DETROIT DIESEL

MTU/DDC SERIES 4000™

8V/12V/16V Construction, Industrial and Generator Set Operator's Guide

TP-6011

6SE4009 MARCH 2000

OPERATOR'S GUIDE

MTU/DDC Series 4000™ Construction, Industrial and Generator Set 8/12/16V Engines

DETROIT DIESEL CORPORATION

Detroit Diesel Corporation
13400 Outer Drive, West / Detroit, Michigan 48239-4001
Telephone: 313-592-5000
Fax: 313-592-7888
http://www.detroitdiesel.com

MTU Motoren-und Turbinen-Union
Friedrichshafen GmbH
88040 Friedrichshafen, Germany
Fax: 497547 90 3642
www.mtu-friedrichshafen.com

CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

IMPORTANT

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed. Proper service and repair are important to the safety of the service technician and the safe, reliable operation of the engine.

If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part number. Do not use a replacement part of lesser quality. The service procedures recommended and described in this manual are effective methods of performing repair. Some of these procedures require the use of specially designed tools. Accordingly, anyone who intends to use a replacement part, procedure or tool that is not recommended, must first determine that neither personal safety nor the safe operation of the engine will be jeopardized by the replacement part, procedure or tool selected.

It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during repair, or the possibility that improper repair may damage the engine or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is impossible to warn personnel of the possible hazardous consequences that might result from failure to follow these instructions.

ATTENTION

This document is a guideline for qualified personnel. It contains recommendations of Detroit Diesel Corporation for the DDC engines covered by this document. DDC makes no representations or warranties regarding the information contained in this document.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

A – SAFETY INSTRUCTIONS

These Safety Instructions must be read and followed by any persons operating or carrying out maintenance on the engine.

A-1 – BASIC SAFETY PRECAUTIONS

The following cautions must be observed by the operator of the unit in which this engine is installed and/or by those performing basic engine preventive maintenance. Failure to read and heed these cautions and exercise reasonable care for personal safety and the safety of others when operating the unit or performing basic engine preventive maintenance may result in injury as well as engine and/or unit damage.

A-2 – CORRECT USE

The engine is intended solely for the application specified in the contract. Any other use is considered improper. The manufacturer will accept no liability for any resultant damage. The responsibility is borne by the user alone.

Correct use also includes observation of and compliance with the maintenance instructions.

A-3 – PERSONNEL REQUIREMENTS

Service on the engine must be carried out only by trained personnel.

A-4 – MODIFICATIONS OR CONVERSIONS

Modifications made by the customer to the engine may affect safety. No modifications or conversions should be implemented without prior consent from Detroit Diesel product support personnel.

Liability will not be accepted for damage resulting from unauthorized modifications.

A-5 – ORGANIZATIONAL MEASURES

The *Series 4000 C & I Engine Operator's Guide* (6SE4009) must be made available to the equipment user. It must be kept at hand near the engine and accessible to the operating and maintenance personnel at all times.

The operator should become familiar with the contents of this manual before operating the engine or carrying out the maintenance procedures.

A-6 – AUXILIARY MATERIALS

Fluids and lubricants must be kept in properly designated containers. When using fluids, lubricants and other chemical substances, follow the safety instructions applicable to the product. Take special care when using hot and caustic materials.

CAUTION:

To avoid injury from fire, contain and eliminate leaks of flammable fluids as they occur. Failure to eliminate leaks could result in fire.

Use only fluids and lubricants that have been tested and approved by DDC and are listed in *Engine Service Guide and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273).

A-7 – SPARE PARTS

Spare parts must at least satisfy performance requirements specified by the manufacturer. This is guaranteed when original components are used.

A-8 – WORKING CLOTHES

Safe work clothing fits and is in good condition. Work shoes are sturdy and rough-soled. Bare feet, sandals or sneakers are not acceptable footwear when adjusting and/or servicing an engine.

CAUTION:

To avoid injury when working near or on an operating engine, remove loose items of clothing, jewelry, tie back or contain long hair that could be caught in any moving part causing injury.

A-9 – TRANSPORT

Lift the engine only with the lifting eye brackets provided. Use only the transport and lifting equipment approved by DDC. The engine must only be transported in the installation position.

A-10 – ENGINE OPERATION

Follow the safety procedures in this section when in the engine room.

CAUTION:

To avoid injury from loud noise, wear ear protectors when the engine is running.

The engine room must be well-ventilated.

CAUTION:

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

Immediately clean up any spills.

CAUTION:

To avoid injury from contact with the contaminates in used engine oil, wear protective gloves and apron.

Inadequate protection of electrical components can lead to electric shocks and serious injuries.

CAUTION:

To avoid injury from electrical shock, do not touch battery terminals, alternator terminals, or wiring cables while the engine is operating.

A-11 – MAINTENANCE AND REPAIR

Compliance with maintenance specifications is an important safety factor.

CAUTION:

To avoid injury from accidental engine startup while servicing the engine, disconnect/disable the starting system.

Persons not involved in the maintenance procedures must keep clear.

Never attempt to rectify faults or carry out repairs if you do not have the special tools required. Check power tools before using.

CAUTION:

To avoid injury, do not use defective portable power tools. Check for frayed cords prior to use. Ensure all electric tools are grounded. Using defective electrical equipment can cause severe injury. Improper use of electrical equipment can result in electrical shock, fire, or explosion under certain conditions which may cause severe injury.

Before starting work, relieve pressure in systems and high pressure lines which are to be opened.

CAUTION:

To avoid injury from penetrating fluids, do not put your hands in front of fluid under pressure. Fluids under pressure can penetrate skin and clothing.

The cooling system fill pressure cap must not be opened until the engine has cooled. Allow pressure to escape before removing the cap.

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

Take special care when draining hot fluids to avoid risk of injury. Drain the fluids into a suitable container and wipe up any spillages.

CAUTION:

To avoid injury, take special care when draining hot fluids. Drain the fluids into a suitable container and wipe up any spillages.

When changing engine oil or working on the fuel system, ensure that the engine room is adequately ventilated.

CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

When working with compressed air, always wear protective goggles.

CAUTION:

To avoid injury from flying debris, wear a face shield or goggles when pressurizing the charge cooler system.

When working with liquid nitrogen, always wear protective clothing.

CAUTION:

To avoid injury from freezing or suffocation when using liquid nitrogen, wear a face shield and protective clothing and work in a well-ventilated area.

Use suitable ladders and work platforms when working high on the engine. Ensure components are placed on stable surfaces.

Do not place tools on the battery.

CAUTION:

To avoid injury from battery explosion or contact with battery acid, work in a well-ventilated area, wear protective clothing, and avoid sparks or flames near the battery. Always establish correct polarity before connecting cables to the battery or battery circuit. If you come in contact with battery acid:

- ☐ **Flush your skin with water.**
- ☐ **Apply baking soda or lime to help neutralize the acid.**
- ☐ **Flush your eyes with water.**
- ☐ **Get medical attention immediately.**

Before connecting the cable to the battery, check battery polarity.

CAUTION:

To avoid injury from electrical shock, follow OEM furnished operating instructions prior to usage.

Before barring the engine, make sure that nobody is standing in the danger zone. After working on the engine, check that all guards have been reinstalled and that all tools and loose components have been removed from the engine.

A-12 – ENVIRONMENTAL PROTECTION

Dispose of used fluids and lubricants and filters in accordance with local environmental regulations.

Manipulation of the injection or control system can influence the engine performance and exhaust emissions. As a result, compliance with environmental regulations may no longer be guaranteed.

A-13 – FIRE PREVENTION

Fix any fuel or oil leaks immediately

CAUTION:

To avoid injury from fire, contain and eliminate leaks of flammable fluids as they occur. Failure to eliminate leaks could result in fire.

CAUTION:

To avoid injury from fire, check for fuel or oil leaks before welding or carrying an open flame near the engine.

CAUTION:

To avoid injury from flames, explosion, and toxicants when using ether, the following precautions must be taken:

- ☐ **Do not smoke when servicing ether system.**
- ☐ **Work in well-ventilated area.**
- ☐ **Do not work near open flames, pilot flames (gas or oil heaters), or sparks.**
- ☐ **Do not weld or carry an open flame near the ether system if you smell ether or otherwise suspect a leak.**
- ☐ **Always wear goggles when testing.**
- ☐ **If fluid enters the eyes or if fumes irritate the eyes, wash eyes with large quantities of clean water for 15 minutes. A physician, preferably an eye specialist, should be contacted.**
- ☐ **Contents of cylinder are under pressure. Store cylinders in a cool dry area. Do not incinerate, puncture or attempt to remove cores from cylinders.**

Before welding, clean with a noncombustible fluid.

CAUTION:

To avoid injury from fire caused by heated diesel-fuel vapors:

- ☐ **Keep those people who are not directly involved in servicing away from the engine.**
- ☐ **Stop the engine immediately if a fuel leak is detected.**
- ☐ **Do not allow open flames or smoke when working on an operating engine.**
- ☐ **Wear adequate protective clothing (face shield, insulated gloves and apron, etc.).**
- ☐ **To prevent a buildup of potentially volatile vapors, keep the engine area well ventilated during operation.**

Diesel fuel is relatively harmless at ambient temperatures.

CAUTION:

To avoid injury from fire, check for fuel or oil leaks before welding or carrying an open flame near the engine.

Welding work must not be carried out on pipes and components containing oil.

CAUTION:

To avoid injury, never mix gasoline with diesel fuel. There is increased risk of fire when gasoline is added to diesel fuel.

Never mix gasoline with diesel fuel.

When starting the engine with an external power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the external power source to the ground lead of the engine or to the ground terminal of the starter.

Always keep a fire extinguisher at hand for the appropriate fire hazard conditions, and learn how to operate it.

A-14 – WARNING SIGNS

Before putting the engine into service and before working on the engine, read and follow all warning signs. Do not paint on warning signs. Replace illegible signs.

A-15 – SAFETY INSTRUCTIONS IN THE TEXT

Section "F" of this Publication contains especially emphasized safety instructions in accordance with the American standard ANSI Z535, which begin with one of the following signal words according to the degree of danger:

CAUTION:

This is a CAUTION. The contents contain information and directions that must be followed to avoid injury.

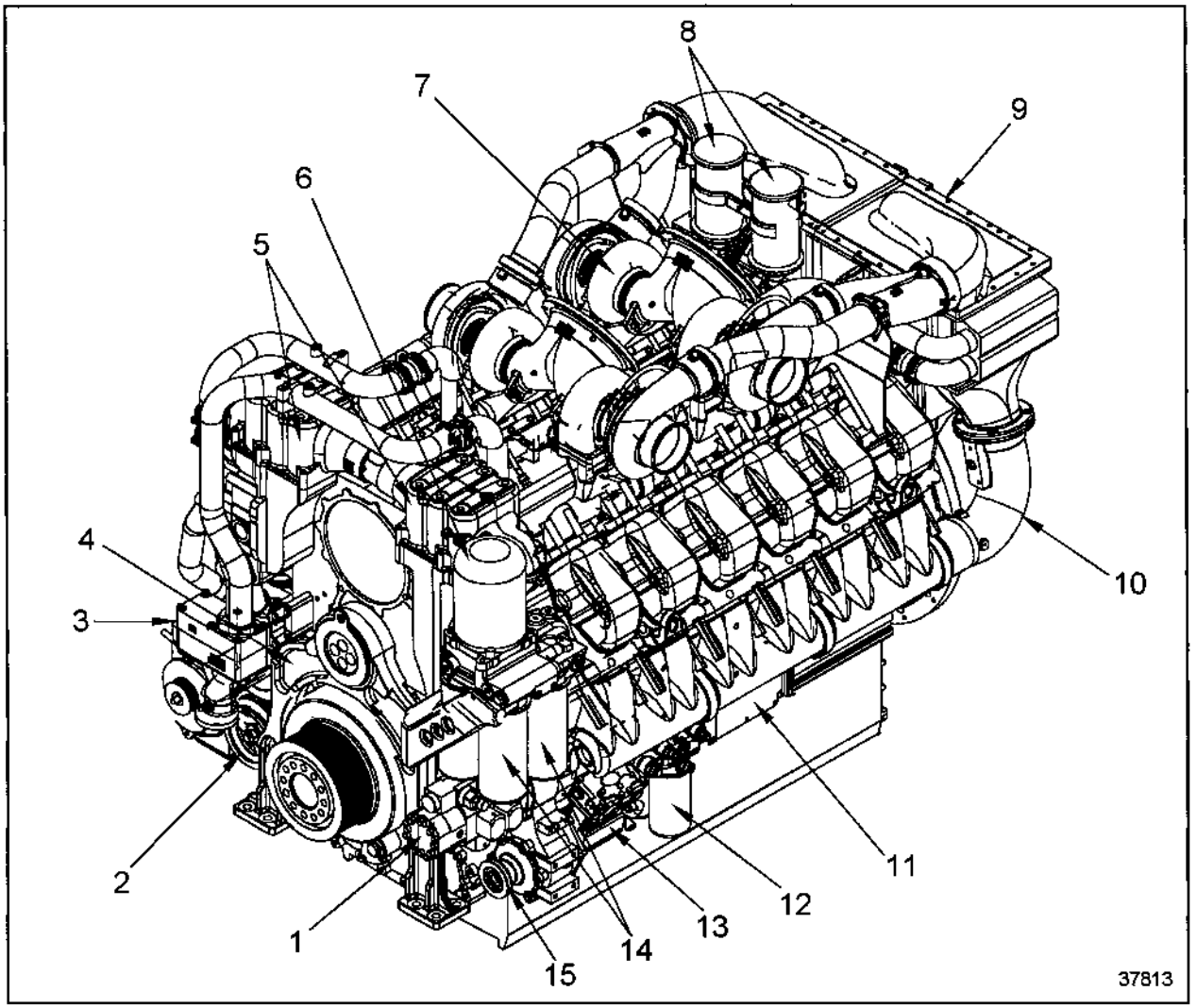
NOTICE:

This is a NOTICE. The contents warn of conditions that can cause damage to the machinery.

B – PRODUCT SUMMARY

B-1 – ENGINE LAYOUT

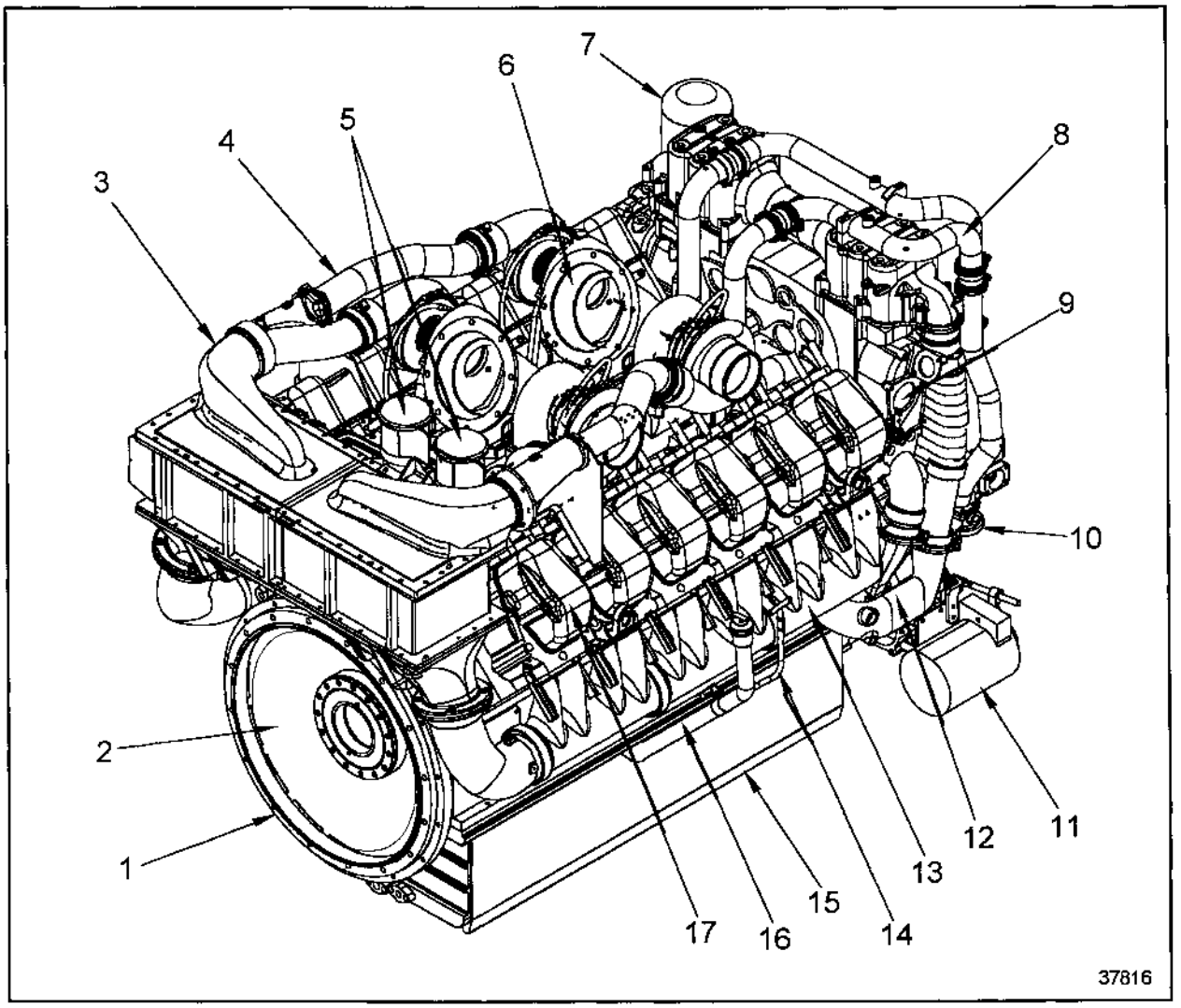
See Figure 1 for the front view of the Series 4000 12V engine.



1. High Pressure Fuel Pump
2. Alternator Drive
3. Low Temp Coolant (LTC) Thermostat
4. Trunnion Mount
5. Oil Coolers
6. Centrifugal Oil Filter
7. Turbocharger (4)
8. Crankcase Breathers
9. Charge Air Cooler
10. Intake Manifold
11. DDEC ECMs
12. Fuel Filters
13. Air Compressor
14. Oil Filter Cartridges
15. Accessory Drive

Figure 1 Front View, 12V Engine

See Figure 2 for the back view of the Series 4000 12V engine.



1. Flywheel Housing
2. Flywheel
3. Charge Air Cooler Intake
4. Air Inlet
5. Crankcase Breathers
6. Exhaust Outlet
7. Centrifugal Oil Filter
8. Charge Air Coolant Line
9. High Temp Thermostat Housing
10. Low Temp Water Pump
11. Alternator Drive
12. High Temp Water Pump Drive
13. Intake Manifold
14. Dipstick
15. Oil Pan
16. Oil Filler Tube
17. Cylinder Head Rocker Cover

Figure 2 Back View 12V Engine

B-2 – ENGINE MODEL DESIGNATION

For the key to engine model designation for the 8V, 12V and 16V engines, refer to Table 1. Example of a Series 4000 engine model number is T1237K16, for the DDC model numbering format:

Series	Cylinders	Application	Rotation and Type	Design Variation	Specific Model Number
Position 1	Position 2, 3	Position 4	Position 5	Position 6	Position 7, 8
T - 4000	08	0 - Incomplete	0 - LH	K - DDEC III, IV	00 - Basic
	12	2 - Marine	1 - LA		
	16	3 - Industrial and Genset	2 - LB		
		4 - Power Base	3 - LC		
		5 - Generator	4 - LD		
			5 - RA		
			6 - RB		
			7 - RC		
			8 - RF		
			9 - RH		

Table 1 DDC Model Numbering Format

B-3 – ENGINE SIDE AND CYLINDER DESIGNATIONS

Engine sides are always designated as viewed from the driving end.

The left bank of cylinders is marked "A" and the right bank "B" (as per DIN ISO 1204).

Each cylinder bank is numbered consecutively from No. 1, starting at the driving end of the engine.

Other components and assemblies are also numbered consecutively starting with No. 1 at the driving end. See Figure 3.

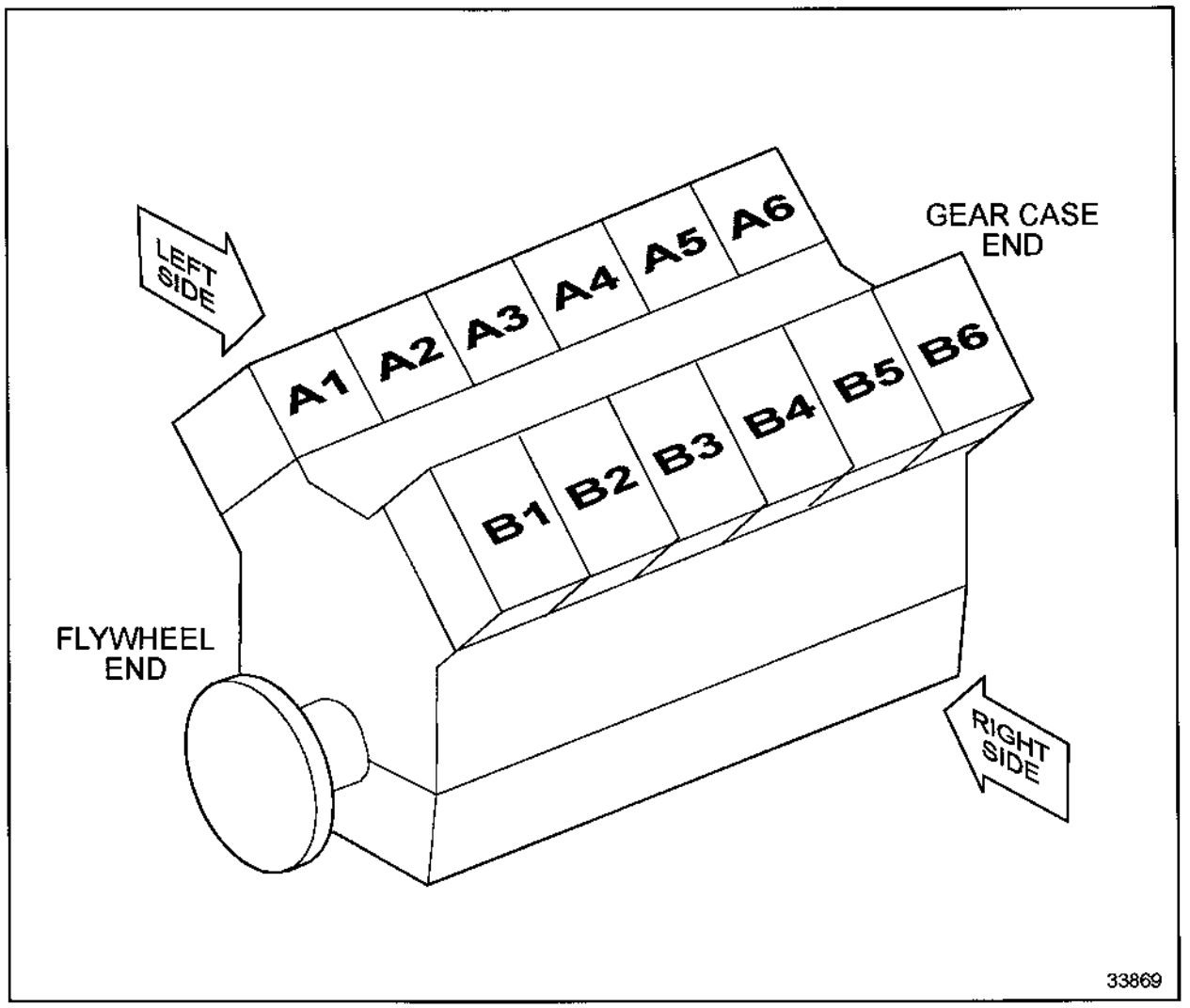
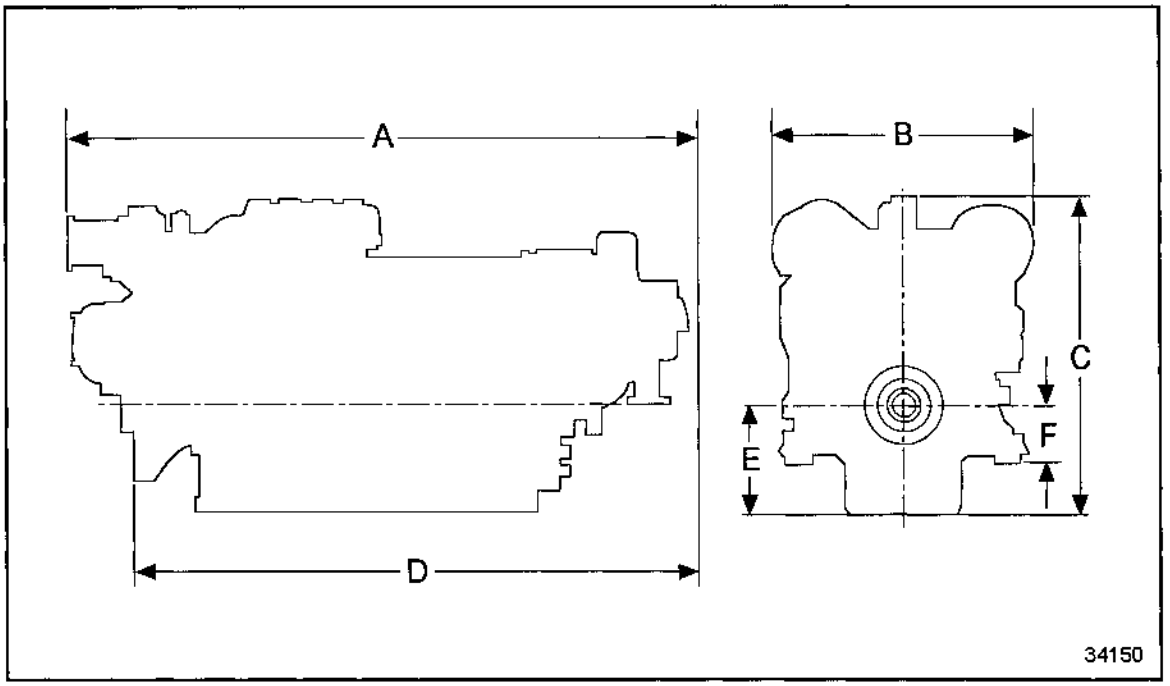


Figure 3 Cylinder Designations, 12V Engine

B-4 – MAIN ENGINE DIMENSIONS

See Figure 4 for the main dimension measurements; dimensions are listed in Table 2.



A - Overall Length
B - Overall Width
C - Overall Height
D - Engine Length to Flange-mounting Surface
E - Crankshaft CL to Oil Pan Bottom
F - Crankshaft CL to Engine Mount

Figure 4 Main Engine Dimensions

Dimensions	8V	12 V	16 V
Length - A	2066 mm 81.4 in.	2537.7 mm 99.91 in.	3008 mm 118.43 in.
Width - B	1594 mm 62.8 in.	1610.7 mm 63.41 in.	1626 mm 64.01 in.
Height - C	1737 mm 68.4 in.	2259.1 mm 88.94 in.	1985 mm 78.15 in.
To flange surface - D	N/A	1984.8 mm 78.14 in.	2730 mm 107.48 in.
Centerline to oil pan bottom - E	N/A	625 mm 24.61 in.	625 mm 24.60 in.
Centerline to engine mount - F	N/A	337 mm 13.27 in.	337 mm 13.27 in.

Table 2 Main Engine Dimensions

The general engine specifications for the Series 4000 8, 12 and 16V engine are listed on sheet 2 of the performance curves and may be found at the end of this book. Consult a DDC distributor for updates. Specifications do change with product modification.

B-5 – ENGINE INCLINATIONS

The permissible inclinations for the Series 4000 engines are listed in Table 3.

Inclinations with Standard Oil Pan	8V	12V	16V
Longitudinal, driving end down, permanent	N/A	15 degrees max	12 degrees max
Longitudinal, free end down, permanent	N/A	5 degrees max	12 degrees max
Transverse, permanent	N/A	22.5 degrees max	22.5 degrees max
Inclinations with Deeper Oil Pan			
Longitudinal, driving end down, permanent	—	—	15 degrees max
Longitudinal, free end down, permanent	—	—	13.5 degrees max
Transverse, permanent	—	—	22.5 degrees max

Table 3 Engine Inclinations

B-6 – GENERAL ENGINE SPECIFICATIONS

The general engine specifications for the Series 4000 8V, 12V and 16V engine are listed on sheet 2 of the performance curves and may be found at the end of this book. Specifications do change with product modification. Consult a DDC distributor for updates.

Listed in Table 4 are the available construction and industrial curves:

Engine	Rated Power bhp (kW) @ r/min	Peak Torque lb·ft (N·m) @ r/min	Curve Number
12V	1600 (1194) @ 1800	5602(7595) @ 1500	E4-T123-32-05, page 132 Sheet 2, page 133
12V	1725 (1286) @ 1900	5151 (6983) @ 1500	E4-T123-32-02, page 134 Sheet 2 , page 135
12V	1875 (1398) @ 1900	5613 (7610) @ 1500	E4-T123-32-03, page 136 Sheet 2 , page 137
12V	2025 (1510) @ 1900	6047 (8199) @ 1500	E4-T123-32-04, page 138 Sheet 2 , page 139
12V	2250 (1679) @1950	6300 (8542) @1650	E4-T123-32-01, page 140 Sheet 2 , page 141
16V	2300 (1715) @ 1900	6870 (9314) @ 1500	E4-T163-32-04, page 142 Sheet 2, page 143
16V	2500 (1864) @ 1900	7486 (10150) @ 1500	E4-T163-32-05, page 144 Sheet 2, page 145
16V	2700 (2013) @ 1900	8064 (10933) @ 1500	E4-T163-32-06, page 146 Sheet 2, page 147
16V	3000 (2238) @ 1950	8400 (11389) @ 1650	E4-T163-32-07, page 148 Sheet 2 , page 149

* Petroleum Hydro-Frac

Performance curves are subject to change without notice.

Table 4 Available Construction and Industrial Power Curves

Listed in Table 5 are the available genset curves:

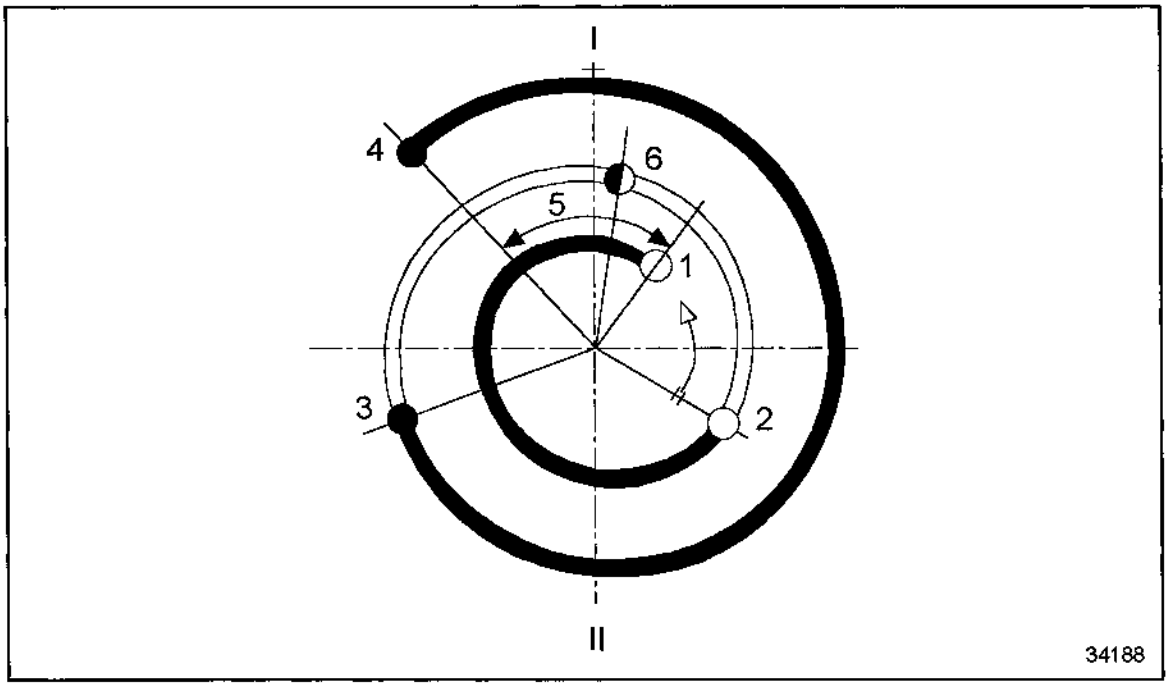
Engine	Standby Power bhp (kW) @ r/min	Prime Power bhp kW) @ r/min	Continuous Power bhp (kW) @ r/min	Curve Number
12V	2200 (1640) @ 1800	2000 (1490) @ 1800	1500 (1120) @ 1800	E4-T125-32-1, page 150 Sheet 2 , page 151 Sheet 3 , page 152 Sheet 4 , page 153
12V	1965 (1465) @ 1500	1785 (1330) @ 1500	1470 (1095) @ 1500	E4-T125-32-3 , page 154 Sheet 2 , page 155 Sheet 3 , page 156 Sheet 4 , page 157
12V	1850 (1380) @ 1800	1680 (1255) @ 1800	-	E4-T125-32-2, page 158 Sheet 2 , page 159 Sheet 3 , page 160
12V	1615 (1205) @ 1500	1440 (1070) @ 1500	-	E4-T125-32-4 , page 162 Sheet 2 , page 163 Sheet 3 , page 164
16V	2935 (2190) @1800	2670 (1990) @1800	2000 (1495) @1800	E4-T165-32-1 , page 166 Sheet 2 , page 167 Sheet 3 , page 168 Sheet 4 , page 169
16V	2600 (1940) @ 1500	2360 (1760) @ 1500	1945 (1450) @ 1500	E4-T165-32-3 , page 170 Sheet 2 , page 171 Sheet 3 , page 172 Sheet 4 , page 173
16V	2550 (1900) @ 1800	2320 (1730) @ 1800	-	E4-T165-32-2, page 174 Sheet 2 , page 175 Sheet 3, page 176
16V	2260 (1686) @ 1500	2055 (1533) @ 1500	-	E4-T165-32-4, page 177 Sheet 2, page 178 Sheet 3, page 179
16V	2935 (2190) @ 1800 r/min	2670 (1990) @ 1800	2000 (1495) @ 1800	E4-T165-32-6, page 181 Sheet 2, page 182 Sheet 3, page 183 Sheet 4, page 184

Performance curves are subject to change without notice.

Table 5 Available Genset Performance Curves

B-7 – TIMING DATA

See Figure 5 for valve timing with valve clearance adjusted.



1 - Inlet valve opens; crank angle 42.6 degrees before TDC.

2 - Inlet valve closes; crank angle 66.6 degrees after BDC.

3 - Exhaust valve opens; crank angle 57.6 degrees before BDC.

4 - Exhaust valve closes; crank angle 30.4 degrees after TDC.

5 - Overlap; crank angle 73 degrees.

6 - Start of delivery; map based.

I — TDC (top dead center)

II — BDC (bottom dead center)

Figure 5 Valve Timing, Valve Clearance Adjusted

Firing Order

8V: N/A

12V: A1 - B2 - A5 - B4 - A3 - B1 - A6 - B5 - A2 - B3 - A4 - B6

16V: A1 - A7 - B4 - B6 - A4 - B8 - A2 - A8 - B3 - B5 - A3 - A5 - B2 - A26 - B1 - B7

B-8 – VALVE CLEARANCES

Listed in Table 6 are the valve clearances with engine cold, 20°C (68°F).

Inlet	0.20 mm (0.008 in.)
Exhaust	0.50 mm (0.02 in.)

Table 6 Valve Clearance

B-9 – OIL CAPACITY

Oil capacity is listed in Table 7. All quantities are approximate.

	8V	12V	16V
Oil capacity, oil pan			
To lower mark on oil dipstick	N/A	160 L (42.3 gal)	190 L (50.2 gal)
To upper mark on dipstick	N/A	200 L (52.8 gal)	230 L (60.8 gal)
Total capacity			
For initial fill	N/A	265 L (70 gal)	265 L (70 gal)
For oil change	N/A	215 L (56.8 gal)	215 L (56.8 gal)

Table 7 Oil Capacity

C – OPERATING INSTRUCTIONS

C-1 – OPERATING INSTRUCTIONS - INTRODUCTION

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing being carried out in compliance with our specifications and instructions.

It is essential that:

- ☐ Trained personnel be employed.
- ☐ Suitable tools be used.
- ☐ Fluids and lubricants used should be those specified by DDC publication *Oil, Fuel, and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273).
- ☐ Only MTU/DDC oil filters, P/N: 23550401, should be used. Certain aftermarket filters do not meet MTU/DDC requirements for filtration and/or flow.
- ☐ The maintenance tasks be carried out as per the MTU/DDC Maintenance Schedule; refer to section D-2.

Our Product Support Service is available at all times should assistance be needed.

Prior to engine start-up it must be determined whether start-up is:

- ☐ After a short, scheduled operational shutdown
- ☐ After an extended out-of-service period
- ☐ Initial start-up of a new engine

Accordingly the Before-Operation Services are subdivided into:

- ☐ B1 - Before-Operation Services after a short, scheduled operational shutdown
- ☐ B2 - Before-Operation Services after an extended operational shutdown (exceeding 1 week)
- ☐ B3 - Before-Operation Services before initial start-up of a new or preserved engine

Correct engine installation and alignment according to MTU / DDC regulations are basic requirements for initial engine start-up.

Prior to engine shutdown it must be determined whether shutdown is for:

- ☐ A short, scheduled operational shutdown
- ☐ An extended out-of-service period

If the engine malfunctions, a decision must be made to either:

- ☐ Shut down the engine
- ☐ Continue engine operation for a short period, using emergency measures, until the fault can be rectified

NOTE:
The section numbers on the following pages refer to Section F of this manual.

NOTE:
These operating instructions may include components which are not installed on your engine; these may be disregarded.

C-2 – BEFORE-OPERATION SERVICES

The tasks to be performed for before-operation services B1, B2, and B3 and the numbers of the sections containing task descriptions are listed in Table 8.

