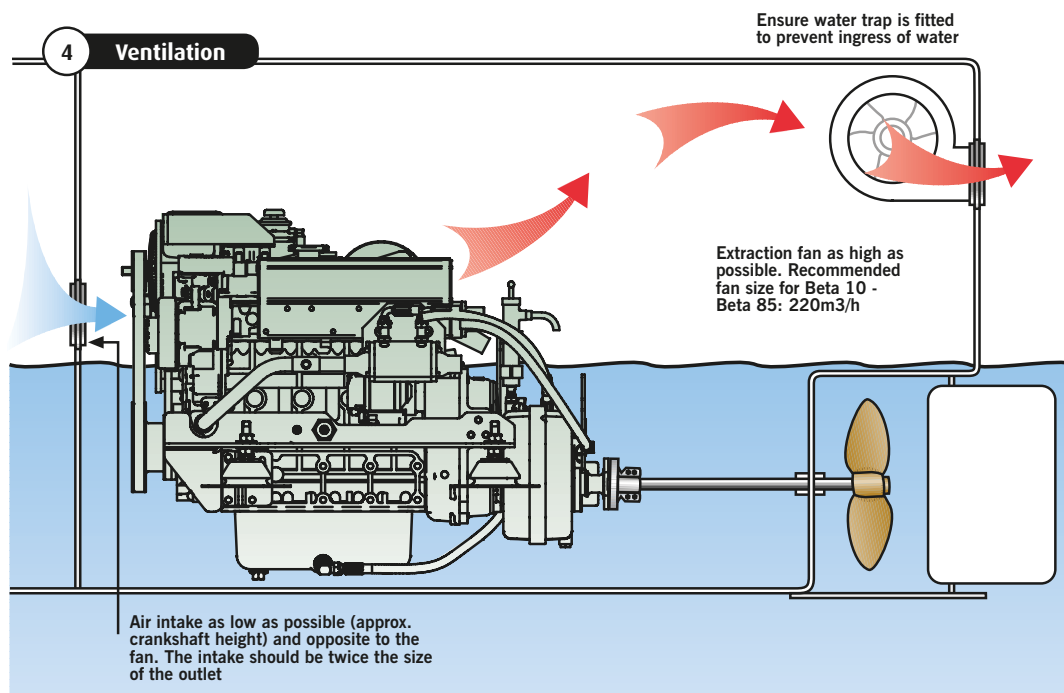
▼ INSTALLATION RECOMMENDATIONS

The installation details are basic guidelines to assist installation, however due to the great diversity of marine craft it is unrealistic 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 should 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.
- The insulating materials inside engine spaces shall be non-combustible.

▼ VENTILATION



An engine will produce radiated heat - approximately equal to 1/3 of the engine output power. Additionally, larger Amp starter battery and/or domestic battery bank charging alternators create high amounts of heat, building ambient temperatures further*.

*A symptom of which is black alternator belt dust

As a consequence, it is highly important and the vessels owner and/or installation engineer/s responsibility to ensure that the engine compartment has adequate ventilation to enable both efficient internal combustion and effective transference of heat out of the engine compartment/room.

Best practice for efficient & effective ventilation is an air intake that is located in the engine compartment/room that is as low as possible, allowing cooler air to enter below the alternator and drive belts, an air outlet with an electric extraction fan should be located as high as possible in the engine compartment/room maximising ventilation and reducing ambient temperatures.

The cooler the engine compartment/room can be maintained the more efficient the engine will perform.

The required air flow volumes in m³/min = 0.05 x engine power in hp (naturally aspirated) or 0.06 x engine power in hp turbocharged.

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

▼ 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 Beta Marine can offer optional 'Special Engine Feet' manufactured to your dimensions to suit your existing engine bearers and shaft alignment/installation.

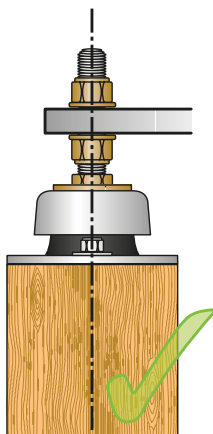
⚠ WARNING!

- 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.

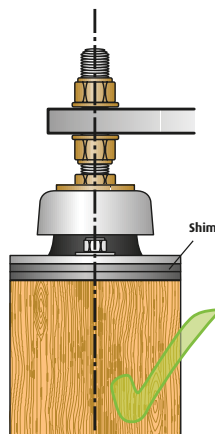


- The pillar stud on the flexible mount is secured into position by the lower locknut, do not forget to tighten this.

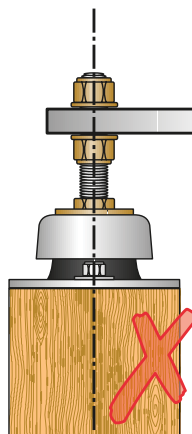
NB: Please ensure ensure that the stud is not screwed too far through the mounting body so that it can touch the bearer. This will cause vibration and/or knocking noise. If the flexible mounting is too far offset then the loading on the flexible mounting will cause premature failure, modifications are needed. Please refer to image 6.

**Recommended**

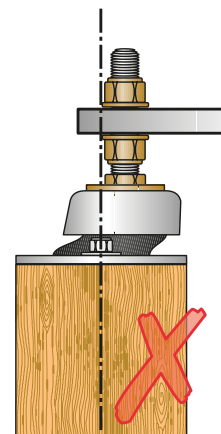
Correct height
and positioning

**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 10° please contact Beta Marine or alternatively consider the 7° down angle gearbox.

When our engines are installed at varying angles of inclination the normal oil level markings on the dipstick must be disregarded and recalibrated.

To recalibrate the dipstick, first ensure all oil is drained from the engine pre-installation and replace the oil filter, post installation refill the engine with the correct quantity of oil as indicated within the table on page 6 and allow time for the oil to settle. Remove the dipstick, wipe clean and reinsert. Carefully remove the dipstick so the engine oil on it is not disturbed. Once removed, note the wet/dry line then score or engrave this new correct level on it for future use.

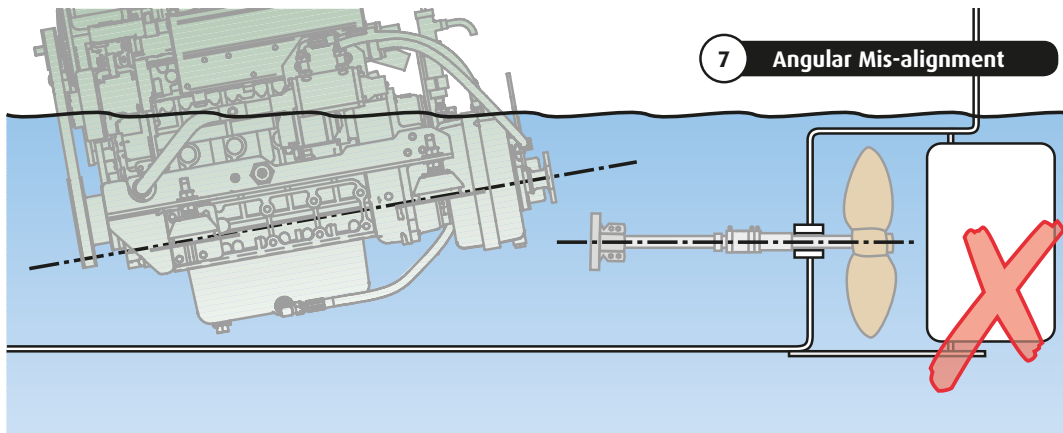
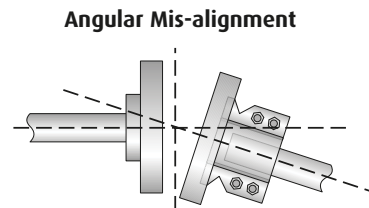
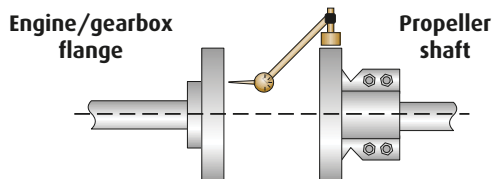
If in doubt please contact Beta Marine.

▼ ALIGNMENT

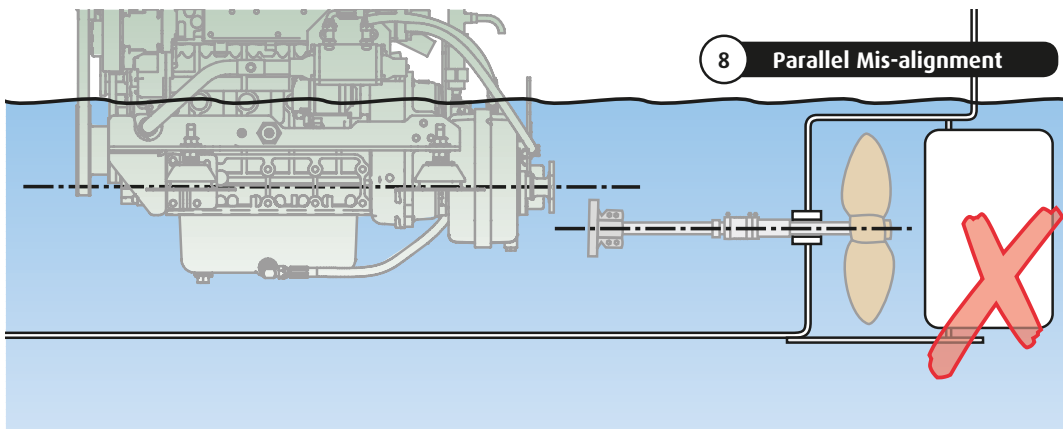
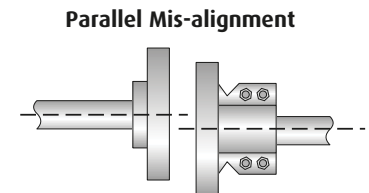
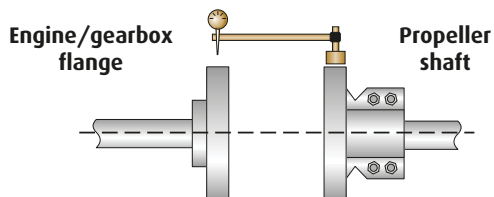
To obtain accurate alignment the flexible mountings must be adjusted until alignment is attained, and the mountings must be locked in position. The engine/gearbox unit has to be aligned with the propeller shaft in two ways. The traditional engine alignment method involves measuring with either feeler gauges or a DTI (Dial Test Indicator)

mounted on a magnetic foot so that they are aligned within 0.125mm (0.005"). 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 vibration will be experienced.

ANGULAR ALIGNMENT



PARALLEL ALIGNMENT



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

▼ FLEXIBLE OUTPUT COUPLINGS

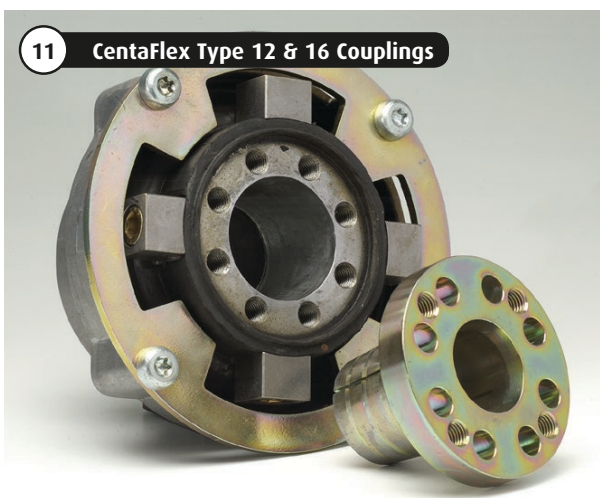
A flexible coupling mounted on the gearbox output flange is strongly recommended. Flexible couplings do not resolve poor alignment as they are designed to absorb torsional vibrations from the propeller which are transmitted along the propeller shaft.

Beta Marine can offer:

R & D Coupling's with a flexible nylon disc and optional Clamp Coupling.



The CentaFlex coupling design is able to absorb high torsional shocks and loads. These couplings are complete and replace the need for both a R&D flexible coupling and clamp coupling above.



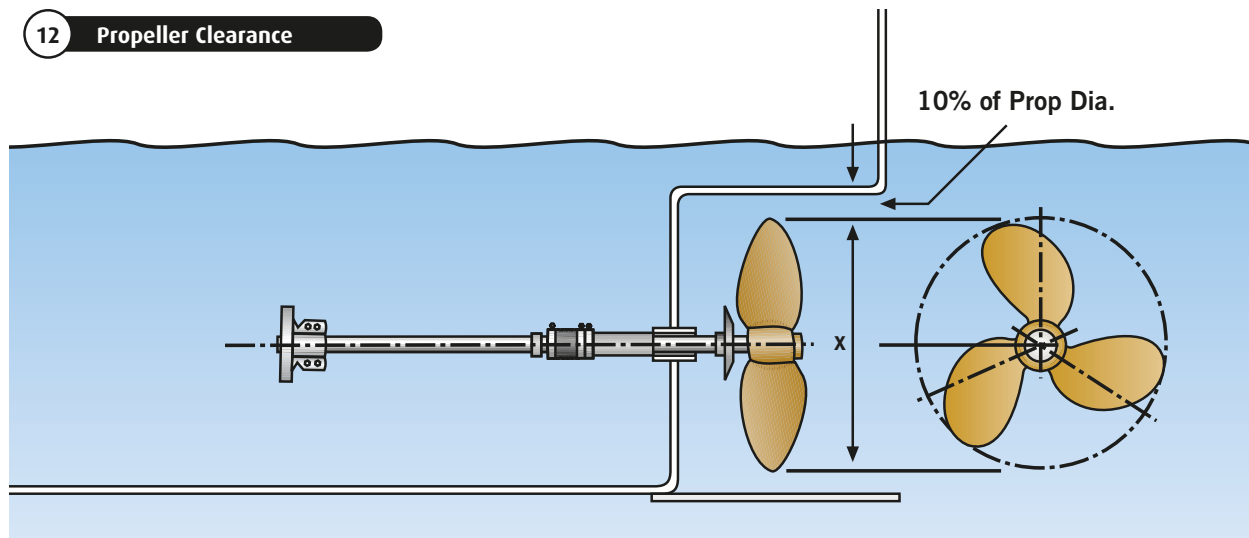
NB: If a constant velocity drive shaft is being considered for fitting then it may be necessary to have the standard engine drive plate that is supplied replaced to avoid torsional noise problems. Please contact Beta Marine for technical guidance.

▼ 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 < 15% of the diameter of the propeller to reduce 'tip noise'.

12 Propeller Clearance



▼ EXHAUST SYSTEMS

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.

▼ EXHAUST BACK PRESSURE

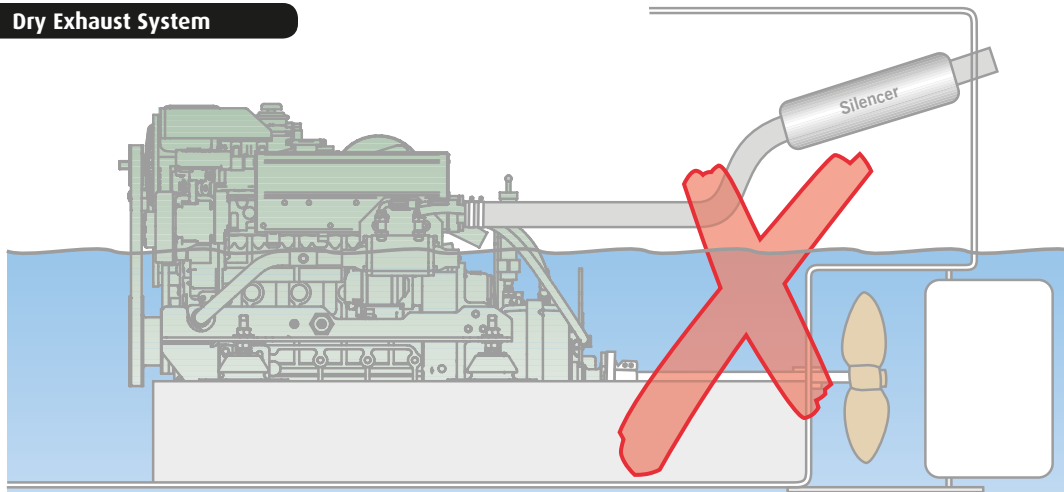
Exhaust back pressure should be as low as possible; it is increased by long exhaust length and sharp bends. Keep exhaust systems to a minimum length and have gradual bends avoid tight angled elbows. Back pressure should be measured with the complete exhaust system connected and the engine running at full speed. The correct measuring point is before the injection bend (at the manifold flange).

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 90T, Beta 105T & Beta 115T	85 to 115 mm Hg

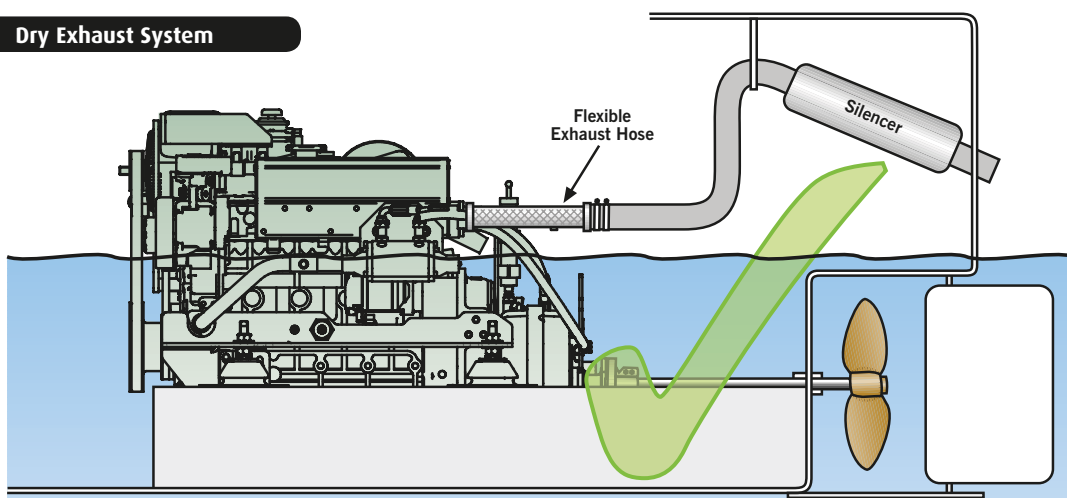
▼ KEEL COOLING - DRY EXHAUSTS

- a) An engine correctly installed in accordance with this handbook will meet the emission requirements of the RCD (Recreational Craft Directive).
- b) Keep exhaust systems to a minimum length and have gradual bends.
- c) The dry exhaust system installed in a vessel should be $1\frac{1}{2}$ " minimum internal diameter. The engine is fitted with a $1\frac{1}{2}$ " 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 always be used. It is up to the installer to work out the most appropriate 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.
 - Hydraulic lock, occurs when water is allowed to enter the combustion chamber via the exhaust and 'hydraulics' against the rising piston with the consequences possible being, a bent con rod/s, an emulsified engine oil and/or a damaged fuel pump. It is imperative that it is avoided, always ensure that canal, river or sea water cannot enter the exhaust port and run back down the pipe, flooding the silencer and then the engine. Please refer to image 13 & 14.
 - 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, please refer to page 7.

13 Dry Exhaust System



14 Dry Exhaust System



Ensure exhaust raises then falls to outlet

▼ KEEL COOLING - SKIN TANKS

Keel cooling 'skin' tanks are normally welded into the 'swim' of the vessel, please refer to image 27. They use the hull's 8mm steel plate as one side of the keel cooling tank that transfers the engine heat into the canal, river or sea water. The larger the engine/horse power the larger the 'skin' tank surface area that is required for keel cooling engines. Keel cooling pipes under the hull of vessels 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, river or sea water of:

0.25 x the hp of the engine = the square feet of cooling tank area required (for steel hulls).

Engine	B43	B50	B60
Steel Tanks (Ft ²)	10.8	12.5	15.5
Steel Tanks (M ²)	1.00	1.16	1.43

The ideal keel cooling tank should have:

- The most efficient keel cooling tank/s are hull side mounted, please refer to image 15 & 16.
- 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.
- The 'baffle' must be continuously welded to the outer skin and to one end as shown, and should be as close as possible to the inner skin.

