

Contents

General

Basic Engine Design	1
Example Engine Scope of Supply	1-5
Ratings	5-6
Matching of Propellers and Waterjets	7-9
Technical Data and Performance Curves	10-32
Free Field Mechanical and Exhaust Noise	33-38
Torsional Vibration Data	39-40
Torsional Limits	41

Lubrication Oil System

General	42
Internal Lubrication System	42
Prelubrication	43
Oil Requirements	43
Oil Change Interval	44
Inclination Capability	44
Lube Oil System Schematic	45

Crankcase Ventilation System

Crankcase Fumes Disposal	46
Crankcase Piping System	46-47

Fuel System

Tank Position	48
Line Restriction	48
Fuel Line Dimension	48
Fuel Recommendations	48
Engine Fuel System Description	49
Fuel Temperature	49
Fuel System Schematic	50

Cooling System

Introduction	51
Coolant Flow Control	51
Coolant Temperature Control	51
Water Quality, Rust Inhibitors, and Antifreeze	52
Heat Exchanger Sizing	53
Jacket Water Heater Sizing	53
System Pressures and Velocities	53
Weld Flange Sizes	53
Fresh Water Pumps	54
Sea Water Pump	54
High Capacity Sea Water Pump	54
Cooling System Schematics	55-56

Contents *(con't.)*

Starting Air System

Air Starters	57
System Requirements	57
Receiver Sizing	57
Customer Connections	57
Air Start Tank Sizing	58
Starting Air System Schematic	59

Combustion Air System

Introduction	60
System Design	60-61
General	61
Combustion Air System Schematics	62-63

Exhaust System

Exhaust Manifolds	64
Exhaust Backpressure Limits	64
Turbochargers	64
Exhaust Slobber (Extended Periods of Low Load)	64
Exhaust Piping	65
Exhaust System Schematic	66

Engine Governing and Control System

Introduction	67
Main Engine Governing System	67
Clutches	67
Shaft Brake	67

Engine Monitoring and Shutdown

Engine Shutdown	68
Engine Monitoring	68
Control and Monitoring System Diagram	68
Control and Monitoring System Drawings	69-74
Control System Inputs to PLC and Redundant Relay Logic	75-87
MODBUS Address List	88-101

Engine Mounting and Foundation

Foundation Design	102
Mounting	103
Resin Chocks	103
General	103

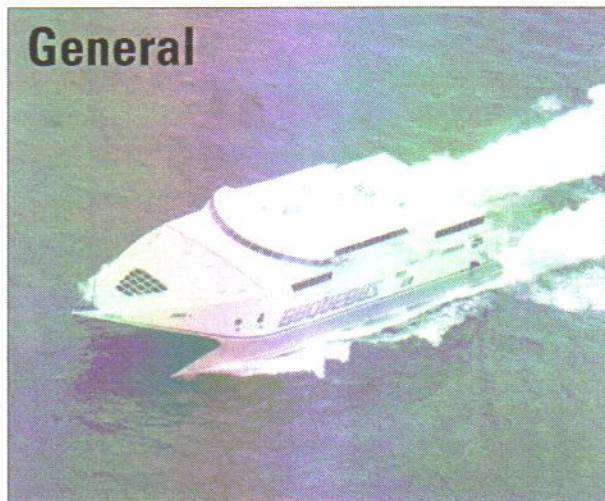
General Arrangement Drawings 104-124

Miscellaneous

Engine Weights	125
Parts	126
Maintenance Interval Schedule — CSR and MCR Ratings	127-128
Maintenance Interval Schedule — Fast Vessel Ratings	129

Typical Supplied Auxiliary Equipment 130-132

General



Basic Engine Design

The 3612/3616 engine family for marine applications is a modern, highly efficient, IMO certified engine series consisting of vee engines of 12 and 16 cylinders. These are four-stroke, non-reversible engines rated at speeds from 900 to 1030 rpm and intended for use as main propulsion for vessels. The engines are turbocharged, charge air cooled and with a direct injection fuel system using unit fuel injectors. The use of individual fuel injectors eliminates the need for high pressure piping and provides for an accurate, high injection pressure.

The engine block is available in two versions.

- Nodular cast iron block
- One-piece casting of heavily ribbed, weldable, gray iron alloy

The intake plenum runs the full length of the engine, providing even air distribution to the cylinders.

The crankshaft is a pressed forging that is induction hardened. A counterweight for each cylinder is bolted to the crankshaft using a robust three-bolt design. Crankshaft end flanges are identical so full power can be taken off from either end.

Main, rod, and camshaft bearings are steel-backed, nickel bonded aluminum with a lead-tin overlay, copper-bonded to the aluminum. Experience has shown this produces the best bearing construction available for the longest possible life.

Connecting rods are forged, heat treated and shot peened before machining. The special four-bolt design allows for an extra-large bearing which reduces bearing load and extends bearing life.

Cylinder liners are high alloy iron castings, induction hardened, plateau honed and water jacketed over their full length. The liners are equipped with an anti-polishing ring (cuff) to avoid piston/liner carbonizing and thus improve lube oil control and liner life.

Pistons are two-piece with a steel crown and forged aluminum skirt for excellent strength and durability, yet light weight. Each piston has four rings, two in hardened grooves in the crown and two in the skirt. The top compression ring is asymmetrically faced with a chrome-ceramic matrix coating to provide extended ring and liner life. The two middle rings are taper faced and chrome plated, while the lower lube oil control ring is double rail chrome faced with a spring expander. Oil is jet sprayed into passageways within the pistons for cooling and lubrication of the piston pin.

Valves. The seat on the replaceable inserts is induction-hardened. Positive rotators on all the valves maintain a uniform temperature and wear pattern across the valve face and seat. The exhaust and air inlet valves are both manufactured from Nimonic 80A material.

Example Engine Scope of Supply

The following is a typical scope of supply for a main propulsion engine package. The scope of supply varies with the application to meet specific customer needs.

Scope of Supply	
Caterpillar 3600 Marine Diesel Engine — General Technical Data	
Model	Caterpillar 3612 Diesel Engine
Rating (IMO certified)	3700 bkW at 1000 rpm (fuel stop/rated power @ CSR IMO certified)
Load profile	100% of time at 100% rated power
Ambient conditions	45°C (113°F) air/32°C (90°F) cooling water to the aftercooler
TBO	Approx. 40,000 hours
BSFC	206 g/kW-hr (0.338 lb/hp-hr) + 5% tolerance
Number of cylinders	12
Cylinder configuration	Vee
Bore	280 mm (11 in)
Stroke	300 mm (12 in)
Compression ratio	13:1
Low idle speed	350 rpm
Rotation	ccw/cw (viewed from flywheel end)
Service side	Right/left (viewed from flywheel end)
Water connections	Right/left (viewed from flywheel end)

Speed Control Options

1. Heinzmann governing system consisting of:
 - Off-engine-mounted electronic governor
 - Heinzmann electric driven actuator
 - Panel for power supply panel/battery backup, off engine mounted
 - Potentiometer for local speed control
 - Local/remote speed control switch
2. Woodward governing system consisting of:
 - Off-engine-mounted electronic governor
 - Woodward UG18 hydra-electric actuator
 - Panel for power supply battery backup, off engine mounted
 - Potentiometer for local speed control
 - Local/remote speed control switch

An optional governor panel can be supplied to enclose the governor, the local/remote speed switch, the local speed control potentiometer, and any optional amplifiers or transducers required for speed input or pitch control systems. All components installed in this panel are wired and a terminal strip is provided for shipyard connections.

Cooling System

The engine cooling system is a single (combined) circuit system. The cooling circuit is designed for a coolant supply temperature of 90°C (194°F) to the water jacket, 32°C (90°F) nominal [38°C (100°F) maximum] to the engine-mounted charge air cooler, and 85°C (185°F) regulated temperature for the lubrication oil supply to the bearings. The following main components are included:

- Fresh water pumps, 2 pcs (high- and low-temperature pumps), engine gear driven
- Thermostat valve, three-way, 32°C (90°F) for heat exchanger circuit (shipped loose)

Cooling system options include:

- Sea water pump, engine gear driven
- Heat exchanger, plate type for 32°C (90°F) sea water temperature, 38°C (100°F) max engine water temperature (shipped loose)
- Jacket water heater (shipped loose) with engine-mounted connections
- Heat recovery connections with three-way thermostatic valve
- Emergency coolant connections for jacket water and aftercooler/oil cooler pumps

Fuel System

The fuel system is designed for distillate #2, MDO, JP-8 turbine fuel and ISO 8217 DMX, DMA, and DMB fuels. ISO DMC and JP-4 aviation fuel must not be used. The following main components are included:

- Direct injection system with individual unit injectors with 430 kPa (127 in. Hg) minimum supply pressure.
- Engine-mounted fuel oil filter, duplex, with service indicator
- Engine gear driven fuel oil transfer pump

Fuel system options include:

- Flexible connections
- Off-engine-mounted duplex fuel oil strainer or a 30 micron fuel/water separator package
- Fuel cooler

Lube Oil System

The lube oil system is an integrated system with wet sump supplying 85°C (185°F) filtered oil at 430 kPa (127 in. Hg) under all operating conditions. The following main components are included:

- Engine gear driven lube oil pump
- Shell and tube type engine-mounted lube oil cooler
- Engine-mounted thermostatic valve for lube oil temperature control
- Engine-mounted duplex lube oil filter
- Front and rear oil pan drain valves
- Electric pre-lube pump, shipped loose for off-engine mounting

Lube oil system options include:

- Emergency lube oil connections
- Air prelude pump, engine mounted
- Flexible hoses for electric pre-lube pump connections

Air Intake and Exhaust Systems

The following main components are included:

- Asea Brown Boveri or Napier twin turbochargers (depending on engine rating)
- Turbocharger-mounted air intake silencer (requires clean engine room air)
- Engine-mounted, fresh water cooled charge air cooler
- Exhaust manifold, dry, with soft wrap thermal protection
- Flexible exhaust connections (shipped loose)
- Expander to 457 mm (18 in.) exhaust pipe
- 457 mm (18 in.) diameter exhaust weld flanges

Air intake and exhaust system options include:

- Standard or heavy-duty air cleaners, mounted in an enclosure which is epoxy coated and can be remote mounted. 508 mm (20 in.) air cleaner outlet to each turbocharger.
- Single element round type paper element air cleaner for each turbocharger. Must be mounted within 1.5 m (5 ft) of the turbocharger inlet. (requires clean engine room air)
- Rotatable turbocharger exhaust center housings to provide non-vertical exhaust outlet
- Cylinder pressure gauge valves at each cylinder head

Engine Protection Options

Marine Monitoring System (MMSII) — PLC Based System:

Signals for alarms and shutdowns are provided as required by applicable marine society. The alarm signals are provided for use with the ship's control and monitoring system. The following main components are included:

Engine control panel

This panel contains the PLC, screen, relays, relay modules, and starting logic. All temperature and pressure signals from the engine are taken to the panel and processed for communication with the ship's control and monitoring system via a MODBUS or hard wiring.

A Hz to mA transducer is installed in the panel intended for engine rpm meters mounted on the bridge. The transducer will supply an engine rpm signal (4.20 mA) for bridge tachometers. (tachometers not included)

The following parameters are displayed as "electronic gauges" on the screen mounted in the front of the panel:

- Lube oil pressure to the engine
- Lube oil filter differential pressure
- Fuel oil pressure to the engine
- Fuel oil filter differential pressure
- Jacket water pump outlet pressure
- AC/OC pump outlet pressure
- Sea water pump outlet pressure
- Inlet air manifold pressure
- Lube oil temperature to engine
- Inlet air manifold temperature
- Jacket water outlet temperature
- AC/OC water outlet temperature
- Fuel oil inlet temperature
- Exhaust temperature (each cylinder plus turbocharger inlet and stack)

The following "traditional" gauges are located on the engine-mounted transducer panel:

- Lube oil pressure
- Fuel oil pressure
- Inlet air restriction

In addition to the screen, the following are installed in the front panel of the engine control panel:

- Engine tachometer
- Engine hour meter
- Starting air pressure gauge

Temperature sensors

Engine mounted temperature sensors are wired to a common engine mounted junction box.

Pressure sensors

Pressure sensors are mounted on the engine on a common sensor panel. All signals are wired to the engine-mounted junction boxes.

Other safety features included are:

- Cylinder pressure relief valves
- Crankcase explosion relief valves

Engine Control Panel (ECP) — Relay Based System:

Signals for alarms and shutdowns are provided as required by applicable marine society. The alarm signals are provided for use with the ship's control and monitoring system. The following main components are included:

Engine instrument panel

The instrument panel contains the following gauges:

- Cooling water temperature
- Lube oil temperature
- Inlet air manifold temperature
- Lube oil pressure
- Fuel oil pressure
- Inlet air manifold pressure
- Lube oil filter differential pressure
- Fuel oil filter differential pressure
- Inlet air restriction
- Exhaust stack temperature

The instrument panel is shipped loose with 8 m (26 ft) capillaries for temperature instruments. Pressure lines and wiring are not included.

Starting control panel instrumentation

- Engine tachometer
- Engine hour meter
- Starting air pressure gauge
- Engine rpm signal (4-20 mA) for bridge tachometers (tachometers not included)

Temperature sensors

Engine-mounted temperature sensors are wired to a common engine-mounted junction box.

Pressure sensors

Pressure sensors are mounted on a separate panel, which is shipped loose, for bulkhead installation. Pressure lines between a common termination point on the engine and the panel are not included. Cylinder pressure gauge valves are installed at each cylinder.

These other safety features are included:

- Cylinder pressure relief valves
- Crankcase explosion relief valves
- Oil mist detector

Starting System

The starting system is an indirect air starting system. The following main components are included:

- Air starting motor
- Pressure reducing valve
- Air start control options:
 1. MMSII — engine control panel (see description above)
 2. ECP — starting control panel including:
 - Start/pre-lube switch
 - Stop button
 - Emergency stop button
 - Indicator lamp, start blocked (if applicable)
 - Indicator lamp, pre-lube pressure

The start control panel is shipped loose for bulkhead installation.

Other Equipment

- Electric motor driven engine barring device
- Flexible coupling between engine and marine gear
- Torsional vibration damper and guard
- Engine lifting brackets
- Anti-vibration mounts
- Two sets of parts books and maintenance manuals
- Classification society certificate
- Shrinkwrap and tarpaulin protection for transportation and storage

Scheduled Oil Sampling

Caterpillar Scheduled Oil Sampling (S•O•SSM) oil analysis is included for one year.

Torsional Analysis

Torsional vibration analysis is included. We reserve the right to adjust price and delivery time if changes are required as a result of the torsional vibration analysis and shaft line design review.

Classification Society

The engine is equipped in accordance with classification society rules at time of order.

Classification Society:

Class Notation: Unmanned Machinery Space

Commissioning/Sea Trials

As defined for each project.

Warranty

12-month Caterpillar warranty.

Ratings

Continuous Service Rating (CSR) — Marine Diesel Oil				
Engine Model	3612		3616	
Rated speed — rpm	900	1000	900	1000
Rated power — bkW	3460	3700	4600	4920
Rated power — bhp	4640	4962	6169	6598
Rated power — PS	4705	5032	6256	6690
Maximum air temperature to turbocharger — °C (°F)	45 (113)	45 (113)	45 (113)	45 (113)
Maximum aftercooler inlet water temp — °C (°F)	38 (100)	38 (100)	38 (100)	38 (100)

The above ratings are based on the following approximate load profile:

- 100% of the engine operating hours at 100% of rated power.

These ratings correspond to the ISO 3046 Fuel Stop Power definitions.

3612 AND 3616 MARINE PROJECT GUIDE

Maximum Continuous Rating (MCR) — Marine Diesel Oil				
Engine Model	3612		3616	
Rated speed — rpm	900	1000	900	1000
Rated power — kW	3800	4060	5060	5420
Rated power — bhp	5096	5445	6786	7268
Rated power — PS	5168	5522	6881	7370
Maximum air temperature to turbocharger — °C (°F)	45 (113)	45 (113)	45 (113)	45 (113)
Maximum aftercooler inlet water temp — °C (°F)	38 (100)	38 (100)	38 (100)	38 (100)

The above ratings are based on the following approximate load profile:

- 8% of the engine operating hours at 100% of rated power.
- 92% of the engine operating hours at 91% of rated power.

These ratings correspond to the ISO 3046 Fuel Stop Power definitions.

Commercial Fast Vessel Ratings — Marine Diesel Oil			
Engine Model	3612	3616	
Rated speed — rpm	1000	1000	1020
Rated power — kW	4250	5650	6000
Rated power — bhp	5699	7577	8046
Rated power — PS	5779	7683	8159
Maximum air temperature to turbocharger — °C (°F)	45 (113)	45 (113)	45 (113)
Maximum aftercooler inlet water temp — °C (°F)	38 (100)	38 (100)	38 (100)

The above ratings are based on the following approximate load profile:

- 85% of the engine operating hours at 100% of rated power.
- 15% of the engine operating hours at less than 50% of rated power.

These ratings correspond to the ISO 3046 Fuel Stop Power definitions.

Military Fast Vessel Ratings — Marine Diesel Oil	
Engine Model	3616
Rated speed — rpm	1030
Rated power — kW	6180
Rated power — bhp	8285
Rated power — PS	8401
Maximum air temperature to turbocharger — °C (°F)	45 (113)
Maximum aftercooler inlet water temperature — °C (°F)	38 (100)

The above ratings are based on the following approximate load profile:

- 3% of the engine operating hours at 100% of rated power.
- 82% of the engine operating hours at 85% of rated power.
- 15% of the engine operating hours at less than 50% of rated power.

These ratings correspond to the ISO 3046 Fuel Stop Power definitions.

Ratings are based on ISO 3046/1 and SAE J1995 standard reference conditions of 100 kPa (30 in. Hg), 25°C (77°F), and 30% relative humidity at the stated charge air cooler water temperature.

Performance and fuel consumption based on 35 API, 16°C (61°F) fuel used @ 29°C (84°F) with a density of 838.9 g/L (7.001 lbs/U.S. gal). Lower heat value of fuel 42 750 kJ/kg (18,380 btu/lb).

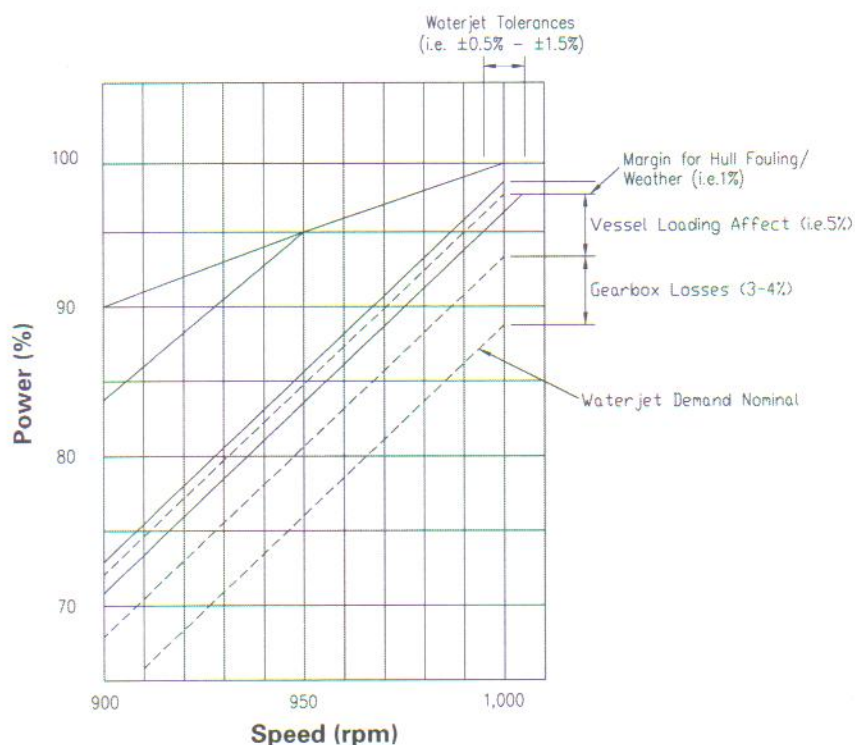
Ratings meet the classification society maximum requirements of 45°C (113°F) to the air inlet of the turbocharger and 32°C (100°F) sea water temperature without derate, unless otherwise stated.

Matching of Propellers and Waterjets

Controllable Pitch (CP) propellers are normally designed so that 90 to 100 percent of the rated power is utilized when the ship is on trial at specified speed and load. Overload protection or load control is necessary to protect the engine from overload in the event of heavy vessel loading, weather conditions, sea state, or hull fouling.

Waterjets approximate a fixed pitch propeller demand curve and can also be affected by vessel loading, weather conditions, sea state, and hull fouling. The waterjet power demand should be matched such that these conditions do not result in engine overload. The waterjet-to-engine match should be based on expected heavy ship conditions, propulsion system power losses, reduction gear losses, etc.

The following graph provides an example of correct waterjet match.



System Response

The waterjet should be matched to the engine such that the engine can smoothly reach its rated speed in a time frame that optimizes acceleration and fuel combustion (smoke). This optimized condition is frequently programmed into the electronic governing system and the waterjet should not inhibit the programmed acceleration rate. An oversized waterjet may result in engine lug (maximum fuel @ less than rated rpm), resulting in owner dissatisfaction with vessel performance, as well as possible harm to the engine from excessive exhaust temperatures.

Engine and Waterjet Tolerances

Engine and waterjet tolerances should be taken into account in the propulsion system design. Waterjets typically have a rated speed tolerance of ± 0.5 to ± 1.5 percent; the waterjets will absorb the rated power somewhere within this speed band tolerance. If the situation arises where the waterjet is supplied within these specifications but at the lower limit of the speed tolerance, it could mean that the propeller demand would require 4.5 percent more power at the nominal rated speed. If the waterjet is supplied with the ability to absorb the power only at the upper limit of the speed tolerance, the engine may not be able to pull the rated power out of the waterjet, as the engine may not be able to operate at this higher rpm. The 3612/3616 tolerances provide nominal power ± 1.5 percent with a rated speed tolerance of $+0.5$ to -1.0 percent. To ensure the best possible match between the engine and the waterjet in view of the tolerance differences, the following procedure applies.

Engine adjustment and acceptability guidelines for sea trials:

1. If the maximum engine speed in the ship installation during full load sea trials is between 995 rpm and 1000 rpm, no adjustments will be made to the engine settings.
2. If the maximum engine speed in the ship installation during full load sea trials is 1000 rpm and the shipyard measured parameters such as boost, fuel rate, rack position, and/or cylinder pressure indicate that between 1001 and 1005 rpm is necessary to achieve the rated power, no adjustments will be made to the engine settings.

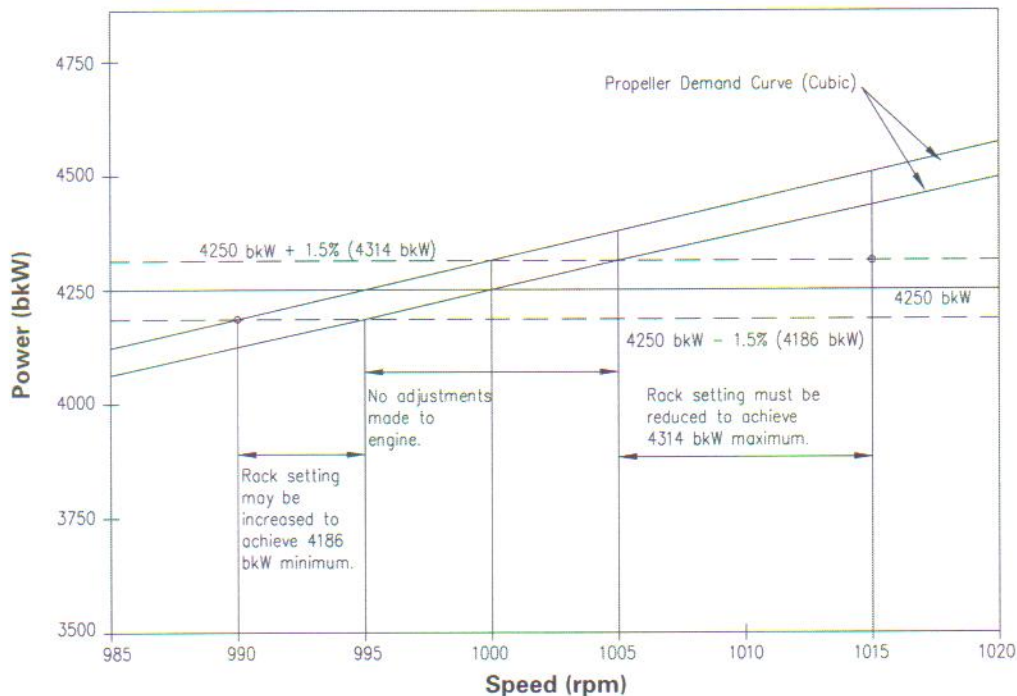
3. If the maximum engine speed in the ship installation during full load sea trials is between 990 rpm and 994 rpm and the shipyard parameters indicate that the engine is in the lower end of the power tolerance, the rack setting can be increased so that the *minimum* power will be within -1.5 percent tolerance [4186 kW (5614 bhp) in the case of the 4250 kW (5699 bhp) rating] based on standard ambient conditions. A new specification will be created to reflect the new rack setting and a new engine nameplate will be stamped.
4. If the maximum engine speed in the ship installation during full load sea trials is 1000 rpm and the shipyard measured parameters indicate that between 1006 rpm and 1010 rpm is necessary to achieve the rated power, the engine rated speed may be increased. The engine rated speed will not exceed 1010 rpm and Caterpillar reserves the option of reducing fuel stop setting to provide a *maximum* output of 4314 kW (5785 bhp) at standard conditions within the 1006-1010 rpm speed range. If necessary, a new specification will be created to reflect the new rack setting and a new nameplate will be stamped.
5. A maximum attainable engine speed of less than 990 rpm is considered unacceptable for lug for continuous operation.

Requirements/Conditions:

1. The dynamometer test results at fuel stop power will be used as the criteria for evaluating installed engine power.
2. ISO standard reference conditions apply for power, not site conditions.
3. Minimum power setting (no negative tolerance in the Dyno) will be driven by the quoter including the associated additional cost.
4. The minimum tolerance on engine power in the Dyno will be reduced to 2 percent.
5. A tolerance of ± 1.5 percent applies to engine power in the field based on standard conditions.
6. The standard rated power and speed will not be changed on the new nameplate, only the rack setting.

The nominal propeller demand curve shown in the graph below shows the cubic demand curve through the engine design point of 4250 bkW (5699 bhp) at 1000 rpm. The propeller demand curves 2 and 3 are matched through the minimum and maximum power tolerance limits at rated speed.

3612 Fast Vessel Waterjet Tolerances
based on 4250 bkW (5699 bhp) @ 1000 rpm rating



Waterjet Tolerances

Standard waterjet tolerances are ± 1.5 percent speed at rated power. This speed tolerance is a function of the pump design, hull form, vessel speed, and waterjet intake design. The engine speed tolerance at rated power is less than the waterjet tolerance ($+0.5$ percent/ -1.0 percent versus ± 1.5 percent). This means there is a possibility for the waterjet to be oversized or undersized if the maximum minus or plus speed tolerance on the waterjet is obtained at rated power.

An oversized waterjet will cause the engine to operate at fuel stop rack (lug) when the engine is set for the rated 4250 bkW (5699 bhp) at 1000 rpm. The engine speed may be less than the minimum 990 rpm (-1.0 percent engine speed tolerance) required to obtain power within the minus tolerance band with factory rack setting. The engine can operate in lug continuously down to 980 rpm. However, the engine power output will be out of the minus tolerance band.

An undersized waterjet will prevent the engine from reaching rated power at the rated 1000 rpm. Engine speed may be increased to a maximum of 1015 rpm but power output may still be below the minimum tolerance of 4186 bkW (5614 bhp) with the factory rack setting. The rack setting may be changed to achieve a maximum output of 4314 bkW (5786 bhp) at standard ambient conditions at 1015 rpm.

To minimize the possibility of a significantly oversized waterjet, the customer and/or jet manufacturer may choose to use a different nominal jet sizing point than the rated engine operating point [4250 bkW (5699 bhp) at 1000 rpm]. By choosing a lower nominal waterjet rating at 1000 rpm, the jet speed tolerance band may be made to fall entirely within the engine limits such that continuous lug operation is not possible.

3612 AND 3616 MARINE PROJECT GUIDE

Technical Data and Performance Curves

TECHNICAL DATA			Engine:	3612 Vee		
			Rating:	CSR		
			Fuel:	MDO		
			Engine Speed Ratings			
Units			900	1000		
General Data						
Engine Output ¹ (IMO certified)	bkW	(bhp)	3460	(4640)	3700	(4962)
Cylinder Bore	mm	(in)	280	(11.0)	280	(11.0)
Stroke	mm	(in)	300	(11.8)	300	(11.8)
Displacement/Cylinder	L	(in3)	18.5	(1,127)	18.5	(1,127)
Compression Ratio			13:1		13:1	
Firing Pressure, maximum	kPa	(psi)	16 200	(2,350)	16 200	(2,350)
BMEP @ 100% Load	kPa	(psi)	2082	(302)	2003	(291)
Mean Piston Speed	m/s	(ft/s)	9.0	(29.5)	10.0	(32.8)
Idle Speed	rpm	rpm	350		350	
Crash Reversal Speed, minimum	rpm	rpm	300		300	
Firing Order — CCW			1-12-9-4-5-8-11-2-3-10-7-6			
Firing Order — CW			1-6-7-10-3-2-11-8-5-4-9-12			
Combustion Air System ⁴						
Flow of Air @ 100% Load	m ³ /min	(ft ³ /min)	335.4	(11,842)	388.2	(13,708)
Air Temp. @ Air Cleaner, maximum	°C	(°F)	45	(113)	45	(113)
Air Temp. After Aftercooler, alarm	°C	(°F)	60	(140)	60	(140)
Intake Manifold Pressure @ 100% Load	kPa	(psi)	243	(35)	250	(36)
Air Inlet Restriction, new/maximum	mm H ₂ O	(in. H ₂ O)	125/380	(5/15)	125/380	(5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa	(psi)	3.4	(0.5)	3.4	(0.5)
Exhaust Gas System						
Exhaust Gas Flow @ 100% Load	m ³ /min	(ft ³ /min)	706.3	(24,943)	794.5	(28,056)
Exhaust Stack Temperature						
Exhaust Stack Temp @ 100% Load	°C	(°F)	362	(684)	345	(653)
Exhaust Stack Temp Alarm @ 100% Load	°C	(°F)	550	(1,022)	550	(1,022)
Exhaust Temp to Turbo						
Exhaust Temp to Turbo @ 100% Load	°C	(°F)	539	(1,002)	530	(986)
Exhaust Temp to Turbo Alarm @ 100% Load	°C	(°F)	630	(1,166)	630	(1,166)
Exhaust System Backpressure, maximum	mm H ₂ O	(in. H ₂ O)	254	(10)	254	(10)
Heat Balance @ 100% Load ⁴						
Lube Oil Cooler	kW	(Btu/min)	364	(20,712)	408	(23,215)
Jacket Water	kW	(Btu/min)	728	(41,423)	752	(42,789)
Aftercooler	kW	(Btu/min)	1098	(62,502)	1280	(72,807)
Total Heat Rejection to Raw Water	kW	(Btu/min)	2190	(124,637)	2440	(138,811)
Exhaust Gas ²	kW	(Btu/min)	2537	(144,327)	2866	(163,077)
Radiation	kW	(Btu/min)	167	(9,507)	184	(10,458)
Fuel System						
Pump Suction Restriction, maximum	kPa	(psi)	-20	(-2.9)	-20	(-2.9)
Return Line Backpressure, maximum	kPa	(psi)	350	(51)	350	(51)
Manifold Pressure @ 100% Load	kPa	(psi)	430-676	(62.4-98)	430-676	(62.4-98)
Flow Rate, supply	Lpm	(gpm)	72.0	(19.0)	78.5	(20.7)
Flow Rate, return	Lpm	(gpm)	58.0	(15.3)	63.1	(16.7)
BSFC (with pumps ± 3%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	203.2	(0.334)	209.0	(0.344)
BSFC (with pumps +5%/-0%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	199.3	(0.328)	205.0	(0.337)

TECHNICAL DATA			Engine: 3612 Vee Rating: CSR Fuel: MDO			
			Engine Speed Ratings			
Units			900		1000	
Lubricating Oil System						
Manifold Pressure, nominal	kPa	(psi)	380	(55)	380	(55)
Manifold Pressure, alarm (788-1050 rpm)	kPa	(psi)	320	(46)	320	(46)
Manifold Pressure, alarm (0-788 rpm)	kPa	(psi)	120	(17)	120	(17)
Manifold Pressure, stop (788-1050 rpm)	kPa	(psi)	260	(38)	260	(38)
Manifold Pressure, stop (0-788 rpm)	kPa	(psi)	105	(15)	105	(15)
Manifold Temperature, alarm	°C	(°F)	92	(198)	92	(198)
Manifold Temperature, stop	°C	(°F)	98	(208)	98	(208)
Manifold Temperature, nominal	°C	(°F)	85	(185)	85	(185)
Prelube Pump Capacity, intermittent	Lpm	(gpm)	76	(20)	76	(20)
Prelube Pump Capacity, continuous	Lpm	(gpm)	23	(6)	23	(6)
Sump Capacity (marine)	L	(gal)	910	(240)	910	(240)
BSOC @ 100% Load, typical	g/bkW-hr	(lb/bhp-hr)	0.70	(0.0012)	0.70	(0.0012)
Lube Oil Filter Differential Pressure, maximum	kPa	(psi)	104	(15)	104	(15)
Lube Oil Flow	Lpm	(gpm)	868	(229)	868	(229)
Cooling Water System — Block Cooling						
Inlet Temperature, nominal	°C	(°F)	90	(194)	90	(194)
Inlet Temperature, maximum	°C	(°F)	95	(203)	95	(203)
Inlet Temperature, minimum	°C	(°F)	83	(181)	83	(181)
Outlet Temp before Regulator, maximum	°C	(°F)	99	(210)	99	(210)
Pump Rise (Delta P) @ 85°C (185°F)	kPa	(psi)	240	(34.8)	295	(42.8)
Pump Capacity	Lpm	(gpm)	2630	(695)	2920	(771)
Pump Inlet Pressure, minimum	kPa	(psi)	30	(4.4)	30	(4.4)
Outlet Temperature, alarm	°C	(°F)	100	(212)	100	(212)
Outlet Temperature, stop	°C	(°F)	104	(219)	104	(219)
Cooling Water System — AC/OC Cooling						
Inlet Temperature, nominal	°C	(°F)	32	(90)	32	(90)
Inlet Temperature, maximum	°C	(°F)	38	(100)	38	(100)
Pump Rise (Delta P) @ 32°C (90°F)	kPa	(psi)	245	(35.5)	305	(44.2)
Pump Capacity	Lpm	(gpm)	1560	(412)	1730	(457)
Pump Inlet Pressure, minimum	kPa	(in. Hg)	-5	(-1.48)	-5	(-1.48)
Starting Air System						
Air Pressure, nominal	kPa	(psi)	1225	(178)	1225	(178)
Air Pressure, minimum	kPa	(psi)	620	(90)	620	(90)
Air Pressure, maximum	kPa	(psi)	1575	(228)	1575	(228)
Low Air Pressure, alarm	kPa	(psi)	850	(123)	850	(123)
Tolerances						
Power	±3%		Specific Fuel Consumption	±3%		
Heat Rejection	±10%		Exhaust Stack Temperature	±8%		
Charge Air Pressure	±10%		Fuel Rate	±5%		
Exhaust Flow	±6%		Inlet Air Flow	±5%		
Notes						
¹ Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature.						
² Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total.						
³ Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter.						
⁴ Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.						

3612 AND 3616 MARINE PROJECT GUIDE

TECHNICAL DATA			Engine: 3612 Vee Rating: MCR Fuel: MDO			
			Engine Speed Ratings			
Units			900		1000	
General Data						
Engine Output ¹ (IMO certified)	bkW	(bhp)	3800	(5096)	4060	(5445)
Cylinder Bore	mm	(in)	280	(11.0)	280	(11.0)
Stroke	mm	(in)	300	(11.8)	300	(11.8)
Displacement/Cylinder	L	(in3)	18.5	(1,127)	18.5	(1,127)
Compression Ratio			13:1		13:1	
Firing Pressure, maximum	kPa	(psi)	17 300	(2,509)	17 300	(2,509)
BMEP @ 100% Load	kPa	(psi)	2286	(332)	2198	(319)
Mean Piston Speed	m/s	(ft/s)	9.0	(29.5)	10.0	(32.8)
Idle Speed	rpm	rpm	350		350	
Crash Reversal Speed, minimum	rpm	rpm	300		300	
Firing Order — CCW			1-12-9-4-5-8-11-2-3-10-7-6			
Firing Order — CW			1-6-7-10-3-2-11-8-5-4-9-12			
Combustion Air System ⁴						
Flow of Air @ 100% Load	m3/min	(ft3/min)	362.3	(12,794)	413.5	(14,602)
Air Temp. @ Air Cleaner, maximum	°C	(°F)	45	(113)	45	(113)
Air Temp. After Aftercooler, alarm	°C	(°F)	60	(140)	60	(140)
Intake Manifold Pressure @ 100% Load	kPa	(psi)	273	(40)	275	(40)
Air Inlet Restriction, new/maximum	mm H ₂ O	(in. H ₂ O)	125/380	(5/15)	125/380	(5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa	(psi)	3.4	(0.5)	3.4	(0.5)
Exhaust Gas System						
Exhaust Gas Flow @ 100% Load	m ³ /min	(ft ³ /min)	771.9	(27,259)	860.8	(30,398)
Exhaust Stack Temperature						
Exhaust Stack Temp @ 100% Load	°C	(°F)	369	(696)	355	(671)
Exhaust Stack Temp Alarm @ 100% Load	°C	(°F)	550	(1,022)	550	(1,022)
Exhaust Temp to Turbo						
Exhaust Temp to Turbo @ 100% Load	°C	(°F)	558	(1,036)	550	(1,022)
Exhaust Temp to Turbo Alarm @ 100% Load	°C	(°F)	650	(1,202)	650	(1,202)
Exhaust System Backpressure, maximum	mm H ₂ O	(in. H ₂ O)	254	(10)	254	(10)
Heat Balance @ 100% Load ⁴						
Lube Oil Cooler	kW	(Btu/min)	382	(21,736)	426	(24,239)
Jacket Water	kW	(Btu/min)	770	(43,813)	804	(45,748)
Aftercooler	kW	(Btu/min)	1288	(73,307)	1481	(84,291)
Total Heat Rejection to Raw Water	kW	(Btu/min)	2440	(138,856)	2711	(154,278)
Exhaust Gas ²	kW	(Btu/min)	2804	(159,558)	3158	(179,674)
Radiation	kW	(Btu/min)	185	(10,503)	203	(11,530)
Fuel System						
Pump Suction Restriction, maximum	kPa	(psi)	-20	(-2.9)	-20	(-2.9)
Return Line Backpressure, maximum	kPa	(psi)	350	(51)	350	(51)
Manifold Pressure @ 100% Load	kPa	(psi)	430-676	(62.4-98)	430-676	(62.4-98)
Flow Rate, supply	Lpm	(gpm)	72.0	(19.0)	78.5	(20.7)
Flow Rate, return	Lpm	(gpm)	56.6	(14.9)	61.6	(16.3)
BSFC (with pumps ± 3%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	204.4	(0.336)	210.0	(0.345)
BSFC (with pumps +5%/-0%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	200.5	(0.330)	206.0	(0.339)

TECHNICAL DATA

Engine: 3612 Vee
Rating: MCR
Fuel: MDO

		Units		Engine Speed Ratings			
				900		1000	
Lubricating Oil System							
Manifold Pressure, nominal	kPa	(psi)	380	(55)	380	(55)	
Manifold Pressure, alarm (788-1050 rpm)	kPa	(psi)	320	(46)	320	(46)	
Manifold Pressure, alarm (0-788 rpm)	kPa	(psi)	120	(17)	120	(17)	
Manifold Pressure, stop (788-1050 rpm)	kPa	(psi)	260	(38)	260	(38)	
Manifold Pressure, stop (0-788 rpm)	kPa	(psi)	105	(15)	105	(15)	
Manifold Temperature, alarm	°C	(°F)	92	(198)	92	(198)	
Manifold Temperature, stop	°C	(°F)	98	(208)	98	(208)	
Manifold Temperature, nominal	°C	(°F)	85	(185)	85	(185)	
Prelube Pump Capacity, intermittent	Lpm	(gpm)	76	(20)	76	(20)	
Prelube Pump Capacity, continuous	Lpm	(gpm)	23	(6)	23	(6)	
Sump Capacity (marine)	L	(gal)	910	(240)	910	(240)	
BSOC @ 100% Load, typical	g/bkW-hr	(lb/bhp-hr)	0.70	(0.0012)	0.70	(0.0012)	
Lube Oil Filter Differential Pressure, maximum	kPa	(psi)	104	(15)	104	(15)	
Lube Oil Flow	Lpm	(gpm)	868	(229)	868	(229)	
Cooling Water System — Block Cooling							
Inlet Temperature, nominal	°C	(°F)	90	(194)	90	(194)	
Inlet Temperature, maximum	°C	(°F)	95	(203)	95	(203)	
Inlet Temperature, minimum	°C	(°F)	83	(181)	83	(181)	
Outlet Temp before Regulator, maximum	°C	(°F)	99	(210)	99	(210)	
Pump Rise (Delta P) @ 85°C (185°F)	kPa	(psi)	240	(34.8)	295	(42.8)	
Pump Capacity	Lpm	(gpm)	2630	(695)	2920	(771)	
Pump Inlet Pressure, minimum	kPa	(psi)	30	(4.4)	30	(4.4)	
Outlet Temperature, alarm	°C	(°F)	100	(212)	100	(212)	
Outlet Temperature, stop	°C	(°F)	104	(219)	104	(219)	
Cooling Water System — AC/OC Cooling							
Inlet Temperature, nominal	°C	(°F)	32	(90)	32	(90)	
Inlet Temperature, maximum	°C	(°F)	38	(100)	38	(100)	
Pump Rise (Delta P) @ 32°C (90°F)	kPa	(psi)	245	(35.5)	305	(44.2)	
Pump Capacity	Lpm	(gpm)	1560	(412)	1730	(457)	
Pump Inlet Pressure, minimum	kPa	(in. Hg)	-5	(-1.48)	-5	(-1.48)	
Starting Air System							
Air Pressure, nominal	kPa	(psi)	1225	(178)	1225	(178)	
Air Pressure, minimum	kPa	(psi)	620	(90)	620	(90)	
Air Pressure, maximum	kPa	(psi)	1575	(228)	1575	(228)	
Low Air Pressure, alarm	kPa	(psi)	850	(123)	850	(123)	
Tolerances							
Power	±3%	Specific Fuel Consumption	±3%				
Heat Rejection	±10%	Exhaust Stack Temperature	±8%				
Charge Air Pressure	±10%	Fuel Rate	±5%				
Exhaust Flow	±6%	Inlet Air Flow	±5%				
Notes							
1 Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature.							
2 Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total.							
3 Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter.							
4 Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.							