Section	Task Description		B1	B2	B3
Refer to F-39	Air filter	Check contamination indicator*	x	x	x
Refer to F-46	Engine oil	Check level	x	x	x
Refer to F-56	Engine coolant	Check level	x	x	x
Refer to F-62	Engine coolant	Preheat†‡	x	x	x
Refer to F-65	Charge air coolant	Check level†‡			
Refer to F-86	Fuel	Check supply	x	x	x
Refer to F-92	DDEC	Switch ON	x	x	x
Refer to F-3	Running gear	Bar engine manually		x	x
Refer to F-25	Fuel H.P. pump	Check weep hole for obstructions		x	x
Refer to F-82	Mechanical accessories	Ensure that guards are correctly installed		x	x
Refer to F-92	DDEC	Check wiring for security and condition; check plug		x	x
Refer to G-1	Removal from storage	Carry out before-operation services			x
Refer to F-30	Fuel system	Check level†‡			x
Refer to F-37	Air system	Ensure that cover plates are removed			x
Refer to F-40	Exhaust system	Ensure that cover plates are removed			x
Refer to F-46	Engine oil	Fill system			x
Refer to F-55	Engine coolant system	Fill system			x
Refer to F-62	Preheater	Switch ON†‡			x
Refer to F-63	Engine Coolant System	Check vent line for obstructions†‡			x
Refer to F-64	Charge air coolant	Fill system†‡			x
Refer to F-67	Charge air coolant system	Check vent line for obstructions†‡			x
Refer to F-92	DDEC	Switch ON			x
-	Crankshaft	Ensure transportation locking device is removed†‡			x

* 8V procedure

†12V procedure

‡16V procedure

Table 8 Before-Operation Procedures

C-3 – INITIAL OPERATION

The tasks to be performed for initial operation and the numbers of the sections containing task descriptions are listed in Table 9.

Section	Task Description	
-		Carry out before-operation services
Refer to F-4	Engine	Crank engine: ☐ after 1st start-up ☐ after engine oil change ☐ after engine oil filter change ☐ after extended out-of-service period (exceeding 1 month)
Refer to F-5	Engine	Start engine
Refer to F-6	Engine operation	Carry out warm-up procedure
Refer to F-7	Engine operation	Check speed
Refer to F-8	Engine operation	Check pressures (where gages are installed)
Refer to F-9	Engine operation	Check temperatures (where gages are installed)
Refer to F-10	Engine operation	Check running noises
Refer to F-11	Engine operation	Check engine and external pipelines for leaks
	On initial start-up of a new or preserved engine or after a W6 overhaul, the following additional tasks must be preformed:	
Refer to F-21	Valve gear	Check oil supply†‡
Refer to F-43	Engine test run	Check exhaust overpressure
Refer to F-37	Engine test run	Check intake depression†‡
Refer to F-92	DDEC	Switch OFF

†12V procedure

‡16V procedure

Table 9 Initial Engine Operation Procedures

C-4 – OPERATIONAL CHECKS — MAINTENANCE PROCEDURES

Carry out tasks specified in Maintenance Schedule. Refer to section D.

C-5 – ENGINE SHUTDOWN

The tasks to be performed for engine shutdown and the numbers of the sections containing task descriptions are listed in Table 10.

Section	Task Description	
Refer to F-12	Engine	Shut down engine

Table 10 Engine Shutdown Procedures

C-6 – AFTER-SHUTDOWN SERVICES

The tasks to be performed after engine shutdown and the numbers of the sections containing task description are listed in Table 11.

Section	Task Description	
Refer to F-46	Engine oil	Check level
Refer to F-58	Engine coolant	Drain - Only when freezing temperatures are expected and the engine is to remain out of service for an extended period and: ☐ the coolant has no antifreeze additive ☐ the engine room cannot be heated ☐ the coolant temperature cannot be maintained at a suitable level ☐ the antifreeze concentration is insufficient for the engine room temperature ☐ or with an antifreeze concentration of 50% and at an engine room temperature below -40°C, if the antifreeze additive conforms to specifications, refer to 7SE273
Refer to F-66	Charge air coolant	Drain - Only when freezing temperatures are expected and the engine is to remain out of service for an extended period and: ☐ the coolant has no antifreeze additive ☐ the engine room cannot be heated ☐ the coolant temperature cannot be maintained at a suitable level ☐ the antifreeze concentration is insufficient for the engine room temperature ☐ or with an antifreeze concentration of 50% and at an engine room temperature below -40°C, if the antifreeze additive conforms to specifications, refer to 7SE273
Refer to F-86	Fuel supply	Close supply line
Refer to F-92	DDEC	Switch OFF

Table 11 After Engine Shutdown Procedures

C-7 – OUT-OF-SERVICE PERIOD

If the engine is to remain out of service for a period exceeding two weeks, seal the engine air and exhaust systems.

If the engine is to remain out-of-service for more than three months, store and preserve the engine as described. Refer to section G.

C-8 – ENGINE TRANSPORTATION

Before transporting the engine, the transportation locking devices for the crankshaft must be installed. The engine must only be lifted using the lifting eyes provided.

D – MAINTENANCE SCHEDULE

D-1 – INTRODUCTION

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing being carried out in compliance with our specifications and instructions.

The overall system, of which the engine is an integral part, must be maintained in a manner that ensures trouble free engine operation. This maintenance will ensure that:

- ☐ Sufficient fuel is available
- ☐ Combustion air is dry and clean (prevents hydrostatic lock)
- ☐ Trained personnel are employed
- ☐ Suitable tools are used
- ☐ Detroit Diesel approved replacement parts are used
- ☐ Fluids and lubricants used per DDC publication *Oil, Fuel, and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273)

Contact the local distributor for technical service.

D-2 – MAINTENANCE SYSTEM

The DDC maintenance system utilizes the preventive maintenance concept. Preventive maintenance procedures allow advanced planning. To facilitate the detection of possible leaks and prevent subsequent damage, keep the machinery clean and in serviceable condition at all times. Protect rubber and synthetic parts from oil and fuel, never treat with organic detergents. Wipe with a dry cloth only.

The DDC maintenance concept features the W1 to W6 maintenance levels as listed in Table 12.

Maintenance Level	Description
W1	Operational Checks.
50 Hour Inspection	Listed in Table 15
W2, W3 and W4	Periodic maintenance services to be performed during out-of-service periods without the need for engine disassembly.
W5	Partial engine disassembly required.
W6	Major overhaul. Complete engine disassembly required.

Table 12 Maintenance Level

The maintenance level structure and timing are based on operational experience. The time intervals have been structured to ensure correct engine operation until the next scheduled maintenance level. Particular operating conditions may require altering the maintenance schedule to compensate accordingly.

NOTE:
The section numbers in the maintenance schedules refer to groups and subgroups in Section F.

NOTE:
Disregard the maintenance schedule for components not installed on your engine.

D-3 – APPLICATION GROUP

The application group for the Series 4000 construction and industrial engine are: heavy vehicles and heavy-duty machinery. Refer to Detroit Diesel Sales and Application information for a full description of application guidelines.

D-4 – MAINTENANCE FREQUENCY TABLE

The maintenance level and the frequency of use for the Series 4000 construction and industrial engine are listed in Table 13.

Maintenance Level	Frequency Performed, 8V Engines	Frequency Performed, 12V and 16V Engines
W1	Daily Operational Checks	Daily Operational Checks
50 Hour Inspection	Listed in Table 15	Listed in Table 15
W2	Operating hours - 500 Limit - 6 months	Operating hours - 500 Limit - 6 months
W3	Operating hours - 1,000 Limit - 1 year	Operating hours - 2,500 Limit - 1 year
W4	Operating hours - 5,000 Limit - 2 years	Operating hours - 5,000 Limit - 2 years
W5	Operating hours - 10,000 Limit - 6 years	Operating hours - 10,000 Limit - 6 years
W6	Operating hours - 20,000 Limit - 16 years	Operating hours - 20,000 Limit - 18 years

Table 13 Maintenance Frequency

D-5 – PREVENTIVE MAINTENANCE ITEMS

The tasks for Maintenance Level W1 and the numbers of the sections containing task description are listed in Table 14. To find task descriptions refer to the *Series 4000 Service Manual* (6SE4011).

Section	Maintenance Level W1 - Operational Checks	
Refer to F-7	Engine operation	Check speeds
Refer to F-8	Engine operation	Check pressures, if gages are provided
Refer to F-90	Engine operation	Check temperatures, if gages are provided
Refer to F-10	Engine operation	Check running noises
Refer to F-11	Engine operation	Check engine and external pipelines for leaks
Refer to F-33	Turbocharger connections	Check connections for leaks; check oil supply, and return lines for leaks
Refer to F-39	Air filter	Check contamination indicator
Refer to F-42	Exhaust system	Check exhaust gas color
-	Exhaust system	Drain condensation, if drain valve provided
Refer to F-46	Engine oil	Check level
Refer to F-65	Engine coolant	Check level
Refer to F-81	Compressor unit	Check operating pressure, hoses, lines and attachments
Refer to F-93	Monitoring system	Carry out lamp test

Table 14 W1 Maintenance Level

The one-time services preformed after the first 50 operating hours are listed in Table 15.

Section	One-time services after the first 50 operating hours*	
—	Installation check	Check condition and security of elements securing engine to vehicle
Refer to F-22	Valve gear	Check valve clearances; adjust if necessary
-	H.P. fuel pump, if applicable	Check weep hole for obstructions
Refer to F-31	Fuel filter, engine mounted	Replace filter element
Refer to F-40	Exhaust system	Check tightness of bolts and nuts
Refer to F-48	Engine oil	Used oil - take sample and analyze
Refer to F-60	Engine coolant pump	Check weep hole for obstructions
Refer to F-67	Charge air coolant pump	Check weep hole for obstructions
Refer to F-76	Engine cooling fan	Check belt condition and tension
Refer to F-81	Air-conditioning compressor	Check belt condition and tension
Refer to F-74	Alternator / generator drive	Check belt condition and tension
*On a new engine, or after a W5 or W6 maintenance		

Table 15 50 Hour Inspection

The tasks for Maintenance Levels W2, W3, W4 and W5 and the numbers of the sections containing task description are listed in Table 16. The extra tasks for Maintenance Level W5 *only* are listed in Table 17.

Section	Maintenance Levels		W2	W3	W4	W5
Refer to F-25	HP fuel delivery pump	Check weep hole for obstructions	x	x	x	x
Refer to F-31	Fuel filter	Replace filter every second W2 (1000 operating hours		x	x	x
Refer to F-31	Fuel filter (vehicle mounted)	Replace filter	x	x	x	x
Refer to F-31	Fuel Prefilter (vehicle mounted)	Replace filter elements	x	x	x	x
Refer to F-38	Air filter*	Clean, empty dust collection box; replace filter if necessary	x	x	x	x
Refer to F-45	Starter, if applicable	Check air flow control flap for ease of movement	x	x	x	x
Refer to F-48	Engine oil	Used oil; take sample and analysis	x	x	x	x
Refer to F-49	Engine oil	Oil Type 1 - Change after 500 operating hours	x	x	x	x
		Oil Type 2 - Change after every 500 operating hours	x	x	x	x
Refer to F-53	Engine oil filter	Replace when changing oil				x
Refer to F-54	Centrifugal oil filter	Check thickness of deposit layer, clean centrifuges, replace sleeve I	x	x	x	x
Refer to F-60	Engine coolant pump	Check weep hole for obstructions	x	x	x	x
Refer to F-67	Charge air coolant pump	Check weep hole for obstructions	x	x	x	x
Refer to F-73	Battery charging alternator	Check belt condition and tension	x	x	x	x
Refer to F-75	Battery charging alternator	Inspect terminals for corrosion and loose connections; inspect wiring	x	x	x	x
Refer to F-76	Engine cooling fan	Check belt condition and tension	x	x	x	x
Refer to F-81	Air-condition compressor	Check belt condition and tension	x	x	x	x
Refer to F-22	Valve gear	Check valve clearances		x	x	x
Refer to F-44	Exhaust system	Check connections, check drain for obstructions; check security		x	x	x
Refer to F-57	Engine coolant	Take and analyze sample; change if necessary. See Specifications.		x	x	x

Section	Maintenance Levels		W2	W3	W4	W5
Refer to F-60	Engine coolant pump	Check weep hole for oil and coolant discharge and contamination		x	x	x
Refer to F-63	Engine coolant cooler	Check cooler elements for external contamination; clean		x	x	x
Refer to F-69	Charge-air coolant cooler	Check cooler elements for external contamination; clean		x	x	x
Refer to F-17	Cylinder chambers	Examine with borescope			x	x
Refer to F-28	Fuel injectors	Remove and check; replace and code again			x	x
Refer to F-72	Wiring	Check security and condition			x	x
Refer to F-74	Alternator	Check condition of coupling			x	x
Refer to F-78	Engine mounting	Check security; tightness of bolts			x	x
Refer to F-79	Engine mounting	Check condition of resilient mounts			x	x
Refer to F-92	DDEC	Wiring: Check plug and threaded connections			x	x

Table 16 W2, W3, W4 and W5 Maintenance Levels

Maintenance Level	
Before starting W5 maintenance services, drain coolant and flush coolant systems	
Valve gear	Remove and check rocker arms and valve bridges.
Vibration damper	Remove and examine; replace if necessary.
Charge Air Cooler	Remove, clean, leak test. Replace seals.
Turbocharger	Replace.
Air supply lines	Remove. Clean. Replace seals.
H.P. fuel pump	Replace.
H.P. fuel sensor	Replace.
Engine coolant pump	Rebuild or replace. Replace gearing and gaskets.
Charge air coolant pump	Rebuild or replace. Replace gearing and gaskets.
Engine coolant cooler	Clean; check for leaks.
Charge air coolant cooler	Clean; check for leaks.
Coolant thermostat	Check, replace if necessary.
Charge air coolant thermostat	Remove. Clean and check for leaks. Replace sealing rings.
Crankcase breather	Replace filter elements.
Centrifugal oil filter	Check, replace bearing if necessary.

Table 17 Extra Tasks for W5 Maintenance Level Only

NOTE:
The W6 Maintenance Level requires complete disassembly of the engine. Repair or overhaul of the relevant components is determined by the actual condition of the components and their dimensions, referenced to the Tolerances and Wear Limits.

E – TROUBLESHOOTING

E-1 – TROUBLESHOOTING

For troubleshooting information, refer to the *Series 4000 Service Manual* (6SE4011); refer to section E. This section covers mechanical troubleshooting and testing of the C & I engine.

F – TASK DESCRIPTION

F-1 – DISABLING ENGINE START

When performing certain engine checks and before engine storage, disable engine start as follows:

1. Switch off the ignition and remove the key.

CAUTION:

To avoid injury from battery explosion or contact with battery acid, work in a well-ventilated area, wear protective clothing, and avoid sparks or flames near the battery. Always establish correct polarity before connecting cables to the battery or battery circuit. If you come in contact with battery acid:

- ☐ **Flush your skin with water.**
- ☐ **Apply baking soda or lime to help neutralize the acid.**
- ☐ **Flush your eyes with water.**
- ☐ **Get medical attention immediately.**

1. Disconnect the battery.
2. Shut off fuel supply to engine. Refer to section F-85.
3. Attach safety lockout tag.

F-2 – ENABLING ENGINE START

After engine checks are performed, enable engine start as follows:

1. Before connecting the cable to the battery, check battery polarity.

CAUTION:

To avoid injury from battery explosion when jump starting the engine, do not attach the cable end to the negative terminal of the disabled battery.

2. Connect the battery.
3. Open the fuel supply to the engine. Refer to section F-85.
4. Remove safety lockout tag.
5. Switch on the ignition.

F-3 – MANUAL ENGINE BARRING

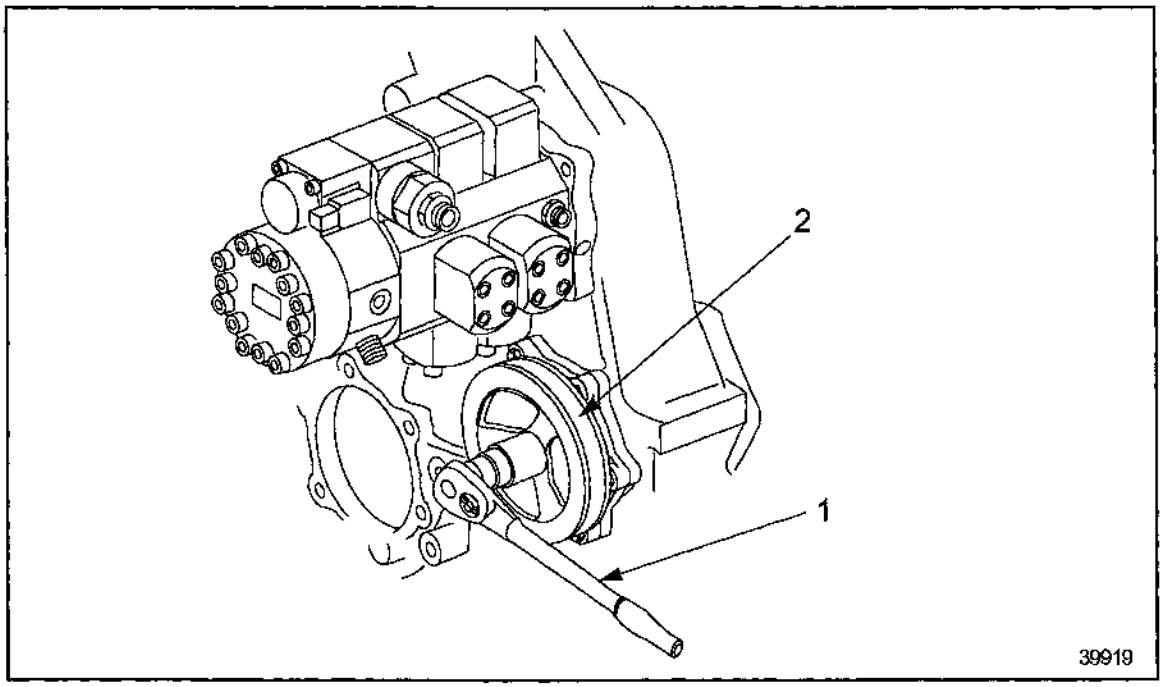
Manually bar the engine as follows:

CAUTION:

To avoid injury from unguarded rotating and moving engine components, check that all protective devices have been reinstalled after working on the engine.

NOTE:
Apart from the normal compression resistance, there should be no abnormal resistance when barring the engine.

1. Disable engine start; refer to section F-1.
2. Attach an M24 socket and ratchet with extension handle (1) on the accessory drive nut. Refer to section F-19. See Figure 6.



1. M24 Socket and Ratchet
2. Accessory Drive

Figure 6 Engine Barring

3. Bar engine manually, pushing down only on ratchet.

NOTE:
Pulling up on the bracket, loosen accessory drive pulley nut.

4. Remove socket and ratchet from the accessory drive nut. Refer to section F-20.
5. Enable engine start. Refer to section F-2.

F-4 – ENGINE CRANKING WITH STARTER

CAUTION:

To avoid injury from unguarded rotating and moving engine components, check that all protective devices have been reinstalled after working on the engine.

Activate the starter for 10 seconds maximum, no longer. Before repeating a start attempt, wait at least 20 seconds so that the starter cools down. For engine cranking without firing, refer to the *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

F-5 – ENGINE STARTING

CAUTION:

To avoid injury from unguarded rotating and moving engine components, check that all protective devices have been reinstalled after working on the engine.

When the preparatory work has been carried out in accordance with the Operating Instructions, refer to section C-1, the engine can be restarted.

NOTE:
Always start the engine under no-load conditions.

Carry out engine start; refer to the *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

Activate the starter for 10 seconds maximum, no longer. Before repeating a start attempt, wait at least 20 seconds so that the starter cools down.

Do not increase engine speed until oil pressure is displayed.

F-6 – ENGINE WARM-UP

NOTICE:

Do not operate the engine at full speed until engine coolant temperature reaches 40°C (104°F).

Increase engine load as slowly as possible until coolant temperature of 40°C (104°F) is reached.

F-7 – ENGINE SPEED CHECK

Check idle and full-load speeds.

F-8 – ENGINE PRESSURE CHECK

Check engine oil pressure for specified values.

For specified values, refer to the power curves. Refer to section B-6.

F-9 – ENGINE TEMPERATURE CHECK

Check engine coolant temperature for specified values.

For specified values, refer to the power curves. Refer to section B-6.

F-10 – ENGINE RUNNING NOISE CHECK

CAUTION:

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

Run engine at idling speed.

No abnormal sounds should be heard apart from the usual running noises.

F-11 – ENGINE AND EXTERNAL PIPELINE LEAK CHECK

Check for leaks as follows:

CAUTION:

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

1. Run engine under load.
2. Check engine and all pipework for leaks.
3. If leaks are found, shut down the engine.
4. When the engine has cooled, repair or replace the leaking pipes.

NOTE:
Never tighten lines when under pressure.

F-12 – ENGINE SHUTDOWN

NOTICE:

Never shut down the engine directly from full-load operation, as this may result in overheating and wear of the engine components

Before shutting down the engine, disengage the gearbox and run the engine at idling speed watching the temperature decrease. Do not press the Engine Shutdown button until a constant temperature is indicated.

Press Engine Shutdown button at the Control Station or on the driver's console.

F-13 – EMERGENCY SHUTDOWN

Press the Emergency Shutdown button at the control station or on the driver's console.

F-14 – ATTACHMENTS — SECURING BOLT TIGHTNESS CHECK

Check the securing bolt tightness for exhaust system. Refer to section F-44.

Check the securing bolt tightness for the PTO system, front end. Refer to section F-80.

Check engine bolts. Check tightness of all securing bolts using a torque wrench.

F-15 – ATTACHMENTS — HOSE AND HOSE CONNECTIONS CHECK

Check all hoses and hose connections on the engine for condition and leaks. Immediately replace hoses showing signs of scuffling, aging or cracking.

F-16 – COMPRESSION PRESSURE CHECK

Follow these steps to check the compression pressure:

1. Shut off fuel supply to engine. Refer to section F-84.
2. Remove cylinder head rocker cover. Refer to section F-23.
3. Remove injector. Refer to section C 075.05.05, *Series 4000 Service Manual* (6SE4011) for the procedure to install fuel injectors.
4. Bar engine with starting system to remove any loose carbon deposits from the combustion chambers. Refer to section F-4.
5. Install adaptor with sealing ring in the injector bore and tighten with the clamping element.
6. Connect the compression pressure recorder to the adaptor.
7. Bar engine with starting system until no further pressure rise is indicated.
8. Read off and note down the values.
9. Actuate vent valve.
10. Carry out check in the same way on all other cylinders.
11. Determine mean value of the compression pressures:
    - ☐ The difference between the mean value and the individually measured compression pressures must not exceed 3 bar (300 kPa).
12. Install injector. Refer to section C 075.05.11 , *Series 4000 Service Manual* (6SE4011) for the procedure to install fuel injectors.
13. Install cylinder head valve cover. Refer to section F-24.
14. Open fuel supply to the engine. Refer to section F-84.

F-17 – COMBUSTION CHAMBER BORESCOPE EXAMINATION

A borescope examination allows visual assessment of cylinder liners, piston crowns, and cylinder heads and valves.

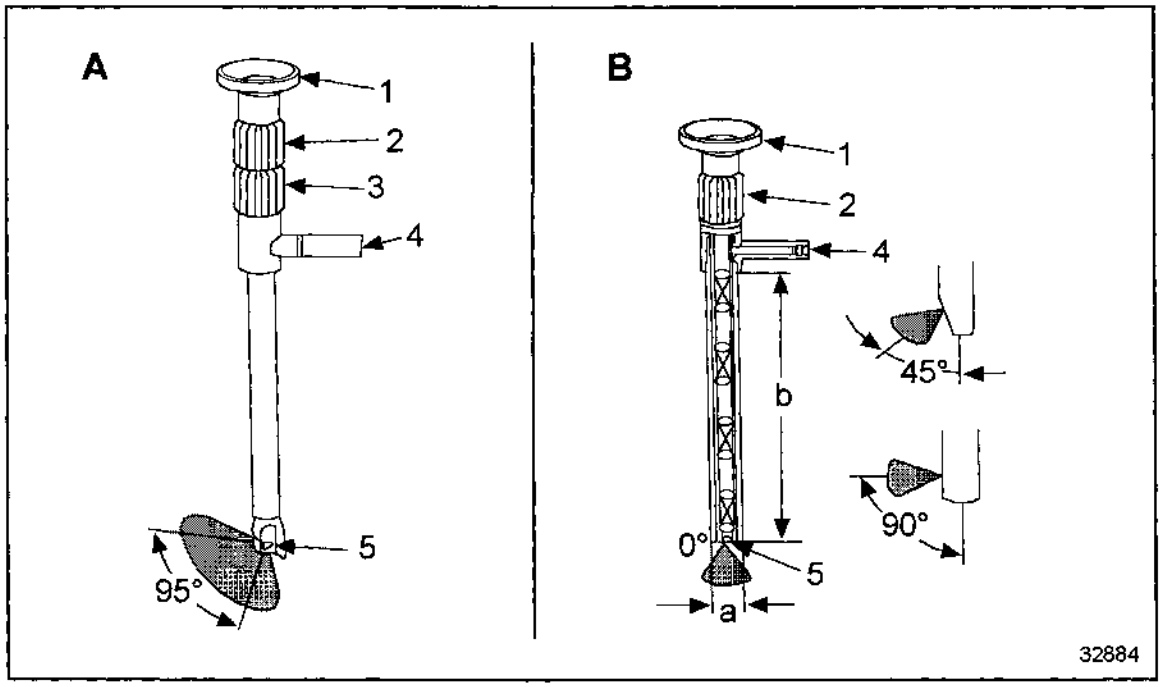
NOTE:
For engines in service, If possible carry out a combustion chamber borescope examination after operation under load.

Before the Borescope Examination

Prepare for the borescope examination as follows:

1. Remove injector.
2. Crank engine with starting system.
3. Disable engine start; refer to section F-1.
4. Install M24 socket and ratchet with extension handle on the accessory drive nut. refer to section F-3.
5. Use tool to turn engine until, for the respective cylinder:
   [a] The piston is at BDC for cylinder liner inspection.
   [b] The piston is in a position which allows unrestricted examination of the piston crown, lower side of the cylinder head and valves.
   [c] All valves are open and closed for inspection of valves and valve seats.

NOTE:
Use a borescope with an adequate light rating and a prism (5) which pivots 95 degrees (total viewing angle 140 degrees). See Figure 7A. If a borescope with pivoting system is not available, individual borescopes with prism settings of 0, 45 and 90 degrees are required. See Figure 7B.



1. Eyepiece
2. Focus Device
3. Adjuster Ring
4. Light Source
5. Prism

Figure 7 Types of Borescopes

NOTE:
Maximum possible diameter of dimension **a** in the illustration is 16 mm (0.6 in.). See Figure 7B.

Borescope Examination:

Follow these steps to examine with a borescope:

1. Connect borescope to light source (4) and insert it through the cylinder head (fuel injector bore) into the combustion chamber.
2. Use the focus device (2) to focus the eyepiece (1) and adjuster ring (3) to align the prism (5) with the area under inspection.
3. Visually assess the cylinder liners, piston crowns, underside of the cylinder heads and valves. To do the visual assessment, rotate the borescope through 360 degrees in each case and set the prism accordingly.

Assessment:

Cylinder liners may be used again when:

1. The honing pattern is clearly visible.
2. Locally limited polished areas are evident in the honing structure.
3. Minor scoring is evident (minor scoring can be caused during piston installation).
4. Minor corrosion is evident (film rust after extended out-of-service periods is possible).

Piston crowns may be used again when:

- ☐ Fuel injector spray pattern is clearly visible.
- ☐ Minor carbon or oil deposits are evident.
- ☐ Minor corrosion is evident.

Cylinder heads and valves may be used again when:

- ☐ Minor carbon or oil deposits are evident.
- ☐ Minor corrosion is evident.
- ☐ Minor pitting is evident on valves and valve seats.
- ☐ The valves close fully.

NOTE:
If extensive wear or damage due to mechanical, chemical or thermal action is found, or the problems still exist, remove the affected cylinder heads and check again. Repair or replace the individual components as necessary.

After the Borescope Examination

Perform the following after the borescope examination:

1. Remove M24 socket and ratchet with extension handle. Refer to section F-20.
2. Install injector. Refer to section C 075.05.11 , *Series 4000 Service Manual* (6SE4011) for the procedure to install fuel injectors.
3. Enable engine start. Refer to section F-2.

F-18 – ENGINE EXTERNAL CLEANING

NOTICE:
When removing deposits and/or cleaning, use only non-chemical cleaning agents which do not damage light-alloy, nonferrous metal, steel, gray cast iron and elastomers.

For environmental reasons, clean the engine only at places with a suitable oil separator.

Use a high-pressure or steam jet for cleaning. Read through the appropriate operating instructions, paying particular attention to the safety instructions before initial operation.

NOTICE:
For exterior cleaning with the high-pressure jet, use a fan jet nozzle only.

Cleaning the engine externally as follows:

CAUTION:
To avoid injury when working with high-pressure and steam jets, never aim at persons, animals, electrical or electronic equipment. Wear protective clothing, protective gloves and protective goggles or safety mask.

1. Disable engine start. Refer to section F-1.

CAUTION:
To avoid injury, do not go any closer than 20 cm (8 in.) to the object that is being sprayed.

CAUTION:
To avoid injury and damage to the equipment, the temperature of the cleaning agent must not rise above a maximum of 80°C (176°F).

NOTICE:
The jet pressure must not exceed 10 bar (150 psi) during exterior engine cleaning with a high-pressure cleaner or steam jet.

NOTICE:
Ensure that the electrical components do not become moist as this can lead to engine malfunctions and failure.

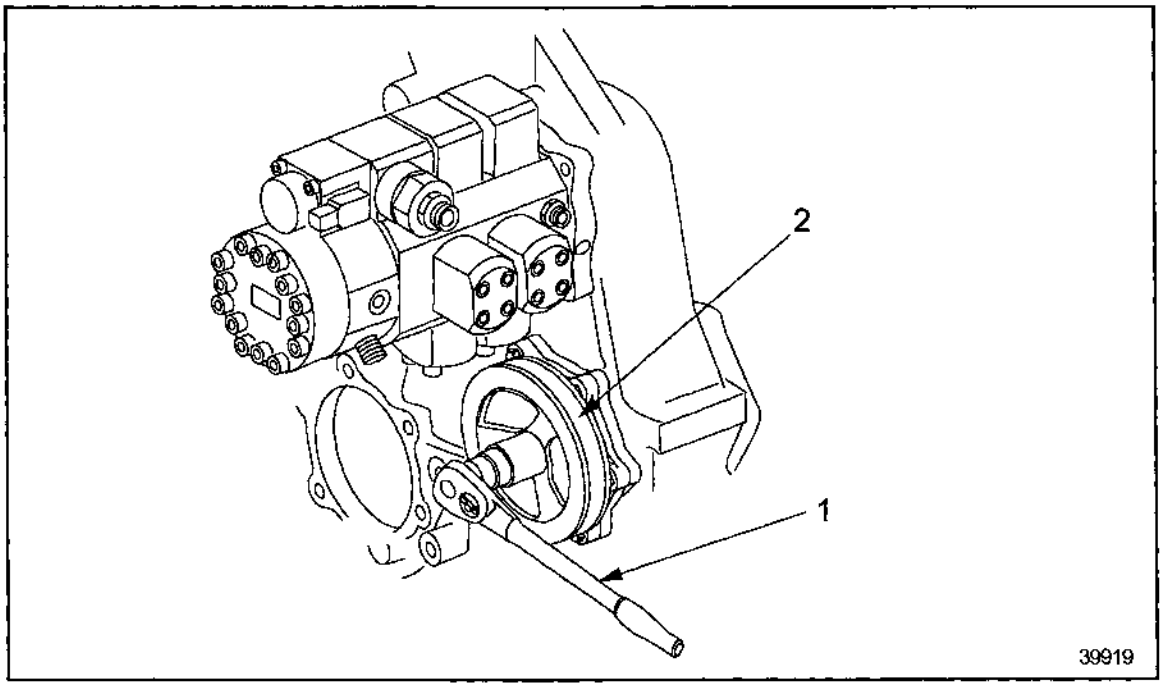
NOTICE:
To prevent damage to ECMs, protect the ECMs from direct spray contact, preventing entry of cleaning agent into ECM.

2. Loosen the dirt by spraying on a thin coating of cleaning agent and allow one to five minutes, depending on the degree of contamination, for it to react.
3. Remove the dirt by spraying off the dirt that has been loosened.
4. Enable engine start. Refer to section F-2.

F-19 – ENGINE BARRING TOOL INSTALLATION

Install M24 socket and ratchet with extension handle as follows:

1. Disable engine start. Refer to section F-1.
2. Attach M24 socket and ratchet with extension handle (1) on the accessory drive nut. See Figure 8.



1. M24 Socket and Ratchet
2. Accessory Drive

Figure 8 Barring the Engine Manually

F-20 – ENGINE BARRING TOOL REMOVAL

Remove M24 socket and ratchet with extension handle as follows:

1. Remove M 24 socket and ratchet (1) with extension handle from accessory drive (2). See Figure 8.
2. Enable engine start. Refer to section F-2.

F-21 – VALVE OPERATING MECHANISM OIL SUPPLY CHECK

Check the valve operating mechanism oil supply as follows:

1. Shut down engine. Refer to section F-12.
2. Disable engine start. Refer to section F-1.
3. Remove rocker cover. Refer to section F-23.
4. Check that the rocker arms and the rocker cover (inside) are coated with oil.
5. Install rocker cover. Refer to section F-24.
6. Enable engine start. Refer to section F-2.

F-22 – VALVE CLEARANCE

The procedures to adjust the valve clearance can be found in the *Series 4000 Service Manual* (6SE4011). Refer to section C 055.05.11 .

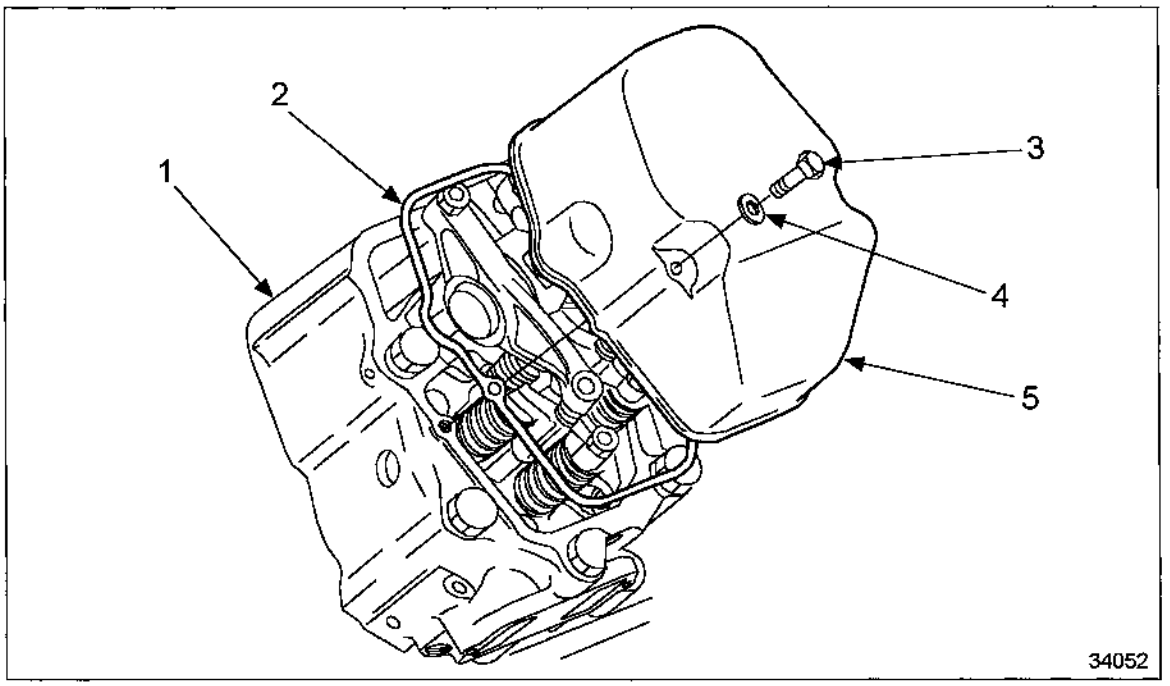
These procedures cover:

- ☐ Valve clearance adjustment in two crankshaft positions
- ☐ Valve bridge adjustment

F-23 – CYLINDER HEAD ROCKER COVER REMOVAL

Remove the cylinder head rocker cover as follows: (This procedure can also be found in the *Series 4000 Service Manual*, 6SE4011. Refer to section C 056.05.05 .)

1. Disable engine start. Refer to section F-1.
2. Remove bolts (3).
3. Remove cylinder head rocker cover (5) and gasket (2).



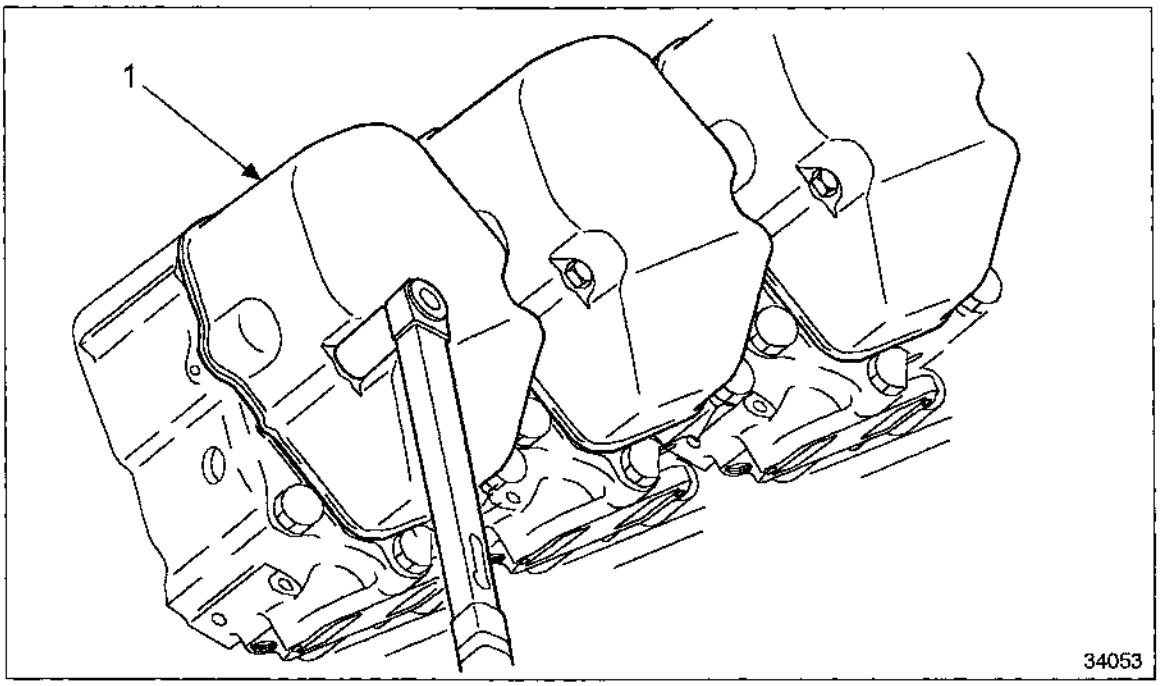
1. Cylinder Head
2. Profile Gasket
3. Bolt
4. Washer
5. Cylinder Head Rocker Cover

Figure 9 Removing Cylinder Head Rocker Cover

F-24 – CYLINDER HEAD ROCKER COVER INSTALLATION

Install the cylinder head rocker cover as follows:

1. Clean the mating faces.
2. Check that the profile gasket in the cover is in perfect condition, replace if necessary.
3. Place the cylinder head rocker cover (1) on the cylinder head.
4. Insert bolts with new sealing washers and torque to 25 N·m (18 lb·ft). See Figure 10. Use engine oil as lubricant.