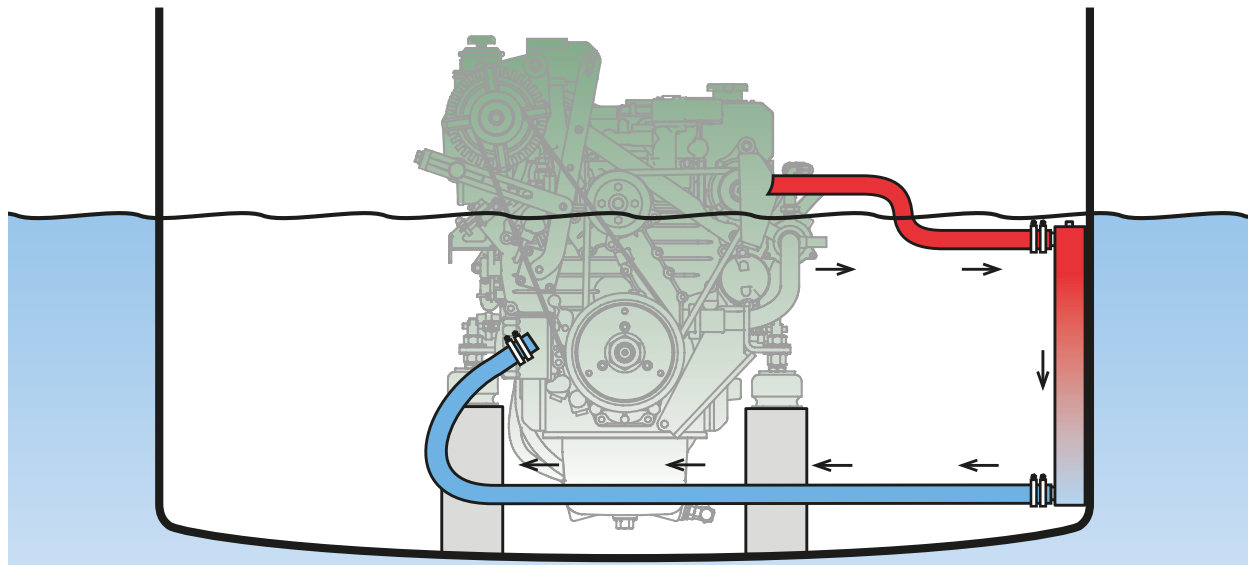
Engine	B43 - B60
Supply & Return Pipe	28 mm
Baffle Gap Minimum	40 mm
Baffle Gap Maximum	85 mm

- The tank should be thin in section (C = 30 mm to 40 mm) as it is the most efficient heat transfer to the canal, river or sea water that is important.
- The engine coolant for keel cooling (is the same 50:50 ratio of fresh water/anti-freeze solution* as heat exchanger cooling) and flows around the engine, then the keel cooling tanks, before returning to the engine.
- The keel cooling tank must have air bleed valves fitted on the top at both ends of the tank.
- The hot water feed enters at the top of the tank and the colder engine return comes out of the bottom.

NB: 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 contact Beta Marine.

* Please refer to 'Technical Specifications' on page 6.

15 Ideal Keel Cooling Tank

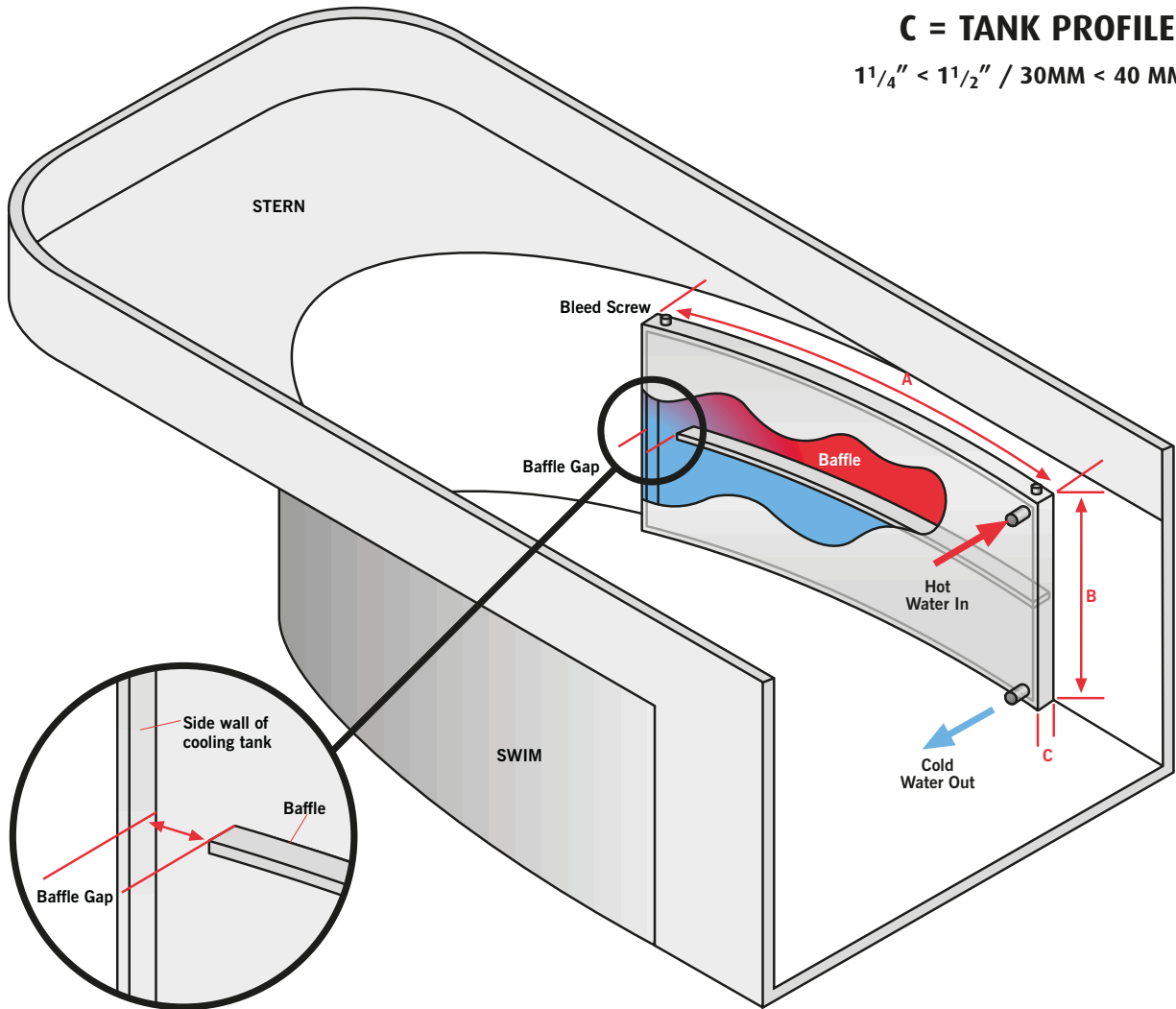


A x B = SURFACE AREA

(MUST BE BELOW WATER LEVEL)

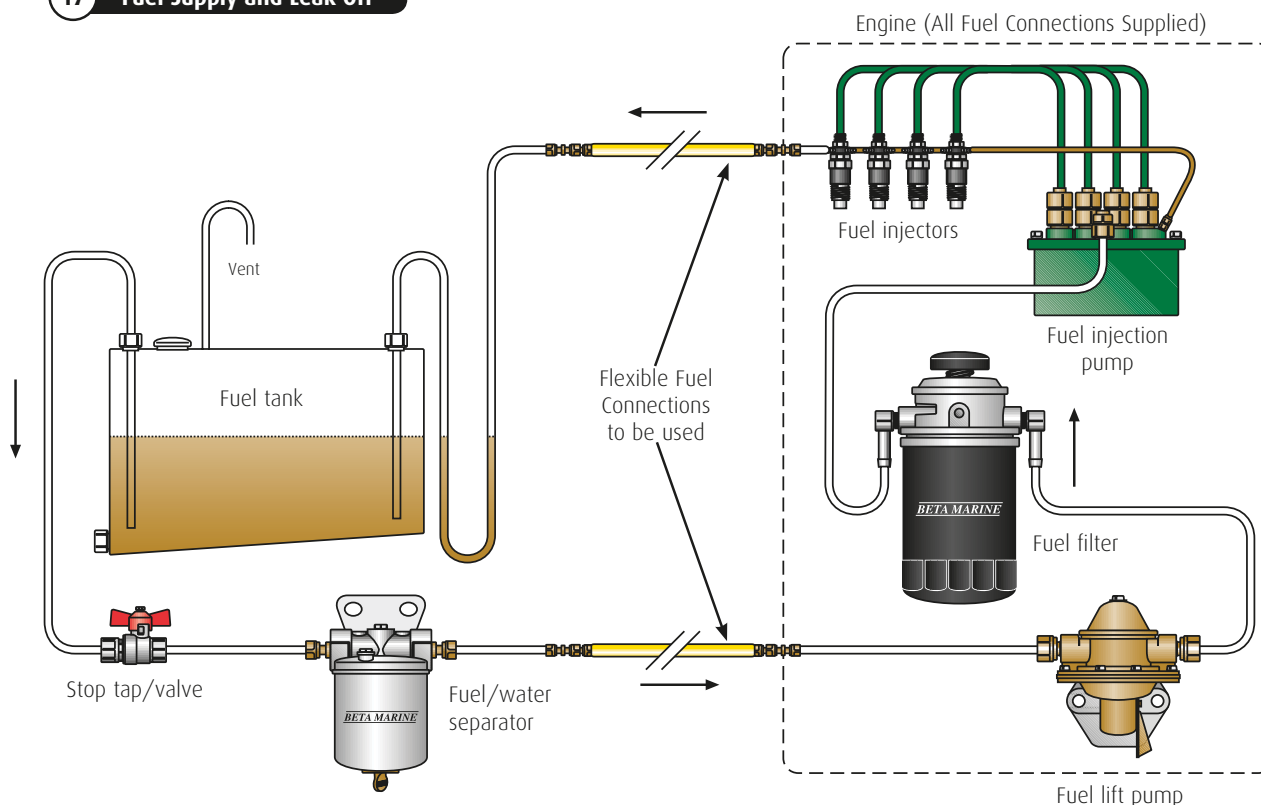
C = TANK PROFILE:

$1\frac{1}{4}'' < 1\frac{1}{2}'' / 30\text{MM} < 40\text{MM}$



▼ FUEL SUPPLY & LEAK OFF

17 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.
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, please refer to image 17. 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, marine grade flexible fuel hoses are highly recommended.
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 & COOLING CONNECTIONS

Engine Connector	Hose O.D
Fuel supply and leak-off connections are 8 mm conex with olives	8 mm O.D

▼ 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. For a calorifier to operate it is essential for all the air to be removed from the system.
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 or pipework is fitted above the heat exchanger/header tank then you will need to fit a remote header tank slightly above the calorifier tank.

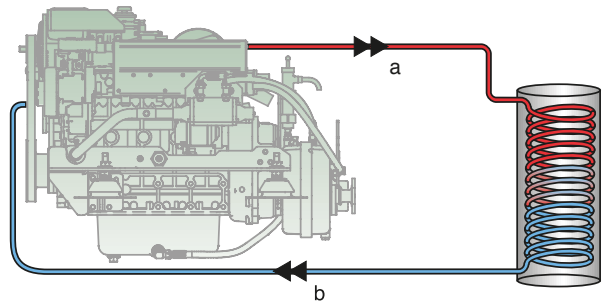


CAUTION:

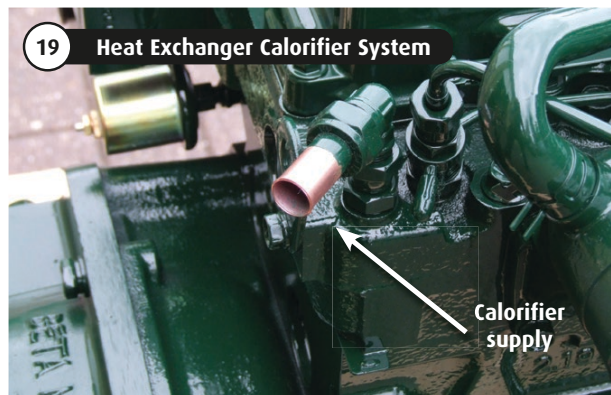
TO AVOID PERSONAL INJURY!

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

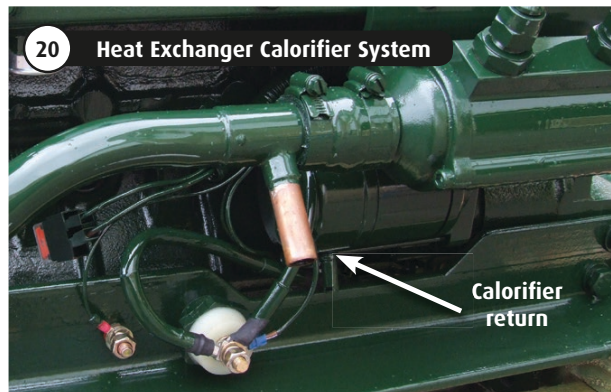
18 Keel Cooled Calorifier System



19 Heat Exchanger Calorifier System



20 Heat Exchanger Calorifier System



Calorifier Connector Hose I.D

Require $\frac{5}{8}$ " / 15 mm I.D

▼ BATTERY INSTALLATIONS

Starter batteries and battery cables are a major consideration for engine starting systems. Incorrect selection of both battery and cables is a major cause of starting failure.

BATTERIES

1. Battery sizes: For starter battery capacity recommendation please refer to 'Technical Specifications' on page 6.
2. In extreme conditions, low temperatures, battery capacity needs to be increased as performance will decrease. This needs to be allowed for during selection of a battery.
3. Battery terminals and connections must always be kept clean, in good condition and tight. Faulty connections can lead to poor performance and/or in extreme conditions explosion.
4. Batteries must be in good condition and must hold voltage. When measured, an idle standing battery would be expected to be read a minimum of 12.6 volts and 12 volts on the starter motor terminals.
5. Charging circuits must be sufficient for the battery system used. Ensure you have enough battery capacity whilst considering the recharge capability. Depending upon the battery type the recharge voltage will be in the region of 14.7 volts.

BATTERY CABLES

1. 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.
2. 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 the voltage drop will be, due to resistance within the cables.
3. For smaller engines we recommend battery cables of 25mm² (4 AWG) conductor cross sectional area with length up to 1.5m per cable. This equals a cable run of 3m total which would have a voltage drop of 0.8 volts if the starter motor was using 160 amps when motoring. Battery cables that are too small will overheat and their insulation could catch fire.
4. 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 current (often referred to the 'rolling' or 'cranking' 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.
5. 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.
6. Please note that cranking time should be no longer than 10 seconds with at least a 10 second rest between attempts.

25mm² (4 AWG) Cable

Engine	Cranking Amp	Cable Volt drop*	Max length, both cables added together
Up to Beta 45T	100	0.00017V	4.7m
Up to Beta 50	120	0.00017V	3.9m
Up to Beta 60	170	0.00017V	2.8m
Up to Beta 115T	210/250**	0.00017V	Not suitable
Beta 150	333	0.00017V	Not suitable

35mm² (2 AWG) Cable

Engine	Cranking Amp	Cable Volt drop*	Max length, both cables added together
Up to Beta 45T	100	0.00013V	6.2m
Up to Beta 50	120	0.00013V	5.2m
Up to Beta 60	170	0.00013V	3.6m
Up to Beta 115T	210/250**	0.00013V	2.5m
Beta 150	333	0.00013V	1.8m (70mm ² cable preferred)

70mm² (2/0 AWG) Cable

Engine	Cranking Amp	Cable Volt drop*	Max length, both cables added together
Up to Beta 45T	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 115T	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.

** Varies between models and builds.

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

▼ BATTERY CHARGING

For efficient charging of the batteries we recommend setting the engine to a minimum of 1,200 rpm.

This also applies for AC generation through an inverter.

Charging below 1,200 rpm risks damage.

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BETA MARINE **IMPORTANT**

**When battery charging and/or generation AC
the engine must be run at 1200rpm
OTHERWISE DAMAGE MAY OCCUR**

▼ KEY SWITCH TERMINATIONS

The standard panel key switch 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 key switches, the terminal to achieve this ignition switched positive is marked 'AC'.

For panels with push buttons, gauges can be driven from the 1mm² 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.

NB: Key switch 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.

Please refer to diagram index on page 52 for an illustration of a typical electric fuel lift pump with ignition switched, relay.

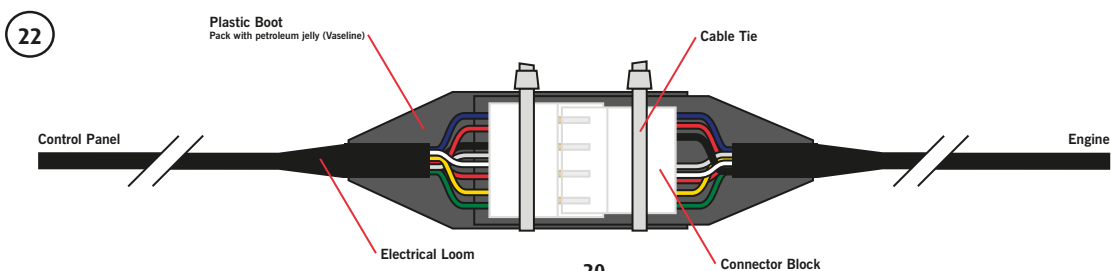
▼ CONTROL PANEL INSTALLATION

All Beta Marine engines are supplied as standard with 12 volt electric starting. 24 volt electric starting is available as an optional extra at placement of order.

CONTROL PANELS

Beta Marine offer 10 control panel options, standard for heat exchange is the ABV panel, standard for keel cooled is the AB or C panel. For further information please refer to pages 24, 25, 46, 47 & 48.

1. Control Panels must be fitted in a location where the helmsman can either see or hear the alarm system.
2. Control panels are supplied as standard with a 3m multi-core cable for connection to the engine wiring loom. Extension looms of 5m or more are available should your installation require it or you wish to relocate your existing panel/s, all looms include a start relay to overcome the voltage drop.
3. For standard wiring diagrams see diagram index, page 52.
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 interconnection plugs 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 ingress of water. See illustration below.
5. The control panels must not be installed where rain and or sea water/spray can reach them. If vulnerable, 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. Which should be firmly secured and protected from any possible ingress of water.



Section 2: Initial Engine Start Up

▼ INITIAL ENGINE START UP

IMPORTANT!

CHECKS PRIOR TO INITIAL USE

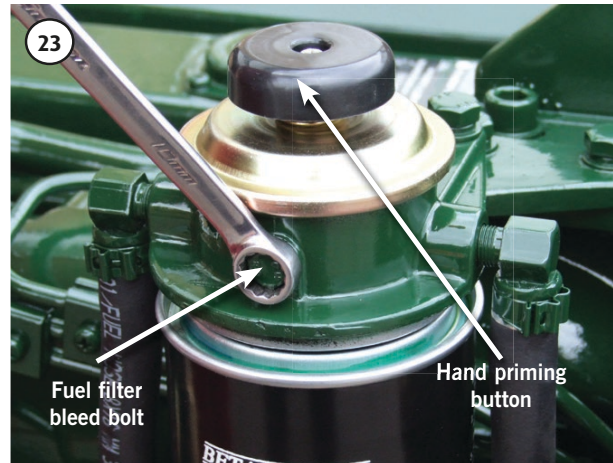
1. A new engine has the oil and anti-freeze removed after the works test. Fill the engine with the correct oil and anti-freeze (see sections on Engine oil and Cooling). **Check gearbox oil level** - see gearbox 'Owners Hand Book'.
2. Ensure the engine is free to turn without obstructions.
3. Ensure battery is fully charged and connected with the battery isolator in the 'ON' position.
4. Ensure "Morse" speed and gearbox cables are fitted correctly and that cable travel lengths are correct.

CAUTION:

Gear selection lever - all mechanical gearboxes: care must be taken to ensure that the remote control cable is adjusted so that the selector lever on the gearbox moves **full** travel and is brought "hard up" against its end stop in both directions.

Failure to achieve the correct adjustment will reduce efficiency of the clutch and may cause slippage at low revs. Warranty will not be accepted on gearboxes returned in the warranty period for failure due to incorrect adjustment.

5. Carefully check the keel cooling water circuit to ensure there are no water leaks.
6. Bleeding the fuel system for initial start up.
 - a) The fuel system must have all the trapped air carefully 'bled' out; starting at the fuel tank and progressively working through to: the fuel/water trap, the fuel filter, to the fuel injection pump.
 - b) Open the fuel tank stop tap/valve and then bleed the fuel/water separator of air as shown in manufacturer's literature.
 - c) Fuel should now arrive at the fuel lift pump.
 - d) Open the fuel bleed bolt on top of the fuel filter by 1 to 2 turns, please refer to image 23.



- e) Move the hand priming lever on fuel lift pump up and down (please refer to image 23) until fuel with "no bubbles" come out of the fuel filter bleed bolt (please refer to image 23). The hand priming lever normally has about 90° travel; **but the camshaft lobe may block this travel requiring you to rotate the engine crankshaft 90° to obtain full travel.**
- f) Shut/tighten the fuel bleed bolt.
- g) Open the bleed screw on the fuel injection pump and again 'bleed' through to the injection pump. Continue to hand prime for 30 seconds to push fuel and any remaining air through the fuel pump. Clean all areas thoroughly of fuel with tissue paper.