3612 AND 3616 MARINE PROJECT GUIDE

TECHNICAL DATA			Engine:	3612 Vee		
			Rating:	Marine Auxiliary		
			Fuel:	MDO		
			Engine Speed Ratings			
Units			900	1000		
General Data						
Engine Output¹ (IMO certified)	bkW	(bhp)	3800	(5096)	4060	(5445)
Cylinder Bore	mm	(in)	280	(11.0)	280	(11.0)
Stroke	mm	(in)	300	(11.8)	300	(11.8)
Displacement/Cylinder	L	(in3)	18.5	(1,127)	18.5	(1,127)
Compression Ratio			13:1		13:1	
Firing Pressure, maximum	kPa	(psi)	17 300	(2,509)	17 300	(2,509)
BMEP @ 100% Load	kPa	(psi)	2286	(332)	2198	(319)
Mean Piston Speed	m/s	(ft/s)	9.0	(29.5)	10.0	(32.8)
Idle Speed	rpm	rpm	350		350	
Crash Reversal Speed, minimum	rpm	rpm	300		300	
Firing Order — CCW			1-12-9-4-5-8-11-2-3-10-7-6			
Firing Order — CW			1-6-7-10-3-2-11-8-5-4-9-12			
Combustion Air System⁴						
Flow of Air @ 100% Load	m3/min	(ft3/min)	362.3	(12,794)	413.5	(14,602)
Air Temp. @ Air Cleaner, maximum	°C	(°F)	45	(113)	45	(113)
Air Temp. After Aftercooler, alarm	°C	(°F)	60	(140)	60	(140)
Intake Manifold Pressure @ 100% Load	kPa	(psi)	273	(40)	275	(40)
Air Inlet Restriction, new/maximum	mm H₂O	(in. H₂O)	125/380	(5/15)	125/380	(5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa	(psi)	3.4	(0.5)	3.4	(0.5)
Exhaust Gas System						
Exhaust Gas Flow @ 100% Load	m3/min	(ft3/min)	771.9	(27,259)	860.8	(30,398)
Exhaust Stack Temperature						
Exhaust Stack Temp @ 100% Load	°C	(°F)	369	(696)	355	(671)
Exhaust Stack Temp Alarm @ 100% Load	°C	(°F)	550	(1,022)	550	(1,022)
Exhaust Temp to Turbo						
Exhaust Temp to Turbo @ 100% Load	°C	(°F)	558	(1,036)	550	(1,022)
Exhaust Temp to Turbo Alarm @ 100% Load	°C	(°F)	650	(1,202)	650	(1,202)
Exhaust System Backpressure, maximum	mm H₂O	(in. H₂O)	254	(10)	254	(10)
Heat Balance @ 100% Load⁴						
Lube Oil Cooler	kW	(Btu/min)	382	(21,736)	426	(24,239)
Jacket Water	kW	(Btu/min)	770	(43,813)	804	(45,748)
Aftercooler	kW	(Btu/min)	1288	(73,307)	1481	(84,291)
Total Heat Rejection to Raw Water	kW	(Btu/min)	2440	(138,856)	2711	(154,278)
Exhaust Gas²	kW	(Btu/min)	2804	(159,558)	3158	(179,674)
Radiation	kW	(Btu/min)	185	(10,503)	203	(11,530)
Fuel System						
Pump Suction Restriction, maximum	kPa	(psi)	-20	(-2.9)	-20	(-2.9)
Return Line Backpressure, maximum	kPa	(psi)	350	(51)	350	(51)
Manifold Pressure @ 100% Load	kPa	(psi)	430-676	(62.4-98)	430-676	(62.4-98)
Flow Rate, supply	Lpm	(gpm)	72.0	(19.0)	78.5	(20.7)
Flow Rate, return	Lpm	(gpm)	56.6	(14.9)	61.6	(16.3)
BSFC (with pumps ± 3%)³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	204.4	(0.336)	210.0	(0.345)
BSFC (with pumps +5%/-0%)³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	200.5	(0.330)	206.0	(0.339)

TECHNICAL DATA

Engine: 3612 Vee
Rating: Marine Auxiliary
Fuel: MDO

		Units		Engine Speed Ratings		
				900	1000	
Lubricating Oil System						
Manifold Pressure, nominal	kPa	(psi)	380	(55)	380	(55)
Manifold Pressure, alarm (788-1050 rpm)	kPa	(psi)	320	(46)	320	(46)
Manifold Pressure, alarm (0-788 rpm)	kPa	(psi)	120	(17)	120	(17)
Manifold Pressure, stop (788-1050 rpm)	kPa	(psi)	260	(38)	260	(38)
Manifold Pressure, stop (0-788 rpm)	kPa	(psi)	105	(15)	105	(15)
Manifold Temperature, alarm	°C	(°F)	92	(198)	92	(198)
Manifold Temperature, stop	°C	(°F)	98	(208)	98	(208)
Manifold Temperature, nominal	°C	(°F)	85	(185)	85	(185)
Prelube Pump Capacity, intermittent	Lpm	(gpm)	76	(20)	76	(20)
Prelube Pump Capacity, continuous	Lpm	(gpm)	23	(6)	23	(6)
Sump Capacity (marine)	L	(gal)	910	(240)	910	(240)
BSOC @ 100% Load, typical	g/bkW-hr	(lb/bhp-hr)	0.70	(0.0012)	0.70	(0.0012)
Lube Oil Filter Differential Pressure, maximum	kPa	(psi)	104	(15)	104	(15)
Lube Oil Flow	Lpm	(gpm)	868	(229)	868	(229)
Cooling Water System — Block Cooling						
Inlet Temperature, nominal	°C	(°F)	90	(194)	90	(194)
Inlet Temperature, maximum	°C	(°F)	95	(203)	95	(203)
Inlet Temperature, minimum	°C	(°F)	83	(181)	83	(181)
Outlet Temp before Regulator, maximum	°C	(°F)	99	(210)	99	(210)
Pump Rise (Delta P) @ 85°C (185°F)	kPa	(psi)	240	(34.8)	295	(42.8)
Pump Capacity	Lpm	(gpm)	2630	(695)	2920	(771)
Pump Inlet Pressure, minimum	kPa	(psi)	30	(4.4)	30	(4.4)
Outlet Temperature, alarm	°C	(°F)	100	(212)	100	(212)
Outlet Temperature, stop	°C	(°F)	104	(219)	104	(219)
Cooling Water System — AC/OC Cooling						
Inlet Temperature, nominal	°C	(°F)	32	(90)	32	(90)
Inlet Temperature, maximum	°C	(°F)	38	(100)	38	(100)
Pump Rise (Delta P) @ 32°C (90°F)	kPa	(psi)	245	(35.5)	305	(44.2)
Pump Capacity	Lpm	(gpm)	1560	(412)	1730	(457)
Pump Inlet Pressure, minimum	kPa	(in. Hg)	-5	(-1.48)	-5	(-1.48)
Starting Air System						
Air Pressure, nominal	kPa	(psi)	1225	(178)	1225	(178)
Air Pressure, minimum	kPa	(psi)	620	(90)	620	(90)
Air Pressure, maximum	kPa	(psi)	1575	(228)	1575	(228)
Low Air Pressure, alarm	kPa	(psi)	850	(123)	850	(123)
Tolerances						
Power	±3%	Specific Fuel Consumption		±3%		
Heat Rejection	±10%	Exhaust Stack Temperature		±8%		
Charge Air Pressure	±10%	Fuel Rate		±5%		
Exhaust Flow	±6%	Inlet Air Flow		±5%		
Notes						
1 Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature.						
2 Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total.						
3 Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter.						
4 Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.						

3612 AND 3616 MARINE PROJECT GUIDE

TECHNICAL DATA			Engine:	3612 Vee
			Rating:	Fast Vessel
			Fuel:	MDO
			Engine Speed Ratings	
Units			1000	
General Data				
Engine Output ¹ (IMO certified)	bkW	(bhp)	4250	(5699)
Cylinder Bore	mm	(in)	280	(11.0)
Stroke	mm	(in)	300	(11.8)
Displacement/Cylinder	L	(in ³)	18.5	(1127)
Compression Ratio			13:1	
Firing Pressure, maximum	kPa	(psi)	17 000	(2,466)
BMEP @ 100% Load	kPa	(psi)	2301	(334)
Mean Piston Speed	m/s	(ft/s)	10.0	(32.8)
Idle Speed	rpm	rpm	350	
Crash Reversal Speed, minimum	rpm	rpm		300
Firing Order — CCW			1-12-9-4-5-8-11-2-3-10-7-6	
Firing Order — CW			1-6-7-10-3-2-11-8-5-4-9-12	
Combustion Air System ⁴				
Flow of Air @ 100% Load	m ³ /min	(ft ³ /min)	396.5	(14,002)
Air Temp. @ Air Cleaner, maximum	°C	(°F)	45	(113)
Air Temp. After Aftercooler, alarm	°C	(°F)	60	(140)
Intake Manifold Pressure @ 100% Load	kPa	(psi)	271	(39)
Air Inlet Restriction, new/maximum	mm H ₂ O	(in. H ₂ O)	125/380	(5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa	(psi)	3.4	(0.5)
Exhaust Gas System				
Exhaust Gas Flow @ 100% Load	m ³ /min	(ft ³ /min)	933.3	(32,957)
Exhaust Stack Temperature				
Exhaust Stack Temp @ 100% Load	°C	(°F)	435	(815)
Exhaust Stack Temp Alarm @ 100% Load	°C	(°F)	550	(1,022)
Exhaust Temp to Turbo				
Exhaust Temp to Turbo @ 100% Load	°C	(°F)	614	(1,137)
Exhaust Temp to Turbo Alarm @ 100% Load	°C	(°F)	650	(1,202)
Exhaust System Backpressure, maximum	mm H ₂ O	(in. H ₂ O)	254	(10)
Heat Balance @ 100% Load ⁴				
Lube Oil Cooler	kW	(Btu/min)	436	(24,808)
Jacket Water	kW	(Btu/min)	834	(47,455)
Aftercooler	kW	(Btu/min)	1290	(73,412)
Total Heat Rejection to Raw Water	kW	(Btu/min)	2560	(145,675)
Exhaust Gas ²	kW	(Btu/min)	3698	(210,410)
Radiation	kW	(Btu/min)	214	(12,202)
Fuel System				
Pump Suction Restriction, maximum	kPa	(psi)	-20	(-2.9)
Return Line Backpressure, maximum	kPa	(psi)	350	(51)
Manifold Pressure @ 100% Load	kPa	(psi)	430-676	(62.4-98)
Flow Rate, supply	Lpm	(gpm)	78.5	(20.7)
Flow Rate, return	Lpm	(gpm)	60.6	(16.0)
BSFC (with pumps ± 3%) ³				
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	212.3	(0.349)
BSFC (with pumps +5%/-0%) ³				
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	208.3	(0.342)

TECHNICAL DATA

Engine: 3612 Vee
Rating: Fast Vessel
Fuel: MDO

Engine Speed Ratings
1000

Units

Lubricating Oil System

Manifold Pressure, nominal	kPa	(psi)	380	(55)
Manifold Pressure, alarm (788-1050 rpm)	kPa	(psi)	320	(46)
Manifold Pressure, alarm (0-788 rpm)	kPa	(psi)	120	(17)
Manifold Pressure, stop (788-1050 rpm)	kPa	(psi)	260	(38)
Manifold Pressure, stop (0-788 rpm)	kPa	(psi)	105	(15)
Manifold Temperature, alarm	°C	(°F)	92	(198)
Manifold Temperature, stop	°C	(°F)	98	(208)
Manifold Temperature, nominal	°C	(°F)	85	(185)
Prelube Pump Capacity, intermittent	Lpm	(gpm)	76	(20)
Prelube Pump Capacity, continuous	Lpm	(gpm)	23	(6)
Sump Capacity (marine)	L	(gal)	910	(240)
BSOC @ 100% Load, typical	g/bkW-hr	(lb/bhp-hr)	0.70	(0.0012)
Lube Oil Filter Differential Pressure, maximum	kPa	(psi)	104	(15)
Lube Oil Flow	Lpm	(gpm)	868	(229)

Cooling Water System — Block Cooling

Inlet Temperature, nominal	°C	(°F)	90	(194)
Inlet Temperature, maximum	°C	(°F)	95	(203)
Inlet Temperature, minimum	°C	(°F)	83	(181)
Outlet Temp before Regulator, maximum	°C	(°F)	99	(210)
Pump Rise (Delta P) @ 85°C (185°F)	kPa	(psi)	295	(42.8)
Pump Capacity	Lpm	(gpm)	2920	(771)
Pump Inlet Pressure, minimum	kPa	(psi)	30	(4.4)
Outlet Temperature, alarm	°C	(°F)	100	(212)
Outlet Temperature, stop	°C	(°F)	104	(219)

Cooling Water System — AC/OC Cooling

Inlet Temperature, nominal	°C	(°F)	32	(90)
Inlet Temperature, maximum	°C	(°F)	38	(100)
Pump Rise (Delta P) @ 32°C (90°F)	kPa	(psi)	305	(44.2)
Pump Capacity	Lpm	(gpm)	1730	(457)
Pump Inlet Pressure, minimum	kPa	(in. Hg)	-5	(-1.48)

Starting Air System

Air Pressure, nominal	kPa	(psi)	1225	(178)
Air Pressure, minimum	kPa	(psi)	620	(90)
Air Pressure, maximum	kPa	(psi)	1575	(228)
Low Air Pressure, alarm	kPa	(psi)	850	(123)

Tolerances

Power	±3%	Specific Fuel Consumption	±3%
Heat Rejection	±10%	Exhaust Stack Temperature	±8%
Charge Air Pressure	±10%	Fuel Rate	±5%
Exhaust Flow	±6%	Inlet Air Flow	±5%

Notes

- Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature.
- Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total.
- Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter.
- Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.

3612 AND 3616 MARINE PROJECT GUIDE

TECHNICAL DATA			Engine:	3616 Vee		
			Rating:	CSR		
			Fuel:	MDO		
			Engine Speed Rating			
Units			900	1000		
General Data						
Engine Output ¹ (IMO certified)	bkW	(bhp)	4600	(6169)	4920	(6598)
Cylinder Bore	mm	(in)	280	(11.0)	280	(11.0)
Stroke	mm	(in)	300	(11.8)	300	(11.8)
Displacement/Cylinder	L	(in ³)	18.5	(1,127)	18.5	(1,127)
Compression Ratio			13:1		13:1	
Firing Pressure, maximum	kPa	(psi)	16 200	(2,350)	16 200	(2,350)
BMEP @ 100% Load	kPa	(psi)	2076	(301)	1998	(290)
Mean Piston Speed	m/s	(ft/s)	9.0	(29.5)	10.0	(32.8)
Idle Speed	rpm	rpm	350		350	
Crash Reversal Speed, minimum	rpm	rpm	300		300	
Firing Order — CCW			1-2-5-6-3-4-9-10-15-16-11-12-13-14-7-8			
Firing Order — CW			1-8-7-14-13-12-11-16-15-10-9-4-3-6-5-2			
Combustion Air System ⁴						
Flow of Air @ 100% Load	m ³ /min	(ft ³ /min)	465.3	(16,431)	520.6	(18,383)
Air Temp. @ Air Cleaner, maximum	°C	(°F)	45	(113)	45	(113)
Air Temp. After Aftercooler, alarm	°C	(°F)	60	(140)	60	(140)
Intake Manifold Pressure @ 100% Load	kPa	(psi)	245	(35)	244	(35)
Air Inlet Restriction, new/maximum	mm H ₂ O	(in. H ₂ O)	125/380	(5/15)	125/380	(5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa	(psi)	3.4	(0.5)	3.4	(0.5)
Exhaust Gas System						
Exhaust Gas Flow @ 100% Load	m ³ /min	(ft ³ /min)	974.1	(34,399)	1092.2	(38,568)
Exhaust Stack Temperature						
Exhaust Stack Temp @ 100% Load	°C	(°F)	359	(678)	361	(682)
Exhaust Stack Temp Alarm @ 100% Load	°C	(°F)	550	(1,022)	550	(1,022)
Exhaust Temp to Turbo						
Exhaust Temp to Turbo @ 100% Load	°C	(°F)	523	(973)	508	(946)
Exhaust Temp to Turbo Alarm @ 100% Load	°C	(°F)	630	(1,166)	630	(1,166)
Exhaust System Backpressure, maximum	mm H ₂ O	(in. H ₂ O)	254	(10)	254	(10)
Heat Balance @ 100% Load ⁴						
Lube Oil Cooler	kW	(Btu/min)	484	(27,540)	542	(30,840)
Jacket Water	kW	(Btu/min)	968	(55,079)	1000	(56,900)
Aftercooler	kW	(Btu/min)	1322	(75,196)	1348	(76,692)
Total Heat Rejection to Raw Water	kW	(Btu/min)	2774	(157,815)	2890	(164,432)
Exhaust Gas ²	kW	(Btu/min)	3459	(196,839)	3738	(212,664)
Radiation	kW	(Btu/min)	221	(12,579)	236	(13,409)
Fuel System						
Pump Suction Restriction, maximum	kPa	(psi)	-20	(-2.9)	-20	(-2.9)
Return Line Backpressure, maximum	kPa	(psi)	350	(51)	350	(51)
Manifold Pressure @ 100% Load	kPa	(psi)	430-676	(62.4-98)	430-676	(62.4-98)
Flow Rate, supply	Lpm	(gpm)	72.0	(19.0)	78.5	(20.7)
Flow Rate, return	Lpm	(gpm)	53.5	(14.1)	58.8	(15.5)
BSFC (with pumps ± 3%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	202.2	(0.332)	201.5	(0.331)
BSFC (with pumps +5%/-0%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	198.4	(0.326)	197.7	(0.325)

TECHNICAL DATA

Engine: 3616 Vee
Rating: CSR
Fuel: MDO

		Units		Engine Speed Ratings		
				900	1000	
Lubricating Oil System						
Manifold Pressure, minimum	kPa	(psi)	380	(55)	380	(55)
Manifold Pressure, alarm (650-1000 rpm)	kPa	(psi)	320	(46)	320	(46)
Manifold Pressure, alarm (0-650 rpm)	kPa	(psi)	120	(17)	120	(17)
Manifold Pressure, stop (650-1000 rpm)	kPa	(psi)	260	(38)	260	(38)
Manifold Pressure, stop (0-650 rpm)	kPa	(psi)	105	(15)	105	(15)
Manifold Temperature, alarm	°C	(°F)	92	(198)	92	(198)
Manifold Temperature, stop	°C	(°F)	98	(208)	98	(208)
Manifold Temperature, nominal	°C	(°F)	85	(185)	85	(185)
Prelube Pump Capacity, intermittent	Lpm	(gpm)	76	(20)	76	(20)
Prelube Pump Capacity, continuous	Lpm	(gpm)	23	(6)	23	(6)
Sump Capacity (marine)	L	(gal)	1060	(280)	1060	(280)
BSOC @ 100% Load, typical	g/bkW-hr	(lb/bhp-hr)	0.70	(0.0012)	0.70	(0.0012)
Lube Oil Filter Differential Pressure, maximum	kPa	(psi)	104	(15)	104	(15)
Lube Oil Flow	Lpm	(gpm)	1117	(295)	1117	(295)
Cooling Water System — Block Cooling						
Inlet Temperature, nominal	°C	(°F)	90	(194)	90	(194)
Inlet Temperature, maximum	°C	(°F)	95	(203)	95	(203)
Inlet Temperature, minimum	°C	(°F)	83	(181)	83	(181)
Outlet Temp before Regulator, maximum	°C	(°F)	99	(210)	99	(210)
Pump Rise (Delta P) @ 85°C (185°F)	kPa	(psi)	240	(34.8)	295	(42.8)
Pump Capacity	Lpm	(gpm)	2630	(695)	2920	(771)
Pump Inlet Pressure, minimum	kPa	(psi)	30	(4.4)	30	(4.4)
Outlet Temperature, alarm	°C	(°F)	100	(212)	100	(212)
Outlet Temperature, stop	°C	(°F)	104	(219)	104	(219)
Cooling Water System — AC/OC Cooling						
Inlet Temperature, nominal	°C	(°F)	32	(90)	32	(90)
Inlet Temperature, maximum	°C	(°F)	38	(100)	38	(100)
Pump Rise (Delta P) @ 32°C (90°F)	kPa	(psi)	245	(35.5)	305	(44.2)
Pump Capacity	Lpm	(gpm)	1560	(412)	1730	(457)
Pump Inlet Pressure, minimum	kPa	(in. Hg)	-5	(-1.48)	-5	(-1.48)
Starting Air System						
Air Pressure, nominal	kPa	(psi)	1225	(178)	1225	(178)
Air Pressure, minimum	kPa	(psi)	620	(90)	620	(90)
Air Pressure, maximum	kPa	(psi)	1575	(228)	1575	(228)
Low Air Pressure, alarm	kPa	(psi)	850	(123)	850	(123)
Tolerances						
Power	±3%	Specific Fuel Consumption	±3%			
Heat Rejection	±10%	Exhaust Stack Temperature	±8%			
Charge Air Pressure	±10%	Fuel Rate	±5%			
Exhaust Flow	±6%	Inlet Air Flow	±5%			
Notes						
1 Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature.						
2 Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total.						
3 Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter.						
4 Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.						

3612 AND 3616 MARINE PROJECT GUIDE

TECHNICAL DATA			Engine:		3616 Vee	
			Rating:		MCR	
			Fuel:		MDO	
			Engine Speed Rating			
Units			900		1000	
General Data						
Engine Output ¹ (IMO certified)	bkW	(bhp)	5060	(6786)	5420	(7268)
Cylinder Bore	mm	(in)	280	(11.0)	280	(11.0)
Stroke	mm	(in)	300	(11.8)	300	(11.8)
Displacement/Cylinder	L	(in ³)	18.5	(1,127)	18.5	(1,127)
Compression Ratio			13:1		13:1	
Firing Pressure, maximum	kPa	(psi)	17 300	(2,509)	17 300	(2,509)
BMEP @ 100% Load	kPa	(psi)	2283	(331)	2201	(319)
Mean Piston Speed	m/s	(ft/s)	9.0	(29.5)	10.0	(32.8)
Idle Speed	rpm	rpm	350		350	
Crash Reversal Speed, minimum	rpm	rpm	300		300	
Firing Order — CCW			1-2-5-6-3-4-9-10-15-16-11-12-13-14-7-8			
Firing Order — CW			1-8-7-14-13-12-11-16-15-10-9-4-3-6-5-2			
Combustion Air System ⁴						
Flow of Air @ 100% Load	m ³ /min	(ft ³ /min)	497.9	(17,581)	561.3	(19,822)
Air Temp. @ Air Cleaner, maximum	°C	(°F)	45	(113)	45	(113)
Air Temp. After Aftercooler, alarm	°C	(°F)	60	(140)	60	(140)
Intake Manifold Pressure @ 100% Load	kPa	(psi)	272	(39)	274	(40)
Air Inlet Restriction, new/maximum	mm H ₂ O	(in. H ₂ O)	125/380	(5/15)	125/380	(5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa	(psi)	3.4	(0.5)	3.4	(0.5)
Exhaust Gas System						
Exhaust Gas Flow @ 100% Load	m ³ /min	(ft ³ /min)	1066.2	(37,650)	1196.6	(42,256)
Exhaust Stack Temperature						
Exhaust Stack Temp @ 100% Load	°C	(°F)	373	(703)	371	(700)
Exhaust Stack Temp Alarm @ 100% Load	°C	(°F)	550	(1,022)	550	(1,022)
Exhaust Temp to Turbo						
Exhaust Temp to Turbo @ 100% Load	°C	(°F)	547	(1,017)	529	(984)
Exhaust Temp to Turbo Alarm @ 100% Load	°C	(°F)	650	(1,202)	650	(1,202)
Exhaust System Backpressure, maximum	mm H ₂ O	(in. H ₂ O)	254	(10)	254	(10)
Heat Balance @ 100% Load ⁴						
Lube Oil Cooler	kW	(Btu/min)	510	(29,019)	568	(32,319)
Jacket Water	kW	(Btu/min)	1026	(58,379)	1074	(61,111)
Aftercooler	kW	(Btu/min)	1550	(88,222)	1601	(91,106)
Total Heat Rejection to Raw Water	kW	(Btu/min)	3086	(175,620)	3243	(184,536)
Exhaust Gas ²	kW	(Btu/min)	3866	(219,990)	4175	(237,557)
Radiation	kW	(Btu/min)	245	(13,949)	262	(14,908)
Fuel System						
Pump Suction Restriction, maximum	kPa	(psi)	-20	(-2.9)	-20	(-2.9)
Return Line Backpressure, maximum	kPa	(psi)	350	(51)	350	(51)
Manifold Pressure @ 100% Load	kPa	(psi)	430-676	(62.4-98)	430-676	(62.4-98)
Flow Rate, supply	Lpm	(gpm)	72.0	(19.0)	78.5	(20.7)
Flow Rate, return	Lpm	(gpm)	51.5	(13.6)	56.6	(15.0)
BSFC (with pumps ± 3%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	203.9	(0.335)	203.4	(0.334)
BSFC (with pumps +5%/-0%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	200.0	(0.329)	199.5	(0.328)

TECHNICAL DATA

Engine: 3616 Vee
Rating: MCR
Fuel: MDO

		Engine Speed Ratings	
Units		900	1000
Lubricating Oil System			
Manifold Pressure, minimum	kPa (psi)	380 (55)	380 (55)
Manifold Pressure, alarm (650-1000 rpm)	kPa (psi)	320 (46)	320 (46)
Manifold Pressure, alarm (0-650 rpm)	kPa (psi)	120 (17)	120 (17)
Manifold Pressure, stop (650-1000 rpm)	kPa (psi)	260 (38)	260 (38)
Manifold Pressure, stop (0-650 rpm)	kPa (psi)	105 (15)	105 (15)
Manifold Temperature, alarm	°C (°F)	92 (198)	92 (198)
Manifold Temperature, stop	°C (°F)	98 (208)	98 (208)
Manifold Temperature, nominal	°C (°F)	85 (185)	85 (185)
Prelube Pump Capacity, intermittent	Lpm (gpm)	76 (20)	76 (20)
Prelube Pump Capacity, continuous	Lpm (gpm)	23 (6)	23 (6)
Sump Capacity (marine)	L (gal)	1060 (280)	1060 (280)
BSOC @ 100% Load, typical	g/bkW-hr (lb/bhp-hr)	0.70 (0.0012)	0.70 (0.0012)
Lube Oil Filter Differential Pressure, maximum	kPa (psi)	104 (15)	104 (15)
Lube Oil Flow	Lpm (gpm)	1117 (295)	1117 (295)
Cooling Water System — Block Cooling			
Inlet Temperature, nominal	°C (°F)	90 (194)	90 (194)
Inlet Temperature, maximum	°C (°F)	95 (203)	95 (203)
Inlet Temperature, minimum	°C (°F)	83 (181)	83 (181)
Outlet Temp before Regulator, maximum	°C (°F)	99 (210)	99 (210)
Pump Rise (Delta P) @ 85°C (185°F)	kPa (psi)	240 (34.8)	295 (42.8)
Pump Capacity	Lpm (gpm)	2630 (695)	2920 (771)
Pump Inlet Pressure, minimum	kPa (psi)	30 (4.4)	30 (4.4)
Outlet Temperature, alarm	°C (°F)	100 (212)	100 (212)
Outlet Temperature, stop	°C (°F)	104 (219)	104 (219)
Cooling Water System — AC/OC Cooling			
Inlet Temperature, nominal	°C (°F)	32 (90)	32 (90)
Inlet Temperature, maximum	°C (°F)	38 (100)	38 (100)
Pump Rise (Delta P) @ 32°C (90°F)	kPa (psi)	245 (35.5)	305 (44.2)
Pump Capacity	Lpm (gpm)	1560 (412)	1730 (457)
Pump Inlet Pressure, minimum	kPa (in. Hg)	-5 (-1.48)	-5 (-1.48)
Starting Air System			
Air Pressure, nominal	kPa (psi)	1225 (178)	1225 (178)
Air Pressure, minimum	kPa (psi)	620 (90)	620 (90)
Air Pressure, maximum	kPa (psi)	1575 (228)	1575 (228)
Low Air Pressure, alarm	kPa (psi)	850 (123)	850 (123)
Tolerances			
Power	±3%	Specific Fuel Consumption	±3%
Heat Rejection	±10%	Exhaust Stack Temperature	±8%
Charge Air Pressure	±10%	Fuel Rate	±5%
Exhaust Flow	±6%	Inlet Air Flow	±5%
Notes			
¹ Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature. ² Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total. ³ Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter. ⁴ Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.			

3612 AND 3616 MARINE PROJECT GUIDE

TECHNICAL DATA			Engine: 3616 Vee		Rating: Marine Auxiliary	
			Fuel: MDO			
			Engine Speed Ratings			
Units			900		1000	
General Data						
Engine Output ¹ (IMO certified)	bkW	(bhp)	5060	(6786)	5420	(7268)
Cylinder Bore	mm	(in)	280	(11.0)	280	(11.0)
Stroke	mm	(in)	300	(11.8)	300	(11.8)
Displacement/Cylinder	L	(in ³)	18.5	(1,127)	18.5	(1,127)
Compression Ratio			13:1		13:1	
Firing Pressure, maximum	kPa	(psi)	17 300	(2,509)	17 300	(2,509)
BMEP @ 100% Load	kPa	(psi)	2283	(331)	2201	(319)
Mean Piston Speed	m/s	(ft/s)	9.0	(29.5)	10.0	(32.8)
Idle Speed	rpm	rpm	350		350	
Crash Reversal Speed, minimum	rpm	rpm	300		300	
Firing Order — CCW			1-2-5-6-3-4-9-10-15-16-11-12-13-14-7-8			
Firing Order — CW			1-8-7-14-13-12-11-16-15-10-9-4-3-6-5-2			
Combustion Air System ⁴						
Flow of Air @ 100% Load	m ³ /min	(ft ³ /min)	501.6	(17,713)	561.3	(19,822)
Air Temp. @ Air Cleaner, maximum	°C	(°F)	45	(113)	45	(113)
Air Temp. After Aftercooler, alarm	°C	(°F)	60	(140)	60	(140)
Intake Manifold Pressure @ 100% Load	kPa	(psi)	277	(40)	274	(40)
Air Inlet Restriction, new/maximum	mm H ₂ O	(in. H ₂ O)	125/380	(5/15)	125/380	(5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa	(psi)	3.4	(0.5)	3.4	(0.5)
Exhaust Gas System						
Exhaust Gas Flow @ 100% Load	m ³ /min	(ft ³ /min)	1045.0	(36,901)	1196.6	(42,256)
Exhaust Stack Temperature						
Exhaust Stack Temp @ 100% Load	°C	(°F)	356	(673)	371	(700)
Exhaust Stack Temp Alarm @ 100% Load	°C	(°F)	550	(1,022)	550	(1,022)
Exhaust Temp to Turbo						
Exhaust Temp to Turbo @ 100% Load	°C	(°F)	523	(974)	529	(984)
Exhaust Temp to Turbo Alarm @ 100% Load	°C	(°F)	650	(1,202)	650	(1,202)
Exhaust System Backpressure, maximum	mm H ₂ O	(in. H ₂ O)	254	(10)	254	(10)
Heat Balance @ 100% Load ⁴						
Lube Oil Cooler	kW	(Btu/min)	510	(29,019)	568	(32,319)
Jacket Water	kW	(Btu/min)	1026	(58,379)	1074	(61,111)
Aftercooler	kW	(Btu/min)	1528	(86,931)	1601	(91,106)
Total Heat Rejection to Raw Water	kW	(Btu/min)	3064	(174,329)	3243	(184,536)
Exhaust Gas ²	kW	(Btu/min)	3621	(206,051)	4175	(237,557)
Radiation	kW	(Btu/min)	240	(13,639)	262	(14,908)
Fuel System						
Pump Suction Restriction, maximum	kPa	(psi)	-20	(-2.9)	-20	(-2.9)
Return Line Backpressure, maximum	kPa	(psi)	350	(51)	350	(51)
Manifold Pressure @ 100% Load	kPa	(psi)	430-676	(62.4-98)	430-676	(62.4-98)
Flow Rate, supply	Lpm	(gpm)	72.0	(19.0)	78.5	(20.7)
Flow Rate, return	Lpm	(gpm)	52.0	(13.7)	56.6	(15.0)
BSFC (with pumps ± 3%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	199.3	(0.328)	203.4	(0.334)
BSFC (with pumps +5%/-0%) ³						
@ 100% Load	g/bkW-hr	(lb/bhp-hr)	195.5	(0.321)	199.5	(0.328)

TECHNICAL DATA

Engine: 3616 Vee
Rating: Marine Auxiliary
Fuel: MDO

		Engine Speed Ratings	
Units		900	1000
Lubricating Oil System			
Manifold Pressure, minimum	kPa (psi)	380 (55)	380 (55)
Manifold Pressure, alarm (650-1000 rpm)	kPa (psi)	320 (46)	320 (46)
Manifold Pressure, alarm (0-650 rpm)	kPa (psi)	120 (17)	120 (17)
Manifold Pressure, stop (650-1000 rpm)	kPa (psi)	260 (38)	260 (38)
Manifold Pressure, stop (0-650 rpm)	kPa (psi)	105 (15)	105 (15)
Manifold Temperature, alarm	°C (°F)	92 (198)	92 (198)
Manifold Temperature, stop	°C (°F)	98 (208)	98 (208)
Manifold Temperature, nominal	°C (°F)	85 (185)	85 (185)
Prelube Pump Capacity, intermittent	Lpm (gpm)	76 (20)	76 (20)
Prelube Pump Capacity, continuous	Lpm (gpm)	23 (6)	23 (6)
Sump Capacity (marine)	L (gal)	1060 (280)	1060 (280)
BSOC @ 100% Load, typical	g/bkW-hr (lb/bhp-hr)	0.70 (0.0012)	0.70 (0.0012)
Lube Oil Filter Differential Pressure, maximum	kPa (psi)	104 (15)	104 (15)
Lube Oil Flow	Lpm (gpm)	1117 (295)	1117 (295)
Cooling Water System — Block Cooling			
Inlet Temperature, nominal	°C (°F)	90 (194)	90 (194)
Inlet Temperature, maximum	°C (°F)	95 (203)	95 (203)
Inlet Temperature, minimum	°C (°F)	83 (181)	83 (181)
Outlet Temp before Regulator, maximum	°C (°F)	99 (210)	99 (210)
Pump Rise (Delta P) @ 85°C (185°F)	kPa (psi)	240 (34.8)	295 (42.8)
Pump Capacity	Lpm (gpm)	2630 (695)	2920 (771)
Pump Inlet Pressure, minimum	kPa (psi)	30 (4.4)	30 (4.4)
Outlet Temperature, alarm	°C (°F)	100 (212)	100 (212)
Outlet Temperature, stop	°C (°F)	104 (219)	104 (219)
Cooling Water System — AC/OC Cooling			
Inlet Temperature, nominal	°C (°F)	32 (90)	32 (90)
Inlet Temperature, maximum	°C (°F)	38 (100)	38 (100)
Pump Rise (Delta P) @ 32°C (90°F)	kPa (psi)	245 (35.5)	305 (44.2)
Pump Capacity	Lpm (gpm)	1560 (412)	1730 (457)
Pump Inlet Pressure, minimum	kPa (in. Hg)	-5 (-1.48)	-5 (-1.48)
Starting Air System			
Air Pressure, nominal	kPa (psi)	1225 (178)	1225 (178)
Air Pressure, minimum	kPa (psi)	620 (90)	620 (90)
Air Pressure, maximum	kPa (psi)	1575 (228)	1575 (228)
Low Air Pressure, alarm	kPa (psi)	850 (123)	850 (123)
Tolerances			
Power	±3%	Specific Fuel Consumption	±3%
Heat Rejection	±10%	Exhaust Stack Temperature	±8%
Charge Air Pressure	±10%	Fuel Rate	±5%
Exhaust Flow	±6%	Inlet Air Flow	±5%
Notes			
¹ Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature. ² Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total. ³ Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter. ⁴ Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.			

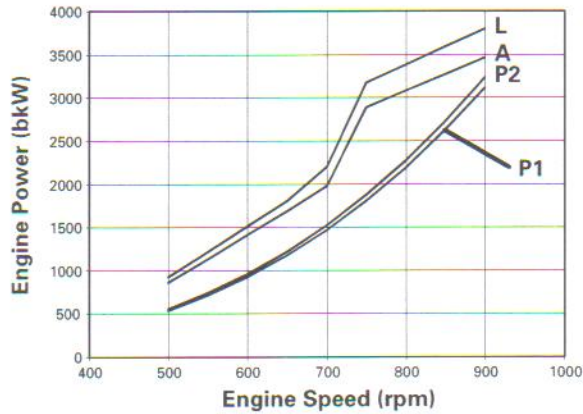
3612 AND 3616 MARINE PROJECT GUIDE

TECHNICAL DATA			Engine: 3616 Vee	
			Rating: Fast Vessel	
			Fuel: MDO	
			Engine Speed Ratings	
			1000	1020
General Data				
Engine Output ¹ (IMO certified)	bkW (bhp)		5650 (7577)	6000 (8046)
Cylinder Bore	mm (in)		280 (11.0)	280 (11.0)
Stroke	mm (in)		300 (11.8)	300 (11.8)
Displacement/Cylinder	L (in ³)		18.5 (1,127)	18.5 (1,127)
Compression Ratio			13:1	13:1
Firing Pressure, maximum	kPa (psi)		17 500 (2,538)	17 500 (2,538)
BMEP @ 100% Load	kPa (psi)		2295 (333)	2389 (346)
Mean Piston Speed	m/s (ft/s)		10.0 (32.8)	10.2 (33.5)
Idle Speed	rpm		350	350
Crash Reversal Speed, minimum	rpm		300	300
Firing Order — CCW			1-2-5-6-3-4-9-10-15-16-11-12-13-14-7-8	
Firing Order — CW			1-8-7-14-13-12-11-16-15-10-9-4-3-6-5-2	
Combustion Air System ⁴				
Flow of Air @ 100% Load	m ³ /min (ft ³ /min)		517.5 (18,274)	646.6 (22,832)
Air Temp. @ Air Cleaner, maximum	°C (°F)		45 (113)	45 (113)
Air Temp. After Aftercooler, alarm	°C (°F)		60 (140)	60 (140)
Intake Manifold Pressure @ 100% Load	kPa (psi)		269 (39)	305 (44)
Air Inlet Restriction, new/maximum	mm H ₂ O (in. H ₂ O)		125/380 (5/15)	125/380 (5/15)
Aftercooler Press. Diff. @ 100% Load, clean state	kPa (psi)		3.4 (0.5)	3.4 (0.5)
Exhaust Gas System				
Exhaust Gas Flow @ 100% Load	m ³ /min (ft ³ /min)		1193.8 (42,158)	1393.8 (49,221)
Exhaust Stack Temperature				
Exhaust Stack Temp @ 100% Load	°C (°F)		421 (790)	378 (713)
Exhaust Stack Temp Alarm @ 100% Load	°C (°F)		550 (1,022)	550 (1,022)
Exhaust Temp to Turbo				
Exhaust Temp to Turbo @ 100% Load	°C (°F)		595 (1,102)	557 (1,035)
Exhaust Temp to Turbo Alarm @ 100% Load	°C (°F)		650 (1,202)	630 (1,166)
Exhaust System Backpressure, maximum	mm H ₂ O (in. H ₂ O)		254 (10)	254 (10)
Heat Balance @ 100% Load ⁴				
Lube Oil Cooler	kW (Btu/min)		579 (32,945)	686 (39,033)
Jacket Water	kW (Btu/min)		1110 (63,159)	1164 (66,232)
Aftercooler	kW (Btu/min)		1763 (100,292)	1865 (106,126)
Total Heat Rejection to Raw Water	kW (Btu/min)		3452 (196,397)	3715 (211,391)
Exhaust Gas ²	kW (Btu/min)		4659 (265,078)	4951 (281,735)
Radiation	kW (Btu/min)		281 (15,979)	299 (17,031)
Fuel System				
Pump Suction Restriction, maximum	kPa (psi)		-20 (-2.9)	-20 (-2.9)
Return Line Backpressure, maximum	kPa (psi)		350 (51)	350 (51)
Manifold Pressure @ 100% Load	kPa (psi)		430-676 (62.4-98)	430-676 (62.4-98)
Flow Rate, supply	Lpm (gpm)		78.5 (20.7)	80.0 (21.1)
Flow Rate, return	Lpm (gpm)		55.0 (14.5)	55.0 (14.5)
BSFC (with pumps ± 3%) ³				
@ 100% Load	g/bkW-hr (lb/bhp-hr)		209.1 (0.344)	209.9 (0.345)
BSFC (with pumps +5%/-0%) ³				
@ 100% Load	g/bkW-hr (lb/bhp-hr)		205.1 (0.337)	205.9 (0.339)

TECHNICAL DATA			Engine: 3616 Vee Rating: Fast Vessel Fuel: MDO			
			Engine Speed Ratings			
Units			1000		1020	
Lubricating Oil System						
Manifold Pressure, minimum	kPa	(psi)	380	(55)	430	(62)
Manifold Pressure, alarm (650-1000 rpm)	kPa	(psi)	320	(46)	320	(46)
Manifold Pressure, alarm (0-650 rpm)	kPa	(psi)	120	(17)	120	(17)
Manifold Pressure, stop (650-1000 rpm)	kPa	(psi)	260	(38)	260	(38)
Manifold Pressure, stop (0-650 rpm)	kPa	(psi)	105	(15)	105	(15)
Manifold Temperature, alarm	°C	(°F)	92	(198)	82	(180)
Manifold Temperature, stop	°C	(°F)	98	(208)	88	(190)
Manifold Temperature, nominal	°C	(°F)	85	(185)	75	(167)
Prelube Pump Capacity, intermittent	Lpm	(gpm)	76	(20)	76	(20)
Prelube Pump Capacity, continuous	Lpm	(gpm)	23	(6)	23	(6)
Sump Capacity (marine)	L	(gal)	1060	(280)	1060	(280)
BSOC @ 100% Load, typical	g/bkW-hr	(lb/bhp-hr)	0.70	(0.0012)	0.80	(0.0013)
Lube Oil Filter Differential Pressure, maximum	kPa	(psi)	104	(15)	104	(15)
Lube Oil Flow	Lpm	(gpm)	1117	(295)	1117	(295)
Cooling Water System — Block Cooling						
Inlet Temperature, nominal	°C	(°F)	90	(194)	90	(194)
Inlet Temperature, maximum	°C	(°F)	95	(203)	95	(203)
Inlet Temperature, minimum	°C	(°F)	83	(181)	83	(181)
Outlet Temp before Regulator, maximum	°C	(°F)	99	(210)	99	(210)
Pump Rise (Delta P) @ 85°C (185°F)	kPa	(psi)	295	(42.8)	300	(43.5)
Pump Capacity	Lpm	(gpm)	2920	(771)	2920	(771)
Pump Inlet Pressure, minimum	kPa	(psi)	30	(4.4)	30	(4.4)
Outlet Temperature, alarm	°C	(°F)	100	(212)	100	(212)
Outlet Temperature, stop	°C	(°F)	104	(219)	104	(219)
Cooling Water System — AC/OC Cooling						
Inlet Temperature, nominal	°C	(°F)	32	(90)	32	(90)
Inlet Temperature, maximum	°C	(°F)	38	(100)	38	(100)
Pump Rise (Delta P) @ 32°C (90°F)	kPa	(psi)	305	(44.2)	315	(45.7)
Pump Capacity	Lpm	(gpm)	1730	(457)	1730	(457)
Pump Inlet Pressure, minimum	kPa	(in. Hg)	-5	(-1.48)	-5	(-1.48)
Starting Air System						
Air Pressure, nominal	kPa	(psi)	1225	(178)	1225	(178)
Air Pressure, minimum	kPa	(psi)	620	(90)	690	(100)
Air Pressure, maximum	kPa	(psi)	1575	(228)	1575	(228)
Low Air Pressure, alarm	kPa	(psi)	850	(123)	875	(127)
Tolerances						
Power	±3%	Specific Fuel Consumption	±3%			
Heat Rejection	±10%	Exhaust Stack Temperature	±8%			
Charge Air Pressure	±10%	Fuel Rate	±5%			
Exhaust Flow	±6%	Inlet Air Flow	±5%			
Notes						
¹ Ratings are based on ISO 3046/1 and SAE J1995 Jan 90 standard reference conditions of 100 kPa, 25°C, and 30% relative humidity at the stated aftercooler water temperature.						
² Exhaust heat rejection is based on fuel LHV and is not normally recoverable in total.						
³ Performance and fuel consumption are based on 35 API, 16°C fuel having a lower heating value of 42,780 kJ/kg used at 29°C with a density of 838.9 g/liter.						
⁴ Air flows are shown for 25°C air inlet to the turbocharger and 32°C cooling water to the charge air cooler.						