1. Cylinder Head Rocker Cover

Figure 10 Installing Cylinder Head Rocker Cover

5. Enable engine start. Refer to section F-2.

F-25 – ENGINE FUEL PUMPS — WEEP HOLE OBSTRUCTION CHECK

Visually check weep hole of high pressure and low pressure fuel pumps for obstructions; see Figure 11. Clean bore if it is obstructed.

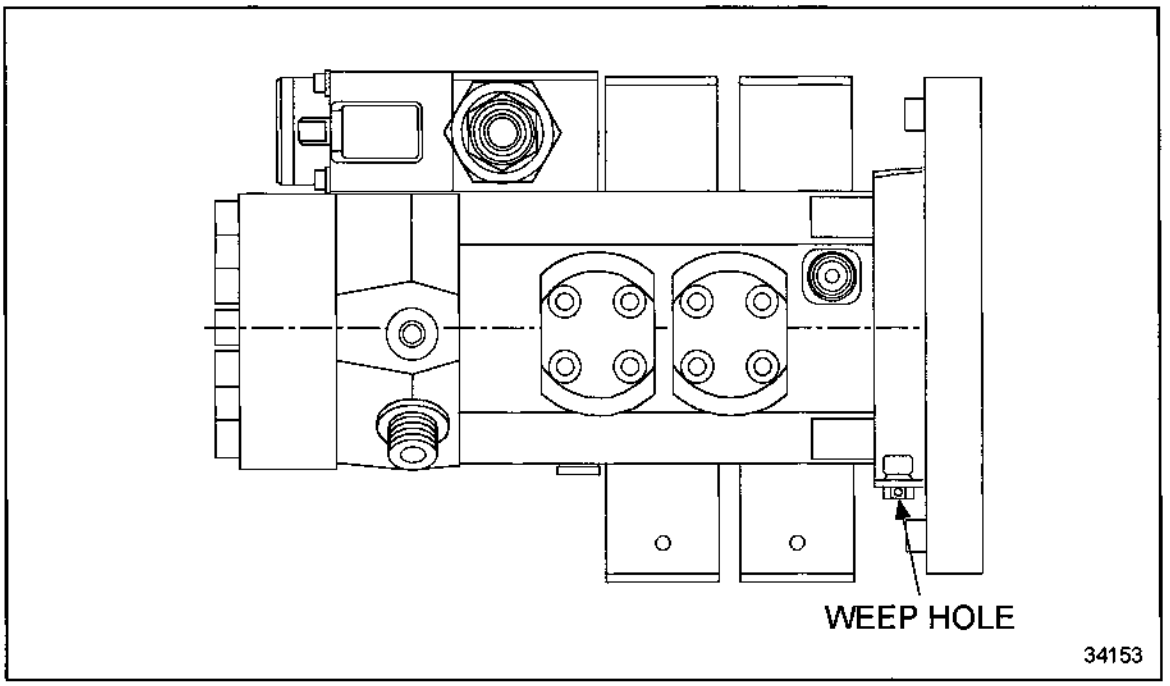


Figure 11 Check Weep Hole

F-26 – FUEL INJECTOR REMOVAL

Refer to section C 075.05.05in the *Series 4000 Service Manual* (6SE4011) for the procedure to remove fuel injectors.

F-27 – INJECTOR INSPECTION

Refer to section C 075.05.08, *Series 4000 Service Manual* (6SE4011) for the procedure to inspect fuel injectors.

F-28 – INJECTOR REPLACEMENT

The fuel injectors can be ordered from DDC. The DDEC engine control system must have the new injector calibration code changed for the specific cylinder location after installing the new injectors. Refer to the *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

F-29 – FUEL INJECTOR INSTALLATION

Refer to section C 075.05.11 *Series 4000 Service Manual* (6SE4011) for the procedure to install fuel injectors.

F-30 – FUEL SYSTEM PRIMING

The fuel system must be refilled after work on the fuel high pressure system. Fill the fuel system as follows:

CAUTION:

To avoid injury from fire caused by heated diesel-fuel vapors:

- ☐ **Keep those people who are not directly involved in servicing away from the engine.**
- ☐ **Stop the engine immediately if a fuel leak is detected.**
- ☐ **Do not allow open flames or smoke when working on an operating engine.**
- ☐ **Wear adequate protective clothing (face shield, insulated gloves and apron, etc.).**
- ☐ **To prevent a buildup of potentially volatile vapors, keep the engine area well ventilated during operation.**

Diesel fuel is relatively harmless at ambient temperatures.

1. Open the vehicle fuel supply and return valves, if applicable.
2. Connect the pressurized fuel supply (0.5 to 2.0 bar) to the priming port. See Figure 12.

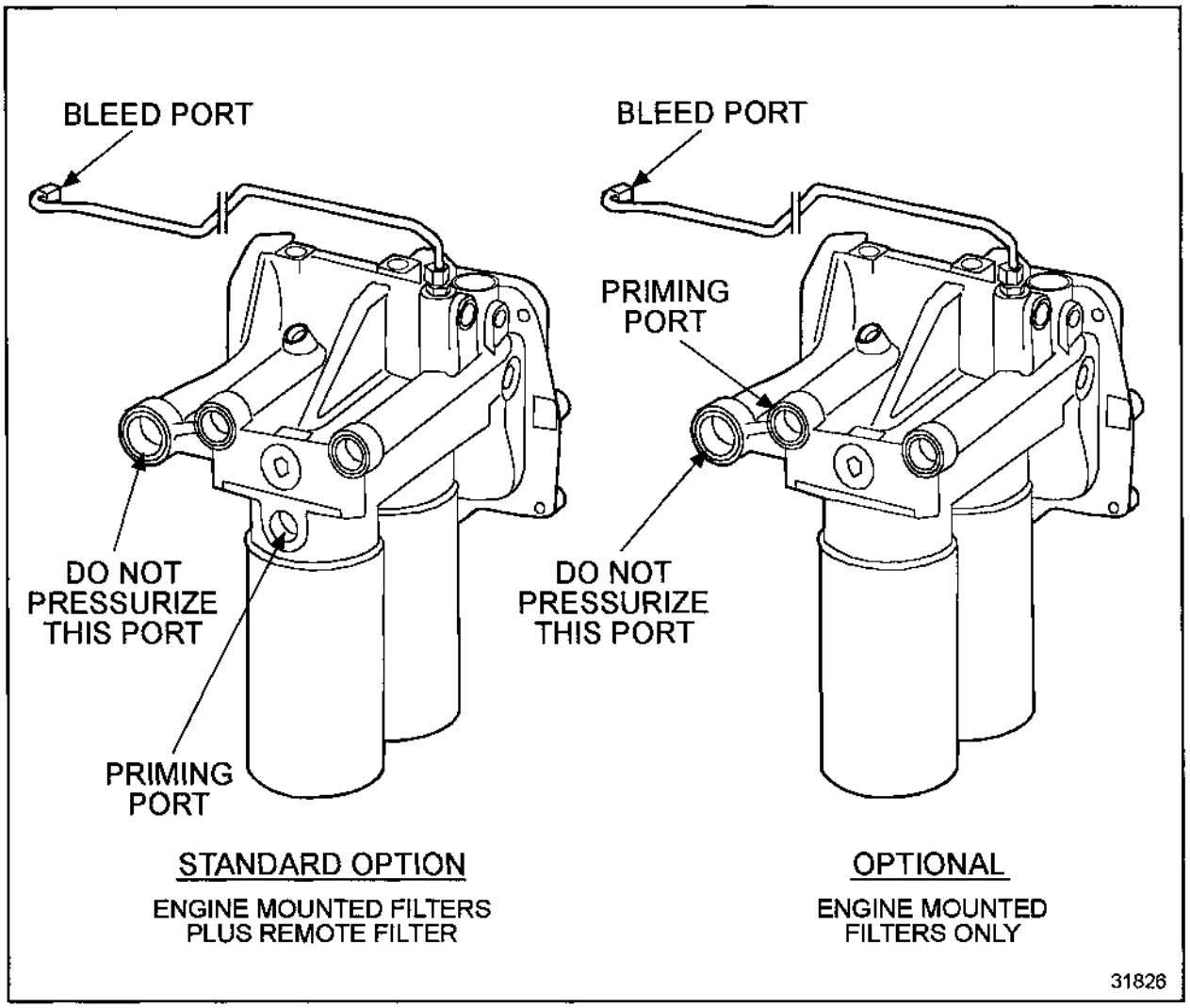


Figure 12 Priming and Bleed Ports for Series 4000 Fuel System

NOTICE:
Do not skip step 3. Do not try to bleed air at another location. Severe damage to the pump will occur if it is not full of fuel at start-up.

3. Loosen the high-pressure pump vent connection (bleed port) to allow air to bleed out. Tighten once fuel without air bubbles leaks out.
4. Disconnect priming fuel supply.

5. Crank the engine in 20 second intervals, up to four times.
6. If the engine did not start, repeat the steps beginning with step 2.
7. After three attempts and the engine still did not start, loosen the high-pressure lines for injectors at cylinder locations A1 and B1, at the high pressure rail. Repeat the steps beginning with step 2.
8. Tighten the high pressure line at cylinders A1 and B1 at the connector. Torque to 100 N·m + 10 N·m (74 lb·ft +7.4 lb·ft).

F-31 – FUEL FILTER REPLACEMENT

CAUTION:

To avoid injury from fire, keep all potential ignition sources away from diesel fuel, open flames, sparks, and electrical resistance heating elements. Do not smoke when refueling.

Follow this procedure to replace the fuel filters:

1. Remove the first filter, using a strap wrench, and dispose of it in accordance with local regulations.
2. Clean the sealing surface at the connector.
3. Check sealing ring of the new filter, and moisten with fuel.
4. Install filter and hand-tighten. Refer to section C 083.05.11 in the Series 4000 Service Manual (6SE4011).

5. Replace the second filter in the same manner. See Figure 13.

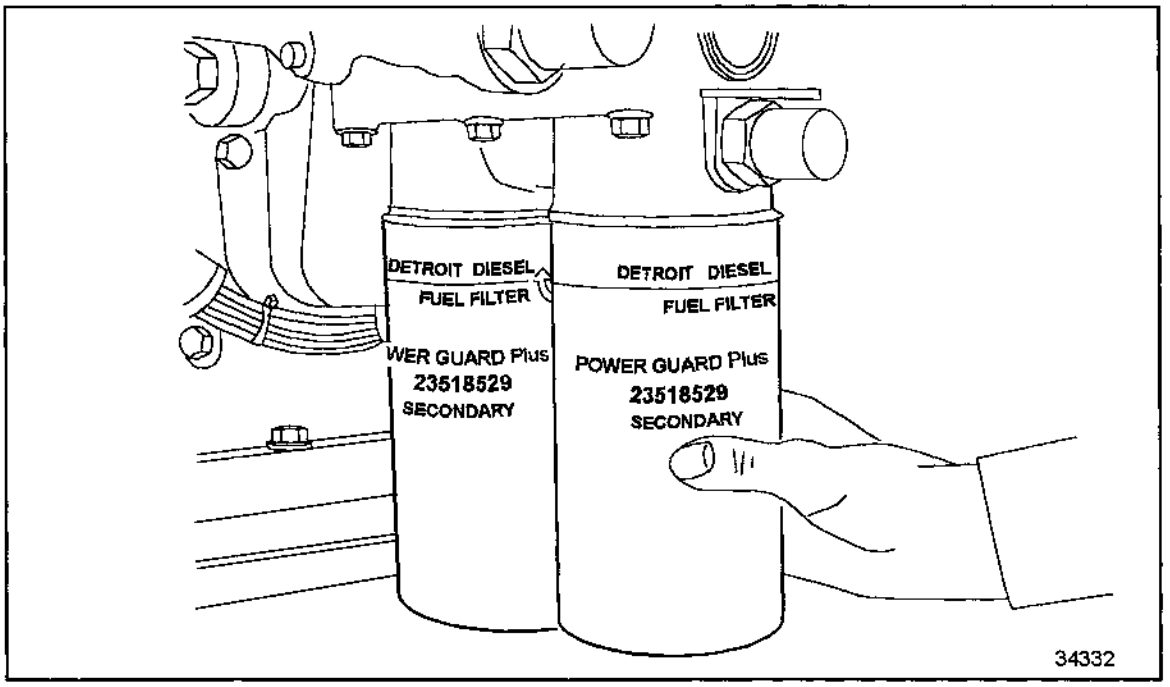


Figure 13 Fuel Filters

6. Enable engine start. Refer to section F-2.

F-32 – ENGINE OPERATION WITH FAULTY TURBOCHARGER

If the turbocharger fails, determine the cause and assess whether the engine can continue in operation without risk.

NOTICE:
Run the engine in this condition only until it is possible to replace or repair the turbocharger.

Run the engine only under partial load if the engine must continue in operation and there is a turbocharger failure (e.g. if rotor is seized).

F-33 – EXHAUST TURBOCHARGER CONNECTION CHECK

Check exhaust connections for leaks.

Check oil supply and return lines for leaks.

F-34 – CHARGE AIR COOLER — DRAIN LINE CHECK

If the coolant is continuously discharged and the coolant level falling, the charge air cooler could be leaking. If the leaking charge air cooler cannot be repaired immediately, before starting the engine, follow this procedure.

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

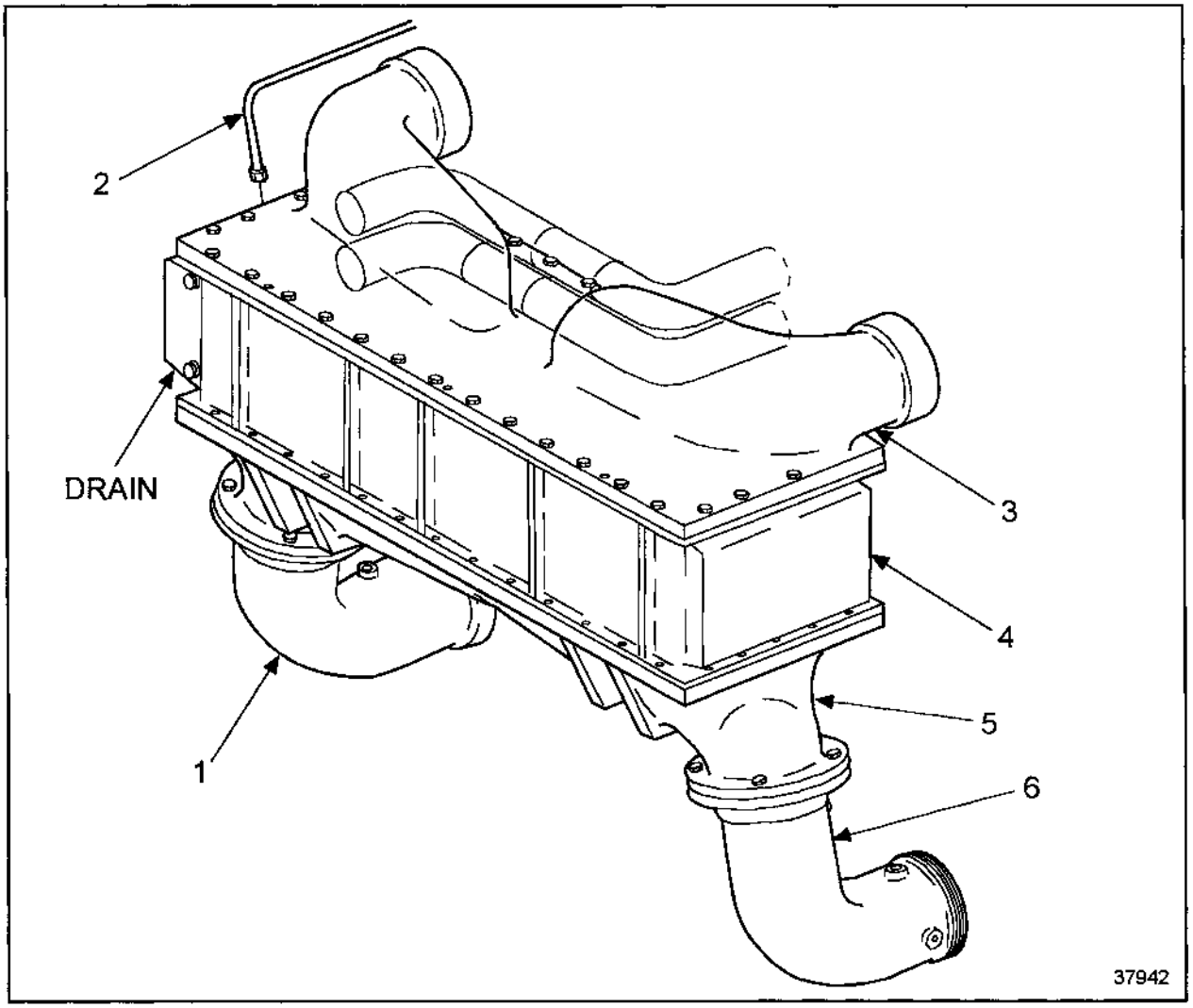
NOTICE:

If the charge air cooler is leaking, activate the engine only in an emergency.

1. Remove the injectors. Refer to section C 075.05.05, of the *Series 4000 Service Manual* (6SE4011) for the procedure to remove fuel injectors.
2. Bar the engine manually. Refer to section F-3.
3. Bar the engine with starting system, and blow out combustion chambers. Refer to section F-3.

Obstruction Check

Check for obstructions with the engine running. Oil-contaminated air must emerge at the drain opening. See Figure 14.



1. Elbow, A Bank
2. Vent Line
3. Top Connecting Housing
4. Intercooler Element
5. Bottom Connecting Housing
6. Elbow, B Bank

Figure 14 Charge Air Cooling System

F-35 – CHARGE AIR COOLER — DRAIN CLEANING

Clean the drain as follows:

1. Disable engine start. Refer to section F-1.
2. Remove drain line and union.

CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

3. Clean all components. Blow out drain bores from inside to outside with compressed air and check for obstructions.
4. Install drain line.
5. Enable engine start. Refer to section F-2.
6. Enable engine start. For further information about the charge air cooling system, refer to section F-66.

F-36 – AIR SYSTEM — INTAKE DEPRESSION CHECK

Check the intake depression as follows:

1. Connect the manometer pressure gages to turbocharger air intake housings.
2. Run engine at full load and read measurement on the manometer pressure gage. Refer to section B-6.
3. Remove gage.

F-37 – INTAKE AIR SYSTEM CHECK

Check whether the covers have been removed from the air filters and check for cleanliness. Install air filter.

F-38 – AIR FILTER REPLACEMENT

Contact the OEM for air filter information.

F-39 – CONTAMINATION INDICATOR CHECK

Contact the OEM for contamination indicator information.

F-40 – EXHAUST SYSTEM CHECK

Visually check engine exhaust system for leaks and damage.

Check that the cover is removed.

Check for cleanliness.

F-41 – EXHAUST SYSTEM — SECURITY CHECK

When the engine is cold, check tightness of securing bolts with a torque wrench.

F-42 – EXHAUST SYSTEM — EXHAUST GAS COLOR CHECK

The color check for exhaust gas is listed in Table 18.

Exhaust Gas Color	Description
Light Gray	Good Combustion
Black	Incomplete Combustion
Blue	Excessive Engine Oil in Combustion Chamber
White	Unburned Fuel

Table 18 Exhaust Gas Color Check

F-43 – EXHAUST SYSTEM — CHECK EXHAUST BACK PRESSURE

Check the exhaust back pressure as follows:

1. Connect the manometer pressure gage to the exhaust manifold.
2. Run engine at full load and take gage reading.
3. For specified pressure, refer to section B-6.
4. Remove the manometer pressure gage.

F-44 – EXHAUST SYSTEM — EXHAUST PIPEWORK SECURITY AND INSULATION CHECK

Check tightness of the exhaust system securing bolts with a torque wrench. Visually inspect the insulation for damage. For torque information, refer to *Series 4000 Fastener Torque Specifications* 028T4000. The torque specifications are also listed in A 003 of the Series 4000 Service Manual.

F-45 – STARTER, CABLE SECURITY AND CONDITION CHECK

To check cable security and condition of the starter, follow this procedure:

1. Disable engine start. Refer to section F-1.
2. Disconnect battery.
3. Check all plug-in connections for security and damage.
4. Check all mechanical fixtures and electrical connections.
5. Connect battery.
6. Enable engine start. Refer to section F-2.

F-46 – ENGINE OIL LEVEL CHECK

The engine oil level may be checked before starting the engine and after engine shutdown.

Checking before starting engine

Check the oil before starting the engine as follows:

1. Withdraw dipstick from guide tube and wipe.
2. Carry out oil level check.
3. Engine oil must be between minimum and maximum marks. See Figure 15.

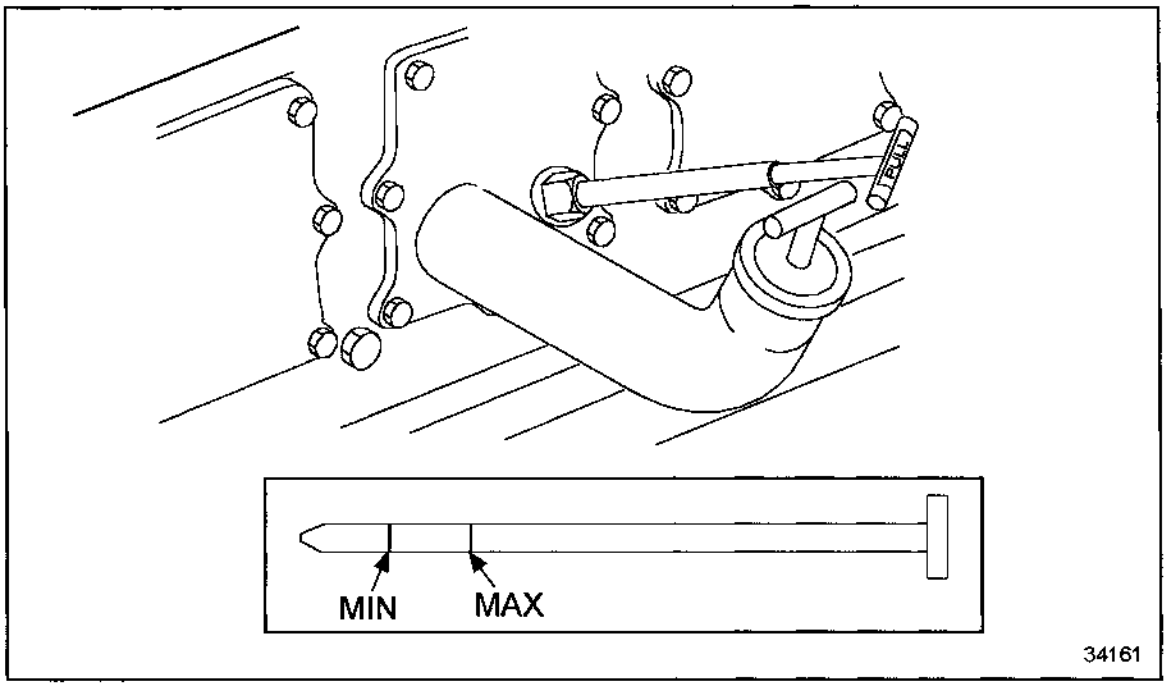


Figure 15 Oil Level Check

4. If necessary, add oil to MAX mark.
5. Insert dipstick into guide tube.

Checking after engine shutdown

Check the oil after engine shutdown as follows:

1. Remove the oil dipstick from the guide tube five minutes after engine shutdown.
2. Engine oil must be between MIN and MAX marks.
3. If necessary, top off the oil to the MAX mark.
4. Insert the dipstick into the guide tube.

F-47 – ENGINE OIL FILLING

NOTE:
Always use only new, DDC/MTU-approved engine oil — per DDC publication *Oil, Fuel, and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273).

Fill engine oil as follows:

1. Turn the oil filler tube cover counterclockwise until it can be removed. See Figure 16.

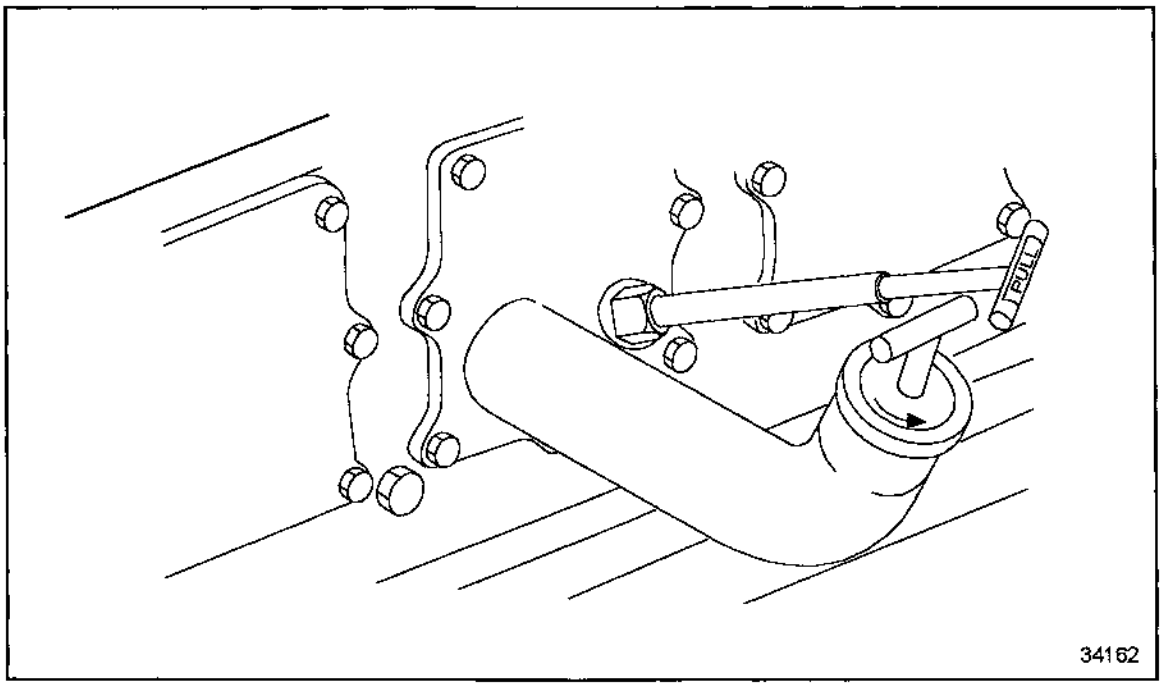


Figure 16 Remove Oil Filler Tube Cover

2. Pour engine oil in at oil filler tube up to MAX mark when checked with the dipstick.
3. Start engine and run at idle for approximately one to two minutes.
4. Shut down engine; after approximately five minutes withdraw dipstick from guide tube and wipe.
5. Carry out oil level check.
6. Engine oil must be between minimum and maximum marks. If necessary, add oil to MAX mark.

NOTE:
Do not fill engine oil above the MAX mark.

7. Insert dipstick in guide tube.
8. Replace oil filler tube cover.

F-48 – ENGINE OIL — SAMPLE EXTRACTION AND ANALYSIS

CAUTION:

To avoid injury from fire caused by heated lubricating-oil vapors:

- ☐ **Keep those people who are not directly involved in servicing away from the engine.**
- ☐ **Stop the engine immediately if an oil leak is detected.**
- ☐ **Do not allow open flames or smoke when working on an operating engine.**
- ☐ **Wear adequate protective clothing (face shield, insulated gloves, apron, etc.) to avoid burns.**
- ☐ **To prevent a buildup of potentially volatile vapors, keep the engine area well ventilated during operation.**

Lubricating oil is relatively harmless at ambient temperatures.

NOTE:
An oil sample should be analyzed at each 500 hour interval. Improvements permitting the extended oil drain interval went into effect with engine serial number 526000266 (12V) and 5272000563 (16V).

Use the directions from the Power Trac® Oil Analysis Kit, P/N: 23520989. Take an oil sample and mail it, using the preaddressed container, to the Power Trac analysis center. Analysis reports are available within 24 hours of sample receipt.

F-49 – ENGINE OIL CHANGE

NOTE:
The oil filtration system on Series 4000 engines has been improved to permit the extending of oil drain intervals to 500 hours from 250 hours in severe duty applications when using either Category 1 or 2 oil. An oil filter service maintenance alert system is available. Refer to *Series 4000 Service Manual* (6SE4011) for the procedure to install the service kit. When the oil pressure differential becomes excessive, the pressure differential switch is triggered, illuminating a check engine light on the operator display panel, indicating oil filters are plugged and require changing.

Change engine oil as follows:

1. Disable engine start. Refer to section F-1.
2. Drain engine oil. Refer to section F-50.
3. Replace engine oil filter. Refer to section C 075.05.11, in the *Series 4000 Service Manual* (6SE4011) for the procedure to install fuel injectors. Refer to section F-53.
4. Add new engine oil. Refer to section F-47.
5. Enable engine start. Refer to section F-2.
6. Check for leaks.

F-50 – ENGINE OIL DRAINING

Drain the engine oil as follows:

CAUTION:

To avoid injury from fire, keep open flames, sparks, electrical resistance heating elements, or other potential ignition sources away when draining lubrication oil. Do not smoke when draining lubrication oil.

NOTE:
Drain engine oil with the engine at operating temperature. Oil must be drained from both the gear case and the oil pan to remove all oil.

1. Drain remaining oil at the gear case and at the oil drain plug on the oil pan. See Figure 17.

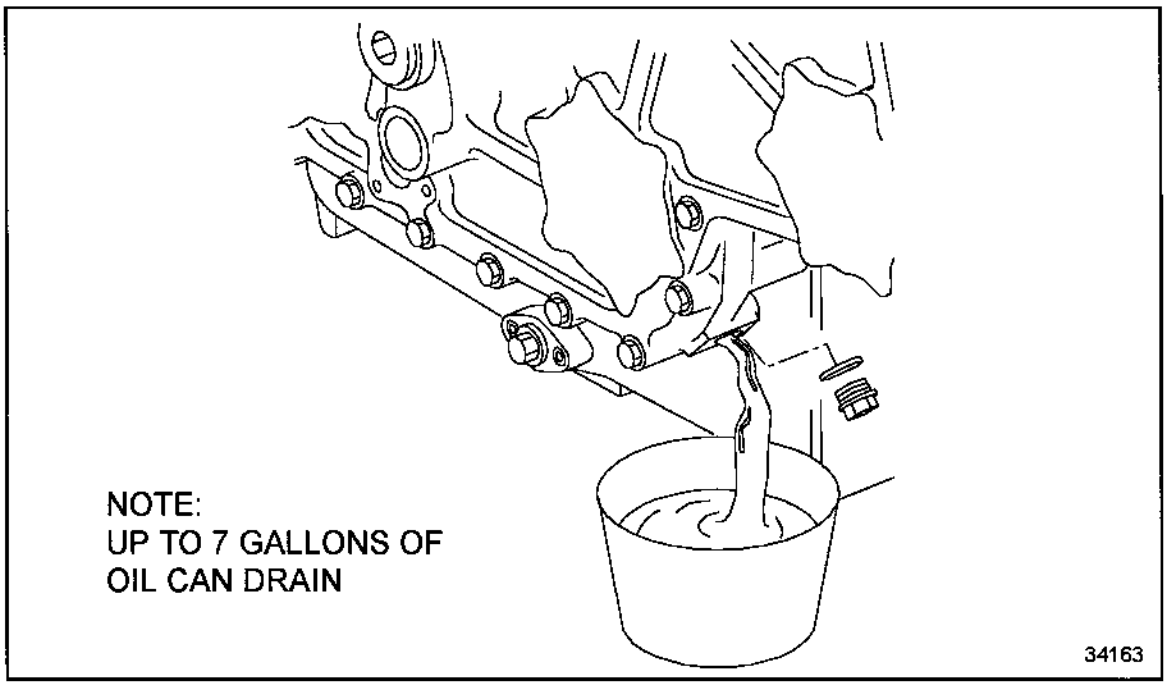


Figure 17 Draining Remaining Oil from the Gear Case

2. See Figure 18. Drain the used oil from the oil pan at the oil drain plug. Drain oil into a suitable container

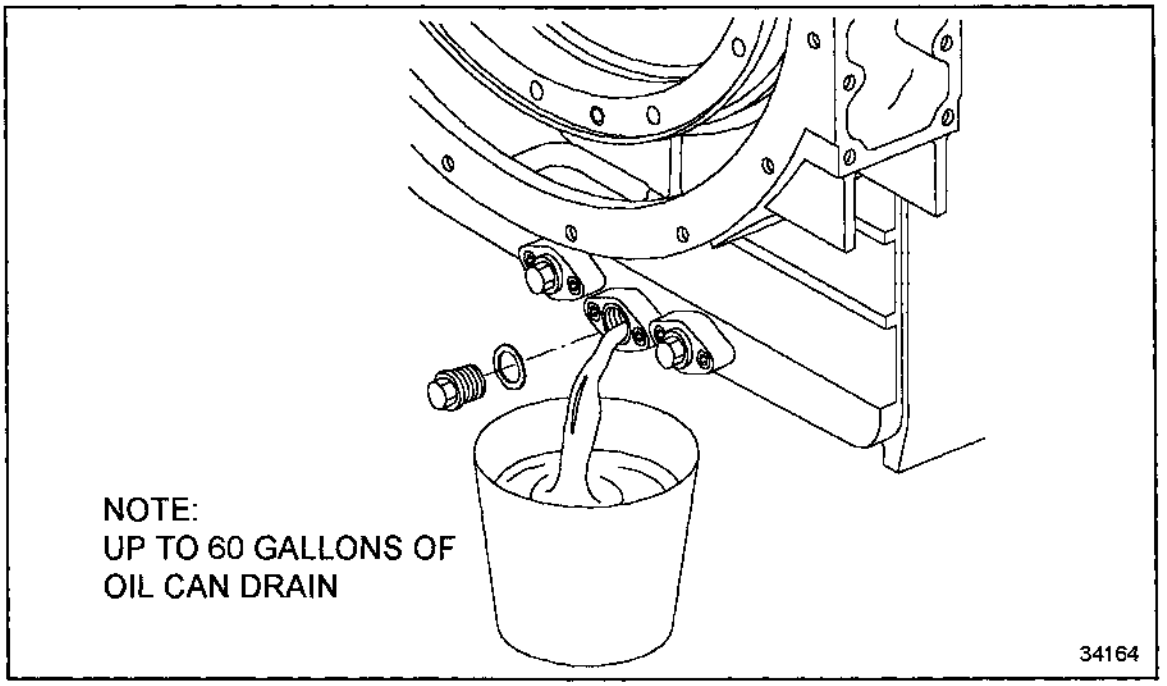


Figure 18 Draining Remaining Oil from the Oil Pan

3. Install oil drain plug with a new sealing ring.

F-51 – CORROSION INHIBITOR OIL FILLING

NOTE:
Always use only new, DDC/MTU-approved corrosion inhibitor oil — per DDC publication *Oil, Fuel, and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273).

Fill engine with corrosion inhibitor oil in same way as engine oil. Refer to section F-47.

F-52 – CORROSION INHIBITOR OIL EXTRACTION

Drain corrosion inhibitor oil in same way as engine oil. Refer to section F-50.

NOTE:
Drain corrosion inhibitor oil with the engine at operating temperature.

F-53 – ENGINE OIL FILTER REPLACEMENT

NOTE:
With the centrifugal oil filter system, oil filters should be serviced every 250 hours.

CAUTION:

To avoid injury from fire caused by heated lubricating-oil vapors:

- ☐ **Keep those people who are not directly involved in servicing away from the engine.**
- ☐ **Stop the engine immediately if an oil leak is detected.**
- ☐ **Do not allow open flames or smoke when working on an operating engine.**
- ☐ **Wear adequate protective clothing (face shield, insulated gloves, apron, etc.) to avoid burns.**
- ☐ **To prevent a buildup of potentially volatile vapors, keep the engine area well ventilated during operation.**

Lubricating oil is relatively harmless at ambient temperatures.

Remove oil filters with a strap wrench. Follow this procedure when removing the filters:

CAUTION:

To avoid injury from contact with the contaminates in used engine oil, wear protective gloves and apron.

1. Drain remaining oil from the filters into a container.
2. Clean the sealing surface at the connector.
3. Check the sealing ring of the new engine oil filter, and coat with oil.

4. Install new engine oil filter and hand-tighten. See Figure 19.

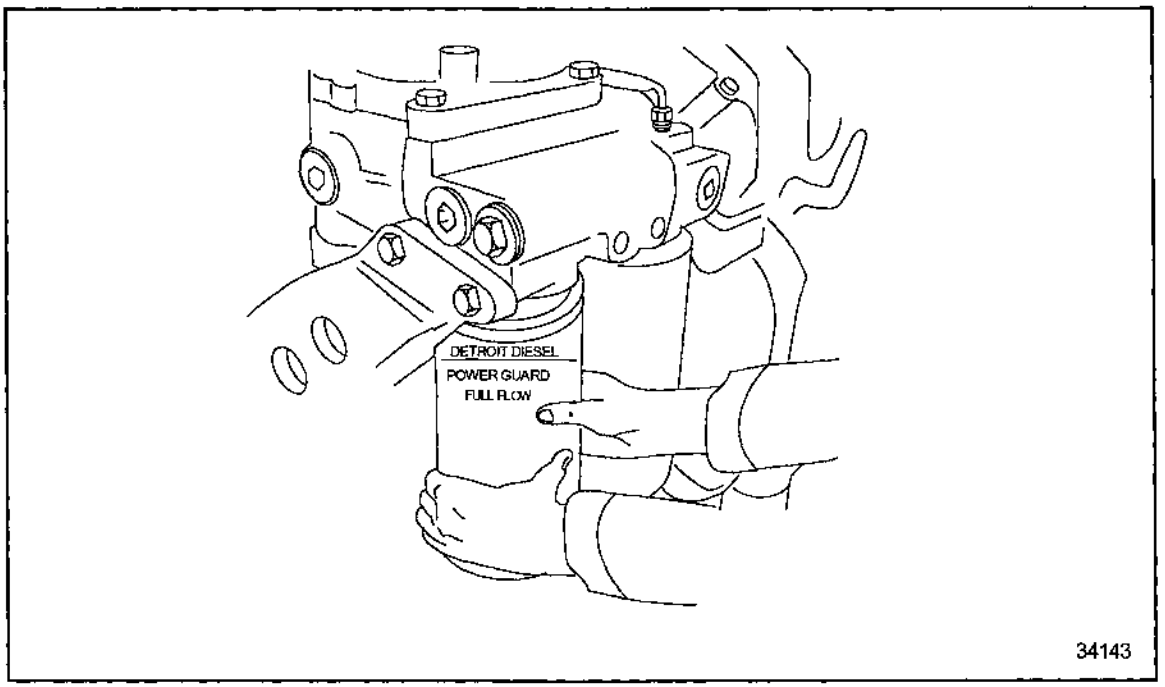


Figure 19 Oil Filter Replacement

5. Replace other engine oil filters in the same way.

F-54 – CENTRIFUGAL OIL FILTER CLEANING

CAUTION:

To avoid injury from contact with the contaminates in used engine oil, wear protective gloves and apron.

