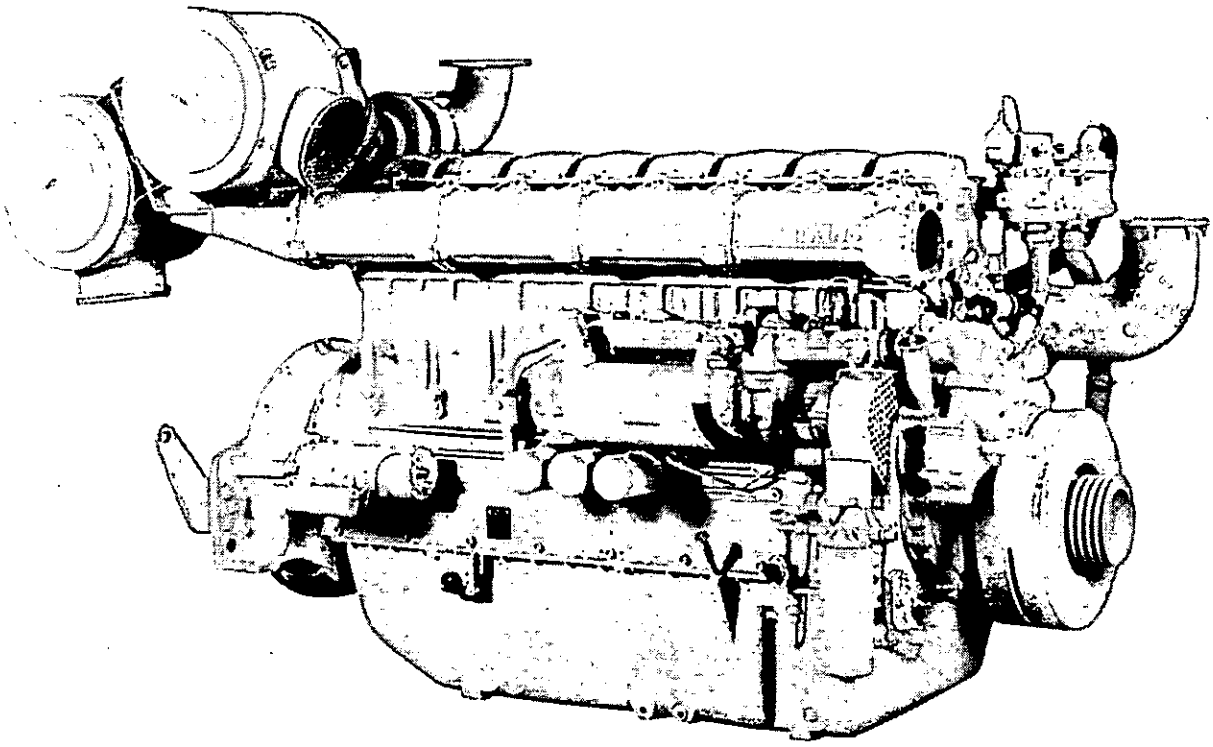
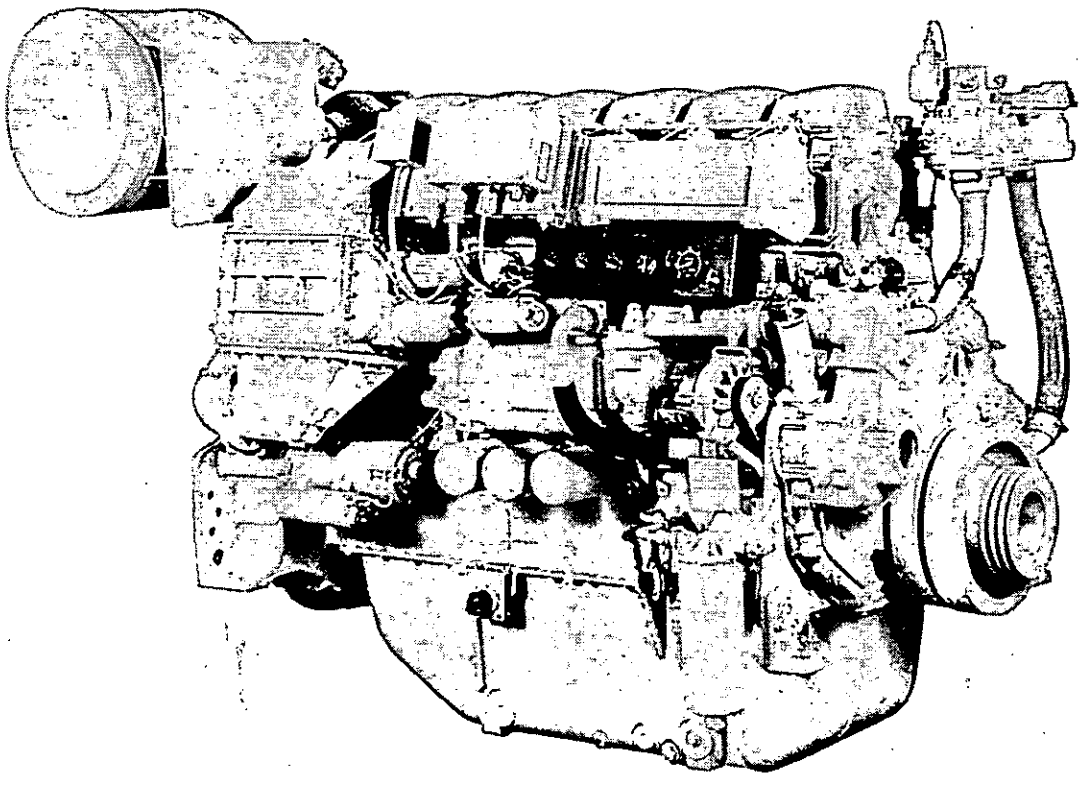
PERKINS ENGINES (STAFFORD) ENGINE DESIGNATIONS 4000 SERIES AND SE SERIES EQUIVALENT TERMS	
4000 SERIES	**SE SERIES**
4006TG	6SET
4006TWG	6SETCR
4006TWG3	6SETCR3
4006TAG1	6SETCA1
4006TAG2	6SETCA2
4006TAG3	6SETCA3
4006TEG	6SETCW
4008TWG2	8SETCR2
4008TAG	8SETCA
4008TAG1	8SETCA1
4008TAG2	8SETCA2