CAUTION:

TO AVOID PERSONAL INJURY!

- Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a fire.
- Do not mix petrol/gasoline or alcohol with diesel fuel. This mixture can cause an explosion.
- Do not get diesel fuel or oil on the flexible mounts - they will deteriorate rapidly if soaked in these.
- Fuel must be removed from skin to prevent infection.

7. Ensure engine is **out of gear** and set to $\frac{1}{3}$ throttle - see "single lever control" instructions/manual.

8. Initial engine start (please refer to 'Normal Starting and Stopping' on page 25). Note the engine may have to be turned over with the starter for a few seconds before it fires.

Do not run the starter for more than 10 seconds. If the engine has not started after 10 seconds there is probably still air in the fuel system; disengage the starter and continue to hand prime the engine with the fuel lift pump lever for a further 30 seconds, then repeat.

If engine does not start after 3 attempts then allow 5 minutes for the starter to cool down before repeating 6 (b) to 8.



CAUTION:

THE STARTER MOTOR WINDINGS CAN BE BURNT OUT WITH CONTINUOUS CRANKING.

9. If the engine does not easily start at the first or second attempt, do not over crank the engine with the seawater inlet seacock turned 'on'. (This problem may have been caused by air in the fuel system, running out of fuel, or changing a fuel filter, etc).

▼ NORMAL STARTING AND STOPPING

BETA MARINE KEY SWITCH CONTROL PANELS

Optional Control Panel 'A'

Is key switch controlled for engine preheat & start, push button controlled for engine stop, has a green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature and engine alternator not charging.



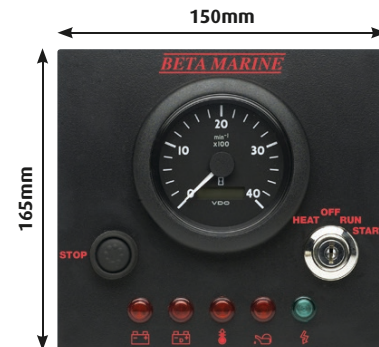
Standard Heat Exchanger Control Panel 'ABV'

Is key switch controlled for engine preheat & start, push button controlled for engine stop, has a tachometer with running hour recorder, green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature and engine alternator not charging.



Standard Keel Cooled Control Panel 'AB' - Beta 14 to Beta 38

Is key switch controlled for engine preheat & start, push button controlled for engine stop, has a tachometer with running hour recorder, green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature, domestic and or engine alternators not charging.



Optional Control Panel 'B'

Is key switch controlled for engine preheat & start, push button controlled for engine stop, has a tachometer with running hour recorder and a water temperature gauge. Green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature and engine alternator not charging.



▼ NORMAL STARTING AND STOPPING

Standard Keel Cooled Control Panel 'C' - Beta 43 to Beta 115T. Optional for Beta 14 to Beta 38

Is key switch controlled for engine preheat & start, push button controlled for engine stop, has a tachometer with running hour recorder, oil pressure, voltmeter & water temperature gauges. Green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature, domestic and or engine alternators not charging.



BETA MARINE PUSH BUTTON CONTROL PANELS

Optional Control Panel 'ABVW'

Is push button controlled for engine preheat, start & stop, has a tachometer with running hour recorder, green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature and engine alternator not charging.



Optional Control Panel 'BW'

Is push button controlled for engine preheat, start & stop, has a tachometer with running hour recorder and a water temperature gauge. Green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature and engine alternator not charging.



Optional Control Panel 'CW'

Is push button controlled for engine preheat, start & stop, has a tachometer with running hour recorder, oil pressure, voltmeter & water temperature gauges. Green light indicator for 'power on', red warning light indicators & audible alarm for low oil pressure, high water temperature, domestic and or engine alternators not charging.



▼ NORMAL STARTING AND STOPPING

KEY SWITCH CONTROL PANEL - FUNCTIONALITY

Control Panel Options: A, AB, ABV, B & C.



1. Turn on the battery isolating switch/es and move the engine start key to the run position, the panel lights should function as follows.



Red panel light for 'low oil pressure' should illuminate.



Red panel light for 'high engine temperature' should not illuminate. **NB:** This light will only ever illuminate if the engine crosses over the high temperature safety threshold.



Red panel light for 'no starter battery charge' should illuminate.



Red panel light for 'no domestic battery charge' should illuminate - Applies for control panels AB & C only. **NB:** This red panel light will only illuminate if a second alternator is fitted to the engine and connected to a battery bank.



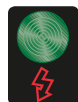
Green panel light for 'power on' should illuminate and the audible buzzer should sound.

2. Turn key to 'START' and hold in position until the engine fires (please refer to guidelines for initial engine start up for maximum time starter can be operated). Release key when the engine has started and allow to return to the RUN position.

All red panel warning lights should stop illuminating and the audible buzzer should cease.



The low oil pressure light may take a few seconds to stop illuminating and the no starter battery charge & no domestic battery bank charge light/s (if appropriate) may remain on until the engine rpm is increased to approximately 1,000rpm if the engine was started on tick-over.



Green light for 'power on' should remain illuminated.

3. To stop the engine press the 'STOP' push button, hold in until engine stops then turn the key to the OFF position.

⚠ WARNING! DO NOT leave the key in 'HEAT' position for more than 6 seconds - this will damage the heater/glow plugs and eventually lead to poor starting.

▼ EMERGENCY STOPPING

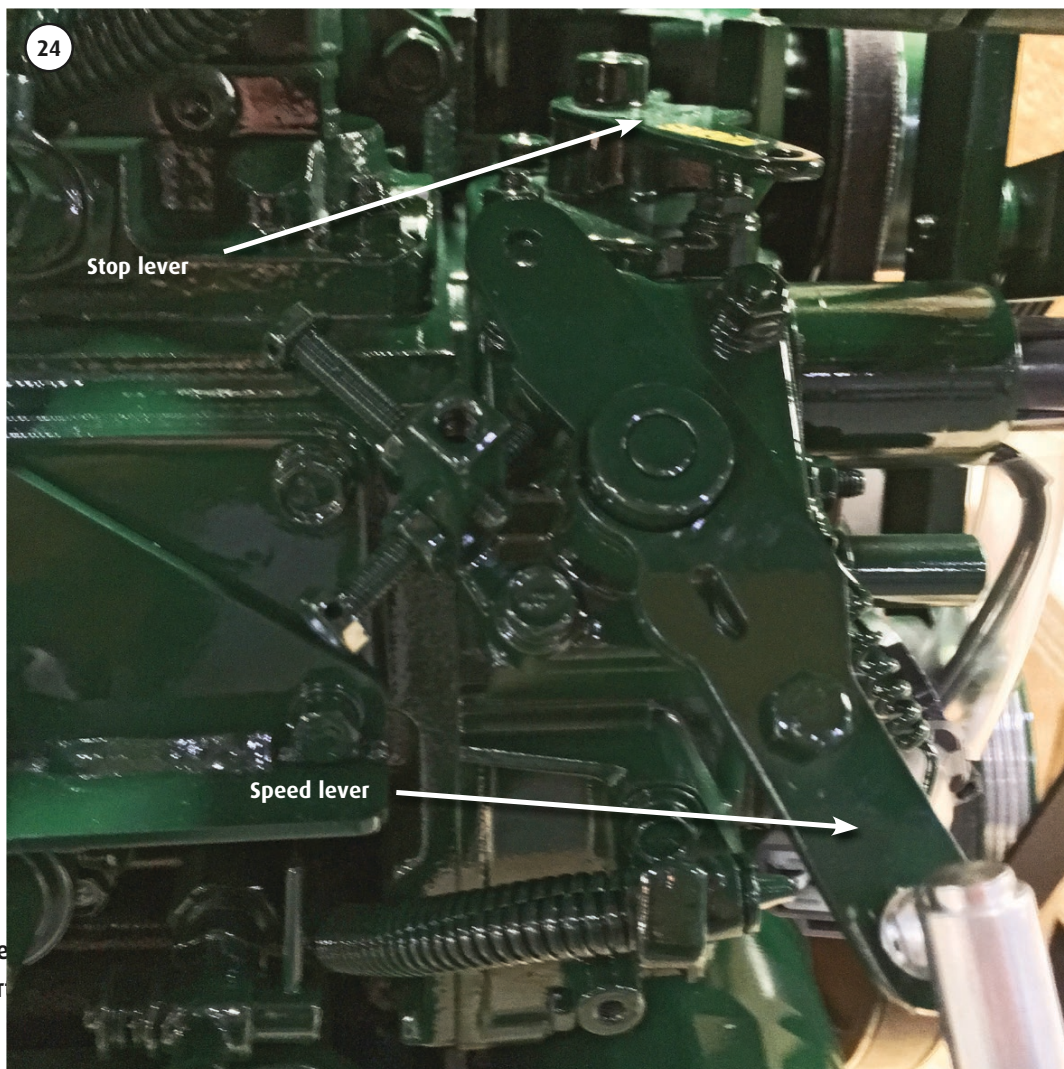
Every propulsion engine is fitted with a back up stop lever. To activate and stop the engine manually, simply press the stop lever highlighted in image 24 down and hold in place until engine stops.

For control panels operated by a key switch, turn the key from the run to the off position. Then for all engines regardless of control panel type, isolate the starter battery.

WARNING!

DO NOT leave the key in the 'OFF' position when engine is running. This will not allow the alternator to charge and will damage the alternator.

DO NOT depress the stop lever for more than ten seconds as this will lead to overheating and failure of the solenoid.



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Section 3: Maintenance Guidelines

▼ MAINTENANCE SCHEDULE

DAILY OR EVERY 8 HOURS RUNNING

- Check engine oil level.
- Check gearbox oil level.
- Check coolant level.
- Check battery fluid.
- Check belt tension and alternator bolts.
- Ensure raw water inlet strainer is clear.
- Check stern gland lubrication if used.
- Drain off any water in fuel/water separator.

AFTER THE FIRST 25 HOURS RUNNING

- Change gearbox lubricant (See separate gearbox manual).
- Check that all external nuts, bolts and fastenings are tight. See table for torque values. **Do NOT over tighten.** Special attention should be paid to the flexible mount lock nuts, these should be checked for tightness, starting with lower nut first in each case. If the lower nuts are found to be very loose, then the alignment of the shaft to the gearbox half coupling should be re-checked. Poor alignment due to loose flexible mount nuts will cause excessive vibration and knocking.
- Check and adjust all drive belt tensions, please refer to page 35.
- Check ball joint nyloc nuts for tightness on both gearbox and speed control levers. Grease both fittings all over.

AFTER FIRST 50 HOURS

- Change engine lubricating oil.
- Change oil filter.
- Drain off any water in fuel/water separator.

AFTER 150 HOURS

- If shallow sump (option) is fitted, change engine lubricating oil and filter.

EVERY YEAR OR 250 HOURS IF SOONER

- Change engine lubricating oil (standard sump)
- Change lubricating oil filter
- Check air cleaner element
- Spray the key switch with WD40 or equivalent to lubricate the barrel.
- Check that all external nuts, bolts and fastenings are tight. See table for torque values.
- Check ball joint nyloc nuts for tightness on both gearbox and speed control levers.

EVERY 750 HOURS (IN ADDITION TO 250 HOURS MAINTENANCE)

- Change air cleaner element.
- Change fuel filter.
- Change anti-freeze.
- Change gearbox oil.
- Check electrical equipment, condition of hoses and belts, replace as necessary.

Maintenance Schedule

	Daily or every 8hr running	After first 25hrs	After first 50hrs	Every 150hrs with shallow sump	Every Year or 250hrs if sooner	Every Year or 750hrs if sooner
Check engine oil level	●	●	●	●	●	●
Check gearbox oil level	●	●	●	●	●	●
Check engine coolant level	●	●	●	●	●	●
Check battery fluid	●	●	●	●	●	●
Check belt tension and alternator bolts	●	●	●	●	●	●
Check stern gland lubrication	●	●	●	●	●	●
Drain off any water in fuel / water separator	●	●	●	●	●	●
Change gearbox oil		●	See separate gearbox manual			
Check all external nuts, bolts and fastenings are tight. Check belt tension and alternator bolts. Check for leaks.		●	●		●	●
Change engine oil			●	●	●	●
Change oil filter			●	●	●	●
Lubricate keyswitch on control panel with "Vaseline" or WD40			●		●	●
Check general condition			●		●	●
Check air cleaner element and change if required					●	●
Change air cleaner element						●
Change diesel fuel filter						●
Change gearbox oil						●
Drain and replace engine coolant/anti-freeze						●*

*Check condition every year and change when necessary.

▼ ENGINE LUBRICANT & COOLANT

Engine oil: Engine oil quality should have the minimum properties of the American Petroleum Institute "API" classification **CF** with multi-grade SAE ratings as listed in the following table.

NB: An acceptable alternative is a mineral based, semi-synthetic lubricating oil with a content mix no greater than 30% being synthetic based.

Do not mix two different types of oil or SAE rating.

Do not use lubricant additives and/or fully synthetic lubricating oil.

The following table gives grades of oil viscosity required for various ambient temperature ranges.

Ambient Temp.	Multi-Grade
-30°C to 0°C	SAE 10W/30
-15°C to +15°C	SAE 15W/40
0°C to +30°C	SAE 15W/40
25°C and above	SAE 15W/40

Engine coolant: Always use a Mono Ethylene Glycol Based Extended Life Anti-freeze mixed 30 < 50% with water.

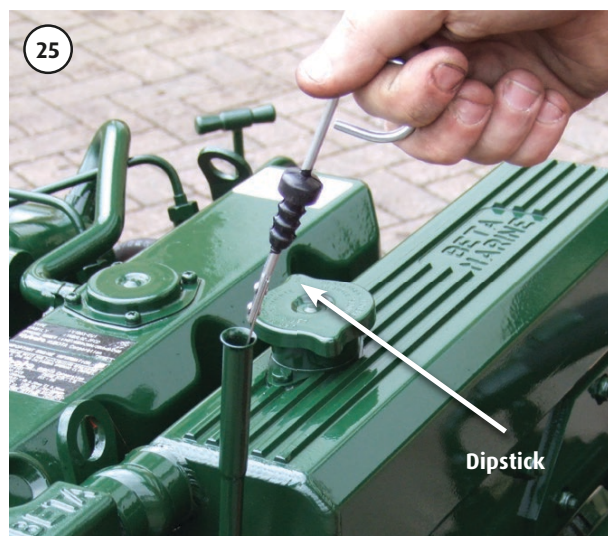
NB: Do not exceed an Anti-freeze mix greater than 50%, as the engine cooling efficiency will be detrimentally affected.

▼ CHECKING THE ENGINE OIL LEVEL

For quantities of oil required please refer to page 6. When checking the engine oil level, do so before starting, or more than five minutes after stopping.

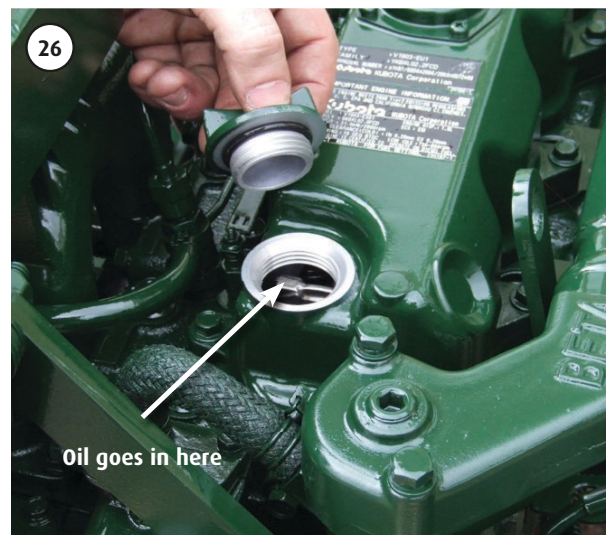
1. To check the oil level, draw out the dipstick, wipe it clean, re-insert it, and draw it out again, please refer to image 25. Check to see that the oil level lies between the two notches.
2. If the level is too low, add new oil to the engine to the specified level, please refer to image 26.

When using an oil of a different make or viscosity from the previous one, drain out the old oil. **Never mix two different types of oil.**



Engine oil should be changed after first 50 hours running time and then every year or every 250 hours if sooner (Shallow sumps are every 150 hours).

The oil filter is a cartridge type mounted on the side of the engine and should be changed when you change the oil. Please refer to images 27 & 28.



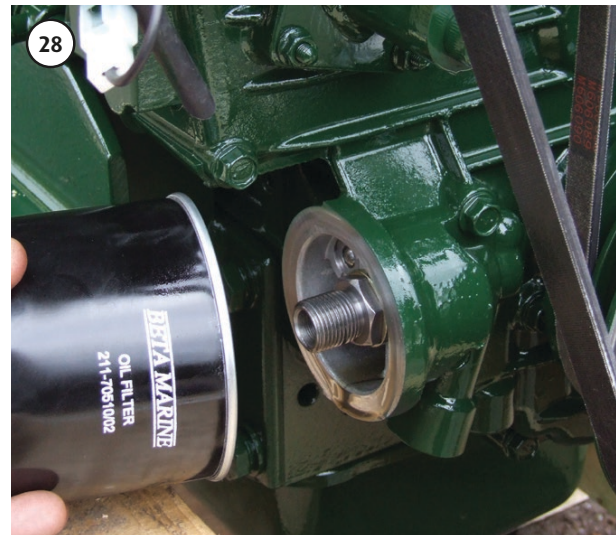
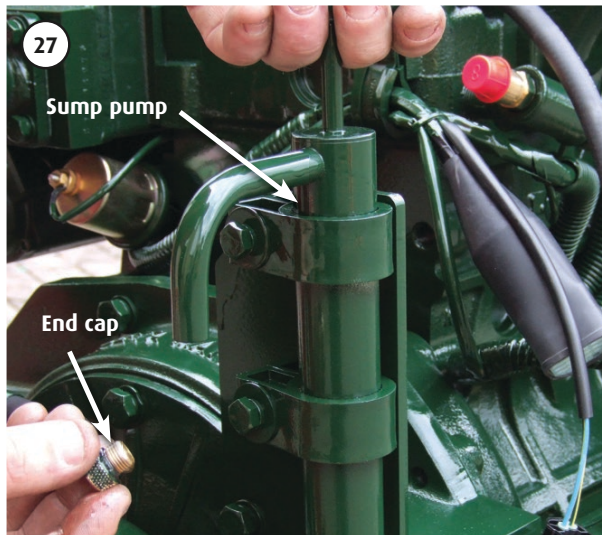
⚠ IMPORTANT! Over-filling your gearbox with oil can be as detrimental as under-filling.

▼ CHANGING THE ENGINE OIL

1. Run the engine for 10 minutes to warm up the oil, then stop it and open the oil filler cap.
2. Your engine is provided with a sump drain pump. Unscrew the end cap on the end of the pump spout, turn the tap to 'on'. Use the hand pump as shown to pump out the oil into a bucket. Turn the tap to off position and replace end cap. Please refer to image 27.
3. Unscrew the oil filter and replace with a new one. Please refer to image 28.

NB: It is best to have a plastic bag wrapped round the filter to catch any oil left in the system and help with keeping the bilge clean. Before screwing in the new filter spread a thin film of oil round the rubber gasket to ensure a good seal and screw in - hand tight.

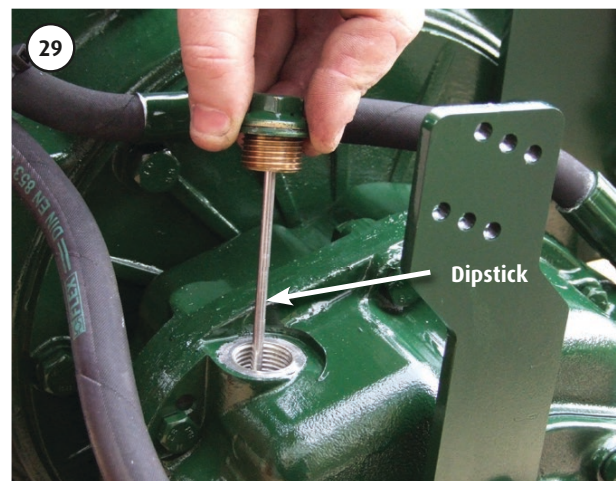
4. Fill the engine with new oil as described on the previous page and replace the oil filler cap.
5. Run the engine and check for oil leaks.



▼ CHECKING THE GEARBOX OIL LEVEL

1. The gearbox is fitted with a dipstick and oil filler plug, please refer to image 29.
2. Each engine is supplied with a gearbox 'operators manual' which specifies the type of lubricating oil to be used, the capacity and frequency of changing of the oil.