Perform the following steps to clean the centrifugal oil filter:

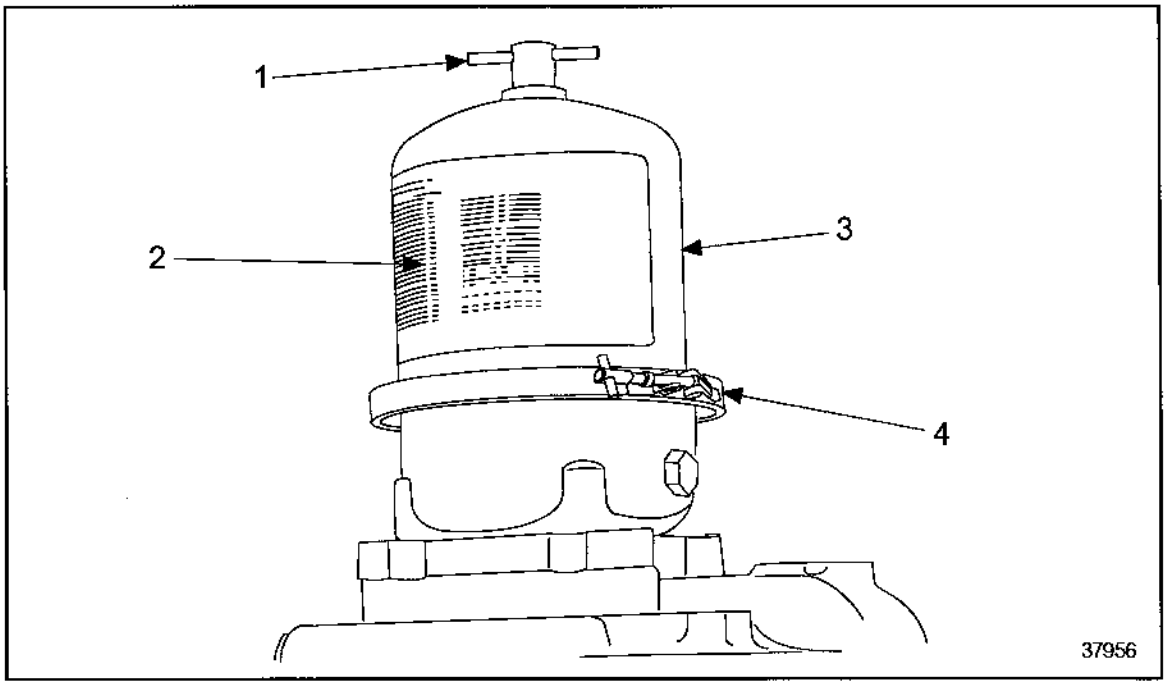
1. Stop engine and enable engine lockout.

CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

NOTE:
Clean centrifugal oil filter area before disassembly. Service instructions are found on the outside of the centrifugal oil filter cover.

2. Remove the band clamp (4) and cover nut (1). See Figure 20.



1. Cover Nut
2. Service Instructions
3. Cover Assembly
4. Band Clamp T-Bolt

Figure 20 Nut and Band Clamp Removal

3. Remove cover assembly (3).

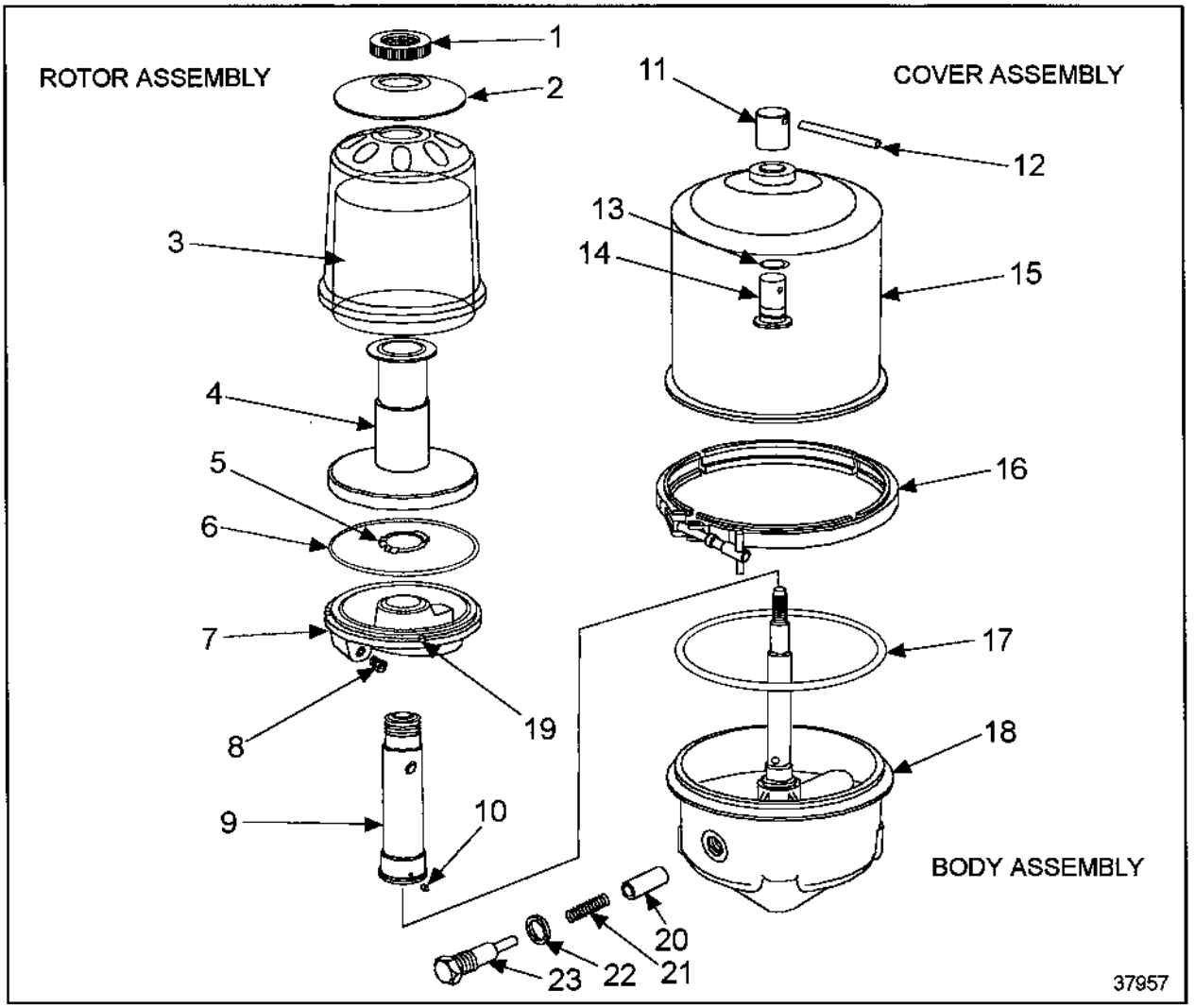
4. Drain oil from the rotor assembly. Raising the rotor on the spindle may assist draining. Withdraw the rotor assembly vertically (upwards) from the spindle.

NOTICE:
To ensure the rotor bearings are not damaged, remove and replace the rotor on the spindle with care.

5. Secure the rotor assembly and disassemble components.

NOTE:
Do not clamp the rotor in a vise.

6. Remove the stand tube (4). See Figure 21.



1. Rotor Cover Nut
2. Stiffener Plate
3. Paper Insert
4. Stand Tube
5. Snap Ring
6. O-ring
7. Rotor Cover
8. Nozzle
9. Bearing Tube Assembly
10. Pin
11. Cover Nut Tube
12. Pin
13. O-ring
14. Cover Nut
15. Cover Subassembly
16. Band Clamp
17. O-ring
18. Body Assembly
19. Locating Pin
20. Shuttle
21. Spring
22. Washer
23. Plug

Figure 21 Exploded View of Centrifugal Filter Assembly

7. Remove sludge deposits from the inside of the rotor cover (7) using a spatula. Sludge deposits should not exceed 35 mm (1.38 in.) thickness. See Figure 21.

CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

8. Clean all rotor components including the two nozzles (8) located in the rotor body. Ensure they are free from debris before assembly. Blow out with compressed air.

NOTICE:

If all debris is not removed, an unbalance condition can occur. Carefully clean each component.

9. If the rotor assembly O-ring (6) is damaged, replace it (O-ring Kit P/N 23525947). See Figure 21.
10. Inspect the centrifugal spindle and rotor assembly bearings for wear. Replace the rotor or body assembly if necessary.
11. Disassemble and inspect the cut-off valve assembly. If the shuttle valve is damaged, replacement of the centrifugal filter body assembly (18) is necessary. See Figure 21.
12. Install a new paper filter (3) into the rotor cover (Filter Pack of 25, P/N 8951840001) and assemble the rotor assembly. Ensure the rotor cover slot and rotor body pins are aligned. See Figure 21.

NOTICE:

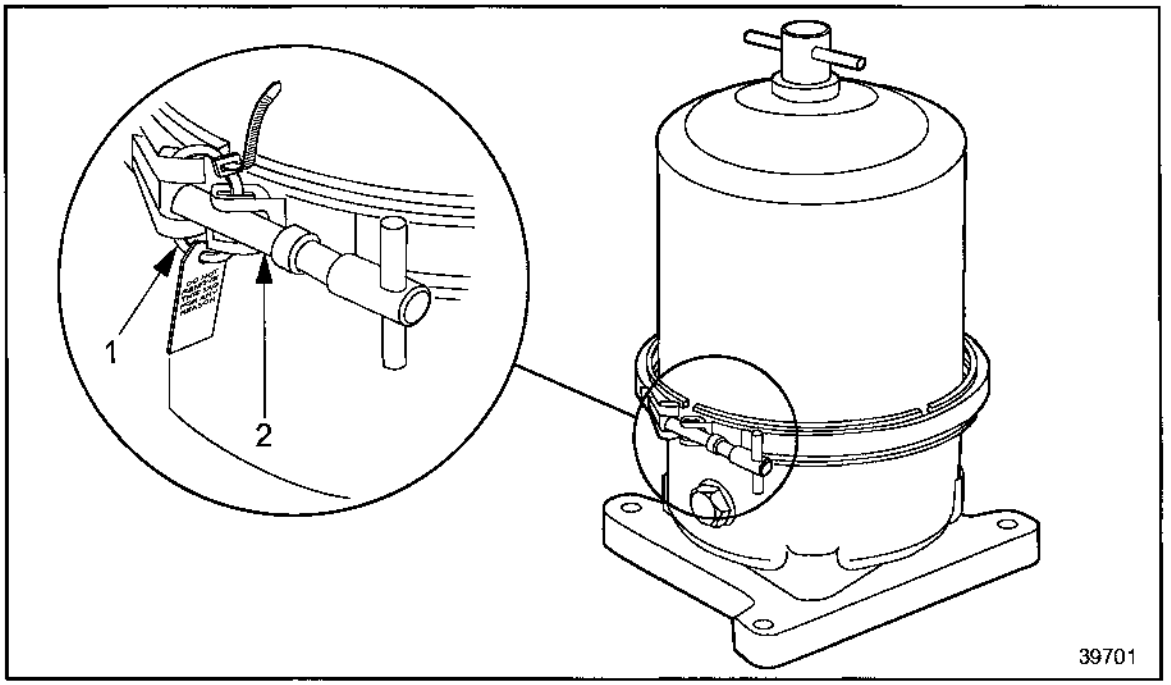
Do not interchange rotor covers from other units. Pin alignments vary. Uneven operation and leakage will occur.

13. Replace the rotor on the spindle and check the rotor spins freely.
14. Examine the centrifugal filter body O-ring for damage; replace if necessary (O-ring Kit P/N 23525947).
15. Replace the centrifugal filter cover and hand-tighten the cover nut.
16. Replace the band clamp and hand-tighten. The band clamp must fit securely during operation to prevent oil leaks.

NOTICE:
To prevent an external oil leak, ensure the band clamp T-bolt threads are clean. This will avoid improper clamp torque that could cause an engine fire.

NOTE:
Ensure the band clamp T-bolt threads are clean.

17. Using a tie strap, place a service tag with date and hour of service around both sides of the band clamp bolt and secure tightly. This tie strap will act as a safety tie to ensure the band clamp remains secure and in place. See Figure 22.

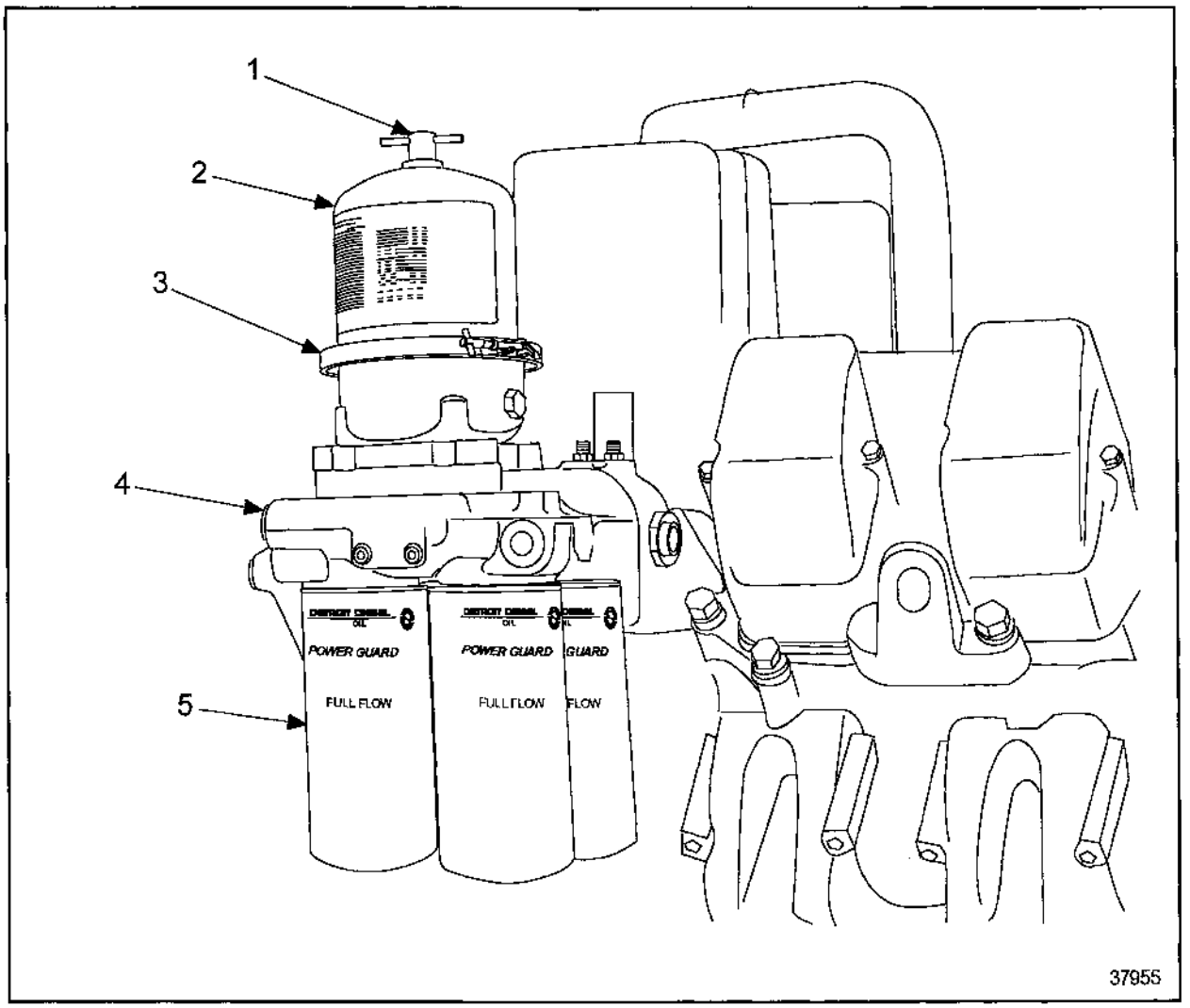


1. Tie Strap
2. Oil Filter Clamp

Figure 22 Installation of Tie Strap

18. Check engine oil level. Start the engine.

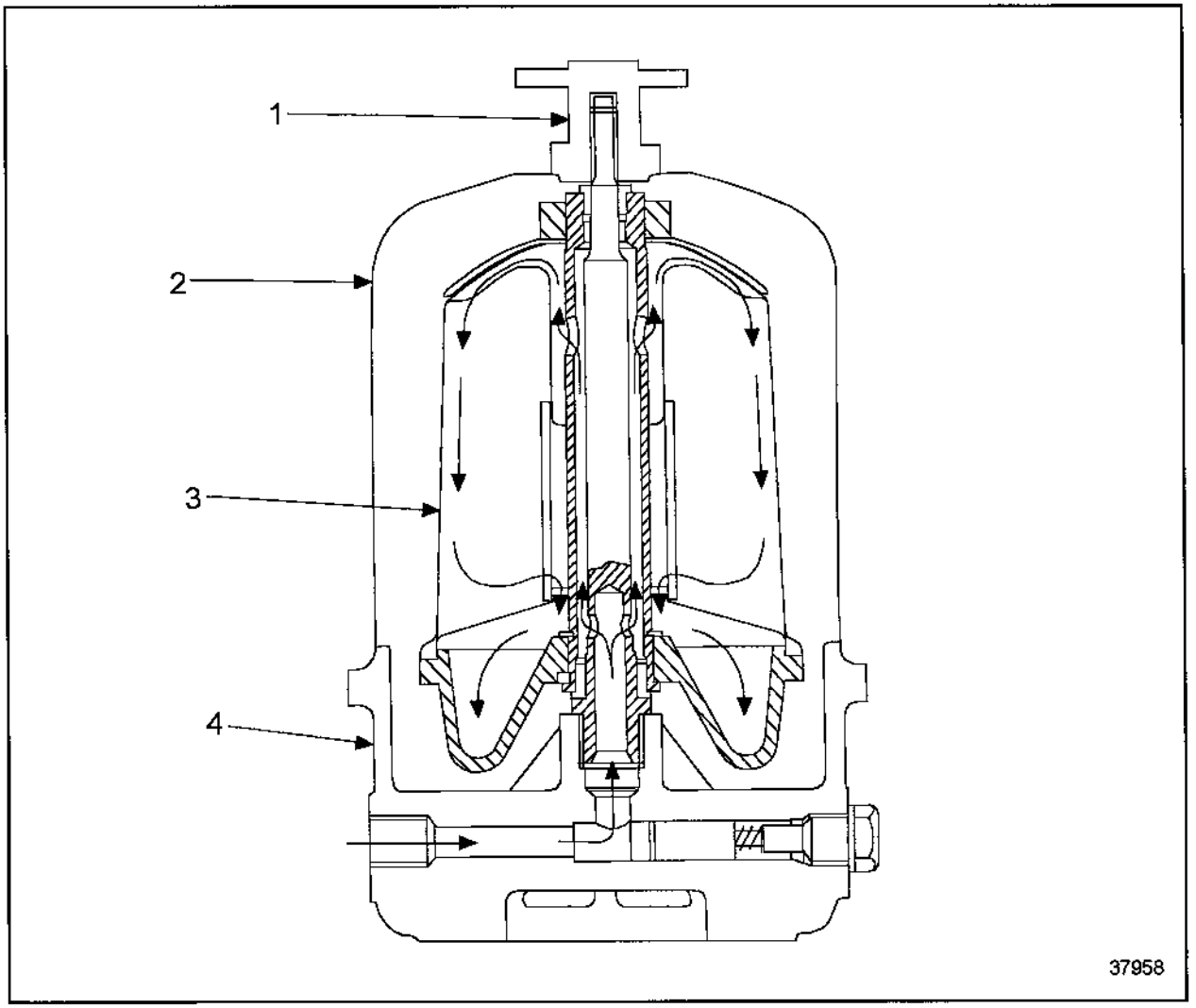
19. Check for leaks or unusual noise. See Figure 23.



1. Cover Nut
2. Centrifugal Oil Filter
3. T-bolt Clamp
4. Oil Filter Housing
5. Cartridge Oil Filters

Figure 23 Oil Filter System

20. Enable engine start. Refer to section F-2.
21. Check the centrifugal oil filters for leaks the next time the engine is started. See Figure 24.



1. Cover Nut
2. Cover Assembly
3. Rotor Assembly
4. Body Assembly

Figure 24 Cross-sectional View of Centrifugal Filter

F-55 – ENGINE COOLANT FILLING

NOTE:
Always use only treated coolants in accordance with *Oil, Fuel, and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273).

Fill engine coolant as follows:

1. Ensure engine is cold.
2. Open coolant pressure cap (arrow). Refer to section F-70.

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

3. Pour in treated engine coolant via the filter neck. See Figure 25.

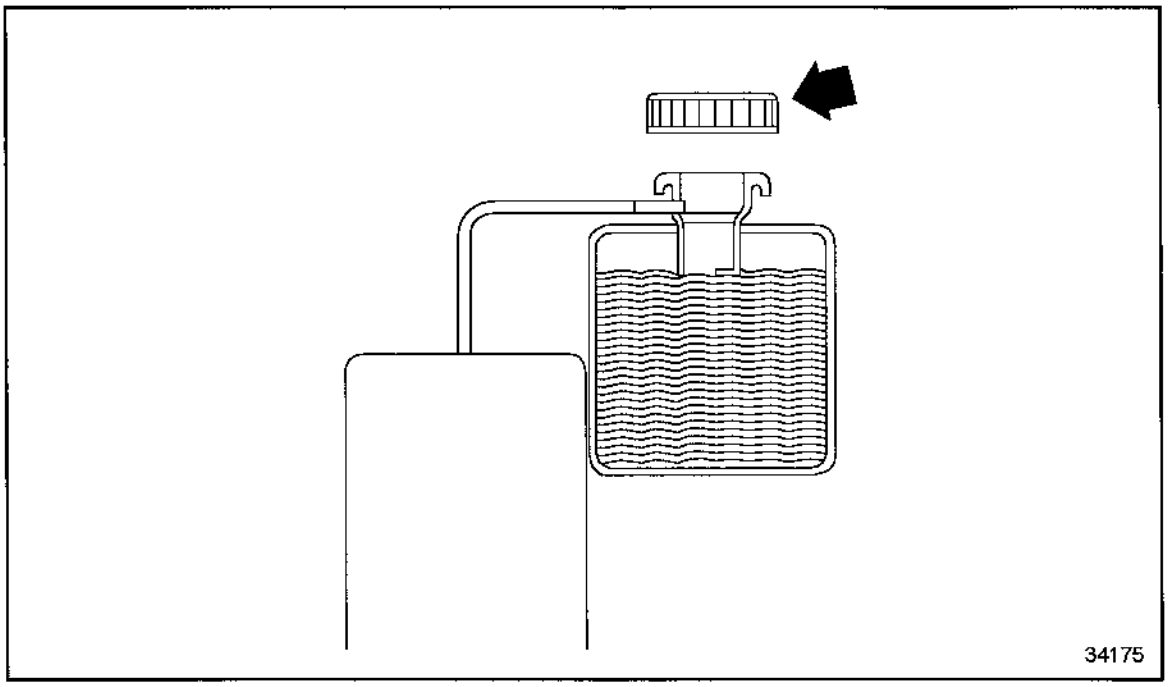


Figure 25 Filling Engine Coolant

4. Check coolant level; refer to section F-56.
5. Close pressure cap (arrow). Refer to section F-71.
6. Run engine a number of minutes at idling speed.
7. Check coolant level; refer to section F-56.

F-56 – ENGINE COOLANT LEVEL CHECK

NOTE:
The MIN coolant level is automatically monitored by DDEC.

Via level sensor: Switch on the engine control system and check the indicator. Refer to *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

Manual check: Refer to OEM operating instructions.

Via filler neck: Follow this procedure to check engine coolant level via the filler neck:

1. Open coolant pressure cap. Refer to section F-70.
2. Coolant must reach the bottom of the filling neck. See Figure 26.

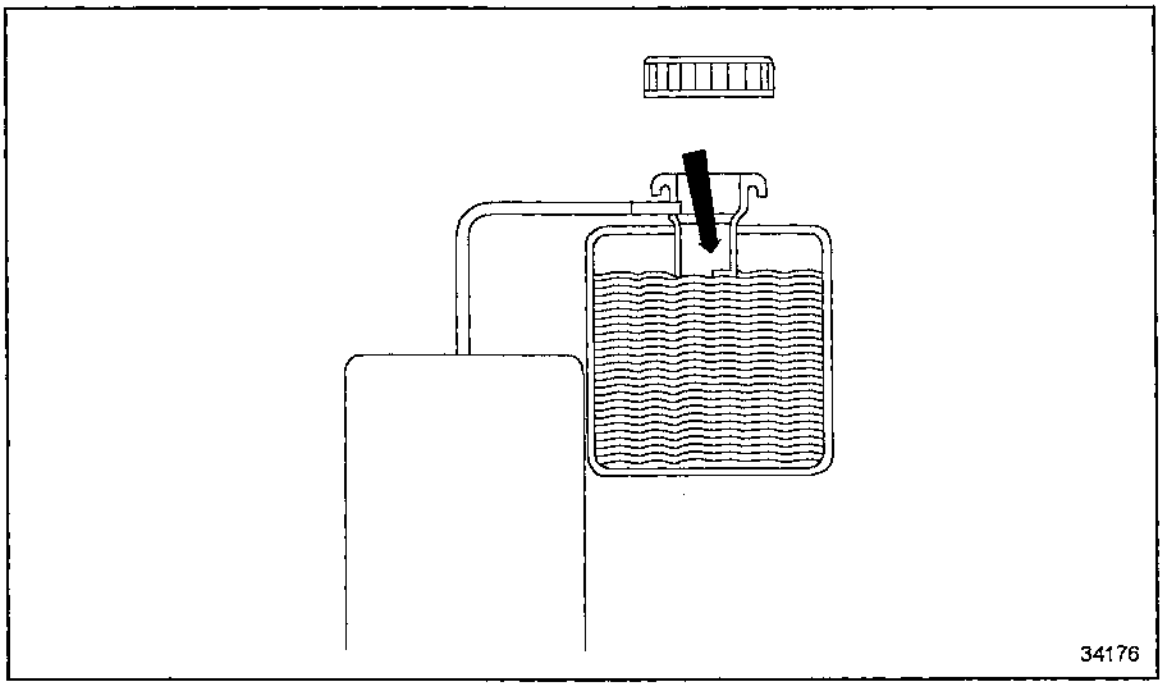


Figure 26 Check Coolant Level

NOTICE:
Never pour cold coolant into a hot engine.

NOTICE:
If untreated water is used to top up the coolant system in an emergency, the coolant concentration must be checked and rectified at the earliest opportunity.

3. Add only treated engine coolant, as necessary.
4. Close the coolant pressure cap. Refer to section F-71.

F-57 – COOLANT — SAMPLE EXTRACTION AND ANALYSIS

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

Extract and analyze the coolant as follows:

1. Disable engine start. Refer to section F-1.
2. Open the breather valve. Refer to section F-70.
3. Draw off precipitated corrosion inhibitor oil from the expansion tank via the filler neck, and dispose of oil in environmentally safe manner.
4. Drain approximately one liter of engine coolant into a clean container.
5. Using the DDC test kit, P/N: 23523398, mail the required sample to the Power Trac analysis center in the preaddressed container. The analysis will measure:
   [a] Coolant condition
   [b] Inhibitor strength
   [c] Water quality
   [d] Corrosion products
6. Check engine coolant level. Refer to section F-56.
7. Enable engine start. Refer to section F-2.

F-58 – ENGINE COOLANT DRAINING

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

Drain engine coolant as follows:

1. Disable engine start. Refer to section F-1.
2. Allow engine to cool.

3. Before draining coolant, open pressure cap (arrow) on coolant expansion tank. See Figure 27.

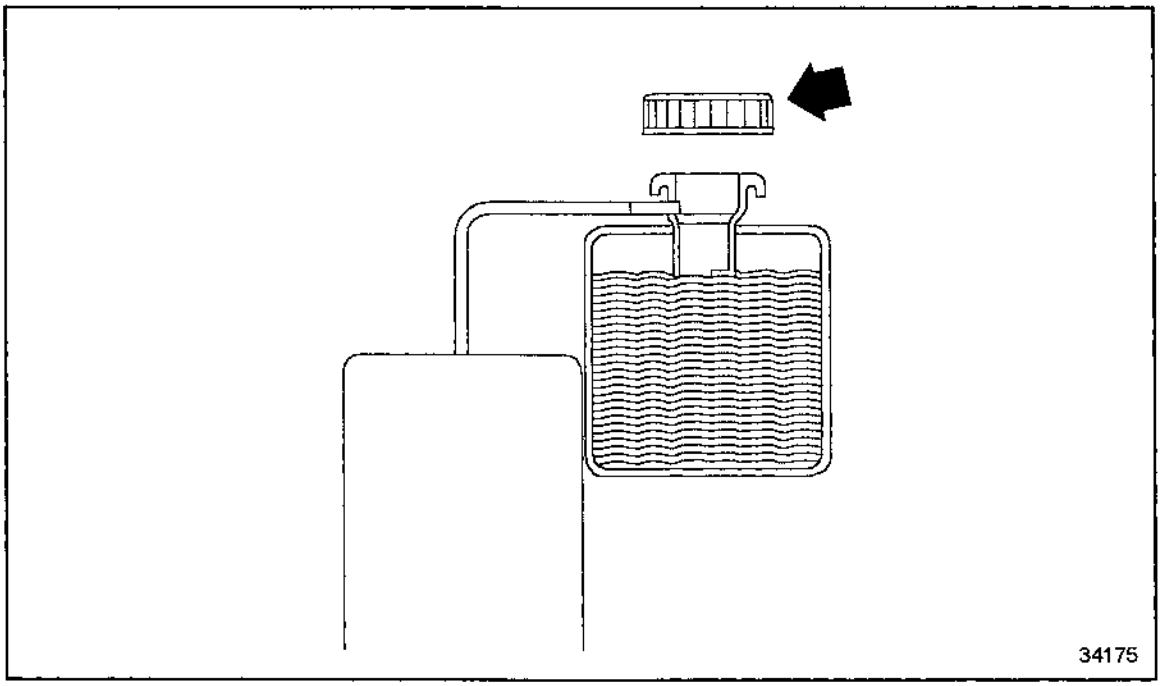


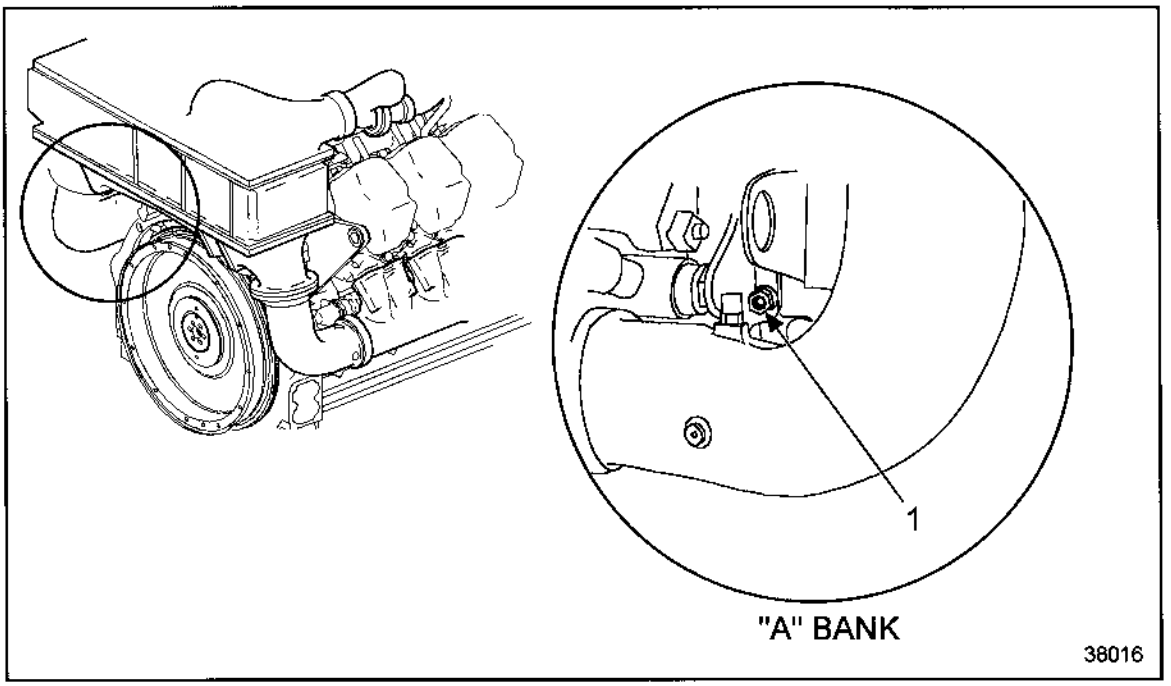
Figure 27 Open Coolant Pressure Cap

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

4. Provide a suitable container to collect and dispose of the coolant.
5. Drain the coolant expansion tank via the filler neck.
6. Drain into a container for disposal in an environmentally safe manner.

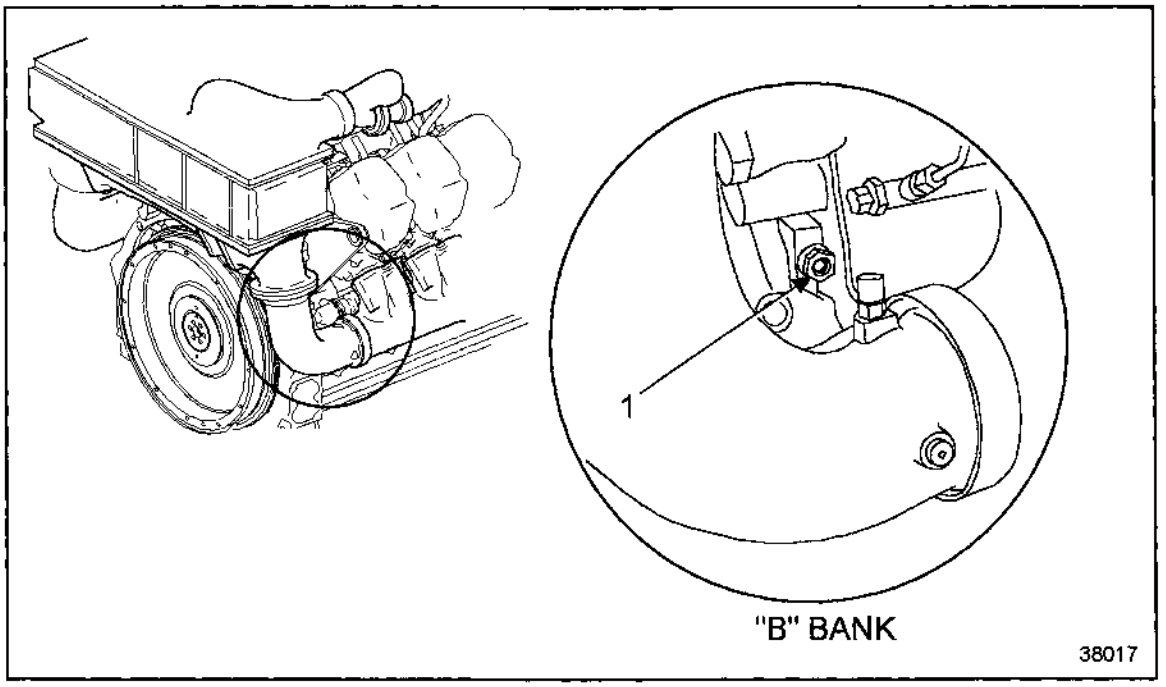
7. Drain engine coolant at the blanking plug on engine A bank at flywheel housing. Seal all drain points. See Figure 28.



1. Blanking Plug

Figure 28 Engine A Bank Blanking Plug

8. Drain engine coolant at the blanking plugs on engine B bank at flywheel housing. Seal all drain points. See Figure 29.



1. Blanking Plug

Figure 29 Engine B Bank Blanking Plug

9. Close the pressure cap.
10. Enable engine start. Refer to section F-2.

F-59 – ENGINE COOLANT CHANGE

Change the engine coolant as follows:

- ☐ Drain engine coolant. Refer to section F-58.
- ☐ Fill engine coolant system. Refer to section F-55.

F-60 – ENGINE COOLANT PUMPS — WEEP HOLE OBSTRUCTION CHECK

Visually check weep hole (arrow) on both the high temperature and low temperature engine coolant pumps for obstructions. See Figure 30.

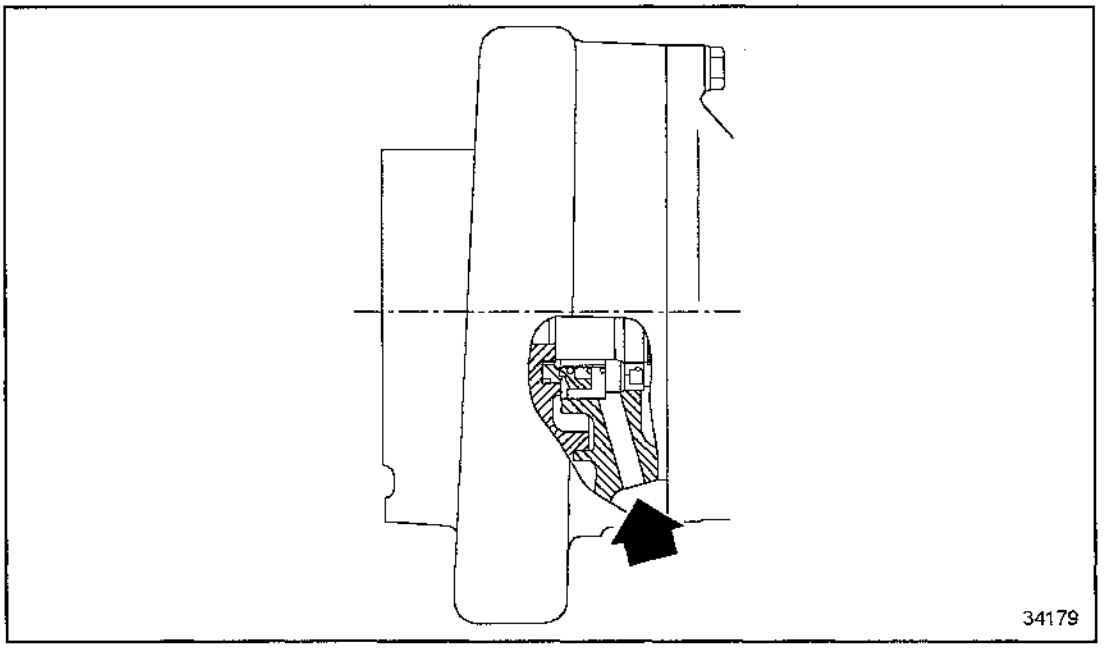


Figure 30 Weep Hole Check

Clean the weep hole if obstructed.