4006TG	6 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit.
4006TWG	6 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler and charge air cooler in engine cooling circuit.
4006TWG3	Up-rated version of the 4006TWG. 6 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler and charge air cooler in engine cooling circuit.
4006TAG1	6 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit and air cooled charge air cooler in radiator.
4006TAG2	Up-rated version of the 4006TAG1. 6 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit and air cooled charge air cooler in radiator.
4006TAG3	Up-rated version of the 4006TAG2. 6 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit, and air cooled charge air cooler in radiator.
4006TEG	6 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit, and water cooled charge air cooler with raw water pump in separate cooling circuit.
4008TWG2	8 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler and charge air cooler in engine cooling circuit.
4008TAG	8 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit and air cooled charge air cooler in radiator.
4008TAG1	Up-rated version of the 4008TAG. 8 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit and air cooled charge air cooler in radiator.
4008TAG2	Up-rated version of the 4008TAG1. 8 cylinder, inline, water cooled, 4 stroke, turbocharged diesel engine, with jacket water cooled oil cooler in engine cooling circuit and air cooled charge air cooler in radiator.



4008TAG1/2



4006TWG

⚠ SAFETY PRECAUTIONS

For safe and reliable operation of the engine it is essential that the recommended procedures as outlined in the manual are adhered to, and where necessary the special tools are used. Improper operation or maintenance procedures are dangerous and could result in injury or death.

The operator should check before operation that all the basic safety precautions have been carried out to avoid an accident occurring.

Read and understand all safety precautions and warnings before operating or servicing the engine.

The safety precautions that must be adhered to when operating the engine or carrying out service work are listed below under separate headings together with the relative symbols:

Ensure guards are fitted 	(a) over exposed rotating parts (b) over exposed hot surfaces (c) over exposed air intakes (d) over exposed belts (e) over live electrical terminals, high and low tension
Ensure protection equipment: for hands, ears, eyes, feet etc.  (1)  (2)  (3)  (5)  (4)	(a) (1) is worn when using inhibitors (b) (1) is worn when using anti-freeze (c) (1) is worn when taking pressure cap off radiator or heat exchanger filler (d) (5) is worn when working on or underneath engine (e) (3) is worn when using air pressure line (f) (1) is worn when changing lubricating oil/filter (g) (2) is worn when working in enclosed engine room (h) (1) is worn when changing electrolyte in battery (j) (4) is worn always when working on the engine
No smoking or naked flame 	(a) when checking battery electrolyte (b) when working in engine room (c) when operating or servicing engine
Fuel/oil pipes 	(a) check for leaks (b) check for spilt oil (clean up) (c) always use barrier cream on hands
Gas/air pipes 	(a) check for gas/air mixture leaks (b) never run gas engine with failed pressure disc (c) that gas line and valves meet local safety standards (d) that the gas line pressure is correct
Shutdown equipment 	(a) for stopping engine in case of over speed, high water temperature or low oil pressure should be provided (b) for heat sensors, methane and smoke detectors should be provided (if applicable) (c) test that protection system is working correctly (d) Always be in a position to stop engine (even remotely)
Start up 	(a) disconnect battery or any other means in case of accidental start up when working on engine (b) never start engine with governor linkage disconnected (c) do not hold stop lever in run position when starting engine (d) always hold stop lever in stop position when cranking only
Electrical equipment 	(a) check that electrics are earthed to local safety standards (b) disconnect electrical supply to water jacket heater (if fitted) before working on engine (c) take care against electric shocks (d) Never re-adjust settings of electronic equipment without reference to Operation Manual

Freezing or heating component 	(a) Always wear heat resistant gloves and use correct handling equipment
Exhaust system 	(a) check for leaks (b) check for correct ventilation of engine room (c) check that guards are fitted (d) check that diesel exhaust is clear (e) check that pipework allows gas to escape upwards (f) check that pipework is supported
Stop the engine 	(a) before changing lubricating oil (b) before filling radiator or topping up with anti-freeze (c) before repairing engine (d) before adjusting belts (e) before adjusting tappets (f) before changing spark plugs/injectors (g) before changing air/oil/fuel filters (non change-over) (h) before tightening fixing bolts etc
Flammable fluids 	(a) never store near engine (b) never use near naked light
Clothing 	(a) do not wear loose clothing, ties, jewellery etc. (b) always wear steel toe cap shoes (c) always wear head, eye and ear protection (d) always wear overalls (e) always replace spillage contaminated overall immediately
Lifting heavy components  	(a) use correct lifting equipment (b) do not work alone (c) always wear helmet
Viton 'O' rings  	(a) always wear both hand and eye protection when handling 'O' rings which have been exposed to very high temperatures (eg a fire)
De-scaling solution  	(a) always wear both hand and eye protection whilst handling (b) always wear overalls and proper footwear
Handling/cutting gaskets and joints containing asbestos 	(a) always wear respiratory protection (b) always provide dust extract system (c) always dispose of waste in accordance with local/legislative requirement
Waste disposal 	(a) do not leave oily rags on or near the engine (b) do not leave loose items on or near the engine (c) provide fireproof container for oily rags

Most accidents are caused by failure to observe basic precautions, and can be avoided by recognising potentially dangerous situations before an accident occurs.

Stop and isolate the engine, and ensure it cannot be restarted whilst servicing the engine.

Improper operation of the engine is dangerous and could result in injury or death.

Warnings are outlined in the operation manual and on the engine and are identified by the following symbol.