3612 AND 3616 MARINE PROJECT GUIDE

3612 Engine Performance @ 900 rpm

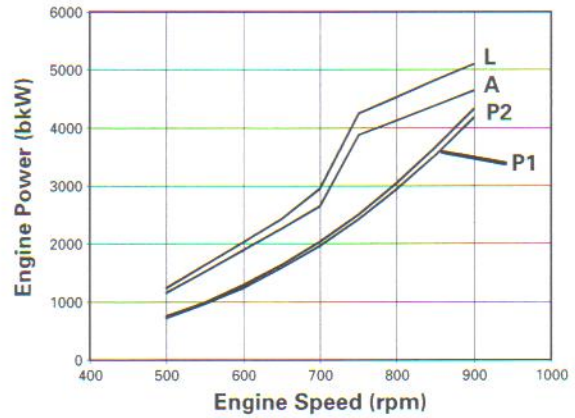


Zone Limit Data

	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Curve A	900	3460	203	835.2	242	333.7	540	703.5
	850	3268	203	788.9	222	301.4	552	655.0
	800	3076	202	738.8	202	269.0	564	602.4
	750	2884	204	699.6	181	236.7	570	571.8
	700	1974	209	490.6	114	207.7	574	509.4
	650	1682	212	424.1	73	129.4	574	321.0
	600	1408	216	361.7	58	109.0	542	261.4
	550	1134	220	296.7	42	88.5	509	205.4
	500	860	224	229.1	25	69.8	476	156.1
	400							
Curve L	900	3800	204	921.8	273	362.7	556	769.7
	850	3588	203	866.1	254	328.6	565	715.4
	800	3378	202	811.4	233	294.6	573	656.7
	750	3166	204	768.0	207	258.8	579	622.8
	700	2200	208	544.2	127	217.9	591	541.7
	650	1800	211	451.7	81	136.2	591	342.2
	600	1506	215	385.1	64	115.8	561	282.8
	550	1212	219	315.7	46	95.3	530	226.2
	500	920	223	244.0	28	73.2	498	168.4
	400							

Propeller Demand Data

	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Optimum Load (Curve P1)	900	3114	204	755.4	208	301.4	530	639.3
	850	2623	205	639.5	164	248.6	531	544.9
	800	2187	207	538.4	119	195.8	531	443.6
	750	1802	210	450.0	87	160.0	535	373.4
	700	1465	213	371.1	60	125.1	518	290.8
	650	1173	216	301.3	41	102.7	486	231.4
	600	923	223	244.7	29	88.5	440	188.0
	550	711	230	194.4	18	74.9	392	149.4
	500	534	233	148.0	12	61.3	346	114.2
	400							
Optimum Load (Curve P2)	900	3230	204	783.5	212	311.6	533	659.0
	850	2721	205	663.3	169	257.1	534	562.7
	800	2269	206	555.7	126	202.6	536	459.0
	750	1869	209	464.6	99	159.5	540	373.7
	700	1520	212	383.2	69	132.1	518	305.5
	650	1217	215	311.1	43	104.5	495	238.5
	600	957	222	252.7	28	90.2	448	193.8
	550	737	229	200.8	18	74.9	400	151.1
	500	554	232	152.8	12	61.3	354	115.5
	400							



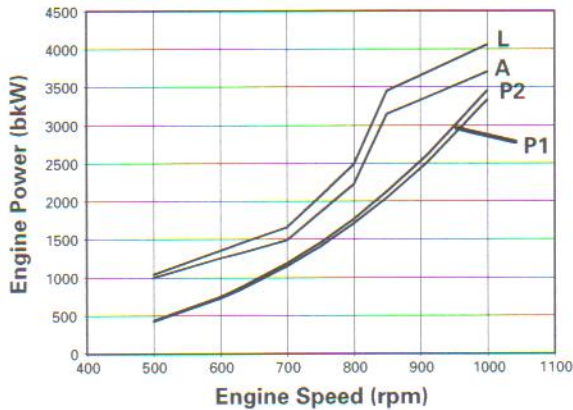
Zone Limit Data

	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Curve A	900	4640	0.333	220.5	72	11,786	1,004	24,845
	850	4382	0.333	208.3	66	10,644	1,025	23,131
	800	4125	0.332	195.1	60	9,501	1,046	21,272
	750	3867	0.335	184.7	54	8,358	1,057	20,193
	700	2647	0.343	129.5	34	7,336	1,066	17,988
	650	2256	0.348	112.0	22	4,570	1,066	11,338
	600	1888	0.355	95.5	17	3,848	1,007	9,233
	550	1521	0.361	78.3	12	3,126	948	7,255
	500	1153	0.368	60.5	7	2,465	890	5,511
	400							
Curve L	900	5096	0.335	243.4	81	12,809	1,032	27,181
	850	4812	0.333	228.7	75	11,606	1,048	25,265
	800	4530	0.332	214.2	69	10,403	1,064	23,192
	750	4246	0.335	202.8	61	9,140	1,075	21,995
	700	2950	0.342	143.7	38	7,697	1,096	19,130
	650	2414	0.347	119.3	24	4,810	1,096	12,083
	600	2020	0.353	101.7	19	4,088	1,041	9,987
	550	1625	0.360	83.3	14	3,367	986	7,988
	500	1234	0.366	64.4	8	2,585	929	5,946
	400							

Propeller Demand Data

	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Optimum Load (Curve P1)	900	4176	0.335	199.4	62	10,644	986	22,577
	850	3518	0.337	168.8	49	8,779	988	19,243
	800	2933	0.340	142.1	35	6,915	988	15,665
	750	2417	0.345	118.8	26	5,652	995	13,186
	700	1965	0.350	98.0	18	4,419	964	10,269
	650	1573	0.355	79.6	12	3,625	907	8,171
	600	1237	0.366	64.6	9	3,126	824	6,641
	550	953	0.378	51.3	5	2,645	738	5,277
	500	716	0.383	39.1	4	2,164	654	4,032
	400							
Optimum Load (Curve P2)	900	4331	0.335	206.9	63	11,005	991	23,273
	850	3649	0.337	175.1	50	9,080	993	19,873
	800	3042	0.338	146.7	37	7,156	997	16,209
	750	2507	0.343	122.7	29	5,634	1,004	13,196
	700	2038	0.348	101.2	21	4,666	964	10,788
	650	1632	0.353	82.1	13	3,692	923	8,421
	600	1283	0.365	66.7	8	3,186	838	6,845
	550	989	0.376	53.0	5	2,645	752	5,335
	500	743	0.381	40.4	4	2,164	669	4,078
	400							

3612 Engine Performance @ 1000 rpm

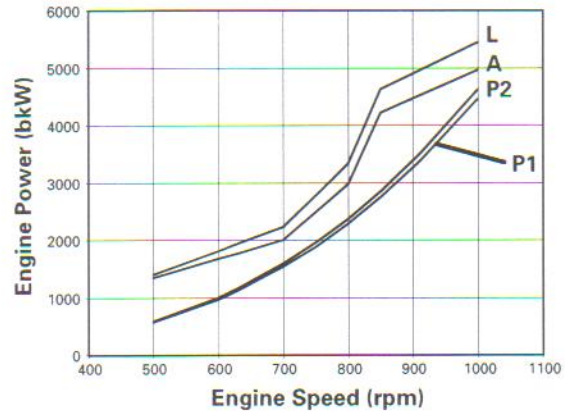


Zone Limit Data

	Engine Speed rpm	Power b kW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Curve A	1000	3700	208	917.4	236	371.1	517	790.5
	910	3366	202	811.8	206	322.2	517	707.2
	850	3144	200	751.5	184	285.1	529	645.7
	800	2220	202	535.4	103	198.1	509	464.9
	750	1856	204	451.3	76	165.4	489	390.3
	700	1490	206	365.5	49	132.5	469	314.7
	630	1318	203	318.9	39	115.3	458	276.4
	600	1246	201	298.5	34	108.0	453	260.0
	500	1000	196	233.5	18	83.3	437	203.0
	500	1000	196	233.5	18	83.3	437	203.0
Curve L	1000	4060	210	1014.4	263	402.9	540	870.5
	910	3694	203	893.9	236	351.8	534	767.4
	850	3451	200	823.9	211	312.8	540	701.7
	800	2480	201	592.7	122	216.8	525	513.7
	750	2070	203	500.9	92	180.5	510	433.4
	700	1660	204	404.5	61	143.6	495	349.1
	630	1444	201	346.0	46	122.8	478	301.0
	600	1350	199	320.7	40	113.9	471	280.1
	500	1040	194	239.9	19	84.3	449	209.7
	500	1040	194	239.9	19	84.3	449	209.7

Propeller Demand Data

	Engine Speed rpm	Power b kW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Optimum Load (Curve P1)	1000	3330	210	832.0	206	337.5	501	719.2
	910	2509	205	613.9	127	243.4	476	532.9
	850	2045	202	493.2	127	194.1	502	443.7
	800	1705	207	421.2	65	161.3	462	370.0
	750	1405	207	347.2	53	145.9	459	344.6
	700	1142	212	288.0	31	117.8	415	263.1
	630	833	214	212.7	18	94.2	350	192.7
	600	719	219	187.8	14	84.3	334	167.2
	500	416	236	117.0	3	51.1	282	90.8
	500	416	236	117.0	3	51.1	282	90.8
Optimum Load (Curve P2)	1000	3452	208	857.5	216	348.6	506	742.8
	910	2601	205	634.9	142	257.7	483	563.0
	850	2120	205	518.0	94	199.8	487	454.8
	800	1767	206	434.9	70	165.5	469	381.4
	750	1456	208	361.3	49	142.2	450	335.5
	700	1184	211	297.7	33	119.5	422	269.0
	630	863	213	219.5	19	95.5	358	197.9
	600	746	218	193.8	15	84.8	341	170.3
	500	432	234	120.5	4	49.4	285	88.6
	500	432	234	120.5	4	49.4	285	88.6



Zone Limit Data

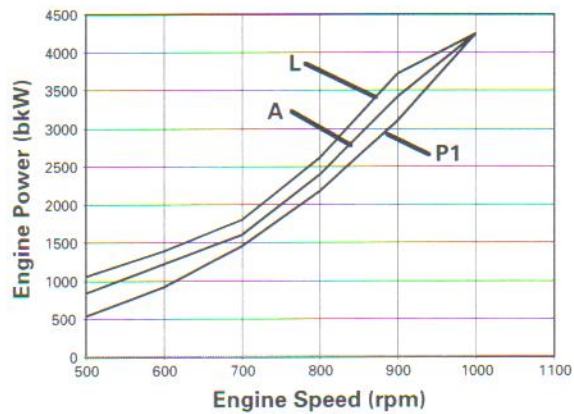
	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Curve A	1000	4962	0.342	242.2	70	13,104	963	27,915
	910	4514	0.333	214.3	61	11,378	963	24,977
	850	4217	0.330	198.4	55	10,067	985	22,804
	800	2977	0.333	141.3	31	6,994	949	16,416
	750	2489	0.336	119.2	23	5,840	913	13,783
	700	1998	0.339	96.5	15	4,679	877	11,112
	630	1767	0.334	84.2	11	4,071	856	9,762
	600	1671	0.331	78.8	10	3,815	847	9,181
	500	1341	0.323	61.7	5	2,941	818	7,169
	500	1341	0.323	61.7	5	2,941	818	7,169
Curve L	1000	5444	0.345	267.8	78	14,229	1,003	30,743
	910	4954	0.334	236.0	70	12,425	993	27,101
	850	4627	0.330	217.5	63	11,048	1,003	24,780
	800	3326	0.330	156.5	36	7,656	977	18,142
	750	2776	0.334	132.3	27	6,375	950	15,307
	700	2226	0.337	106.8	18	5,070	923	12,329
	630	1936	0.331	91.3	14	4,336	893	10,631
	600	1810	0.328	84.7	12	4,023	881	9,890
	500	1395	0.319	63.3	6	2,977	840	7,404
	500	1395	0.319	63.3	6	2,977	840	7,404

Propeller Demand Data

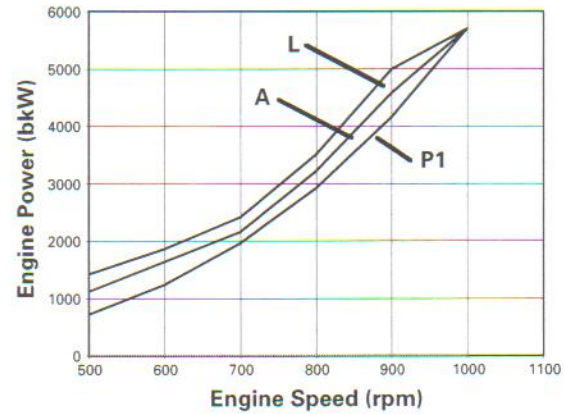
	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Optimum Load (Curve P1)	1000	4466	0.345	219.7	61	11,917	934	25,400
	910	3365	0.338	162.1	38	8,594	888	18,821
	850	2742	0.333	130.2	38	6,854	936	15,670
	800	2286	0.341	111.2	19	5,695	863	13,065
	750	1884	0.341	91.7	19	5,154	858	12,171
	700	1532	0.348	76.0	9	4,162	780	9,290
	630	1117	0.353	56.2	5	3,326	662	6,804
	600	965	0.361	49.6	4	2,977	633	5,905
	500	558	0.388	30.9	1	1,804	540	3,208
	500	558	0.388	30.9	1	1,804	540	3,208
Optimum Load (Curve P2)	1000	4629	0.343	226.4	64	12,311	944	26,233
	910	3488	0.337	167.6	42	9,099	902	19,883
	850	2843	0.338	136.8	28	7,054	909	16,061
	800	2370	0.340	114.8	21	5,846	875	13,470
	750	1953	0.343	95.4	14	5,022	842	11,849
	700	1588	0.347	78.6	10	4,222	792	9,498
	630	1158	0.351	57.9	6	3,374	676	6,990
	600	1000	0.359	51.2	5	2,995	645	6,013
	500	579	0.386	31.8	1	1,744	545	3,128
	500	579	0.386	31.8	1	1,744	545	3,128

3612 AND 3616 MARINE PROJECT GUIDE

3612 Fast Vessel Engine Performance



		Zone Limit Data						
	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
					Press kPa Gauge			
CONT	1000	4250	212	1076.4	273	398.0	612	934.7
	900	3410	204	829.8	193	290.9	601	701.9
	800	2392	208	593.0	102	182.6	621	548.5
	700	1603	213	406.4	48	115.7	605	302.5
	600	1219	217	315.8	29	84.7	584	218.3
	500	831	221	218.7	14	59.9	519	143.4
INT	1000	4250	212	1074.0	273	398.0	612	934.6
	900	3717	205	907.6	223	318.8	608	765.7
	800	2610	207	643.9	119	198.5	631	515.2
	700	1800	212	455.5	60	126.5	633	340.1
	600	1385	219	361.0	39	92.7	629	251.4
	500	1054	226	283.8	26	69.0	609	184.1

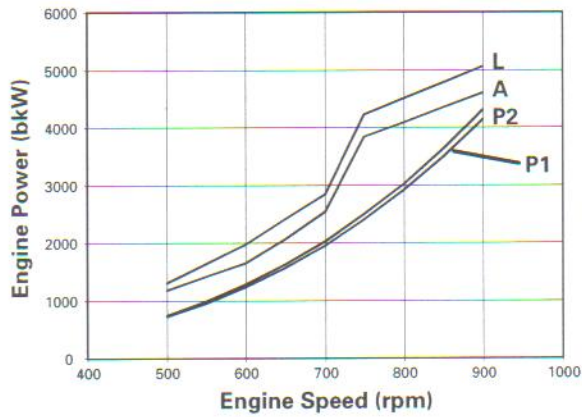


		Zone Limit Data						
	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
					Press in. Hg Gauge			
CONT	1000	5699	0.350	284.2	81	14,056	1,134	33,008
	900	4573	0.336	219.1	57	10,274	1,114	24,787
	800	3208	0.342	156.6	30	6,449	1,150	19,370
	700	2150	0.350	107.3	14	4,085	1,120	10,683
	600	1635	0.358	83.4	9	2,991	1,083	7,709
	500	1114	0.363	57.7	4	2,117	966	5,065
INT	1000	5699	0.349	283.6	81	14,056	1,134	33,006
	900	4984	0.337	239.6	66	11,258	1,126	27,041
	800	3500	0.341	170.0	35	7,010	1,167	18,193
	700	2414	0.350	120.3	18	4,468	1,172	12,011
	600	1857	0.360	95.3	11	3,273	1,164	8,877
	500	1413	0.372	74.9	8	2,435	1,128	6,501

		Propeller Demand Data						
Optimum Load	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
					Press kPa Gauge			
	1000	4250	212	1074.0	273	398.0	612	934.6
	900	3098	205	756.3	164	263.5	595	639.9
	800	2176	209	542.1	86	167.5	609	430.9
	700	1458	213	370.1	39	108.2	579	275.0
	600	918	217	237.0	15	72.8	482	167.7
	500	531	223	141.2	3	51.5	392	105.0

		Propeller Demand Data						
Optimum Load	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
					Press in. Hg Gauge			
	1000	5699	0.349	283.6	81	14,056	1,134	33,006
	900	4155	0.337	199.7	49	9,306	1,103	22,599
	800	2918	0.344	143.1	25	5,914	1,128	15,217
	700	1965	0.351	97.7	12	3,819	1,074	9,711
	600	1231	0.357	62.6	4	2,572	900	5,922
	500	712	0.367	37.3	1	1,820	738	3,708

3616 Engine Performance @ 900 rpm

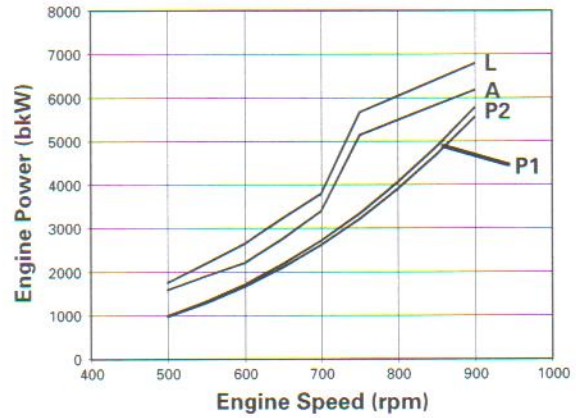


Zone Limit Data

	Engine Speed rpm	Power kW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Curve A	900	4600	203	1110.4	245	465.7	520	969.2
	850	4344	200	1036.5	227	428.1	526	908.6
	800	4089	198	964.1	209	390.5	532	845.0
	750	3833	195	893.1	191	352.9	538	778.4
	700	2532	205	617.4	122	211.4	555	508.7
	650	2058	211	516.6	57	163.3	574	410.3
	600	1645	218	426.7	36	127.8	574	327.4
	550	1409	224	376.6	26	100.8	568	258.1
	500	1174	231	322.8	16	73.8	561	189.5
	400							
Curve L	900	5060	204	1227.5	272	497.8	545	1059.7
	850	4779	201	1145.9	255	460.9	547	992.1
	800	4498	199	1065.9	238	424.1	549	922.9
	750	4217	196	987.5	220	387.3	550	852.0
	700	2833	203	683.9	109	236.2	563	565.2
	650	2408	208	595.6	77	189.2	591	478.4
	600	1972	216	506.8	52	147.1	614	388.7
	550	1636	224	437.1	37	119.4	614	318.7
	500	1300	233	360.5	22	91.7	614	247.4
	400							

Propeller Demand Data

	Engine Speed rpm	Power kW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Optimum Load (Curve P1)	900	4140	202	994.4	215	430.4	502	885.2
	850	3488	198	825.1	172	358.2	491	747.1
	800	2908	196	680.9	127	284.8	497	619.0
	750	2396	193	552.4	87	220.9	507	500.8
	700	1948	210	486.6	54	167.9	527	399.0
	650	1560	215	399.0	32	131.2	520	313.6
	600	1227	221	322.6	19	105.7	497	247.4
	550	945	229	257.6	11	83.5	461	187.9
	500	710	234	197.8	6	66.7	406	139.0
	400							
Optimum Load (Curve P2)	900	4301	202	1033.1	228	443.6	508	916.9
	850	3623	198	857.2	182	370.4	497	772.7
	800	3021	196	707.4	135	295.7	500	640.6
	750	2489	193	573.9	93	229.3	509	518.5
	700	2024	209	503.1	58	173.0	534	413.5
	650	1620	214	412.5	34	134.7	529	325.1
	600	1274	221	335.2	21	108.1	507	256.4
	550	982	228	266.4	12	84.9	473	195.0
	500	737	231	202.8	6	67.5	417	142.8
	400							



Zone Limit Data

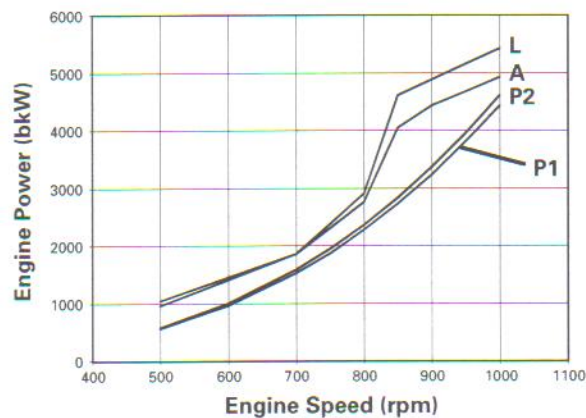
	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Curve A	900	6169	0.333	293.2	73	16,446	969	34,229
	850	5826	0.330	273.7	67	15,118	979	32,087
	800	5483	0.326	254.5	62	13,789	990	29,840
	750	5141	0.322	235.8	57	12,461	1,001	27,490
	700	3396	0.337	163.0	36	7,465	1,031	17,966
	650	2760	0.347	136.4	17	5,767	1,065	14,490
	600	2206	0.358	112.7	11	4,515	1,065	11,561
	550	1890	0.369	99.4	8	3,560	1,054	9,116
	500	1574	0.380	85.2	5	2,607	1,042	6,692
	400							
Curve L	900	6785	0.335	324.1	81	17,578	1,013	37,425
	850	6408	0.331	302.6	75	16,278	1,016	35,037
	800	6032	0.327	281.4	70	14,978	1,019	32,593
	750	5654	0.323	260.7	65	13,677	1,022	30,089
	700	3799	0.333	180.6	32	8,341	1,046	19,959
	650	3229	0.342	157.3	23	6,681	1,096	16,894
	600	2644	0.355	133.8	15	5,194	1,137	13,729
	550	2194	0.369	115.4	11	4,217	1,137	11,256
	500	1743	0.383	95.2	7	3,239	1,137	8,737
	400							

Propeller Demand Data

	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Optimum Load (Curve P1)	900	5552	0.332	262.6	64	15,200	935	31,261
	850	4677	0.327	217.9	51	12,649	915	26,384
	800	3899	0.323	179.8	38	10,059	926	21,859
	750	3213	0.318	145.9	26	7,799	945	17,685
	700	2612	0.345	128.5	16	5,930	981	14,092
	650	2091	0.353	105.3	9	4,633	969	11,074
	600	1645	0.363	85.2	6	3,732	926	8,738
	550	1267	0.377	68.0	3	2,950	861	6,636
	500	952	0.385	52.2	2	2,354	763	4,908
	400							
Optimum Load (Curve P2)	900	5768	0.332	272.8	67	15,667	947	32,381
	850	4859	0.327	226.3	54	13,081	926	27,289
	800	4051	0.323	186.8	40	10,442	831	22,623
	750	3338	0.318	151.5	28	8,098	949	18,310
	700	2714	0.343	132.8	17	6,110	994	14,603
	650	2173	0.352	108.9	10	4,756	985	11,481
	600	1709	0.363	88.5	6	3,817	944	9,054
	550	1316	0.375	70.3	4	2,998	883	6,887
	500	989	0.380	53.6	2	2,383	783	5,042
	400							

3612 AND 3616 MARINE PROJECT GUIDE

3616 Engine Performance @ 1000 rpm

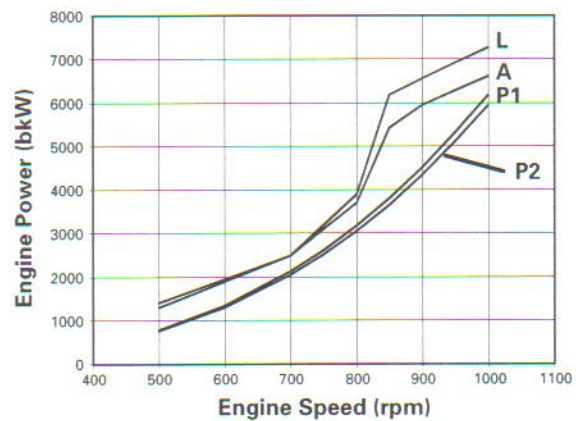


Zone Limit Data

	Engine Speed rpm	Power b kW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Curve A	1000	4920	201	1199.5	228	465.4	547	1030.2
	950	4674	203	1128.3	212	427.9	547	960.5
	900	4428	199	1052.9	195	390.4	547	888.4
	850	4038	202	969.9	157	332.4	569	804.4
	800	2758	208	682.3	77	208.0	593	533.5
	750	2304	215	589.4	54	168.8	604	444.1
	700	1850	221	486.6	31	129.6	614	349.7
	600	1404	234	391.2	19	97.2	594	258.3
	500	958	247	281.9	7	64.8	574	169.7
	1000	5420	208	1340.9	274	501.2	578	1137.0
Curve L	950	5150	205	1255.6	251	465.4	570	1059.1
	900	4878	200	1165.8	228	429.6	562	979.2
	850	4608	203	1112.4	172	375.0	571	909.3
	800	2900	207	714.0	84	218.2	596	560.4
	750	2376	216	610.7	58	173.9	609	458.2
	700	1850	221	486.6	31	129.6	614	349.7
	600	1444	235	404.1	20	98.0	614	266.8
	500	1038	249	307.9	9	66.5	614	182.8

Propeller Demand Data

	Engine Speed rpm	Power b kW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Optimum Load (Curve P1)	1000	4428	205	1079.5	215	421.6	531	927.5
	950	3796	205	925.6	164	350.6	536	797.5
	900	3228	205	787.0	112	279.7	541	657.7
	850	2719	209	676.0	82	227.7	557	556.7
	800	2267	212	571.8	51	175.6	573	445.7
	750	1868	218	484.6	34	144.9	574	368.6
	700	1519	223	403.1	20	115.1	557	290.6
	600	956	229	260.7	7	86.9	454	193.7
	500	554	235	154.9	1	58.8	350	113.7
Optimum Load (Curve P2)	1000	4607	205	1123.2	207	437.6	537	964.3
	950	3950	205	963.0	164	364.8	538	828.5
	900	3359	204	814.8	121	291.5	540	682.4
	850	2829	208	700.0	87	236.9	561	579.9
	800	2359	211	592.1	54	180.7	581	461.7
	750	1944	217	501.9	36	150.0	584	386.1
	700	1580	223	419.4	22	117.6	568	301.2
	600	995	229	271.3	8	88.6	475	200.5
	500	576	235	161.1	1	59.0	361	116.0



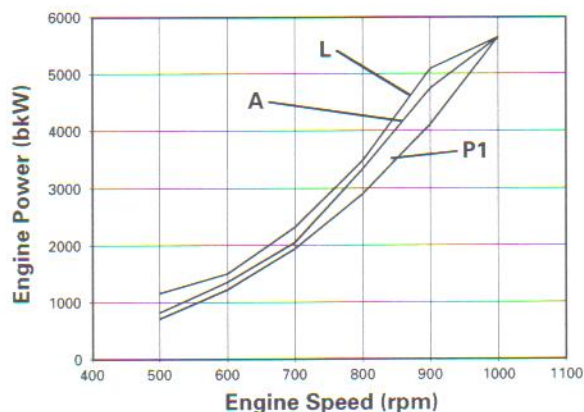
Zone Limit Data

	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Curve A	1000	6598	0.337	316.7	68	16,434	1,017	36,382
	950	6268	0.333	297.9	63	15,110	1,017	33,919
	900	5938	0.328	278.0	58	13,786	1,017	31,375
	850	5415	0.332	256.1	47	11,739	1,056	28,407
	800	3698	0.342	180.2	23	7,344	1,099	18,842
	750	3090	0.353	155.6	16	5,960	1,119	15,682
	700	2481	0.363	128.5	9	4,575	1,137	12,348
	600	1883	0.385	103.3	6	3,431	1,101	9,124
	500	1285	0.406	74.4	2	2,288	1,065	5,994
Curve L	1000	7268	0.342	354.0	81	17,699	1,072	40,154
	950	6906	0.337	331.5	75	16,434	1,058	37,403
	900	6541	0.330	307.8	68	15,170	1,044	34,582
	850	6179	0.333	293.7	51	13,244	1,060	32,110
	800	3889	0.340	188.5	25	7,706	1,105	19,792
	750	3186	0.355	161.2	17	6,140	1,128	16,181
	700	2481	0.363	128.5	9	4,575	1,137	12,348
	600	1936	0.386	106.7	6	3,461	1,137	9,422
	500	1392	0.410	81.3	3	2,348	1,137	6,454

Propeller Demand Data

	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Optimum Load (Curve P1)	1000	5938	0.337	285.0	64	14,887	988	32,755
	950	5091	0.337	244.4	49	12,383	997	28,164
	900	4329	0.337	207.8	33	9,879	1,006	23,227
	850	3647	0.343	178.5	24	8,043	1,035	19,659
	800	3040	0.348	151.0	15	6,201	1,063	15,739
	750	2505	0.358	127.9	10	5,117	1,065	13,018
	700	2037	0.367	106.4	6	4,063	1,035	10,263
	600	1283	0.377	68.8	2	3,070	849	6,839
	500	742	0.386	40.9	0.3	2,077	661	4,014
Optimum Load (Curve P2)	1000	6178	0.337	296.5	61	15,453	999	34,053
	950	5297	0.337	254.3	49	12,883	1,001	29,258
	900	4504	0.335	215.1	36	10,294	1,004	24,097
	850	3794	0.342	184.8	26	8,368	1,042	20,478
	800	3163	0.347	156.3	16	6,381	1,078	16,307
	750	2606	0.357	132.5	11	5,298	1,083	13,636
	700	2119	0.367	110.7	6	4,154	1,055	10,636
	600	1334	0.377	71.6	2	3,130	887	7,082
	500	772	0.386	42.5	0.3	2,083	681	4,096

3616 Engine Performance @ 5650 kW

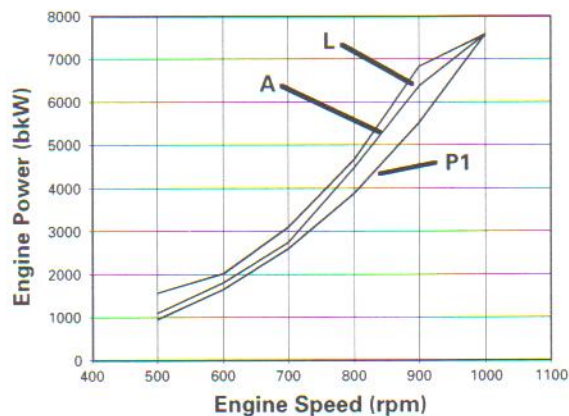


Zone Limit Data

	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Curve A	1000	5650	204	1371.9	289	576.0	543	1242.4
	900	4748	199	1123.5	235	466.8	527	1021.1
	800	3336	201	797.3	127	288.4	560	705.4
	700	2040	212	516.3	44	154.6	615	421.6
	600	1345	219	351.3	18	103.6	565	270.0
	500	814	225	218.7	7	69.2	473	161.1
Curve L	1000	5650	204	1371.9	289	576.0	544	1242.4
	900	5085	199	1207.5	257	496.2	511	897.1
	800	3480	200	828.4	137	301.8	559	733.3
	700	2310	210	580.5	58	172.5	630	475.5
	600	1496	220	393.0	24	110.4	604	300.3
	500	1160	231	319.8	14	79.8	621	221.3

Propeller Demand Data

	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Optimum Load (Curve P1)	1000	5650	204	1371.9	289	576.0	543	1242.4
	900	4119	199	975.1	193	409.1	511	897.1
	800	2893	203	701.0	99	248.8	560	617.9
	700	1938	213	490.9	40	148.5	604	400.8
	600	1220	219	318.7	15	98.4	531	246.2
	500	706	225	189.6	5	66.7	427	145.8



Zone Limit Data

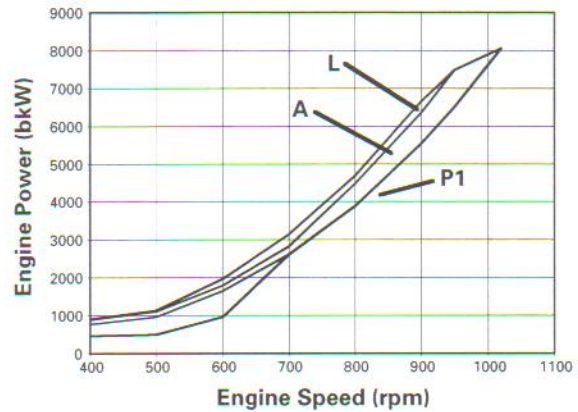
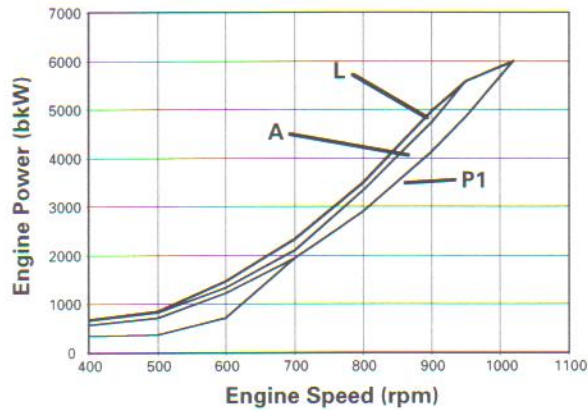
	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Curve A	1000	7577	0.335	362.2	86	20,343	1,010	43,875
	900	6367	0.327	296.6	70	16,486	980	36,059
	800	4474	0.330	210.5	38	10,186	1,040	24,912
	700	2736	0.350	136.3	13	5,460	1,139	14,890
	600	1804	0.361	92.7	5	3,660	1,048	9,534
	500	1092	0.371	57.7	2	2,444	884	5,688
Curve L	1000	7577	0.335	362.2	86	20,343	1,010	43,875
	900	6819	0.328	318.8	76	17,523	1,001	38,496
	800	4667	0.329	218.7	41	10,657	1,038	25,895
	700	3098	0.347	153.3	17	6,091	1,165	16,791
	600	2006	0.363	103.8	7	3,898	1,118	10,604
	500	1556	0.381	84.4	4	2,819	1,149	7,814

Propeller Demand Data

	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Optimum Load (Curve P1)	1000	7577	0.335	362.2	86	20,343	1,010	43,875
	900	5523	0.327	257.4	57	14,448	952	31,680
	800	3879	0.335	185.1	29	8,786	1,040	21,821
	700	2599	0.350	129.6	12	5,245	1,119	14,155
	600	1637	0.361	84.2	4	3,475	988	8,693
	500	947	0.371	50.1	1	2,354	801	5,149

3612 AND 3616 MARINE PROJECT GUIDE

3616 Engine Performance @ 6000 kW



Zone Limit Data

	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
CONT	1020	6000	212	1513.2	323	652.9	540	1366.3
	950	5579	208	1380.3	286	579.6	538	1236.5
	900	4732	206	1159.3	223	509.2	510	1061.8
	800	3327	210	831.1	107	306.4	564	730.6
	700	2102	226	565.5	40	185.0	610	483.9
	600	1327	231	365.0	12	106.4	563	269.8
	500	813	235	227.5	3	70.1	474	157.1
INT	1020	6000	212	1513.2	323	652.9	540	1366.3
	950	5579	208	1380.3	286	579.6	538	1236.5
	900	4960	206	1215.2	242	519.9	514	1142.6
	800	3486	209	866.6	119	325.6	563	773.8
	700	2332	223	619.0	51	202.8	618	532.3
	600	1461	232	403.6	16	115.6	600	300.8
	500	846	234	235.7	4	70.1	491	161.4

Zone Limit Data

	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
CONT	1020	8046	0.348	399.5	96	23,056	1,004	48,250
	950	7481	0.342	364.4	85	20,468	1,001	43,668
	900	6346	0.338	306.1	66	17,982	951	37,496
	800	4462	0.345	219.4	32	10,820	1,047	25,802
	700	2819	0.372	149.3	12	6,535	1,130	17,088
	600	1780	0.380	96.4	3	3,756	1,046	9,529
	500	1090	0.386	60.1	1	2,476	885	5,547
INT	1020	8046	0.348	399.5	96	23,056	1,004	48,250
	950	7481	0.342	364.4	85	20,468	1,001	43,668
	900	6651	0.338	320.8	72	18,359	958	40,350
	800	4675	0.343	228.8	35	11,498	1,046	27,327
	700	3127	0.367	163.4	15	7,162	1,144	18,799
	600	1959	0.382	106.6	5	4,083	1,112	10,622
	500	1134	0.385	62.2	1	2,476	915	5,702

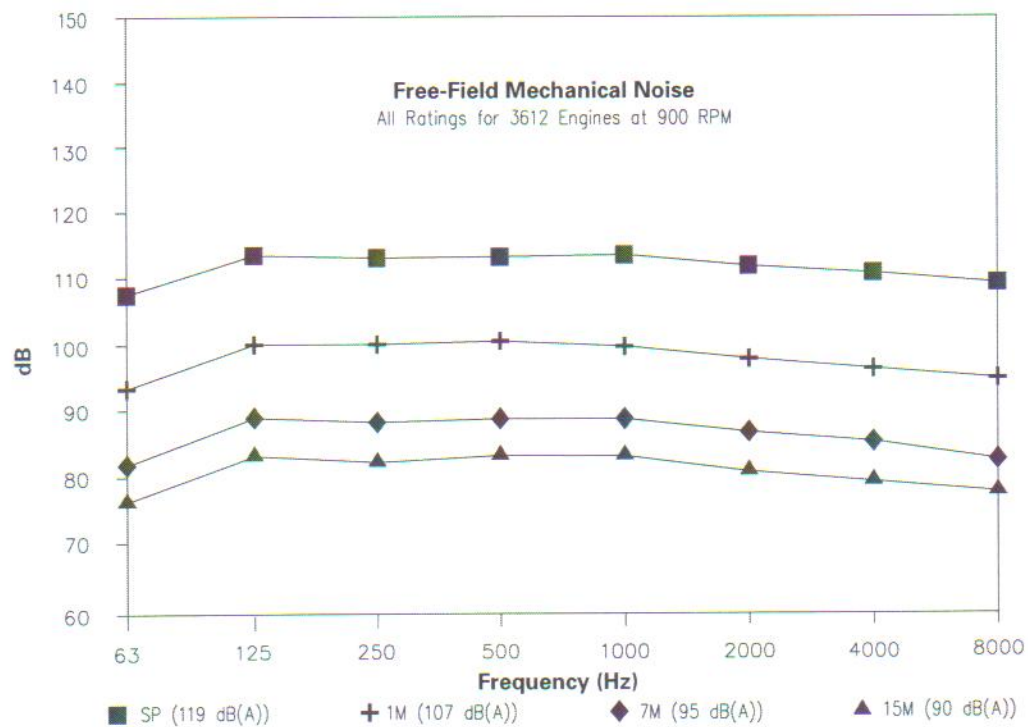
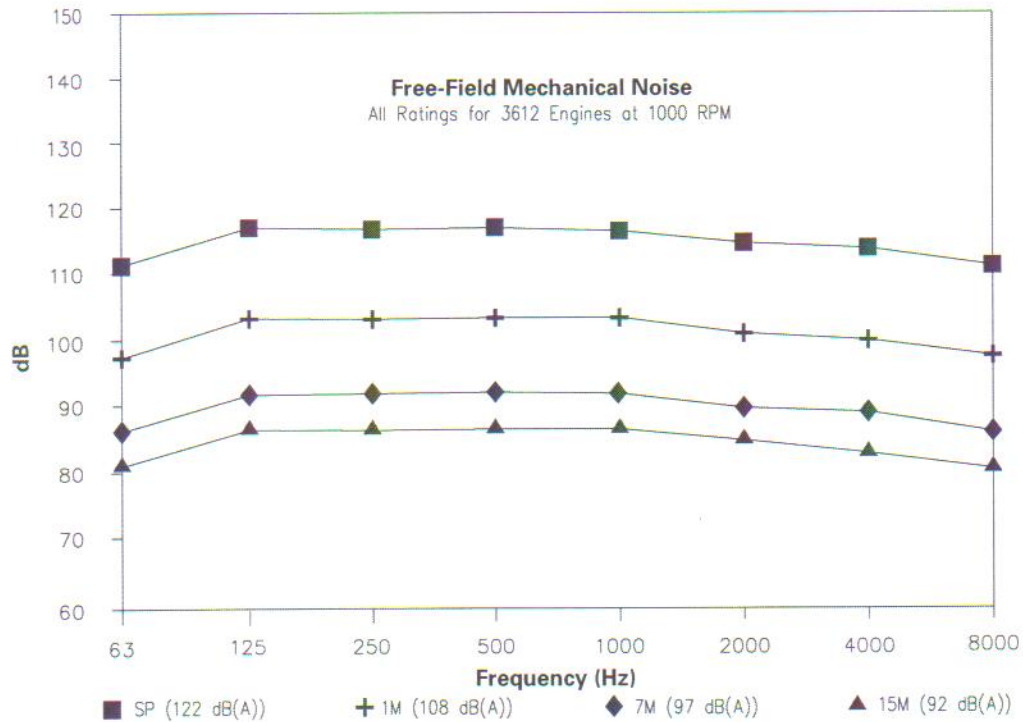
Propeller Demand Data

	Engine Speed rpm	Power bkW	Fuel Cons g/kW-hr	Fuel Rate L/hr	Boost Press kPa Gauge	Air Flow cu m/min	Exh Temp to Turbo °C	Exh Flow cu m/min
Optimum Load	1020	6000	212	1513.2	323	652.9	540	1366.3
	950	4848	207	1193.5	226	511.4	534	1115.5
	900	4122	206	1009.8	173	440.7	509	943.6
	800	2895	212	730.1	81	267.5	564	645.9
	700	1939	226	521.7	33	169.2	596	437.7
	600	1221	230	334.4	10	101.1	538	248.1
	500	707	232	195.2	2	61.9	428	131.6

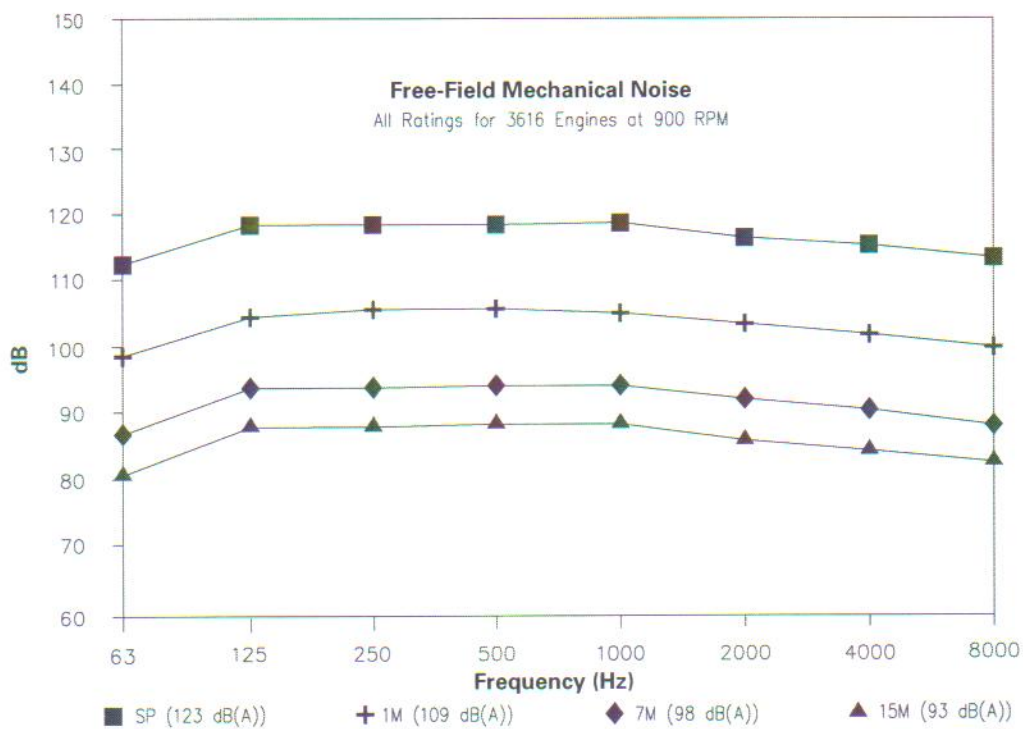
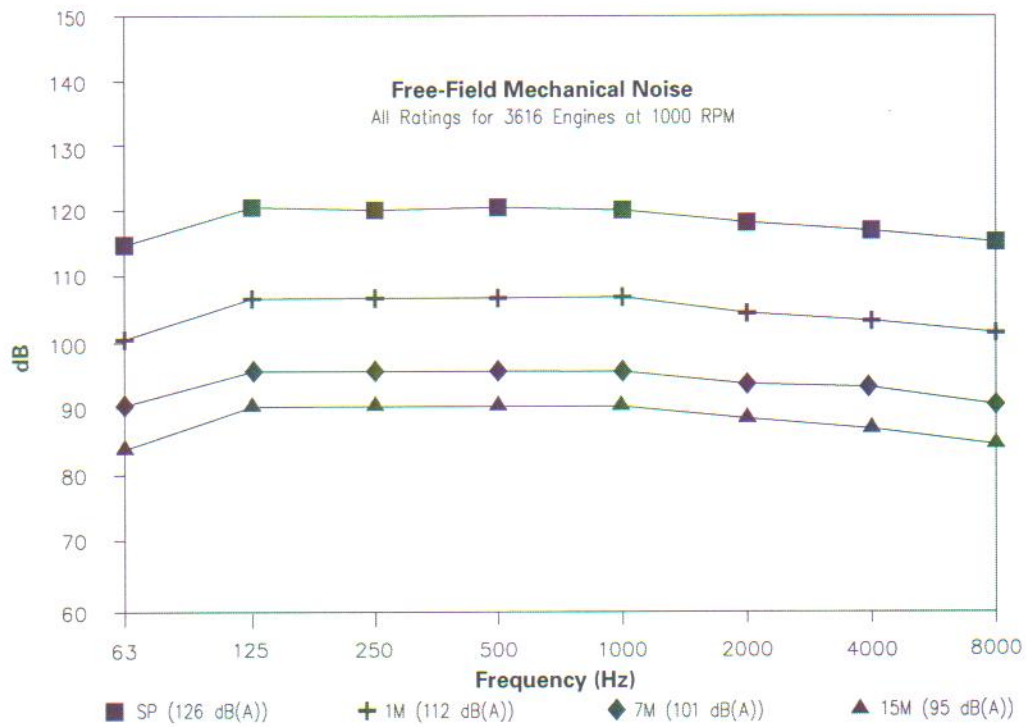
Propeller Demand Data