F-61 – ENGINE COOLANT PREHEATING

Switch ON the preheater.

Check the function of the coolant circulating pump.

Preheat the engine coolant to the preheat temperature. Refer to section B-6.

Switch the preheating unit OFF.

F-62 – ENGINE COOLANT PREHEATER OPERATION

The engine coolant preheater is not supplied by DDC. Refer to OEM manuals for unit operation.

F-63 – ENGINE COOLANT SYSTEM — VENT LINE OBSTRUCTION CHECK

CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

Remove vent lines and blow out with compressed air.

Install vent lines.

F-64 – CHARGE AIR COOLANT SYSTEM FILLING

Follow this procedure to fill the charge air coolant system:

NOTE:
Always use only treated coolants in accordance with *Oil, Fuel, and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273).

1. Open the pressure cap. Refer to section F-70.
2. Pour in treated engine coolant via the filler neck.
3. Check charge air coolant level. Refer to section F-56.
4. Close the pressure cap. Refer to section F-70.
5. Run the engine a number of minutes at idling speed.
6. Check the charge air coolant level. Refer to section F-56.

F-65 – CHARGE AIR COOLANT LEVEL CHECK

NOTE:
The MIN coolant level is automatically monitored by the engine control system.

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

Via level sensor: Switch on the engine control system and check indicator. Refer to *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

Manual Checks: Refer to OEM vehicle operating instructions.

Open pressure cap of radiator expansion tank. Refer to section F-70.

If coolant level dropped, only fill with treated engine coolant.

NOTICE:

Never pour cold coolant into a hot engine.

NOTICE:

If untreated water is used to top up the coolant system in an emergency, the coolant concentration must be checked and rectified at the earliest opportunity.

Close pressure cap of radiator expansion tank. Refer to section F-71.

F-66 – CHARGE AIR COOLANT DRAINING

Follow this procedure to drain the charge air coolant:

1. Disable engine start. Refer to section F-1.
2. Allow engine to cool.

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

3. Before draining the coolant, remove the pressure cap on the radiator expansion tank. Refer to section F-70.
4. Drain the radiator expansion tank via the filler neck.
5. Collect the coolant in a suitable container and dispose in an environmentally safe manner.
6. Drain engine coolant at the drain plug.
7. Drain remaining engine coolant at the charge air cooler.
8. Seal all drain points.
9. Fill charge air coolant. Refer to section F-64.
10. Replace pressure cap.
11. Enable engine start. Refer to section F-2.

F-67 – CHARGE AIR COOLANT SYSTEM VENT LINE OBSTRUCTION CHECK

CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

Remove vent lines and blow out with compressed air.

Install vent lines.

F-68 – ENGINE COOLANT RADIATOR CORE EXTERNAL CONTAMINATION CHECK

Coolant radiator is not provided by DDC.

Follow OEM instructions.

F-69 – CHARGE AIR COOLANT RADIATOR ELEMENTS EXTERNAL CONTAMINATION CHECK

Coolant radiator is not provided by DDC.

Follow OEM instructions.

F-70 – COOLANT PRESSURE CAP — RADIATOR EXPANSION TANK OPENING

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

NOTE:
Detroit Diesel has determined that the need for remote cooling system pressurization is no longer required for construction and industrial applications if the following cooling system conditions are met.
For engines operating at:

1. Less than 8,000 ft (2440 m) altitude requires water with SCA or ethylene glycol coolant.
2. Altitude of 8,001 ft to 12,000 ft (2440 m to 3660 m) requires a minimum of 30% ethylene glycol concentration.
3. Altitude of 12,001 ft (3660 m) or more requires a minimum of 50% ethylene glycol concentration.

NOTE:
The cooling system requires a 14 psi (97 kPa) pressure cap for all construction and industrial applications and must be inspected at the W3 inspection (2500 hours or 1 year, whichever occurs first).

Remove the pressure cap as follows:

1. Turn pressure cap counterclockwise to first stop (arrow). See Figure 31.

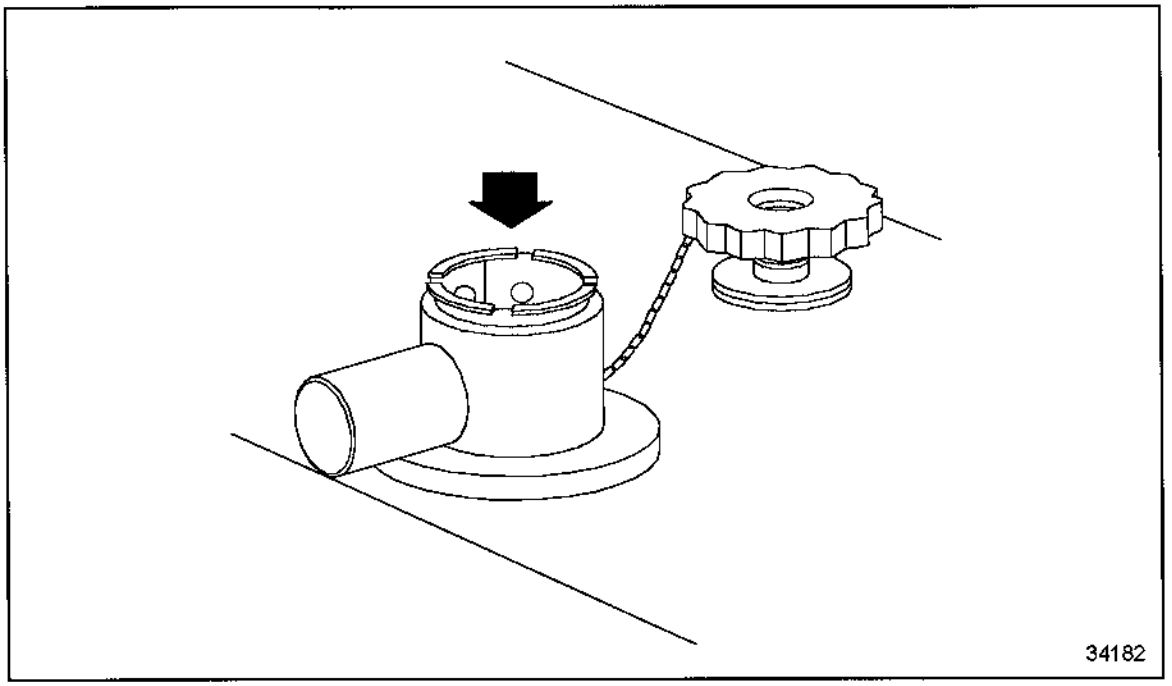


Figure 31 Pressure Cap Stop

2. Allow pressure to escape.
3. Continue to turn pressure cap counterclockwise and remove.
4. To close pressure cap, refer to section F-71.

F-71 – COOLANT PRESSURE CAP — RADIATOR EXPANSION TANK CLOSING

Check and close the pressure cap as follows:

1. Check that the pressure cap is in perfect condition.
2. Clean sealing surfaces.
3. Fit pressure cap and turn clockwise as far as it will go.

F-72 – WIRING — SECURITY AND CONDITION CHECK

1. Disable engine start. Refer to section F-1.
2. Disconnect the battery.
3. Check all plug-in connections for security and damage at:
   [a] Speed, pressure and temperature transmitters
   [b] Level Sensor
   [c] Actuating solenoid on high pressure fuel pump
4. Check all mechanical fixtures and electrical connections at the:
   [a] Starter
   [b] Alternator / generator
   [c] Battery
   [d] Turbocharger control
5. Connect the battery.
6. Enable engine start. Refer to section F-2.

F-73 – ALTERNATOR DRIVE — VEE-RIBBED BELT CONDITION AND TENSION CHECK

Perform the following steps to check condition of the vee-ribbed belt:

1. Disable engine start. Refer to section F-1.
2. Remove guard plate.
3. Check vee-ribbed belts for cracks, oil, overheating and wear.
   [a] Clean the vee-ribbed belts.
   [b] Replace the belts if damaged.
4. Enable engine start. Refer to section F-2.

Damage Pattern of Vee-ribbled Belts

Inspect the belts for the following wear patterns.

1. Normal wear would have one or two cracks measuring approximately 25 mm (1 in.). Cracks usually appear after long-term use. The vee-ribbed belts can continue to be used. See Figure 32.

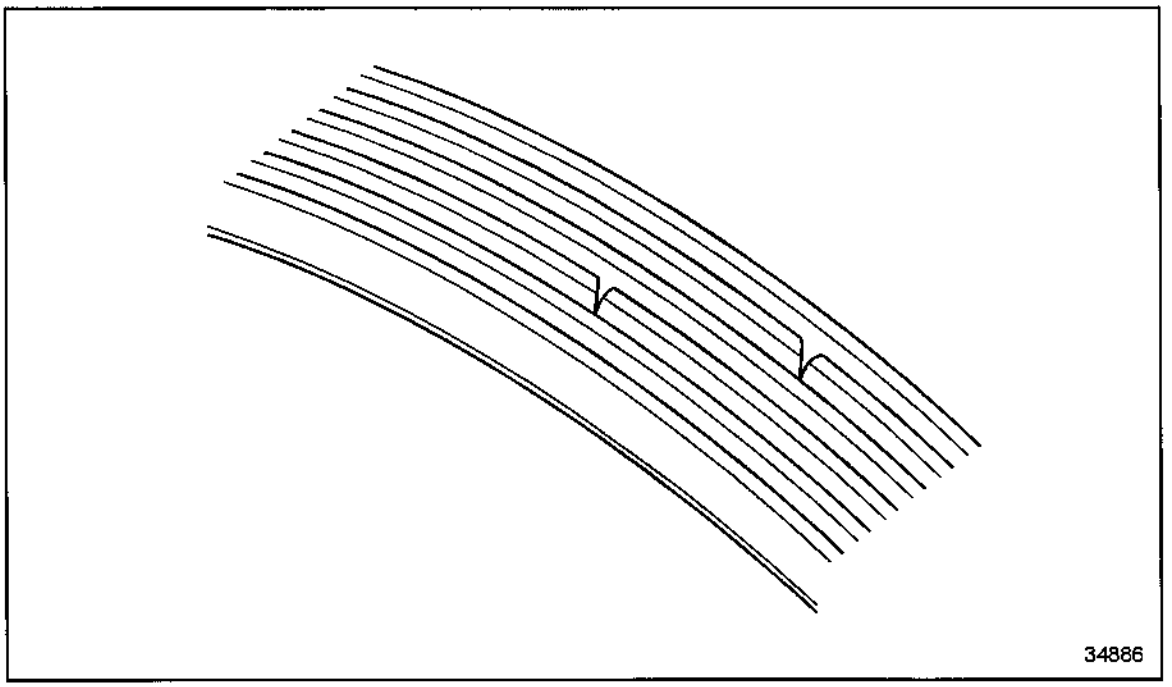


Figure 32 Normal Wear

2. The vee-ribbed belts must be replaced if the ribs are broken around the entire circumference. See Figure 33.

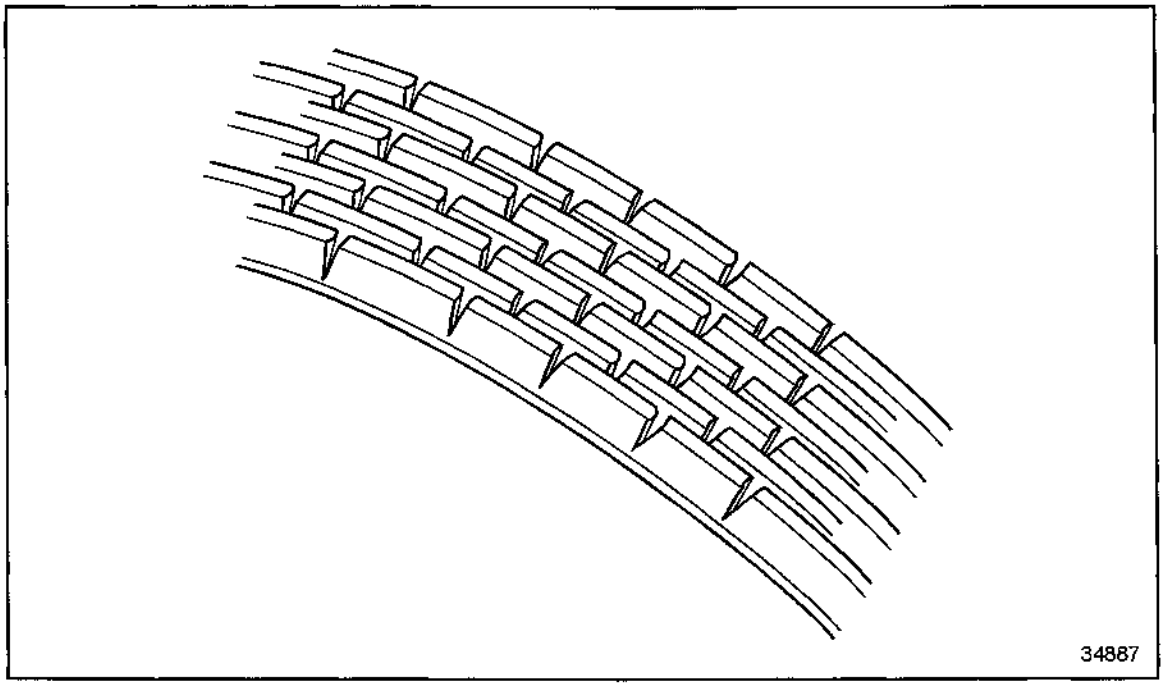


Figure 33 Broken Ribs

3. The vee-ribbed belt must be replaced immediately if the ribs are cracked around the entire circumference and ribbed material has broken off. See Figure 34.

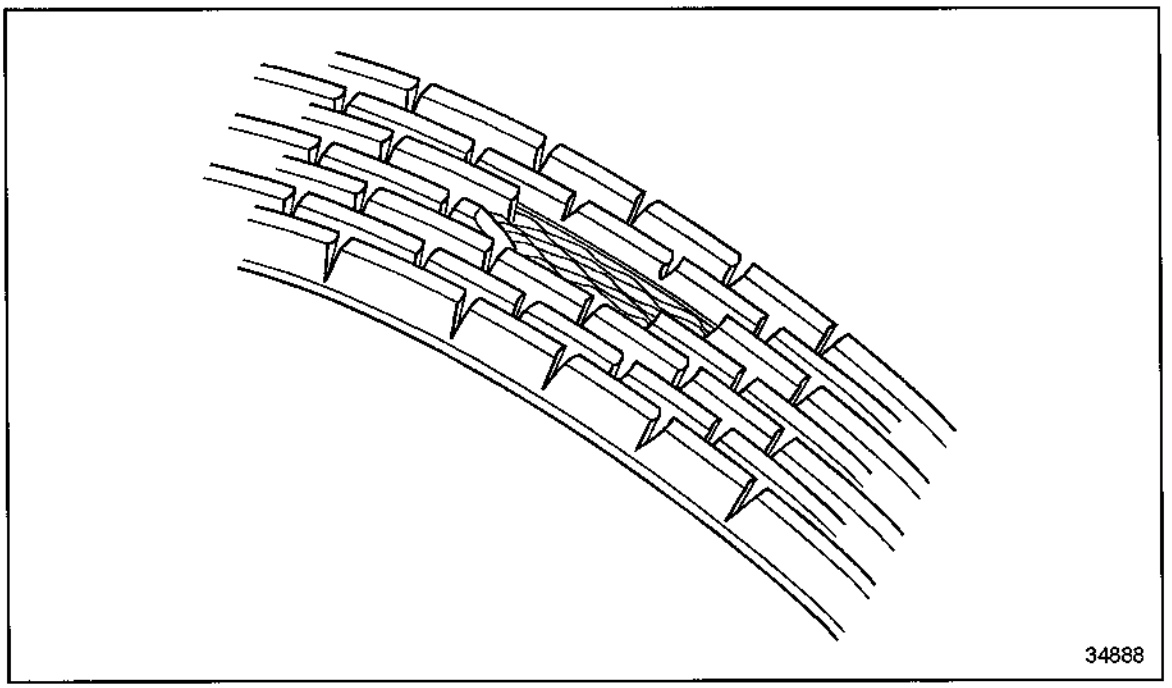


Figure 34 Rib Material Broken Away

Tension Check

Position the vee-ribbed belt tension tester on the vee-ribbed belt, midway between the belt pulleys. Read off the belt tension indicated where the pointer crosses the gage scale.

For new or used vee-ribbed belts, tension for the alternator drive should be 57–70 kg (125–155 lb).

1. The vee-ribbed belt tension must be correctly adjusted if the value measured does not correspond to the required value.
2. Release locknut and securing screws.
3. Adjust vee-ribbed belt tension with clamping nut.
4. Check vee-ribbed belt tension.
5. Tighten locknut.
6. Tighten securing screws.
7. Install guard plate.
8. Enable engine start. Refer to section F-2.

F-74 – ALTERNATOR DRIVE — VEE-RIBBED BELT REPLACEMENT

Perform the following steps to replace the vee-ribbed belt.

1. Disable engine start. Refer to section F-1.
2. Remove guard plate.
3. Release securing screws.
4. Release locknut and clamping nut to remove both vee-ribbed belts.
5. Check that belt pulleys are clean; clean if necessary.
6. Fit new vee-ribbed belts and secure with clamping nut.
7. Set belt tension. Refer to section F-73.
8. Tighten locknut.
9. Tighten securing screws.
10. Install guard plate.
11. Enable engine start. Refer to section F-2.

NOTE:
After the engine has run for 30 minutes, again check the vee-ribbed belt tension and readjust if necessary. After the engine has run for eight hours, again check the tension and readjust if necessary.

F-75 – SECURITY CHECK

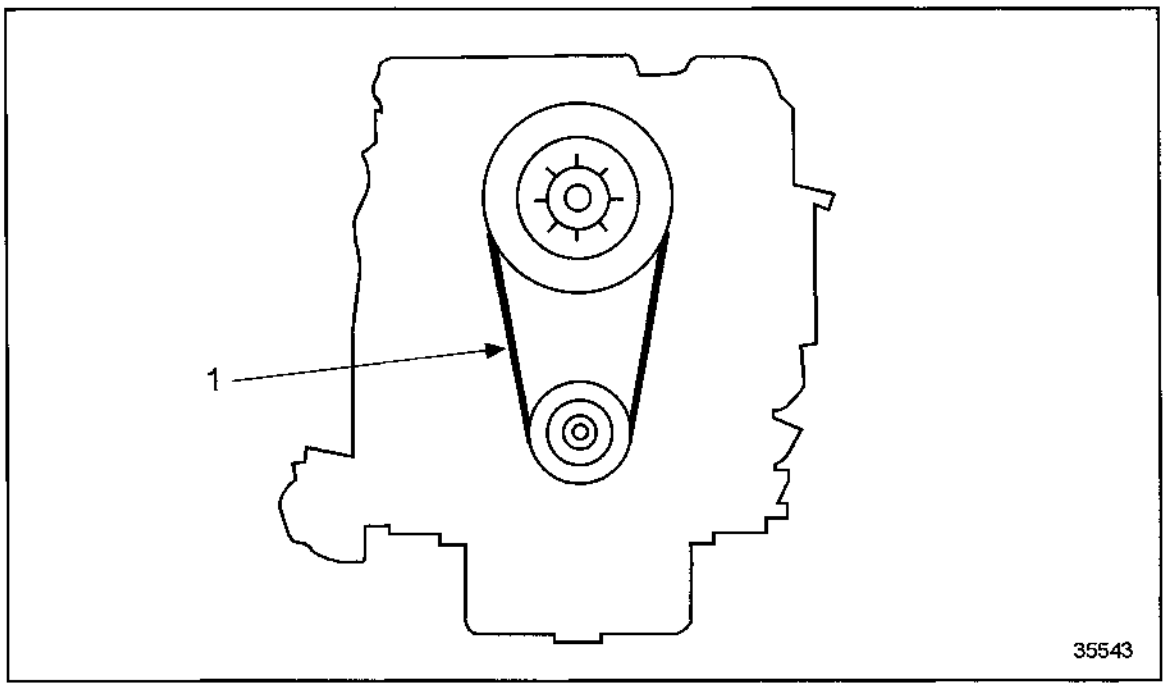
Perform these steps to check the cable security and condition:

1. Disable engine start. Refer to section F-1.
2. Disconnect battery.
3. Check all plug-in connections for security and damage at:
   - ☐ Mechanical fixtures
   - ☐ Electrical connections
4. Connect battery.
5. Enable engine start. Refer to section F-2.

F-76 – FAN DRIVE — VEE-RIBBED BELT CONDITION AND TENSION CHECK

Perform the following steps to check condition of the vee-ribbed belt:

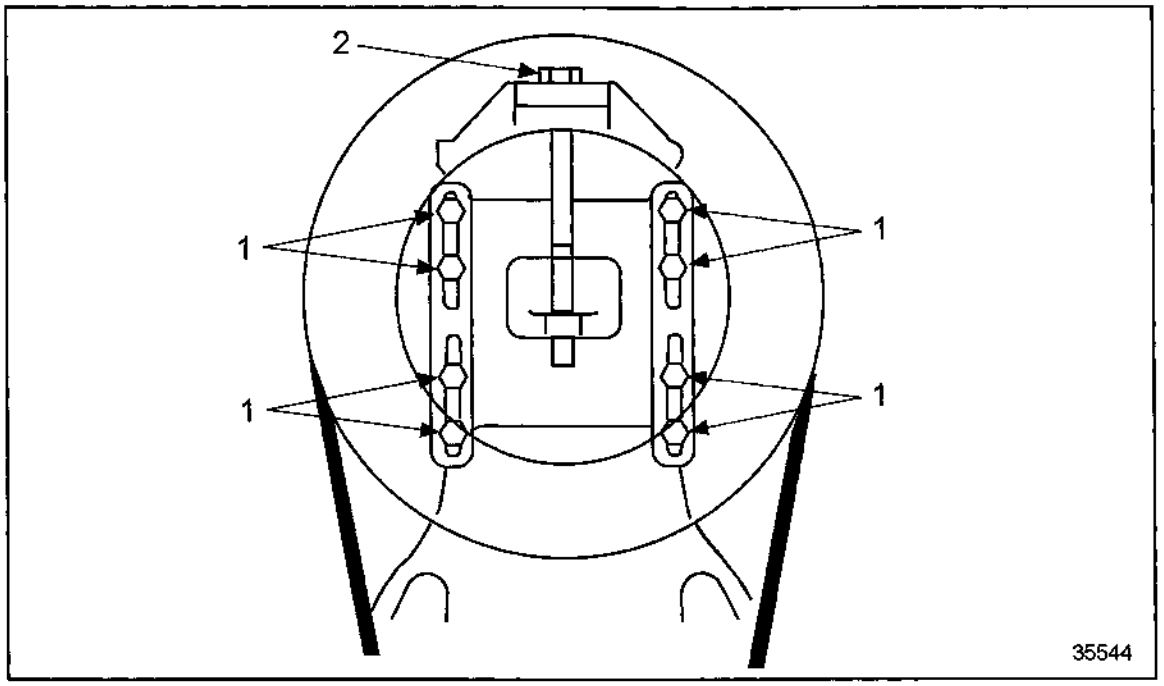
1. Disable engine start. Refer to section F-1.
2. Check vee-ribbed belts for cracks, oil, overheating and wear; clean or replace as necessary.
3. Refer to section F-73 for belt condition checks.
4. Settings for new or used vee-ribbed belts for the fan drive should be 250–259 kg (550–650 lb).
5. To check tension, position the belt tension tester on the belt midway between the pulleys. See Figure 35.



1. Tension Tester Position

Figure 35 Tension Check

6. See Figure 36 to adjust the vee-ribbed belt tension if it does not correspond to the required value.



1. Securing Bolts
2. Adjusting Bolt

Figure 36 Tension Check

[a] Release fan coupling securing bolts (1).

[b] Adjust tension with adjusting bolt (2).

[c] After adjustment, tighten fan coupling securing bolts (1) to 100 N·m (74 ft·lb).

7. Enable engine start. Refer to section F-2.

F-77 – FAN DRIVE — VEE-RIBBED BELT REPLACEMENT

Perform these steps to replace the vee-ribbed fan drive belt:

1. Disable engine start. Refer to section F-1.
2. Release fan coupling securing bolts (1).
3. Release adjusting bolt (2) to remove the vee-ribbed belt.
4. Check pulleys on the fan coupling and crankshaft for cleanliness; clean if necessary.
5. Fit new vee-ribbed belt and secure with the adjusting bolt (2).
6. Set tension.
   [a] Release fan coupling adjusting bolt (1).
   [b] Adjust tension with adjusting bolt (2).
   [c] After adjustment, tighten fan coupling securing bolts (1) to 100 N·m (74 ft·lb).
7. Enable engine start. Refer to section F-2.

NOTE:
After the engine has run for 30 minutes under low load, again check the vee-ribbed belt tension and readjust if necessary. After the engine has run for eight hours, again check the tension and readjust if necessary.

F-78 – ENGINE MOUNT — SECURITY CHECK

Check tightness of all securing bolts using a torque wrench.

F-79 – ENGINE MOUNT — RESILIENT MOUNT CONDITION CHECK

Visually check resilient mounts for cracks and deformation.

Replace cracked rubber elements.

NOTE:
Wipe rubber surfaces with dry cloth only; never clean with organic detergents.

F-80 – CRANKSHAFT PULLEY — SECURITY CHECK

Perform the following security checks:

1. Disable engine start. Refer to section F-1.
2. Remove protective guard from crankshaft pulley.
3. Check tightness of crankshaft pulley. Use a torque wrench to check securing bolts.
4. Install protective guard to the crankshaft pulley.
5. Enable engine start. Refer to section F-2.

F-81 – AIR COMPRESSOR DRIVE

Contact the OEM for information about the air compressor drive, belts and tension checks.

F-82 – GUARD CHECK

Check that all guards are correctly installed on the generator/alternator and PTO systems. The protective guards are OEM supplied.

F-83 – BATTERY CHECK

CAUTION:

To avoid injury from battery explosion or contact with battery acid, work in a well-ventilated area, wear protective clothing, and avoid sparks or flames near the battery. If you come in contact with battery acid:

- ☐ **Flush your skin with water.**
- ☐ **Apply baking soda or lime to help neutralize the acid.**
- ☐ **Flush your eyes with water.**
- ☐ **Get medical attention immediately.**

The battery is OEM supplied. Use the manufacturer's specifications to check the battery.

F-84 – FUEL SUPPLY CUT OUT

Close the shut-off valve in the supply line before the fuel prefilter.

F-85 – FUEL SUPPLY CUT IN

Open the shut-off valve in the supply line before the fuel prefilter.

F-86 – FUEL SUPPLY CHECK

CAUTION:

To avoid injury from fire caused by heated diesel-fuel vapors:

- ☐ **Keep those people who are not directly involved in servicing away from the engine.**
- ☐ **Stop the engine immediately if a fuel leak is detected.**
- ☐ **Do not allow open flames or smoke when working on an operating engine.**
- ☐ **Wear adequate protective clothing (face shield, insulated gloves and apron, etc.).**
- ☐ **To prevent a buildup of potentially volatile vapors, keep the engine area well ventilated during operation.**

Diesel fuel is relatively harmless at ambient temperatures.

Check fuel supply in the fuel tank. Top up if necessary.

NOTE:
A full fuel tank reduces condensation and the growth of bacteria.

F-87 – EXHAUST SYSTEM DRAINLINE OBSTRUCTION CHECK

The exhaust system is supplied by an OEM. Refer to vehicle manufacturer's operating instructions.

F-88 – ENGINE CONTROL SYSTEM CUT IN

The vehicle monitoring system is supplied by the OEM.

Move the power supply master switch to ON.

F-89 – ENGINE CONTROL SYSTEM CUT OUT

The vehicle monitoring system is supplied by the OEM.

Move the power supply master switch to OFF.

F-90 – PREPARATION FOR WELDING OPERATIONS

NOTE:
Before starting welding operations, disconnect the negative and positive battery cables.

NOTICE:
Never use the engine as a ground connection. Grounding through the engine can result in burning or scorching and lead to bearing pitting. The ground connection for the welding unit must not be attached more than 60 cm (2 ft) from the welding point.

NOTICE:
Never carry out welding work on the engine or engine-mounted units. If welding must be performed on components (e.g. exhaust pipe), remove these components from the engine prior to welding.

NOTICE:
Never position the welding power supply cable adjacent to, or crossing the wiring harnesses. (The welding current can be induced in the wiring harness, which could damage the DDEC III/IV electronic control modules (ECM).

F-91 – DDEC — OPERATION

For information on DDEC, refer to the *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

F-92 – DDEC CONNECTION CHECKS

For information on DDEC, refer to the *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

F-93 – MONITORING SYSTEM

Check operation of level sensor on the engine coolant expansion tank. Refer to *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

The temperature transmitter, speed transmitter and pressure transmitter are continuously monitored with the Integrated Test System (ITS) in the Engine Control System. If a monitoring unit fails, a warning is given.

Refer to the *DDEC Multi-ECM Troubleshooting Manual*, (6SE496).

G – PRESERVATION

G-1 – PRESERVATION — INTRODUCTION

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing being carried out in compliance with DDC/MTU specifications and instructions.

These instructions differentiate between preservation procedures for storage, preservation procedures for extended storage and restoration to service of MTU/DDC diesel engines.

Preservation procedures must be carried out on:

- ☐ New or overhauled engines, following the test run (storage is carried out by MTU/DDC, but may be omitted if the engine is to be put into immediate operation).
- ☐ Engines being withdrawn from operation for a period exceeding three months, as soon after the final operating period as possible.

Preservation procedures are adequate for storage for a period up to:

- ☐ Twelve (12) months under favorable storage conditions
- ☐ Six (6) months under unfavorable storage conditions, e.g. high humidity, salt-laden atmosphere, pronounced temperature fluctuations, etc.

On conclusion of the storage period, carry out the extended preservation procedures at the required intervals.

Extended storage is adequate for a storage period of up to:

- ☐ Six (6) months under favorable storage conditions
- ☐ Three (3) months under unfavorable conditions, e.g. high humidity, salt-laden atmosphere, pronounced temperature fluctuations, etc.

Engines in special packing do not need the extended preservation procedures as long as the permissible relative humidity is not exceeded in the packaging enclosure; refer to the current specification for DDC/MTU Special Packing A060374.

Only DDC/MTU-approved storage agents may be used for storage and extended storage. Refer to DDC publication *Oil, Fuel, and Filter Requirements, DDC/MTU Series 2000, MTU/DDC Series 4000* (7SE273).

These services may be omitted if:

- ☐ They cannot be completed due to operationally required special equipment (e.g. test stand)
- ☐ The specified component is not fitted on the diesel engine

Before- and after-operation services on the engine must be carried out in accordance with the Operating Instructions.

The preservation, storage and restoration operations and tasks must be carried out in the recommended sequence. The preservation, storage and restoration operations are the following:

- ☐ Preservation and storage (listed in Table 19)
- ☐ Extended preservation and extended storage (listed in Table 20)
- ☐ Restoration to service (listed in Table 21)

The procedures in all three tables are specified by three-digit and eight-digit codes.

The three-digit code procedures can be found in this chapter. Refer to section G-5.

The eight-digit code procedures can be found in the previous chapter, and carry the prefix F. They are tasks that are covered in detail in the numbered sections.

G-2 – PRESERVATION AND STORAGE

The operations and tasks required for preservation and storage must be carried out in the recommended sequence listed in Table 19.

Section	Task Description
Refer to F-12	Shut down engine
Refer to F-1	Disable engine start
Refer to F-50	Drain engine oil
Refer to 001 Clean engine	Clean engine
Refer to F-51	Fill corrosion inhibitor oil into engine
Refer to 002 Preserve fuel system	Preserve fuel system
Refer to F-2	Release engine start
Refer to F-5	Start engine
Refer to 003 Preserve engine coolant system	Preserve engine coolant system
Refer to 004 Perform preservation run	Perform preservation run
Refer to F-12	Shut down engine
Refer to F-1	Disable engine start
Refer to 005 Spray corrosion inhibitor oil into air manifolds	Spray corrosion inhibitor oil into air manifolds
Refer to 006 Spray corrosion inhibitor oil onto turbocharger compressor wheels	Spray corrosion inhibitor oil onto turbocharger compressor wheels
-	Connect fuel suction line to fuel system
Refer to F-52	Draw off corrosion inhibitor oil from engine
Refer to 007 Seal engine exhaust system	Seal engine exhaust system
Refer to 008 Seal engine air system	Seal engine air system
Refer to 009 Preserve engine externally	Preserve engine externally

Table 19 Storage Procedures

G-3 – EXTENDED PRESERVATION AND STORAGE

The operations and tasks required for extended preservation and extended storage must be carried out in the recommended sequence listed in Table 20.

Section	Task Description
Refer to 001 Clean engine	Clean engine
Refer to F-3	Bar engine manually, and
Refer to 005 Spray corrosion inhibitor oil into air manifolds	Spray corrosion inhibitor oil into air manifolds
Refer to 006 Spray corrosion inhibitor oil onto turbocharger compressor wheels	Spray corrosion inhibitor oil onto turbocharger compressor wheels
Refer to 009 Preserve engine externally	Preserve engine externally

Table 20 Extended Storage Procedures

G-4 – RESTORE TO SERVICE

The operations and tasks required for restoration to service must be carried out in the recommended sequence listed in Table 21.

Section	Task Description
Refer to 001 Clean engine	Clean engine
Refer to F-21	Remove cylinder head covers
Refer to F-4	Turn engine on starter, and
Refer to 010 Inspect and preserve valve gear	Check valve gear
Refer to 011 Remove seals from engine air system	Remove seals from engine air system
Refer to 012 Remove seals from engine exhaust system	Remove seals from engine exhaust system
—	For other services see Operating Instructions

Table 21 Restore to Service Procedures

G-5 – TASK DESCRIPTIONS WITH THREE-DIGIT CODES

The task description with three–digit codes are described in the following sections.

001 Clean engine

Clean engine externally and check for corrosion. If necessary, remove rust spots and renew paint.

NOTE:
Do not use organic detergents to clean rubber or synthetic components. Wipe with a dry cloth only.

002 Preserve fuel system

Connect the fuel delivery pump suction line to a separate tank, which should be filled with:

- ☐ Injection pump testing oil, to DIN ISO 4113 or
- ☐ Diesel fuel with 10% corrosion inhibitor oil, for internal preservation

If possible, store the fuel system when the engine is hot. (Storage is carried out during the pre-storage run, refer to section G-1.)

003 Preserve engine coolant system

NOTE:
Engine coolant systems are usually filled with prepared engine coolant and, therefore, protected from corrosion.

Fill engine coolant system with coolant containing 2% corrosion inhibitor oil or 50% antifreeze. The coolant preserves the engine during the pre-storage run.

The coolant should be allowed to remain in the engine to provide protection against corrosion.

Only drain the coolant for ambient temperatures.

- ☐ Below 0°C for coolant/corrosion inhibitor oil emulsions
- ☐ Below 40°C for coolant/antifreeze emulsions

004 Perform preservation run

Run the engine approximately 20 minutes at idling speed.

005 Spray corrosion inhibitor oil into air manifolds

Spray corrosion inhibitor oil into the air manifolds as follows:

1. Remove plugs from air manifolds.
2. Turn engine on starter.
3. Spray corrosion inhibitor oil into air manifolds.

NOTICE:
Use only sealing rings which are in perfect condition.

4. Insert plugs into air manifolds.

006 Spray corrosion inhibitor oil onto turbocharger compressor wheels

Spray corrosion inhibitor oil into the turbocharger compressor wheels as follows:

1. Disconnect air pipework from turbochargers.
2. Spray compressor wheels and compressor housing with corrosion inhibitor oil while rotating the compressor wheels.
3. Reconnect air pipework.

007 Seal engine exhaust system

Cover the exhaust outlets at the turbocharger with blanking plates so that they are sealed against air and moisture penetration.

NOTE:
In order to ensure that these plates are not overlooked when the engine is returned to service, they must be shaped in such a way as to project beyond the flanges at a certain point. Paint the projections bright red and fold them back.

008 Seal engine air system

Cover the air filter with plastic sheet.

009 Preserve engine externally

Spray or brush preservation agent on all exposed metalwork.

NOTE:
Do not apply grease to the sealing lips of radial-lip oil seals.

NOTE:
Seal all openings in pipework, housings and turbochargers, with suitable, plugs or plates.

010 Inspect and preserve valve gear

Check valve gear and fuel injection components for moisture, corrosion or other evidence of damage.

Spray corrosion inhibitor oil into housing and onto valve gear and fuel injection system components.

NOTE:
When removing the plates, ensure that no foreign particles fall into the engine.

Connect the bellows.

011 Remove seals from engine air system

Remove plastic sheet from air filters.

012 Remove seals from engine exhaust system

Remove blanking plates from exhaust outlets.

NOTE:
When removing the plates, ensure that no foreign particles fall into the engine.

Connect the bellows.