WARNING △— USE APPROPRIATE SYMBOL

There are many potential hazards that can occur during operation of the engine which cannot always be anticipated. Therefore a warning cannot be included in the manual for every possible circumstance that might involve a potential hazard.

Should a procedure be used not specially recommended then you must satisfy yourself that it is safe and will not damage the engine.

KEY TO SYMBOLS THAT MAY BE FOUND IN THE MANUAL					
	WARNING		NO SMOKING		WEAR EYE PROTECTION
	HIGHLY FLAMMABLE		NO NAKED LIGHT		USE EAR PROTECTORS
	DANGER LIVE WIRES		EMERGENCY STOP		PROTECTIVE FOOTWEAR MUST BE BE WORN
	DANGER HOT SURFACE		GUARDS MUST BE FITTED BEFORE STARTING		WEAR HELMET
	STAND CLEAR SUSPENDED LOADS		DANGER BATTERY ACID		HAND PROTECTION MUST BE WORN

SAFETY

Engine lift equipment

Use only the lift equipment which is designed for the engine.

Use lift equipment or obtain assistance to lift heavy engine components such as the cylinder block, cylinder head, flywheel housing, crankshaft and flywheel.

Check the engine lift brackets for security before the engine is lifted.

Asbestos joints

Some joints and gaskets contain compressed asbestos fibres see **Warning label Fig. 1** in a rubber compound or in a metal outer cover. The 'white' asbestos (Chrysotile) which is used is a safer type of asbestos and the danger of damage to health is extremely small.

Contact with asbestos particles normally occurs at joint edges or where a joint is damaged during removal, or where a joint is removed by an abrasive method.

To ensure that the risk is kept to a minimum, the procedures given below must be followed when an engine which has asbestos joints is dismantled or assembled.

- Work in an area with good ventilation.
- Do NOT smoke.
- Use a hand scraper to remove the joints - do NOT use a rotary wire brush.
- Ensure that the joint to be removed is wet with oil or water to contain any loose particles.
- Spray all asbestos debris with water and place it in a closed container which can be sealed for safe disposal.

Dangers from used engine oils

Prolonged and repeated contact with mineral oil will result in the removal of natural oils from the skin, leading to dryness, irritation and dermatitis. The oil also contains potentially harmful contaminants which may result in skin cancer.

Adequate means of skin protection and washing facilities should be readily available.

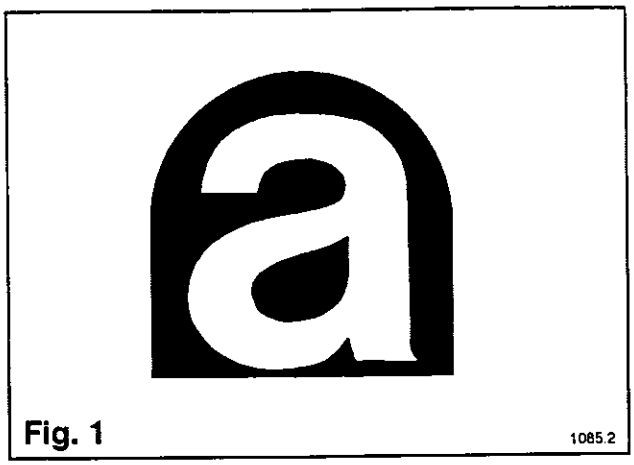


Fig. 1 1085.2

The following is a list of 'Health Protection Precautions', suggested to minimise the risk of contamination.

1. Avoid prolonged and repeated contact with used engine oils.
2. Wear protective clothing, including impervious gloves where applicable.
3. Do not put oily rags into pockets.
4. Avoid contaminating clothes, particularly underwear, with oil.
5. Overalls must be cleaned regularly. Discard unwashable clothing and oil impregnated footwear.
6. First aid treatment should be obtained immediately for open cuts and wounds.
7. Apply barrier creams before each period of work to aid the removal of mineral oil from the skin.
8. Wash with soap and hot water, or alternatively use a skin cleanser and a nail brush, to ensure that all oil is removed from the skin. Preparations containing lanolin will help replace the natural skin oils which have been removed.
9. Do NOT use petrol, kerosene, diesel fuel, gas oil, thinners or solvents for washing the skin.
10. If skin disorder appears, medical advice must be taken.
11. Degrease components before handling if practicable.
12. Where there is the possibility of a risk to the eyes, goggles or a face shield should be worn. An eye wash facility should be readily available.

Environmental protection

There is legislation to protect the environment from the incorrect disposal of used lubricating oil. To ensure that the environment is protected, consult your Local Authority who can give advice.

Viton seals

Some seals used in engines and in components fitted to engines are made from Viton.

Viton is used by many manufacturers and is a safe material under normal conditions of operation.

If Viton is burned, a product of this burnt material is an acid which is extremely dangerous. Never allow this burnt material to come into contact with the skin or with the eyes.

If it is necessary to come into contact with components which have been burnt, ensure that the precautions which follow are used:

- Ensure that the components have cooled.
- Use Neoprene gloves and discard the gloves safely after use.
- Wash the area with a calcium hydroxide solution and then with clean water.
- Disposal of gloves and components which are contaminated, must be in accordance with local regulations.

If there is contamination of the skin or eyes, wash the affected area with a continuous supply of clean water or with a calcium hydroxide solution for 15-60 minutes. Obtain immediate medical attention.

Practical Information

To clean components

It is important that the work area is kept clean and that the components are protected from dirt and other debris. Ensure that dirt does not contaminate the fuel system.

Before a component is removed from the engine, clean around the component and ensure that all openings, disconnected hoses and pipes are sealed.

Remove, clean and inspect each component carefully. If it is usable, put it in a clean dry place until needed. Ball and roller bearings must be cleaned thoroughly and inspected. If the bearings are usable, they must be flushed in low viscosity oil and protected with clean paper until needed.

Before the components are assembled, ensure that the area is free from dust and dirt as possible. Inspect each component immediately before it is fitted, wash all pipes and ports and pass dry compressed air through them before connections are made.