⚠ IMPORTANT! over-filling your gearbox with oil can be as detrimental as under-filling.



▼ CHANGING THE GEARBOX OIL

1. The oil can be changed via the drain plug at the bottom of the box or sucked out with a hand pump via the filler plug or dipstick hole.
2. Run the gearbox for 10 minutes to warm up the oil.
3. Switch off the engine, remove the dipstick and begin to drain oil from the gearbox and cooling system. The drain plug is located on aft starboard side of the gearbox on most models.
4. Allow to drain, before refilling the gearbox with new oil as recommended.
5. Run the engine to allow oil to circulate, then stop and allow the oil to settle. Re-check the oil level and top up if necessary.
6. Ensure dipstick and cap are firmly secured and check for oil leaks, especially around the output shaft oil seal and gasket sealing surfaces.

NB: ATF is Automatic Transmission Fluid.

Gearbox operator manuals can be downloaded as PDF's. Please visit: www.betamarine.co.uk or contact Beta Marine.

Gearbox	Lubricant	Capacity (Approx.)
TMC40	ATF	0.2 L
TMC60/A	ATF	0.6 L
TMC260	ATF	1.2 L
TM345/A	Oil	1.6 L
TM93/A	Oil	2.4 L
TM170/A	Oil	2.8 L

Gearbox	Lubricant	Capacity (Approx.)
ZF 25/A	ATF	1.8 L
ZF 45/A	ATF	2.5 L
ZF 15 MIV	ATF	1.0 L
ZF 63 IV	ATF	4.0 L

Gearbox	Lubricant	Capacity (Approx.)
PRM 90	ATF	0.3 L
PRM 125	ATF	0.4 L
PRM 150	Oil	1.4 L
PRM 280	Oil	1.5 L
PRM 500	Oil	2.5 L
PRM 750	Oil	2.5 to 3.5 L
PRM 1000	Oil	3.0 to 4.0 L

▼ FUEL SYSTEM

⚠ IMPORTANT!

- Always fit a fuel/water separator in the fuel supply system. **Water in the fuel can seriously damage the injection system.**
- If a fuel supply shutoff valve is fitted do not use a taper tap, only use a ball valve tap. The ball valve type are more reliable and less likely to let air into the fuel system.
- Be sure to use a strainer when filling the fuel tank. Dirt or sand in the fuel may cause trouble in the fuel injection pump.
- Always use diesel fuel. **Do not use paraffin/kerosene**, as this has a low cetane rating and adversely affects the engine.
- Biodiesel fuel can be added to the normal diesel fuel up to a maximum limit of 7% without affecting the warranty.
- Most diesel fuels now contain up to a maximum limit of 7% Biodiesel and this does not affect the engine warranty. The recent changes to fuel specifications allow the addition of FAME (fatty acid methyl ester) Biodiesel EN14214:2009, to diesel fuel, but please be aware that Biodiesel does allow bacteria to grow more easily in the fuel and this can clog your fuel tank, pipes and filters. If you experience an outbreak of bacterial growth you can either empty and clean out your fuel pipes and tank, or use biocide additives and filtering.

- Low sulphur diesel fuel - regulations changed recently reducing the sulphur content by 99%, in many countries. The European standard is EN590:2009, and in the USA ASTM D975-09. The engine is designed to run on low sulphur fuel, and this is now preferred.
- We know that some customers are using 100% Biodiesel fuel, if you use a higher percentage of Biodiesel fuel you must fit an electric lift pump into the fuel supply line, and the fuel filter and oil filter must both be changed together when the oil filter is normally replaced.

⚠ IMPORTANT!

Beta Marine warranty will not cover fuel equipment when more than 7% Biodiesel is used.

- Be careful not to let the fuel tank become empty, or air can enter the fuel system, necessitating bleeding before next engine start.
- The fuel lift pump will only lift fuel through 0.25m. If this is insufficient then an electric fuel lift pump must be fitted. Drawing 202-06421, illustrates the recommended wiring required for this pump, please refer to diagram index on page 52.

▼ FUEL FILTER REPLACEMENT

1. The fuel filter is a spin on type. Remove by turning anti-clockwise when viewed from below.
2. Replace the fuel filter cartridge every 750 hours or every 2 years. Please refer to image 30.
3. Apply fuel oil thinly over the gasket and tighten into position - hand tight.
4. Bleed as detailed, please refer to 'Initial Start Up' on page 26.
5. Check for leaks.
6. Do not get fuel on the flexible mounts, this will degrade and damage the rubber.



▼ FILLING THE FRESH WATER SYSTEM

New engines are supplied with the fresh water 'coolant' drained off. The following instructions must be followed to correctly fill the system.

- a) Pour into a clean bucket a mixture of both fresh water and anti-freeze; with an anti-freeze ratio of 50%. For the required volume please refer to 'Technical Specifications' on page 6.

NB: Always use a Mono Ethylene Glycol Based Extended Life Anti-freeze mixed 30 < 50% with water.

- b) Check that the coolant drain tap or plug is turned off. Please refer to image 31.



- c) Fill engine with freshwater/anti-freeze solution through the top of the heat exchanger or header tank with the filler cap removed. Please refer to image 32.



- d) Fill header tank to the top of the filler neck and replace cap. Press down firmly on filler cap and hand tighten in a clockwise direction.

NB: For keel cooled engines a large quantity of coolant (anti-freeze solution) is required depending upon the size

of the keel cooling system (refer to builder's instructions).

- e) Run the engine for 5 minutes on no load (out of gear) and check coolant level, this will help remove air from the system. Top up as necessary.

- f) Check system for leaks.

NB: For keel cooled engines it is very important to bleed all of the air out of the complete cooling system before the engine is run on load (check with builder's instructions).

- g) If a calorifier is fitted care must be taken to see that this is also full of coolant and all the air is expelled. Please refer to 'Calorifier Connection' on page 17.
- h) Run the engine on one third load for 15 minutes, preferably with the boat tied up. As the system warms up coolant may be expelled from the overflow pipe into the bilge. Stop the engine and allow the engine to cool down before removing the pressure cap and top up the coolant to 25 mm/1" below the filler neck.



CAUTION:

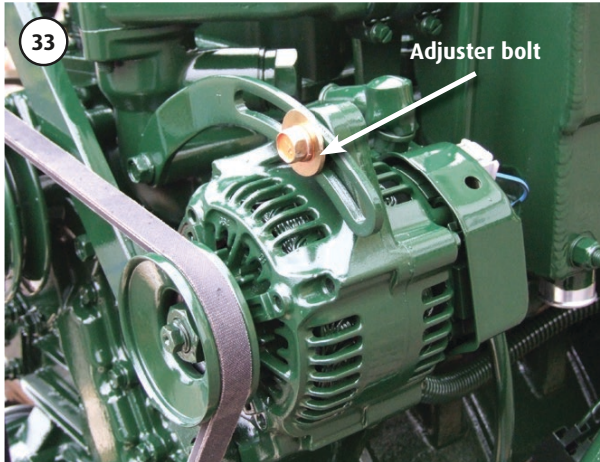
TO AVOID PERSONAL INJURY!

Removal of the pressure cap when the engine is hot can cause severe injury from scalding hot water under pressure. Always allow the engine to cool and then use a large cloth when turning the cap anti-clockwise to the stop. This allows the pressure to be released. Press firmly down on the cap and continue to turn anticlockwise to release the cap.

- i) Repeat (h) if coolant level is more than 1 inch below the base of the filler neck when the engine has cooled down.
- j) Run engine on $\frac{2}{3}$ full load for 20 minutes, check for leaks and repeat (i).
- k) Anti-freeze solutions should be drained off every 2 years and replaced with a new solution.

NB: When draining the fresh water system, ensure the engine has cooled sufficiently to prevent scalding from hot pressurised water. Prior to draining a cold engine, remove the filler cap from the header tank and then open the water drain tap. This allows the water to drain freely from the system. Please refer to image 31.

▼ BELT TENSION



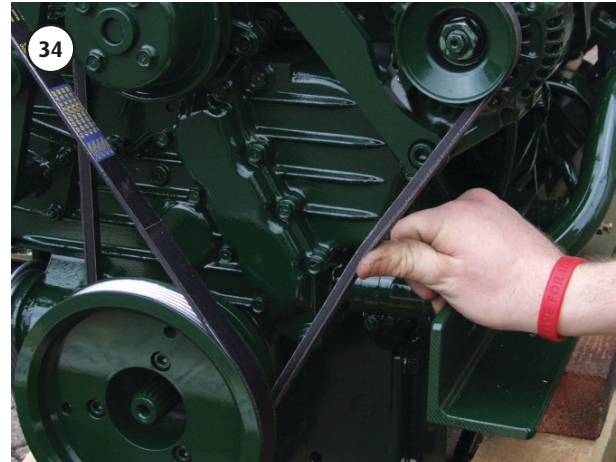
WARNING!

Belt tension must only be checked with the engine switched off.

BATTERY CHARGING ALTERNATOR

These engines are fitted as standard with a 'polyvee' flat belt that drives both the battery charging alternator and the fresh water/engine coolant circulating pump.

1. The belt tension is adjusted by swinging the alternator outboard as it pivots on its support bolts. Please refer to image 33.
2. With the engine stopped, loosen the support bolts and the link adjusting bolt.



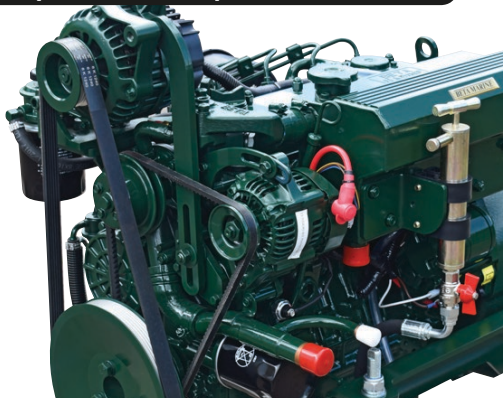
3. Push alternator outboard by hand to tension the belt, then tighten link bolt.
4. Check that the depression of the belt (at position shown) is approximately $\frac{1}{2}$ " or 12 mm when pushed down firmly by thumb. Tighten support bolts. Please refer to image 34.
5. Belt tension should be regularly checked especially during the first 20 hours of running in a new belt, as stretching occurs.

 **IMPORTANT! Tension drive belts by hand only, do not over tension.**

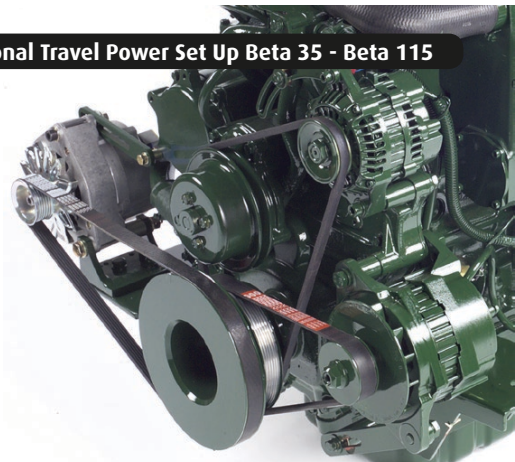
SECONDARY DOMESTIC BATTERY CHARGING ALTERNATOR

The same method applies as outlined above when an engine is fitted with a secondary domestic battery bank alternator and/or travel power.

Secondary Alternator Set Up Beta 30 – Beta 115

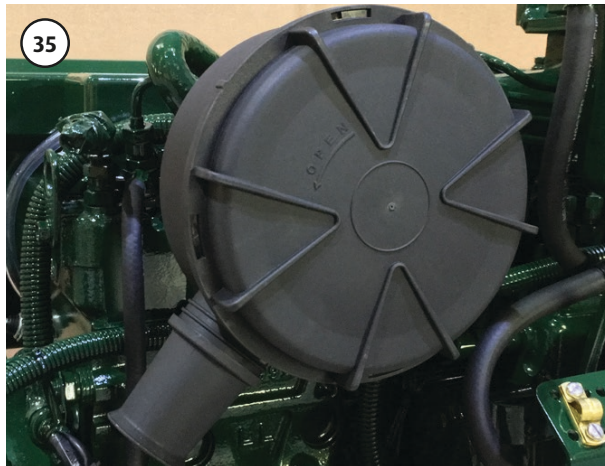


Optional Travel Power Set Up Beta 35 - Beta 115



▼ AIR FILTER

These engines are fitted with a replaceable air filter which should be inspected annually and replaced every 2 years or sooner if heavily clogged. If this occurs increase inspection frequency.



▼ ELECTRICAL MAINTENANCE

WARNING!

UNDER NO CIRCUMSTANCES SHOULD THE BATTERY BE DISCONNECTED OR SWITCHED OFF WHEN THE ENGINE IS RUNNING. THIS WILL SERIOUSLY DAMAGE THE ALTERNATOR.

▼ GENERAL MAINTENANCE

1. The control panels must be protected from rain and or sea water/spray. If vulnerable, Beta Marine recommend that a suitable flap or cover is fitted. Water entering the key switch will eventually cause corrosion and could result in the starter motor being permanently energised and burning out. Spray key switch every month with WD40 or equivalent; or apply 'Vaseline'.
2. Check batteries for acid level and top up if required. For low maintenance and 'gel' batteries, please refer to manufacturers instructions.
3. Loose spade terminal connections are the most common cause for electrical faults - check on a regular basis, please refer to 'Electrical Fault Finding' within trouble shooting.

▼ WINTERISING AND LAYING UP

- a) The engine lubricating oil and lubricating oil filter should be changed at the end of the season rather than in the spring. Please refer to 'Section 2'.
- b) The closed circuit cooling system must contain an anti-freeze coolant solution. The coolant solution is a mixture of fresh water and anti-freeze (Mono Ethylene Glycol based conforming to BS6580:1992) with the anti-freeze being a 50% solution (this also applies to warm and tropical climates). The warranty is invalid if the correct percentage/ratio is not used.
- c) For cold climates where the air or water temperatures can fall below 3°C, the sea water circuit must be protected in addition to the fresh water system. This is best achieved as follows:
 - Close the inlet seacock to the engine (engine stopped).
 - Disconnect the sea water inlet pipe and dip it into a small bucket containing 50:50 anti-freeze solution.
- Start the engine (out of gear) and run for 5 to 10 seconds until the anti-freeze is used up and can be seen coming out of the exhaust outlet.
- Shut engine off and reconnect the inlet pipe to the seacock. The sea water or raw water circuit is now protected by anti-freeze.
- d) Ensure instrument panel is well protected and give the key switch a spray of WD40/Petroleum Jelly or equivalent.
- e) With the engine stopped, disconnect the battery (always disconnect the negative cable first and re-connect the negative cable last) and take it ashore for trickle charging and top up as necessary. If AC power is available then this can be done on the boat.
- f) Fuel tanks should be kept full during the lay up period to eliminate water condensation in the tank. Water entering the fuel injection system can cause considerable damage.

▼ LAYING UP ASHORE

- a) Change the engine oil before the vessel is taken out of the water as warm engine oil is much easier to remove than cold.
- b) Cooling system - As above in 'Winterising and Laying up' paragraphs (b) to (f) should be followed.
- c) If the engine is to be laid up for more than 6 months then remove the sea water pump impeller - heat exchanger cooled only.
- d) If the engine will not be used or run for periods longer than 6 months we recommend that the engine is 'inhibited' - this involves running the engine for about 5 minutes to:
 - Replace all the diesel fuel in the fuel system and injection pump by running the engine with 'calibration fluid' (fuel pump test oil ISO 4113).
 - Allow 'Ensis' to circulate around the lubricating oil system by draining out the standard lubricating oil and replacing it with a rust preventative oil such as 'Ensis' or similar.

Section 4: Trouble Shooting

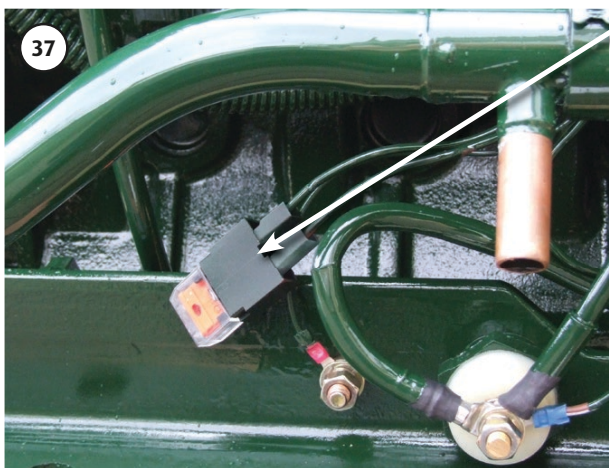
Beta diesels are very reliable if installed and serviced correctly, but problems can occur and the following list gives the most common ones and their solution.

Problem: Engine does not start but starter motor turns over OK

Possible Cause	Solution
No fuel:	Turn fuel cock on and fill tank.
Air in fuel system:	Vent air (please refer to 'Initial Start-up' on page 21).
Water in fuel:	Change fuel filter, check fuel/water separator and bleed system.
Blocked fuel pipe:	Clean out and bleed system.
Fuel filter clogged:	Change filter and bleed system.
Fuel lift pump blocked:	Remove and replace.
Blocked injector:	Remove and clean.
Fuel return not fed back to the tank:	Re-route fuel return pipe.
Heater plugs not working:	Check wiring to the plugs, and replace plugs if they are burnt out.
Stop solenoid stuck in off position:	Check solenoid is free to return to run position.

Problem: Starter motor will not turn or turns over very slowly

Possible Cause	Solution
Battery discharged:	Charge battery or replace. Check alternator belt tension.
Starter motor flooded with sea water:	Remove and clean, or replace.
Wiring disconnected or loose:	Check circuit for loose connections.
Water in cylinders:	Check engine oil for signs of water (creamy-coloured oil). If found do not attempt to start the engine, contact your dealer or service agent.
Engine harness fuse blown:	Replace fuse located by starter motor (or above flywheel housing) and check for wiring faults.



Fuse.

NB: For convenience, some engines are supplied with a spare fuse and holder attached to the main engine fuse holder.

Problem: Low power output

Possible Cause	Solution
Propeller is too big:	Change or depitch.
Check gearbox reduction ratio relative to propeller size:	Change the most appropriate item.
Blocked fuel filter:	Replace.
Blocked air filter:	Replace.
Air in fuel system:	Check system and bleed
Governor spring incorrectly mounted:	Dealer to adjust.
Single lever control not operating correctly:	Disconnect speed control cable and move the lever by hand. Adjust cable.
The electrical load is too large on start up:	Disconnect or reduce the load.

Problem: Erratic running/hunting

Possible Cause	Solution
Air in fuel supply:	Check supply system for leaks and fix.
Fuel lift pump faulty:	Replace.
Clogged fuel filter:	Replace.
Fuel return not fed back to the fuel tank, or blocked pipe:	Re-route pipe or clean.
Air filter blocked:	Replace.
Worn or blocked injector:	Service injectors.
Engine rpm in gear is too low, this must be 850 min:	Increase engine tick over speed.
Faulty stop solenoid:	Disconnect wiring to solenoid. If running improves check for a wiring fault.
Broken fuel injection pump spring:	Replace, this is usually caused by water in the engine oil/fuel.
Fuel suction head is too great:	Fit electric fuel lift pump.

Problem: Hunting at idle

Possible Cause	Solution
Idle adjustment screw may need adjusting:	Always contact Beta Marine for advice with idle adjustment.

Problem: Hunting at higher speeds

Possible Cause	Solution
Fuel supply problem:	Change fuel filter and check fuel supply

Problem: White or blue exhaust gas

Possible Cause	Solution
Engine oil level too high:	Reduce the level.
Blocked injector:	Service injectors.
Piston ring and bore worn or con rod bent due to water ingress, giving a low compression:	Get the compression checked by your dealer or service agent. They will advise action to be taken.
Check that the breather pipe is clear and not obstructed:	Remove and clean out.

Problem: Black exhaust gas

Possible Cause	Solution
Blocked air filter element:	Inspect and replace.
Over pitched propeller - engine will not reach its full rpm:	Get the propeller re-pitched if necessary.
Accumulated debris on hull:	Inspect and clean if required.

Problem: Low oil pressure warning light on when underway

Possible Cause	Solution
Oil frothing due to high installation angle or high oil level:	Always contact Beta Marine for advice.

Problem: Low oil pressure warning light when engine speed reduced to tick over

Possible Cause	Solution
Faulty switch sender:	Replace.
Engine running too hot:	Check cooling water flow (please refer to 'Cooling').
Oil relief valve stuck partially open with dirt:	Remove and clean.
Blocked oil filter:	Change.
Wiring fault:	Check circuit.
Insufficient oil:	Top up and check for leaks.

Problem: High oil consumption

Possible Cause	Solution
Oil leaks:	Check for leaks.
Piston rings worn:	Overhaul required.
Valve stem and guide worn:	Overhaul required.
Piston rings gap facing the same direction:	Shift ring gap position. Dealer or service agent to check.