P – PERFORMANCE CURVES

P-1 – PERFORMANCE CURVES

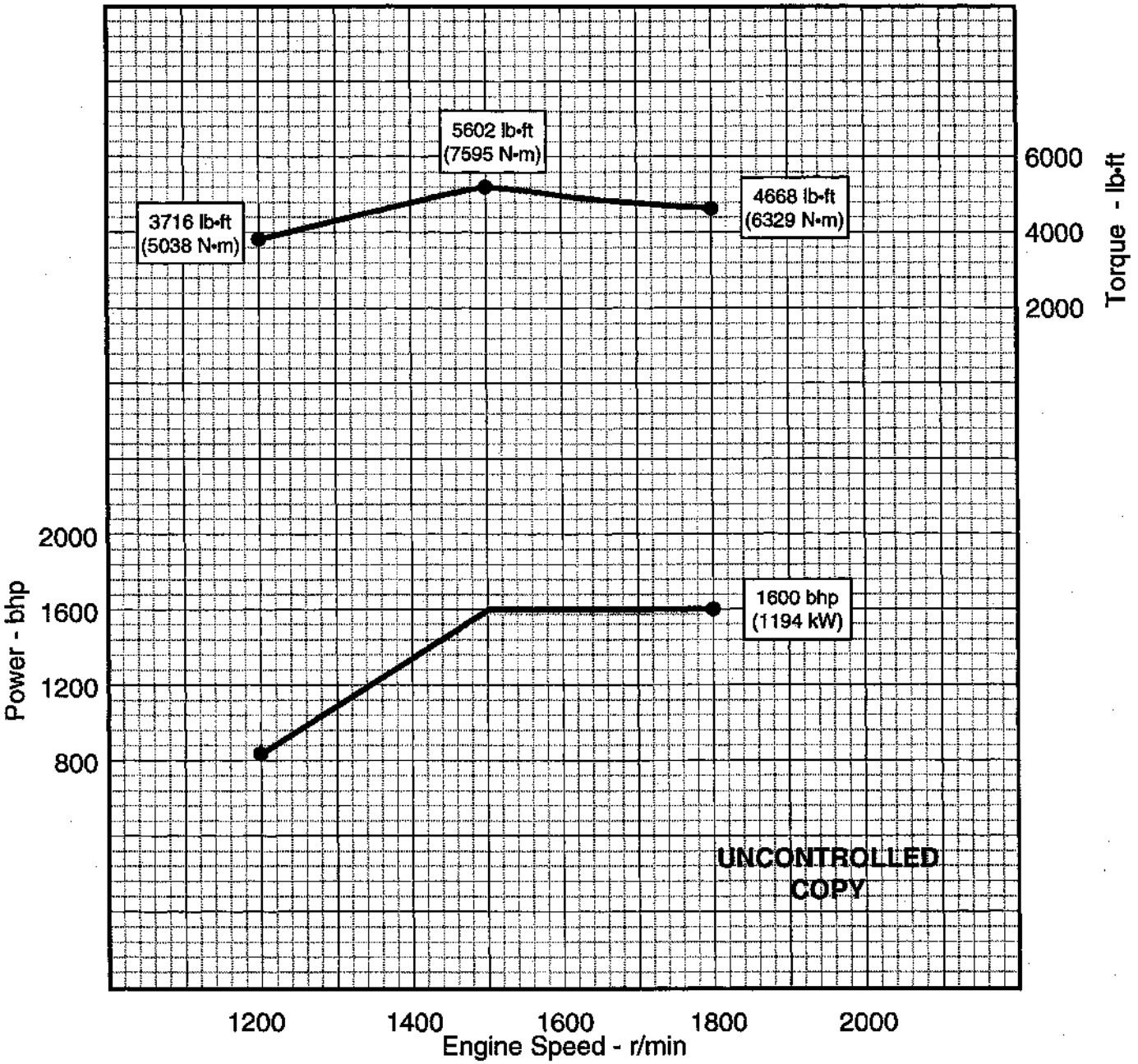
Applicable performance curves follow:

MTU/DDC Series 4000™

Industrial Power

Model: Series 12V-4000

Rating: 1600 bhp @ 1800 r/min
5602 lb•ft @ 1500 r/min



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42600 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: kg/kW•hr = lb/bhp•hr x 0.608 Torque: N•m = lb4 ft x 1.356	**6N4M - 1284** **Turbo:** BTV7506 **Fuel Injector:** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T123-32-05
Rev. / Date: 1 / 28 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data	
Application Group	5A
Application Designation	C20
Model	T1237K11
Power Output – bhp	1600
Power Output – kW	1194
Rated Speed – r/min	1800
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14.0:1
Piston Speed – ft/min (m/s)	2369 (12.0)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.5 x 7.5 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	99.9 (2538)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	13382 (6070)
Weight, Wet – lb (kg)	13920 (6314)
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	Not Available
Fuel Consumption – lb/hr (kg/hr)	Not Available
Fuel Spill Rate – gal/hr (L/min)	Not Available
Fuel Spill Heat Rejection – Btu/min (kW)	Not Available
Total Fuel Flow – gal/hr (L/min)	Not Available
Fuel Inlet Temperature, Maximum –°F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	Not Available
Aftercooler Circuit to Coolant. – Btu/min (kW)	Not Available
Engine Radiated Heat – Btu/min (kW)	Not Available
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	374 (85)
Engine Circuit External Restriction – lb/in.^{2} (kPa)	10.2 (70)
Aftercooler Circuit – gal/min (m^3/hr)	220 (50)
Aftercooler Circuit External Restriction – lb/in.^{2} (kPa)	10.2 (70)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant In Temperature, Maximum –°F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	169 (160)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.^{2} (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.^{2} (kPa)	52 (360)
Intercooler Circuit – lb/in.^{2} (kPa)	30 (206)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – lb/in^2 (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	3750 (106
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Single – in. (mm)	12 (305)
Double – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Volume Flow – ft^3/min (m^3/s)	8000 (3.78) †
Exhaust Temperature – °F (°C)	700 (371) †
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.^{2} (kPa)	80 (550)
Oil Pressure at Low Idle – lb/in.^{2} – (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	90 (341)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in.H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Above 32°F / (0°C)	1900
24 Volt System, Below 32°F / (0°C)	2500
Resistance of Starting Circuit, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	21000 (640
Manifold Boost Pressure – In. Hg (kPa)	Not Available
BMEP – lb/in.^{2} (bar)	237 (16.3)
Friction Power:	
Rated Speed – hp (kW)	200 (149)
Peak Torque Speed – hp (kW)	130 (97)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N-m)	Rated BSFC * lb/bhp (g/kW-hr)
1800	1600 (1194)	4668 (6329)	Not Available
1650	1600 (1194)	5093 (6905)	Not Available
1500	1600 (1194)	5602 (7595)	Not Available
1350	1213 (905)	4719 (6398)	Not Available
1200	849 (633)	3716 (5038)	Not Available

Emissions	
Smoke, Bosch Number:	
Rated Power	Not Available
Peak Torque Speed	Not Available
Noise – dB(A) @ 1m	Not Available
NO_x – g/hr	Not Available
CO – g/hr	Not Available
HC – g/hr	Not Available
SO_2 – g/hr (0.1% sulfur fuel)	Not Available

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Estimated data

UNCONTROLLED COPY

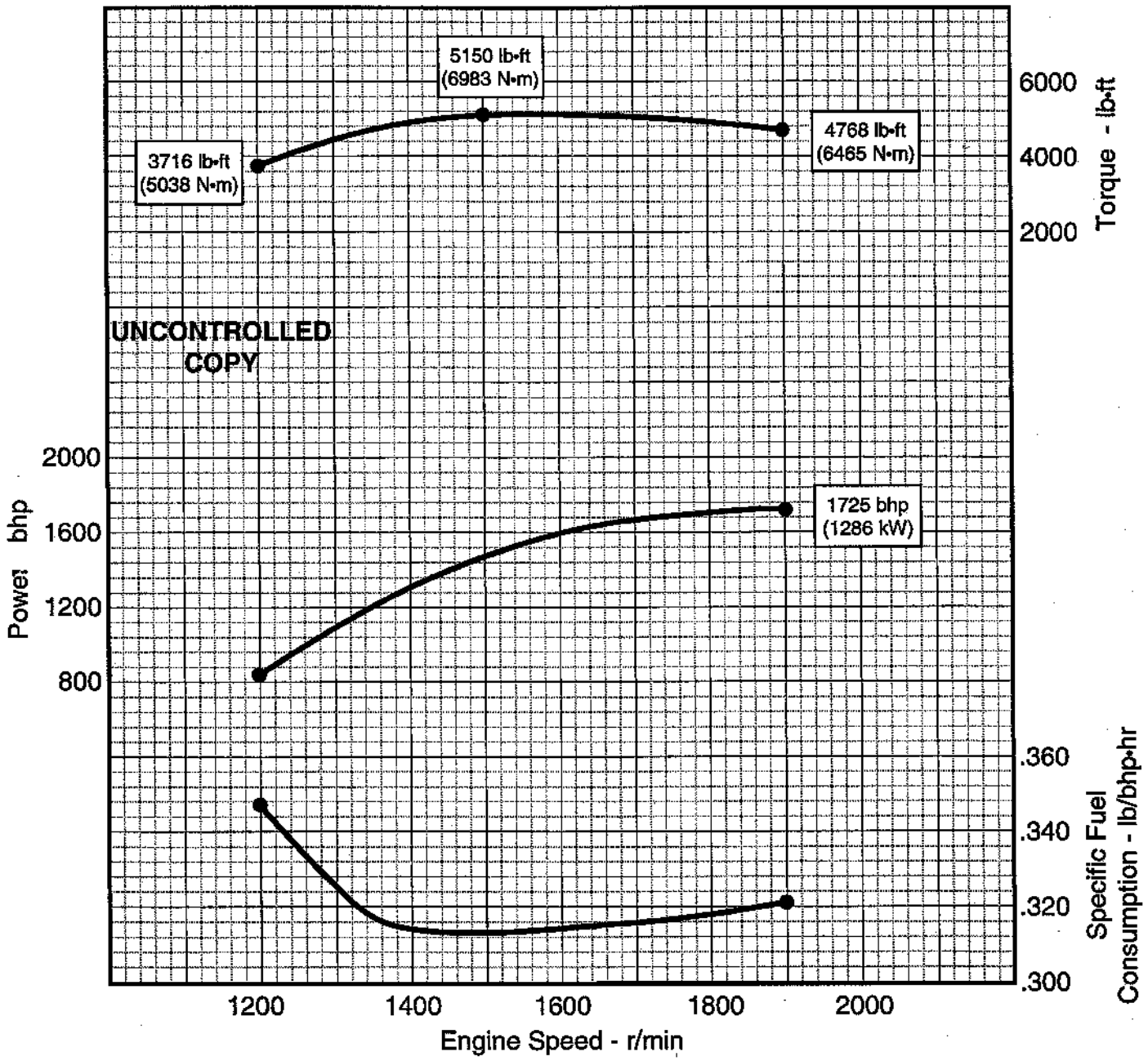
Curve No. E4-T123-32-05
Rev. / Date: 1 / 28 June 99
Sheet No. 2 of 2

MTU/DDC Series 4000™

Industrial Power

Model: Series 12V-4000

Rating: 1725 bhp @ 1900 r/min
5150 lb-ft @ 1500 r/min



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW-hr = lb/bhp-hr x 608 Torque: N-m = lb-ft x 1.356	**6N04M - 1102** **Fuel Injector :** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T123-32-02
Rev. / Date: 6 / 28 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data	
Application Group	5A
Application Designation	C20
Model	T1237K11
Power Output – bhp	1725
Power Output – kW	1286
Rated Speed – r/min	1900
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14.0:1
Piston Speed – ft/min (m/s)	2369 (12.0)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.5 x 7.5 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	99.9 (25.38)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	13325 (6044)
Weight, Wet – lb (kg)	14171 (6428)
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	35.4 (899)
Above Crankshaft (y axis) – in. (mm)	4.4 (238)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	79.0 (4.98) *
Fuel Consumption – lb/hr (kg/hr)	553 (251) *
Fuel Spill Rate – gal/hr (L/min)	105 (6.62)
Fuel Spill Heat Rejection – Btu/min (kW)	399 (7.02)
Total Fuel Flow – gal/hr (L/min)	184 (11.6)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	0000107851
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	27297 (480)
Aftercooler Circuit to Coolant. – Btu/min (kW)	17061 (300)
Engine Radiated Heat – Btu/min (kW)	2559 (45)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	370 (84)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	7 (48)
Aftercooler Circuit – gal/min (m^3/hr)	180 (40.9)
Aftercooler Circuit External Restriction – $lb/in.^2$ (kPa)	11 (76)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant In Temperature, Maximum – °F (°C)	174 (79) †
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	169 (160)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	60 (415)
Intercooler Circuit – $lb/in.^2$ (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – lb/in^2 (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	3920 (1.85)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	287 (130)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	3927 (1.85) ‡
Exhaust Temperature – °F (°C)	716 (380)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	91 (630)
Oil Pressure at Low Idle – $lb/in.^2$ – (kPa)	23 (150)
Oil Flow @ Rated Speed – gal/min (L/min)	93 (353)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in.H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA): †	
24 Volt System, Above 32° F / (0°C)	1900
24 Volt System, Below 32° F / (0°C)	2500
Resistance of Starting Circuit, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	21000 (640
Manifold Boost Pressure – in. Hg (kPa)	47 (160)
BMEP – $lb/in.^2$ (bar)	242 (16.7)
Friction Power:	
Rated Speed – hp (kW)	200 (149)
Peak Torque Speed – hp (kW)	130 (97)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N·m)	Rated BSFC * lb/bhp (g/kW·hr)
1900	1725 (1286)	4768 (6465)	0.321 (195)
1800	1710 (1275)	4990 (6765)	0.317 (193) †
1650	1610 (1201)	5125 (6948)	0.314 (191) †
1500	1471 (1097)	5150 (6983) †	0.312 (190) †
1350	1213 (904)	4719 (6398)	0.316 (192) †
1200	849 (633)	3716 (5038)	0.347 (211) †

Emissions	
Smoke, Bosch Number:	
Rated Power	0.5
Peak Torque Speed	1.0
Noise - dB(A) @ 1m	105.5
NO_x – g/hr	18250
CO – g/hr	1000
HC – g/hr	928
SO_2 – g/hr (0.1% sulfur fuel)	250

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature reference – 1.169 kg/m^3

UNCONTROLLED COPY

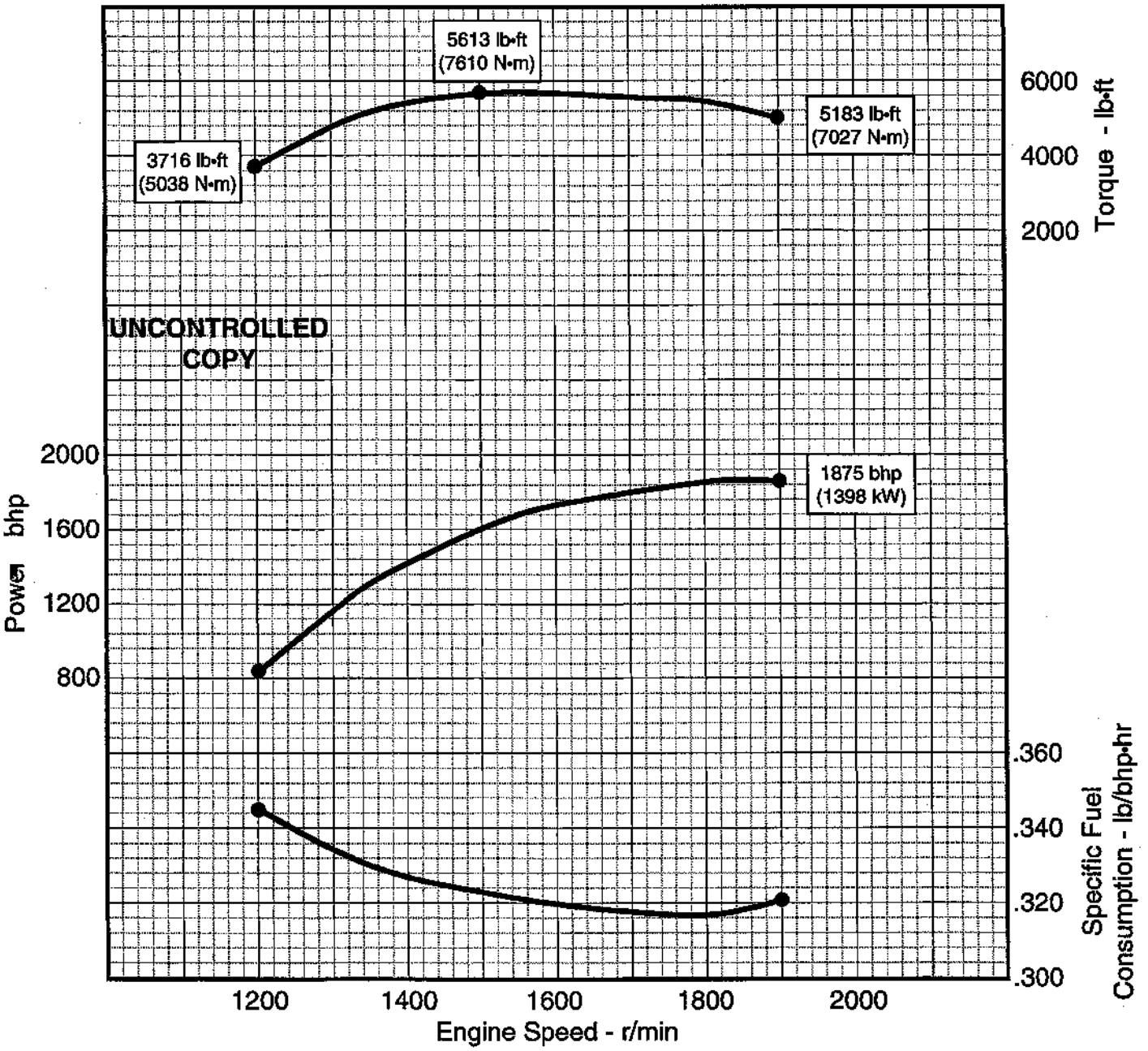
Curve No. E4-T123-32-0Z
Rev. / Date: 6 / 28 June 99
Sheet No. 2 of 2

MTU/DDC Series 4000™

Industrial Power

Model: Series 12V-4000

Rating: 1875 bhp @ 1900 r/min
5613 lb•ft @ 1500 r/min



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW-hr = lb/bhp-hr x 608 Torque: N•m = lb•ft x 1.356	**6N04M - 1100** **Fuel Injector :** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T123-32-03
Rev. / Date: 5 / 10 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data	
Application Group	5A
Application Designation	C20
Model	T1237K11
Power Output – bhp	1875
Power Output – kW	1398
Rated Speed – r/min	1900
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14.0:1
Piston Speed – ft/min (m/s)	2369 (12.0)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.5 x 7.5 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	99.9 (2538)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	13325 (6044)
Weight, Wet – lb (kg)	14171 (6428)
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	35.4 (899)
Above Crankshaft (y axis) – in. (mm)	9.4 (238)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb·ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	85.6 (5.40) *
Fuel Consumption – lb/hr (kg/hr)	601 (273) *
Fuel Spill Rate – gal/hr (L/min)	109 (6.88)
Fuel Spill Heat Rejection – Btu/min (kW)	410 (7.21)
Total Fuel Flow – gal/hr (L/min)	194.6 (12.3)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	28435 (500)
Aftercooler Circuit to Coolant. – Btu/min (kW)	18198 (320)
Engine Radiated Heat – Btu/min (kW)	2843 (50)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	370 (84)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	7 (48)
Aftercooler Circuit – gal/min (m^3/hr)	180 (40.9)
Aftercooler Circuit External Restriction – $lb/in.^2$ (kPa)	11 (76)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant In Temperature, Maximum – °F (°C)	174 (79) †
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	169 (160)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	60 (415)
Intercooler Circuit – $lb/in.^2$ (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – $lb/in.^2$ (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4135 (1.95
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	309 (140)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	4229 (2.00) ‡
Exhaust Temperature – °F (°C)	734 (390)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	91 (630)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	23 (150)
Oil Flow @ Rated Speed – gal/min (L/min)	93 (353)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA): †	
24 Volt System, Above 32° F / (0° C)	1900
24 Volt System, Below 32° F / (0° C)	2500
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	18000 (5486)
Manifold Boost Pressure – in. Hg (kPa)	56 (190)
BMEP – $lb/in.^2$ (bar)	263 (18.1)
Friction Power:	
Rated Speed – hp (kW)	200 (149)
Peak Torque Speed – hp (kW)	130 (97)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb·ft (N·m)	Rated BSFC * lb/bhp (g/kW·hr)
1900	1875 (1399)	5183 (7027)	0.321 (195)
1800	1868 (1394)	5451 (7390)	0.317 (193)
1650	1746 (1303)	5558 (7535)	0.319 (194)
1500	1603 (1196)	5613 (7610)	0.324 (197)
1350	1317 (983)	5124 (6947)	0.330 (201)
1200	849 (633)	3716 (5038)	0.345 (210)

Emissions	
Smoke, Bosch Number:	
Rated Power	0.6
Peak Torque Speed	1.2
Noise – dB(A) @ 1m	105.8
NO_x – g/hr	19750
CO – g/hr	1140
HC – g/hr	910
SO_2 – g/hr (0.1% sulfur fuel)	275

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature reference – 1.169 kg/m^3

UNCONTROLLED COPY

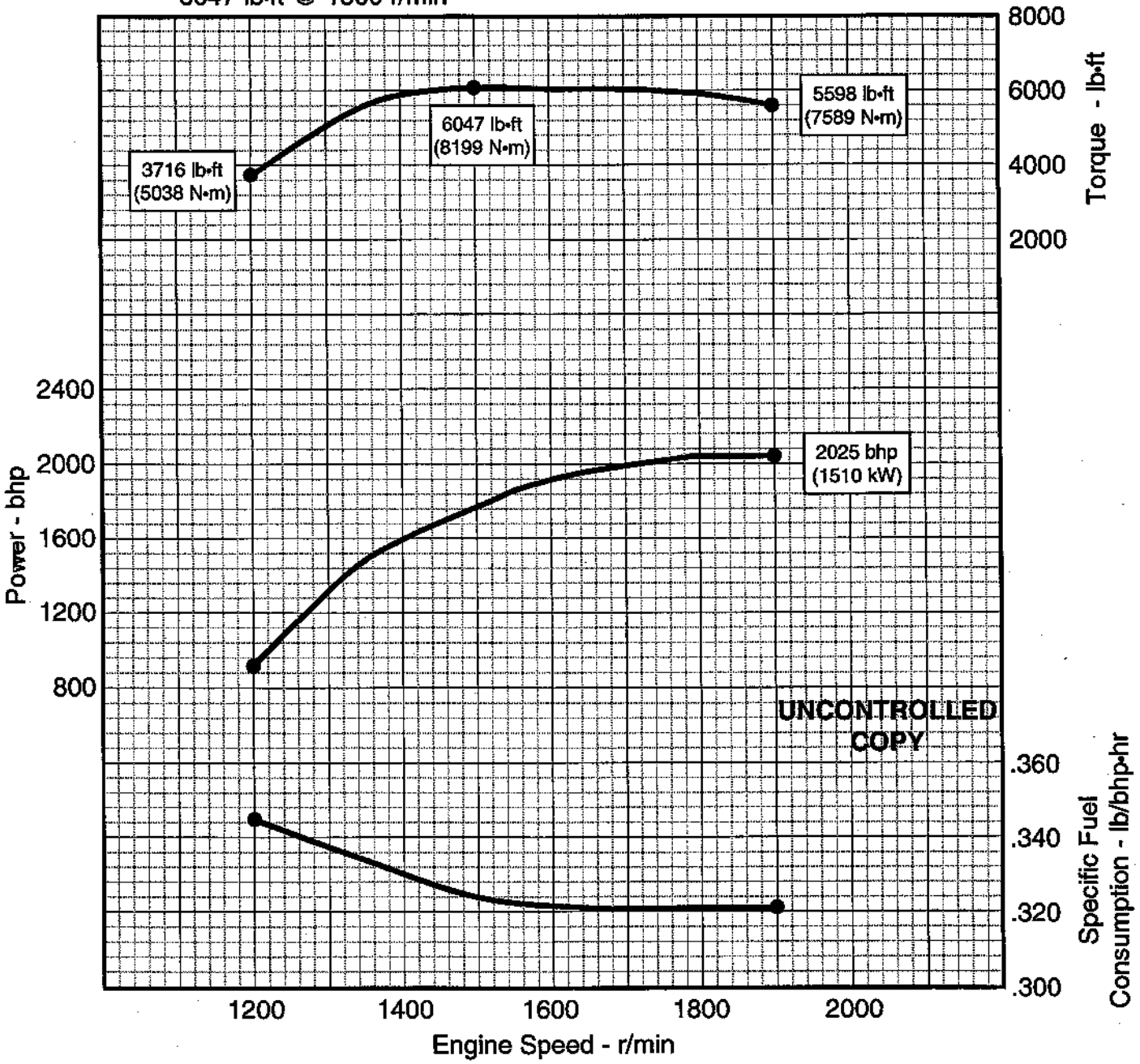
Curve No. E4-T123-32-03
Rev. / Date: 5 / 10 June 99
Sheet No. 2 of 2

MTU/DDC Series 4000™

Industrial Power

Model: Series 12V-4000

Rating: 2025 bhp @ 1900 r/min
6047 lb•ft @ 1500 r/min



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa). Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW•hr = lb/bhp•hr x 608. Torque: N•m = lb•ft x 1.356	**6N04M - 1099** **Fuel Injector :** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T123-32-04
Rev. / Date: 5 / 10 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data

Application Group	5A
Application Designation	C20
Model	T1237K11
Power Output – bhp	2025
Power Output – kW	1510
Rated Speed – r/min	1900
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14.0:1
Piston Speed – ft/min (m/s)	2369 (12.0)
Turbocharger	BTV7506

Engine Configuration

Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.5 x 7.5 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open

Dimensions

Length – in. (mm)	99.9 (2538)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	13325 (6044)
Weight, Wet – lb (kg)	14171 (6428)

Center of Gravity Wet

From R.F.O.B. (x axis) – in. (mm)	35.4 (899)
Above Crankshaft (y axis) – in. (mm)	9.4 (238)
Right of Crankshaft (z axis) – in. (mm)	0 (0)

Mechanical Limits

Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)

Fuel System

Fuel Consumption – gal/hr (L/min)	92.6 (5.84) *
Fuel Consumption – lb/hr (kg/hr)	648 (294) *
Fuel Spill Rate – gal/hr (L/min)	112 (7.07)
Fuel Spill Heat Rejection – Btu/min (kW)	425 (7.47)
Total Fuel Flow – gal/hr (L/min)	204.6 (12.9)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb^2/in (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851

Cooling System

Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	34121 (800)
Aftercooler Circuit to Coolant. – Btu/min (kW)	21042 (370)
Engine Radiated Heat – Btu/min (kW)	2957 (52)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	370 (84)
Engine Circuit External Restriction – lb/in.^{2} (kPa)	7 (48)
Aftercooler Circuit – gal/min (m^3/hr)	180 (40.9)
Aftercooler Circuit External Restriction – lb/in.^{2} (kPa)	11 (76)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant In Temperature, Maximum – °F (°C)	174 (79) †
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	169 (160)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.^{2} (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.^{2} (kPa)	60 (415)
Intercooler Circuit – lb/in.^{2} (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – lb/in^2 (kPa)	7-10 (48-69)

Intake Air System

Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4644 (2.05
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)

Exhaust System

Exhaust Mass Flow – lb/min (kg/min)	331 (150)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	4531 (2.14) ‡
Exhaust Temperature – °F (°C)	779 (415)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)

Lubrication System

Oil Pressure at Rated Speed – lb/in.^{2} (kPa)	91 (630)
Oil Pressure at Low Idle – lb/in.^{2} (kPa)	23 (150)
Oil Flow @ Rated Speed – gal/min (L/min)	93 (353)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)

Electrical

Battery Capacity, Recommended (CCA): †	
24 Volt System, Above 32° F / (0° C)	1900
24 Volt System, Below 32° F / (0° C)	2500
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002

Performance Data

Altitude Capability – ft (m)	15000 (4572
Manifold Boost Pressure – In. Hg (kPa)	71 (240)
BMEP – lb/in.^{2} (bar)	284 (19.6)
Friction Power:	
Rated Speed – hp (kW)	200 (149)
Peak Torque Speed – hp (kW)	130 (97)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N-m)	Rated BSFC * lb/bhp (g/kW-hr)
1900	2025 (1511) †	5598 (7589)	0.321 (195)
1800	2017 (1505) †	5885 (7979)	0.321 (195)
1650	1883 (1405) †	5994 (8127)	0.321 (195)
1500	1727 (1288)	6047 (8199)	0.324 (197)
1350	1422 (1061) †	5532 (7500) †	0.334 (203)
1200	849 (633)	3716 (5038)	0.345 (210)

Emissions

Smoke, Bosch Number:	
Rated Power	0.6
Peak Torque Speed	1.5
Noise – dB(A) @ 1m	106.2
NO_x – g/hr	20500
CO – g/hr	1330
HC – g/hr	888
SO_2 – g/hr (0.1% sulfur fuel)	294

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature reference – 1.169 kg/m^3

UNCONTROLLED COPY

Curve No. E4-T123-32-04
Rev. / Date: 5 / 10 June 99
Sheet No. 2 of 2

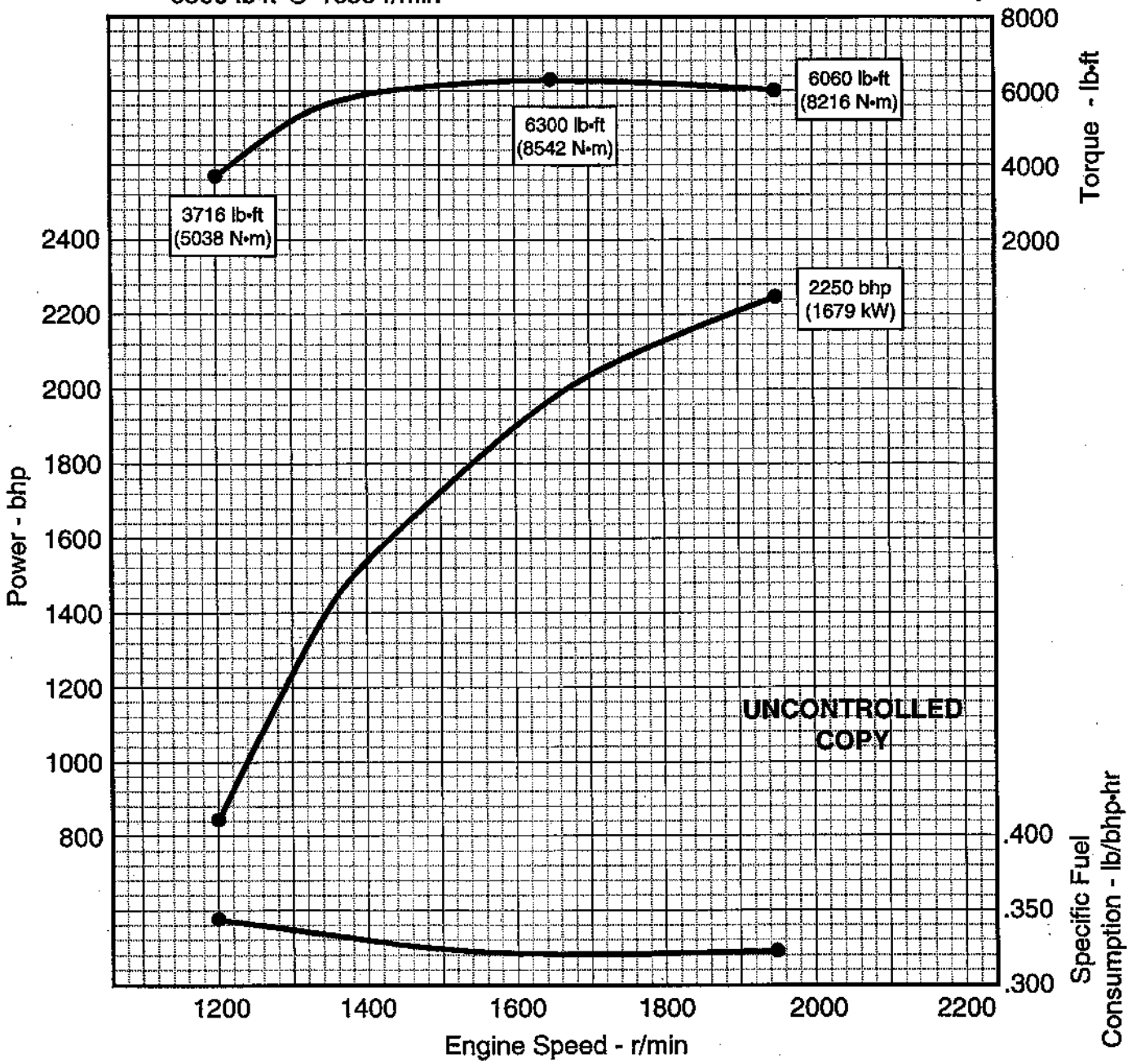
MTU/DDC Series 4000™

Industrial Power

Model: 12V-4000 DDEC®

Rating: 2250 bhp @ 1950 r/min
6300 lb•ft @ 1650 r/min

Petroleum - Frac Only



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW - hr = lb/bhp - hr x 608. Torque: N • m = lb • ft x 1.356	**6N04M - 1223** **Fuel Injector :** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T123-32-01
Rev. / Date: 9 / 28 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data	
Application Group	5A
Application Designation	C80
Model	T1237K73
Power Output – bhp	2250
Power Output – kW	1679
Rated Speed – r/min	1950
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14.0:1
Piston Speed – ft/min (m/s)	2431 (12.3) †
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.5 x 7.5 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	99.9 (2538)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	13325 (6044)
Weight, Wet – lb (kg)	14171 (6428)
Center of Gravity, Wet	
From R.F.O.B. (x axis) – in. (mm)	35.4 (899)
Above Crankshaft (y axis) – in. (mm)	9.4 (238)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb·ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	103.4 (6.52) *
Fuel Consumption – lb/hr (kg/hr)	724 (320) *
Fuel Spill Rate – gal/hr (L/min)	116 (7.12)
Fuel Spill Heat Rejection – Btu/min (kW)	440 (7.74)
Total Fuel Flow – gal/hr (L/min)	219 (13.8)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa	6 (20)
Fuel Return Pressure, Maximum – in. Hg (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	34600 (608)
Aftercooler Circuit to Coolant. – Btu/min (kW)	28100 (494)
Engine Radiated Heat – Btu/min (kW)	3375 (59)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	420 (95)
Engine Circuit External Restriction – lb/$in.^2$ (kPa)	7 (48)
Aftercooler Circuit – gal/min (m^3/hr)	180 (40.9)
Aftercooler Circuit External Restriction – lb/$in.^2$ (kPa)	11 (76)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant In Temperature, Maximum – °F (°C)	174 (79) †
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	169 (160)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator –in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/$in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/$in.^2$ (kPa)	60 (415)
Intercooler Circuit – lb/$in.^2$ (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – lb/$in.^2$ (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	5000 (2.36)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	365 (185)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	5589 (2.64) ‡
Exhaust Temperature – °F (°C)	825 (440)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/$in.^2$ (kPa)	91 (630)
Oil Pressure at Low Idle – lb/$in.^2$ (kPa)	23 (150)
Oil Flow @ Rated Speed – gal/min (L/min)	93 (353)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA): †	
24 Volt System, Above 32° F / (0°C)	1900
24 Volt System, Below 32° F / (0°C)	2500
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	10000 (304
Manifold Boost Pressure – in. Hg (kPa)	73 (248)
BMEP – lb/$in.^2$ (bar)	307 (21.2)
Friction Power:	
Rated Speed – hp (kW)	200 (149)
Peak Torque Speed – hp (kW)	130 (97)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N-m)	Rated BSFC * lb/bhp (g/kW-hr)
1950	2250 (1679)	6060 (8216)	0.322 (196)
1800	2132 (1590)	6221 (8436)	0.321 (195)
1650	1979 (1477)	6300 (8542)	0.321 (195)
1500	1727 (1288)	6047 (8199)	0.324 (197)
1350	1422 (1061)	5532 (7500)	0.334 (203)
1200	849 (633)	3716 (5038)	0.345 (210)

Emissions	
Smoke, Bosch Number:	
Rated Power	0.8
Peak Torque Speed	1.6
Noise – dB(A) @ 1m	106.7
NO_x – g/hr	20900
CO – g/hr	1680
HC – g/hr	850
SO_2 – g/hr (0.5% sulfur fuel)	320

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature reference – 1.169kg/m^3

UNCONTROLLED COPY

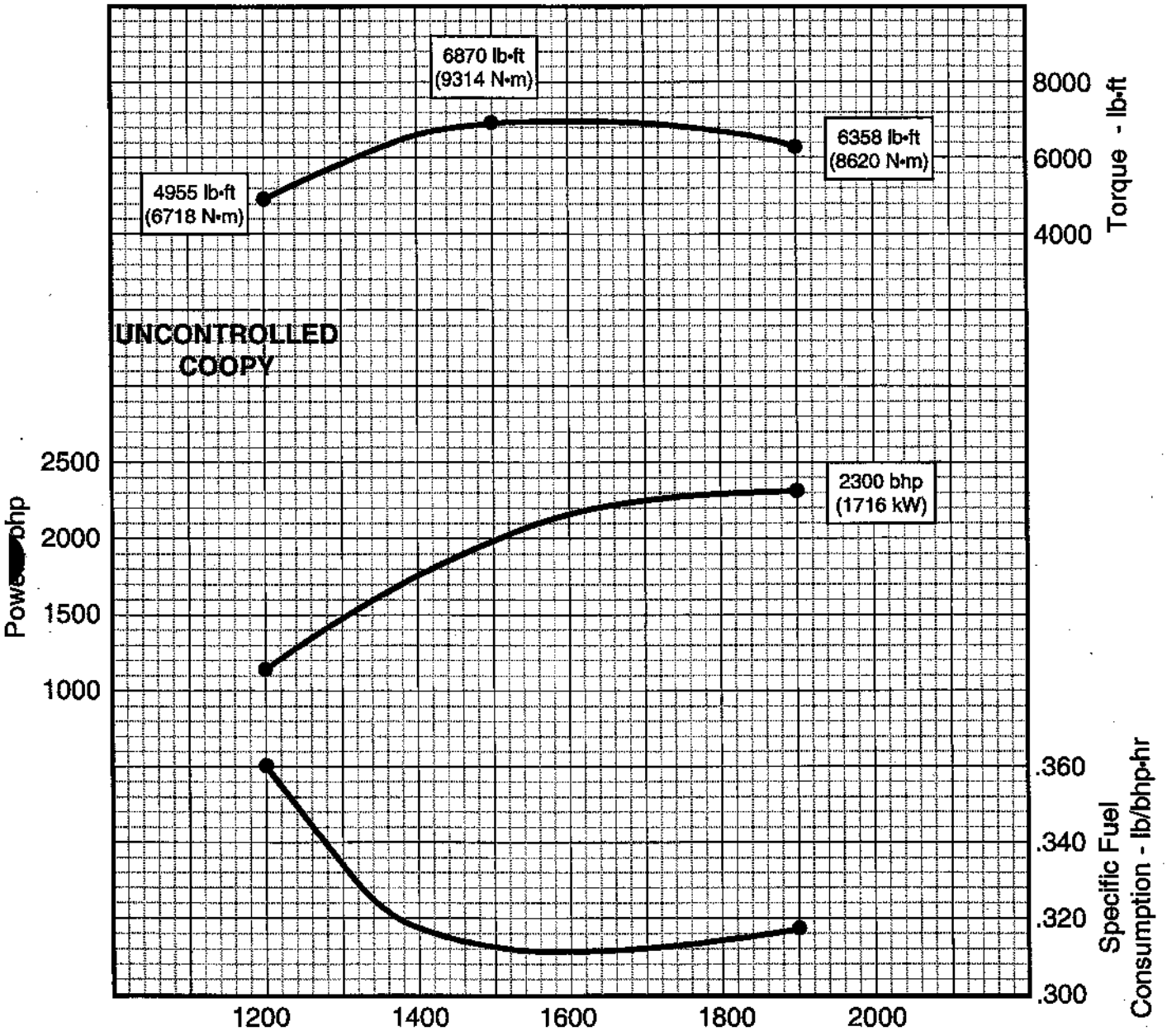
Curve No. E4-T123-3
Rev. / Date: 9 / 28 June 9
Sheet No. 2 of 2