Use suitable gloves for protection when components are degreased or cleaned with trichloroethylene, white spirit, etc. Degreasing solutions which are basically trichloroethane are not recommended.

For full technical data please refer to the **Product Information Manual.**
Type: Water-cooled, turbocharged, charge cooled, industrial diesel engine.

RANGE	**4006**	**4008**
Cycle	4 Stroke	
No. of cylinders	6	8
Configuration	Inline	
Bore	160 mm	
Stroke	190 mm	
Total swept volume	22.92 litres	30.561 litres
Compression ratio	13.6:1	
Rotation	Anti-clockwise looking on flywheel end	
Firing order	1-5-3-6-2-4	1-4-7-6-8-5-2-3
Cylinder numbering	Cylinder 1 furthest from flywheel	
Valve Clearance		
Inlet and exhaust (cold)	0.40 mm (0.016")	
Valve dia. (mm)	48 (early engines)	
Inlet and exhaust	52 (later and uprate engines)	
Valve setting	See **Page 51**	
Valve timing	See Workshop Manual **Section U**	
Injection timing	See Engine Number plate	
Piston speeds	Engine r/min.	m/s (ft/min.)
	1000	6.33 (1247)
	1200	7.60 (1496)
	1500	9.50 (1870)
	1800	11.40 (2244)

TYPICAL COOLING SYSTEM

Approved coolants: See **Page 25**

Water capacity (block only): 36 litres (8 gal) / 48 litres (10.5 gal)

Total water capacity
Engine with tropical radiator

Ltrs	Gals	Spec
106	23.3	TG
110	24.2	TAG1
110	24.2	TAG2
125	27.5	TAG3
106	23.3	TWG
130	28.6	TWG3
46	10.1	TEG**

Ltrs	Gals	Spec
135	29.7	TAG
145	31.9	TAG1
145	31.9	TAG2
48	10.6	TWG2*

* Engine only
** Engine with heat exchanger

Engine shut down temperature	96°C
Max water temperature into engine	To be determined from heat dissipated & water flow through each particular engine model
Thermostat opening temperature	71°C
System pressure	0.5 to 0.7 bar

FUEL SYSTEM

	4006	4008
Approved fuels	See **page 26**	
Relief valve setting	276 kPa (40 lb/in^2)	
Injector nozzle pressure	225-235 atm	
Injection equipment	Lucas-Bryce unit injector	
Filter/water separator	Spin-on expendable canister(s)	
Fuel lift pump	Maximum suction lift 2 metres	
Fuel flow	13.4 litres/min. (3 gpm) @ 1800 r/min.	

GOVERNORS

Type	Electronic	Electronic
Type	Hydraulic	Hydraulic

LUBRICATION SYSTEM

Recommended oil	See **page 23**	
Type of system	Wet sump, external engine mounted oil pump	
Total oil capacity (oil cooler and filter)	122.7 litre (27 gal)	165.6 litre (36.5 gal)
Sump capacity (dipstick) Min.	90.7 litre (20 gal)	127 litre (27.9 gal)
Sump capacity (dipstick) Max.	113.4 litre (25 gal)	154 litre (33.9 gal)
Min. oil pressure (rated speed) to bearings	200 kPa (28 lb/in^2)	
Crankcase pressure	25 mm water gauge	
Max. oil temperature to bearings	105°C	
Lubricating oil filter	disposable canister type	

INDUCTION SYSTEM

Air cleaner	Single air cleaner	Twin air cleaners
	Twin air cleaners (Uprate)	
Type (paper element)	S551A	
Max. Air intake Depression	381mm H_2O (28mm Hg)	
Air restriction Indicator setting	380mm H_2O	
Turbocharger	Garrett (x1)	(x2)
	(x2 uprate only)	

EXHAUST SYSTEM

	4006	4008
Manifold type	Dry	Dry
Exhaust outlet flange (non uprate)	Vertical (single)	Vertical (single) Option
(uprate)	Vertical (single) Option Vertical (twin)	Vertical (twin)
Mating flange (non uprate)	1 x 8" Table "D" BS4	1 X 10" Table "D"
(up rate)	1 X 10" Table "D" 2 X 6" Table "D" Option	2 X 6" Table "D"
Max. exhaust back pressure	See **Product Information Manual**	
Max. exhaust temperature	See **Product Information Manual**	

FLYWHEEL

SAE size	14"	18"

FLYWHEEL HOUSING

SAE size	0	0

CRANKSHAFT

Max. overhung weight on rear bearing	1000 kg	
Tuning plate	1 x 14.6"	-
T.V. damper (non uprate)	1 x 14"	2 x 20"
(uprate)	1 x 18"	

NOTE: Subject to a torsional vibration investigation different T.V. dampers may be fitted.

TYPICAL DRY WEIGHT

	4006	4008
Dry weight (engine)	2295 kg 4006TG 2320 kg 4006TAG1/2 2340 kg 4006TWG 2420 kg 4006TEG 2400 kg 4006TAG3 2340 kg 4006TWG3	3120 kg 4008TAG 3250 kg 4008TAG1/2 3325 kg 4008TWG2
Dry weight (engine and tropical radiator)	2636 kg 4006TG 2761 kg 4006TAG1/2 2477 kg 4006TWG1/2 3010 kg 4006TAG3 2790 kg 4006TWG3	3730 kg 4008TAG 4360 kg 4008TAG1/2
Dry weight (engine and heat exchanger)	2560 kg 4006TEG	3462 kg 4008TWG2

HOLDING DOWN BOLT HOLES

Bolt size (engine feet)	20 mm
No. off	6

ELECTRICAL SYSTEM

Voltage	24	
Alternator type	PRESTOLITE (BUTEC) A3024 with internal regulator	
Alternator output (amps)	30 at a stabilised output of 28 volts	
Starter motor type	PRESTOLITE/BUTEC MS1/105	MS7/3A
No. of teeth (gear ring)	190	
No. of teeth (starter motor)	12	
Battery capacity cold cranking amps to IEC Standard at 0°C (32°F)	540 (each battery)	600 (each battery)
Battery (lead acid) 24V	(2 x 12V) Total 143 Ah	(2 x 12V) Total 178 Ah

PROTECTION EQUIPMENT

Before resetting protection equipment, it must be established whether special settings (for that individual engine) have been specified in the engine sales contract. This is particularly important with ALL high water temperature settings.