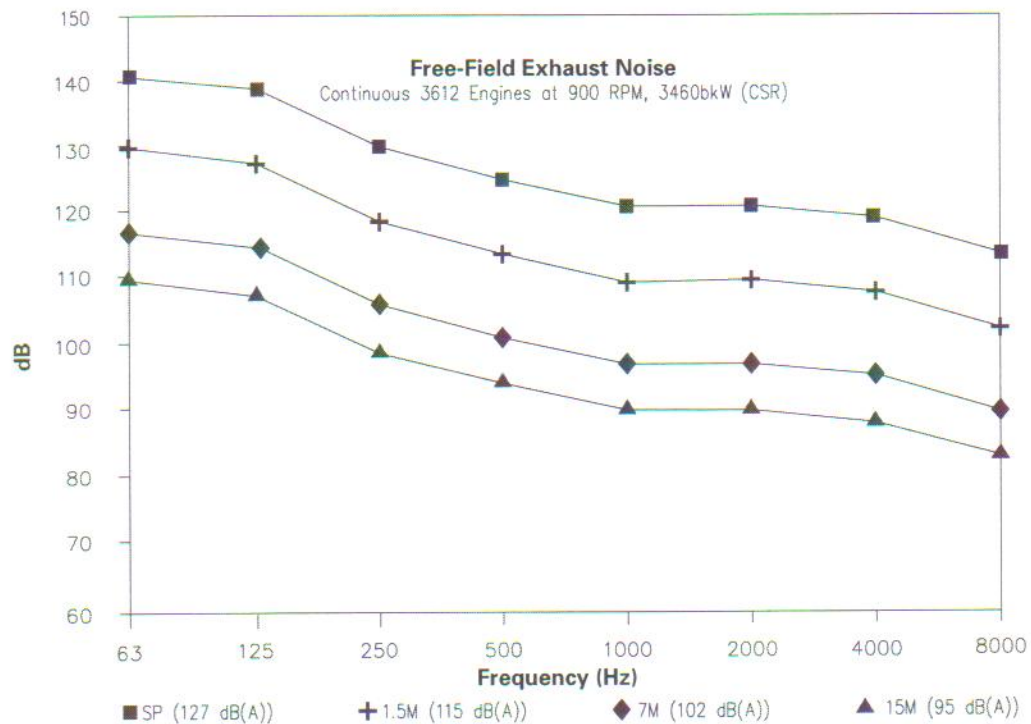
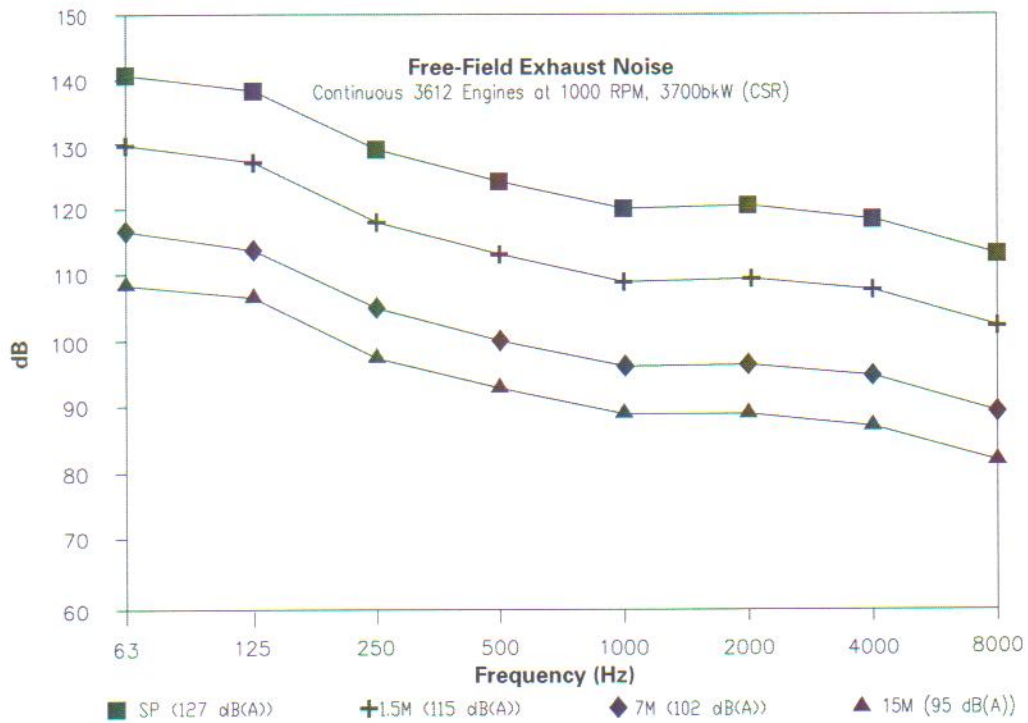
	Engine Speed rpm	Power bhp	Fuel Cons lb/hp-hr	Fuel Rate gal/hr	Boost Press in. Hg Gauge	Air Flow cfm	Exh Temp to Turbo °F	Exh Flow cfm
Optimum Load	1020	8046	0.348	399.5	96	23,056	1,004	48,250
	950	6501	0.340	315.1	67	18,060	994	39,396
	900	5527	0.338	266.6	51	15,563	949	33,323
	800	3882	0.348	192.8	24	9,446	1,047	22,809
	700	2601	0.372	137.7	10	5,977	1,105	15,457
	600	1638	0.378	88.3	3	3,571	1,001	8,671
	500	948	0.382	51.5	1	2,186	803	4,647

Free Field Mechanical and Exhaust Noise

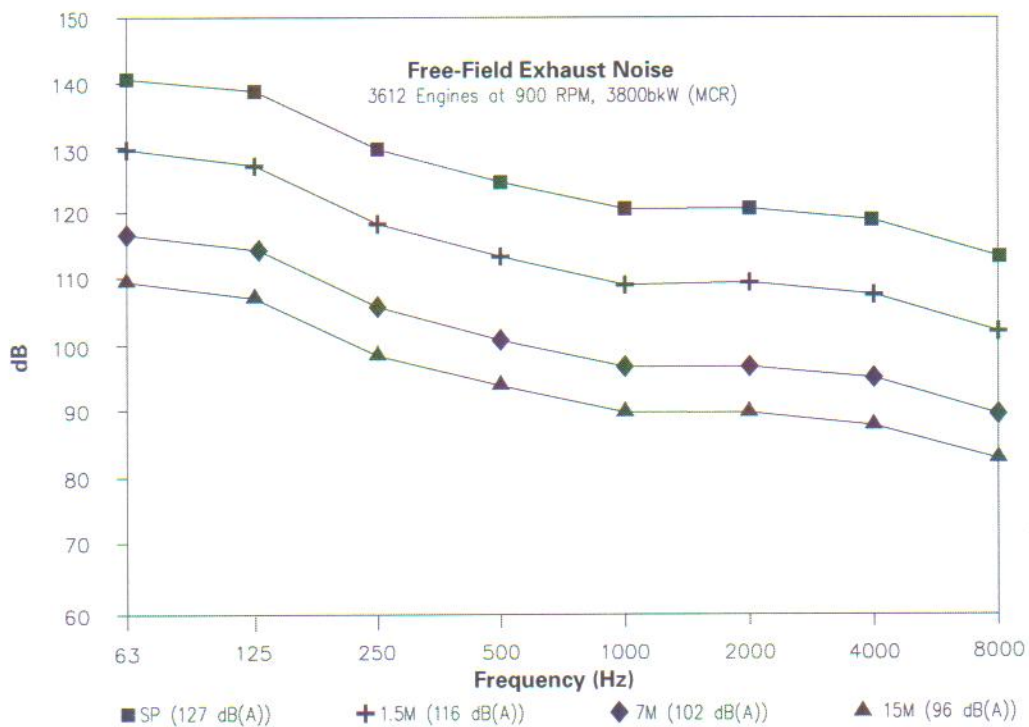
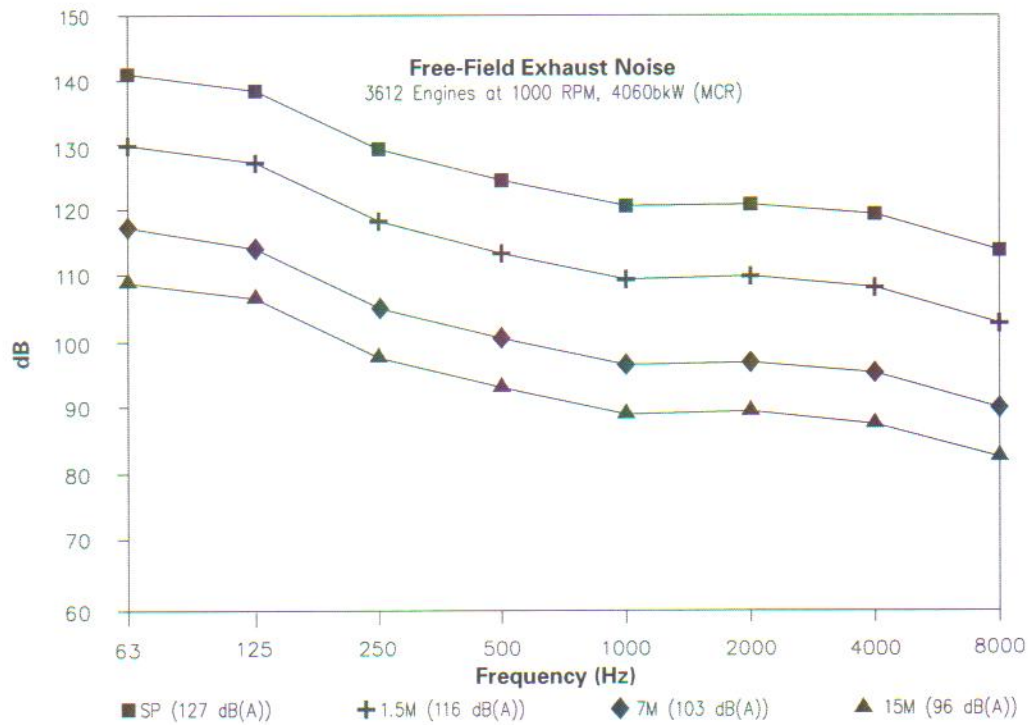


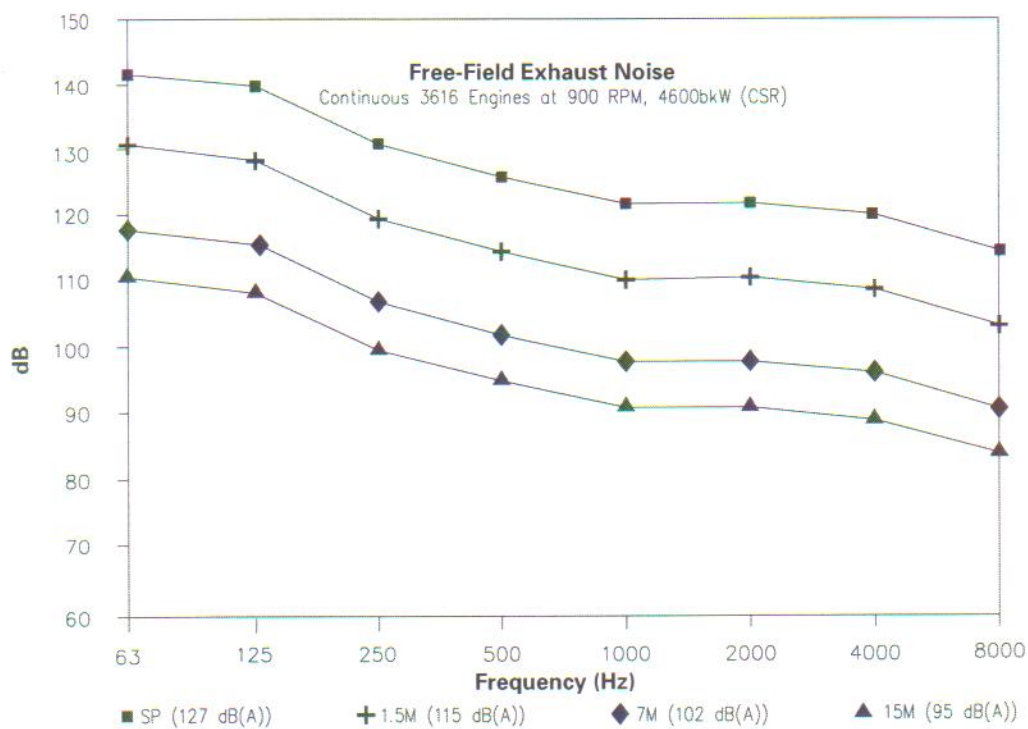
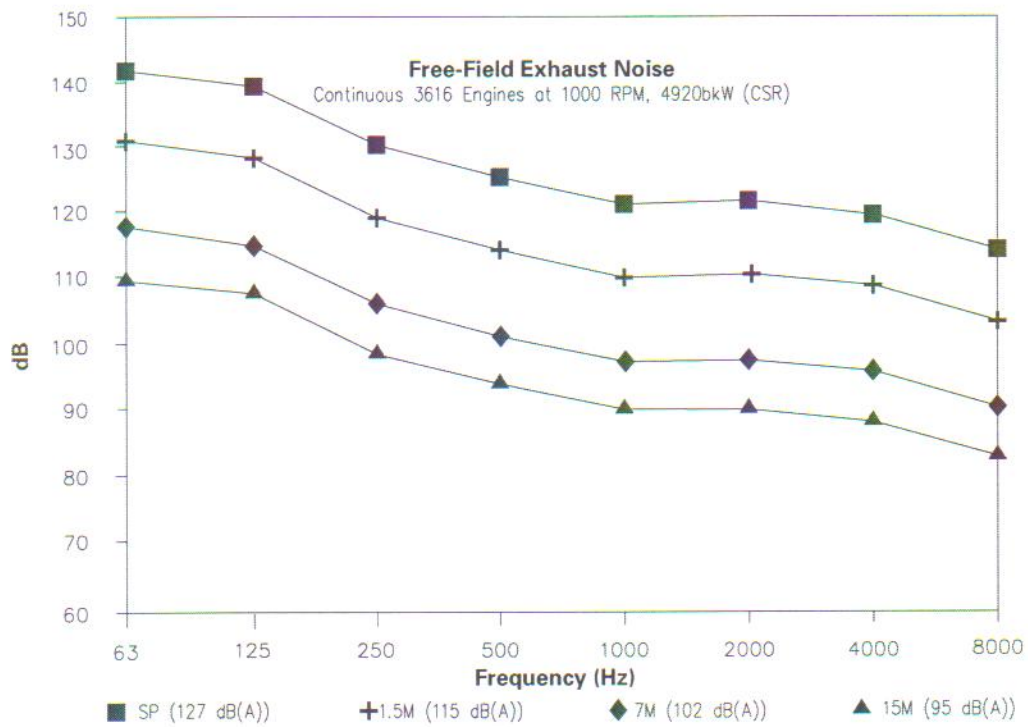
3612 AND 3616 MARINE PROJECT GUIDE



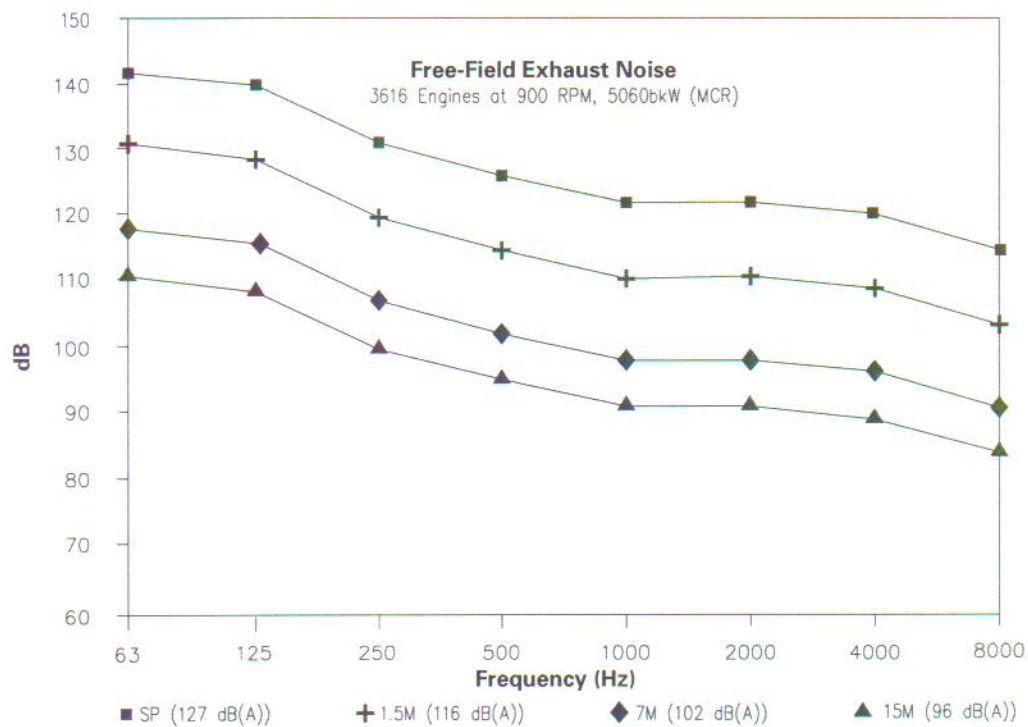
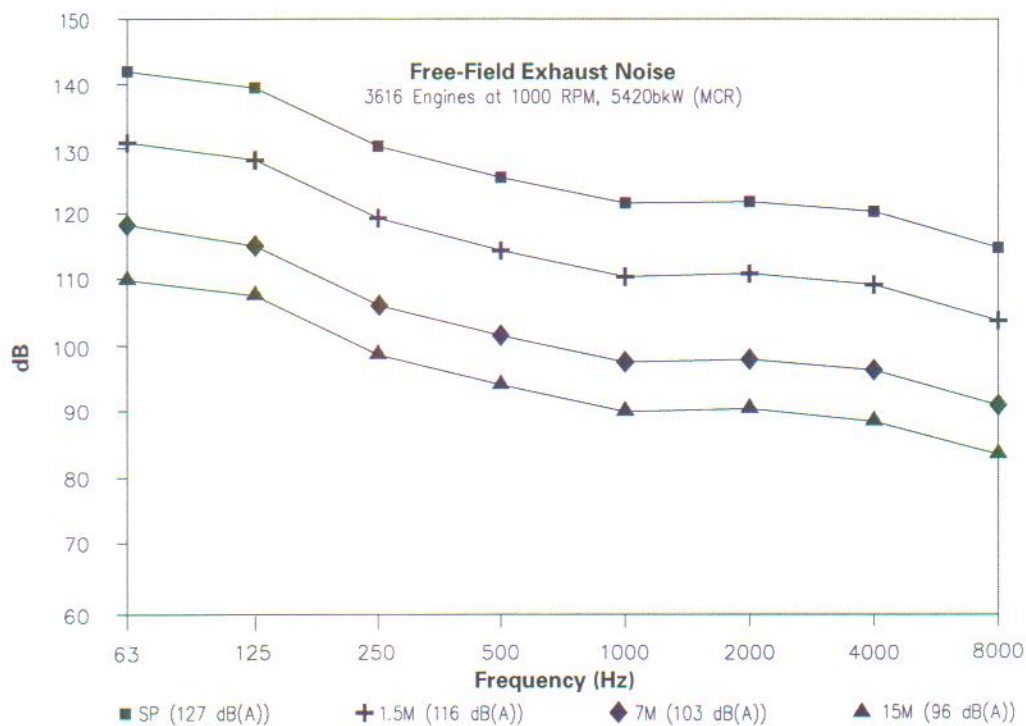


3612 AND 3616 MARINE PROJECT GUIDE





3612 AND 3616 MARINE PROJECT GUIDE



Torsional Vibration Data

Model 3612 @ 1000 rpm — CCW Rotation					
Degrees to Firing After #1 Fires CCW Rotation After #1R Fires		Engine	J (N•m/s ²)	K (N•m x 10 ⁶ /rad)	Damping (N•m/s-rad)
Left Bank	Right Bank	Front Crank	7.50		
				67.79	700
2L-410	1R-000	Throw #1	17.00		
				40.11	700
4L-170	3R-480	Throw #2	16.31		
				40.11	700
6L-650	5R-240	Throw #3	16.31		
				40.11	700
8L-290	7R-600	Throw #4	16.31		
				40.11	700
10L-530	9R-120	Throw #5	16.31		
				40.11	700
12L-050	11R-360	Throw #6	17.00		
				40.11	700
				67.79	
		Rear Crank	7.42		

Direction of rotation is looking forward from the flywheel end.

Associated with each stiffness is an internal damping value of 200 N•m/s-rad. This is used along with the damping table listed. The damping table listed is for damping to "ground." For stress calculations a journal diameter of 235 mm at each stiffness is used.

The firing order for CW rotation is shown in Technical Data.

Front Mounted Equipment: (* add to Front Crank)

Rear Drive Engines:

Damper Data:

J — Damper Housing	=	11.6 N•m/s ² *
J — Damper Flywheel	=	29.2 N•m/s ²
C — Damping Constant	=	7000 N•m/s-rad
K — Spring Rate	=	2.85 N•m x 10 ⁶ /rad

Rear Mounted Equipment: (** add to Rear Crank)

Rear Drive Engines: Flywheel (standard)	=	74.9 N•m/s ² **
Reciprocating mass per cylinder	=	68.36 kg
Rotating mass per cylinder	=	36.91 kg
Connecting rod length	=	600 mm (between pin centers)

3612 AND 3616 MARINE PROJECT GUIDE

Model 3616 @ 1000 rpm — CCW Rotation					
Degrees to Firing After #1 Fires CCW Rotation After #1R Fires		Engine	J (N•m/s ²)	K (N•m x 10 ⁶ /rad)	Damping (N•m/s-rad)
Left Bank	Right Bank	Front Crank	7.50		
				67.79	700
2L-050	1R-000	Throw #1	17.00		
				40.11	700
4L-230	3R-180	Throw #2	16.31		
				40.11	700
6L-140	5R-090	Throw #3	16.31		
				40.11	700
8L-680	7R-630	Throw #4	16.31		
				40.11	700
10L-320	9R-270	Throw #5	16.31		
				40.11	700
12L-500	11R-450	Throw #6	17.00		
				40.11	700
14L-590	13R-540	Throw #7	16.50		
				40.11	700
16L-410	15R-360	Throw #8	17.7		
				67.79	
		Rear Crank	7.42		

Direction of rotation is looking forward from the flywheel end.

Associated with each stiffness is an internal damping value of 200 N•m/s-rad. This is used along with the damping table listed. The damping table listed is for damping to "ground." For stress calculations a journal diameter of 235 mm at each stiffness is used.

The firing order for CW rotation is shown in Technical Data.

Front Mounted Equipment: (* add to Front Crank)

Front and Rear Drive Engines:

Damper Data:

J — Damper Housing	=	8.6 N•m/s ² *
J — Damper Flywheel	=	28.9 N•m/s ²
C — Damping Constant	=	8100 N•m/s-rad
K — Spring Rate	=	1.35 N•m x 10 ⁶ /rad

Rear Mounted Equipment: (** add to Rear Crank)

Front and Rear Drive Engines: Flywheel (standard)	=	26.19 N•m/s ² **
Reciprocating mass per cylinder	=	68.36 kg
Rotating mass per cylinder	=	36.91 kg
Connecting rod length	=	600 mm (between pin centers)

Torsional Limits

The following guidelines should be used in the coupling selection process, but may be exceeded in special cases with prior approval from Caterpillar engineering:

Crankshaft Amplitude Limits:

Misfire calculated using #1 engine cylinder misfiring. Individual order analysis with or without misfire.

Amplitude limits at Front of Crank:

- Do not exceed $\pm 1.0^\circ$ for 0.5 order
- Do not exceed $\pm 1.0^\circ$ for 1st order
- Do not exceed $\pm 0.25^\circ$ for 1.5 order
- Do not exceed $\pm 0.15^\circ$ for all orders above 1.5

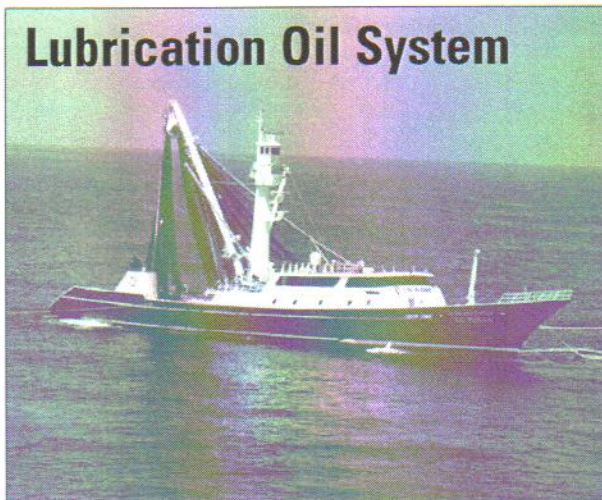
Crankshaft:

- Do not exceed ± 21 Mpa (3000 psi) crankshaft stress for each engine order.

Coupling:

- Vibratory torque: Limit of coupling with #1 cylinder misfire.
- Coupling power loss: Limit of coupling with #1 cylinder misfire.

Lubrication Oil System



General

The lube system is designed to supply 85°C (185°F) filtered oil at 430 kPa (62 psi) pressure under all engine operating conditions. For engines with front-mounted turbochargers, the lube oil system is designed to supply 70°C (158°F) filtered oil at 430 kPa (62 psi) under all engine operating conditions. The major feature of the 3600 lube system is a priority valve to regulate the oil pressure at the oil manifold rather than at the oil pump. The oil manifold pressure thus becomes independent of the oil filter and oil cooler under pressure drop.

The other major features of the 3600 lube system are as follows:

Internal Lubrication System

Oil Coolers

The engines are equipped with a two-element lube oil tube cooler with the water flow arranged in series. As an option, a three-element oil cooler is available if additional cooling capacity is required. For engines with front-mounted turbochargers, a fresh water cooled plate-type cooler is shipped loose.

Thermostats

Four thermostats in the lube system control the oil inlet temperature to 85°C (185°F) for engines with rear-mounted turbochargers and 70°C (158°F) for engines with front-mounted turbochargers. The thermostat is mounted on the plate-type cooler for engines with front-mounted turbochargers.

Oil Filters

The oil pan is equipped with a 650-micron suction screen. The two final 20-micron lube oil filters can be changed while the engine is operating. The normal procedure specifies the filters to be changed at 100 kPa (14.5 psi) pressure drop across the filters.

Centrifugal Bypass Filters

Engine-mounted centrifugal bypass oil filters are installed as standard. The filters receive three to four percent of the oil pump flow to remove solid, micron size particles and can extend the oil filter change periods. The centrifugal filters each have a dirt capacity of 3.6 kg (8 lb). Cleaning intervals are discussed in the Caterpillar Operation & Maintenance Manual.

Oil Pumps

On-line connections are identical for all pumps. The pumps provide more than the required engine oil flow at rated conditions. This allows high oil pressure early in the operating speed range and provides flow margin.

Prelubrication

All 3600 engines must be lubricated prior to starting. The pump is electrically driven. Prelubrication prior to starting may take several minutes depending upon oil viscosity, temperature, engine condition, and configuration. When the engine oil manifold pressure reaches 10 kPa (1.5 psi), the starter interlock allows the engine to be cranked. A prelubrication system supplied by Caterpillar is integrated with the engine and starting controls. An engine-mounted, air-driven prelube pump is available as an option.

Oil Requirements

Caterpillar recommends the use of **Cat DEO CF** lubrication oil for the 3600 family engines operating on distillate diesel fuel. Caterpillar does not recommend other lubrication oils by brand name as the formulations are not controlled by Caterpillar and the lube oil properties may vary geographically.

To be acceptable in a 3600 engine, the oil must demonstrate satisfactory performance in the following areas:

1. **API category:** The oil must have an API classification of CF. Specifications Mil-L-2104D oils also meet this requirement.

API CC oils are unacceptable.

2. Caterpillar **Micro-Oxidation Test (MOT):** The oil must pass the Caterpillar Micro-Oxidation Test. For additional information on this test, contact a Caterpillar dealer. The test must be performed on samples from the supplier's facility supporting the engine.

3. **Field experience:** In addition to the above items, the oil must show its performance in the field with good results, demonstrated through a test program.

Lubricant Viscosity

The primary recommendation for the 3600 family of engines is an SAE 40-grade oil. SAE 30 and some multigrade oils may be used if the application requires. SAE 30 is preferable to a multigrade oil.

Total Base Number (TBN)

Always consult a Caterpillar dealer for the latest lubricant recommendations.

3600 engines operating on distillate Marine Diesel Oil require a TBN of 10 times the sulfur level measured in percent of weight. (Example: For a sulfur content of one percent weight, the TBN would be 10.) The minimum TBN level regardless of the sulfur content is 10. Excessively high TBN or high ash oils should not be used in 3600 family engines on distillate fuel, as these oils may lead to excessive piston deposits and loss of oil control. Successful operation of 3600 family engines has generally been obtained with new TBN levels between 10 and 15.

Ultra low sulfur content: Caterpillar has not experienced any detrimental effects operating on 0.05 percent sulfur fuel in the 3600 family engine.

Ambient Temperature Range	
Oil Viscosity	Ambient Temp. Range °C
SAE 40	+5 to +50
SAE 30	+0 to +40
SAE 20W/40	-10 to +40
SAE 15W/40	-15 to +40

Oil Change Interval

To achieve maximum life from the engine oil and provide optimum protection for the internal engine components, a **Scheduled Oil Sampling** program (S•O•SSM) should be used. This program is available through the Caterpillar dealer network. If an S•O•S analysis program is not available, the oil change interval is recommended in accordance with the table at right.

Scheduled Oil Sampling

TBN, viscosity, and oil consumption trends must be analyzed every 250 hours. The S•O•S analysis involves a two-part test program:

1. Wear analysis

The wear analysis identifies engine wear elements present in the oil. These elements indicate the condition of the engine.

2. Oil condition analysis

The oil condition analysis identifies the wear status of the oil. The program will determine oil change intervals based on trend analysis and condemning limits established for the engine.

Increasing Oil Change Intervals

Oil change intervals can only be increased when the S•O•S analysis indicates that the condemning limits have not been reached, and only when trend lines indicate a stable constant slope. Oil change intervals should only be increased in 250-hour increments, especially in situations where the turnaround time for the oil analysis is long.

Initial Oil Change Interval

The following chart shows the required initial oil change based upon engine type used and the standard marine oil sump size.

Engine Model	3612	3616
Oil pan capacity (liters)	910	1057
Initial oil change interval (hours)	750	600

Change Interval Without Oil Analysis Results

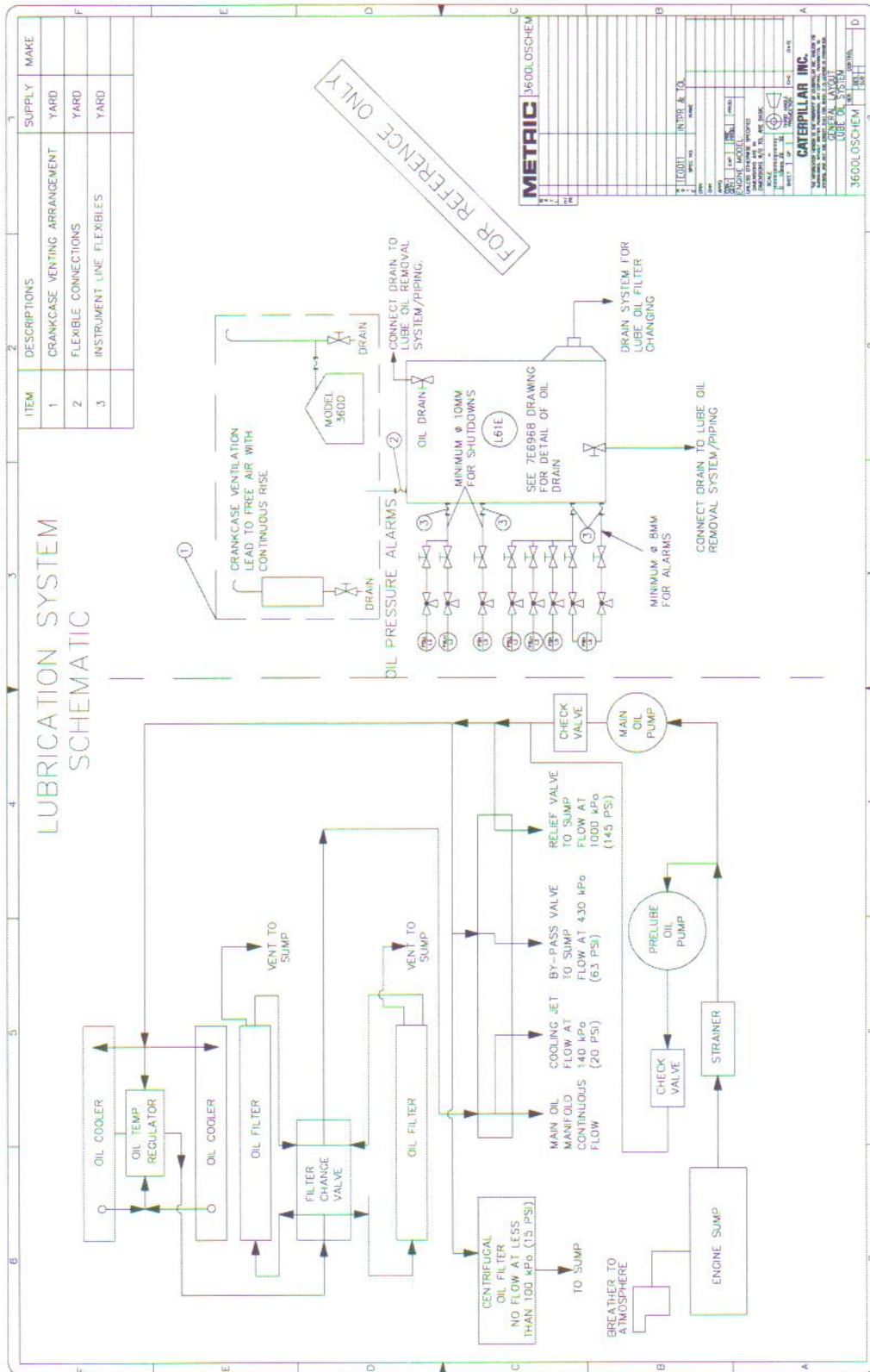
If S•O•S analysis results are not available, the initial oil change interval should be used to determine oil change intervals. Even though oil sampling results may not be available on the recommended 250-hour intervals, analyze oil at every oil change period, even if the turnaround time for the data is long.

Inclination Capability

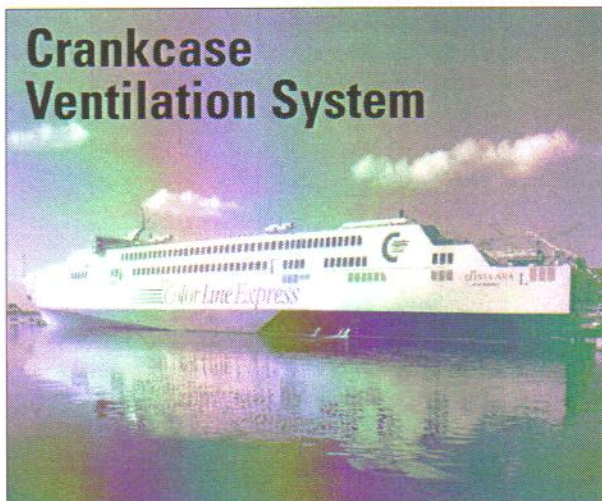
The standard oil pan is capable of meeting the inclination criteria for installation angles (rear down), of five degrees for the 3612 and three degrees for the 3616. The **inclination criteria** are any combination of ± 10 degree trim and ± 22.5 degree list. If the engines are installed at an angle greater than zero degrees, the oil pan capacity and thus the oil change intervals will be reduced.

Lube Oil System Schematic

Engine internal and typical external lube oil systems are illustrated on the schematic shown on page 45.



Crankcase Ventilation System



Crankcase Fumes Disposal

Normal combustion pressures of an internal combustion engine cause pressure buildup within the crankcase due to blowby. Vent tubes and crankcase breathers are provided to allow this gas to escape.

Do not vent crankcase fumes into the engine room. The oily fumes will have a tendency to clog air filters.

Crankcase fumes should be discharged directly to the atmosphere through a venting system individual for each engine.

The engine has breathers located on each cylinder bank on the engine. Crankcase fumes vent pipes must be of sufficient size to prevent the buildup of excessive backpressure in the crankcase. *Blowby on a new engine will be approximately 0.02 m³/hr-bkW. The pipes should also be adequately sized to accommodate a worn engine. Size vent piping for 0.04 m³/hr-bkW with a maximum of 13 mm H₂O (0.5 in. H₂O) pressure drop in the piping.*

Loops or low points in a crankcase vent pipe must be avoided to prevent liquid locks from the condensation in the pipe and thus restricting the discharge of fumes. *Where horizontal runs are required, install the pipe with a gradual rise of 41.7 mm/m, (1/2 in/ft), slope from the engine.* The weight of the vent pipes will require separate off-engine supports as part of the installation design. Further additional flexible connections will need to be installed to accommodate the engine movement.

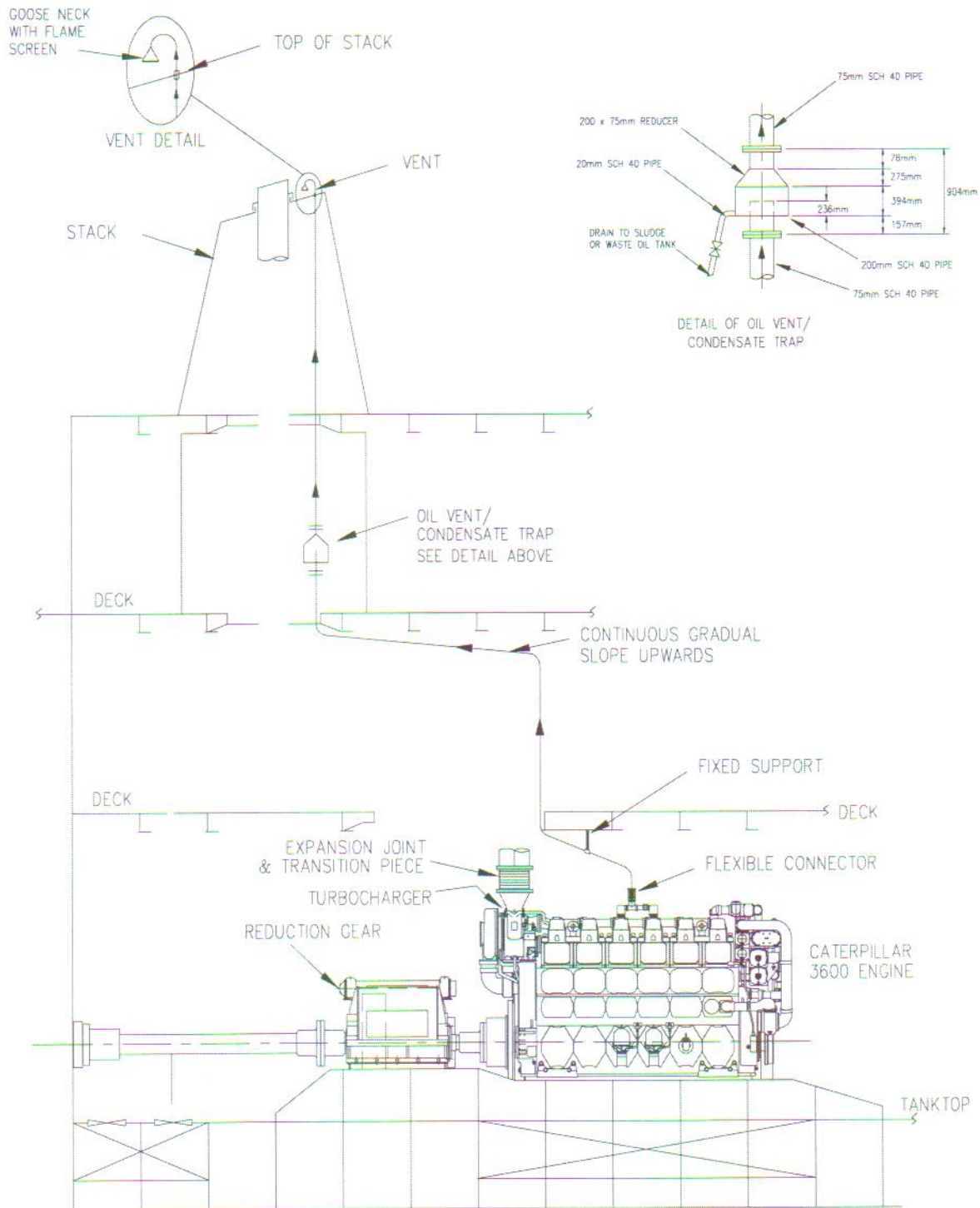
Crankcase Piping System

Vent the pipe directly into the atmosphere at a well-considered location and be fitted with a gooseneck or similar arrangement to keep rain or water spray from entering the engine. Consideration should also be given to other equipment located near the discharge area. If not located properly, the oil carryover can accumulate over time and become unsightly.

An oil condensate trap, as shown on the following drawing, will minimize the amount of oil discharged from the vent pipe.

The crankcase pressure should not vary more than 25.4 mm H₂O (1.0 in. H₂O) of water from ambient barometric pressure. Measurement should be made at the engine dipstick location with the engine at operating temperature and minimum at 80 to 90 percent of rated load.

A typical crankcase piping system is illustrated on page 47.



Typical Crankcase Piping System

Fuel System



Tank Position

The fuel supply system must assure a continuous, clean supply of fuel. The tanks should not exceed the height of the engine fuel injectors in order to prevent possible leakage of fuel into the cylinders. If a higher position is required, check valves with backpressures set to the fuel column height must be installed.

Caterpillar fuel transfer pumps lifting capability is equivalent to 40 kPa (5.8 psi) inlet restriction.

Line Restriction

The piping carrying fuel to the fuel transfer pump and the return line carrying excess fuel to the tank should be no smaller than the engine connections.

Maximum inlet flow restriction is 20 kPa (2.9 psi) at rated speed. Air in the system causes hard starting and erratic engine operation, and will erode injectors.

Return Line

The return line should enter the top of the tank without shutoff valves. Bypass (return) fuel leaving the engine pressure regulator should be returned to the engine day tank. If the return fuel is cooled and not returned to the day tank, provisions must be made to have the piping system vented for entrapped air and gases.

Fuel Line Dimension

Engine Fuel Line Connections (Inside Diameter)	
Fuel supply	Fuel Return
32 mm (1.3 in.)	25 mm (1.0 in.)

Flexible Connections

Connections to the engine must be flexible hose and must be located directly at the engine inlet and outlet to accommodate engine motion.

Fuel Recommendations

The fuels recommended are normally No. 2-D diesel fuel and No. 2 fuel oil. No. 1 grades are also acceptable, as well as JP-8 turbine fuel, ISO 8217 DMX, DMA, and DMB fuels. Other fuel types may be used when economics or fuel availability dictates.

Fuel with CIMAC designation DB, commonly referred to as Marine Diesel Oil (MDO), is an acceptable fuel, provided the fuel complies with Caterpillar fuel recommendations.

Distillate Fuel Recommendations

Specifications	Requirements ¹
Aromatics (ASTM D1319)	35% maximum
Ash (ASTM D482)	0.02% weight maximum
Cetane number (ASTM D613)	40 minimum
Cloud point (ASTM D97)	Not above min. expected ambient temperature
Gravity API (ASTM D287)	30 minimum and 45 maximum
Pour point (ASTM D97)	6°C (10°F) below ambient minimum
Sulfur (ASTM D2788, D3605, or D1552)	3% maximum (see lube oil section for TBN)
Viscosity, kinematic @ 38°C (100°F) (ASTM D445)	20.0 cSt maximum — 1.4 cSt minimum
Water & sediment (ASTM D1796)	0.1% maximum

¹ As delivered to the engine fuel system.

Engine Fuel System Description

The main fuel system components are the engine-driven transfer pump, secondary duplex media-type fuel filters (5-micron), fuel unit injectors, and a fuel backpressure regulator.

Caterpillar recommends the use of a primary filter/strainer prior to the engine transfer pump. Caterpillar offers a duplex, primary filter (178-micron) for installation prior to the fuel transfer pump.

A manual fuel priming pump is also available. This pump is recommended if no electrical priming pump is available.

The engine-driven fuel transfer pump is a gear-type pump that delivers the fuel through the filters to the injectors. Recommended delivery pressure to the injectors is 430 to 680 kPa (62 to 99 psi) at rated load and speed. Delivery pressure is controlled by adjusting the fuel pressure regulator setting on site during commissioning of the engine. The pump is equipped with a pump-mounted safety valve. Fuel flow at rated rpm is listed in the technical data and varies with engine speed.

Unit Injectors

Fuel unit injectors combine the pumping, metering, and injecting elements into a single unit mounted in the cylinder head. External manifolds supply low pressure fuel from the transfer pump to the cylinder heads. High pressure lines are not used. A 100-micron edge-type filter is built into each unit injector.