Problem: Water in lubricating oil - general

Possible Cause	Solution
Core plug pushed out due to frozen block:	Dealer or service agent to check and replace.
Water pump seal damaged:	Dealer or service agent to check and replace.

Problem: Water in lubricating oil - heat exchanger cooled

Possible Cause	Solution
Oil goes "milky" due to seawater entering exhaust manifold:	Check installation - has an anti-syphon valve been fitted? Change engine oil and run engine for 10 minutes each time to eliminate any water. Get fuel injection pump and compression checked by dealer or service agent.

Problem: Water in lubricating oil - keel cooled

Possible Cause	Solution
Oil goes "milky" due to water entering exhaust manifold and then into the sump:	Check installation - has dry exhaust system been fitted correctly, ensuring rain water cannot enter the exhaust port and run back? (please refer to 'Dry Exhaust System on page 13). Change engine oil and run engine for 10 minutes each time to eliminate any water. Get injection pump checked by dealer or service agent.

Problem: Engine overheats - general

Possible Cause	Solution
Low raw water flow:	See below.
Check coolant level:	Top up.
Pressure cap loose:	Tighten correctly or replace.
Switch sender faulty:	Replace.
Insufficient restrictions in pipe to calorifier:	Clamp off pipe to confirm.
High exhaust back pressure:	Must not exceed the information given in 'exhaust back pressure' in the installation section.
Keel cooler insufficient size:	Contact boat builder.

Problem: Engine overheats - heat exchanger cooled

The most common cause of overheating is insufficient seawater flow due to a blocked intake. If this happens first clear the debris, causing the blockage. If the problem is not cured then check the system for sea water flow which should be 18 litres/minute minimum at 1,500 rpm as follows:

- (a) With the boat tied up and out of gear run the engine up to 1500 rpm. Hold a plastic bucket over the exhaust outlet for 10 seconds and measure the amount of water collected*. Multiply this value by 6 to give the flow in litres/minute. Repeat twice and take an average. If the flow rate is noticeably less than the 18 litre per minute minimum at 1,500 rpm, then:
- (b) Check impeller in sea water pump - if worn replace.
- (c) If impeller has a vane missing then this will be lodged either in the pipe to the heat exchanger or in the end of the exchanger. This must be located and removed.
- (d) Check flow again as in (a).

***NB:** This operation must only be done in safe conditions, in port and with two assistants. Working from a rubber dinghy is best. The person holding the bucket should take precautions against breathing in the exhaust gases.

Problem: Engine overheats - keel cooled

Commonly overheating is 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.

Problem: Vibrations

Possible Cause	Solution
Poor alignment to shaft:	The alignment must be accurate even if a flexible coupling is used (please refer to 'Alignment' on page 10).
Flexible mounts not adjusted correctly to take even weight:	Check relative compression of each mount.
Flexible mount rubber perished:	Replace. (Diesel or oil will eventually perish rubbers).
Loose securing nut on flexible mount:	Check alignment and then tighten the nuts.
Insufficient clearance between the propeller tip and the bottom of the boat:	There must be at least 10% of the propeller diameter as tip clearance between the propeller and the bottom of the boat. Reduce propeller diameter/increase pitch
Loose zinc anode on the shaft:	Tighten or replace.
Worn cutless bearing or shaft:	Replace.
Weak engine support/bearers:	Check for cracked or broken feet.

Problem: Knocking noise

Possible Cause	Solution
Propshaft touching gearbox output coupling through split boss or Type 16 coupling:	Adjust, giving correct clearance give 5mm - 10mm between gearbox and propeller shaft.
Flexible mount stud touching engine bed:	Adjust stud to clear.
Drive plate broken:	Replace/repair.
Engine touching engine bed:	Re-align engine/modify bed.
Injectors blocked through excess carbon caused by water in the fuel:	Remove and check injector nozzles, replace if required.

Problem: Transmission noise

Possible Cause	Solution
Check gearbox oil level:	Top up.
"Singing" propeller:	Check with propeller supplier about 'harmonics'.
Drive plate rattle at tickover:	Check engine rpm (must be 850rpm min. in gear).
Worn drive plate:	Change.
Propeller shaft hitting the Gearbox half coupling:	Move shaft back to give 5mm - 10mm clearance (Type 12/16 couplings only).
Propeller torsionals causing gears to rattle at low rpm:	Fit a torsional flexible coupling such as Centaflex type 16 or equivalent.

Problem: Battery quickly discharges

Possible Cause	Solution
High load and insufficient running:	Reduce load or increase charging time. Large domestic battery banks subject to high electrical loads will take a considerable time to recharge from a single alternator.
Low electrolyte level:	Top up.
Fan belt slipping - black dust in engine compartment, engine compartment temperature too high:	Adjust tension/replace belt with a high temperature type and/or improve engine compartment ventilation.
Alternator defective:	Check with dealer or service agent.
Battery defective:	Replace.
Poor wiring connection:	Check wiring system.

Problem: Morse control cable will not fit

Possible Cause	Solution
Incorrect fitting:	Cables are being fitted the wrong way around, switch over and fit the opposite way.

Problem: Panel rev counter not working (when fitted)

Possible Cause	Solution
No W connection to alternator:	Check output from 'W' connection. Should be about 9V AC.
Wiring fault:	Check circuit.

▼ ELECTRICAL TROUBLESHOOTING - GENERAL OVERVIEW

The following pages are compiled to aid diagnosis of electrical faults, based on the Beta 10 - 115hp range of engines. If your engine was built before July 2005, contact Beta Marine for the relevant electrical trouble shooting guide.

NB: our standard control panels are for earth return installations only (where battery negative cable is connected directly to engine ground). For insulated earth (where battery negative cable is isolated from engine ground) different harnesses, alternators, switches for oil pressure and engine temperature are fitted.

Heat Exchanger Engines

Standard heat exchanger cooled engines are supplied with a single starter battery alternator, a secondary domestic battery bank alternator is optional for the Beta 30 and above.

3.5kVA, 230v, 50Hz Travel Power alternators and inverter are optional for the Beta 35 and above. For the Beta 43 and above a 5kVA variant is additionally available.

Keel Cooled Engines

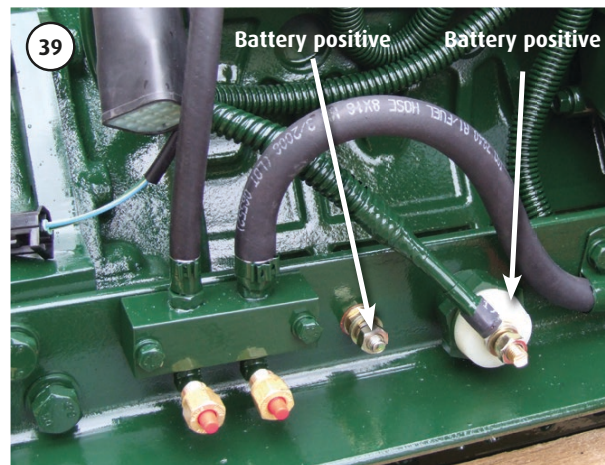
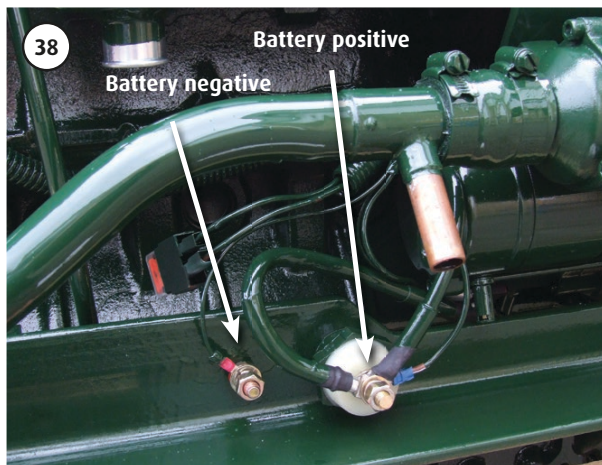
Standard Greenline keel cooled engines are supplied with a single starter battery alternator, a secondary domestic battery bank alternator is additionally included as standard for the Beta 30 and above.

For the Beta 38 and above, it is possible to specify both a secondary domestic battery bank alternator & a 3.5kVA travel power alternator & inverter, 5kVA for the Beta 43 and above.

Both the starter battery alternator and domestic battery bank alternator work independently of each other, when equipped if the domestic battery bank alternator is disconnected, the engine will still run correctly but the:

- Domestic charge warning lamp will not function
- Warning buzzer will remain on at all times.

NB: The two way plug on panel loom will only have a corresponding socket to connect into from the engine if a 2nd alternator is fitted which requires this connection. Engines with only one alternator do not utilise this connection.



▼ ELECTRICAL TROUBLE SHOOTING - ALL CONTROL PANELS

Before investigating any specific electrical problem, always check:

- The connection between the panel harness and panel loom. It must be clean, dry and secured with a cable tie.
- The start battery is connected to the correct terminal on the starter motor.
- The domestic battery is switched on and connected to the correct terminals for the secondary domestic battery charging alternator.
- The battery connections and inspect the condition of cables from the battery to engine. If in doubt measure the voltage at the engine.
- If there is a starter alternator charge problem, measure battery voltage with engine off and again with engine running, if there is an increase the alternator is functioning correctly.

Problem	Possible Cause and Solution
No warning lights or buzzer functioning, engine will not start or stop	• Battery isolation switch in off position - switch on. • Starter battery discharged - charge. • Engine fuse blown - check fuse (above starter motor or flywheel housing) and replace if necessary. • Check for wiring faults.
Non function of warning light. The water temperature light will not function unless engine is overheating or there is a wiring fault	• Disconnect switch wire to non-functioning light: green/blue –water temperature, white/brown –oil pressure, brown/yellow –alternator charge. Reconnect wire temporarily to another warning light that is functioning; if wire switches light on replace faulty light. • Disconnect positive feed to non-functioning light. Reconnect temporarily with wire from another warning light that is functioning, if wire switches light on rewire with new connection. • If none of the above, check continuity of connections from panel to the engine.
Water temperature warning light on when engine is not over temperature (Not B or C deluxe panel see table on on following page)	If engine is cold: • Faulty wiring, check connection and continuity (small green/blue) from switch to panel light. Ensure this connection is not shorting to earth (ground). • Faulty temperature switch - if light switches off on If engine is warm: • Switch wire connected to large sender terminal of switch/sender unit. Remove and refit to smaller (switch) terminal.

Problem	Possible Cause and Solution
Buzzer not functioning. The buzzer will not sound for green 'power on' light	• If light is functioning but buzzer not sounding, check connection and continuity from illuminated warning light (red not green) to buzzer board. • Faulty warning panel buzzer board - replace.
Starter battery charge light not functioning	If tachometer not functioning: • Alternator not connected properly, check continuity of small brown wire from rear of alternator to AC position on keyswitch. • Alternator connected properly, faulty alternator - replace. If tachometer functioning correctly: • Check continuity of small brown/yellow wire from rear of alternator to no charge warning light on rear of panel. • If alternator connected properly, faulty panel warning light - replace.
If tachometer not functioning	• Check connections on rear of tachometer, especially black/blue wire, terminal '4'. • Check connection of black/blue wire on rear of 1st alternator (W connection, usually a bullet on flying lead, or lowest connection on alternators with 3 pin coupler). • Check continuity of black/blue wire from alternator to tachometer. • Measure voltage from alternator W connection to earth (ground), should be approx. 7.5 - 9.0 volts AC.
Domestic charge light not functioning, buzzer remains on with engine running	• Domestic battery not connected. • Domestic battery not connected correctly: B+ to domestic isolation block on starboard rail (port on 75 - 115T) B- to engine earth (ground). • Domestic battery flat. • Panel relay faulty/incorrectly wired: Check voltage at relay terminal 86, white wire is positive feed for warning light from AC position of keyswitch.

Problem	Possible Cause and Solution
Domestic charge light not functioning, buzzer remains on with engine running	• Domestic battery not connected. • Domestic battery not connected correctly: B+ to domestic isolation block on starboard rail (port on 75 - 115T) and B- to engine earth (ground). • Domestic battery flat. • Panel relay faulty/incorrectly wired: Check voltage at relay terminal 86, white wire is positive feed for warning light from AC position of keyswitch.
Domestic charge light not functioning, buzzer switching off with engine running. This light will only function if a second alternator is fitted to the engine	• No second alternator fitted to engine, domestic light not used. • D+ (charge indication) light connection at rear of alternator not connected. • Two way plug and socket disconnected between engine harness and panel loom.

▼ ELECTRICAL TROUBLE SHOOTING - B, BW, C AND CW CONTROL PANELS

In addition to the fault finding detailed on the previous pages, the following is specific for control panels as listed above.

Problem	Possible Cause and Solution
Oil pressure warning light not functioning, oil pressure gauge showing maximum deflection. Engine off and keyswitch in run position	• Faulty wiring - check wire connection and continuity (small white/brown) from sender to panel light. • Ensure this connection is not shorting to earth (ground).
Oil pressure gauge showing no movement - even when engine is started. Warning light functioning correctly oil pressure showing no movement, warning light not functioning correctly	• Faulty wiring - check oil pressure sender wire (small white/brown) is connected. • Check connection to oil pressure gauge, if plug is not connected to socket on rear of gauge, reconnect. • If all connections are correctly made, possible faulty sender unit - check resistance to earth, approx. 50 Ω. Replace if no reading or short-circuited. • If adjusted correctly and buzzer still sounding, possible faulty switch gauge unit - replace.

Problem	Possible Cause and Solution
Oil pressure showing normal operating pressure (0.75 - 5 bar). Buzzer sounding and light illuminated.	Engine warm: • Incorrectly calibrated switching point for warning light, adjust on rear of gauge to 0.5 bar (minimum adjustment on gauge). • If adjusted correctly and buzzer still sounding, faulty switch gauge unit - replace.
Water temperature gauge showing 120°C/250°F. This also applies to the B Panel with Murphy gauge	Engine cold/cool: • Faulty wiring, check water temperature sender wire is not shorting to earth (ground). • Faulty sender unit, - check resistance to earth, approx. 3.5k Ω (cold) – 0.5k Ω (warm). Replace if notably less.
Water temperature gauge showing normal operating temperature (85°C). Buzzer sounding and light illuminated. This also applies to the B Panel with Murphy gauge	Engine warm: • Incorrectly calibrated switching point for warning light adjust on rear of gauge to 100°C/210°F. • If adjusted correctly and buzzer still sounding, faulty switch gauge unit - replace.
Water temperature gauge showing no movement, light not illuminated, engine warm. This also applies to the B Panel with Murphy gauge	• Check connection to sender, if disconnected gauge will not function. • Check connection to temperature gauge, if plug is not connected to socket on rear of gauge reconnect. If all connections are correctly made, faulty sender unit - check resistance to earth, approx. 3.5k Ω (cold) - 0.5k Ω (warm). Replace if no reading.

▼ ELECTRICAL TROUBLE SHOOTING - EXTENSION HARNESSSES

Some installations require one of the 'panel extension 11-way connectors' to be removed to allow the cable to be passed through bulkheads etc.

If any panel problems are experienced, after this has been done, visually check all 11-way connections on engine harness to panel extension* to ensure wire colours to each terminal match up to the correct colour in its corresponding terminal.

Extra attention must be given to black (ground) and black/blue (tacho), also brown (switched positive to alternator) and brown/yellow (charge fail) as these connections are harder to distinguish between in poorly lit areas. Whilst doing this check integrity of each connection to ensure terminals have not become damaged. Once checked, re-fit cable tie around each connection to keep them secure.

* Also applies for panel to panel extension cables for installations with additional flybridge control panel option.

▼ ELECTRICAL TROUBLE SHOOTING - INSULATED EARTH

If your application is wired as insulated earth return and the engine will not operate correctly, always check starter battery negative is connected to the correct terminal on the isolating solenoid.

It should be connected to the terminal which is also used for all the small black wires. **NB:** Not the terminal with the single black wire connected directly to engine ground.

Section 5: Torque Settings

▼ STANDARD NUTS & BOLTS (GRADE/CLASS 4 - 6.8 DIN 267)

ITEM	SIZE	N M	KGF M	LBF FT (FT LBS)
M6	6 MM	7.9 ~ 9.3	0.8 ~ 0.95	5.8 ~ 6.9
M8	8 MM	17.7 ~ 20.6	1.8 ~ 2.1	13.0 ~ 15.2
M10	10 MM	39.2 ~ 45.1	4.0 ~ 4.6	28.9 ~ 33.3
M12	12 MM	62.8 ~ 72.6	6.4 ~ 7.4	46.3 ~ 53.5

▼ SPECIAL NUTS & BOLTS (GRADE/CLASS 7 - 8.8 DIN 267)

ITEM	SIZE	N M	KGF M	LBF FT (FT LBS)
M6	6 MM	9.8 ~ 11.3	1.0 ~ 1.15	7.2 ~ 8.3
M8	8 MM	23.5 ~ 27.5	2.4 ~ 2.8	17.4 ~ 20.3
M10	10 MM	48.1 ~ 55.9	4.9 ~ 5.7	35.4 ~ 41.2
M12	12 MM	77.5 ~ 90.2	7.9 ~ 9.2	57.1 ~ 66.5

▼ BETA 43 TO BETA 60 - SPECIFIC NUTS & BOLTS

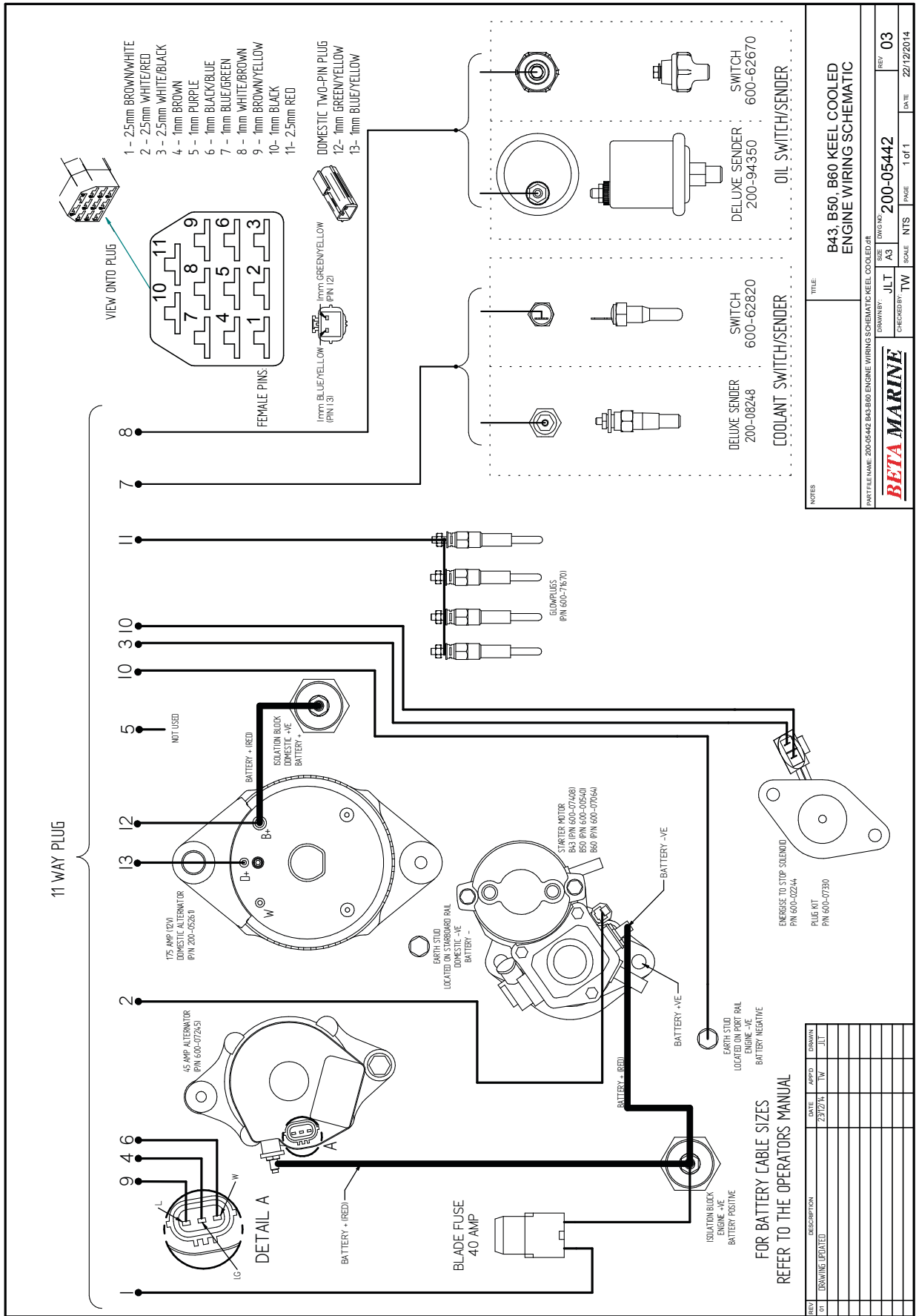
ITEM	SIZE X PITCH	N M	KGF M	LBF FT (FT LBS)
CYLINDER HEAD BOLT	M11 X 1.25	93.2 ~ 98.0	9.5 ~ 10.0	68.8 ~ 72.3
CONNECTING ROD BOLT	M8 X 1.0	45.0 ~ 49.0	4.5 ~ 5.0	33.0 ~ 36.0
FLYWHEEL BOLT	M12 X 1.25	98.1 ~ 107.0	10.0 ~ 11.0	72.4 ~ 79.5
MAIN BEARING CAP - BOLT 1	M9 X 1.25	46.0 ~ 50.0	4.7 ~ 5.2	34.0 ~ 37.0
MAIN BEARING CAP - BOLT 2	M10 X 1.25	69.0 ~ 73.0	7.0 ~ 7.5	51.0 ~ 54.0
NOZZLE HOLDER ASSEMBLY	M20 X 1.5	49.0 ~ 68.0	5.0 ~ 7.0	37.0 ~ 50.0
CYLINDER HEAD COVER BOLT	M6 X 1.0	6.9 ~ 11.2	0.7 ~ 1.15	5.1 ~ 8.3
GLOW PLUG	M10 X 1.25	20.0 ~ 24.0	2.0 ~ 2.5	15.0 ~ 18.0
OIL PRESSURE SWITCH	BSP 1/8"	15.0 ~ 19.0	1.5 ~ 2.0	11.0 ~ 14.0
ROCKER ARM BRACKET SCREW	M8 X 1.25	24.0 ~ 27.0	2.4 ~ 2.8	18.0 ~ 20.0
IDLE GEAR SHAFT BOLT	M8 X 1.25	24.0 ~ 27.0	2.4 ~ 2.8	18.0 ~ 20.0
CRANKSHAFT NUT	M30 X 1.5	138.0 ~ 156.0	14.0 ~ 16.0	102.0 ~ 115.0