Standard settings for protection equipment are as follows:-

	4006	4008
Shutdown switches	**Alarm**	**Shutdown**
High Oil temperature	115°C	120°C
Low oil pressure	2.06 bar (30 lb/in²)	1.93 bar (28 lb/in²)
High water temperature		
71°C Thermostat	91°C	96°C

Caution: The above standard settings do not supersede any settings specified in the engine sales contract.

Overspeed	15% (on 1500 rev/min)
	7% (on 1800 rev/min)

AIR STARTING

Air starter pressure	30 bar
Compressed air supply	17 bar
Type	Ingersoll-Rand Type SS350
Type	GALI A25

INSTRUMENT PANEL (ENGINE MOUNTED)

	Normal Operation
Oil pressure	Between 300-560 kPa (42.6-80 lb/in2)
Oil temperature	Between 80-90°C (176-194°F)
Water temperature	Between 65-85°C (149-185°F)
Exhaust temperature	See **Product Information Manual**
Boost pressure	See Test Certificate

COOLANT JACKET HEATING

Heater	1 x 2 kW	1 x 4 kW

WARNING ⚠ IT IS ESSENTIAL WHEN HANDLING INHIBITORS THAT PROTECTIVE EQUIPMENT IS WORN i.e. GOGGLES, GLOVES, RUBBER BOOTS ETC. TO AVOID EYE AND SKIN CONTACT AND INGESTION.

STANDARD EX-WORKS TREATMENT LEVEL A

For UK/European shipment giving up to 6 months shipping and storage protection when transported by container or lorry.

1. The oil used on engine test gives satisfactory protection for 6 months after despatch from the works.
2. After test the oil is then drained from the sump.
3. The water cooling system is flushed thorough with a Shell corrosion inhibited anti-freeze at 50% dilution with water.
4. After spray painting to the appropriate standard, all bright surfaces and unpainted metal are treated with Valvoline Tectyl 506 preservative, brushing quality. (This includes control linkages etc.)
5. All openings in the engine (including points where pipework has been removed and air cleaner inlet(s), etc.) are sealed with plugs or blank flanges, etc.

SPECIAL PRESERVATION LEVEL B

For overseas shipment giving 12 months shipping and storage protection under normal enclosed storage conditions of -15°C to +55°C and up to 90% relative humidity for up to 12 months.

1. The oil used on engine test confers satisfactory protection for 12 months after despatch from the works.
2. The entire fuel system is drained including filters, pump injectors and fuel tank, and replaced by one of the following fluids:-

SHELL 4113 (CONFORMS TO ISO 4113)
GULF DIESEL FLUID 34
CASTROL H91/61
ESSO IL1047

3. The engine is run for ten minutes at idling speed, until the preserving fluid emerges from the injector return connection.
4. During this period two brief accelerations to maximum speed (no load) are made to ensure complete circulation of the preserving fluid, which then remains in the fuel system after the engine has stopped and no further rotation of the engine takes place.
5. The engine oil is then drained from the sump.
6. The water cooling system is flushed through with a Shell corrosion inhibited anti-freeze at 50% dilution with water.
7. After spray painting to the appropriate standard, all bright surfaces and unpainted metal are treated with Valvoline Tectyl 506 preservative, brushing quality (this includes control linkages, etc.).
8. All openings in the engine (including points where pipework has been removed and air cleaner inlets, etc.), are sealed with plugs or blank flanges.

SPECIAL PRESERVATION LEVEL C

For UK or overseas shipment when prolonged storage and protection is required for up to 5 years in temperate, tropical or arctic climates. Also meets preservation to MOD NES 724 Level J for UK/NW Europe when stored in unheated buildings, or in the open under water-proof covers.

1. After engine test the oil is drained from the sump, filters and oil coolers.
2. The engine is refilled with Crodafluid PQ11 engine preserving oil.
3. The entire fuel system is drained including filters, pump injectors and fuel tank, and replaced by one of the following fluids:-

SHELL 4113 (CONFORMS TO ISO 4113)
GULF DIESEL FLUID 34
CASTROL H91/61
ESSO IL1047

4. The engine is then run for ten minutes at idling speed until the preserving fluid emerges from the injector return connection.
5. During this period, two brief accelerations to a maximum speed (no load) are made to ensure complete circulation of the preserving fluid, which then remains in the fuel system after the engine has stopped. No further rotation of the engine takes place.
6. The engine oil is then drained from the sump.
7. The water cooling system is flushed through with a shell corrosion inhibited anti-freeze at 50% dilution with water.
8. The water pump impellers are sprayed with Crodafluid PM47 oil film rust preventative.
9. After spray painting to the appropriate standard, all bright surfaces and unpainted metal are treated with Valvoline Tectyl 506 preservative brushing quality (this includes control linkages, etc.).
10. Inlet and exhaust manifolds have 5 - 15 milligrammes (depending on engine size) of Shell VPI 260 vapour phase inhibitor placed in them before sealing normally.
11. Air filter bodies are sprayed inside with Crodafluid PQ11 reserving oil.
12. Plastic plugs are fitted to fuel entry points, water connections, spare instrument holes in panels and air filter inlets.
13. Exhaust outlets are fitted with steel blanking plates.
14. Water hoses are treated with silicone grease and wrapped or sleeved with black polythene (silicone rubber hoses need not be treated).
15. Drive belts are removed, wrapped in wax paper, and packed in black polythene with silica gel as desiccant.
16. Starters, alternator, switches, instruments, sensors and wiring are sprayed with ambersil MS4 silicone grease.
17. Pulleys, flywheel, starter ring, pinion, etc., are protected by dipping or painting with Crodafluid PM47 oil film rust preventative.
18. The flywheel housing is fitted with a steel blanking plate.
19. Control panels have desiccants placed inside.
20. The complete engine assembly is sprayed with Crodafluid PW10 wax film rust preventative.