Fuel Temperature

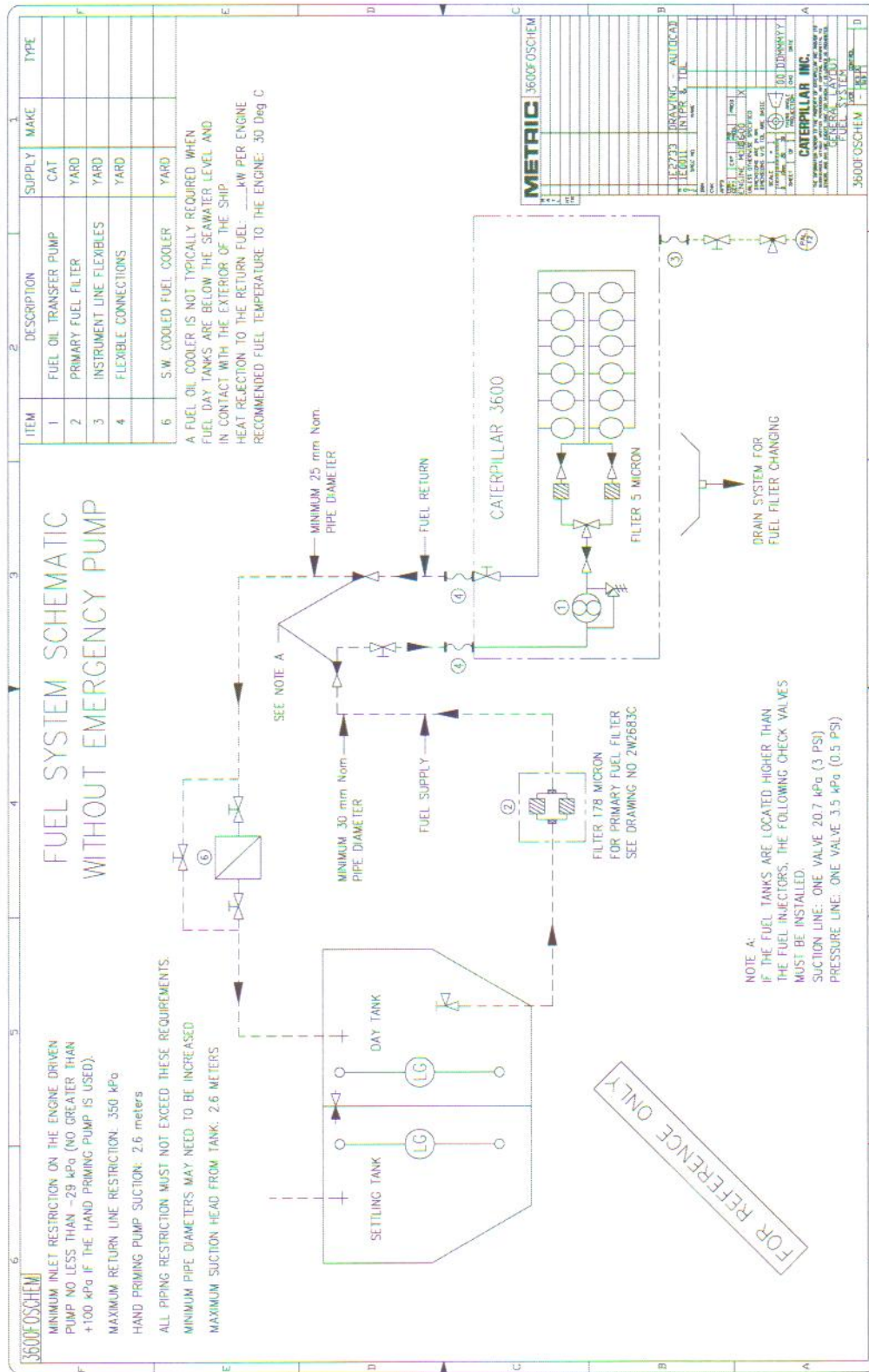
Engines are power set at the factory with 30°C (86°F) $\pm 3^{\circ}\text{C}$ ($86^{\circ}\text{F} \pm 3^{\circ}\text{F}$) fuel to the engine transfer pump. Higher fuel temperatures will reduce fuel stop power capability. The fuel stop power reduction is one percent for each 5.6°C (10.1°F) fuel supply temperature increase above 30°C (86°F). If the engine is operating below the fuel stop limit, the governor will add fuel as required to maintain the required engine speed. Classification societies have a maximum return-to-tank fuel temperature. This temperature is related to the fuel flash point. To obtain good fuel filter life, the engine fuel supply temperature should be less than 40°C (104°F). The minimum allowable viscosity of the fuel entering the engine is 1.4 cSt.

Fuel Coolers

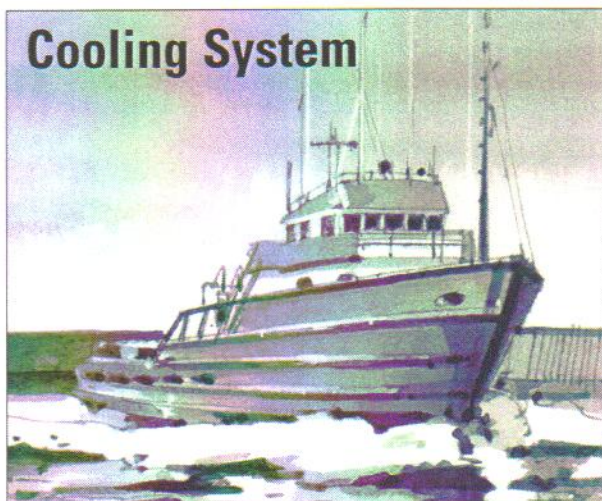
The need for fuel coolers is project specific and depends greatly on day tank size and location. Additional sizing information is available in the 3600 Marine Engines Application and Installation Guide.

Fuel System Schematic

A typical fuel system is illustrated on page 50.



Cooling System



Introduction

The cooling system configuration for the 3612/3616 engine in marine propulsion applications is identified as a combined or single-circuit system. It is also referred to as the single-circuit – two-pump system.

The cooling system is laid out for the following temperature levels:

1. 32°C (90°F) nominal [38°C (100°F) maximum] water temperature to the aftercooler and oil cooler.
2. 90°C (194°F) nominal jacket water temperature to the cylinder block.
3. 85°C (185°F) nominal oil temperature to bearings.

The heat rejection data in this project guide are based on 32°C (90°F) nominal water [38°C (100°F) maximum] to the aftercooler and 25°C (77°F) air to the turbocharger inlet. The thermostatic valve for the low temperature control circuit has 32°C (90°F) nominal elements installed. However, with sea water at 32°C (90°F), the inlet temperature is allowed to go to 38°C (100°F) max. Thus a 6°C (10°F) approach temperature is available for sizing the heat exchanger.

Coolant Flow Control

Correct coolant flows are obtained by factory installed orifices on the engine, combined with proper external circuit resistance set at each site during commissioning. The external circuit resistance setting establishes the total circuit flow by balancing total circuit losses with the characteristic pump performance curves. *Correct external resistance is very important.* Too high a resistance will result in reduced flows to the aftercooler and oil cooler, and their effectiveness will decrease. If there is too low a resistance, the fluid velocity limits may be exceeded, and cavitation/early wear could be the result.

The chart below shows the recommended external resistance maximum pressure drop for a 3612/3616 engine with combined circuit cooling systems.

Coolant Temperature Control

The 3612/3616 engine uses fluid inlet control temperature regulators to provide uniform coolant temperature to the aftercooler, oil cooler, and cylinder block. For the combined system, the AC/OC circuit is externally regulated to provide a nominal 32°C (90°F) coolant temperature. The high temperature jacket water system uses the AC/OC outlet water to maintain 90°C (194°F) inlet water to the block. Jacket water temperature regulation is always required for all configurations and operating conditions.

Fresh Water Pumps

The 3612/3616 engine has two identical gear-driven centrifugal water pumps mounted on the front housing. The right-hand pump (viewed from the flywheel end) supplies coolant to the block and heads. The left-hand pump supplies coolant to the aftercooler, oil cooler, and ultimately supplies the required cooling water needed to control the jacket water inlet temperature.

Engine Speed rpm	3612/3616	3612/3616
	Differential Pressure kPa (psi) Full Cooler Flow	Differential Pressure kPa (psi) Full Bypass Flow
1000	85 (12)	130% of 85 (12)
900	66 (9.6)	130% of 66 (9.6)

Sea Water Pump

An engine-driven sea water pump is available and is normally used to supply sea water to the heat exchangers for the engine and auxiliary equipment. The sea water pump is mounted below the jacket water pump on the right-hand side of the engine. The pump is not self-priming; therefore, if the pump inlet level is above the normal lightship draft, a priming arrangement needs to be incorporated into the design.

Expansion Tanks

Expansion tanks can be purchased from Caterpillar as standard options or supplied from the yard. The expansion tanks are commonly installed as shunt types. An air separator must be provided for in the cooling water system at the engine cooling water outlet.

Cooling

Caterpillar offers heat exchangers of either the shell-and-tube type or the plate-type. The heat exchanger performance depends on water flow and temperature differential. Control of the sea water velocity must be maintained to avoid erosion problems with the heat exchangers.

System Pressure

Correct cooling system pressure minimizes pump cavitation and increases pump efficiency. The combination of static and dynamic pressure heads must meet the pressure criteria listed in the technical data.

Venting

Proper venting is required for all applications. Vent lines should be routed to an expansion tank at a constant upward slope.

Jacket Water Heaters

Jacket water heaters may be required to meet cold starting and load acceptance criteria. To provide for the optimum usage of the heater, it is important to route the heater water to enter into the top of the cylinder block and exit at the bottom to maintain block temperature. Use a solenoid shutoff valve to prevent coolant from circulating through the heater while the engine is running. Caterpillar recommends the use of a 24 kW heater for vee engine installations; however, each application should be checked for special considerations, as the operating geographic area determines the actual sizing.

System Monitoring

During the design and installation phase, it is important that provisions are made to measure pressure and temperature differentials across major system components. This allows accurate documentation of the cooling system during the commissioning procedure. Future system problems or component deterioration (such as fouling) are easier to identify if basic data is available.

Serviceability

Suitable access should be provided for cleaning, removal, or replacement of all system components. Isolation valves should be installed as deemed necessary to facilitate such work.

Water Quality, Rust Inhibitors, and Antifreeze

Maintaining water quality is very important in closed cooling systems. Excessive hardness will cause deposits, fouling, and reduced effectiveness of cooling system components. Caterpillar has available coolant inhibitor to properly condition the cooling water. When using Caterpillar inhibitor, the cooling water piping must not be galvanized and aluminum should not be used. If the piping is galvanized, the zinc will react with the coolant inhibitor and form clogs, which will interfere with the system operation.

Heat Exchanger Sizing

The **minimum** acceptable heat exchanger configuration for a combined circuit system must provide 38°C (100°F) **maximum** coolant temperature at the AC/OC pump inlet at the following conditions:

1. **maximum** expected ambient temperature
2. **maximum** engine power capability (rack stop setting)
3. **maximum** expected sea water temperature
4. expected sea water fouling factor
5. anticipated coolant composition (i.e. 50% glycol).

In addition to the above criteria, the combined circuit heat exchanger should provide 32°C (90°F) coolant at normal load conditions, average summer ambient temperature, and normal sea water temperatures. See the technical data section of this manual for specific heat rejection figures.

Typical Heat Balance of the 3600 Engine

Total energy input	100%
Mechanical work energy	44%
Exhaust gas	29%
Aftercooler cooling water	12%
Cyl block, heads cool water	9%
Lube oil cooling water	4%
Radiation	2%

Jacket Water Heater Sizing

Caterpillar recommends using a separate heater and circulation pump. *An immersion-type heater is not recommended.* The pump should be sized to 150 L/min (39 gal/min) at 120 kPa (17 psi), and the heater is recommended to be minimum 24 kW or as required by the actual application.

System Pressures and Velocities

The following pressure and velocity limits apply to 3600 family of engines:

Water Pump Pressures		
Maximum allowable static head	kPa (psi)	145 (21)
Minimum AC/OC inlet pressure (dynamic)	kPa (psi)	-5 (-0.7)
Minimum JW inlet pressure (dynamic)	kPa (psi)	30 (4)
Minimum sea water inlet pressure (dynamic)	kPa (psi)	-5 (-0.7)
Maximum Operating Pressures		
Engine cooling circuits	kPa (psi)	500 (73)
Caterpillar expansion tanks	kPa (psi)	150 (22)
Heat exchangers		type specific
Water Velocities		
Pressurized lines	m/s (ft/s)	4.5 (14.7)
Pressurized thin walled tubes	m/s (ft/s)	2.0-2.5 (6.6-8.2)
Suction lines (pump inlet)	m/s (ft/s)	1.5 (4.9)
Low velocity de-aeration line	m/s (ft/s)	0.6 (1.9)

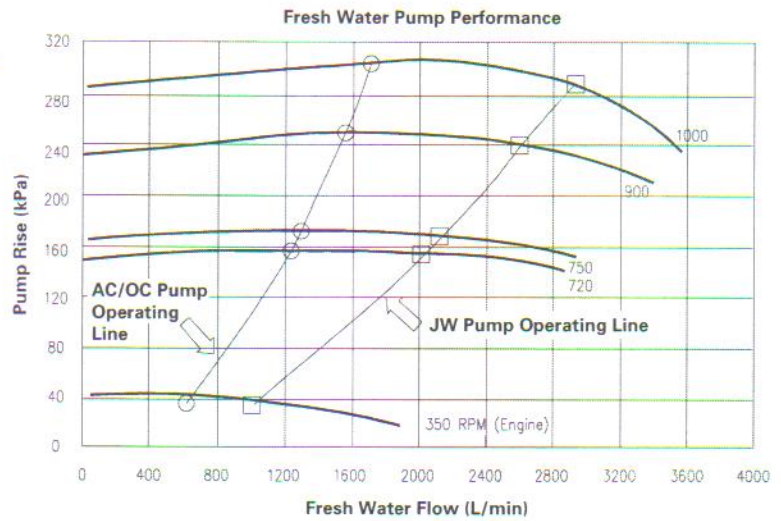
Weld Flange Sizes

All external cooling water connections of 100 mm (3.9 in.) diameter or above are supplied with DIN flanges, drilled to DIN 2501. Available in CAT standard,

ANSI standard, or DIN standard. CAT standard weld flanges are provided at every connection point; ANSI or DIN can be furnished.

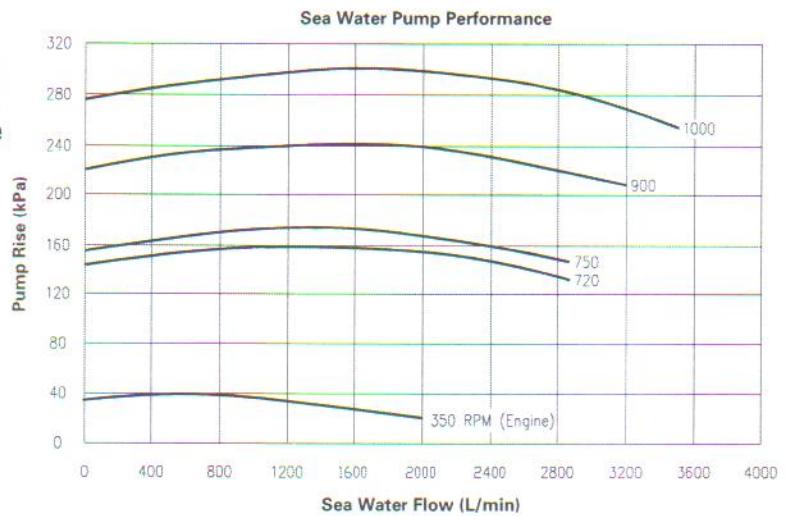
Fresh Water Pumps

The following performance curves reflect the performance of the fresh water pumps.



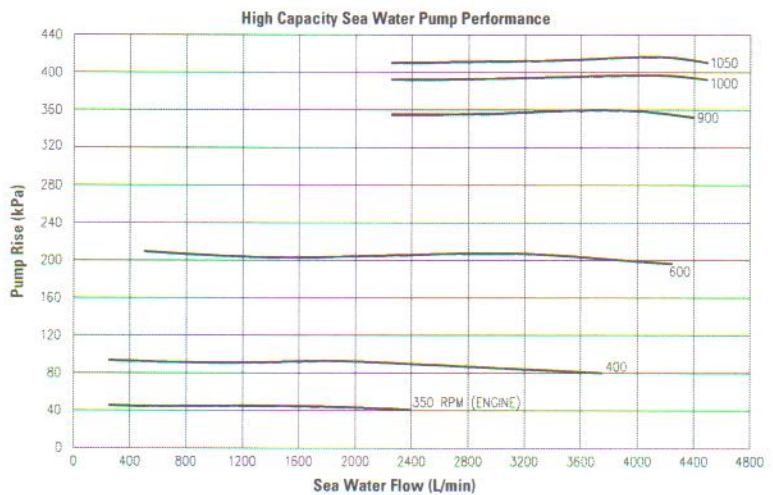
Sea Water Pump

The following performance curves reflect the performance of the sea water pump. The sea water pump is non-self priming but is capable of working with negative lift.

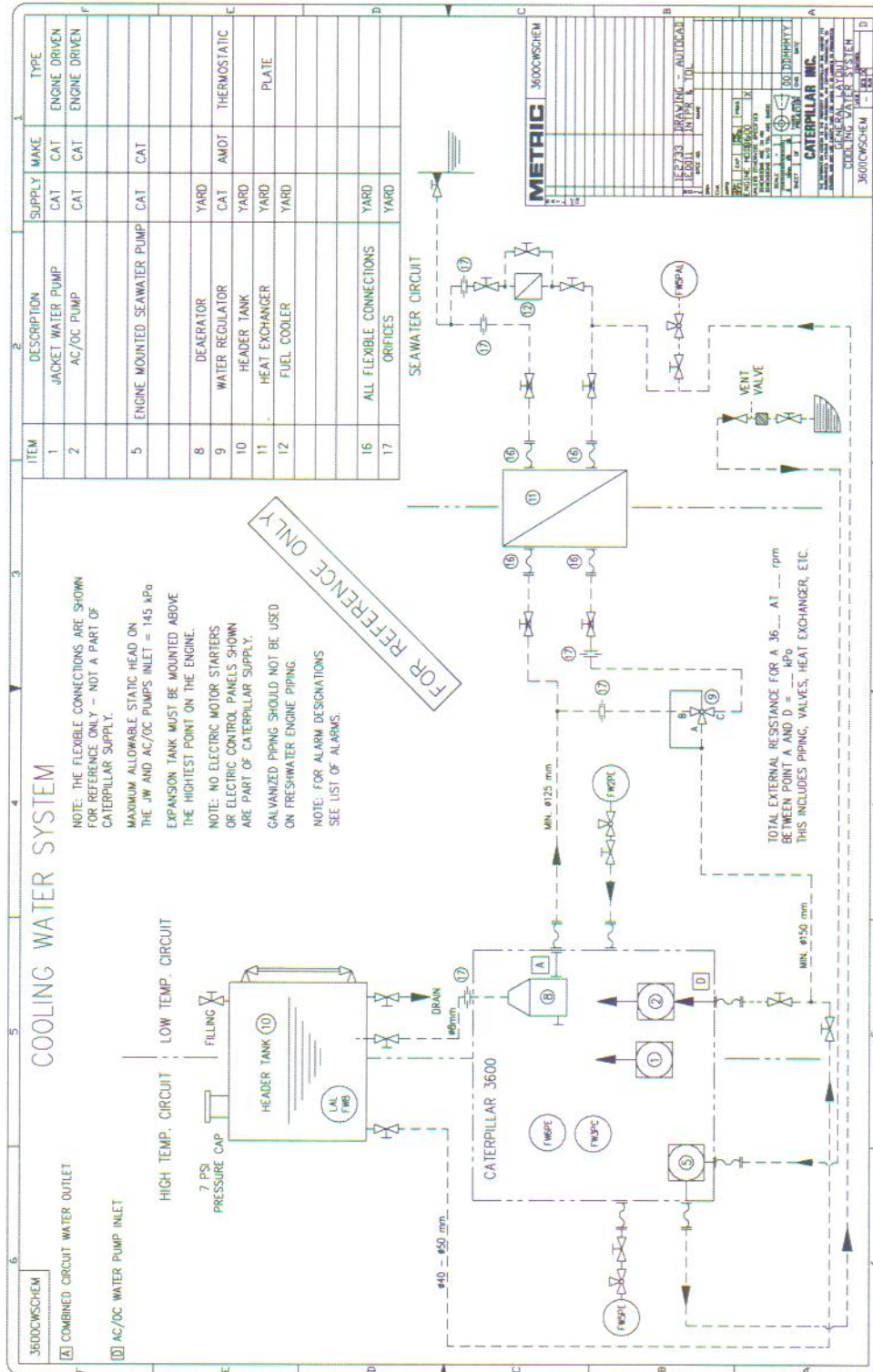


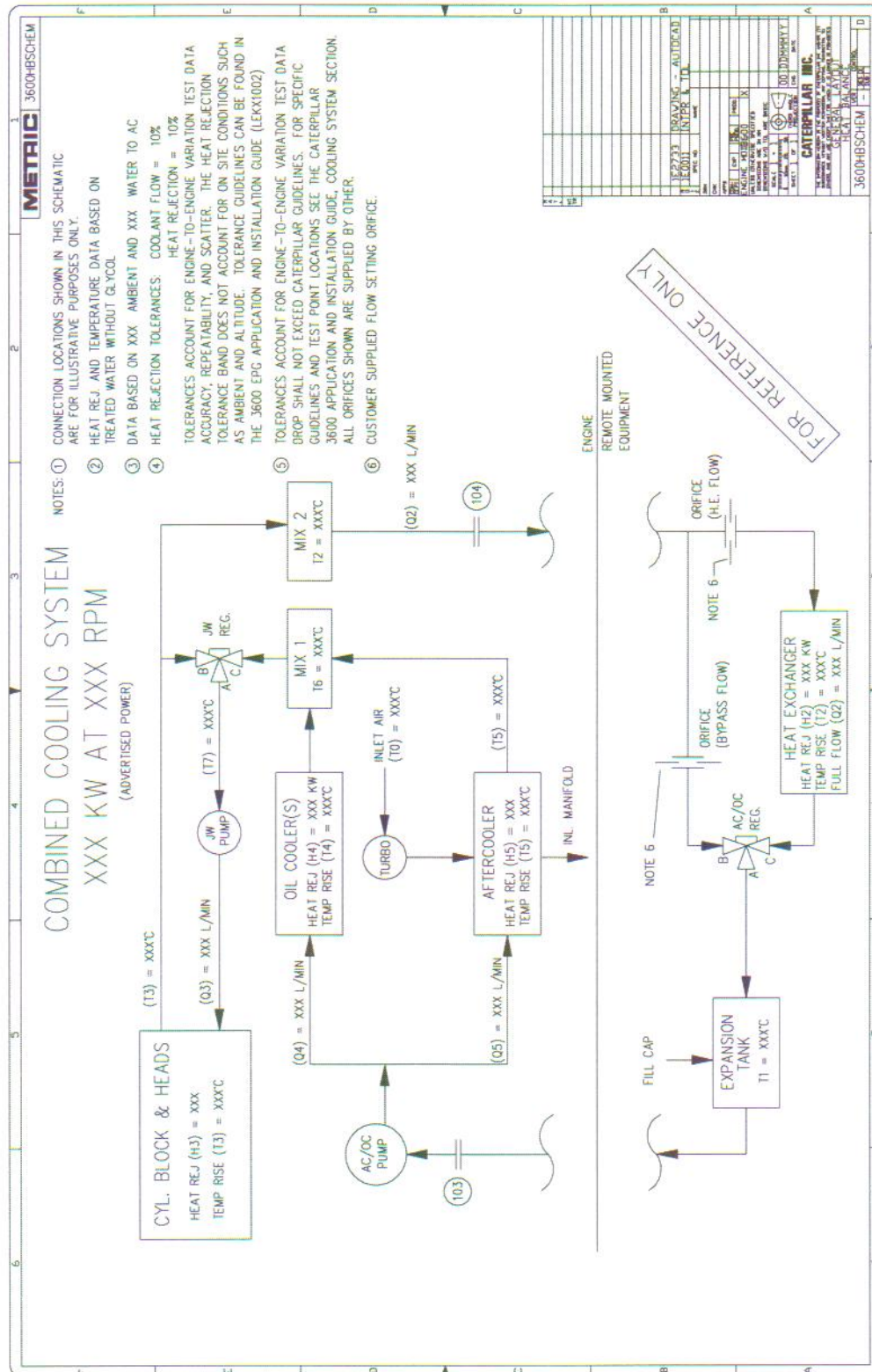
High Capacity Sea Water Pump

Used with high output ratings for 3616.



Cooling System Schematics





Starting Air System



Air Starters

The Caterpillar supplied air starting system includes air starters, lubricator, air relay valve, strainer, shutoff valve, and pressure regulator, if required. The engine uses two vane-type starters as standard equipment. Turbine starters are optional.

System Requirements

The standard vane air starters operate on air inlet pressures from 700 to 1550 kPa (102 to 225 psi). The turbine starters operate on pressures from 480 to 1040 kPa (70 to 151 psi). These pressures are required at the starter inlet port. An air tank pressure of 700 kPa (102 psi) [480 kPa (70 psi) for turbine] will not start the engine because of the pressure drop associated with the air supply lines. For initial system evaluation, assume a 200 kPa (29 psi) pressure drop between the tank and the air starter inlet.

A pressure regulator is necessary when the supply pressure exceeds the starter operating pressure. The pressure regulator should be set from 860 to 1550 kPa (125 to 225 psi). It should have the capacity to flow 300 L/sec (78 gal/sec) per starter at regulator inlet pressures above 860 kPa (125 psi).

The quantity of air required for each start and the size of the air receiver depend upon cranking time and air-starter consumption. A typical first start at 25°C (77°F) ambient will take five to seven seconds.

Restarts of warm engines normally take place in two to three seconds. The control system will shut off the air to the air starters at 170 rpm engine speed. At this firing speed, the governor is activated to allow fuel to the engine.

Receiver Sizing

The chart on page 58 is for typical air receiver sizing. The chart shows the number of starts available with an initial starting air receiver pressure as shown on the curves. This chart assumes: Caterpillar vane-type starters, reduction valve outlet pressure of 860 kPa (125 psi), and a minimum pressure of 690 kPa (100 psi) at the starter inlet port. An average cranking time of three seconds has been used. The starting air receiver size is normally determined by the requirements of the classification society for the number of starts or start attempts.

The size of the air receivers should be increased if the starting air receiver also supplies air for purposes other than the main engine starting (e.g., engine air prelube, work air, auxiliary gen sets). The Caterpillar intermittent air prelube pump consumption rate is 28.2 L/sec (7.3 gal/sec) based on free air at 21°C (70°F) at 100 kPa (70°F at 14.5 psi). The pump motor operating pressure is 690 kPa (100 psi). The prelube pump will normally operate one to five minutes before the engine begins to crank.

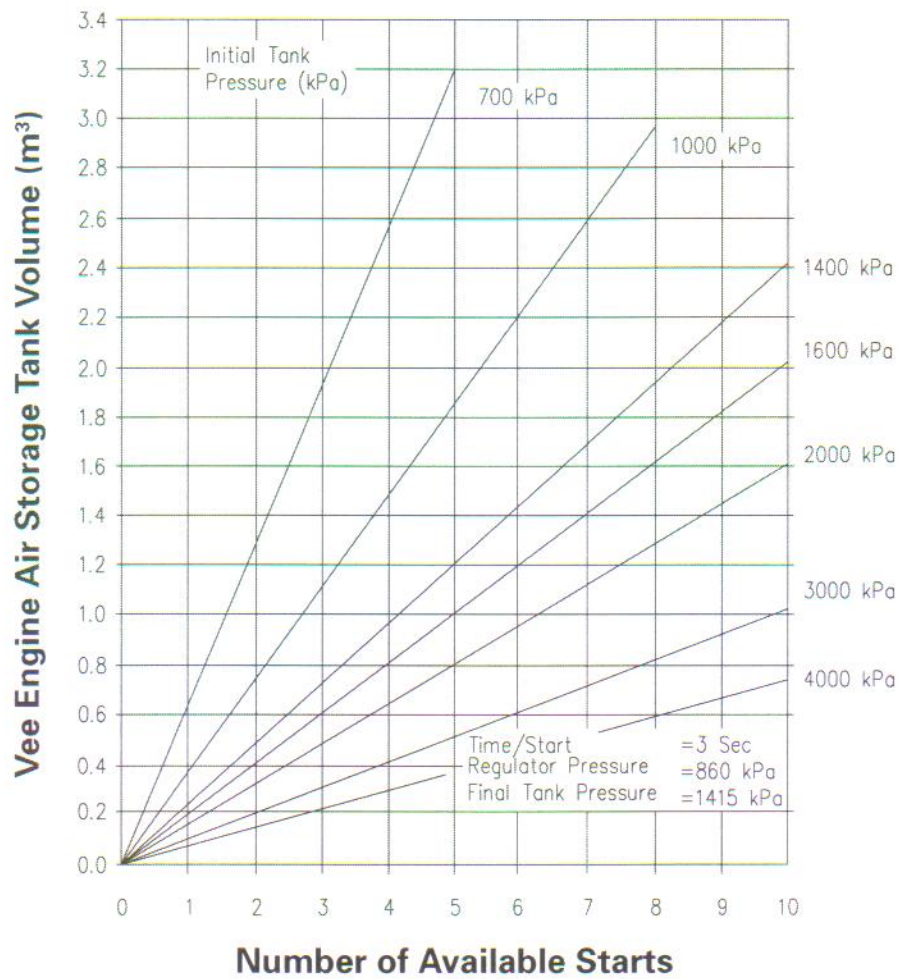
Customer Connections

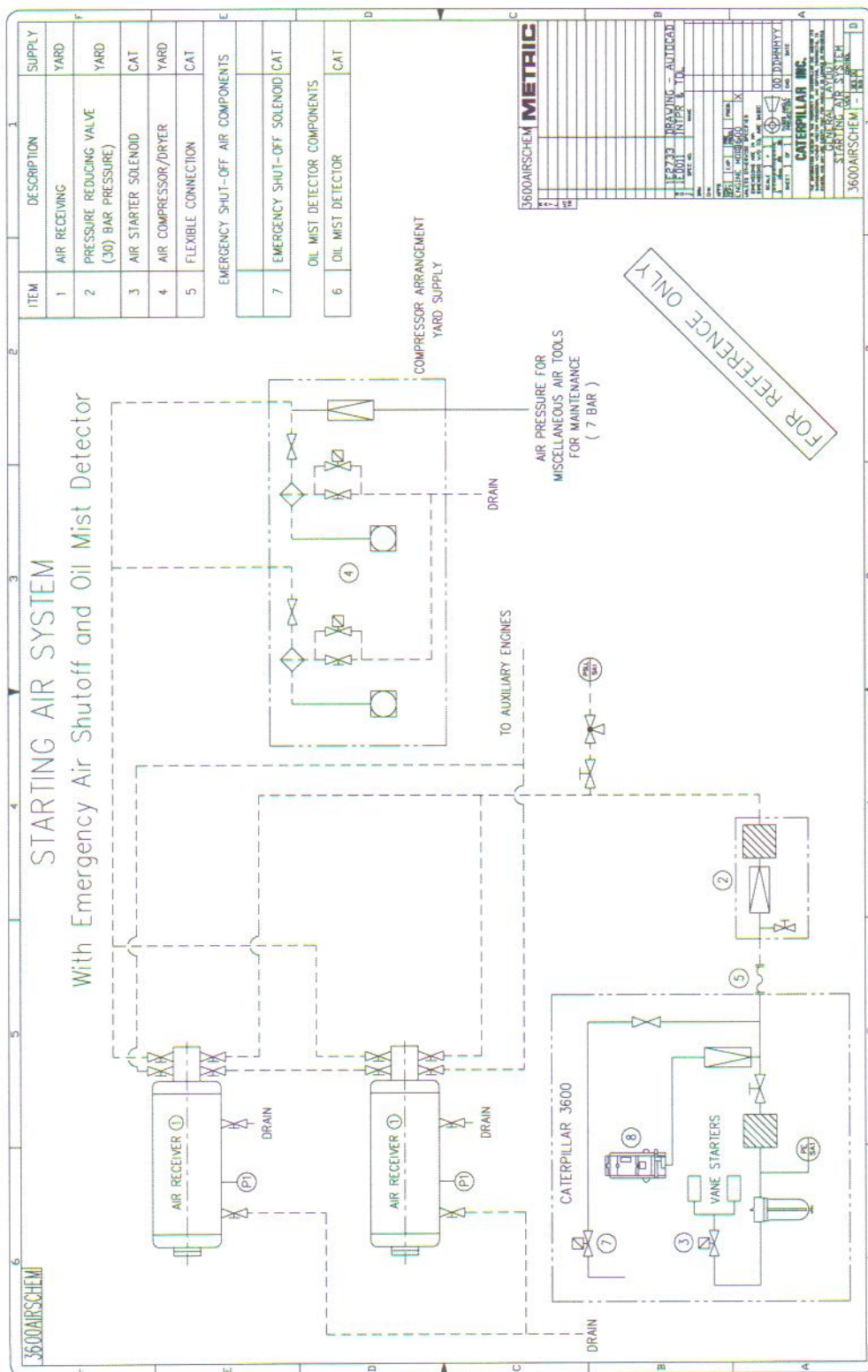
Vane-type starters must be supplied with clean air. Deposits of oil-water mixture must be removed by traps installed in the lines. Lines should slope toward the traps and away from the engine. The air supply pipes should be short and at least equal in size to the engine inlet connection, which is 38 mm (1-1/2 in). Locate the pressure reducing valve as close to the engine as possible to minimize the air pressure reduction valve supply pipe diameter.

Starting Air System Schematic

A typical starting air system is illustrated on page 59.

3600 Air Start Tank Sizing







Introduction

The aftercooler system is a High Performance Air Cooling (HPAC) system designed in a modular layout. The aftercooler inlet section is insulated with a soft wrap insulation to comply with marine society rules for surface temperature. The top covers of the three aftercooler sections are provided with a screen for protection/insulation. The flexible bellow joints are connected by means of V-shaped clamps and the use of metallic C-rings.

The maximum inlet air temperature to the turbocharger is 45°C (113°F). This temperature is in accordance with the marine society rules for equipment performance and will provide good engine component life. For temperatures above 45°C (113°F), the engine will be derated to a power output level that will provide for safe engine operation.

The 3612/3616 engine will normally draw engine combustion air in one of two ways:

1. The engine room is supplied with filtered air for engine combustion as well as for removal of radiated heat from the engine room.
2. The engine room is supplied with ventilation air for engine heat removal. Engine combustion air is supplied separately through a dedicated air intake system, which provides filtered air for the combustion only.

Either system should be designed to provide sufficient clean air for combustion and heat removal based on the ambient conditions and the maximum ratings for each piece of installed equipment (i.e. marine auxiliary engines, pumps, and switchgear). For classed vessels, the specific societies have well defined rules for the design parameters.

System Design

Engine Room Supplied Air

The location and design of the engine room air intakes should consider the following. A typical system arrangement is shown on page 62.

1. The supply air outlets should be close to and directed at the engine turbocharger air intakes.
2. Additional air should flow along the engine, coupling, and reduction gear to absorb the radiated heat.
3. The engine room air inlets should be placed such that water or dirt cannot enter.

Separate Combustion Air System

Supplying the engines with direct outside air for combustion, if possible, is beneficial to the installation for a number of reasons. It will bring down the air movement in the engine room and may reduce the cooling load on the charge air cooler, which would reduce the maximum heating load on the cooling water heat exchanger. This, in turn, will reduce the required sea water circulation in the system. Direct air to the turbocharger inlet will provide a bigger margin to the point where engine load reduction is needed due to high air inlet temperatures. It would be expected that if the turbocharger inlets are supplied with engine room supplied air, a temperature rise above ambient of five to 10°C would take place. By supplying the engines with direct outside air, the vessel will also save on the required fan work.

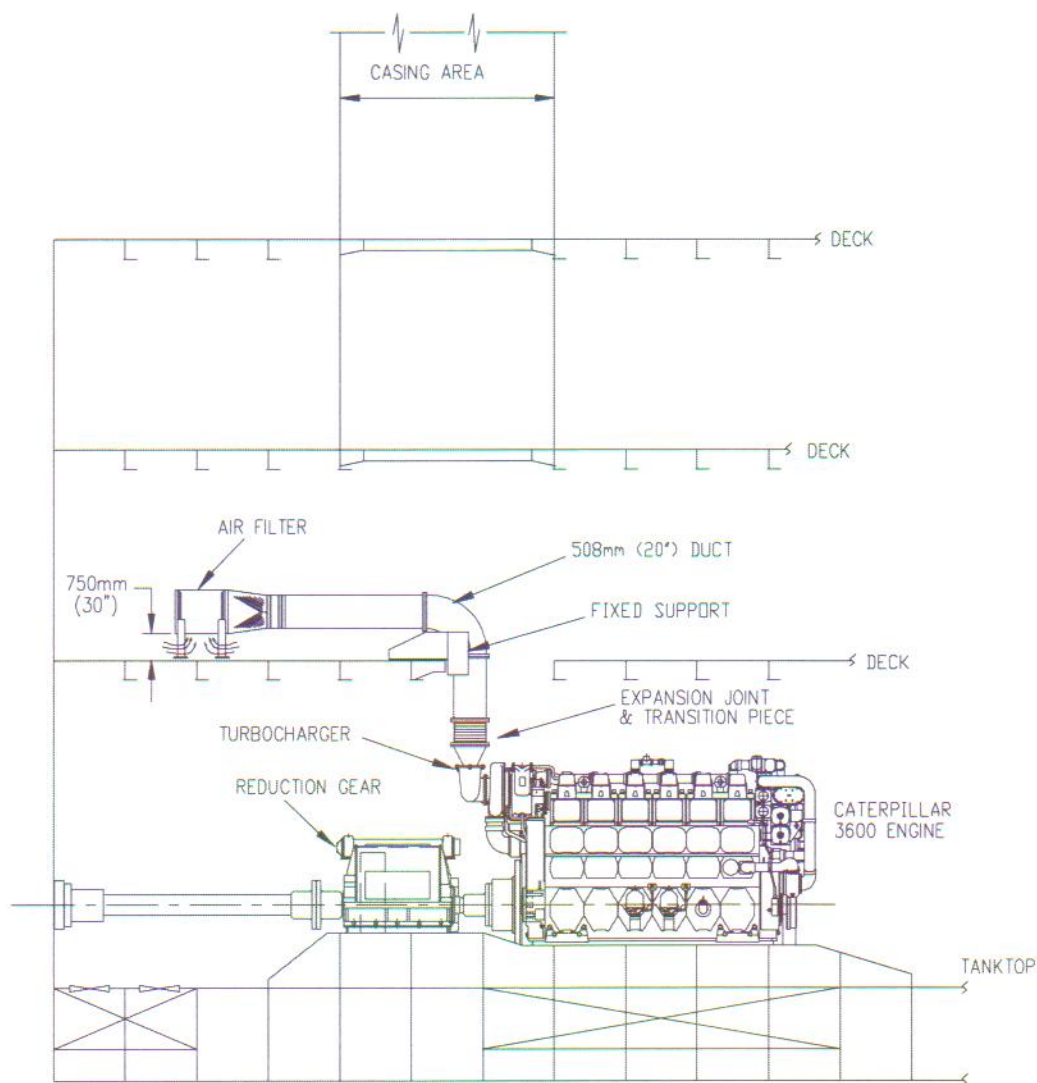
If the engine combustion air is supplied through a separate, dedicated air system, the engine room design should consider the following. A typical system arrangement is shown on page 63.

1. The entire intake system, including clean air filters, should have an initial restriction of no greater than 122 mm H₂O (4.8 in. H₂O).
2. The maximum inlet restriction with dirty air filters should not exceed 380 mm H₂O (15.0 in. H₂O).
3. Flexible connections are necessary to isolate engine vibration from the ducting system. Locate the flex connection as close to the engine as possible, but be aware of the excessive heat generated by the exhaust system.
4. Avoid supporting excessive lengths of ductwork off the turbocharger. The maximum allowable moment on the turbocharger is 300 N•m (222 lb-ft).
5. Caterpillar has specially designed the air intake components to provide the proper airflow pattern before the turbocharger. Turbocharger performance may be adversely affected if these components are not used.

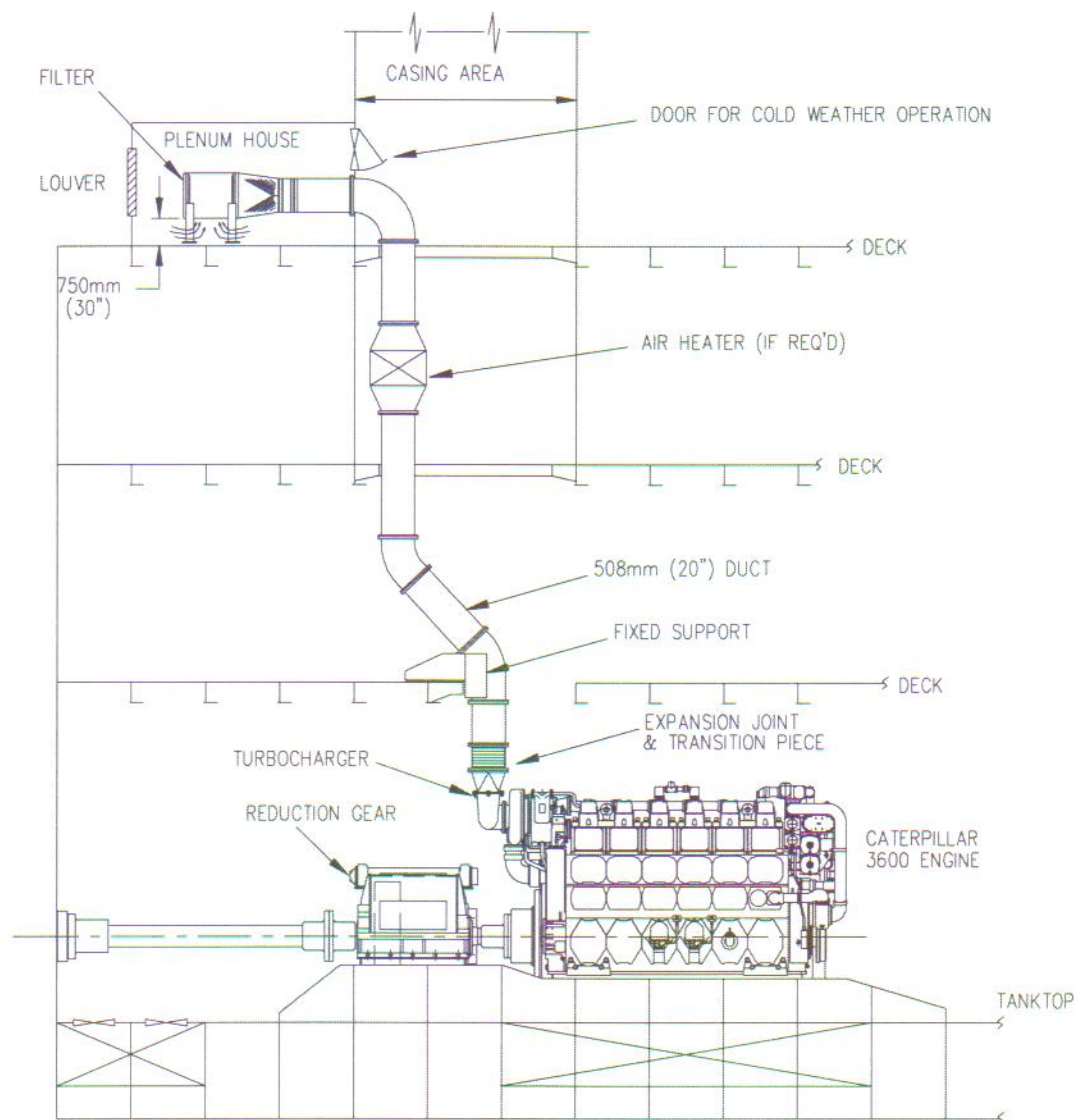
General

The amount of combustion air necessary for the 3612/3616 engine is specified in the technical data section of this manual. The amount of radiated heat emitted by each engine is also specified.

Installations intended for operation in extreme cold may require heated air for starting purposes. In addition, it may be necessary to control the inlet boost pressure for cold air installations. Contact your Caterpillar dealer or the regional Caterpillar representative for further information when extreme ambient conditions are expected.



Remote Mounted Air Cleaner Arrangement
Combustion Air from Inside Engine Room



Remote Mounted Air Cleaner Arrangement
Combustion Air From Outside Engine Room

Exhaust System



Exhaust Manifolds

The 3612/3616 engine uses a pulse exhaust manifold system. The front and rear three cylinders for each bank are connected to separate turbine inlets.

Exhaust Backpressure Limits

The total 3600 exhaust backpressure limit is 254 mm H₂O (10 in. H₂O). This level was established with an emphasis on low specific fuel consumption and exhaust valve temperatures. Therefore, to achieve proper performance of the engine, the exhaust backpressures must be kept below this limit.

Vee engine exhaust piping should be designed with equal restrictions on each bank to prevent unequal bank-to-bank backpressure.

System backpressure should be measured in a straight length of the exhaust pipe at least three to five pipe diameters away from the last size transition from the turbocharger outlet. System backpressure measurement is part of the engine commissioning.

Turbochargers

Turbochargers are located at the flywheel end of the engine. The turbocharger exhaust outlet is rectangular with an area equivalent to 311 mm (12 in.) diameter. Optional cast adapters mount to the turbochargers to provide 355 mm (14 in.) diameter customer connection points.

Also available on an attachment basis are 355 mm (14 in.) diameter flexible bellows, 355 mm (14 in.) diameter 45° and 90° ells, expansion transitions from 355 mm (14 in.) to 457 mm (18 in.) diameter, a 457 mm (18 in.) diameter bellows, and exhaust flanges with bolting and mounting hardware.