MTU/DDC Series 4000™

Industrial Power

Model: 16V-4000

Rating: 2300 bhp @ 1900 r/min
6870 lb-ft @ 1500 r/min



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3048. Diesel fuel to DIN EN 590 with a minimum LHV 42600 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW-hr = lb/bhp-hr x 608. Torque: N-m = lb-ft x 1.356	**6N04M - 1103** **Fuel Injector:** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T163-32-04
Rev. / Date: 7 / 10 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data	
Application Group	5A
Application Designation	C20
Model	T1637K11
Power Output – bhp	2300
Power Output – kW	1715
Rated Speed – r/min	1900
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2369 (12.0)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	118.4 (3008)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	15615 (7083)
Weight, Wet – lb (kg)	16598 (7529)
Center of Gravity, Wet	
From R.F.O.B. (x axis) – in. (mm)	44.1 (1121)
Above Crankshaft (y axis) – in. (mm)	9.3 (235)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	104.2 (6.56) *
Fuel Consumption – lb/hr (kg/hr)	730 (331) *
Fuel Spill Rate – gal/hr (L/min)	180 (11.4)
Fuel Spill Heat Rejection – Btu/min (kW)	458 (8.05)
Total Fuel Flow – gal/hr (L/min)	284 (17.9)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in.^{2} (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	40156 (706)
Aftercooler Circuit to Coolant. – Btu/min (kW)	24402 (4290
Engine Radiated Heat – Btu/min (kW)	3450 (61)
Coolant Flow Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	465 (106)
Engine Circuit External Restriction – lb/in.^{2} (kPa)	9 (62)
Aftercooler Circuit – gal/min (m^3/hr)	180 (40.9)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	11 (76)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant Out Temperature, Maximum – °F (°C)	174 (79)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	218 (206)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.^{2} (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.^{2} (kPa)	50 (345)
Intercooler Circuit – lb/in.^{2} (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – lb/in.^{2} (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	5343 (2.52)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305
Each Turbo – In. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	408 (185)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	5589 (2.64) ‡
Exhaust Temperature – °F (°C)	710 (377)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.^{2} (kPa)	88 (606)
Oil Pressure at Low Idle – lb/in.^{2} (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	124 (470)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA):†	
24 Volt System, Above 32°F / (0°C)	1900
24 Volt System, Below 32°F / (0°C)	2500
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	19000 (579
Manifold Boost Pressure – in. Hg (kPa)	52.9 (179)
BMEP – lb/in.^{2} (bar)	242 (16.7)
Friction Power:	
Rated Speed – hp (kW)	260 (194)
Peak Torque Speed – hp (kW)	170 (127)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N-m)	Rated BSFC * lb/bhp-hr (g/kW-hr)
1900	2300 (1716) †	6358 (8620)	0.317 (193)
1800	2280 (1701) †	6653 (9020)	0.314 (191)
1650	2147 (1602) †	6834 (9266)	0.311 (189)
1500	1962 (1464) †	6870 (9314)	0.312 (190)
1350	1617 (1206)	6291 (8529)	0.323 (196)
1200	1132 (845) †	4955 (6718) †	0.361 (219)

Emissions	
Smoke, Bosch Number:	
Rated Power	0.4
Peak Torque Speed	0.5
Noise – dB(A) @ 1m	107.4
NO_x – g/hr	25806
CO – g/hr	1380
HC – g/hr	1656
SO_2 – g/hr (0.1% sulfur fuel)	662

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature reference – 1.169 kg/m^3

UNCONTROLLED COPY

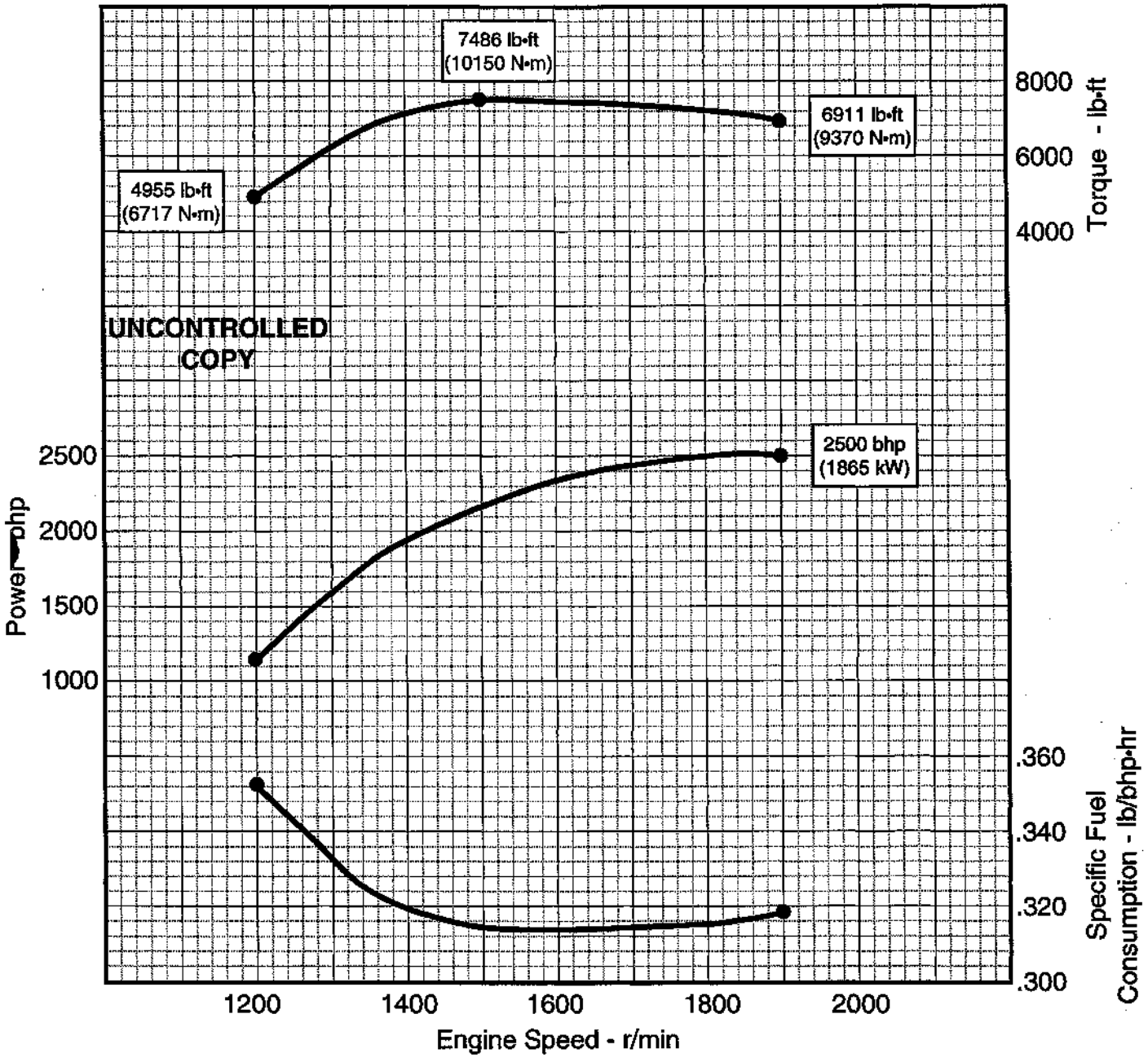
Curve No. E4-T163-32-04
Rev. / Date: 7 / 10 June 99
Sheet No. 2 of 2

MTU/DDC Series 4000™

Industrial Power

Model: 16V- 4000

Rating: 2500 bhp @ 1900 r/min
7486 lb•ft @ 1500 r/min



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW•hr = lb/bhp•hr x 608. Torque: N•m = lb•ft x 1.356	**6N04M - 1085** **Fuel Injector:** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T163-32-05
Rev. / Date: 7 / 10 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data	
Application Group	5A
Application Designation	C20
Model	T1637K11
Power Output – bhp	2500
Power Output – kW	1864
Rated Speed – r/min	1900
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2369 (12.0)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	118.4 (3006)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	15615 (7083)
Weight, Wet – lb (kg)	16598 (7529)
Center of Gravity, Wet	
From R.F.O.B. (x axis) – in. (mm)	44.1 (1121)
Above Crankshaft (y axis) – in. (mm)	9.3 (235)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	113.7 (7.18) * †
Fuel Consumption – lb/hr (kg/hr)	795 (361) *
Fuel Spill Rate – gal/hr (L/min)	186 (11.7)
Fuel Spill Heat Rejection – Btu/min (kW)	484 (8.51)
Total Fuel Flow – gal/hr (L/min)	300 (18.9)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	41661 (733)
Aftercooler Circuit to Coolant. – Btu/min (kW)	27861 (490)
Engine Radiated Heat – Btu/min (kW)	3750 (66)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	465 (106)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	9 (62)
Aftercooler Circuit – gal/min (m^3/min)	180 (40.9)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	11 (76)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant Out Temperature, Maximum – °F (°C)	174 (79)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	218 (206)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	50 (345)
Intercooler Circuit – $lb/in.^2$ (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	5686 (2.68)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	437 (198)
Exhaust Volume Flow – ft^3/min (m^3/s)	5981 (2.82) ‡
Exhaust Temperature – °F (°C)	735 (391)
Back Pressure, Maximum – In. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	88 (606)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	124 (470)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – In. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA): †	
24 Volt System, Above 32°F / (0°C)	1900
24 Volt System, Below 32°F / (0°C)	2500
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	16000 (487
Manifold Boost Pressure – In. Hg (kPa)	58.9 (199)
BMEP – $lb/in.^2$ (bar)	263 (18.1)
Friction Power:	
Rated Speed – hp (kW)	260 (194)
Peak Torque Speed – hp (kW)	170 (127)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N·m)	Rated BSFC * lb/bhp-hr (g/kW-hr)
1900	2500 (1865) †	6911 (9370)	0.318 (193)
1800	2490 (1857)	7265 (9851)	0.315 (192)
1650	2328 (1737)	7410 (10047)	0.313 (191)
1500	2138 (1595)	7486 (10150)	0.314 (191)
1350	1756 (1310)	6832 (9263)	0.324 (197)
1200	1132 (845) †	4955 (6717)	0.354 (215)

Emissions	
Smoke, Bosch Number:	
Rated Power	0.4
Peak Torque Speed	0.5
Noise – dB(A) @ 1m	107.8
NO_x – g/hr	25375
CO – g/hr	1600
HC – g/hr	1598
SO_2 – g/hr (0.1% sulfur fuel)	721

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature reference – 1.169 kg/m^3

UNCONTROLLED COPY

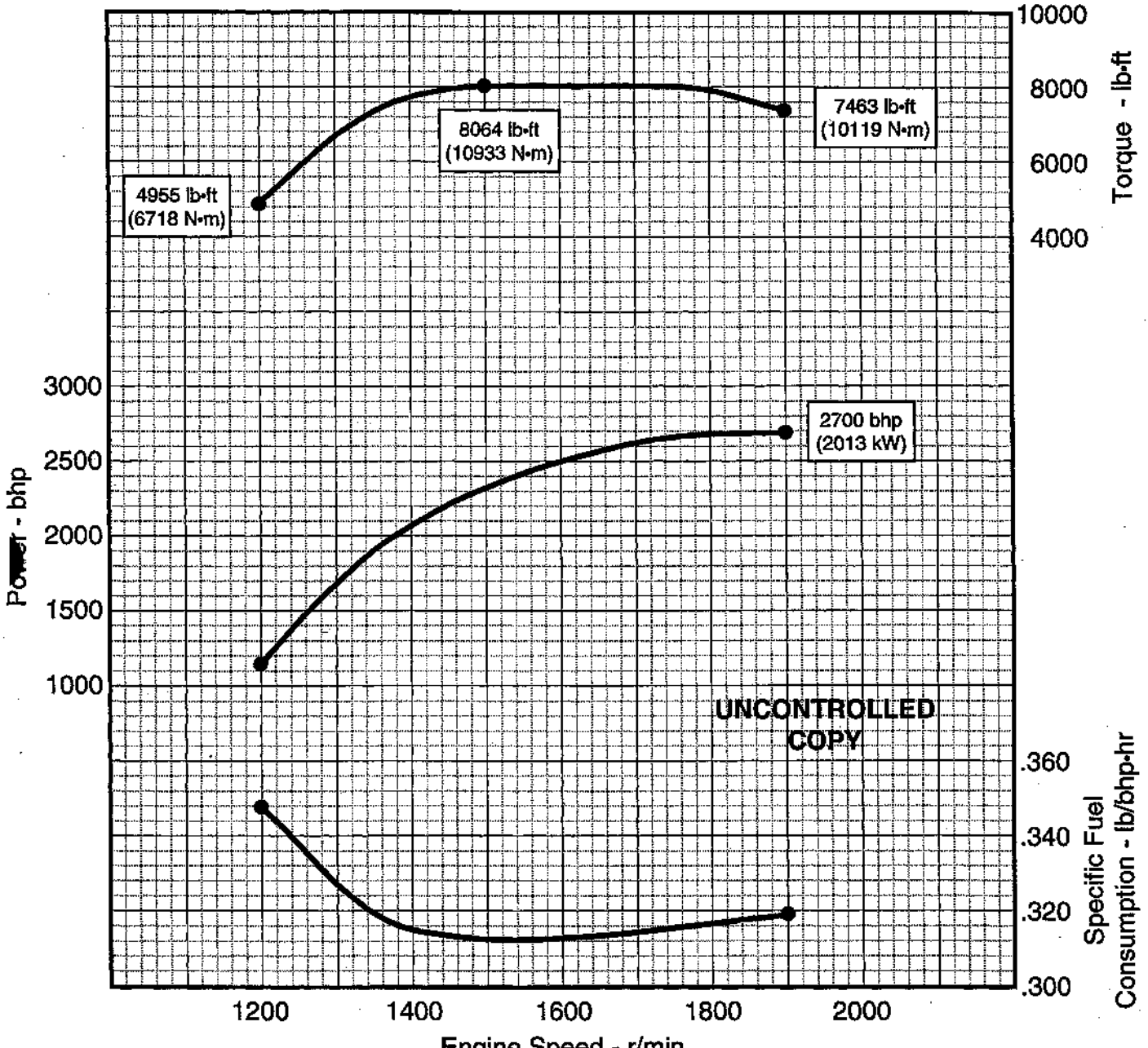
Curve No. E4-T163-32-05
Rev. / Date: 7 / 10 June 99
Sheet No. 2 of 2

MTU/DDC Series 4000™

Industrial Power

Model: Series 16V-4000

Rating: 2700 bhp @ 1900 r/min
8064 lb-ft @ 1500 r/min



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42600 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW-hr = lb/bhp-hr x 608. Torque: N-m = lb-ft x 1.356	**6N04M - 1095** **Fuel Injector:** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T163-32-06
Rev. / Date: 8 / 28 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data

Application Group	5A
Application Designation	C20
Model	T1637K11
Power Output – bhp	2700
Power Output – kW	2013
Rated Speed – r/min	1900
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14.0:1
Piston Speed – ft/min (m/s)	2369 (12.0)
Turbocharger	BTV8506

Engine Configuration

Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open

Dimensions

Length – in. (mm)	118.4 (3008)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	15615 (7083)
Weight, Wet – lb (kg)	16598 (7529)

Center of Gravity, Wet

From R.F.O.B. (x axis) – in. (mm)	44.1 (1121)
Above Crankshaft (y axis) – in. (mm)	9.3 (235)
Right of Crankshaft (z axis) – in. (mm)	0 (0)

Mechanical Limits

Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)

Fuel System

Fuel Consumption – gal/hr (L/min)	123.1 (7.77) *
Fuel Consumption – lb/hr (kg/hr)	862 (391) *
Fuel Spill Rate – gal/hr (L/min)	189 (11.9)
Fuel Spill Heat Rejection – Btu/min (kW)	505 (8.88)
Total Fuel Flow – gal/hr (L/min)	312 (19.7)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851

Cooling System

Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	43055 (757)
Aftercooler Circuit to Coolant. – Btu/min (kW)	31533 (554)
Engine Radiated Heat – Btu/min (kW)	4050 (71)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	465 (106)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	9 (62)
Aftercooler Circuit – gal/min (m^3/hr)	180 (40.9)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	11 (76)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant Out Temperature, Maximum – °F (°C)	174 (79)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	218 (206)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	50 (345)
Intercooler Circuit – $lb/in.^2$ (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – $lb/in.^2$ (kPa)	7-10 (48-69)

Intake Air System

Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	6090 (2.87)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)

Exhaust System

Exhaust Mass Flow – lb/min (kg/min)	465 (211)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	6374 (3.01) ‡
Exhaust Temperature – °F (°C)	754 (401)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)

Lubrication System

Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	88 (606)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	124 (470)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)

Electrical

Recommended Battery Capacity (CCA): †	
24 Volt System, Above 32°F / (0°C)	1900
24 Volt System, Below 32°F / (0°C)	2500
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002

Performance Data

Altitude Capability – ft (m)	13000 (396
Manifold Boost Pressure – in. Hg (kPa)	64.2 (217)
BMEP – $lb/in.^2$ (bar)	284 (19.6)
Friction Power:	
Rated Speed – hp (kW)	260 (194)
Peak Torque Speed – hp (kW)	170 (127)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N·m)	Rated BSFC * lb/bhp-hr (g/kW·hr)
1900	2700 (2013)	7463 (10119) †	0.319 (194)
1800	2689 (2005)	7846 (10638)	0.317 (193)
1650	2510 (1872)	7990 (10833)	0.314 (191)
1500	2303 (1717)	8064 (10933)	0.313 (190)
1350	1895 (1414) †	7376 (10000)	0.319 (194)
1200	1132 (845) †	4955 (6718)	0.348 (212) †

Emissions

Smoke, Bosch Number:	
Rated Power	0.5
Peak Torque Speed	0.4
Noise – dB(A) @ 1m	108.2
NO_x – g/hr	25245
CO – g/hr	1755
HC – g/hr	1607
SO_2 – g/hr (0.1% sulfur fuel)	782

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature ref. – 1.169 kg/m^3

UNCONTROLLED COPY

Curve No. E4-T163-32-06
Rev. / Date: 8 / 28 June 99
Sheet No. 2 of 2

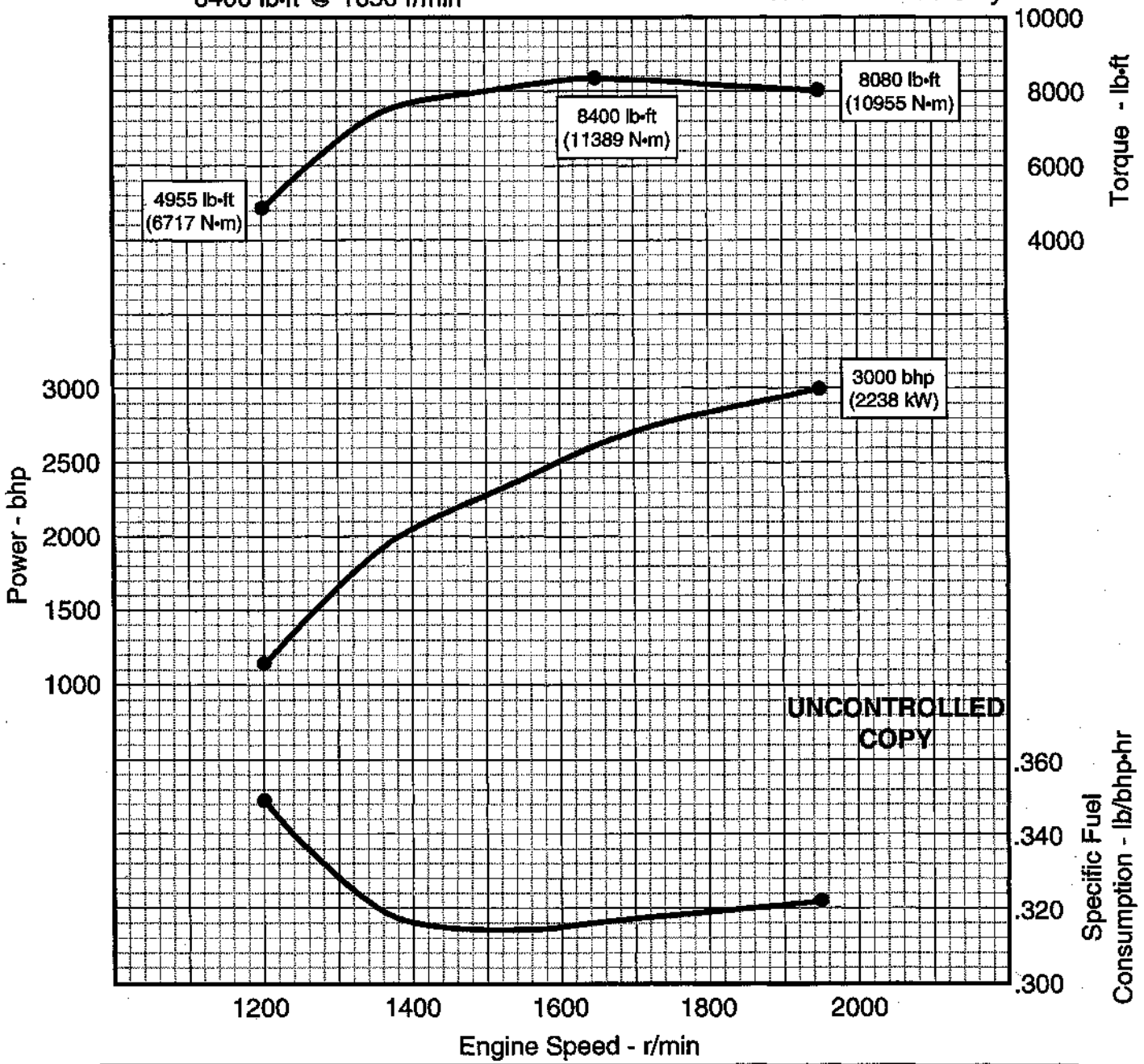
MTU/DDC Series 4000™

Industrial Power

Model: Series 16V-4000

Rating: 3000 bhp @ 1950 r/min
8400 lb•ft @ 1650 r/min

Petroleum - Frac Only



Power output guaranteed within 5% at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: g/kW • hr = lb/bhp • hr x 608. Torque: N•m = lb • ft x 1.356	**6N04M - 1294** **Fuel Injector:** 0000107851

Certified by: Kevin Sisk

Curve No. E4-T163-32-07
Rev. / Date: 4 / 10 June 99
Sheet No. 1 of 2

Performance Curve

Construction and Industrial Specification Sheet

General Data	
Application Group	5A
Application Designation	C80
Model	T1637K73
Power Output – bhp	3000
Power Output – kW	22373
Rated Speed – r/min	1950
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14.0:1
Piston Speed – ft/min (m/s)	2431 (12.3)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	118.4 (3008)
Width – in. (mm)	62.5 (1588)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	15615 (7083)
Weight, Wet – lb (kg)	16598 (7529)
Center of Gravity, Wet	
From R.F.O.B. (x axis) – in. (mm)	44.1 (1121)
Above Crankshaft (y axis) – in. (mm)	9.3 (235)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	136.81 (8.63) *
Fuel Consumption – lb/hr (kg/hr)	958 (434) *
Fuel Spill Rate – gal/hr (L/min)	194 (12.2)
Fuel Spill Heat Rejection – Btu/min (kW)	535 (9.41)
Total Fuel Flow – gal/hr (L/min)	333 (20)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	0000107851
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	45100 (793)
Aftercooler Circuit to Coolant – Btu/min (kW)	35500 (624)
Engine Radiated Heat – Btu/min (kW)	4500 (79)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	477 (108.8)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	9 (62)
Aftercooler Circuit – gal/min (m^3/hr)	185 (42)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	11 (78)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant Out Temperature, Maximum – °F (°C)	174 (79)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	218 (206)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator –in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	50 (345)
Intercooler Circuit – $lb/in.^2$ (kPa)	32 (221)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – $lb/in.^2$ (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	6767 (3.19)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	517 (235)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	7099 (3.35) ‡
Exhaust Temperature – °F (°C)	790 (421)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	88 (606)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	124 (470)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Recommended Battery Capacity (CCA): †	
24 Volt System, Above 32°F / (0°C)	1900
24 Volt System, Below 32°F / (0°C)	2500
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	Not Available
Manifold Boost Pressure – in. Hg (kPa)	75 (255)
BMEP – $lb/in.^2$ (bar)	307 (21.2)
Friction Power:	
Rated Speed – hp (kW)	267 (199)
Peak Torque Speed – hp (kW)	187 (140)

Engine Speed (r/min)	Rated Power bhp (kW)	Rated Torque lb-ft (N-m)	Rated BSFC * lb/bhp-hr (g/kW-hr)
1950	3000 (2238)	8080 (10955)	0.321 (195)
1800	2842 (2120)	8292 (11242) †	0.318 (193)
1650	2639 (1969)	8400 (11389)	0.315 (192)
1500	2303 (1718)	8064 (10933)	0.313 (190)
1350	1896 (1414)	7376 (10000) †	0.319 (194)
1200	1132 (844)	4954 (6717)	0.347 (211)

Emissions	
Smoke, Bosch Number:	
Rated Power	0.7
Peak Torque Speed	1.0
Noise – dB(A) @ 1m	Not Available
NO_x – g/hr	Not Available
CO – g/hr	Not Available
HC – g/hr	Not Available
SO_2 – g/hr (0.1% sulfur fuel)	Not Available

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42600 kJ/kg (18390 Btu/lb).

† Revised

‡ Standard pressure and temperature ref. – 1.169 kg/m^3

UNCONTROLLED COPY

Curve No. E4-T163-32-07
Rev. / Date: 4 / 10 June 99
Sheet No. 2 of 2

MTU/DDC Series 4000™

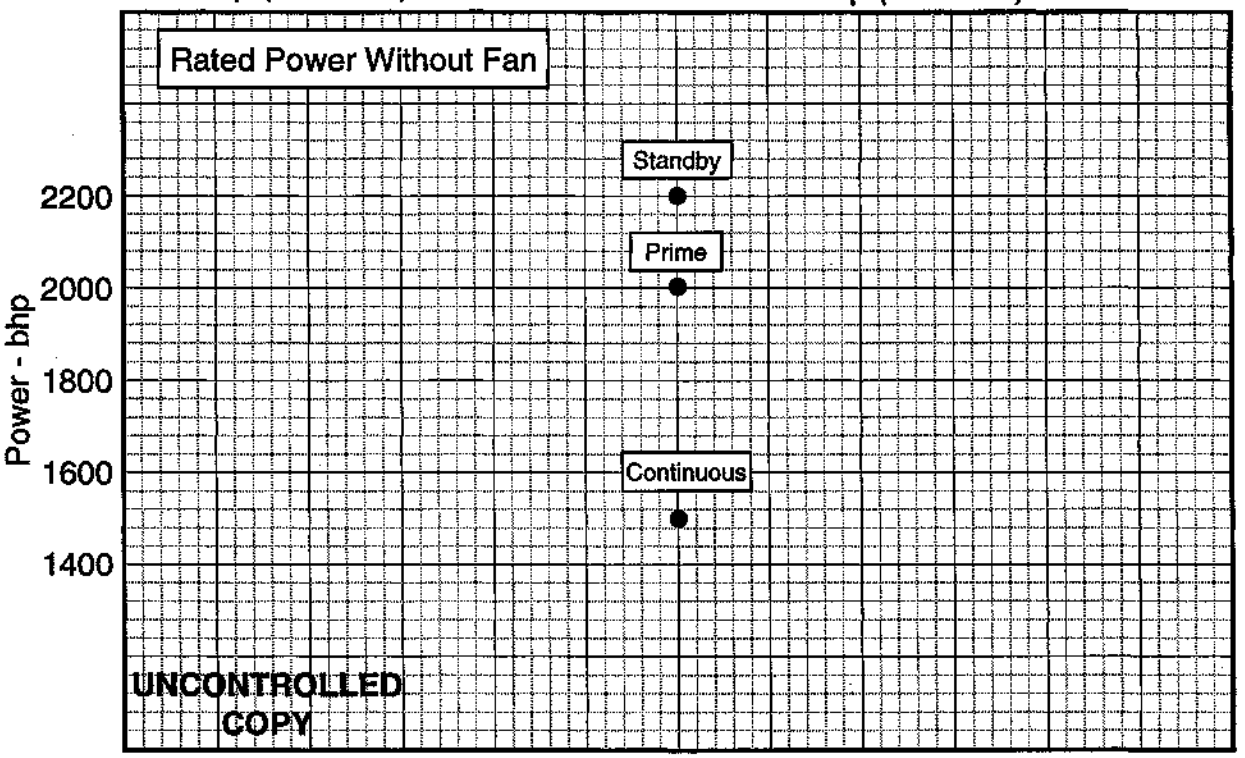
Generator Set Power

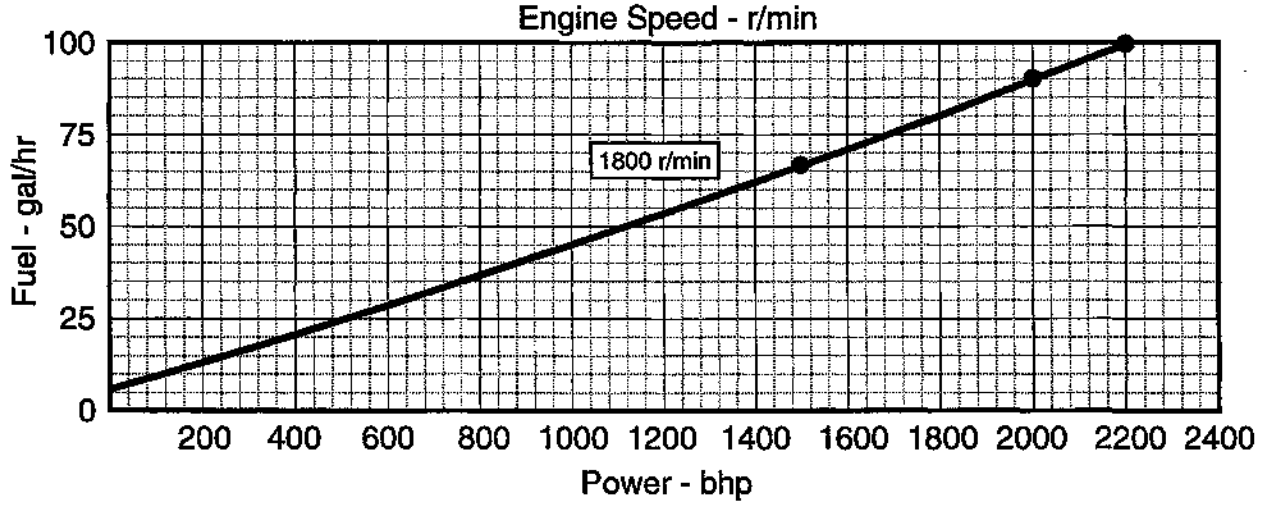
Model: Series 12V-4000

Standby Rating:
2200 bhp (1640 kW) @ 1800 r/min

Prime Rating:
2000 bhp (1490 kW) @ 1800 r/min

Continuous Rating:
1500 bhp (1120 kW) @ 1800 r/min





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV7506 **Injector:** Electronic

Certified by: John Hober

Curve No. E4-T125-32-1
Rev. / Date: 2 / 23 Jun 98
Sheet No. 1 of 4

Performance Curve

GENERATOR SPECIFICATION SHEET

STANDBY POWER - 1800 r/min

General Data	
Application Group	3D
Application Designation	G80
Model	T1237K16
Power Output – bhp	2200
Power Output – kW	1640
Rated Speed – r/min	1800
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	99.7 (6.29)
Fuel Consumption – lb/hr (kg/hr)	708.9 (321.5)
Fuel Spill Rate – gal/hr (L/min)	114 (7.19)
Fuel Spill Heat Rejection – Btu/min (kW)	445 (7.8)
Total Fuel Flow – gal/hr (L/min)	213.7 (13.5)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	37359 (657)
Aftercooler Circuit to Coolant. – Btu/min (kW)	23112 (406)
Engine Radiated Heat – Btu/min (kW)	3300 (56)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	374 (85)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	10.2 (70)
Aftercooler Circuit – gal/min (m^3/min)	220 (50)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	11.6 (80)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	52 (360)
Intercooler Circuit – $lb/in.^2$ (kPa)	30 (206)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration Maximum Time – Minutes	30
Remote Pressurization lb/in^2 (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	5085 (2.4)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	331 (150)
Exhaust Temperature – °F (°C)	806 (430)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	80 (550)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	90 (341)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	21325 (650
Manifold Boost Pressure – in. Hg (kPa)	68 (230)
BMEP – $lb/in.^2$ (Bar)	325 (22.4)
Friction Power:	
Rated Speed – fhp (kW)	200 (150)

Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.2 (0.39)
25% Power	27.2 (1.71)
50% Power	50.6 (3.19)
75% Power	73.6 (4.65)
100% Power	99.7 (6.29)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data	
Smoke – Bosch Number	0.7
Noise – dB(A) @ 1m	106.0

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1000	6000	12000	19000	21000
CO – g/hr	1300	500	600	1200	2000
HC – g/hr	500	900	900	900	900
SO_2 – g/hr (0.1% fuel)	30	90	180	250	320

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-1
Rev. / Date: 2 / 23 Jun 98
Sheet No. 2 of 4

GENERATOR SPECIFICATION SHEET

PRIME POWER - 1800 r/min

General Data

Application Group	3B
Application Designation	G80
Model	T1237K16
Power Output – bhp	2000
Power Output – kW	1490
Rated Speed – r/min	1800
Number of Cylinders	12
Total Displacement – in³ (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV7506

Engine Configuration

Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open

Dimensions

Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †

Center of Gravity Wet

From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available

Mechanical Limits

Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)

Fuel System

Fuel Consumption – gal/hr (L/min)	90.2 (5.69)
Fuel Consumption – lb/hr (kg/hr)	641.2 (290.8)
Fuel Spill Rate – gal/hr (L/min)	111 (7.00)
Fuel Spill Heat Rejection – Btu/min (kW)	420 (7.4)
Total Fuel Flow – gal/hr (L/min)	201.2 (12.7)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in² (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †

Cooling System

Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	35599 (626)
Aftercooler Circuit to Coolant. – Btu/min (kW)	20100 (353)
Engine Radiated Heat – Btu/min (kW)	3000 (53)
Coolant Flow:	
Engine Circuit – gal/min (m³/hr)	374 (85)
Engine Circuit External Restriction – lb/in.² (kPa)	10.2 (70)
Aftercooler Circuit – gal/min (m³/min)	220 (50)
Aftercooler Circuit External Restriction – lb/in² (kPa)	11.6 (80)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.² (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.² (kPa)	52 (360)
Intercooler Circuit – lb/in.² (kPa)	30 (206)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization lb/in² (kPa)	7-10 (48-69)

Intake Air System

Intake Air Flow @ Rated Maximum Power – ft³/min (m³/s)	4873 (2.3)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)

Exhaust System

Exhaust Flow – lb/min (kg/min)	309 (140)
Exhaust Temperature – °F (°C)	770 (410)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)

Lubrication System

Oil Pressure at Rated Speed – lb/in.² (kPa)	80 (550)
Oil Pressure at Low Idle – lb/in.² (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	90 (341)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)

Electrical

Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002

Performance Data

Altitude Capability – ft (m)	21325 (6500)
Manifold Boost Pressure – in. Hg (kPa)	65 (220)
BMEP – lb/in.² (Bar)	296 (20.4)
Friction Power:	
Rated Speed – fhp (kW)	200 (150)

Part Load Fuel Consumption *

Fuel – gal /hr (L/min) – 0% Power	6.2 (0.39)
25% Power	25.4 (1.60)
50% Power	46.3 (2.92)
75% Power	66.9 (4.22)
100% Power	90.2 (5.69)

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	0.6
Noise – dB(A) @ 1m	105.9

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1000	5000	10000	17000	18000
CO – g/hr	1300	500	500	800	1900
HC – g/hr	500	900	900	900	900
SO_2 – g/hr (0.1% fuel)	30	80	150	210	290

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-1
Rev. / Date: 2 / 23 Jun 98
Sheet No. 3 of 4

All information subject to change without notice.