(ALSO REFER TO PERKINS INSTALLATION MANUAL TSL4068)

FOUNDATION

The foundation put down to accommodate a unit powered by a diesel engine is of great importance as it must:

i) Support the static weight of the units and any dynamic loads due to the running engine's out-of-balance forces.

ii) Be sufficiently rigid and stable so that distortion will not take place which would affect the alignment of the engine and driven unit.

iii) Absorb vibrations originating from the running units and prevent them being transmitted to the engine room floor, walls, etc.

COOLING SYSTEM

For satisfactory running of an engine it is essential that the cooling system is efficient and of the correct type for the installation being considered.

The most common system is the utilisation of an engine driven water pump to force coolant through the engine oil cooler, engine water jackets, cylinder heads and, in some cases, around a water cooled exhaust manifold.

The hot water from the engine then enters the header tank of the radiator, passes through the radiator tubes and then out to the suction side of the pump. A pressure of 0.5 to 0.7 bar is maintained throughout the system. Water passing through the radiator, is cooled by pushing air through the matrix by an engine driven fan.

To obtain extra power from a turbo-charged engine the hot air delivered from the turbo compressor(s) is cooled before entering the engine cylinders.

When this compressed air is cooled by the ambient air, an additional radiator is fitted between the normal water radiator and the fan, which pushes the air through the charge air radiator first and then the water radiator. Large bore pipes connect the turbochargers to the charge air radiator and from it to the inlet manifolds. (See the appropriate **Engine Water Circulation diagram**).

When the charge air is cooled by the engine coolant, the engine driven water pump circulates the coolant through engine mounted charge air coolers, before the air enters the inlet manifolds. (See the appropriate **Engine Water Circulation diagram**).

When the charge air is cooled by raw water, an additional pump is fitted to circulate raw water through the engine mounted charge air coolers, before the air enters the inlet manifolds (see the installation variations of the above including remote mounted radiators, break tanks, cooling towers, heat exchangers and special radiators as described in the **Installation Manual TSL4068.**)

EXHAUST SYSTEM

The primary function of the exhaust system is to pipe the exhaust gases from the engine manifold(s) and discharge them, at a controlled noise level, outside the engine room, at a height sufficient to ensure proper dispersal.

Back Pressure - Limitation

Excessive back pressure will cause a lack of complete combustion and deterioration in the scavenging of the cylinders. The result will be lower power output, high exhaust temperature and the formation of soot. The soot, if oily, can affect the turbine of a turbocharger by building up on the blades, hardening and, as pieces of carbon break off, unbalancing the turbine wheel and causing problems due to the ensuing vibration.

Perkins' gas engines give optimum performance when the resistance to exhaust gas flow is below a certain limit. Starting at the engine exhaust outlet flange the total exhaust system should not impose back pressure on the engine greater than that recommended.

Maximum Back Pressure

THE EXHAUST BACK PRESSURE FIGURES FOR PERKINS ENGINES CAN BE FOUND IN THE **PRODUCT INFORMATION MANUAL ENGINE DATA SECTION.**

The exhaust system should be planned at the outset of the installation. The main objectives must be to:

i) Ensure that the back pressure of the complete system is below the maximum limit. (See Product Information Manual).

ii) Keep weight off the engine manifold(s) and turbocharger(s) by supporting the system.

iii) Allow for thermal expansion and contraction.

iv) Provide flexibility if the engine set is on anti-vibration mountings.
If the engine is on anti-vibration mountings, there will be lateral movement of the engine exhaust outlet flange when the engine starts and stops. A flexible element should therefore be fitted as near to the outlet flange as is practically possible.

v) To reduce radiant heat in a closed engine room or canopy, the exhaust system and silencer must be lagged, but not the turbocharger or exhaust manifold.

vi) Ensure that the exhaust pipework allows the gas to flow in an upward direction, so as to avoid build up of gas pockets and prevent an explosion occurring.

vii) Provide each engine with a separate exhaust system.

ENGINE BREATHER

All engines are fitted with a breathing system which prevents a build up of pressure in the crankcase, due to blow-by from the pistons. These fumes contain contaminants from the combustion process and minute globules of oil, they are passed through a mesh filter in order to remove as much oil as possible before the gases are returned to the atmosphere.

BREATHER INSTALLATION

Although the breather discharge is almost entirely oil free, the gases should still be ducted outside of the engine room which must be adequately ventilated.
The pipe diameter should be equal to or larger than the discharge hose provided with the breather, in order to prevent the crankcase pressure build up.

TORSIONAL VIBRATION

Torsional vibrations occur in any rotating shaft system it is important when fitting equipment to an engine particularly single and twin-bearing alternators that there torsional vibration characteristics are known.

CRITICAL SPEED

At certain speeds in the engine running range these vibrations may be of sufficient magnitude and frequency to fracture the engine crankshaft or flywheel bolts, strip teeth off gear wheels etc.
The point in the speed range where any of the above hazards can occur is called the 'CRITICAL SPEED'.
The object of the torsional vibration analysis is to locate the critical speed points from the magnitude and frequency of the disturbing forces and ensure that damaging critical speeds are outside the operating range of the engine and that all is clear within +10% to -5% of the synchronous speed.
There may be some critical speeds in the speed range from starting speed to 95% of synchronous speed but these could be judged as "safe" because the critical speed is passed through in a second or so. However, if the application is an "all speed" range then all critical speeds have to be controlled within safe limits.

FUEL SYSTEM

There are two basic systems for the installation of the fuel supply. The system chosen will depend on the amount of fuel required per day and if labour is available to carry out simple daily routine jobs.