The exhaust bellows are intended to compensate for thermal growth and movement of the engine. **The exhaust system structure immediately after the engine exhaust bellows must be a fixed/rigid point.** The supplied exhaust bellows will only handle the engine movement and thermal growth. **No additional external loading is allowed on the turbochargers.**

Exhaust Slobber (Extended Periods of Low Load)

Prolonged low load operation should be followed by periodic operation at higher load to burn out exhaust deposits. Low load operation is below 400 kPa (58 psi) BMEP (approximately 20 percent load, depending on rating). The engine should be operated above 800 kPa (116 psi) BMEP (about 40 percent load, depending on rating) periodically to burn out the exhaust deposits. The 3600 engine can be run well over 24 hours before exhaust slobber becomes significant. The amount of additional time depends upon the engine configuration, water temperature to the aftercooler, inlet air temperature to the engine, and type of fuel.

Exhaust Piping

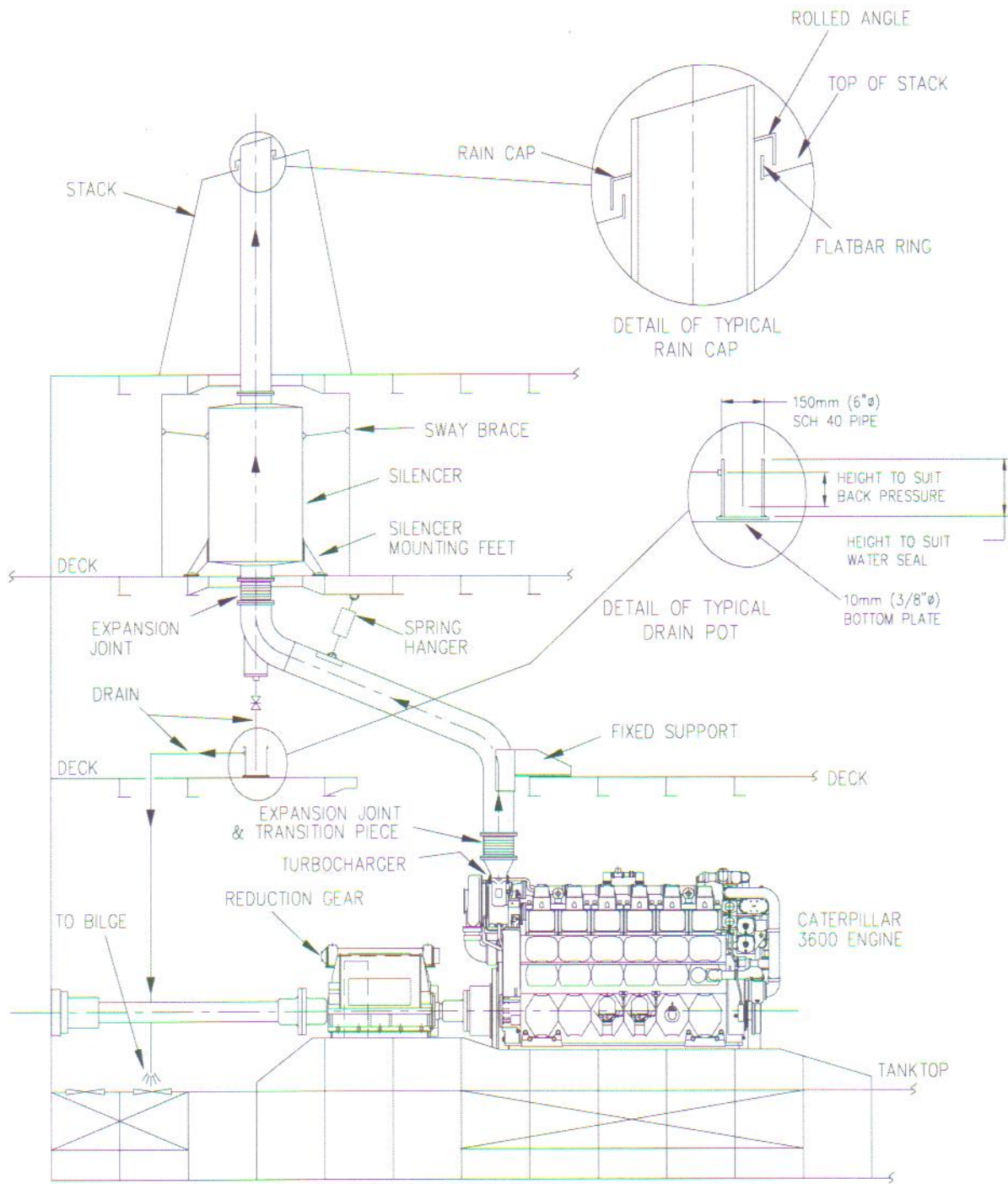
A common exhaust system for multiple installations is not acceptable. An exhaust system combined with other engines allows operating engines to force exhaust gases into engines not operating. The water vapor condenses in the cold engines and may cause engine damage. Additionally, soot clogs turbochargers, aftercoolers, and cleaner elements. Valves separating engines' exhaust systems are also discouraged. High temperatures warp valve seats and soot deposit causes leakage.

The exhaust pipe diameter is based on engine output, gas flow, and length of pipe and number of bends. The maximum gas velocity should not exceed 50 m/sec (164 ft/sec) at full load. Sharp bends should be avoided and, where necessary, should have the largest possible radius. The minimum radius should be 1-1/2 pipe diameters. The piping should be as short as possible and insulated. The insulation should be protected by mechanical lagging to keep it intact. All flexible exhaust fittings should be insulated using removable quilted blankets. It is recommended to provide the system with a valve drain arrangement to prevent rainwater from entering the engine during prolonged shutdown periods. For testing purposes, the exhaust system must have a test port installed after the combined turbocharger outlets. This test port should be a 10 to 13 mm (0.4 to 0.5 in.) plugged pipe welded to the exhaust piping and of sufficient length to bring it to the outer surface of the insulated piping.

Exhaust piping must be able to expand and contract. It is required that one fixed point be installed directly after the flexible exhaust fitting at the turbocharger outlet. This will prevent the transmission of forces resulting from weight, thermal expansion, or lateral displacement of the external exhaust piping from acting on the turbocharger.

Water cooled exhaust systems are commonly used in the fast vessel industry. The systems are designed by the yard or consultants and vary somewhat from installation to installation. Caterpillar has no objections to these systems provided that the engine is properly protected and the parameters as outlined are adhered to. This is the shipyard's responsibility.

A typical exhaust system arrangement is shown on page 66.



Typical Exhaust Pipe System

Engine Governing and Control System



Introduction

This section and the following section describe the standard Caterpillar MMSII control and governor arrangement. The standard control system offering is a PLC-based control and monitoring system with a relay-based backup safety shutdown system. The system is capable of communicating with the vessel main control system through various communication protocols.

Main Engine Governing System

Various governors are available from Woodward and Heinzmann. Refer to Selection Guide.

Clutches

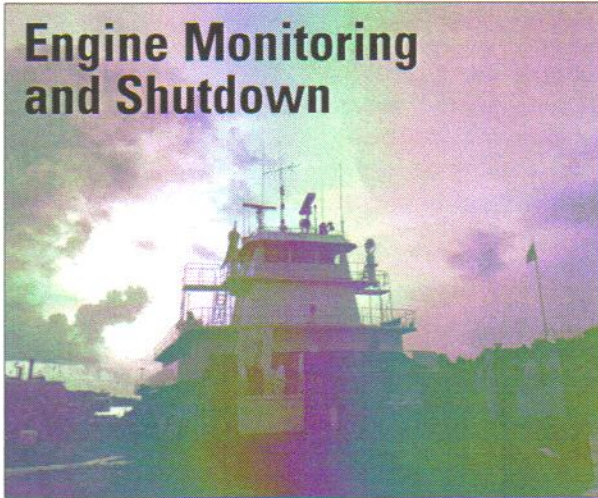
Selection of marine gear clutches is important to the propulsion system operation. Clutch characteristics directly affect how rapidly the propulsion system can respond to the maneuvering demands associated with normal and emergency operation of the vessel. The clutch manufacturer must be consulted in the early project stages.

Shaft Brake

In applications with fixed pitch propellers, where frequent maneuvering is required, or if full speed reversals may be encountered, a propeller shaft brake is beneficial. A properly controlled shaft brake will stop the rotation of the propeller whenever the reduction gear clutches are disengaged.

Several advantages are possible with the use of shaft brakes. Vessel maneuvering time is reduced. Vessel speed is reduced quickly due to increased drag of a stopped propeller vs. a windmilling propeller.

Engine Monitoring and Shutdown



Engine Shutdown

The 3612/3616 engine is installed with shutdown protection for overspeed, low lubrication oil pressure, high crankcase pressure, high jacket water temperature, and Metal Particle Detection. High oil mist level alarm and/or shutdown is available as an option to satisfy marine societies, which typically require this feature on engines above 2250 kW (3015 bhp). In addition, the engine can be shut down through the electrical control system via emergency shutdown buttons installed as required by the marine classification society on the bridge and the engine control panel. For the shutdowns, the engine is stopped via the shutdown solenoid in the governor. However, in case of an overspeed or activated emergency stop button, the engine will be stopped by an emergency air shutoff system. Both of these measures are taken as a precaution and to fulfill society requirements.

The engine safety system is operationally independent from the monitoring system. That means the engine will shut down for the safety functions, high crankcase pressure, overspeed, and low lubrication pressure even when the PLC is not operational.

Engine Monitoring

Engine monitoring switches and analog transducers can vary from one installation to the next.

Pressure Sensors

The engine is installed with a sensor package in accordance with the sensor list enclosed. The pressure sensors are generally mounted on a common panel on the side of the engine.

Temperature Sensors

The exhaust temperature sensors are thermocouples and the remaining sensors are RTDs (PT100).

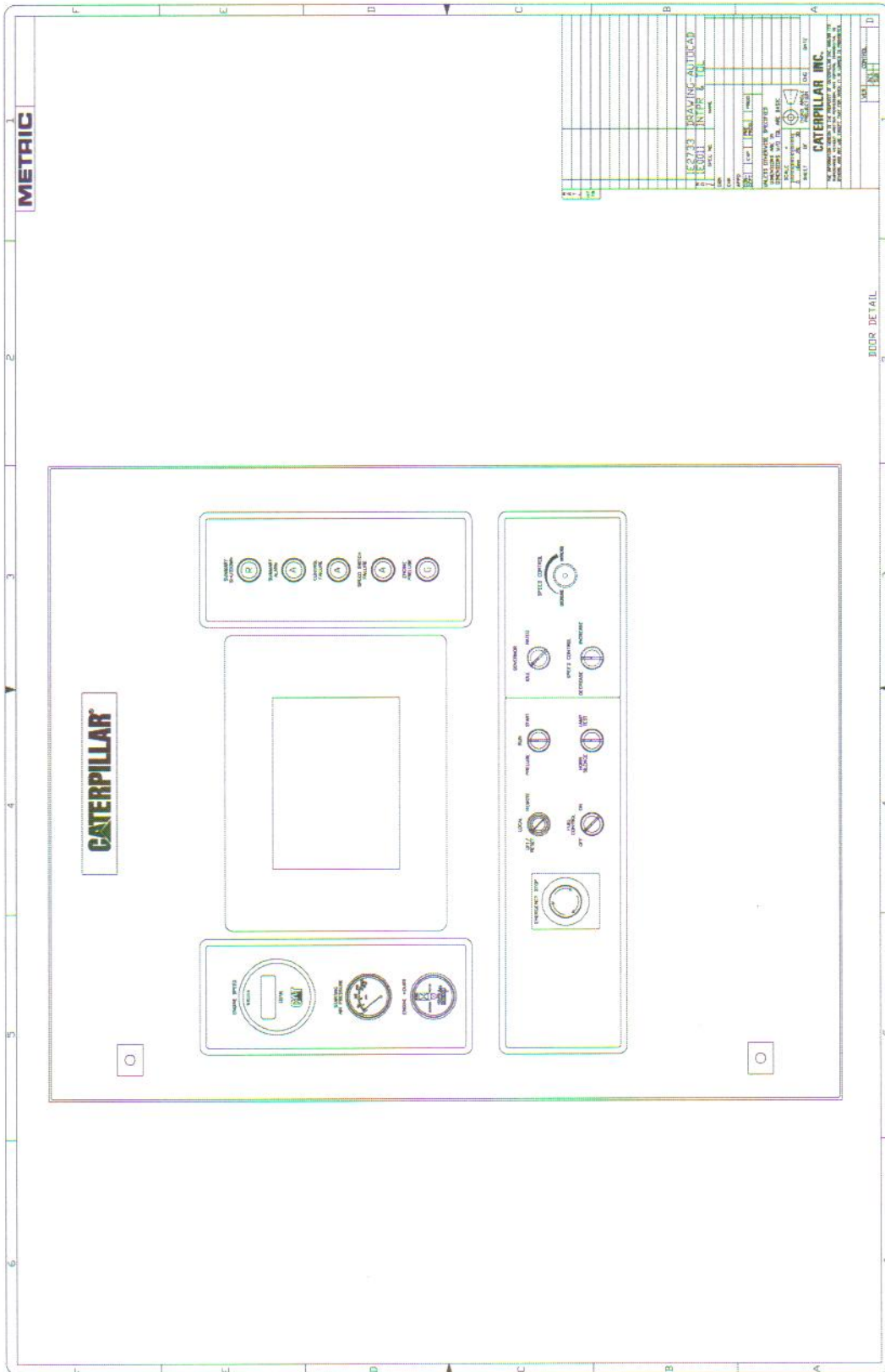
Engine Control Panel

The engine control panel contains all the PLC, start/stop logic, and computer for displaying the operating parameters. These can be viewed on the touch screen located in the engine control panel. The operator is able to call up different screens to view the operational status of each system on the engine. The engine parameters can be viewed on the touchscreen mounted in the panel door. This viewing system contains screens for all the fluid systems with the values displayed. The various screens are called to view by touching the screen. All the engine parameters are further available to the vessel control system via PC communications.

The monitoring and alarm functions listed in the instrumentation list overleaf are typical for a 3600 marine engine supply, marine classification society with notation: **Unmanned Machinery Space**.

Control and Monitoring System Diagram

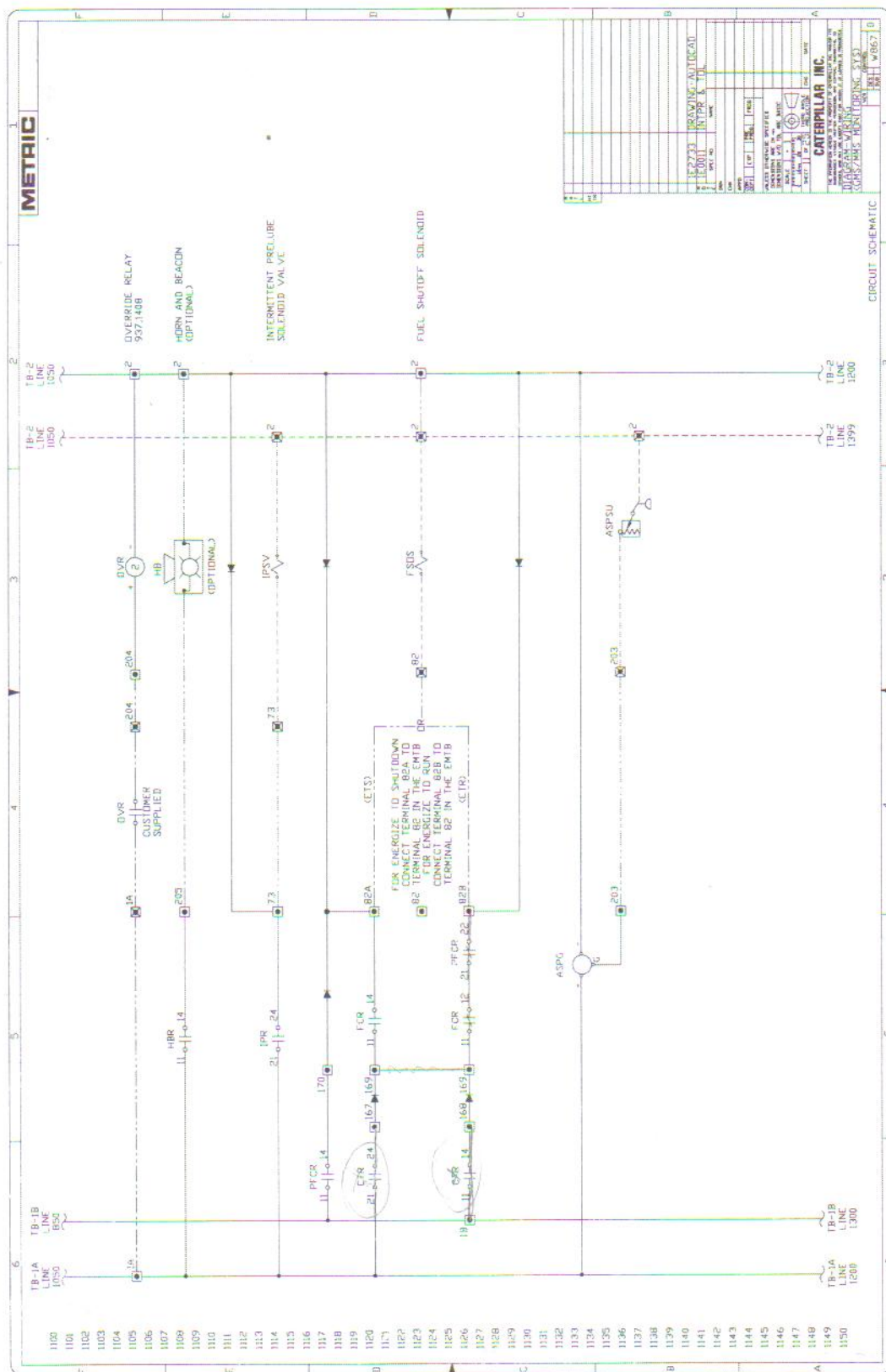
The standard drawings consist of about 24 pages of drawings. A few pages are shown to describe the layout. The following drawings and sensor list are for reference only, and are not to be used for installation purposes.







ENGINE MONITORING AND SHUTDOWN



Control System Inputs to PLC and Redundant Relay Logic

Sensor Description	Signal Type	Alarm	Shut Down	Setpoint Trip	Comments
Pressure Contactors					
Engine low oil pressure: 144-0102	digital		X SB	< 105 kPa	low speed
Engine low oil pressure: 144-0102	digital		X SB	< 260 kPa	high speed
Engine high crankcase pressure: 117-1864	digital		X SB	> 1 kPa	enable when fuel is on
Low air starting pressure: 144-0103	digital	X		< 750 kPa	removed if transducer is ordered
Sea water low pressure: 144-0102 <i>limit</i>	digital	X		< 35 kPa	removed if transducer is ordered
Low jacket water pressure: 144-0102 <i>Normal at 0</i>	digital	X		< 20 kPa (low rpm) < 35 kPa (high rpm)	removed if transducer is ordered
Low AC/OC circuit water pressure: 144-0102	digital	X	SB	< 35 kPa	removed if transducer is ordered
Switches/Misc. Contacts					
Low battery voltage: 7C-3508 <i>inverted</i>	digital	X	SB	< 22 VDC	monitors DC to MMS
Jacket water detection: 125-4340	digital	X	pte. SB	contact close	energizes RJWDA relay
Emergency stop (local)	digital		X SB	contact close	shuts off fuel and air to engine
Engine speed switch crank terminate: 100-5675	digital		SB	> 170 rpm & < 0 + 2 sec	
Engine speed switch alarm time delay: 100-5675	digital		NA	9 sec after SS-001	enables alarms and shutdowns
Engine speed switch oil pressure step: 100-5675	digital		NA	75% rated speed	enables high speed oil contactor
Engine oil sump level low: 7C-6930	digital	X	SB	contact open	
Engine pre-lube pressure: 3N-1400	digital		0, SB	> 9 kPa	engine start interlock
Oil mist detection (system status ready)	digital	X	SB	contact close	oil mist detector ready
Oil mist detection (alarm)	digital	X	SB	contact open	oil mist detector alarm
Expansion tank low level switch	digital	X	Pending	contact open	customer supplied
Engine overspeed (engine speed switch): 100-5675	digital		X SB	113% rated speed	provided by speed switch
Fuel control switch	digital		SB		relay based system
Prelube/start switch — start signal	digital		SB		relay based system
Prelube/start switch — prelube signal	digital		SB		relay based system
Engine control switch — off/reset	digital		SB	contact close	lock out engine and reset system
Alarm/shutdown acknowledge	digital		SB	contact close	indicates ACK alarms
Metal particle detector	digital	X	X SB	contact close	shutdown

ENGINE MONITORING AND SHUTDOWN

Sensor Description	Signal Type	Alarm	Shut Down	Setpoint Trip	Comments
Analog Speed & Pressure Transducer					
Mag pick-up (engine speed switch): 8L-4171	freq		X	113% rated speed	speed switch control sensor
Mag pick-up (PLC): 8L-4171	freq				input to engine speed transducer
Engine speed from SE-005: 115-7954	4-20 mA		X	113% rated speed	0-1200 rpm
Lube oil pressure to filter: 141-9880	4-20 mA			113% rated speed	0-1000 kPa
Lube oil pressure to engine: 141-9880	4-20 mA	X	X	113% rated speed	used to calculate oil filter diff press
Fuel pressure to filter: 141-9880	4-20 mA			113% rated speed	high speed & low speed setpoint
Fuel pressure to engine: 141-9880	4-20 mA	X	X	113% rated speed	0-1000 kPa Used for diff alarm
Engine jacket water pressure: 141-9880	4-20 mA	X	X	113% rated speed	0-1000 kPa
AC/OC circuit water pressure: 141-9880	4-20 mA	X	X	113% rated speed	0-1000 kPa optional
Sea water pressure: 141-9880	4-20 mA	X	X	113% rated speed	0-1000 kPa optional
Engine starting air pressure: 144-4003	4-20 mA	X	X	113% rated speed	0-4000 kPa optional
Engine starting air pressure sending unit: 7W-2118	ohms			113% rated speed	signal for meter on MMS
Engine inlet air manifold pressure: 141-9880	4-20 mA	X	X	113% rated speed	0-1000 kPa

$\Delta p = 17$ 1 kPa

1 kPa = 0.15 psi

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Sensor Description	Signal Type	Alarm	Shut Down	Setpoint Trip	Comments
Analog RTD and Thermocouple					
Engine lube oil temperature: 177-7245	RTD	X	✓	SB > 92°C 197°F	PT100-385
Inlet air manifold temperature: 177-7245	RTD	X	✓	SB > 92°C 197°F	PT100-385
Engine AC/OC circuit inlet water temp: 177-7245	RTD	X	✓	SB > 60°C	PT100-385
Engine jacket water outlet temp: 177-7245	RTD		X	SB > 109°C 228.2°F	PT100-385
Engine jacket water outlet temp: 177-7245	RTD	X		SB > 103°C 217°F	PT100-385 2nd RTD per marine society
Exhaust manifold temp. (left): 124-4598	TC	X	X	> 630°C	type K
Exhaust manifold temp. (right): 124-4598	TC	X		> 630°C	type K — 12 & 16 cyl engine only
Exhaust stack turbo temp. (left): 124-4598	TC	X		> 550°C	type K
Exhaust stack turbo temp. (right): 124-4598	TC	X		> 550°C	type K — 12 & 16 cyl engine only
Cylinder temperature (1): 124-4596	TC	X		> 550°C	type K
Cylinder temperature (2): 124-4596	TC	X		> 550°C	type K
Cylinder temperature (3): 124-4596	TC	X		> 550°C	type K
Cylinder temperature (4): 124-4596	TC	X		> 550°C	type K
Cylinder temperature (5): 124-4596	TC	X		> 550°C	type K
Cylinder temperature (6): 124-4596	TC	X		> 550°C	type K
Cylinder temperature (7): 124-4596	TC	X		> 550°C	type K — 8, 12, & 16 cyl engine only
Cylinder temperature (8): 124-4596	TC	X		> 550°C	type K — 8, 12, & 16 cyl engine only
Cylinder temperature (9): 124-4596 M ₁₀₁ cable disconnected	TC	X		> 550°C	type K — 12 & 16 cyl engine only
Cylinder temperature (10): 124-4596	TC	X		> 550°C	type K — 12 & 16 cyl engine only
Cylinder temperature (11): 124-4596	TC	X		> 550°C	type K — 12 & 16 cyl engine only
Cylinder temperature (12): 124-4596	TC	X		> 550°C	type K — 12 & 16 cyl engine only
Cylinder temperature (13): 124-4596	TC	X		> 550°C	type K — 16 cyl engine only
Cylinder temperature (14): 124-4596	TC	X		> 550°C	type K — 16 cyl engine only

ENGINE MONITORING AND SHUTDOWN

Sensor Description	Signal Type	Alarm	Shut Down	Setpoint Trip	Comments
Analog RTD and Thermocouple (cont.)					
Cylinder temperature (15): 124-4596	TC	X		> 550°C	type K — 16 cyl engine only
Cylinder temperature (16): 124-4596	TC	X		> 550°C	type K — 16 cyl engine only
Marine Gear Inputs					
Gear low oil pressure switch	digital		X	customer setpoint	customer supplied contact
Auxiliary Inputs (Analog and RTD)					
Aux RTD 1	RTD	X		customer configured	0-150°C Customer supplied PT100-385
Aux RTD 2	RTD	X		customer configured	0-150°C Customer supplied PT100-385
Aux 4-20 #1	4-20 mA	X		customer configured	customer supplied
Aux 4-20 #2	4-20 mA	X		customer configured	customer supplied
Auxiliary Inputs (Switches)					
Aux switch 1	digital	X		contact close	customer supplied contact
Remote Input (Customer)					
Remote engine start	digital			contact close	customer supplied contact
Remote engine stop	digital			contact close	customer supplied contact
Remote emergency stop	digital			contact close	customer supplied contact
Engine protection override	digital			contact close	customer supplied contact

Output Description	Data Type	Alarm	Shut Down	Setpoint Trip	Comments
Pressure Alarms/Shutdowns					
Engine low oil pressure	bit		X	105 kPa	low speed shutdown
Engine low oil pressure	bit		X	260 kPa	high speed shutdown
Engine low oil pressure	bit	X		120 kPa/320 kPa	low speed/high speed
Engine high crankcase pressure	bit		X	> 1 kPa	
Low air starting pressure	bit	X		< 750 kPa	
Low sea water pressure	bit	X		< 35 kPa	
Low jacket water pressure	bit	X		< 20 kPa (low rpm) < 35 kPa (high rpm)	
Low AC/OC circuit water pressure	bit	X		< 35 kPa	
Engine oil filter pressure differential (high)	bit	X		> 70 kPa	calc (PT-009 — PT010)
Engine low fuel press. alarm	bit	X		< 260 kPa	
Engine fuel filter pressure differential (high)	bit	X		> 75 kPa	calc (PT-011 — PT-012)
Engine inlet air manifold pressure	bit	X		> 230 kPa	
Marine Gear (Pressure Shutdown)					
Gear low oil pressure switch	bit		X	customer defined	customer supplied contact

ENGINE MONITORING AND SHUTDOWN

Output Description	Data Type	Alarm	Shut Down	Setpoint Trip	Comments
Temperature (Alarm/Shutdowns)					
Engine high jacket water	bit		X	> 109°C	
Engine high jacket water	bit	X		> 103°C	
Engine high AC/OC circuit water temperature	bit	X		> 60°C	
Engine lube oil temperature	bit	X		> 92°C	
High inlet air manifold temperature	bit	X		> 92°C	
Exhaust to turbo temp. (left)	bit	X		> 630°C	
Exhaust to turbo temp. (right)	bit	X		> 630°C	12 & 16 cyl engine only
Exhaust from turbo temp. (left)	bit	X		> 550°C	
Exhaust from turbo temp. (right)	bit	X		> 550°C	12 & 16 cyl engine only
Cylinder temperature (1)	bit	X		> 550°C	
Cylinder temperature (2)	bit	X		> 550°C	
Cylinder temperature (3)	bit	X		> 550°C	
Cylinder temperature (4)	bit	X		> 550°C	
Cylinder temperature (5)	bit	X		> 550°C	
Cylinder temperature (6)	bit	X		> 550°C	
Cylinder temperature (7)	bit	X		> 550°C	8, 12, & 16 cyl engine only
Cylinder temperature (8)	bit	X		> 550°C	8, 12, & 16 cyl engine only
Cylinder temperature (9)	bit	X		> 550°C	12 & 16 cyl engine only
Cylinder temperature (10)	bit	X		> 550°C	12 & 16 cyl engine only
Cylinder temperature (11)	bit	X		> 550°C	12 & 16 cyl engine only
Cylinder temperature (12)	bit	X		> 550°C	12 & 16 cyl engine only
Cylinder temperature (13)	bit	X		> 550°C	16 cyl engine only
Cylinder temperature (14)	bit	X		> 550°C	16 cyl engine only
Cylinder temperature (15)	bit	X		> 550°C	16 cyl engine only
Cylinder temperature (16)	bit	X		> 550°C	16 cyl engine only

Output Description	Data Type	Alarm	Shut Down	Setpoint Trip	Comments
Switches/Misc. Status					
Cylinder (1) temperature deviation from avg.	bit	X		> 50°C	
Cylinder (2) temperature deviation from avg.	bit	X		> 50°C	
Cylinder (3) temperature deviation from avg.	bit	X		> 50°C	
Cylinder (4) temperature deviation from avg.	bit	X		> 50°C	
Cylinder (5) temperature deviation from avg.	bit	X		> 50°C	
Cylinder (6) temperature deviation from avg.	bit	X		> 50°C	
Cylinder (7) temperature deviation from avg.	bit	X		> 50°C	8, 12, & 16 cyl engine only
Cylinder (8) temperature deviation from avg.	bit	X		> 50°C	8, 12, & 16 cyl engine only
Cylinder (9) temperature deviation from avg.	bit	X		> 50°C	12 & 16 cyl engine only
Cylinder (10) temperature deviation from avg.	bit	X		> 50°C	12 & 16 cyl engine only
Cylinder (11) temperature deviation from avg.	bit	X		> 50°C	12 & 16 cyl engine only
Cylinder (12) temperature deviation from avg.	bit	X		> 50°C	12 & 16 cyl engine only
Cylinder (13) temperature deviation from avg.	bit	X		> 50°C	16 cyl engine only
Cylinder (14) temperature deviation from avg.	bit	X		> 50°C	16 cyl engine only
Cylinder (15) temperature deviation from avg.	bit	X		> 50°C	16 cyl engine only
Cylinder (16) temperature deviation from avg.	bit	X		> 50°C	16 cyl engine only
Low battery voltage — system	bit	X		< 22 VDC	
Low PLC memory battery voltage	bit	X			red batt light on PLC's CPU
Jacket water detection	bit	X		contact close	
Emergency stop	bit		X	contact close	
Engine speed switch crank terminate	bit	X		> 170 rpm & 0 + 2 sec	
Low engine oil sump level	bit	X		mechanical position	
Engine pre-lube (starting) pressure available	bit			> 9 kPa	engine start interlock
Oil mist detection (system ready status)	bit	X			

ENGINE MONITORING AND SHUTDOWN

Output Description	Data Type	Alarm	Shut Down	Setpoint Trip	Comments
Switches/Misc. Status (con't.)					
Oil mist detection (shutdown)	bit		X	contact close	
Low expansion tank level switch	bit	X		customer defined	customer supplied contact
Engine overspeed	bit		X	113% rated speed	provided by speed switch or PLC
Reduce engine load	bit	X			manual decrease load
Mag pick-up (engine speed switch)	bit	X		ST-008 and not SE-004	speed switch pick-up
Engine control switch — off	bit			contact close	
Sensor Failures					
Engine lube oil temperature	bit	X		< -50°C or > 150°C	
Inlet air manifold temperature	bit	X		< -50°C or > 150°C	
Engine AC/OC circuit outlet water temp	bit	X		< -50°C or > 150°C	
Engine jacket water outlet temp (shutdown)	bit	X		< -50°C or > 150°C	
Engine jacket water outlet temp (alarm)	bit	X		< -50°C or > 150°C	
Exhaust to turbo temp. (left)	bit	X		< -50°C or > 700°C	
Exhaust to turbo temp. (right)	bit	X		< -50°C or > 700°C	12 & 16 cyl engine only
Exhaust from turbo temp. (left)	bit	X		< -50°C or > 700°C	
Exhaust from turbo temp. (right)	bit	X		< -50°C or > 700°C	12 & 16 cyl engine only
Cylinder temperature (1)	bit	X		< -50°C or > 700°C	
Cylinder temperature (2)	bit	X		< -50°C or > 700°C	
Cylinder temperature (3)	bit	X		< -50°C or > 700°C	
Cylinder temperature (4)	bit	X		< -50°C or > 700°C	
Cylinder temperature (5)	bit	X		< -50°C or > 700°C	
Cylinder temperature (6)	bit	X		< -50°C or > 700°C	
Cylinder temperature (7)	bit	X		< -50°C or > 700°C	8, 12, & 16 cyl engine only

Output Description	Data Type	Alarm	Shut Down	Setpoint Trip	Comments
Sensor Failures (con't.)					
Cylinder temperature (8)	bit	X		< -50°C or > 700°C	8, 12, & 16 cyl engine only
Cylinder temperature (9)	bit	X		< -50°C or > 700°C	12 & 16 cyl engine only
Cylinder temperature (10)	bit	X		< -50°C or > 700°C	12 & 16 cyl engine only
Cylinder temperature (11)	bit	X		< -50°C or > 700°C	12 & 16 cyl engine only
Cylinder temperature (12)	bit	X		< -50°C or > 700°C	12 & 16 cyl engine only
Cylinder temperature (13)	bit	X		< -50°C or > 700°C	16 cyl engine only
Cylinder temperature (14)	bit	X		< -50°C or > 700°C	16 cyl engine only
Cylinder temperature (15)	bit	X		< -50°C or > 700°C	16 cyl engine only
Cylinder temperature (16)	bit	X		< -50°C or > 700°C	16 cyl engine only
Engine speed transducer	bit	X		< 3.85 mA or > 20.15 mA	
Lube oil pressure to filter	bit	X		< 3.85 mA or > 20.15 mA	
Lube oil pressure to engine	bit	X		< 3.85 mA or > 20.15 mA	
Fuel pressure to filter	bit	X		< 3.85 mA or > 20.15 mA	used for diff alarm
Fuel pressure to engine	bit	X		< 3.85 mA or > 20.15 mA	
Engine jacket water pressure	bit	X		< 3.85 mA or > 20.15 mA	optional
AC/OC circuit water pressure	bit	X		< 3.85 mA or > 20.15 mA	optional
Sea water pressure	bit	X		< 3.85 mA or > 20.15 mA	optional
Engine starting air pressure	bit	X		< 3.85 mA or > 20.15 mA	optional
Engine inlet air manifold pressure	bit	X		< 3.85 mA or > 20.15 mA	
Engine low oil pressure contactor	bit	X		no signal — NO and NC	low speed
Engine low oil pressure contactor	bit	X		no signal — NO and NC	high speed
Engine high crankcase pressure contactor	bit	X		no signal — NO and NC	

Output Description	Data Type	Alarm	Shut Down	Setpoint Trip	Comments
RTD and Thermocouple (con't.)					
Exhaust from turbo temp. (right)	word	X		> 550°C	0-700°C 12 & 16 cyl engine only
Cylinder temperature (1)	word	X		> 550°C	0-700°C
Cylinder temperature (2)	word	X		> 550°C	0-700°C
Cylinder temperature (3)	word	X		> 550°C	0-700°C
Cylinder temperature (4)	word	X		> 550°C	0-700°C
Cylinder temperature (5)	word	X		> 550°C	0-700°C
Cylinder temperature (6)	word	X		> 550°C	0-700°C
Cylinder temperature (7)	word	X		> 550°C	0-700°C 8, 12, & 16 cyl engine only
Cylinder temperature (8)	word	X		> 550°C	0-700°C 8, 12, & 16 cyl engine only
Cylinder temperature (9)	word	X		> 550°C	0-700°C 12 & 16 cyl engine only
Cylinder temperature (10)	word	X		> 550°C	0-700°C 12 & 16 cyl engine only
Cylinder temperature (11)	word	X		> 550°C	0-700°C 12 & 16 cyl engine only
Cylinder temperature (12)	word	X		> 550°C	0-700°C 12 & 16 cyl engine only
Cylinder temperature (13)	word	X		> 550°C	0-700°C 16 cyl engine only
Cylinder temperature (14)	word	X		> 550°C	0-700°C 16 cyl engine only
Cylinder temperature (15)	word	X		> 550°C	0-700°C 16 cyl engine only
Cylinder temperature (16)	word	X		> 550°C	0-700°C 16 cyl engine only
Avg. of exhaust port temp. for deviation calc	word				0-700°C

ENGINE MONITORING AND SHUTDOWN

Output Description	Signal Type	Alarm	Shut Down	Setpoint Trip	Comments
Control Sensors					
Mag pick-up (engine speed)	4-20 mA		X	113% rated speed	0-1200 rpm
Lube oil pressure to engine	4-20 mA	X	X	< 320 kPa < 120 kPa	0-1000 kPa
Engine high exhaust temp from turbo (right)	4-20 mA	X		> 630°C	0-700°C
Engine high exhaust temp from turbo (left)	4-20 mA	X		> 630°C	0-700°C
Aux switch out 1	24 VDC				controlled at monitor
High crankcase pressure shutdown	NC		X	PSHH-003	RCPHS relay
Low engine oil pressure shutdown	NC		X	PSLL-001 or PT-002	ROPIS relay
Engine overspeed shutdown	NC		X	SS-002	ROSR relay
Fuel control relay	NO, NC		X	switch or fault	RFCR relay
Low marine gear pressure shutdown	NC		X	PSLL-020	RGOPIS relay
Alarm horn and beacon	NO	X	X	alarm or shutdown	RHB relay
Summary shutdown (engine fault)	NC		X	relay shutdown	REFR relay
Engine running (crank terminate)	NO			engine speed > 170 rpm	RCTR relay
Prelube engine	NO			PS-008 > 9 kPa	RPR relay
Circuit breaker trip alarm	NC	X		circuit breaker opens	aux contacts on circuit breakers
Reduce engine load	NO, NC				REL relay
Engine alarm summary	NO	X			
Lube oil standby pump	24 VDC			< 115 kPa	customer supplied interface 24 VDC provided to customer interface

Output Description	Signal Type	Alarm	Shut Down	Trip/Activation Condition	Comments
Control Sensors (con't.)					
Air start signal to engine	digital				remote start only — RAS relay
Fuel shutoff signal to engine	digital		X	shutdown or fuel off	RFCR relay
Air shutoff signal to engine	digital			overspeed & e-stop	ASOS solenoid
Engine prelube signal to engine	digital			> 9 kPa	RPR relay
Engine protection system override relay on	digital				ROVR relay — override shutdowns
Summary group alarm relay activate	digital	X		any alarm	RSA relay
Summary group shutdown signal	digital		X	protective shutdown	energizes REFR relay on protective shutdown
Jacket water detection relay	digital	X			RJWDA relay
Engine speed tachometer	freq				mag pick-up driven
Engine hour meter	digital				
Starting air pressure meter	ohms				resistive sensor
Summary alarm light	digital	X		any alarm	
Summary shutdown light	digital		X	protective shutdown	
PLC failure	digital	X		no signal to RPLCFA	RPLCFA de-energized on PLC failure
Engine prelubed	digital			> 9 kPa	

MODBUS Address List

Analog Data	MODBUS Address
Fuel rack position	40001
Lube oil to engine temperature (°C)	40002
Lube oil to engine pressure (kPa)	40003
Lube oil to filter pressure (kPa)	40004
Inlet air manifold temperature (°C)	40005
Inlet air manifold pressure (kPa)	40006
Fuel to engine temperature (°C)	40007
Fuel to engine pressure (kPa)	40008
Fuel to filter pressure (kPa)	40009
Jacket water outlet temperature (°C)	40010
Redundant jacket water outlet temperature (°C)	40011
Jacket water pressure (kPa)	40012
AC/OC water inlet temperature (°C)	40013
AC/OC pump pressure (kPa)	40014
Raw water pressure (kPa)	40015
Auxiliary #1 temperature (°C)	40016
Auxiliary #2 temperature (°C)	40017
Auxiliary #1 4-20 mA (kPa)	40018
Auxiliary #2 4-20 mA (kPa)	40019
Air start pressure (kPa)	40020
Non-drive bearing temperature (°C)	40021
Drive bearing temperature (°C)	40022
Stator A temperature (°C)	40023
Stator B temperature (°C)	40024
Stator C temperature (°C)	40025
Turbine inlet left/inline temperature (°C)	40026
Turbine inlet right temperature (°C)	40027
Turbine outlet left/inline temperature (°C)	40028
Turbine outlet right temperature (°C)	40029
Exhaust port #1 temperature (°C)	40030
Exhaust port #2 temperature (°C)	40031
Exhaust port #3 temperature (°C)	40032
Exhaust port #4 temperature (°C)	40033
Exhaust port #5 temperature (°C)	40034
Exhaust port #6 temperature (°C)	40035
Exhaust port #7 temperature (°C)	40036
Exhaust port #8 temperature (°C)	40037
Exhaust port #9 temperature (°C)	40038
Exhaust port #10 temperature (°C)	40039
Exhaust port #11 temperature (°C)	40040
Exhaust port #12 temperature (°C)	40041
Exhaust port #13 temperature (°C)	40042
Exhaust port #14 temperature (°C)	40043
Exhaust port #15 temperature (°C)	40044
Exhaust port #16 temperature (°C)	40045
Write spare	40046
Write spare	40047
Write spare	40048
Write spare	40049
Turbine left/inline speed (rpm)	40050
Turbine right speed (rpm)	40051
Engine speed (rpm)	40052

Analog Data	MODBUS Address
Exhaust port #1 temperature deviation (°C)	40053
Exhaust port #2 temperature deviation (°C)	40054
Exhaust port #3 temperature deviation (°C)	40055
Exhaust port #4 temperature deviation (°C)	40056
Exhaust port #5 temperature deviation (°C)	40057
Exhaust port #6 temperature deviation (°C)	40058
Exhaust port #7 temperature deviation (°C)	40059
Exhaust port #8 temperature deviation (°C)	40060
Exhaust port #9 temperature deviation (°C)	40061
Exhaust port #10 temperature deviation (°C)	40062
Exhaust port #11 temperature deviation (°C)	40063
Exhaust port #12 temperature deviation (°C)	40064
Exhaust port #13 temperature deviation (°C)	40065
Exhaust port #14 temperature deviation (°C)	40066
Exhaust port #15 temperature deviation (°C)	40067
Exhaust port #16 temperature deviation (°C)	40068
Write spare	40069
Write spare	40070
Write spare	40071
Write spare	40072
Fuel filter pressure differential (kPa)	40073
Lube oil filter pressure differential (kPa)	40074
Write spare	40075
Write spare	40076
Write spare	40077
Write spare	40078
Write spare	40079
Write spare	40080
Write spare	40081
Write spare	40082
Write spare	40083
Write spare	40084
Write spare	40085
Write spare	40086
Write spare	40087
Write spare	40088
Write spare	40089
Write spare	40090
Write spare	40091
Write spare	40092
Write spare	40093
Write spare	40094
Write spare	40095
Write spare	40096
Write spare	40097
Write spare	40098
Write spare	40099
Write spare	40100

3612 AND 3616 MARINE PROJECT GUIDE

Analog Data	MODBUS Address
Lube oil to engine temperature (°F)	40101
Lube oil to engine pressure (psi)	40102
Lube oil to filter pressure (psi)	40103
Inlet air manifold temperature (°F)	40104
Inlet air manifold pressure (psi)	40105
Fuel to engine temperature (°F)	40106
Fuel to engine pressure (psi)	40107
Fuel to filter pressure (psi)	40108
Jacket water outlet temperature (°F)	40109
Redundant jacket water outlet temperature (°F)	40110
Jacket water pressure (psi)	40111
AC/OC water inlet temperature (°F)	40112
AC/OC pump pressure (psi)	40113
Raw water pressure (psi)	40114
Auxiliary #1 temperature (°F)	40115
Auxiliary #2 temperature (°F)	40116
Auxiliary #1 4-20 mA (psi)	40117
Auxiliary #2 4-20 mA (psi)	40118
Air start pressure (psi)	40119
Non-drive bearing temperature (°F)	40120
Drive bearing temperature (°F)	40121
Stator A temperature (°F)	40122
Stator B temperature (°F)	40123
Stator C temperature (°F)	40124
Turbine inlet left/inline temperature (°F)	40125
Turbine inlet right temperature (°F)	40126
Turbine outlet left/inline temperature (°F)	40127
Turbine outlet right temperature (°F)	40128
Exhaust port #1 temperature (°F)	40129
Exhaust port #2 temperature (°F)	40130
Exhaust port #3 temperature (°F)	40131
Exhaust port #4 temperature (°F)	40132
Exhaust port #5 temperature (°F)	40133
Exhaust port #6 temperature (°F)	40134
Exhaust port #7 temperature (°F)	40135
Exhaust port #8 temperature (°F)	40136
Exhaust port #9 temperature (°F)	40137
Exhaust port #10 temperature (°F)	40138
Exhaust port #11 temperature (°F)	40139
Exhaust port #12 temperature (°F)	40140
Exhaust port #13 temperature (°F)	40141
Exhaust port #14 temperature (°F)	40142
Exhaust port #15 temperature (°F)	40143
Exhaust port #16 temperature (°F)	40144
Write spare	40145
Write spare	40146
Write spare	40147
Write spare	40148