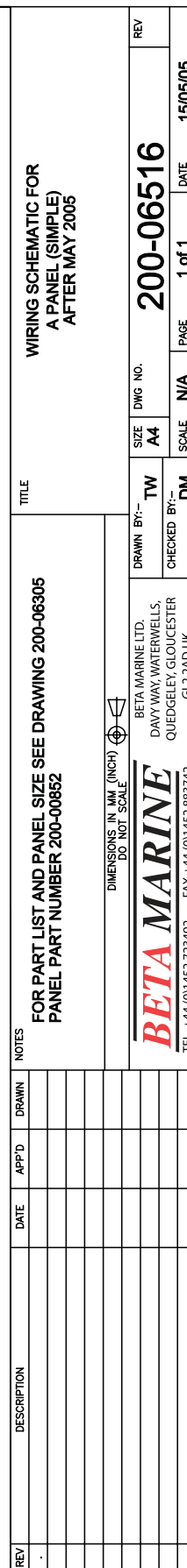
We recommend that you refer to the Kubota Workshop Manual for detailed maintenance and torque setting information, or contact your local Dealer, or direct to us. We can provide Workshop Manuals as a 'PDF' if required.

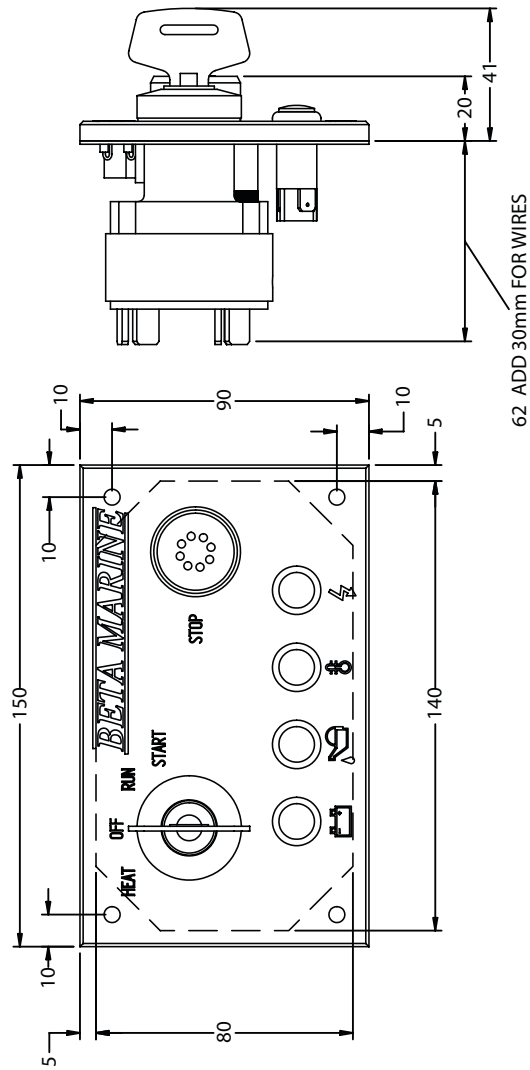
Section 6: Diagram Index

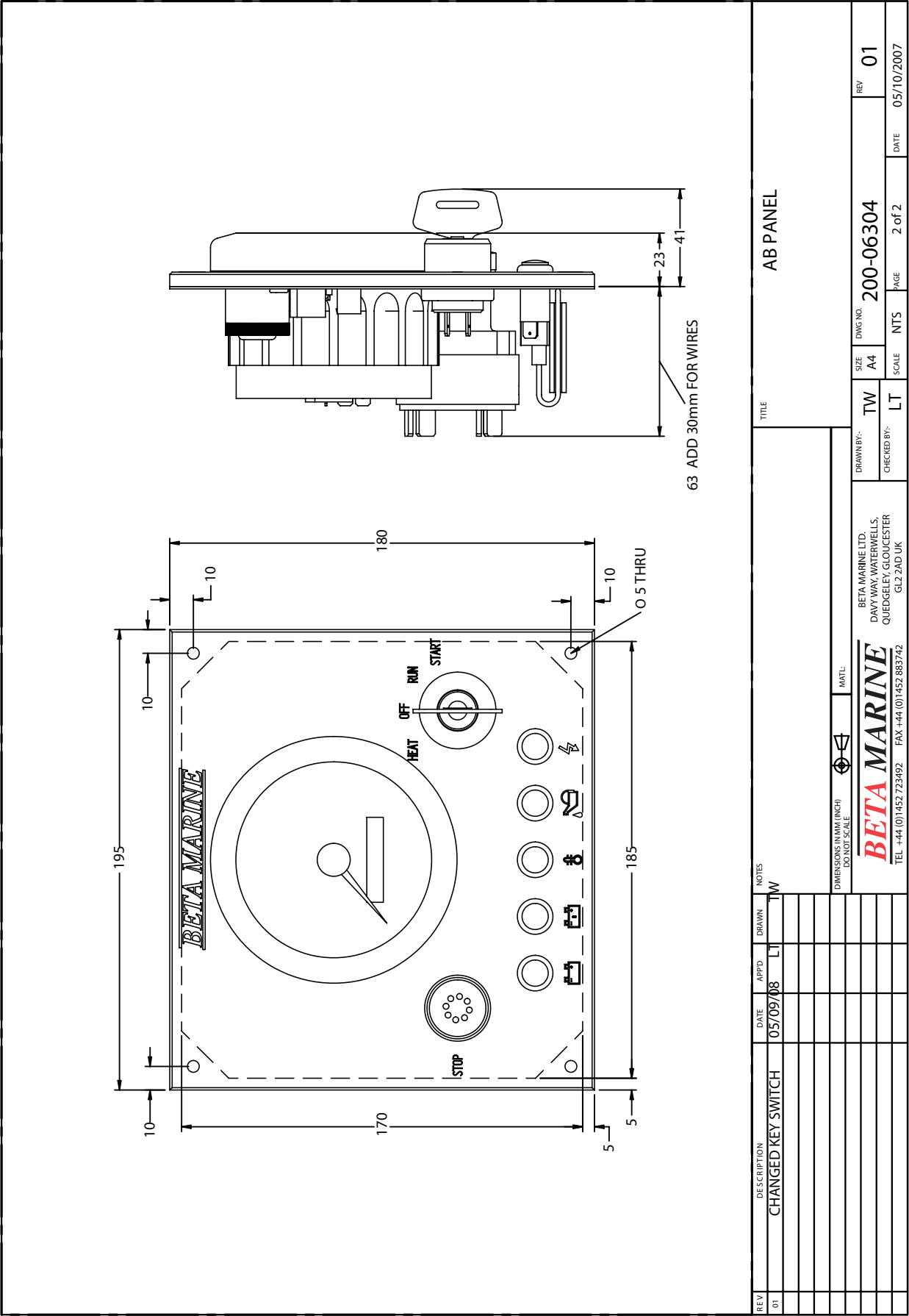
1. Typical starter motor ratings	Page 6
2. Suggested engine started battery size	Page 6
3. Keyswitch terminations	Page 20
4. Beta 43 - Beta 60 K/C engine harness (45 Amp)	Page 53
5. Diagram of panel 'A' & cut-out	Page 54 & 55
6. Diagram of panel 'AB' & cut-out	Page 56 & 57
7. Diagram of panel 'ABV' & cut-out	Page 58 & 59
8. Diagram of panel 'ABVW' & cut-out	Page 60 & 61
9. Diagram of panel 'B' & cut-out	Page 62 & 63
10. Diagram of panel 'BW' & cut-out	Page 64 & 65
11. Diagram of Deluxe panel 'C' & cut-out	Page 66 & 67
12. Diagram of Deluxe panel 'CW' & cut-out	Page 68 & 69
13. GA of Beta 43/50 K/C PRM 150	Page 70
14. GA of Beta 43S/50S K/C PRM 150	Page 71
15. GA of Beta 43/50 K/C PRM 280	Page 72
16. GA of Beta 43S/50S K/C PRM 280	Page 73
17. GA of Beta 43 - 60 K/C TM345	Page 74
18. GA of Beta 43 - 60 K/C F12-40 Hydraulic Pump	Page 75
19. Starter relay wiring - over 4 metres	Page 76
20. Electric fuel lift pump	Page 77
21. Diagram of extension harness	Page 78
39. Declaration of Conformity for Recreational Craft	Page 80
40. Emission Durability	Page 81
41. Emission-Related Warranty	Page 82
42. Hazardous Materials Statement	Page 83
43. Service Record	Page 84

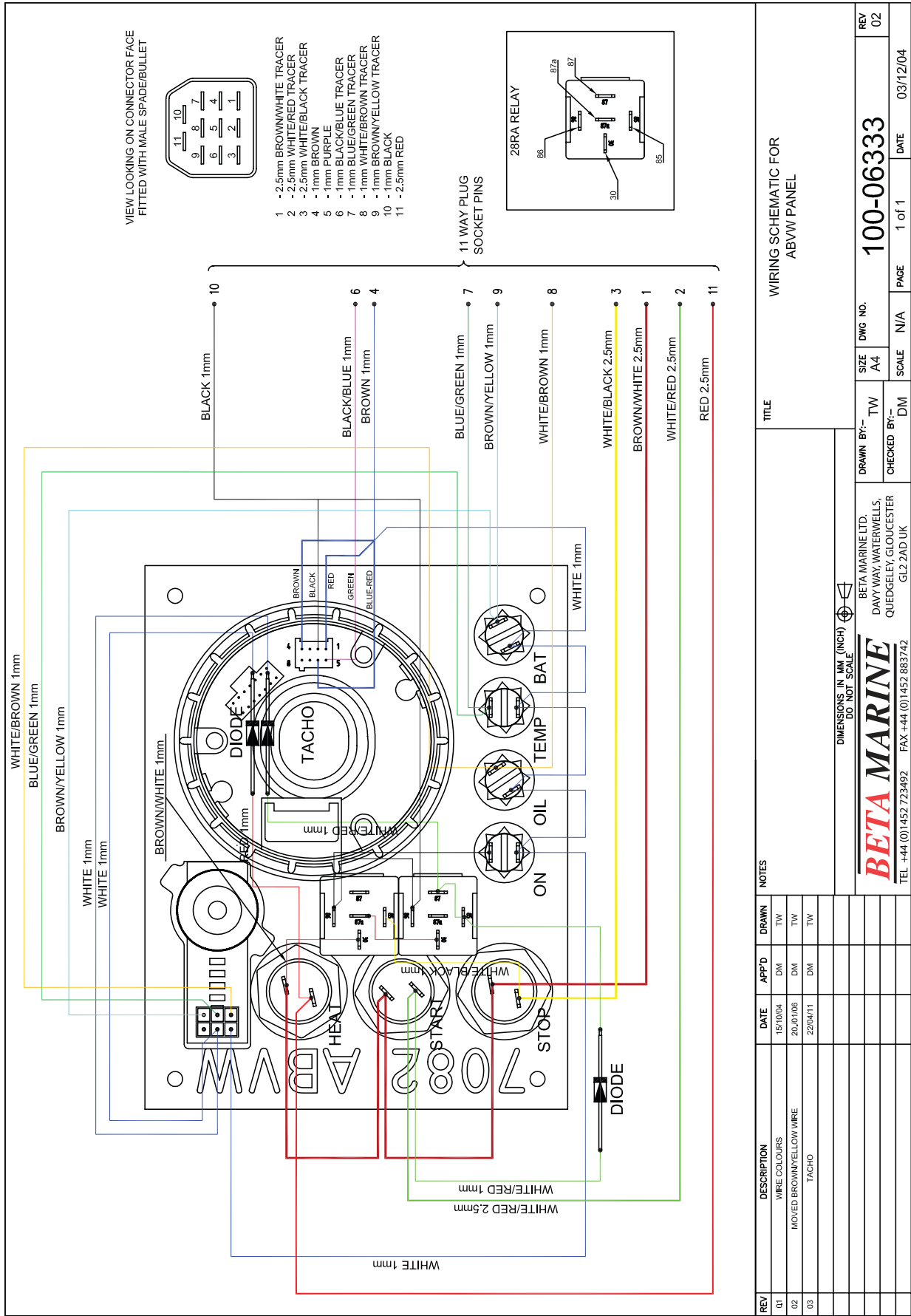
NB: Further information and arrangement drawings can be found on our website at: www.betamarine.co.uk





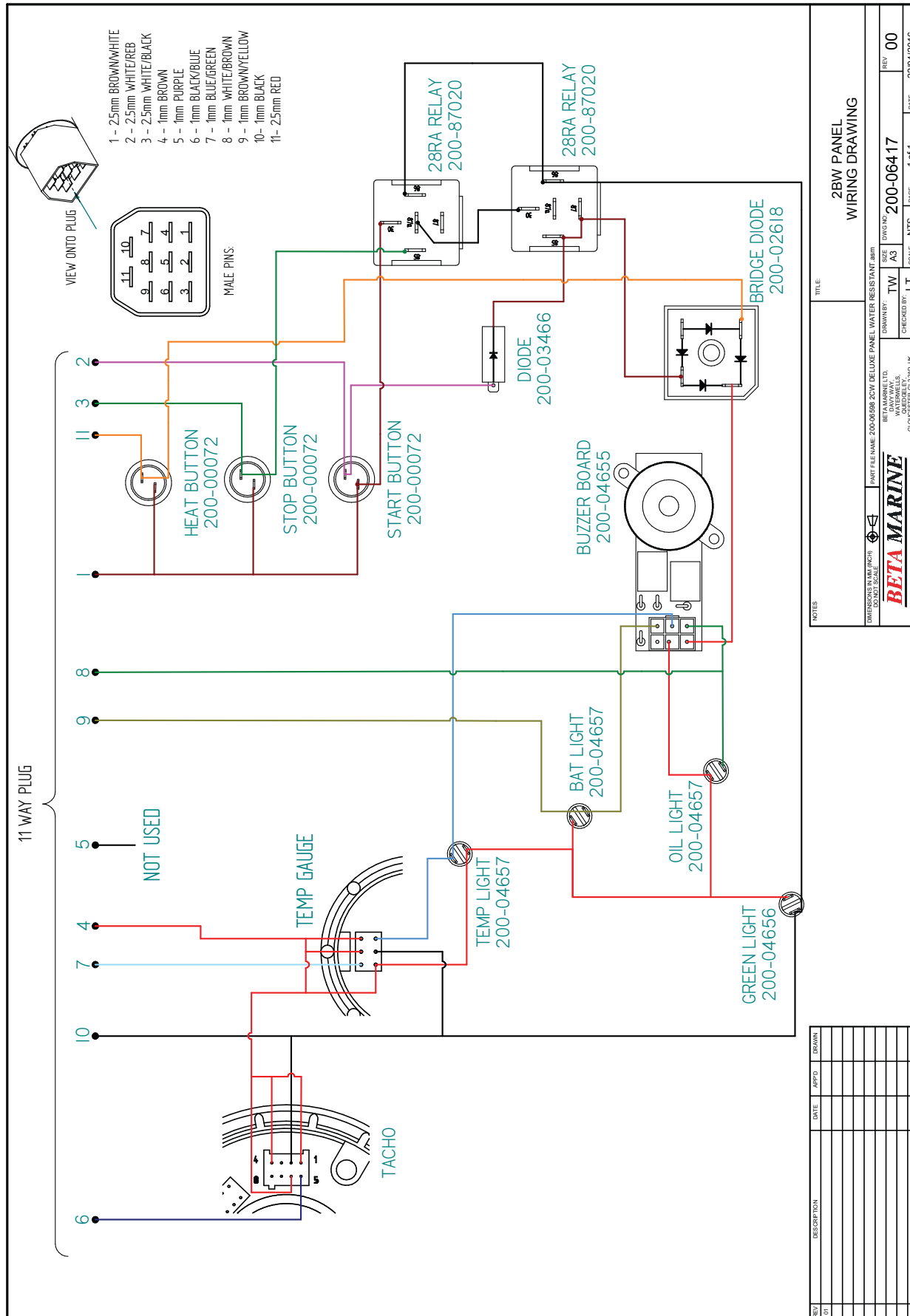
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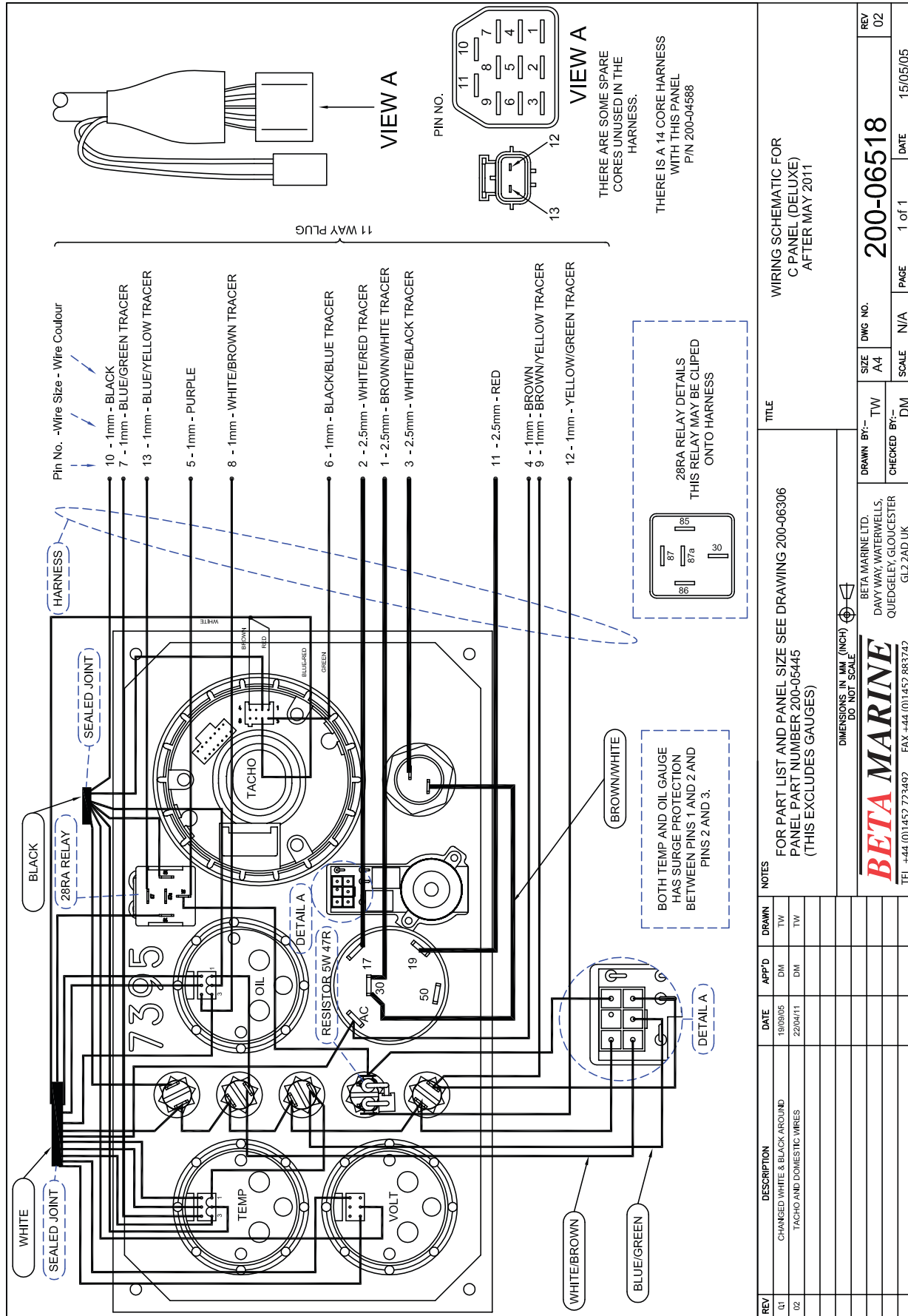