FUEL TANK - DAILY SERVICE

The tank is usually sized to that the **usable** fuel content will be 4500/6500 litres. With a generating set having a full load of electrical output of 650 kW such an amount would last for 20/24 hours with a reserve of approximately 10 hours.

It is preferred that the fuel tank be installed adjacent to the engine on a stand or bulk-head. It is recommended that the tank be so positioned that the minimum level of fuel be higher than the engine injector rail in order to create a positive head and gravity feed to the engine.

WARNING ⚠ SHOULD THE MAXIMUM FUEL LEVEL IN THE TANK BE HIGHER THAN 1.0 m (1.1 lb/in²) ABOVE THE LEVEL OF THE INJECTORS, THEN AN ISOLATING SOLENOID VALVE MUST BE FITTED IN THE FUEL FEED LINE TO OPEN ON CRANKING, WITH DELAYED CLOSURE ON SHUT DOWN, TO PREVENT FUEL STARVATION.

BULK STORAGE TANK

Large engines or multi-engine installations require a large amount of fuel per hour and to contain the fuel a bulk storage tank is sited near to the engine room.

It may be arranged for the day tank to be manually filled by operating valves and using gravity to transfer the fuel from the bulk tank. However, to be sure that the day tank is regularly being filled, even through a night run, it is usual to have the transfer of fuel done automatically.

The capacity of the day tank must be sufficient i.e. a minimum of 5000 litres (1100 gal) for 4006 engines and 8000 litres (1700 gal) for 4008 engines respectively, to avoid overheating the fuel in the tank by the excess returning from the engine, which contains 5 - 10 kW of heat, (maximum permissible fuel temperature is 57°C). If this is not possible, the fuel returning from the injectors must be piped directly to the bulk tank.

SOUND INSULATION

WARNING ⚠ ALWAYS WEAR EAR PROTECTION WHEN WORKING NEAR AN ENGINE OR IN AN ENGINE ROOM.

NOISE LEVEL

Noise levels are measured in decibels - dB - through a frequency range of 31.5, 63, 125, 250 Hz, etc.

The human ear is responsive to noise levels in the frequency range of 63 to 8000 Hz. The noise level in dB can be weighted A, B, C and D to suit different requirements. The accepted norm is the 'A' Weighting as such an overall noise level closely reproduces the response of the human ear. The most commonly accepted readings are "Sound Pressure Level".

RECOMMENDATIONS TO CONTAIN NOISE

In an engine room installation where outside noise levels have to be controlled, the following factors must be considered:-

i) **Building Construction**

Outside walls - should be double brick - with cavity.

Windows - double glazed with an approximate gap of 200 mm between panes.

Doors - double door air-lock or single door with a wall built outside the door as a noise barrier to absorb and reflect noise when the door is opened.

ii) **Ventilation**

The air inlet(s) for engine combustion and cooling air and the air outlet from the radiator fan or extractor fan should be fitted with noise attenuating splitters. These are propietary items and should be discussed with the manufacturer. Ensure that the splitters do not restrict airflow, creating excess resistance to the fans.

With the amount of cooling air required on the larger engines the splitters are of large size and the building should be adapted so that they fit correctly.

iii) The engine set mounted on anti-vibration mountings to prevent vibrations being transmitted to the walls, other pieces of equipment, etc. These vibrations often generate noise.

ENGINE ROOM VENTILATION (SEE INSTALLATION MANUAL)

The engine room should be fitted with an extraction fan to provide adequate ventilation to dissipate the heat radiated by the engine and other components, and to maintain the temperature of the engine room at a satisfactory level. The ventilation system should also allow sufficient air to be drawn into the engine room to cater for the engine combustion air requirements, and prevent engine noise being transmitted via the ducting. Refer to the **Installation Manual or the Applications Department** for any further information.

ELECTRICAL SYSTEM (STARTING AND PROTECTION)

The electrical system should be kept as simple as possible, local starting by key switch on the engine mounted instrument panel is preferred. In the case of remote starting the above facility must be isolated to prevent damage.

MAINTENANCE

Sufficient room must be allowed above and around the engine to permit easy access for routine inspection, servicing and maintenance.

DERATING

SETTING ENGINE POWER TO SUIT ACTUAL SITE CONDITIONS

Derating means reducing of the power output of an engine from its maximum rating at normal British temperature and pressure conditions to allow for adverse effects of overseas site conditions e.g. altitude and ambient temperature.

This reduction in power output is achieved simply by reducing the quantity of fuel injected by a readjustment of the fuel stops. Perkins Engines (Stafford) may be unaware of the final destination of an engine at the time of despatch from the works, and the fuel stops will be set for maximum output at normal British temperature and pressure conditions, (i.e. under ISO 3046 standard conditions), which could, due to the actual site conditions, result in severe damage to the engine.

Any engine so supplied must be derated in accordance with the published percentage derating figure as shown in the **Product Information Manual**, by the equipment builder on his premises, or even on site.

To derate, calculate (using the percentage derating figure) the new reduced power output of the engine, and run the engine or generating set on this load.

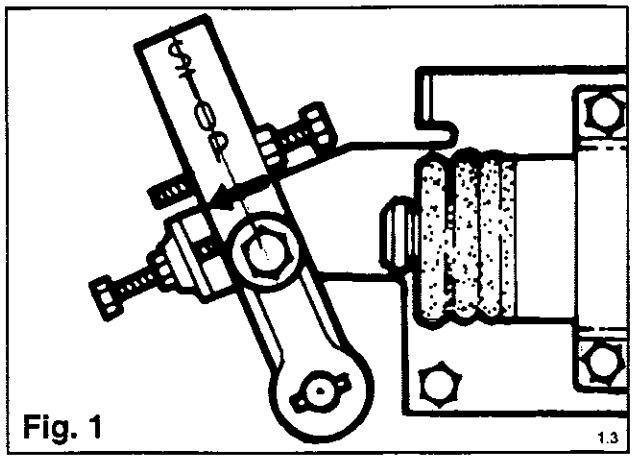


Fig. 1

1.3

Reduce the maximum fuel setting position of the fuel stop **(see Fig. 1 typical installation)**. After breaking the lead seal and slackening the locknut (1), screw in the stop screw (2) until the engine speed **just begins** to fall off. Then screw out the stop screws $^1/_4$ turn to restore full operating speed. Retighten the locknut, relock with wire and apply lead seals to discourage tampering. This adjustment should only be carried out by skilled personnel.