Analog Data	MODBUS Address
Exhaust port #1 temperature deviation (°F)	40149
Exhaust port #2 temperature deviation (°F)	40150
Exhaust port #3 temperature deviation (°F)	40151
Exhaust port #4 temperature deviation (°F)	40152
Exhaust port #5 temperature deviation (°F)	40153
Exhaust port #6 temperature deviation (°F)	40154
Exhaust port #7 temperature deviation (°F)	40155
Exhaust port #8 temperature deviation (°F)	40156
Exhaust port #9 temperature deviation (°F)	40157
Exhaust port #10 temperature deviation (°F)	40158
Exhaust port #11 temperature deviation (°F)	40159
Exhaust port #12 temperature deviation (°F)	40160
Exhaust port #13 temperature deviation (°F)	40161
Exhaust port #14 temperature deviation (°F)	40162
Exhaust port #15 temperature deviation (°F)	40163
Exhaust port #16 temperature deviation (°F)	40164
Write spare	40165
Write spare	40166
Write spare	40167
Write spare	40168
Fuel filter pressure differential (psi)	40169
Lube oil filter pressure differential (psi)	40170
Write spare	40171
Write spare	40172
Write spare	40173
Write spare	40174
Write spare	40175
Write spare	40176
Write spare	40177
Write spare	40178
Write spare	40179
Write spare	40180
Write spare	40181
Write spare	40182
Write spare	40183
Write spare	40184
Write spare	40185
Write spare	40186
Write spare	40187
Write spare	40188
Write spare	40189
Write spare	40190
Write spare	40191
Write spare	40192
Write spare	40193
Write spare	40194
Write spare	40195
Write spare	40196
Write spare	40197
Write spare	40198
Write spare	40199
Write spare	40200

3612 AND 3616 MARINE PROJECT GUIDE

Analog Data	MODBUS Address
PM3000 voltage	40201
PM3000 voltage	40202
PM3000 voltage	40203
PM3000 voltage	40204
PM3000 voltage	40205
PM3000 voltage	40206
PM3000 voltage	40207
PM3000 voltage	40208
PM3000 voltage	40209
PM3000 voltage	40210
PM3000 voltage	40211
PM3000 voltage	40212
PM3000 current	40213
PM3000 current	40214
PM3000 current	40215
PM3000 power	40216
PM3000 power	40217
PM3000 power	40218
PM3000 power	40219
PM3000 power	40220
PM3000 power	40221
PM3000 power factor	40222
PM3000 power factor	40223
PM3000 frequency	40224
PM3000 frequency	40225
Write spare	40226
Write spare	40227
Write spare	40228
Write spare	40229
Write spare	40230
Write spare	40231
Write spare	40232
Write spare	40233
Write spare	40234
Write spare	40235
Write spare	40236
Write spare	40237
Write spare	40238
Write spare	40239
Write spare	40240
Write spare	40241
Write spare	40242
Write spare	40243
Write spare	40244
Write spare	40245
Write spare	40246
Write spare	40247
Write spare	40248
Write spare	40249
Write spare	40250

Analog Data	MODBUS Address
Alarm Status	40251
Lube oil to engine temperature sensor failure alarm	40251.01
Lube oil to engine temperature sensor failure alarm acknowledged	40251.02
Lube oil to engine pressure sensor failure alarm	40251.03
Lube oil to engine pressure sensor failure alarm acknowledged	40251.04
Lube oil to filter pressure sensor failure alarm	40251.05
Lube oil to filter pressure sensor failure alarm acknowledged	40251.06
Inlet air manifold temperature sensor failure alarm	40251.07
Inlet air manifold temperature sensor failure alarm acknowledged	40251.08
Inlet air manifold pressure sensor failure alarm	40251.09
Inlet air manifold pressure sensor failure alarm acknowledged	40251.10
Fuel to engine temperature sensor failure alarm	40251.11
Fuel to engine temperature sensor failure alarm acknowledged	40251.12
Fuel to engine pressure sensor failure alarm	40251.13
Fuel to engine pressure sensor failure alarm acknowledged	40251.14
Fuel to filter pressure sensor failure alarm	40251.15
Fuel to filter pressure sensor failure alarm acknowledged	40251.16
Alarm Status	40252
Jacket water outlet temperature sensor failure alarm	40252.01
Jacket water outlet temperature sensor failure alarm acknowledged	40252.02
Redundant jacket water outlet temperature sensor failure alarm	40252.03
Redundant jacket water outlet temperature sensor failure alarm acknowledged	40252.04
Jacket water pressure sensor failure alarm	40252.05
Jacket water pressure sensor failure alarm acknowledged	40252.06
AC/OC water inlet temperature sensor failure alarm	40252.07
AC/OC water inlet temperature sensor failure alarm acknowledged	40252.08
AC/OC pump pressure sensor failure alarm	40252.09
AC/OC pump pressure sensor failure alarm acknowledged	40252.10
Raw water pressure sensor failure alarm	40252.11
Raw water pressure sensor failure alarm acknowledged	40252.12
Auxiliary #1 temperature sensor failure alarm	40252.13
Auxiliary #1 temperature sensor failure alarm acknowledged	40252.14
Auxiliary #2 temperature sensor failure alarm	40252.15
Auxiliary #2 temperature sensor failure alarm acknowledged	40252.16
Alarm Status	40253
Auxiliary #1 4-20 mA sensor failure alarm	40253.01
Auxiliary #1 4-20 mA sensor failure alarm acknowledged	40253.02
Auxiliary #2 4-20 mA sensor failure alarm	40253.03
Auxiliary #2 4-20 mA sensor failure alarm acknowledged	40253.04
Air start pressure sensor failure alarm	40253.05
Air start pressure sensor failure alarm acknowledged	40253.06
Non-drive bearing temperature sensor failure alarm	40253.07
Non-drive bearing temperature sensor failure alarm acknowledged	40253.08
Drive bearing temperature sensor failure alarm	40253.09
Drive bearing temperature sensor failure alarm acknowledged	40253.10
Stator A temperature sensor failure alarm	40253.11
Stator A temperature sensor failure alarm acknowledged	40253.12
Stator B temperature sensor failure alarm	40253.13
Stator B temperature sensor failure alarm acknowledged	40253.14
Stator C temperature sensor failure alarm	40253.15
Stator C temperature sensor failure alarm acknowledged	40253.16

3612 AND 3616 MARINE PROJECT GUIDE

Analog Data	MODBUS Address
Alarm Status	40254
Turbine inlet left/inline temperature sensor failure alarm	40254.01
Turbine inlet left/inline temperature sensor failure alarm acknowledged	40254.02
Turbine inlet right temperature sensor failure alarm	40254.03
Turbine inlet right temperature sensor failure alarm acknowledged	40254.04
Turbine outlet left/inline temperature sensor failure alarm	40254.05
Turbine outlet left/inline temperature sensor failure alarm acknowledged	40254.06
Turbine outlet right temperature sensor failure alarm	40254.07
Turbine outlet right temperature sensor failure alarm acknowledged	40254.08
Exhaust port #1 temperature sensor failure alarm	40254.09
Exhaust port #1 temperature sensor failure alarm acknowledged	40254.10
Exhaust port #2 temperature sensor failure alarm	40254.11
Exhaust port #2 temperature sensor failure alarm acknowledged	40254.12
Exhaust port #3 temperature sensor failure alarm	40254.13
Exhaust port #3 temperature sensor failure alarm acknowledged	40254.14
Exhaust port #4 temperature sensor failure alarm	40254.15
Exhaust port #4 temperature sensor failure alarm acknowledged	40254.16
Alarm Status	40255
Exhaust port #5 temperature sensor failure alarm	40255.01
Exhaust port #5 temperature sensor failure alarm acknowledged	40255.02
Exhaust port #6 temperature sensor failure alarm	40255.03
Exhaust port #6 temperature sensor failure alarm acknowledged	40255.04
Exhaust port #7 temperature sensor failure alarm	40255.05
Exhaust port #7 temperature sensor failure alarm acknowledged	40255.06
Exhaust port #8 temperature sensor failure alarm	40255.07
Exhaust port #8 temperature sensor failure alarm acknowledged	40255.08
Exhaust port #9 temperature sensor failure alarm	40255.09
Exhaust port #9 temperature sensor failure alarm acknowledged	40255.10
Exhaust port #10 temperature sensor failure alarm	40255.11
Exhaust port #10 temperature sensor failure alarm acknowledged	40255.12
Exhaust port #11 temperature sensor failure alarm	40255.13
Exhaust port #11 temperature sensor failure alarm acknowledged	40255.14
Exhaust port #12 temperature sensor failure alarm	40255.15
Exhaust port #12 temperature sensor failure alarm acknowledged	40255.16
Alarm Status	40256
Exhaust port #13 temperature sensor failure alarm	40256.01
Exhaust port #13 temperature sensor failure alarm acknowledged	40256.02
Exhaust port #14 temperature sensor failure alarm	40256.03
Exhaust port #14 temperature sensor failure alarm acknowledged	40256.04
Exhaust port #15 temperature sensor failure alarm	40256.05
Exhaust port #15 temperature sensor failure alarm acknowledged	40256.06
Exhaust port #16 temperature sensor failure alarm	40256.07
Exhaust port #16 temperature sensor failure alarm acknowledged	40256.08
Turbine left/inline speed sensor failure alarm	40256.09
Turbine left/inline speed sensor failure alarm acknowledged	40256.10
Turbine right speed sensor failure alarm	40256.11
Turbine right speed sensor failure alarm acknowledged	40256.12
Engine speed sensor failure alarm	40256.13
Engine speed sensor failure alarm acknowledged	40256.14
Ball head backup mode sensor failure alarm	40256.15
Ball head backup mode sensor failure alarm acknowledged	40256.16

Analog Data	MODBUS Address
Alarm Status	40257
Crankcase pressure sensor failure alarm	40257.01
Crankcase pressure sensor failure alarm acknowledged	40257.02
Oil mist detector sensor failure alarm	40257.03
Oil mist detector sensor failure alarm acknowledged	40257.04
Low speed low oil pressure sensor failure alarm	40257.05
Low speed low oil pressure sensor failure alarm acknowledged	40257.06
High speed low oil pressure sensor failure alarm	40257.07
High speed low oil pressure sensor failure alarm acknowledged	40257.08
Lube oil to engine temperature high alarm	40257.09
Lube oil to engine temperature high alarm acknowledged	40257.10
Lube oil to engine pressure low alarm	40257.11
Lube oil to engine pressure low alarm acknowledged	40257.12
Lube oil to filter pressure high alarm	40257.13
Lube oil to filter pressure high alarm acknowledged	40257.14
Inlet air manifold temperature high alarm	40257.15
Inlet air manifold temperature high alarm acknowledged	40257.16
Alarm Status	40258
Inlet air manifold pressure high alarm	40258.01
Inlet air manifold pressure high alarm acknowledged	40258.02
Fuel to engine temperature high alarm	40258.03
Fuel to engine temperature high alarm acknowledged	40258.04
Fuel to engine pressure low alarm	40258.05
Fuel to engine pressure low alarm acknowledged	40258.06
Jacket water outlet temperature high alarm	40258.07
Jacket water outlet temperature high alarm acknowledged	40258.08
Jacket water pressure low alarm	40258.09
Jacket water pressure low alarm acknowledged	40258.10
AC/OC water inlet temperature high alarm	40258.11
AC/OC water inlet temperature high alarm acknowledged	40258.12
AC/OC pump pressure low alarm	40258.13
AC/OC pump pressure low alarm acknowledged	40258.14
Raw water pressure low alarm	40258.15
Raw water pressure low alarm acknowledged	40258.16
Alarm Status	40259
Auxiliary #1 temperature alarm	40259.01
Auxiliary #1 temperature alarm acknowledged	40259.02
Auxiliary #2 temperature alarm	40259.03
Auxiliary #2 temperature alarm acknowledged	40259.04
Auxiliary #1 4-20 mA alarm	40259.05
Auxiliary #2 4-20 mA alarm acknowledged	40259.06
Auxiliary #2 4-20 mA alarm	40259.07
Auxiliary #2 4-20 mA alarm acknowledged	40259.08
Air start pressure low alarm	40259.09
Air start pressure low alarm acknowledged	40259.10
Non-drive bearing temperature high alarm	40259.11
Non-drive bearing temperature high alarm acknowledged	40259.12
Drive bearing temperature high alarm	40259.13
Drive bearing temperature high alarm acknowledged	40259.14
Stator A temperature high alarm	40259.15
Stator A temperature high alarm acknowledged	40259.16

3612 AND 3616 MARINE PROJECT GUIDE

Analog Data	MODBUS Address
Alarm Status	40260
Stator B temperature high alarm	40260.01
Stator B temperature high alarm acknowledged	40260.02
Stator C temperature high alarm	40260.03
Stator C temperature high alarm acknowledged	40260.04
Turbine inlet left/inline temperature high alarm	40260.05
Turbine inlet left/inline temperature high alarm acknowledged	40260.06
Turbine inlet right temperature high alarm	40260.07
Turbine inlet right temperature high alarm acknowledged	40260.08
Turbine outlet left/inline temperature high alarm	40260.09
Turbine outlet left/inline temperature high alarm acknowledged	40260.10
Turbine outlet right temperature high alarm	40260.11
Turbine outlet right temperature high alarm acknowledged	40260.12
Exhaust port #1 temperature high alarm	40260.13
Exhaust port #1 temperature high alarm acknowledged	40260.14
Exhaust port #2 temperature high alarm	40260.15
Exhaust port #2 temperature high alarm acknowledged	40260.16
Alarm Status	40261
Exhaust port #3 temperature high alarm	40261.01
Exhaust port #3 temperature high alarm acknowledged	40261.02
Exhaust port #4 temperature high alarm	40261.03
Exhaust port #4 temperature high alarm acknowledged	40261.04
Exhaust port #5 temperature high alarm	40261.05
Exhaust port #5 temperature high alarm acknowledged	40261.06
Exhaust port #6 temperature high alarm	40261.07
Exhaust port #6 temperature high alarm	40261.08
Exhaust port #7 temperature high alarm	40261.09
Exhaust port #7 temperature high alarm acknowledged	40261.10
Exhaust port #8 temperature high alarm	40261.11
Exhaust port #8 temperature high alarm acknowledged	40261.12
Exhaust port #9 temperature high alarm	40261.13
Exhaust port #9 temperature high alarm acknowledged	40261.14
Exhaust port #10 temperature high alarm	40261.15
Exhaust port #10 temperature high alarm acknowledged	40261.16
Alarm Status	40262
Exhaust port #11 temperature high alarm	40262.01
Exhaust port #11 temperature high alarm acknowledged	40262.02
Exhaust port #12 temperature high alarm	40262.03
Exhaust port #12 temperature high alarm acknowledged	40262.04
Exhaust port #13 temperature high alarm	40262.05
Exhaust port #13 temperature high alarm acknowledged	40262.06
Exhaust port #14 temperature high alarm	40262.07
Exhaust port #14 temperature high alarm acknowledged	40262.08
Exhaust port #15 temperature high alarm	40262.09
Exhaust port #15 temperature high alarm acknowledged	40262.10
Exhaust port #16 temperature high alarm	40262.11
Exhaust port #16 temperature high alarm acknowledged	40262.12
Turbine left/inline overspeed alarm	40262.13
Turbine left/inline overspeed alarm acknowledged	40262.14
Turbine right overspeed alarm	40262.15
Turbine right overspeed alarm acknowledged	40262.16

Analog Data	MODBUS Address
Alarm Status	40263
Ball head backup mode alarm	40263.01
Ball head backup mode alarm acknowledged	40263.02
Engine crank terminate alarm	40263.03
Engine crank terminate alarm acknowledged	40263.04
Engine crank terminate time delay alarm	40263.05
Engine crank terminate time delay alarm acknowledged	40263.06
Engine oil step alarm	40263.07
Engine oil step alarm acknowledged	40263.08
Oil level low alarm	40263.09
Oil level low alarm acknowledged	40263.10
Particle detector alarm	40263.11
Particle detector alarm acknowledged	40263.12
Water level low alarm	40263.13
Water level low alarm acknowledged	40263.14
Jacket water detector alarm	40263.15
Jacket water detector alarm acknowledged	40263.16
Alarm Status	40264
Low battery voltage alarm	40264.01
Low battery voltage alarm acknowledged	40264.02
Relay power not available alarm	40264.03
Relay power not available alarm acknowledged	40264.04
Auxiliary #1 alarm	40264.05
Auxiliary #1 alarm acknowledged	40264.06
Auxiliary #2 alarm	40264.07
Auxiliary #2 alarm acknowledged	40264.08
Auxiliary #3 alarm	40264.09
Auxiliary #3 alarm acknowledged	40264.10
Shutdown override alarm	40264.11
Shutdown override alarm acknowledged	40264.12
Exhaust port #1 temperature deviation alarm	40264.13
Exhaust port #1 temperature deviation alarm acknowledged	40264.14
Exhaust port #2 temperature deviation alarm	40264.15
Exhaust port #2 temperature deviation alarm acknowledged	40264.16
Alarm Status	40265
Exhaust port #3 temperature deviation alarm	40265.01
Exhaust port #3 temperature deviation alarm acknowledged	40265.02
Exhaust port #4 temperature deviation alarm	40265.03
Exhaust port #4 temperature deviation alarm acknowledged	40265.04
Exhaust port #5 temperature deviation alarm	40265.05
Exhaust port #5 temperature deviation alarm acknowledged	40265.06
Exhaust port #6 temperature deviation alarm	40265.07
Exhaust port #6 temperature deviation alarm acknowledged	40265.08
Exhaust port #7 temperature deviation alarm	40265.09
Exhaust port #7 temperature deviation alarm acknowledged	40265.10
Exhaust port #8 temperature deviation alarm	40265.11
Exhaust port #8 temperature deviation alarm acknowledged	40265.12
Exhaust port #9 temperature deviation alarm	40265.13
Exhaust port #9 temperature deviation alarm acknowledged	40265.14
Exhaust port #10 temperature deviation alarm	40265.15
Exhaust port #10 temperature deviation alarm acknowledged	40265.16

3612 AND 3616 MARINE PROJECT GUIDE

Analog Data	MODBUS Address
Alarm Status	40266
Exhaust port #11 temperature deviation alarm	40266.01
Exhaust port #11 temperature deviation alarm acknowledged	40266.02
Exhaust port #12 temperature deviation alarm	40266.03
Exhaust port #12 temperature deviation alarm acknowledged	40266.04
Exhaust port #13 temperature deviation alarm	40266.05
Exhaust port #13 temperature deviation alarm acknowledged	40266.06
Exhaust port #14 temperature deviation alarm	40266.07
Exhaust port #14 temperature deviation alarm acknowledged	40266.08
Exhaust port #15 temperature deviation alarm	40266.09
Exhaust port #15 temperature deviation alarm acknowledged	40266.10
Exhaust port #16 temperature deviation alarm	40266.11
Exhaust port #16 temperature deviation alarm acknowledged	40266.12
Fuel filter pressure differential alarm	40266.13
Fuel filter pressure differential alarm acknowledged	40266.14
Lube oil filter pressure differential alarm	40266.15
Lube oil filter pressure differential alarm acknowledged	40266.16
Alarm Status	40267
PLC memory battery low alarm	40267.01
PLC memory battery low alarm acknowledged	40267.02
Slot 1 fault alarm	40267.03
Slot 1 fault alarm acknowledged	40267.04
Slot 2 fault alarm	40267.05
Slot 2 fault alarm acknowledged	40267.06
Slot 3 fault alarm	40267.07
Slot 3 fault alarm acknowledged	40267.08
Slot 4 fault alarm	40267.09
Slot 4 fault alarm acknowledged	40267.10
Slot 5 fault alarm	40267.11
Slot 5 fault alarm acknowledged	40267.12
Slot 6 fault alarm	40267.13
Slot 6 fault alarm acknowledged	40267.14
Slot 7 fault alarm	40267.15
Slot 7 fault alarm acknowledged	40267.16
Alarm Status	40268
Slot 8 fault alarm	40268.01
Slot 8 fault alarm acknowledged	40268.02
Slot 9 fault alarm	40268.03
Slot 9 fault alarm acknowledged	40268.04
Rack 0 group 0 fault alarm	40268.05
Rack 0 group 0 fault alarm acknowledged	40268.06
Rack 0 group 1 fault alarm	40268.07
Rack 0 group 1 fault alarm acknowledged	40268.08
Rack 0 group 2 fault alarm	40268.09
Rack 0 group 2 fault alarm acknowledged	40268.10
Rack 0 group 3 fault alarm	40268.11
Rack 0 group 3 fault alarm acknowledged	40268.12
Rack 0 group 4 fault alarm	40268.13
Rack 0 group 4 fault alarm acknowledged	40268.14
Rack 0 group 5 fault alarm	40268.15
Rack 0 group 5 fault alarm acknowledged	40268.16

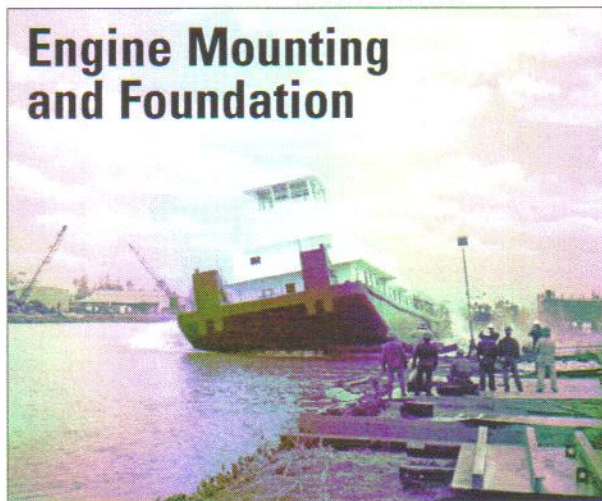
Analog Data	MODBUS Address
Alarm Status	40269
Rack 0 group 6 fault alarm	40269.01
Rack 0 group 6 fault alarm acknowledged	40269.02
Rack 0 group 7 fault alarm	40269.03
Rack 0 group 7 fault alarm acknowledged	40269.04
Rack 1 group 0 fault alarm	40269.05
Rack 1 group 0 fault alarm acknowledged	40269.06
Rack 1 group 4 fault alarm	40269.07
Rack 1 group 4 fault alarm acknowledged	40269.08
Rack 1 group 6 fault alarm	40269.09
Rack 1 group 6 fault alarm acknowledged	40269.10
Lube oil to engine pressure low shutdown	40269.11
Lube oil to engine pressure low shutdown acknowledged	40269.12
Jacket water outlet temperature high shutdown	40269.13
Jacket water outlet temperature high shutdown acknowledged	40269.14
Redundant jacket water outlet temperature high shutdown	40269.15
Redundant jacket water outlet temperature high shutdown acknowledged	40269.16
Alarm Status	40270
Auxiliary #1 temperature shutdown	40270.01
Auxiliary #1 temperature shutdown acknowledged	40270.02
Auxiliary #2 temperature shutdown	40270.03
Auxiliary #2 temperature shutdown acknowledged	40270.04
Auxiliary #1 4-20 mA shutdown	40270.05
Auxiliary #1 4-20 mA shutdown acknowledged	40270.06
Auxiliary #2 4-20 mA shutdown	40270.07
Auxiliary #2 4-20 mA shutdown acknowledged	40270.08
Non-drive bearing temperature high shutdown	40270.09
Non-drive bearing temperature high shutdown acknowledged	40270.10
Drive bearing temperature high shutdown	40270.11
Drive bearing temperature high shutdown acknowledged	40270.12
Engine overspeed shutdown	40270.13
Engine overspeed shutdown acknowledged	40270.14
Crankcase pressure high shutdown	40270.15
Crankcase pressure high shutdown acknowledged	40270.16
Alarm Status	40271
Oil mist detector shutdown	40271.01
Oil mist detector shutdown acknowledged	40271.02
Particle detector shutdown	40271.03
Particle detector shutdown acknowledged	40271.04
Low speed low oil pressure shutdown	40271.05
Low speed low oil pressure shutdown acknowledged	40271.06
High speed low oil pressure shutdown	40271.07
High speed low oil pressure shutdown acknowledged	40271.08
Auxiliary #1 shutdown	40271.09
Auxiliary #1 shutdown acknowledged	40271.10
Auxiliary #2 shutdown	40271.11
Auxiliary #2 shutdown acknowledged	40271.12
Customer shutdown	40271.13
Customer shutdown acknowledged	40271.14
Emergency stop shutdown	40271.15
Emergency stop shutdown acknowledged	40271.16

3612 AND 3616 MARINE PROJECT GUIDE

Analog Data	MODBUS Address
Write spare	40272
Write spare	40273
Write spare	40274
Write spare	40275
Write spare	40276
Write spare	40277
Write spare	40278
Write spare	40279
Write spare	40280
Write spare	40281
Write spare	40282
Write spare	40283
Write spare	40284
Write spare	40285
Write spare	40286
Write spare	40287
Write spare	40288
Write spare	40289
Write spare	40290
Write spare	40291
Write spare	40292
Write spare	40293
Write spare	40294
Write spare	40295
Write spare	40296
Write spare	40297
Write spare	40298
Write spare	40299
Write spare	40300
Acknowledge All Read	40301
Acknowledge all signal from MODBUS SCADA	40301.01
Spare	40301.02
Spare	40301.03
Spare	40301.04
Spare	40301.05
Spare	40301.06
Spare	40301.07
Spare	40301.08
Spare	40301.09
Spare	40301.10
Spare	40301.11
Spare	40301.12
Spare	40301.13
Spare	40301.14
Spare	40301.15
Spare	40301.16

Analog Data	MODBUS Address
Read spare	40302
Read spare	40303
Read spare	40304
Read spare	40305
Read spare	40306
Read spare	40307
Read spare	40308
Read spare	40309
Read spare	40310
Read spare	40311
Read spare	40312
Read spare	40313
Read spare	40314
Read spare	40315
Read spare	40316
Read spare	40317
Read spare	40318
Read spare	40319
Read spare	40320
Read spare	40321
Read spare	40322
Read spare	40323
Read spare	40324
Read spare	40325
Read spare	40326
Read spare	40327
Read spare	40328
Read spare	40329
Read spare	40330
Read spare	40331
Read spare	40332
Read spare	40333
Read spare	40334
Read spare	40335
Read spare	40336
Read spare	40337
Read spare	40338
Read spare	40339
Read spare	40340
Read spare	40341
Read spare	40342
Read spare	40343
Read spare	40344
Read spare	40345
Read spare	40346
Read spare	40347
Read spare	40348
Read spare	40349
Read spare	40350

Engine Mounting and Foundation



Foundation Design

This section deals with propulsion engine and reduction gear foundations and their relationship to ship framing.

Exact analytical methods cannot always be used to design engine foundations. The design is also influenced by several factors, including previous successful installations, the designer's experience, and the basic dimensions of the specific engine being installed. Refer to this guide for specific information on 3600 engine weights and dimensions.

The engine foundation must resist vertical, horizontal, and fore-and-aft deflection. It should also be integrated into the reduction gear foundation to connect the overall structure to the ship's inner bottom structure. In this manner, the thrust from the propeller and the dynamic forces from the main engine and reduction gear are evenly distributed over a large area of the inner bottom structure. If the engine foundation has too little resistance against deflection, it may show up during the alignment of the engines, as the mount depressions may be influenced by the combination of foundation deflection and engine forces, and may be out of tolerance.

The main engine foundation must have sufficient rigidity to transmit static and dynamic forces from the main engine into the foundation.

The girder and faceplate must:

- increase bending inertia of the structure
- facilitate chock installation
- provide a "work shelf" for servicing the side of the engine
- permit installation of side blocks and collision chocks

The main engine and reduction gear foundation must also be designed to absorb the loads from:

- ship's vibration
- propeller thrust
- thrust and torque of the engine
- ship's motion at sea
- thermal, static, and dynamic effects
- crash reversal

Because the loads originate from sources other than the engine, the foundation sections should be uninterrupted and have adequate section strength.

To avoid natural frequency resonance between engine and hull, the engine's 1st and 2nd order free forces and moments must be taken into account when designing the mounting structure. The ship builder must ensure that resonance between torque excitation and the natural transverse hull frequencies does not occur. Caterpillar will supply engine 1st and 2nd order free forces and moments, upon request.

The engine foundation must have sufficient rigidity to minimize shafting and coupling deformation between the engine and gear.

3612/3616 Engine Related Frequencies		
Excitation Frequency	Cause of Excitation	Design of Component's Natural Frequencies
1/2 order = 1/2 x engine speed	Misfiring of one or more cylinders (Correctable)	Stay Above
1st order = 1 x engine speed	Unbalance, misalignment, crankcase overfill (Correctable)	Stay Above
1-1/2 order = 1.5 x engine speed	Normal cylinder combustion (NOT correctable)	Avoid: side to side and roll modes excited by this order
2nd order = 2 x engine speed	Normal cylinder combustion (NOT correctable)	Avoid: side to side and roll modes excited by this order
3rd order = 3 x engine speed	Firing frequency for one bank of a twelve (12) cylinder engine (NOT correctable)	Avoid: side to side and roll modes excited by this order
4th order = 4 x engine speed	Firing frequency for one bank of a sixteen (16) cylinder engine (NOT correctable)	Avoid: side to side and roll modes excited by this order
6th order = 6 x engine speed	Firing frequency for one bank of a twelve (12) cylinder engine (NOT correctable)	Avoid: side to side and roll modes excited by this order
8th order = 8 x engine speed	Firing frequency for one bank of a sixteen (16) cylinder engine (NOT correctable)	Avoid: side to side and roll modes excited by this order

The engine speed varies from 350 rpm for low idle to 1000 rpm for rated speed.

Mounting

The 3600 family engines in fast vessels are normally on flexible mounts (i.e., rubber with steel springs).

The 3600 family mounting feet are aluminum castings that bolt to the engine feet under the crankcase access doors. The standard mounting feet configuration uses six mounting feet, three on each side of the engine.

Resin Chocks

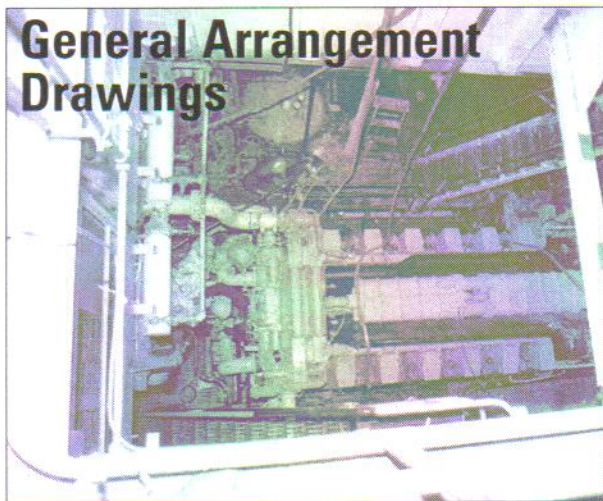
Normally, the flexible mounts are installed with a resin chock between the engine and the engine foundation.

The chocking arrangement, planning, and pouring should be reviewed by an approved manufacturer. The shipyard will have the final responsibility for the planning and installation of chocking material.

General

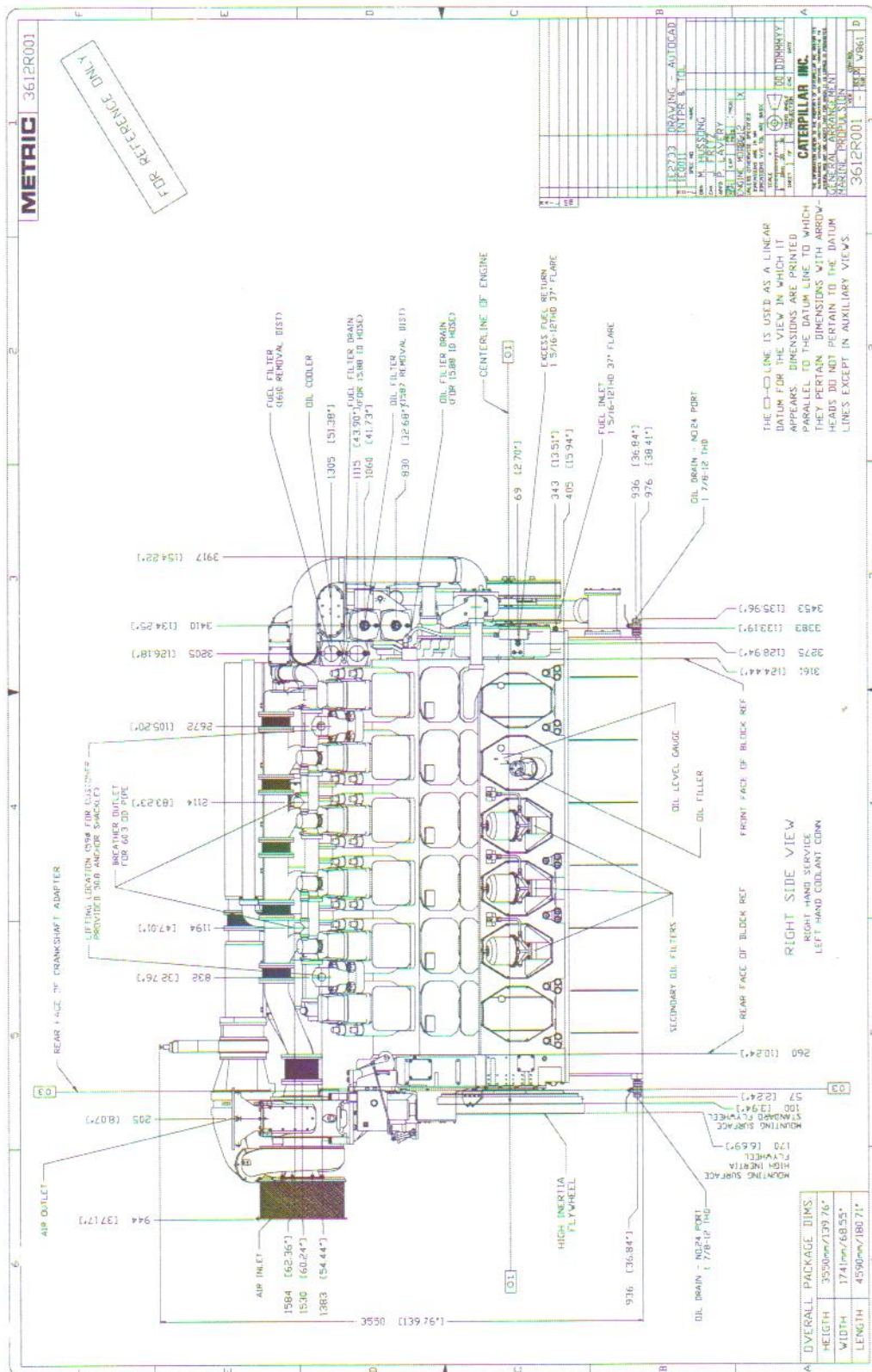
All mounting systems must have provisions for alignment retention, collision stops, and engine thermal growth.

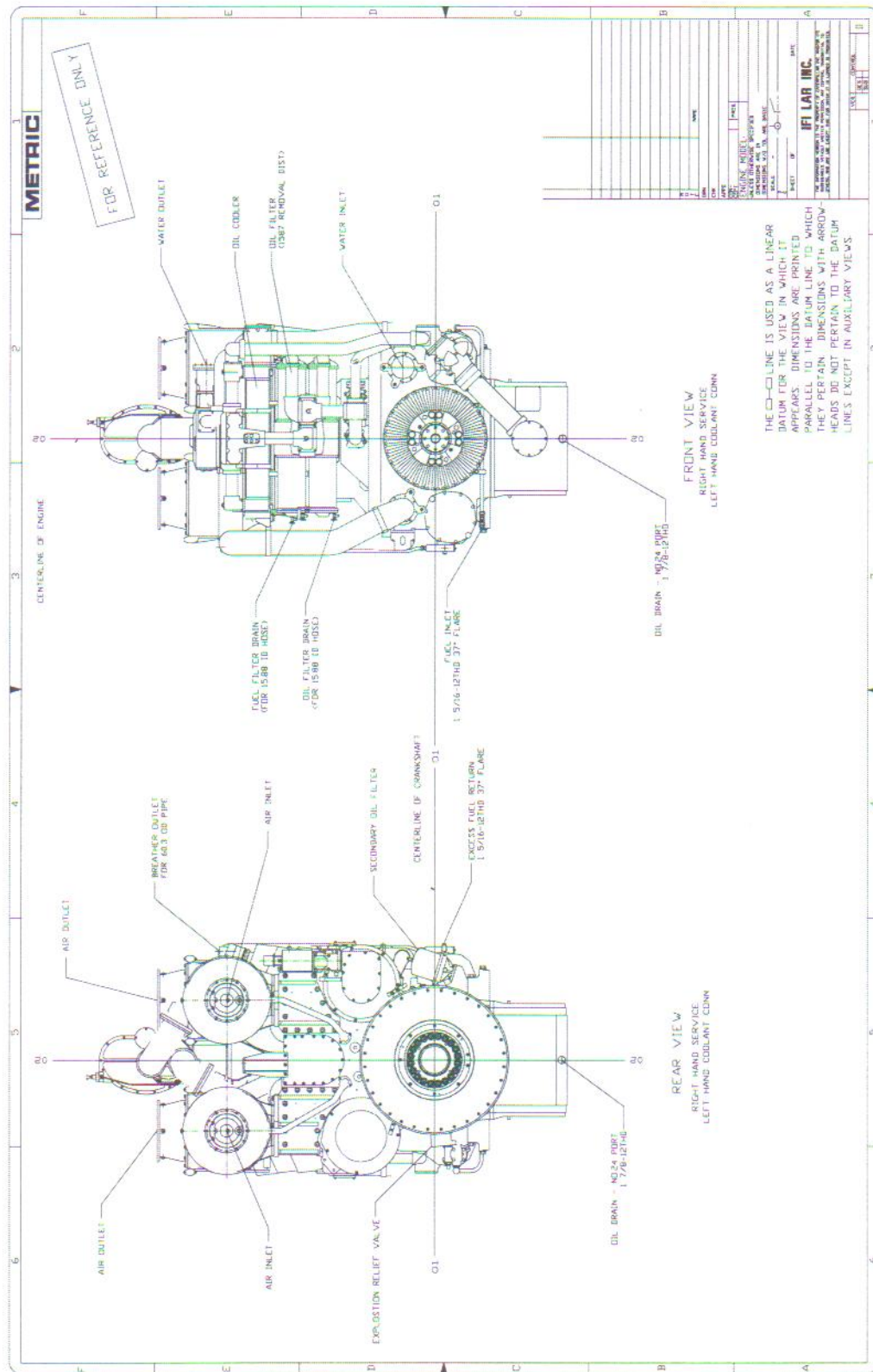
General Arrangement Drawings



Engine General Arrangement Drawings

For 3612/3616 General Arrangement Drawings, see the following pages.