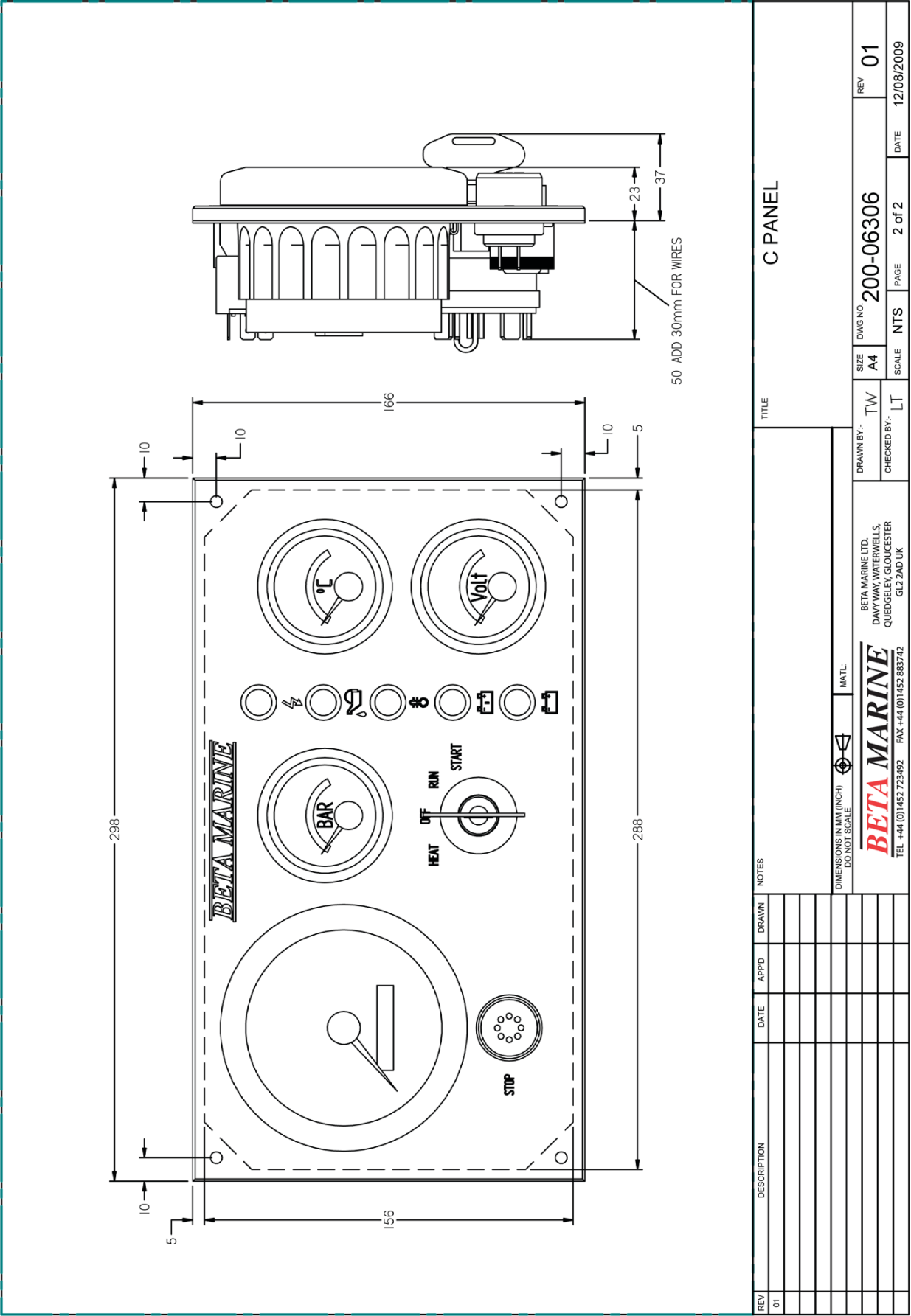


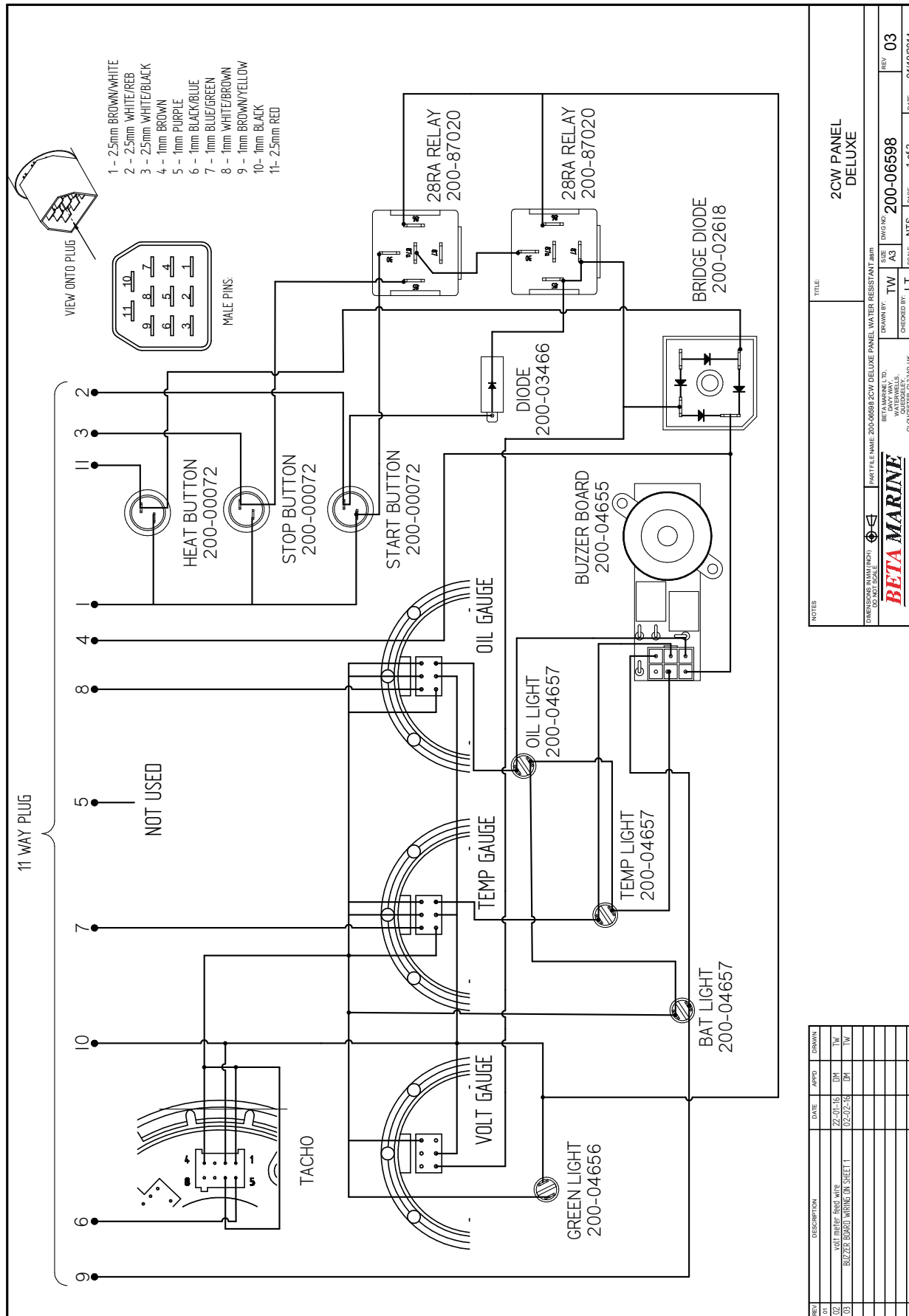
REV	00
9/03/2014	



2BW SPLASH PROOF PANEL

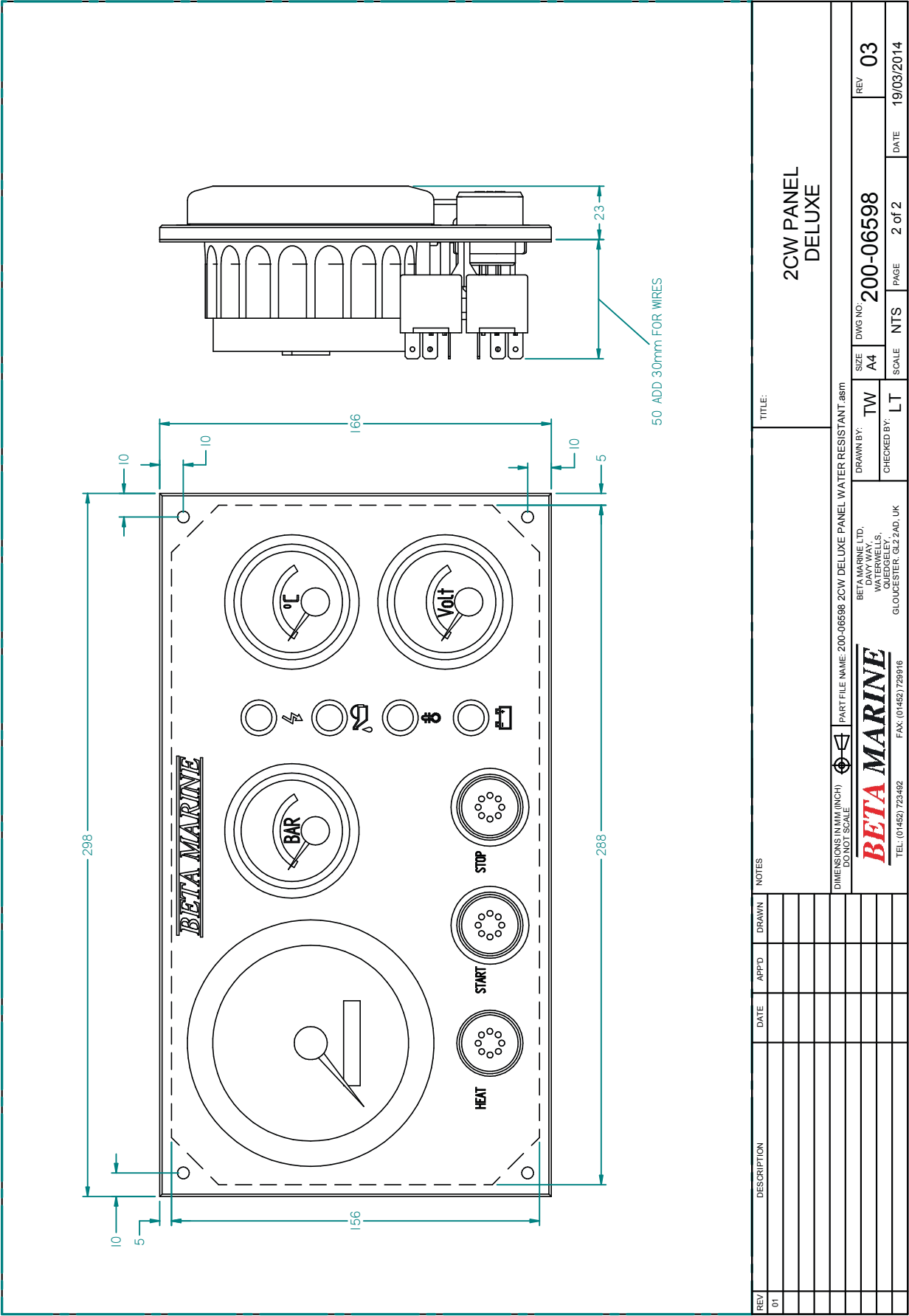


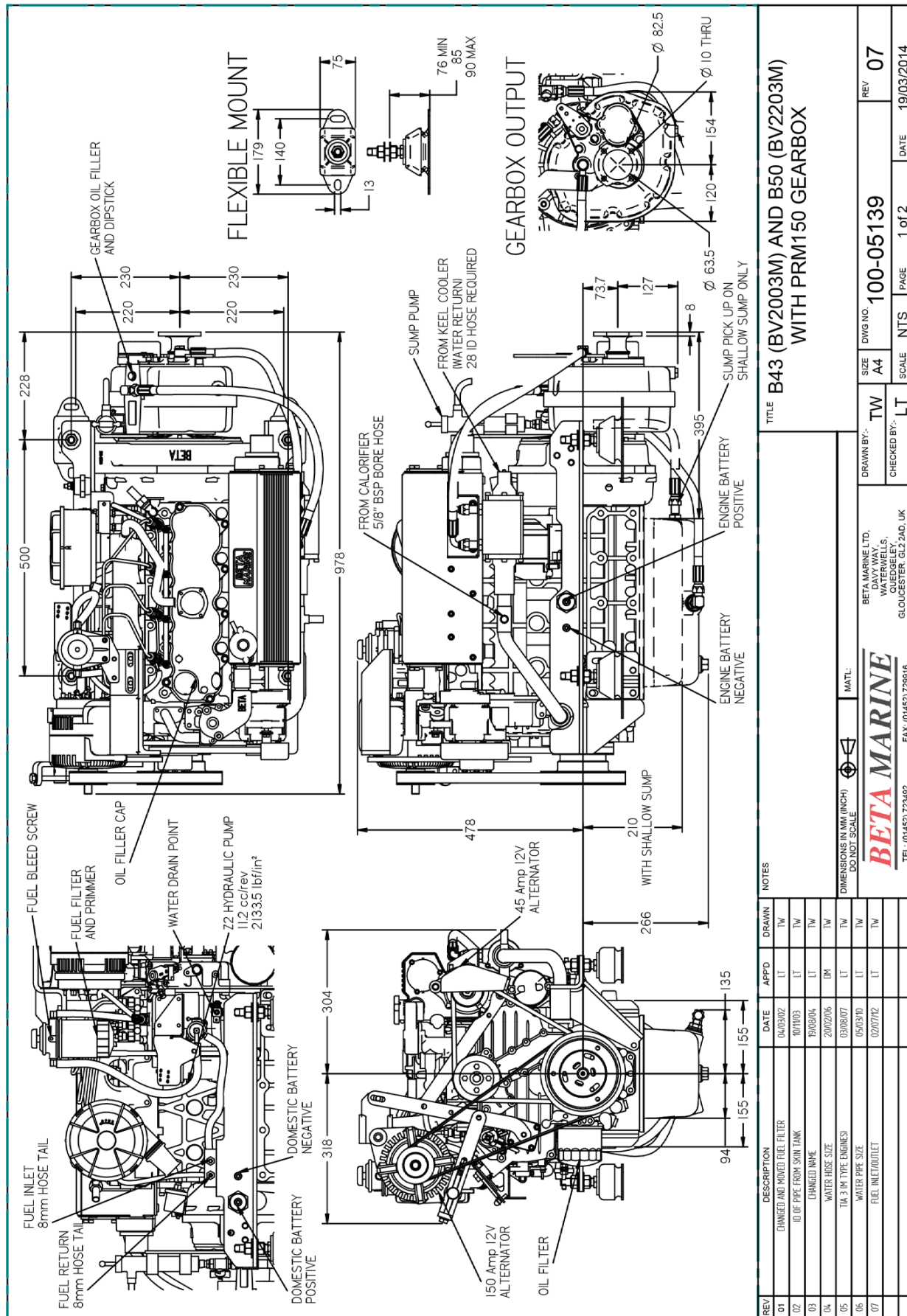




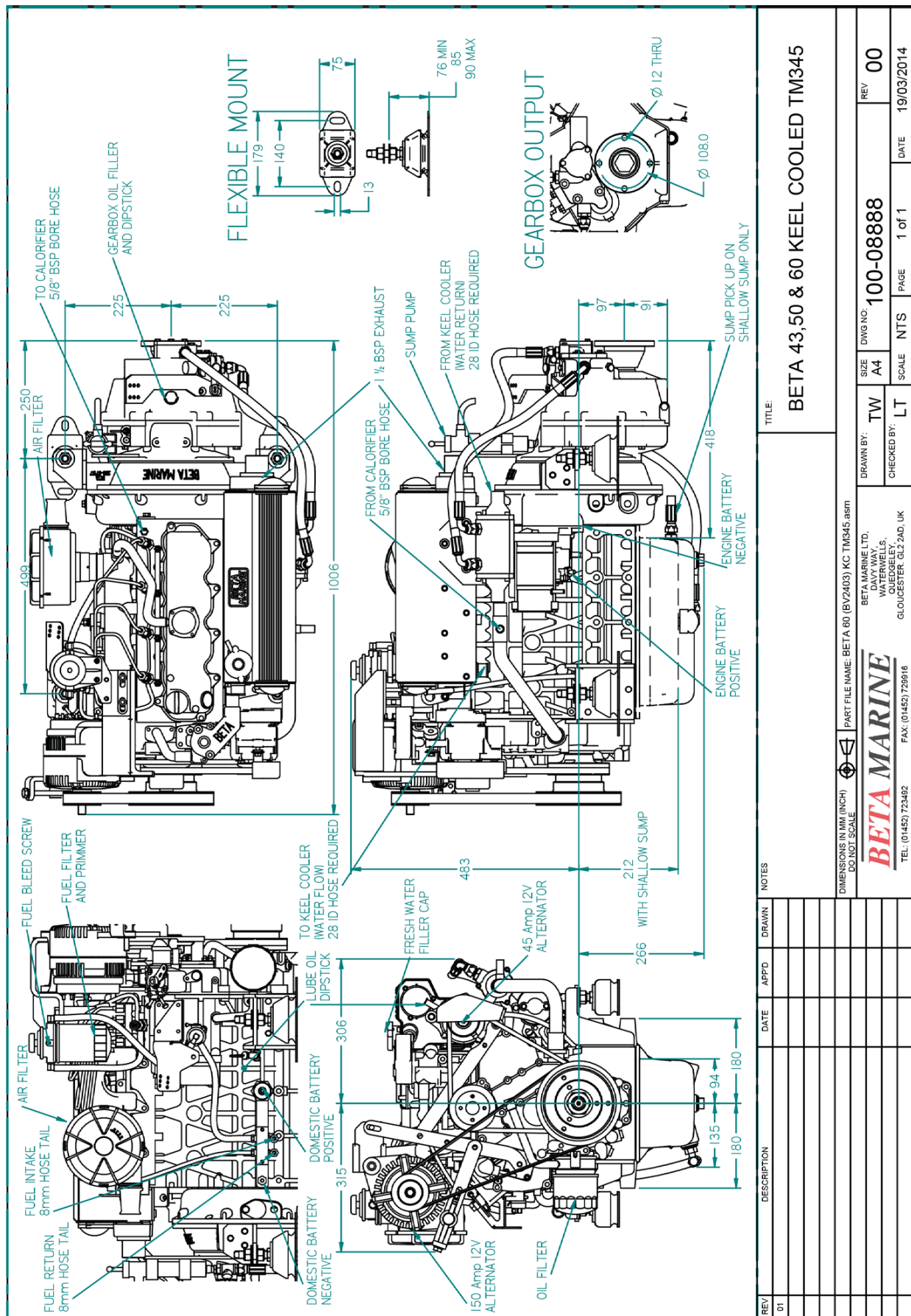
REV	DESCRIPTION	DATE	APPD	DRAWN
01				TW
02	VOLT INTER: fixed wire	22-01-16	DM	TW
03	BUZZER BOARD WIRING IN SHEET 1	02-02-16	DM	TW