NOTE: For more detailed information on equipment installation please consult the **Installation Manual (Publication TL4068)**.

QUANTITY OF OIL

Sump capacity dipstick	4006	4008
Minimum	90.7 litre (20 gal)	127.4 litre (28 gal)
Maximum	113.4 litre (25 gal)	154 litre (34 gal)

TYPE OF OIL

The industrial diesel engine should be lubricated with a good quality oil conforming to API CD or CCMC D4 specifications. All the major oil companies formulate oils to the above specifications.

VISCOSITY OF OIL

Use oil of:

SAE10W/30 in starting temperatures below -15°C (without sump heater)
SAE15W/40 in starting temperatures from -15°C to 0°C
SAE30 in starting temperatures from 0°C to 32°C } or Mobil Delvac Super
SAE40 in starting temperatures above 32°C } 1300 SAE 15W/40

OIL CHANGE PERIODS

For normal operation of the engine the oil should be changed every 250 hours or annually whichever is the sooner.

Under certain circumstances where a centrifugal oil filter is fitted to the engine and an oil analysis programme has been carried out with the oil supplier over a period of 1000 hours of engine operation, it may be possible to extend the oil change period up to maximum of 350 hours.

To achieve this extended oil change period, a centrifugal oil filter must be fitted and cleaned every 250 hours between routine oil changes, and at every oil change point i.e. 350 hours maximum.

As the oil deteriorates it is essential that the following parameters must not be exceeded at the oil change point:

1. The viscosity of the oil must not increase by more than 10cSt at 100°C.
2. The total base number of the oil should not reduce to less than 50% of the value of new oil.
3. The flash point of the oil should exceed 180°C.
4. The water content of the oil must not exceed 1%.
5. The fuel content of the oil must not exceed 1%.
6. Oil samples should be taken from the mean sump oil level of the engine.

ENGINE OPERATION

Excessive periods of idling or repeated cold starts should be avoided, as they will cause excessive dilution of the oil by fuel, requiring more frequent oil changes and dangerously lowering the flash point of the oil.

Should there be a lubricating oil supply problem, or if the fuel being used contains more than 0.5% sulphur, Perkins Engines (Stafford) Limited must be consulted to give advice in selecting a suitable grade.

The following list gives details of some of the oils that meet the required specifications. Note that the brand names may change as oils are upgraded or reformulated.

An up-to-date list is maintained by Perkins Engines (Stafford) Limited of major oil companies products and information, which can be obtained from Perkins Engines (Stafford) Service Department.

WARNING ⚠ FAILURE TO COMPLY WITH THESE INSTRUCTIONS WILL INVALIDATE THE WARRANTY OFFERED WITH THE ENGINE, AS IT MAY RESULT IN ENGINE DAMAGE.

APPROVED INDUSTRIAL OIL A1 SPECIFICATIONS BSEN 590

(Suitable for fuel to Class A2 specifications BS2869 Part 2).

Oil Company	Type
CASTROL	CRH/RX Super
ELF	Multiperfo XC
KUWAIT OIL Co	Q8 T400
MOBIL	Delvac 13
MOBIL	Delvac Super 1300 (15W/40)
SHELL	Rimula X
ESSO	Essolube XD 3+
TEXACO	Ursa Super LA

WARNING ⚠ ALWAYS STOP THE ENGINE AND ALLOW THE PRESSURISED SYSTEM TO COOL BEFORE REMOVING THE FILLER CAP. AVOID SKIN CONTACT WITH ANTIFREEZE BY WEARING HAND PROTECTION.

ENGINE COOLING SYSTEM

To protect the engine cooling system against corrosion it is essential that the engine coolant contains suitable additives which will give the necessary protection.

Caution: untreated water is not suitable.

WATER QUALITY

The water that is mixed with the additive must have the following characteristics:

Chloride less than 80 PPMV (parts per million by volume)

Sulphates less than 80 PPMV

Total hardness less than 200 PPMV pH of water between 7 to 7.5 (i.e. neutral to slightly alkaline)

ADDITIVES TO WATER

Due to the complexity of the cooling system it is necessary to use an additive that contains a balanced package of corrosion inhibitors.

To achieve the required solution a 50/50 mix of Shell Safe Premium anti-freeze with water should be used at all times, even in areas where frost is unlikely.

This mixture will give frost protection down to -35°C. In areas where Shell anti-freeze is unobtainable contact Perkins Engines (Stafford) Ltd for advice.

Under no circumstances should an additive containing nitrites, borates, phosphates, chromates, nitrates or silicates be used, as these materials are not compatible with the materials used in the cooling system.

When mixing the anti-freeze with the water always follow the manufacturer's recommendation which is to add the anti-freeze to water and mix thoroughly before adding the mixture to the engine cooling system.

Mixing water to the anti-freeze can lead to the formation of gel in the mixture, due to over concentration, and this can lead to blockage of water passages and subsequent loss of water flow causing overheating.

MAINTENANCE OF COOLANT

The water/anti-freeze mixture should be replaced in operating engines at least once a year.

It is essential to maintain the coolant at the correct alkalinity level i.e. the pH should not increase above 7.5. A hydrometer only shows the proportion of ethylene glycol. **This is not a measure of protection against corrosion.**

WARNING ⚠ FAILURE TO FOLLOW THE ABOVE RECOMMENDATIONS MAY RESULT IN ENGINE DAMAGE AND WILL INVALIDATE THE ENGINE WARRANTY.