GENERAL ARRANGEMENT DRAWINGS

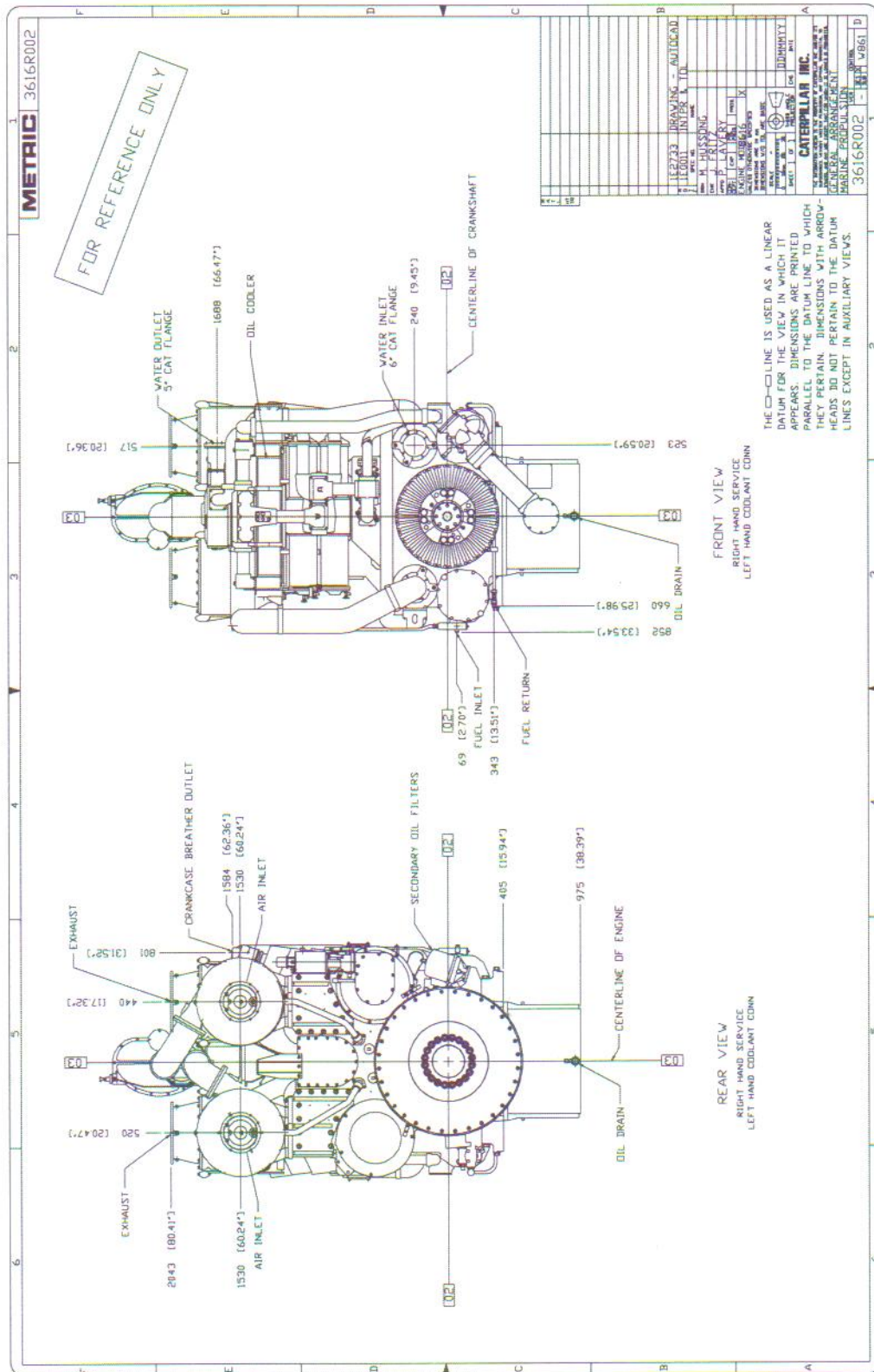


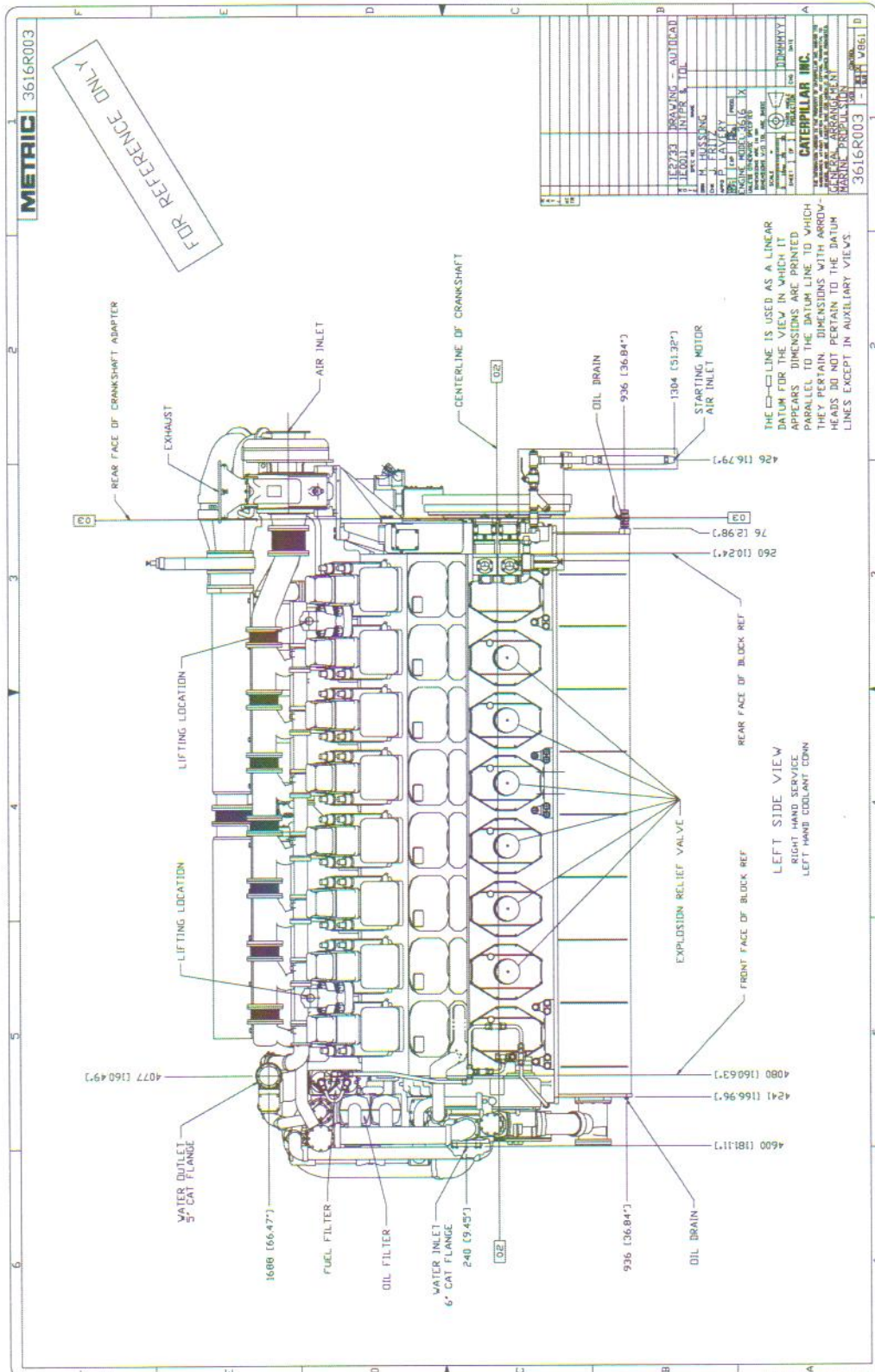




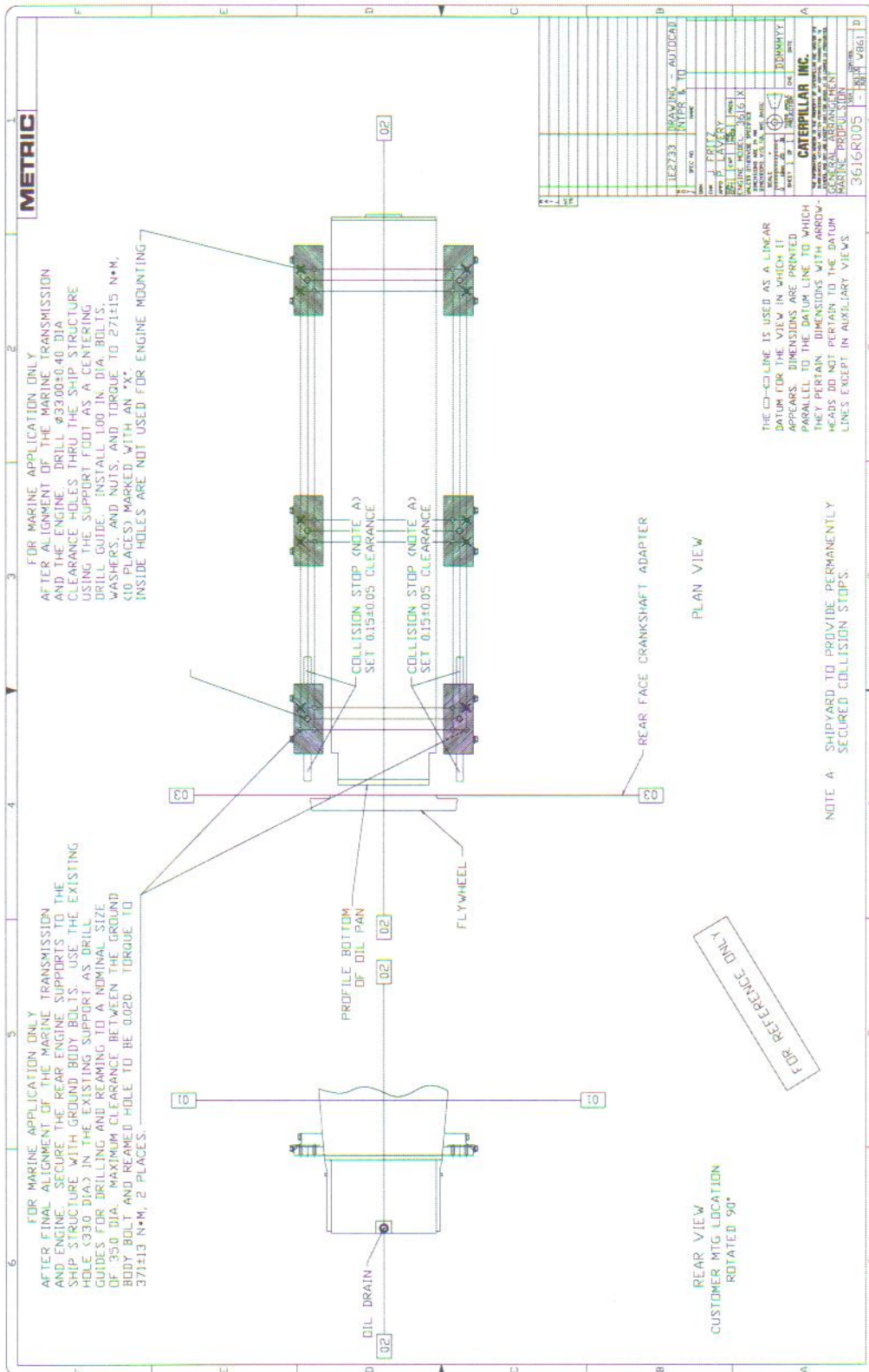
3612 AND 3616 MARINE PROJECT GUIDE

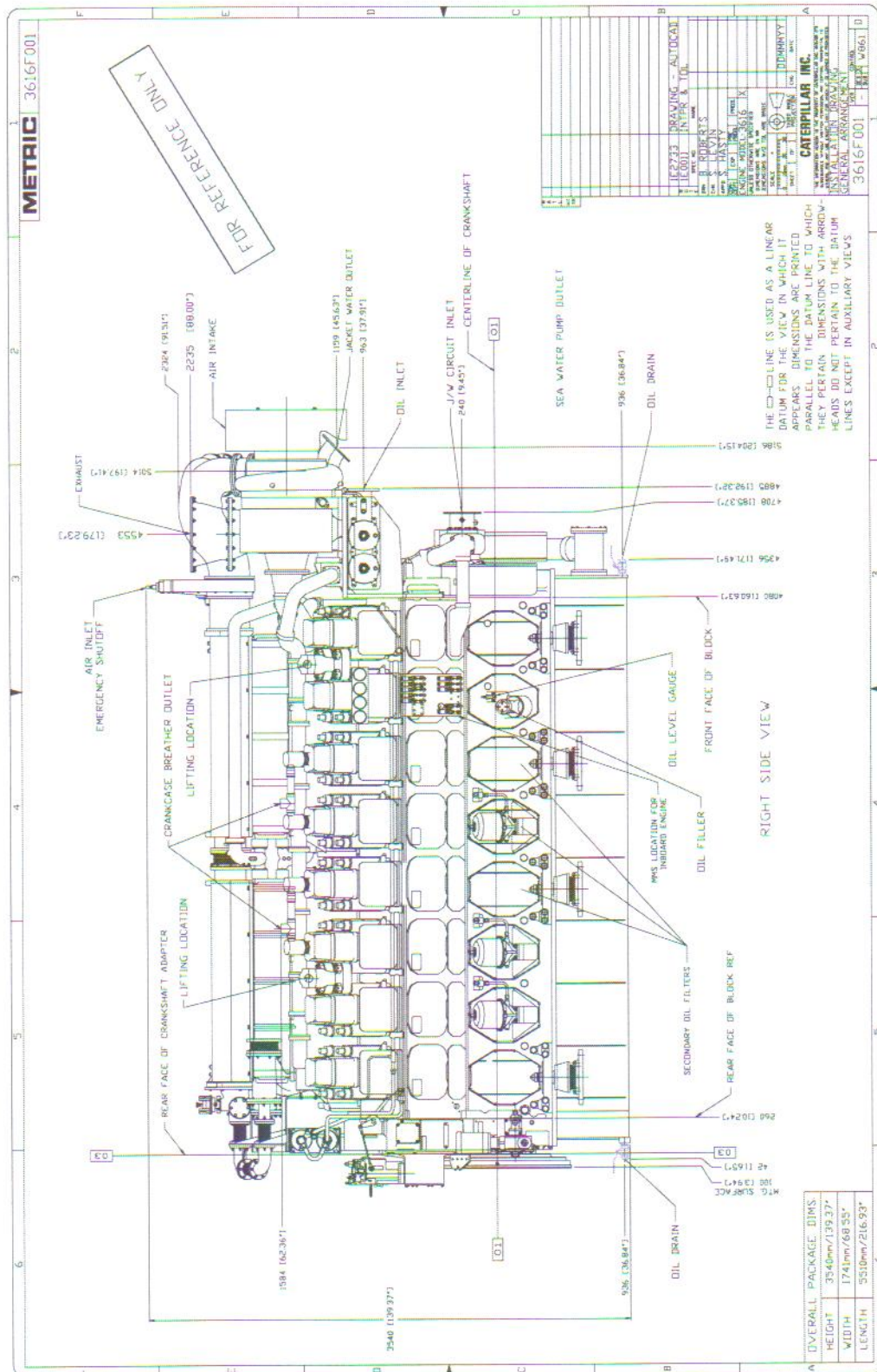
GENERAL ARRANGEMENT DRAWINGS

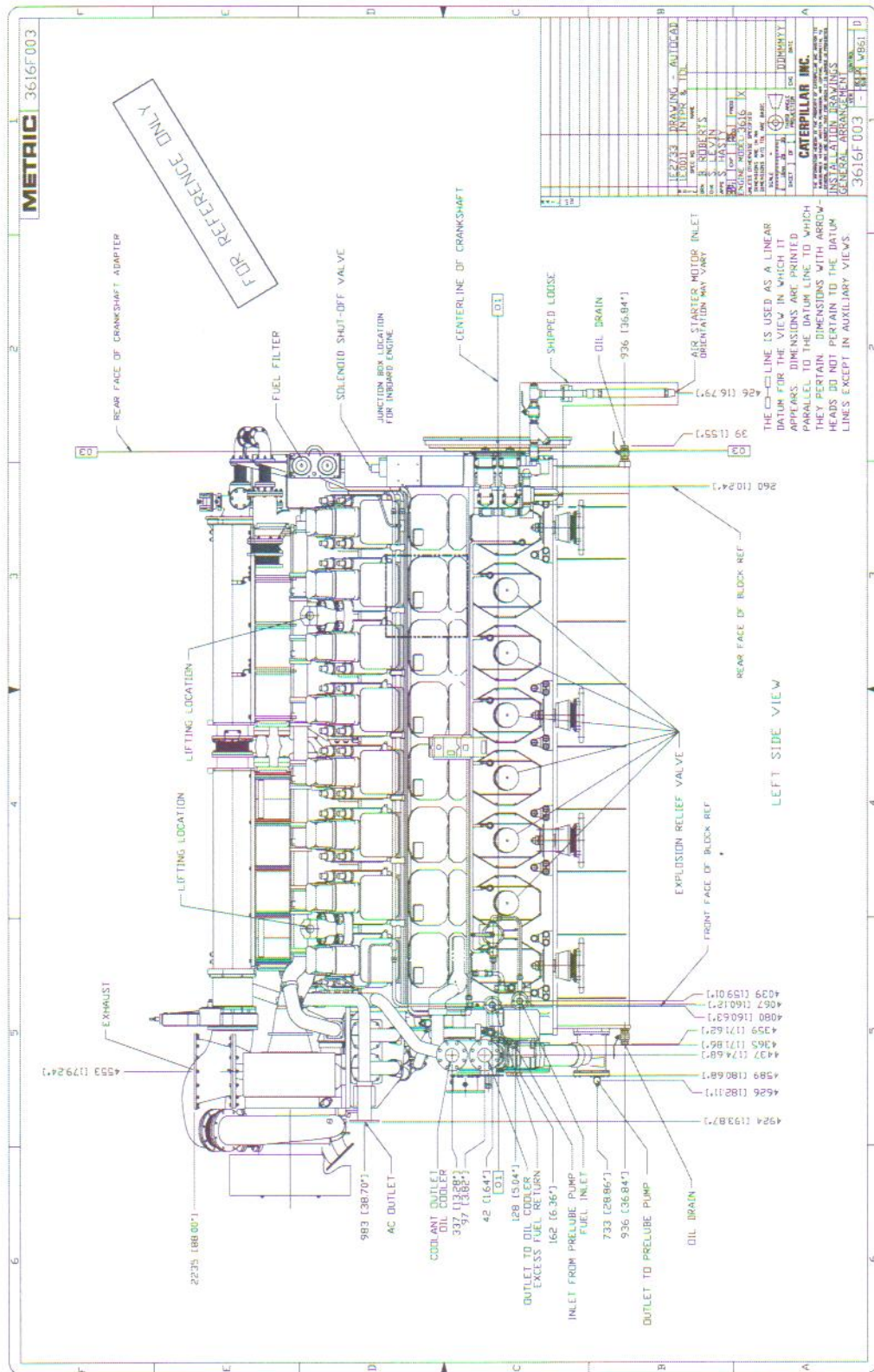






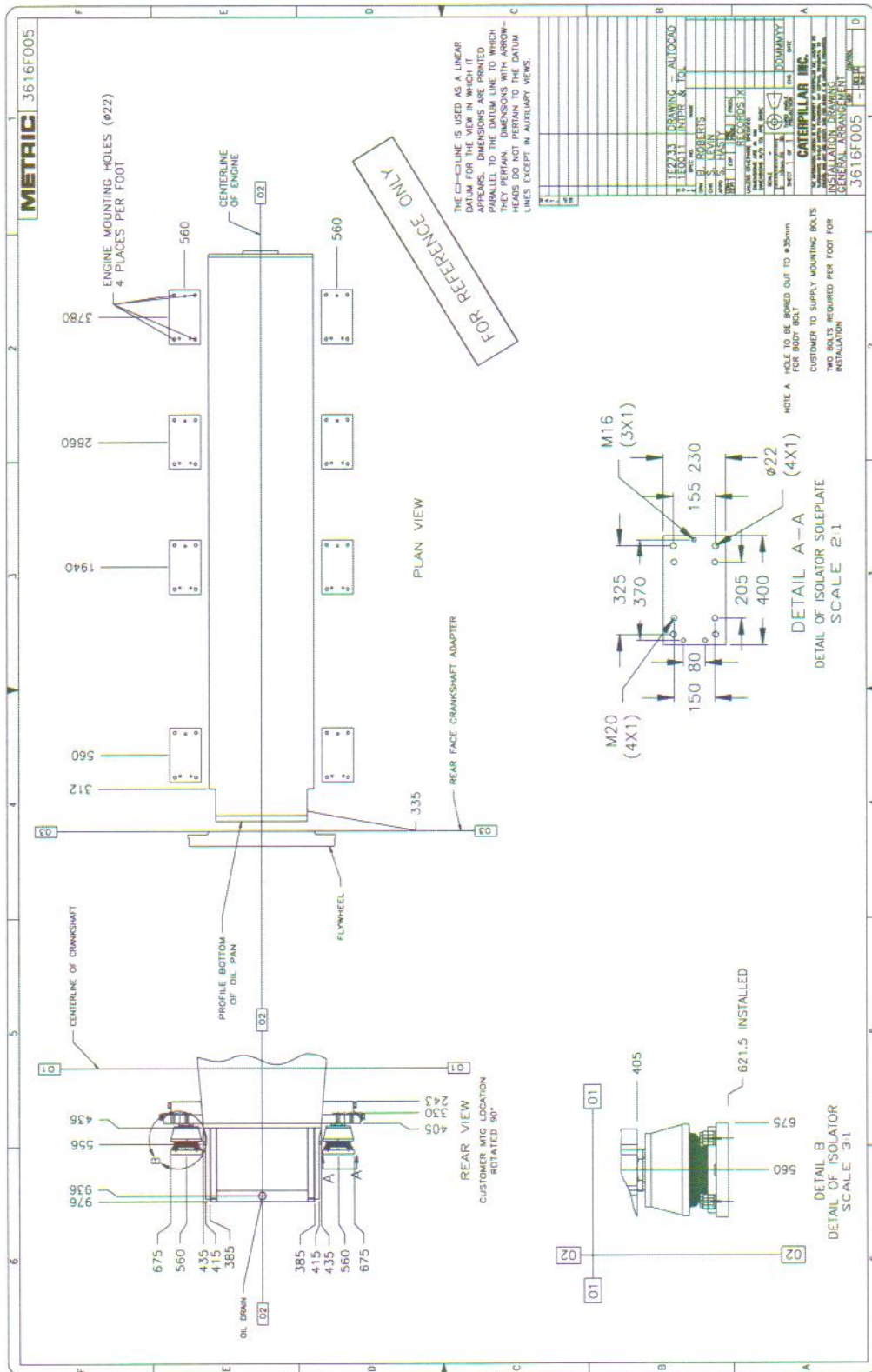






GENERAL ARRANGEMENT DRAWINGS





CONNECTION DATA SHEET

RIGHT AND LEFT HAND SERVICE

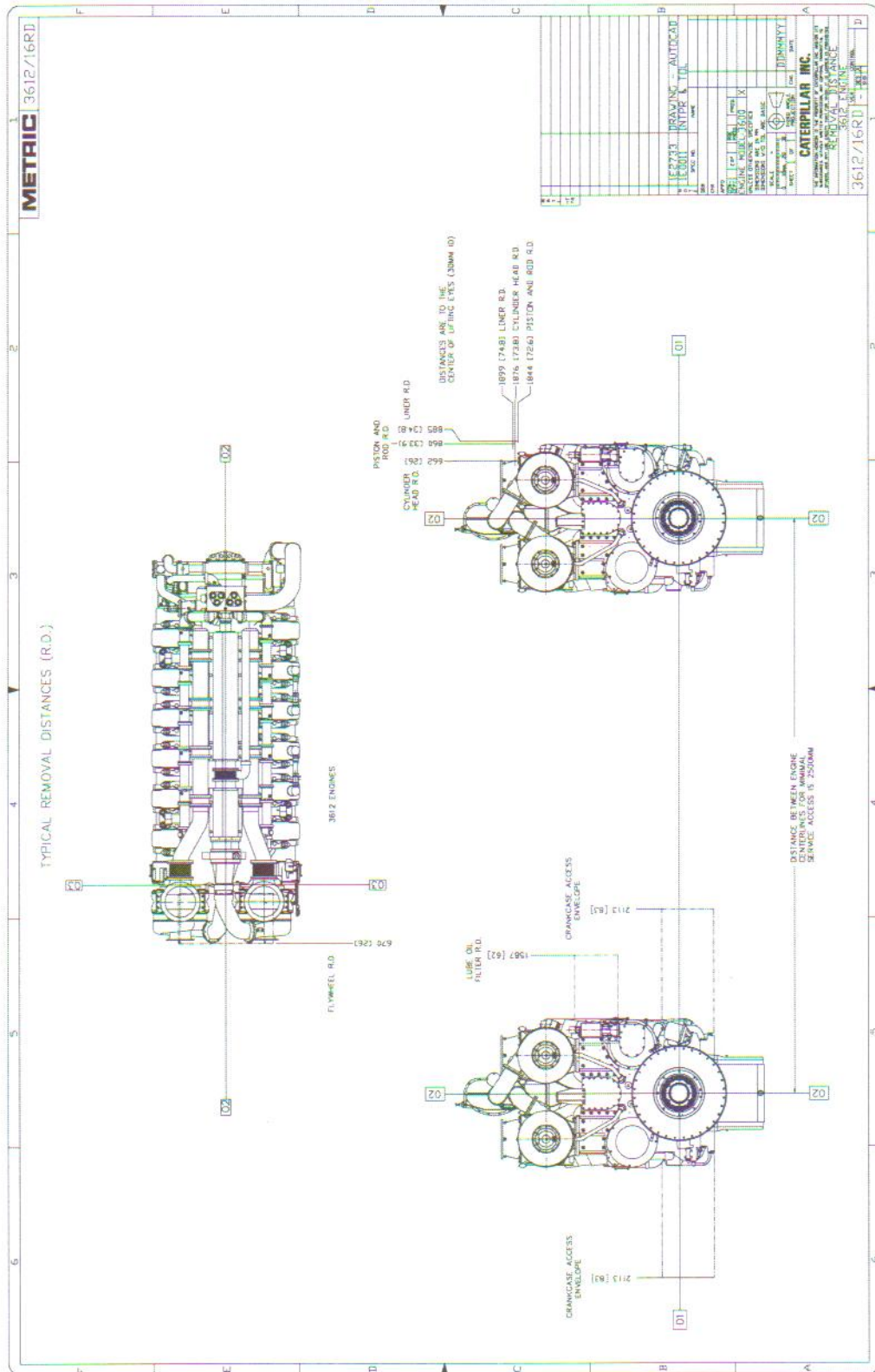
ITEM DESCRIPTION	CONNECTION SPECIFICATIONS	DIMENSIONS (MM)			OTHER DETAIL
		01	02	03	
AFTERCooler/OIL COOLER WATER CIRCUIT INLET	6" ANSI/DIN FLANGE SEE DETAIL ON SHEET PM19006	240	523	4708	PARTNER FLANGE NOT PROVIDED
AFTERCooler WATER CIRCUIT OUTLET	4" DIN FLANGE SEE DETAIL ON SHEET PM19006	983	815	4924	PARTNER FLANGE NOT PROVIDED
OILCOOLER WATER CIRCUIT OUTLET	4" DIN FLANGE SEE DETAIL ON SHEET PM19006	337	918	4437	PARTNER FLANGE NOT PROVIDED
JACKET WATER CIRCUIT INLET	6" ANSI/DIN FLANGE SEE DETAIL ON SHEET PM19006	240	523	4708	PARTNER FLANGE NOT PROVIDED
JACKET WATER CIRCUIT OUTLET	6" ANSI/DIN FLANGE SEE DETAIL ON SHEET PM19006	1159	10	5186	PARTNER FLANGE NOT PROVIDED
SEA WATER INLET	6" ANSI/DIN FLANGE SEE DETAIL ON SHEET PM19006	64	549	4645	PARTNER FLANGE NOT PROVIDED
SEA WATER OUTLET	5" ANSI FLANGE SEE DETAIL ON SHEET PM19006	92	799	4517	PARTNER FLANGE NOT PROVIDED
FUEL INLET	1 5/8 - 12 NPTF THD WITH 37° FLARE	162	917	4039	PARTNER FLANGE NOT NEEDED
EXCESS FUEL RETURN	1 5/16 - 12 NPTF THD WITH 37° FLARE	42	917	4067	PARTNER FLANGE NOT NEEDED
EXHAUST (RIGHT AND LEFT)	18" FLANGE SEE DETAIL ON SHEET PM19006	445	1950	4553	PARTNER FLANGE PROVIDED
AIR START MOTOR INLET	1 1/2 - 11 1/2 NPT	1304	954	426	PARTNER FLANGE NOT NEEDED
CRANKCASE BREATHER OUTLET	FOR 60.3 OD PIPING (RH REAR) (RH FRONT)	1584 1584	801 801	1654 2574	PARTNER FLANGE NOT NEEDED
PRELUBE OUTLET TO PUMP	1 1/2 - 11 1/2 NPT	890	50	5273	PARTNER FLANGE NOT NEEDED
OIL INLET	4" DIN FLANGE SEE DETAIL ON SHEET PM19006	963	775	4885	PARTNER FLANGE NOT PROVIDED
PRELUBE INLET FROM PUMP	1 5/16-12 THD	890	0	5134	PARTNER FLANGE NOT NEEDED
OIL OUTLET TO OIL COOLER	4" DIN FLANGE SEE DETAIL ON SHEET PM19006	97	890	4437	PARTNER FLANGE NOT PROVIDED
OIL DRAIN	1 1/2 - 11 1/2 NPT (REAR) (FRONT)	999 999	260 260	42 4356	PARTNER FLANGE NOT NEEDED

FOR REFERENCE ONLY

[illegible]

3612 AND 3616 MARINE PROJECT GUIDE

GENERAL ARRANGEMENT DRAWINGS



Miscellaneous



Engine Weights

The following weight schedule lists the weights of the 3612/3616 engine model and optional supplied items. Select the optional items and add to the engine's dry weight to estimate the weight of an engine shipset.

One (1) "Engine Dry Weight" consists of the following engine-mounted items: a one-piece, gray iron cylinder block, governor actuator, two freshwater pumps, one sea water pump, one lube oil filter, fuel and lube oil duplex filters, centrifugal lube oil filters, electric prelube pump, exhaust shielding, intake air silencer, air starting motors, barring device, oil mist detector, flywheel, and six anti-vibration mounts.

Engine Model	3612 kg (lb)	3616 kg (lb)
Engine Dry Weight (for an engine as described above)	25 980 (57,286)	29 950 (66,040) RMT 31 000 (68,355) FMT
Weight Reduction Options:		
Weight reduction package: Covers and mounting feet, lightweight flywheel, and removal of lifting eyes	-1280 (-2822)	-1400 (-3086)
Mandatory Supplied Items:		
Lube oil plate-type heat exchanger w/thermostat (FMT only)		636 (1402)
Optional Supplied Items:		
Torsional coupling	420 (926)	480 (1058)
Plate-type heat exchanger	300 (661)	375 (827)
Water temperature regulator	86 (190)	86 (190)
Primary fuel strainer	11 (24)	11 (24)
Pressure reduction valve	20 (44)	20 (44)
Freshwater expansion tank	~135 (~298)	~135 (~298)
Exhaust pieces: (turbocharger adapter, bellows, expander to 18 inch)	268 (591)	268 (591)
Fluids Weight		
Lube oil @ .9097 kg/liter	828 (1825)	961 (2119)
Freshwater coolant	800 (1764)	1060 (2337)
Heat exchanger (FW & SW)	80 (176)	133 (293)
Lube oil heat exchanger (FW & LO) (FMT only)		92 (203)
TOTAL weight per engine		
Number of engines per shipset		
TOTAL engine weight per shipset		

Maintenance Interval Schedule — CSR and MCR Ratings

Daily Maintenance

- Check oil level for the air starting motors
- Drain air tank moisture and sediment
- Check the cooling system coolant level
- Check the engine oil level
- Drain the fuel filter/water separator
- Inspect engine air cleaner service indicator
- Clean engine air precleaner
- Check governor actuator oil level
- Inspect instrument panel
- Perform walk-around inspection

250 Hour Maintenance (or 6 weeks)

- Clean the air starting motor lines screen
- Test the coolant in the cooling system
- Obtain engine oil sample for analysis
- Check the oil mist detector
- Test air shutoff
- Check governor actuator linkage

500 Hour Maintenance (or 3 months)

- Clean the oil mist detector
- Replace the filter for the oil mist detector
- Inspect the engine mounts

6 Month Maintenance

- Obtain Level II cooling system coolant analysis (ELC)

Initial 1,000 Hour Maintenance

- Inspect the engine valve rotators
- Inspect/Adjust engine valve lash

1,000 Hour Maintenance (or 6 months)

- Check the engine mounts
- Lubricate barring device
- Inspect engine air cleaner service indicator
- Change engine oil filter
- Inspect exhaust piping
- Replace fuel system primary filter/water separator element
- Replace fuel system secondary filter
- Clean/inspect magnetic pick-ups
- Lubricate prelube pump

2,000 Hour Maintenance (or 1 year)

- Drain aftercooler condensation
- Clean/Replace oil mist detector
- Inspect/Adjust engine valve lash

Annual Maintenance

- Obtain Level II cooling system coolant analysis (ELC)

4,000 Hour Maintenance (or 1 year)

- Clean and inspect the aftercooler core
- Clean the lubricator bowl for the air starting motors

8,000 Hour Maintenance (or 1 year)

- Calibrate engine protection devices

8,000 Hour Maintenance (or 3 years)

- Change the coolant in the cooling system (DEAC)
- Replace the water temperature regulator
- Inspect camshaft roller followers
- Add cooling system coolant extender (ELC)
- Inspect crankshaft vibration damper
- Replace engine oil temperature regulator
- Inspect exhaust shields
- Replace governor actuator oil
- Inspect turbochargers
- Inspect water pumps

16,000 Hour Maintenance

- Change cooling system coolant (ELC)

16,000 to 24,000 Hour Maintenance

Top End Overhaul

Remanufacture or Rebuild

- Cylinder heads
- Cylinder head exhaust inserts
- Cylinder head dowels
- Cylinder head inlet inserts
- Cylinder head inner valve springs
- Cylinder head outer valve springs
- Cylinder head valve locks
- Cylinder head valve rotocoils
- Cylinder head valve spring guides
- Exhaust valves
- Inlet air valves

If the valves and seats are not replaced, grind the valves and lap the valves for full face contact.

Replace

- Connecting rod bearings
- Cylinder head gaskets
- Exhaust manifold gaskets
- Fuel transfer pump seals
- Inlet air lines seals
- Oil cooler seals
- Oil pump bearings and seals
- O-ring seals and plugs
- Oil temperature regulators and seals
- Turbocharger bearings, bushings, and seals
- Valve lubricator pump
- Water pump bearings and seals
- Water temperature regulators and seals
- Unit injectors

Clean and Inspect

- Oil cooler core
- Oil suction screen

Inspect/Replace

- Cylinder sleeves
- Exhaust shields
- Starting motor

36,000 to 44,000 Hour Maintenance

Major Overhaul

Remanufacture or Rebuild

- Centrifugal oil filter bearings
- Cylinder heads
- Starting motor

Replace

- Accessory group bearings
- Cylinder head valves and valve guides
- Cylinder head valve spring guides
- Exhaust manifold seals and bellows
- Exhaust shields
- Front gear train bearings
- Inlet air lines seals
- Oil temperature regulators and seals
- Unit injectors
- Water temperature regulators and seals
- Grind the valves and lap the valves for full face contact.

Inspect/Replace

- Aftercooler core
- Alarm and shutoff controls
- Camshafts

- Camshaft bearings
- Connecting rod bearings
- Crankshaft
- Cylinder liners
- Cylinder sleeves
- Exhaust manifolds
- Front gear group
- Main bearings
- Oil pump bushings and seals
- O-ring seals and plugs
- Pistons and piston rings
- Priority valve
- Rear gear train bearings and seals
- Rocker arm bearings
- Thrust bearings
- Turbocharger bearings, bushings, and seals
- Valve lubricator pump
- Valve mechanism group

If the crankshaft or the camshaft is removed for any reason, use the magnetic particle inspection process to check the component for cracks.

Clean and Inspect

- Oil cooler core
- Oil suction screen

Replace gaskets and seals

Replace the gaskets and seals for the following components:

- Camshaft front covers
- Camshaft drive gear covers
- Central structure covers
- Crankcase side covers
- Crankshaft
- Crankshaft vibration damper
- Front housing group
- Fuel lines
- Fuel transfer pump
- Gear inspection group
- Oil cooler
- Oil lines
- Power take-off covers
- Priority valve group
- Rear housing group
- Rear structure covers
- Valve covers
- Water lines

Maintenance Interval Schedule — Fast Vessel Ratings

Daily Maintenance

- Check oil level for the air starting motors
- Drain air tank moisture and sediment
- Check the cooling system coolant level
- Check the engine oil level
- Drain the fuel filter/water separator
- Inspect annunciator panel
- Check governor actuator oil level
- Perform walk-around inspection

250 Hour Maintenance (or monthly)

- Clean the air starting motor lines screen
- Test the coolant in the cooling system
- Obtain engine oil sample for analysis
- Check the oil mist detector

500 Hour Maintenance (or 3 months)

- Clean the oil mist detector
- Replace the filter for the oil mist detector
- Inspect the engine mounts
- Check the linkage for the governor actuator

Initial 1,000 Hour Maintenance

- Inspect the engine valve rotators
- Inspect/Adjust engine valve lash

1,000 Hour Maintenance (or 6 months)

- Obtain a coolant sample for analysis
- Check the engine mounts
- Lubricate barring device
- Replace fuel system secondary filter
- Replace governor actuator oil

2,000 Hour Maintenance (or 1 year)

- Inspect the centrifugal oil filter
- Check engine protective devices
- Inspect the engine valve rotators
- Inspect/adjust engine valve lash
- Clean/replace oil mist detector

4,000 Hour Maintenance (or annually)

- Clean and inspect the aftercooler core
- Clean the lubricator bowl for the air starting motors
- Inspect the crankshaft vibration damper
- Inspect the exhaust shields
- Inspect the starting motor
- Inspect the water pumps
- Inspect camshaft roller followers
- Inspect the turbochargers
- Replace the water temperature regulator

8,000 Hour Maintenance (or 3 years)

- Change the coolant in the cooling system

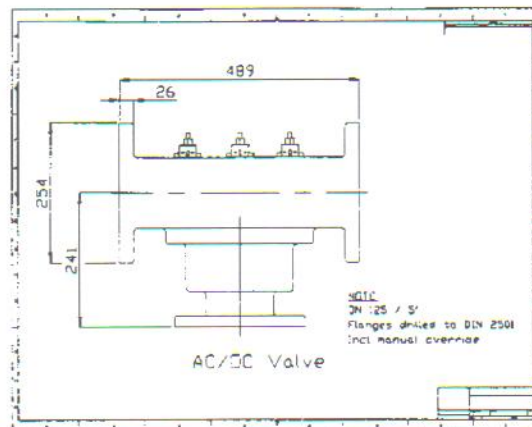
10,000 to 12,000 Hour Maintenance

Top End Overhaul

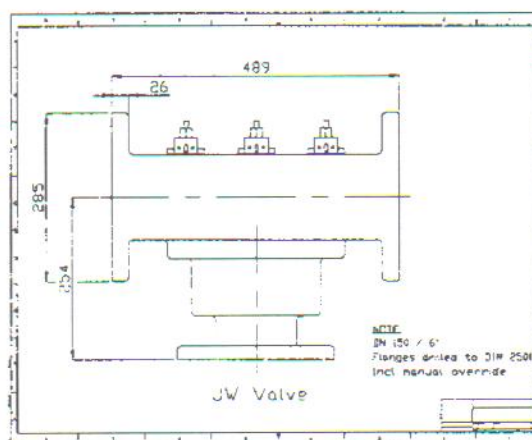
20,000 to 24,000 Hour Maintenance

Major Overhaul

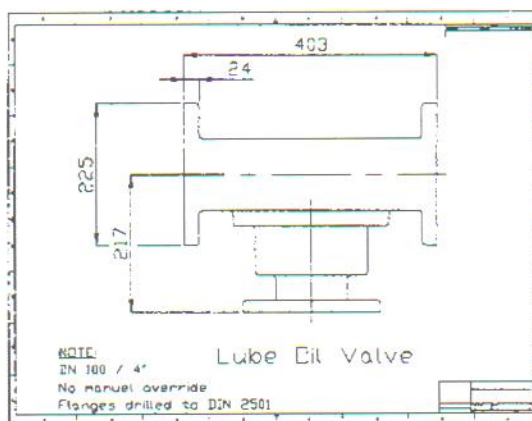
Typical Supplied Auxiliary Equipment



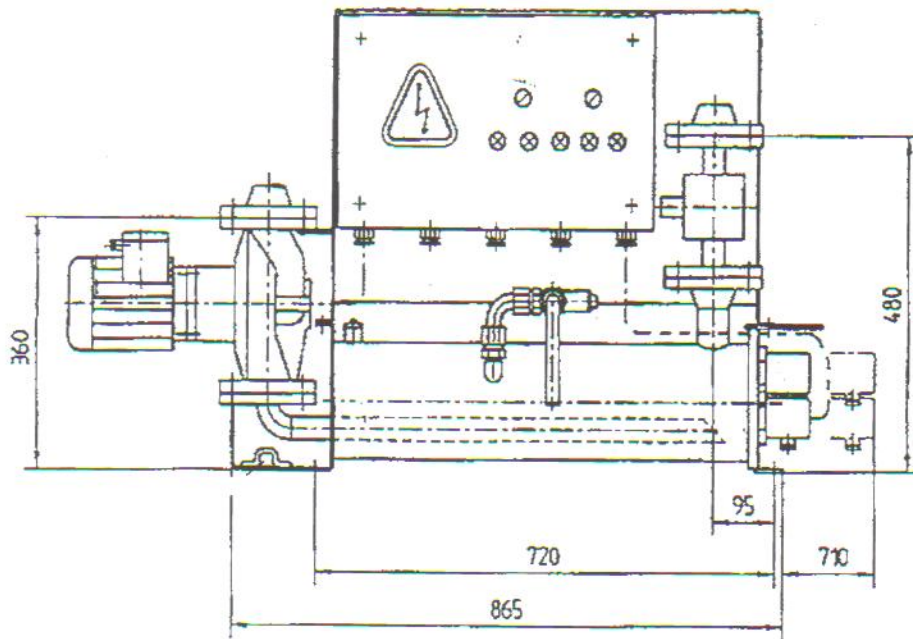
AC/OC Thermostatic



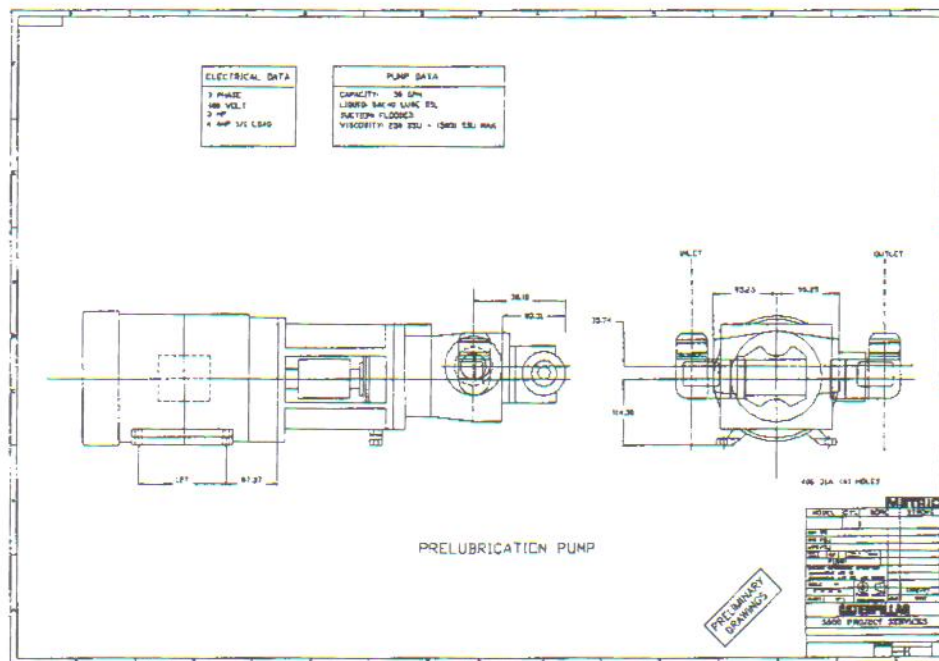
JW Thermostatic Valve



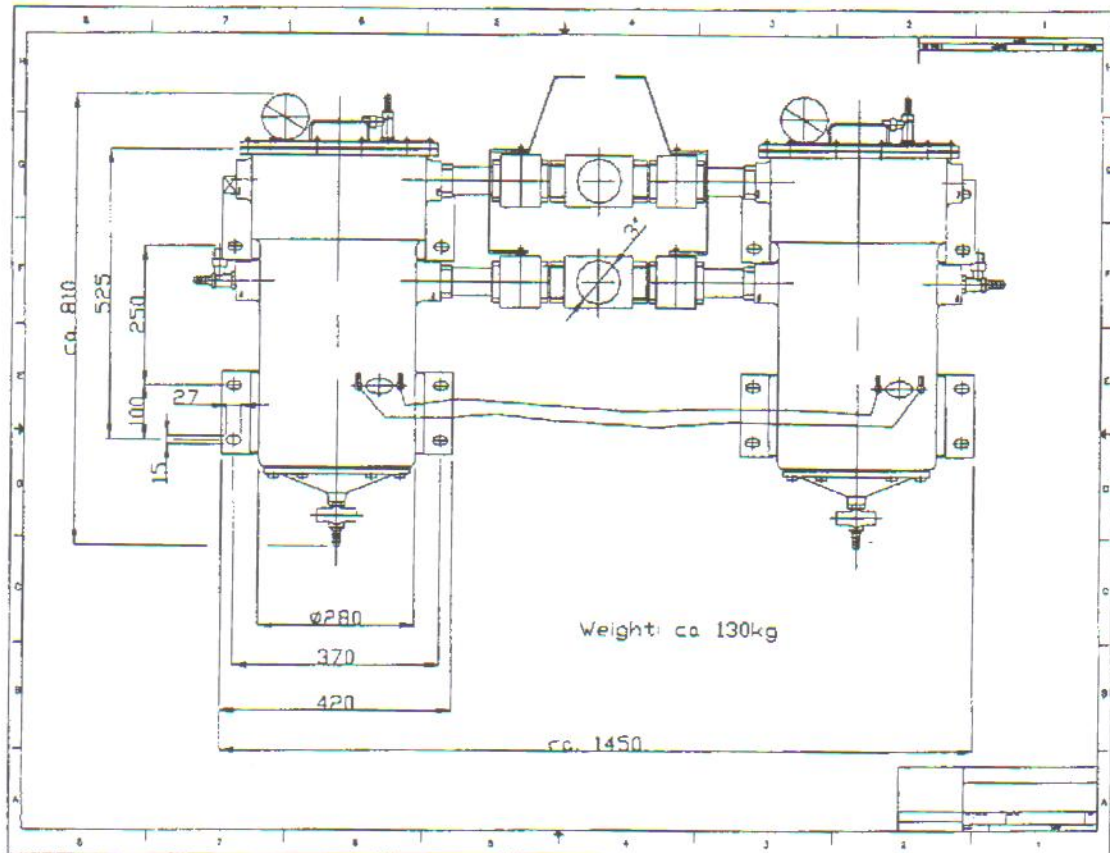
Lube Oil Thermostatic Valve



Jacket Water Heater



Prelubrication Pump



Fuel Pre Filter

Index

A	
Air Intake and Exhaust Systems.....	3
Air Receiver Sizing	57
Air Start Tank Sizing	58
Air Starters.....	57
Ambient Temperature Range.....	43
API category	43

B	
Basic Engine Design.....	1
Bearings	1

C	
Cat DEO CF.....	43
Caterpillar Micro-Oxidation Test (MOT)	43
Centrifugal Bypass Filters.....	42
Change Interval Without Oil Analysis Results.....	44
Clutches.....	67
Combustion Air System	60-63
Combustion Air System Schematics.....	62-63
Connecting Rods	1
Control and Monitoring System Diagram	68-74
Control System	67
Control System Inputs to PLC and Redundant Relay Logic	75-87
Coolant Flow Control.....	51
Coolant Temperature Control.....	51
Cooling.....	52
Cooling System	51-56
Cooling System Monitoring	52
Cooling System Pressure	52
Cooling System Pressure and Velocity	53
Cooling System Schematics	55-56
Crankcase Fumes Disposal	46
Crankcase Piping System.....	46-47
Crankcase Ventilation System	46-47
Crankshaft.....	1
Cylinder Liners.....	1

D	
Differential Press	51
Distillate Fuel Recommendations.....	48

E	
Engine and Waterjet Tolerances	9
Engine Block	1
Engine Control Panel	4, 68
Engine Dry Weight.....	124
Engine Fuel System Description.....	49
Engine General Arrangement Drawings.....	104-124
Engine Governing and Control System	67
Engine Monitoring	68
Engine Monitoring and Shutdown.....	68
Engine Mounting and Foundation	102
Engine Related Frequencies	103
Engine Room Supplied Air	60
Engine Weights.....	125
Excitation	103
Exhaust Backpressure Limits	64
Exhaust Manifolds.....	64
Exhaust Piping.....	65
Exhaust Slobber	64
Exhaust System	64-66
Exhaust System Schematic	66
Expansion Tanks.....	52

F	
Flexible Connections.....	48
Fluids Weight.....	124
Foundation	102
Foundation Design.....	102
Free Field Mechanical and Exhaust Noise.....	33-38
Fresh Water Pump	51, 54
Fuel Coolers.....	49
Fuel Line Dimension	48
Fuel Recommendations	48
Fuel System	3, 48-49
Fuel System Schematic.....	50
Fuel Temperature	49

H	
Heat Balance of the 3600 Engine.....	53
Heat Exchanger Sizing.....	53
High Capacity Sea Water Pump.....	54

Index (con't.)

I		S	
Inclination Capability	44	Scheduled Oil Sampling	5, 44
Increasing Oil Change Intervals	44	Scope of Supply	2
Initial Oil Change Interval	44	Sea Water Pump	52, 54
Internal Lubrication System	42	Separate Combustion Air System	61
J		Shaft Brake	67
Jacket Water Heater Sizing	53	Speed Control Options	2
Jacket Water Heaters	52	Starting Air System	57
L		Starting Air System Customer Connections	57
Line Restriction	48	Starting Air System Schematic	59
Lube Oil System	3	T	
Lube Oil System Schematic	45	Tank Position	48
Lubricant Viscosity	43	Technical Data	10-25
Lubrication Oil System	42-45	Temperature Sensors	68
M		Thermostats	42
Main Engine Governing System	67	Tolerances (Waterjet)	8
Maintenance Interval Schedule	127	Torsional Limits	41
Marine Monitoring System (MMSII)	3	Torsional Vibration Data	39-40
Maximum Operating Pressures	53	Total Base Number (TBN)	43
MODBUS Address List	88-101	Turbochargers	64
Mounting	102	U	
O		Unit Injectors	49
Oil Change Interval	44	V	
Oil Coolers	42	Valves	1
Oil Filters	42	Venting	52
Oil Pan Capacity	44	W	
Oil Pumps	42	Water Pump Pressures	53
Oil Requirements	43	Water Quality, Rust Inhibitors, and Antifreeze	52
P		Water Velocities	53
Performance Curves	26-32	Waterjets	7
Pistons	1	Weld Flange Sizes	53
Prelubrication	43	R	
Pressure Sensors	68	Ratings	5-6
R		Resin Chocks	103
Ratings	5-6	Return Line	48
Resin Chocks	103		
Return Line	48		