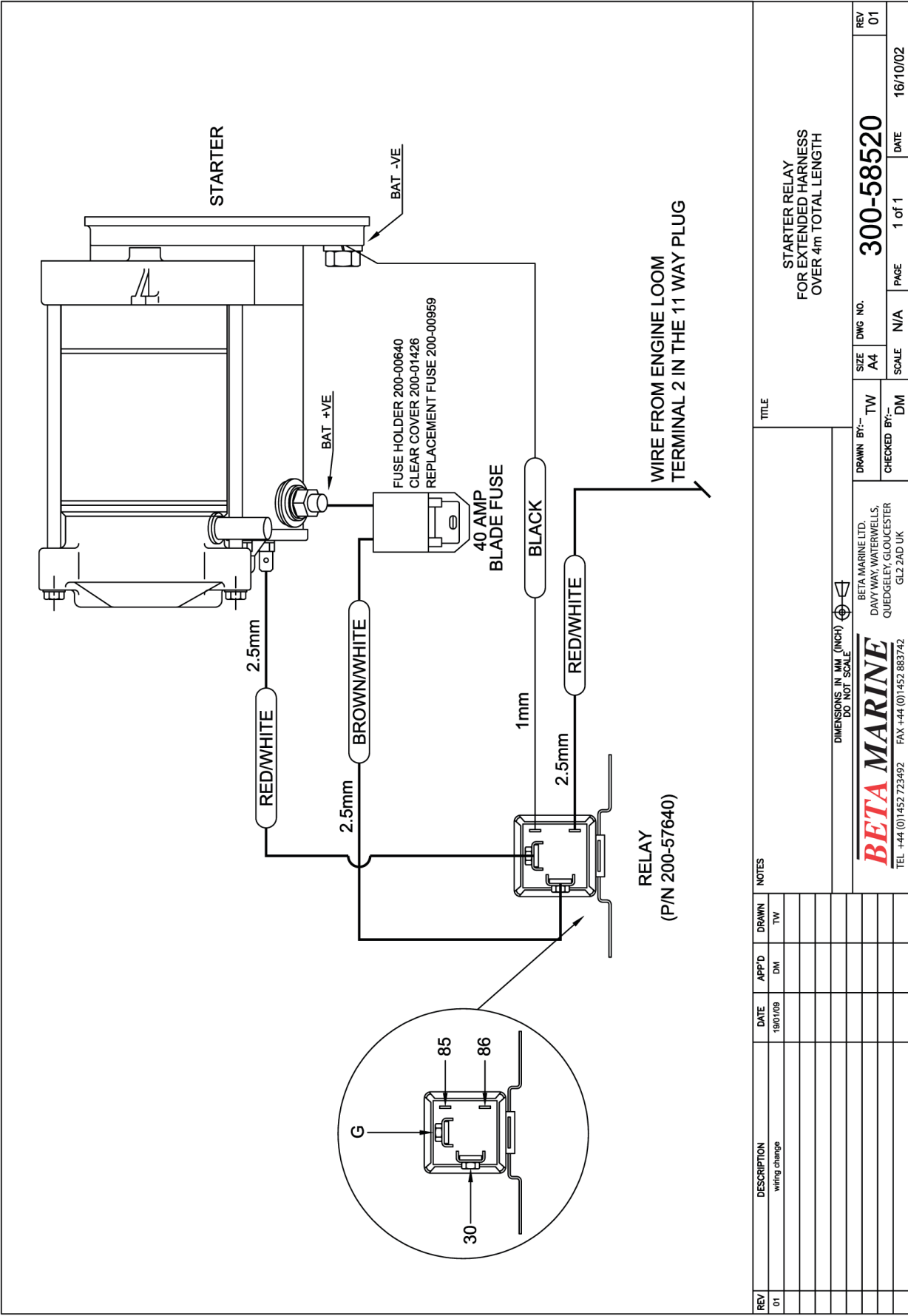
NOTES		TITLE	
2CW PANEL DELUXE			
DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED			
PART FILE NAME: 200-06598 2CW DELUXE PANEL WATER RESISTANT 2mm			
DRAWN BY:	SIZE:	DATE:	REV:
TW	A3	200-06598	03
CHECKED BY:	SCALE:	1 OF 2	DATE:
LT	NTS	01/10/2014	
BETA MARINE LTD. WATERWELL, GLOUCESTER, GL2 2AQ, UK TEL: 01452 72486 FAX: 01452 72895			

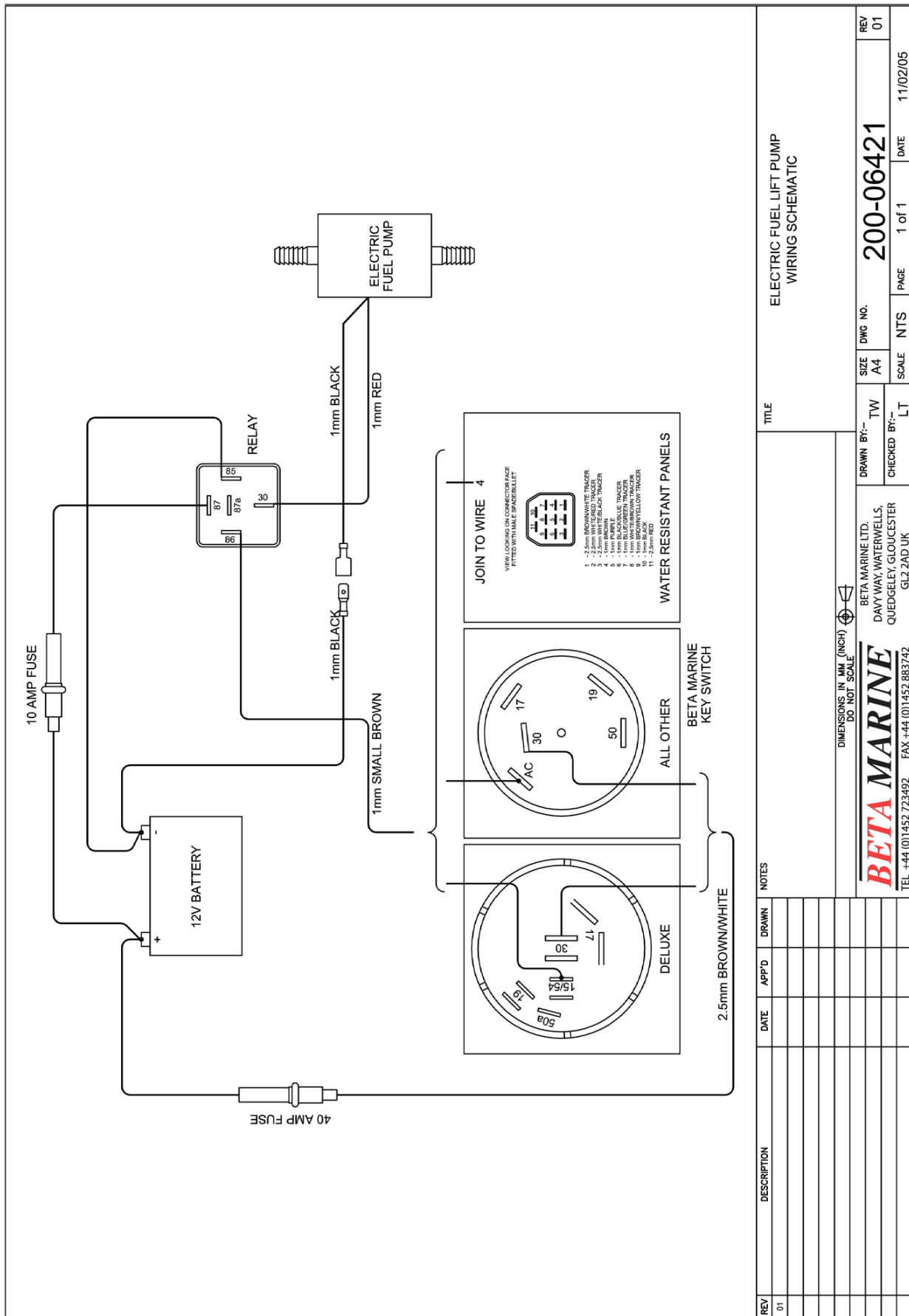




REV	DESCRIPTION	DATE	APPD	DRAWN	NOTES	TITLE								
01	CHANGED AND MOVED FUEL FILTER	04/03/02		TW	NOTES	B43 (BV2003M) AND B50 (BV2203M)								
02	1" OF PIPE FROM SKIN TANK	10/11/03	LT	TW		WITH PRM150 GEARBOX								
03	CHANGED NAME	15/03/04	LT	TW										
04	WATER HOSE SIZE	20/02/06	BM	TW										
05	1 1/4" M TYPE ENGINE3	03/08/07	LT	TW										
06	FUEL PIPE SIZE	05/03/10	LT	TW	DIMENSIONS IN MM (INCH) DO NOT SCALE	DRAWN BY:-	SIZE	DWG NO.	REV					
07	FUEL INLET/OUTLET	02/07/12	LT	TW						CHECKED BY:-	SCALE	NTS	PAGE	DATE
08														
09														
					<									



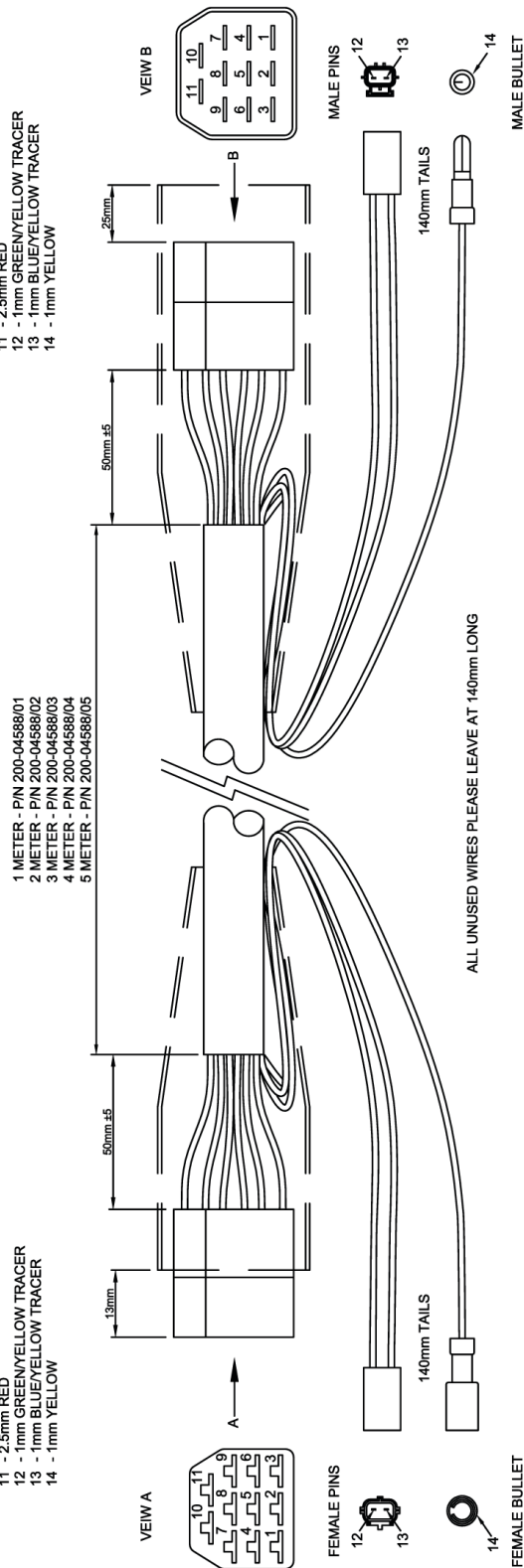




**VIEW LOOKING ON CONNECTOR FACE
FITTED WITH FEMALE SPADE/BULLET**

- | | |
|----|----------------------------|
| 1 | - 2.5mm BROWN/WHITE TRACER |
| 2 | - 2.5mm WHITE/RED TRACER |
| 3 | - 2.5mm WHITE/BLACK TRACER |
| 4 | - 1mm BROWN |
| 5 | - 1mm PURPLE |
| 6 | - 1mm BLACK/BLUE TRACER |
| 7 | - 1mm BLUE/GREEN TRACER |
| 8 | - 1mm WHITE/BROWN TRACER |
| 9 | - 1mm BROWN/YELLOW TRACER |
| 10 | - 1mm BLACK |
| 11 | - 2.5mm RED |
| 12 | - 1mm GREEN/YELLOW TRACER |
| 13 | - 1mm BLUE/YELLOW TRACER |
| 14 | - 1mm YELLOW |

- | | | |
|----|------------|---------------------|
| 1 | - 2.5mm | BROWN/WHITE TRACER |
| 2 | - 2.5mm | WHITEDRED TRACER |
| 3 | - 2.5mm | WHITE/BLACK TRACER |
| 4 | 1mm BROWN | |
| 5 | 1mm PURPLE | |
| 6 | 5mm | BLACK/BLUE TRACER |
| 7 | 1mm | BLUE/GREEN TRACER |
| 8 | 1mm | WHITE/BROWN TRACER |
| 9 | 1mm | BROWN/YELLOW TRACER |
| 10 | - 1mm | BLACK |
| 11 | - 2.5mm | RED |
| 12 | - 1mm | GREEN/YELLOW TRACER |
| 13 | - 1mm | BLUE/YELLOW TRACER |
| 14 | - 1mm | YELLOW |

[illegible]

Notes...

Section 7: Emissions

BETA MARINE

Beta Marine Limited

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Quedgeley
Gloucester, GL2 2AD
United Kingdom
Tel: +44 (0)1452 723492
Fax: +44 (0)1452 883742
Email: sales@betamarine.co.uk
www.betamarine.co.uk

EU DECLARATION OF CONFORMITY

The Beta range of marine propulsion engines Beta10 through Beta105.

Manufactured by Beta Marine Limited at the address given above.

This declaration of conformity is issued under the sole responsibility of the manufacturer.

The object of this declaration is to conform compliance of the propulsion engine in accordance with the exhaust emission requirements of Directive 2013/53/EU in conformity with the relevant Union harmonised legislation.

Standard used include in part as applicable ISO 8178, ISO 8665, ISO 18854, ISO 3046 except where engines are pre-approved in accordance with Stage III of Directive 97/68/EC.

Where applicable, the notified body, DNV-GL, number 0098, performed witness of emission test(s) and issued the certificate(s).

When installed in a watercraft, in accordance with the installation instructions accompanying the engine, the engine will meet:

- (i) the exhaust emission requirement of this Directive,
- (ii) the limits of Directive 97/68/EC as regards engines type-approved in accordance with Directive 97/68/EC which are in compliance with Stage IIIA, Stage IIIB or Stage IV emission limits for CI engines used in other application than propulsion of inland waterways vessels, locomotives and railcars, as provided for in point 4.1.2 of Annex 1 of that Directive.

The person empowered to sign on the behalf of Beta Marine Limited is Mr J. A. Growcott who is Chief Executive Office of the company.

Individual certificates applicable to any particular engine serial number will be issued on request in any requested EU approved European language applicable to the country in which the installation is made.

Signed for and on behalf of Beta Marine Limited.



Dated: 13th December 2016.

Emission Durability

IN RESPECT TO THE RECREATIONAL CRAFT DIRECTIVE 2013/53/EU AND IN PARTICULAR RESPECT TO EXHAUST EMISSIONS.

The engine must be installed, maintained and operated within the parameters detailed in the Operator's Maintenance Manual. Maintenance must use approved materials, parts and consumables. Should the engine lie unused for a period in excess of 6 months it must be inhibited otherwise it will deteriorate with resulting decrease in performance. See also the Winterising and Laying Up procedures in the Operator's Maintenance Manual.

The fuel settings of the diesel injection system must not be tampered with otherwise the guarantee will be invalid and the performance may fall outside prescribed limit. Such adjustment cannot be allowed under the terms of the emission certification.

Performance of the engine depends upon the use of correct fuels, lubricants and inhibitors. These are fully detailed in the Operator's Maintenance Manual.

Particular attention must be paid to the installation with respect to the exhaust system. The system must be designed so that water cannot back feed into the engine. The run must be such that the back pressure at the engine manifold does not exceed the limit detailed in the Operator's Maintenance Manual. Wet (water injected) exhaust systems must be at least the bore mentioned in the Operator's Maintenance Manual and should the run be excessive this bore must be increased accordingly. Back pressure is measured at the outlet of the engine manifold before the water injection bend or dry bellows.

Our experience has proven that properly installed and maintained engines hold their performance without major mishap even when running hours exceed those mentioned in the Recreational Craft Directive. It is the owners / users responsibility to ensure that the engine continues to function properly and any malfunction must be immediately investigated. The Trouble Shooting section as detailed in the Operator's Maintenance Manual is particularly helpful in this respect.

Engine performance, especially with respect to erratic running, exhaust condition, low power output and high oil consumption are indications of engine conditions that may result in emissions outside the prescribed limits and must therefore be investigated and rectified immediately. Only genuine Beta Marine or Kubota approved parts must be used.

This document is to be read in conjunction with our "Enhanced Kubota Based Engine Warranty" ref: **WC 221-10231**.

2013/53/EU and minor text corrections, September 12, 2016.

Cross ref to Warranty Card, October 3, 2017.

Emission-Related Warranty

IN RESPECT TO CATEGORY 1 MARINE PROPULSION ENGINES FOR RECREATIONAL PURPOSE WITH EXHAUST EMISSIONS CONFORMING TO THE APPLICABLE REQUIREMENTS OF 40 CFR PART 1042 AND COVERED BY A CERTIFICATE OF CONFORMITY ISSUED BY US EPA.

The engine must be installed, maintained and operated within the parameters detailed in the Operator's Maintenance Manual. Maintenance must use approved materials, parts and consumables. Should the engine lie unused for a period in excess of 6 months it must be inhibited otherwise it will deteriorate with resulting decrease in performance. See also the Winterising and Laying Up procedures in the Operator's Maintenance Manual.

The fuel settings of the diesel injection system must not be tampered with otherwise the guarantee will be invalid and the performance may fall outside prescribed limit. Such adjustment cannot be allowed as the emission certification relates to factory settings. Performance of the engine depends upon the use of correct fuels, lubricants and inhibitors. These are fully detailed in the Operator's Maintenance Manual.

Particular attention must be paid to the installation with respect to the exhaust system. The system must be designed so that water cannot back feed into the engine. The run must be such that the back pressure at the engine manifold does not exceed the limit detailed in the Operator's Maintenance Manual. Wet (water injected) exhaust systems must be at least the bore mentioned in the Operator's Maintenance Manual and should the run be excessive this bore must be increased accordingly. Back pressure is measured at the outlet of the engine manifold before the water injection bend or dry bellows.

The air induction system and air cleaner supplied with the engine must be used and maintained within the limits specified in the Operator's Maintenance Manual.

For Emission-related Warranty the engine components must not be tampered with or replaced. Engine performance, especially with respect to erratic running, exhaust condition, low power output and high oil consumption are indications of engine conditions that may result in emissions outside the prescribed limits and must therefore be investigated and rectified immediately. Only genuine Beta Marine or Kubota approved parts must be used, installed (and where applicable, properly set) only by our authorized mechanic.

The Emission-related Warranty will be limited to 5 years or 1000 running hours whichever comes first.

This document is to be read in conjunction with our "Enhanced Kubota Based Engine Warranty" ref: **WC 221-10231/1 USA**.

Cross ref to Warranty Card, October 3, 2017.

Important!

Beta Marine Ltd operates a policy of continuous improvement and reserves the right to change prices & specification without prior notification. Information given is subject to our current conditions of tender & sale.

All products with moving parts can be dangerous if used improperly;

Always Read Instructions For Use, Carefully.

Product and performance can vary from market to market, ask your dealer or Beta Marine about available product, performance and accessories in your market.

All technical data within this manual was correct at the time of printing, but such data is subject to change due to ongoing product development.

To view and download pdf files of the latest relevant documents visit: **www.betamarine.co.uk**

Hazardous Materials

Used engine oils - may contain hazardous components which may have the potential to cause skin cancer. In the case of contact, immediately rinse skin with plenty of water for several minutes and then wash contact area with soap and water. Keep out of reach of children.

The rules & regulations for the disposal of waste oil and or antifreeze solutions in the UK varies by location and whether you are a business or a private individual.

To find your nearest disposal bank or learn more visit: **www.oilcare.org.uk**

For the safe and legal way to dispose of hazardous materials outside the UK, carefully check and comply with the legal requirements in your country.

Section 8: Service Record

	Service	Date	Responsible	
1	Commissioned			
2	First 25 hours			
3	First 50 hours			
4	Every 150 hours with shallow sump			
5	Every Year/Every 250 hours if sooner			
6				
7				
8				
9	Every Year/Every 750 hours if sooner			
10				
11				
12				
13				
14				
15				
16				

	Service	Date	Responsible	
17				
18				
19				
20				
21				
22				
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24				
25				
26				
27				
28				
29				
30				
31				
32				



BETA MARINE

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Tel: +44 (0)1452 723492 Fax: +44 (0)1452 883742 Email: sales@betamarine.co.uk Website: www.betamarine.co.uk

Ref: OM 221-04307 REV 00 - 0118