GENERATOR SPECIFICATION SHEET

CONTINUOUS POWER - 1800 r/min

General Data	
Application Group	3A
Application Designation	G80
Model	T1237K16
Power Output – bhp	1500
Power Output – kW	1120
Rated Speed – r/min	1800
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	66.9 (4.22)
Fuel Consumption – lb/hr (kg/hr)	475.9 (215.9)
Fuel Spill Rate – gal/hr (L/min)	100 (6.32)
Fuel Spill Heat Rejection – Btu/min (kW)	380 (6.68)
Total Fuel Flow – gal/hr (L/min)	166.9 (10.5)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	30917 (544)
Aftercooler Circuit to Coolant. – Btu/min (kW)	13404 (236)
Engine Radiated Heat – Btu/min (kW)	2250 (40)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	374 (72)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	10.2 (70)
Aftercooler Circuit – gal/min (m^3/min)	220 (45)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	11.6 (80)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	52 (360)
Intercooler Circuit – $lb/in.^2$ (kPa)	30 (206)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization lb/in^2 (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4270 (2.1)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	298 (135)
Exhaust Temperature – °F (°C)	752 (400)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	80 (550)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	90 (341)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	21325 (650
Manifold Boost Pressure – in. Hg (kPa)	59 (200)
BMEP – $lb/in.^2$ (Bar)	222 (15.3)
Friction Power:	
Rated Speed – fhp (kW)	200 (150)

Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.2 (0.39)
25% Power	19.4 (1.22)
50% Power	34.9 (2.20)
75% Power	50.5 (3.19)
100% Power	66.9 (4.22)

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	0.5
Noise – dB(A) @ 1m	105.5

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1000	4000	9000	14000	18000
CO – g/hr	1300	500	500	700	1400
HC – g/hr	500	900	900	900	900
SO_2 – g/hr (0.1% fuel)	30	100	140	190	270

Note: This engine is able to develop more than continuous power. If this engine is allowed to operate at higher than continuous power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-1
Rev. / Date: 2 / 23 Jun 98
Sheet No. 4 of 4

MTU/DDC Series 4000™

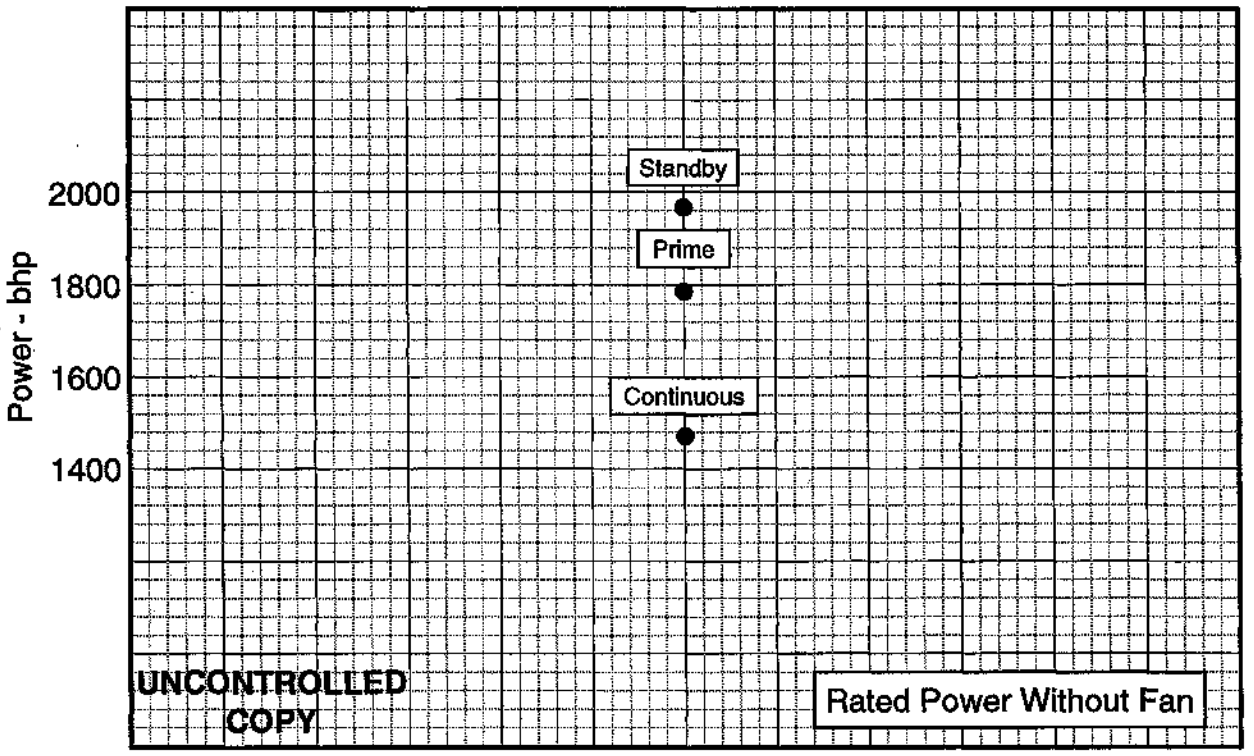
Generator Set Power

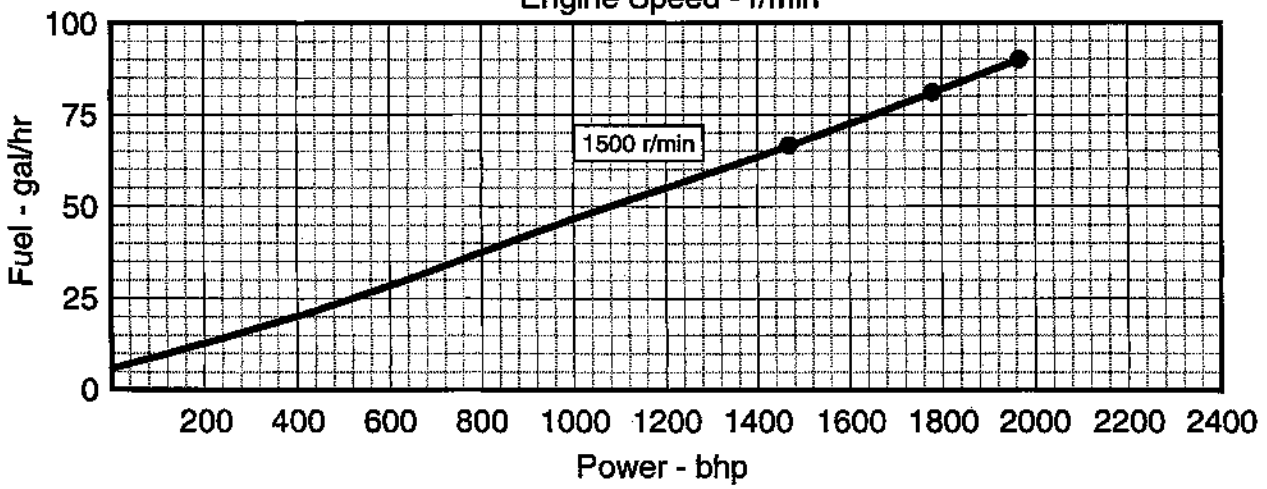
Model: Series 12V-4000

Standby Rating:
1965 bhp (1465 kW) @ 1500 r/min

Prime Rating:
1785 bhp (1330 kW) @ 1500 r/min

Continuous Rating:
1470 bhp (1095 kW) @ 1500 r/min





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb) Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV6506 **Injector:** Electronic

Certified by: John Huber

Curve No. E4-T125-32-3
Rev. / Date: 3 / 24 Jun 98
Sheet No. 1 of 4

Performance Curve

GENERATOR SPECIFICATION SHEET

STANDBY POWER - 1500 r/min

General Data	
Application Group	3D
Application Designation	G60
Model	T1237K16
Power Output – bhp	1965
Power Output – kW	1465
Rated Speed – r/min	1500
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.5)
Turbocharger	BTV6506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb·ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	89.5 (570)
Fuel Consumption – lb/hr (kg/hr)	636.3 (288.6)
Fuel Spill Rate – gal/hr (L/min)	145 (9.1)
Fuel Spill Heat Rejection – Btu/min (kW)	408 (7.2)
Total Fuel Flow – gal/hr (L/min)	234.5 (14.8)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	32415 (570)
Aftercooler Circuit to Coolant. – Btu/min (kW)	18668 (328)
Engine Radiated Heat – Btu/min (kW)	2948 (52)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	280 (64)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	8.7 (60)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	39 (270) 25 (170)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	3874 (1.86)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	265 (120)
Exhaust Temperature – °F (°C)	968 (520)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	80(550)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	81 (307)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	20000 (6096
Manifold Boost Pressure – in. Hg (kPa)	65 (220)
BMEP – $lb/in.^2$ (Bar)	349 (24.0)
Friction Power:	
Rated Speed – bhp (kW)	140 (104)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/hr) – 0% Power	6.2 (0.39)
25% Power	24.2 (1.53)
50% Power	45.9 (2.90)
75% Power	67.1 (4.24)
100% Power	89.5 (5.65)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data	
Smoke – Bosch Number	1.7
Noise – dB(A) @ 1m	104.7

Load	0%	25%	50%	75%	100%
NO_x – g/hr	2800	9000	12500	12500	12500
CO – g/hr	2000	400	900	3000	5000
HC – g/hr	550	550	550	500	400
SO_2 – g/hr (0.1% fuel)	30	80	140	210	300

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-3
Rev. / Date: 3 / 24 Jun 98
Sheet No. 2 of 4

GENERATOR SPECIFICATION SHEET

PRIME POWER - 1500 r/min

General Data	
Application Group	3B
Application Designation	G60
Model	T1237K16
Power Output – bhp	1785
Power Output – kW	1330
Rated Speed – r/min	1500
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.5)
Turbocharger	BTV6506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	81.3 (5.13)
Fuel Consumption – lb/hr (kg/hr)	578.0 (262.2)
Fuel Spill Rate – gal/hr (L/min)	140 (8.8)
Fuel Spill Heat Rejection – Btu/min (kW)	363 (6.4)
Total Fuel Flow – gal/hr (L/min)	221.3 (14.0)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	29740 (623)
Aftercooler Circuit to Coolant. – Btu/min (kW)	16065 (282)
Engine Radiated Heat – Btu/min (kW)	2678 (47)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	280 (64)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	8.7 (60)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	39 (270)
Intercooler Circuit – $lb/in.^2$ (kPa)	25 (170)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	3520 (1.66)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction:	
Clean Air Cleaner, Maximum – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	238 (108)
Exhaust Temperature – °F (°C)	510 (266)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	80(550)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	81 (307)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	20000 (6096) †
Manifold Boost Pressure – in. Hg (kPa)	56 (190)
BMEP – $lb/in.^2$ (Bar)	317 (21.8)
Friction Power:	
Rated Speed – fhp (kW)	140 (104)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/hr) – 0% Power	6.2 (0.39)
25% Power	22.3 (1.41)
50% Power	41.5 (2.62)
75% Power	60.7 (3.83)
100% Power	81.3 (5.13)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	1.5
Noise – dB(A) @ 1m	104.6

Load	0%	25%	50%	75%	100%
NO_x – g/hr	2800	5000	9000	12500	12500
CO – g/hr	2000	400	800	2000	4000
HC – g/hr	550	550	550	550	500
SO_2 – g/hr (0.1% fuel)	30	70	140	190	260

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-3
Rev. / Date 3 / 24 Jun 98
Sheet No. 3 of 4

All information subject to change without notice.

GENERATOR SPECIFICATION SHEET

CONTINUOUS POWER - 1500 r/min

General Data	
Application Group	3A
Application Designation	G60
Model	T1237K16
Power Output – bhp	1470
Power Output – kW	1095
Rated Speed – r/min	1500
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.5)
Turbocharger	BTV6506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear, Maximum Face of Block – lb·ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	66.3 (4.18)
Fuel Consumption – lb/hr (kg/hr)	471.4 (213.6)
Fuel Spill Rate – gal/hr (L/min)	130 (8.2)
Fuel Spill Heat Rejection – Btu/min (kW)	293 (5.1)
Total Fuel Flow – gal/hr (L/min)	196.3 (12.4)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	25065 (441)
Aftercooler Circuit to Coolant – Btu/min (kW)	11466 (202)
Engine Radiated Heat – Btu/min (kW)	2205 (39)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	280 (64)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	8.7 (60)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	39 (270)
Intercooler Circuit – $lb/in.^2$ (kPa)	25 (170)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling Coolant	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	2898 (1.37)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	192 (87)
Exhaust Temperature – °F (°C)	490 (254)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	80(550)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	81 (307)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	20000(6096
Manifold Boost Pressure – in. Hg (kPa)	41 (140)
BMEP – $lb/in.^2$ (Bar)	261 (18.0)
Friction Power:	
Rated Speed – fhp (kW)	140 (104)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/hr) – 0% Power	6.2 (0.39)
25% Power	19.9 (1.25))
50% Power	35.5 (2.24)
75% Power	50.5 (3.18)
100% Power	66.3 (4.18)

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	1.1
Noise – dB(A) @ 1m	104.4

Load	0%	25%	50%	75%	100%
NO_x – g/hr	2800	4500	7500	12500	12500
CO – g/hr	2000	500	600	1000	3000
HC – g/hr	550	550	550	550	500
SO_2 – g/hr (0.1% fuel)	30	60	100	160	210

Note: This engine is able to develop more than continuous power. If this engine is allowed to operate at higher than continuous power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-3
Rev. / Date: 3 / 24 Jun 98
Sheet No. 4 of 4

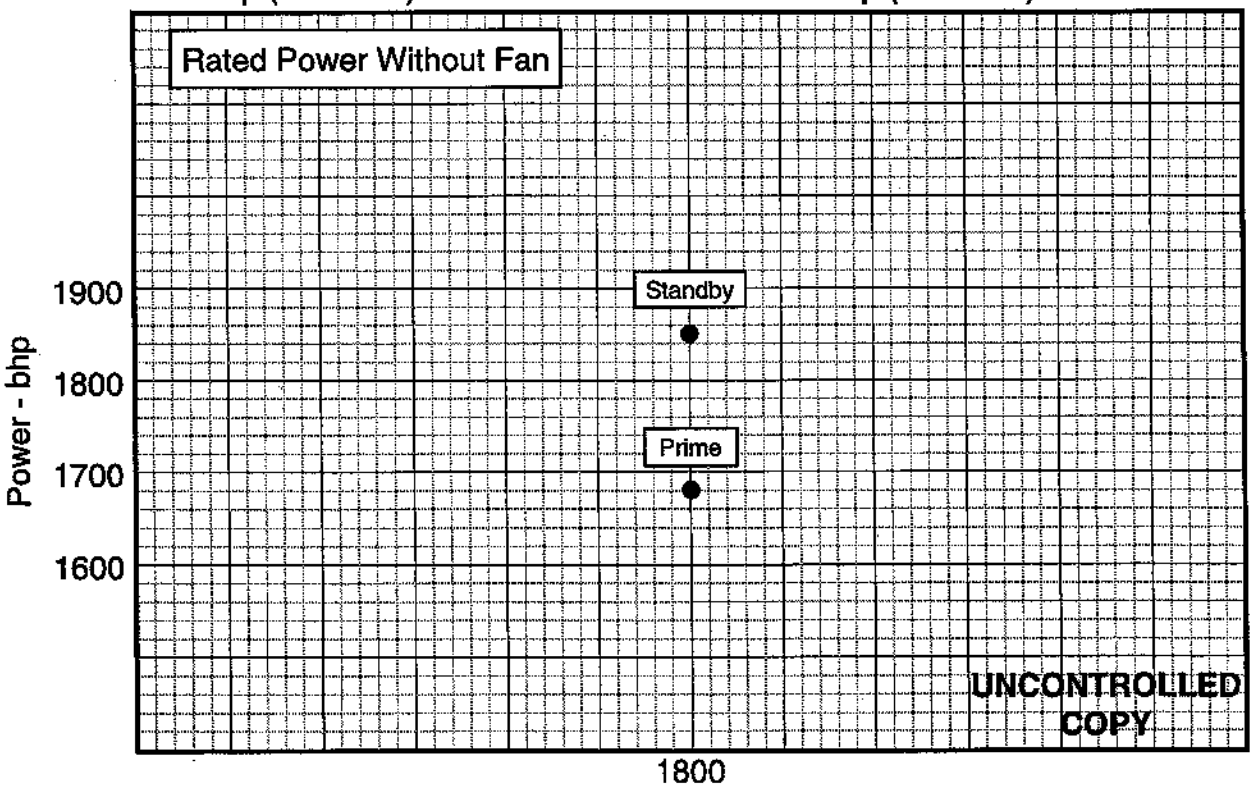
MTU/DDC Series 4000™

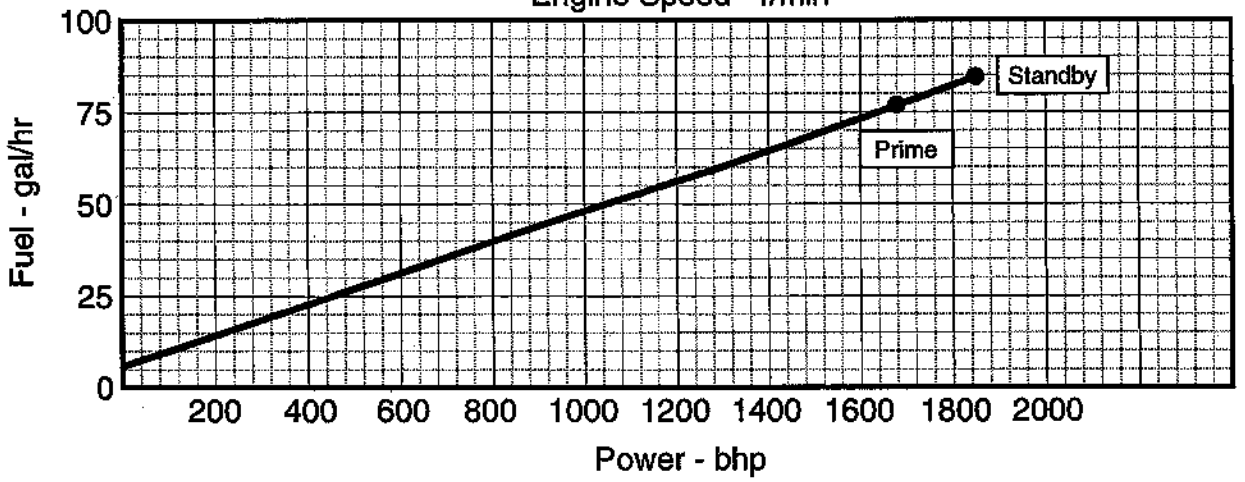
Generator Set Power

Model: Series 12V-4000

Standby Rating:
1850 bhp (1380 kW) @ 1800 r/min

Prime Rating:
1680 bhp (1255 kW) @ 1800 r/min





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb); 7.11 lb/gal Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV7506 **Injector:** Electronic

Certified by: Kevin Lisk

Curve No. E4-T125-32-02
Rev. / Date: 5 / 07 June 99
Sheet No. 1 of 3

Performance Curve

Generator Specification Sheet

STANDBY POWER - 1800 r/min

General Data	
Application Group	3D
Application Designation	G41
Model	T1237K16
Power Output – bhp	1850
Power Output – kW	1380
Rated Speed – r/min	1800
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	84.7 (5.34)
Fuel Consumption – lb/hr (kg/hr)	602 (273)
Fuel Spill Rate – gal/hr (L/min)	111 (7.00)
Fuel Spill Heat Rejection – Btu/min (kW)	400 (7.04)
Total Fuel Flow – gal/hr (L/min)	195.7 (12.3)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	33450 (588)
Aftercooler Circuit to Coolant. – Btu/min (kW)	18833 (331)
Engine Radiated Heat – Btu/min (kW)	2775 (49)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	374 (85)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	10.2 (70)
Aftercooler Circuit – gal/min (m^3/min)	220 (50)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	10.2 (70)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	52 (360)
Intercooler Circuit – $lb/in.^2$ (kPa)	30 (206)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – $lb/in.^2$ (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4730 (2.23)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	14 (360)
Each Turbo – in. (mm)	10 (250)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	300 (136)
Exhaust Temperature – °F (°C)	835 (446)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	80 (550)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	90 (341)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	1900 †
24 Volt System, Cold Climate	2500 †
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	21325 (650
Manifold Boost Pressure – in. Hg (kPa)	58.5 (198)
BMEP – $lb/in.^2$ (bar)	274 (18.9)
Friction Power:	
Rated Speed – fhp (kW)	200 (150)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.2 (0.39)
25% Power	26.1 (1.65)
50% Power	45.1 (2.85)
75% Power	64.2 (4.05)
100% Power	84.7 (5.34)

Emission Data ‡

Smoke – Bosch Number	0.5
Noise – dB(A) @ 1m	105.8

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1000	4500	10000	16500	19000
CO – g/hr	1300	500	500	900	1500
HC – g/hr	500	900	900	900	900
SO_2 – g/hr (0.1% fuel)	30	90	150	220	270

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

† Revised

‡ Estimated

UNCONTROLLED COPY

Curve No. E4-T125-32-02
Rev. / Date: 5 / 07 June 99
Sheet No. 2 of 3

Generator Specification Sheet

PRIME POWER - 1800 r/min

General Data	
Application Group	3B
Application Designation	G41
Model	T1237K16
Power Output – bhp	1680
Power Output – kW	1255
Rated Speed – r/min	1800
Number of Cylinders	12
Total Displacement – in³ (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	77.3 (4.88)
Fuel Consumption – lb/hr (kg/hr)	550 (249)
Fuel Spill Rate – gal/hr (L/min)	100 (6.32)
Fuel Spill Heat Rejection – Btu/min (kW)	360 (6.32)
Total Fuel Flow – gal/hr (L/min)	177.3 (11.2)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in.² (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	31425 (553)
Aftercooler Circuit to Coolant. – Btu/min (kW)	15167 (267)
Engine Radiated Heat – Btu/min (kW)	2520 (44)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m³/hr)	374 (85)
Engine Circuit External Restriction – lb/in.² (kPa)	10.2 (70)
Aftercooler Circuit – gal/min (m³/min)	220 (50)
Aftercooler Circuit External Restriction – lb/in² (kPa)	10.2 (70)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.² (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.² (kPa)	52 (360)
Intercooler Circuit – lb/in.² (kPa)	30 (206)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – lb/in.² (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft³/min (m³/s)	4510 (2.13)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	14 (360)
Each Turbo – in. (mm)	10 (250)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	280 (127)
Exhaust Temperature – °F (°C)	821 (438)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.² (kPa)	80 (550)
Oil Pressure at Low Idle – lb/in.² (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	90 (341)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	1900 †
24 Volt System, Cold Climate	2500 †
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	21325 (6500)
Manifold Boost Pressure – in. Hg (kPa)	52.6 (178)
BMEP – lb/in.² (bar)	249 (17.2)
Friction Power:	
Rated Speed –hp (kW)	200 (150)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.2 (0.39)
25% Power	24.3 (1.53)
50% Power	41.8 (2.64)
75% Power	59.1 (3.73)
100% Power	77.3 (4.88)

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	0.5
Noise – dB(A) @ 1m	105.4

Load	0%	25%	50%	75%	100%
NO_x – g/hr					
CO – g/hr					
HC – g/hr					
SO_2 – g/hr (0.1% fuel)					

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-2
Rev. / Date: 5 / 07 June 99
Sheet No. 3 of 3

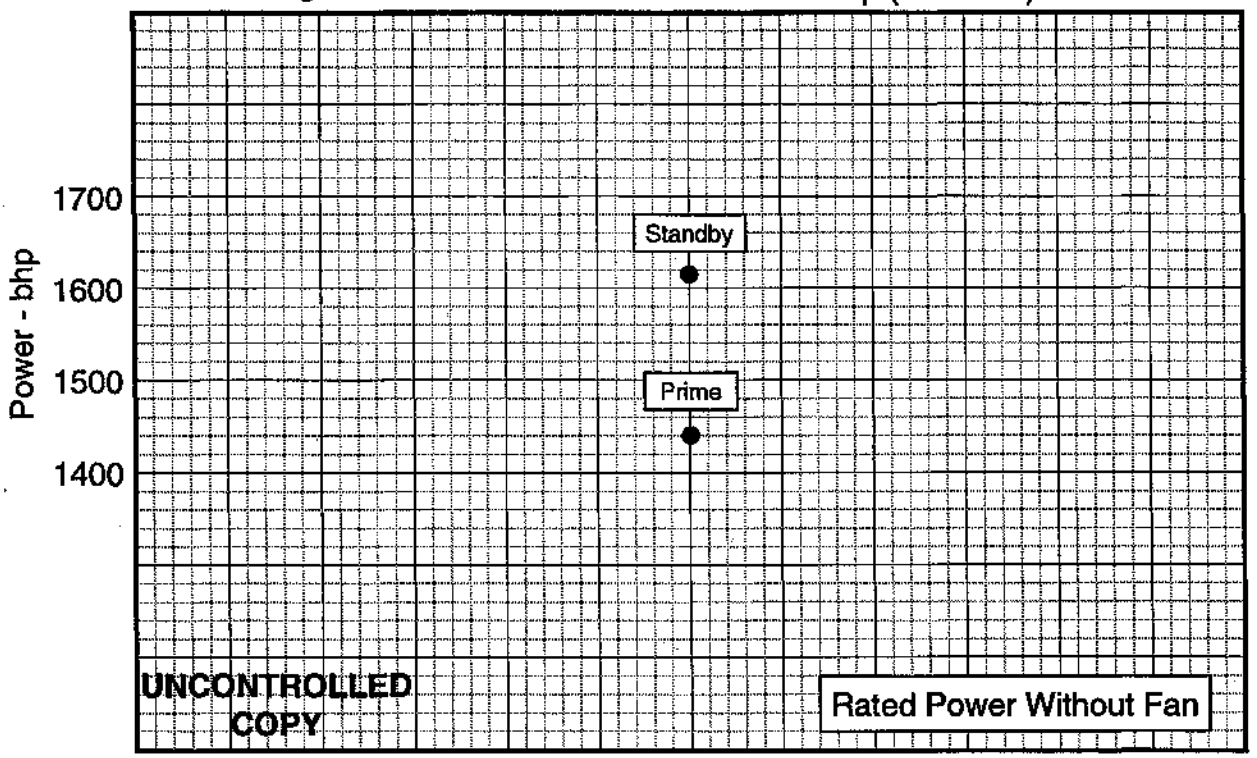
All information subject to change without notice.

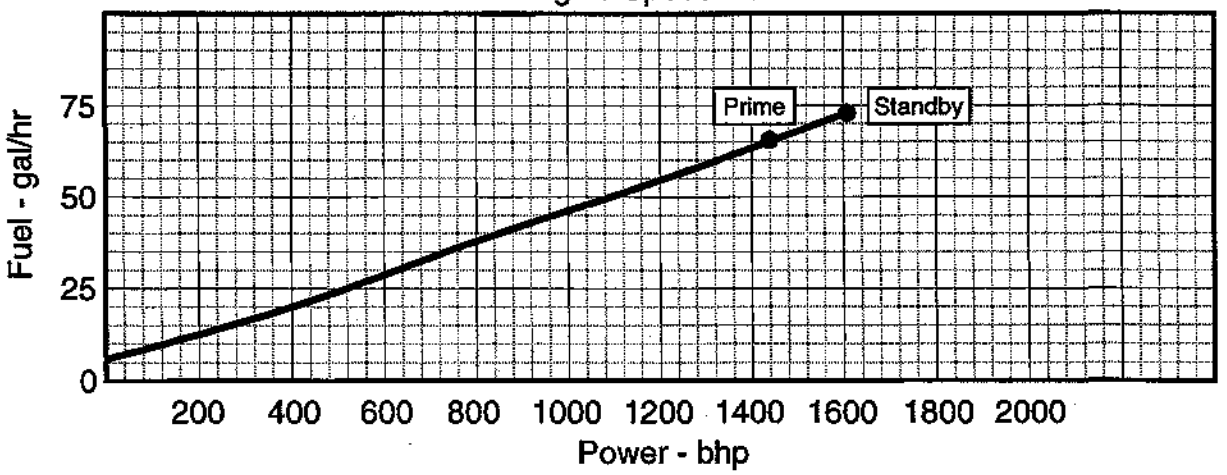
MTU/DDC Series 4000™

Generator Set Power

Standby Rating:
1615 bhp (1205 kW) @ 1500 r/min
Prime Rating:
1440 bhp (1070 kW) @ 1500 r/min

Model: Series 12V-4000
Single Core Radiator





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42600 kJ/kg (18390 Btu/lb); 7.11 lb/gal Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV6506 **Injector:** Electronic

Certified by: John Hober

Curve No. E4-T125-32-4
Rev. / Date: 3 / 24 Jun 98
Sheet No. 1 of 3

Performance Curve

GENERATOR SPECIFICATION SHEET

STANDBY POWER - 1500 r/min (SINGLE CORE RADIATOR)

General Data	
Application Group	3D
Application Designation	G21
Model	T1237K16
Power Output – bhp	1615
Power Output – kW	1205
Rated Speed – r/min	1500
Number of Cylinders	12
Total Displacement – in^3 (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.5)
Turbocharger	BTV6506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	73.5 (4.65)
Fuel Consumption – lb/hr (kg/hr)	522.6 (237.0)
Fuel Spill Rate – gal/hr (L/min)	135 (8.5)
Fuel Spill Heat Rejection – Btu/min (kW)	325 (5.7)
Total Fuel Flow – gal/hr (L/min)	208.5 (13.2)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	30090 (529)
Aftercooler Circuit to Coolant – Btu/min (kW)	13718 (241)
Engine Radiated Heat – Btu/min (kW)	2423 (43)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	260 (64)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	5.8 (40)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	39 (270)
Intercooler Circuit – $lb/in.^2$ (kPa)	25 (170)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	3000 (1.42)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	220 (100)
Exhaust Temperature – °F (°C)	932 (500)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	80 (550)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	81 (307)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	20000 (609
Manifold Boost Pressure – in. Hg (kPa)	47 (160)
BMEP – $lb/in.^2$ (bar)	287 (19.8)
Friction Power:	
Rated Speed – fhp (kW)	140 (104)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.2 (0.39)
25% Power	20.0 (1.26)
50% Power	37.9 (2.39)
75% Power	55.1 (3.48)
100% Power	73.5 (4.65)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Load	0%	25%	50%	75%	100%
NO_x – g/hr					
CO – g/hr					
HC – g/hr					
SO_2 – g/hr (0.1% fuel)					

Smoke – Bosch Number	1.2
Noise – dB(A) @ 1m	104.5

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-4
Rev. / Date: 3 / 24 Jun 98
Sheet No. 2 of 3

GENERATOR SPECIFICATION SHEET

PRIME POWER - 1500 r/min (SINGLE CORE RADIATOR)

General Data	
Application Group	3B
Application Designation	G21
Model	T1237K16
Power Output – bhp	1440
Power Output – kW	1070
Rated Speed – r/min	1500
Number of Cylinders	12
Total Displacement – in³ (L)	2975 (48.75)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.50)
Turbocharger	BTV6506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	95.8 (2409)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	12247 (5555) †
Weight, Wet – lb (kg)	12979 (5887) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	64.9 (4.09)
Fuel Consumption – lb/hr (kg/hr)	461.4 (209.3)
Fuel Spill Rate – gal/hr (L/min)	130 (8.2)
Fuel Spill Heat Rejection – Btu/min (kW)	287 (5.0)
Total Fuel Flow – gal/hr (L/min)	194.9 (12.3)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in.² (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	27773 (488)
Aftercooler Circuit to Coolant. – Btu/min (kW)	10974 (193)
Engine Radiated Heat – Btu/min (kW)	2160 (38)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m³/hr)	280 (64)
Engine Circuit External Restriction – lb/in.² (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m³/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in² (kPa)	5.8 (40)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	130 (123)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.² (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.² (kPa)	39 (270)
Aftercooler Circuit – lb/in.² (kPa)	25 (170)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Maximum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft³/min (m³/s)	2898 (1.37)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	198 (90)
Exhaust Temperature – °F (°C)	880 (471)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.² (kPa)	80 (550)
Oil Pressure at Low Idle – lb/in.² (kPa)	36 (250)
Oil Flow @ Rated Speed – gal/min (L/min)	81 (307)
Oil Flow @ Low Idle Speed – gal/min (L/min)	47 (178)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	211 (200)
Static Low Mark – qt (L)	169 (160)
Total Engine Oil Capacity with Filters – qt (L)	232 (220)
Engine Angularity Limits, Front Up – Degrees	12.5
Engine Angularity Limits, Front Down – Degrees	12.5
Engine Angularity Limits, Left/Right Down – Degrees	22.5
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	20000 (6096)
Manifold Boost Pressure – in. Hg (kPa)	41 (140)
BMEP – lb/in.² (bar)	255 (17.6)
Friction Power:	
Rated Speed – fhp (kW)	140 (104)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.2 (0.39)
25% Power	19.5 (1.23)
50% Power	34.9 (2.20)
75% Power	49.7 (3.13)
100% Power	64.9 (4.09)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	1.0
Noise – dB(A) @ 1m	104.4

Load	0%	25%	50%	75%	100%
NO_x – g/hr					
CO – g/hr					
HC – g/hr					
SO_2 – g/hr (0.1% fuel)					

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T125-32-4
Rev. / Date: 3 / 24 Jun 98
Sheet No. 3 of 3

All information subject to change without notice.

MTU/DDC Series 4000™

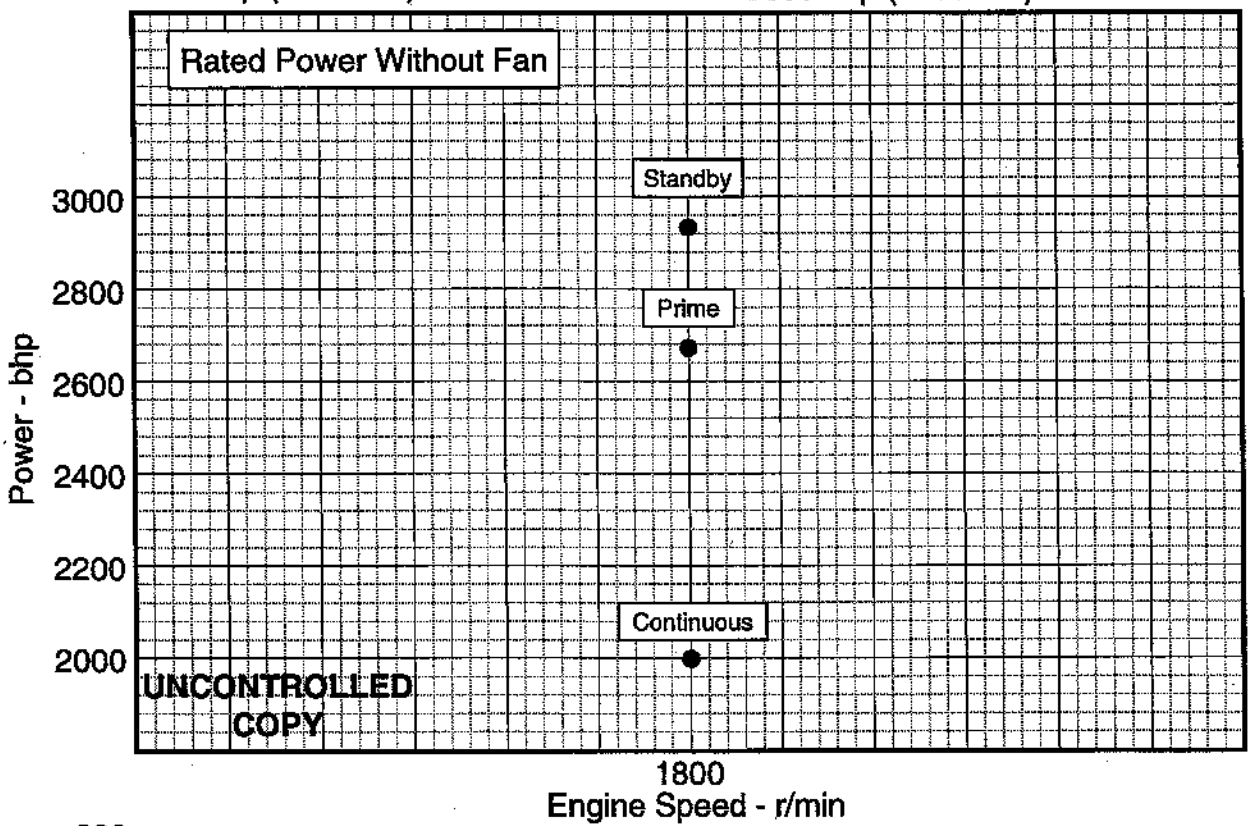
Generator Set Power

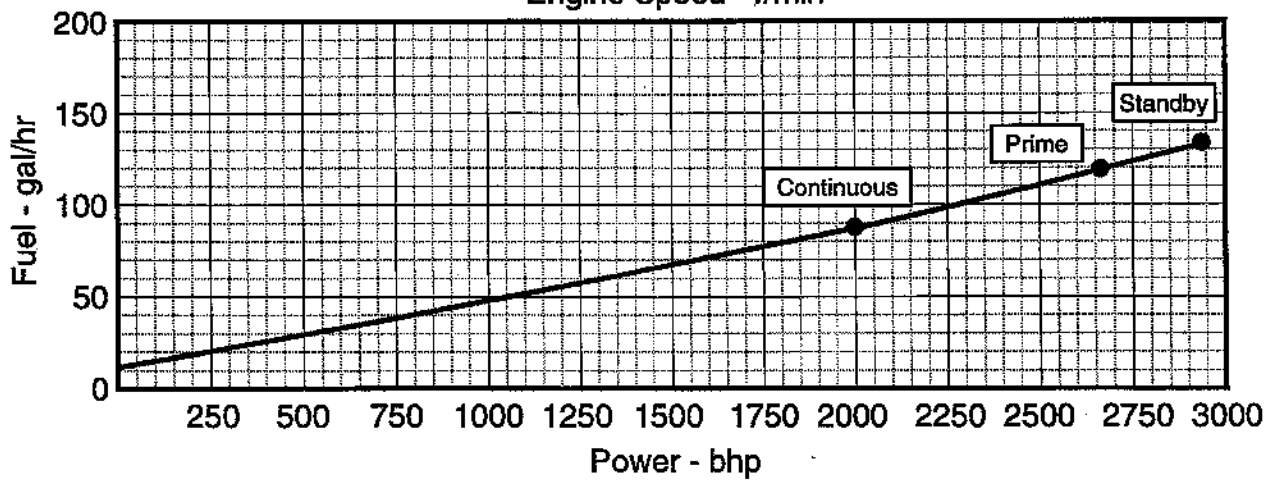
Model: Series 16V-4000

Standby Rating:
2935 bhp (2190 kW) @ 1800 r/min

Prime Rating:
2670 bhp (1990 kW) @ 1800 r/min

Continuous Rating:
2000 bhp (1495 kW) @ 1800 r/min





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb); 7.11 lb/gal Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV8506 **Injector:** Electronic

Certified by: John Hober

Curve No. E4-T165-32-1
Rev. / Date: 4 / 24 Jun 98
Sheet No. 1 of 4

Performance Curve

GENERATOR SPECIFICATION SHEET

STANDBY POWER - 1800 r/min

General Data	
Application Group	3D
Application Designation	G80
Model	T1637K16
Power Output – bhp	2935
Power Output – kW	2190
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	133.2 (8.40)
Fuel Consumption – lb/hr (kg/hr)	947.0 (429.6)
Fuel Spill Rate – gal/hr (L/min)	190 (12.0)
Fuel Spill Heat Rejection – Btu/min (kW)	540 (9.5)
Total Fuel Flow – gal/hr (L/min)	323.2 (20.4)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	45434 (799)
Aftercooler Circuit to Coolant. – Btu/min (kW)	35895 (630)
Engine Radiated Heat – Btu/min (kW)	4403 (77)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	450 (102)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m^3/min)	200 (45)
Aftercooler Circuit External Restriction – $lb/in.^2$ (kPa)	12.8 (88)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warm-up Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	50 (345)
Intercooler Circuit – $lb/in.^2$ (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	5805 (2.74)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	465 (211)
Exhaust Temperature – °F (°C)	824 (440)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	87 (600)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	10500 (320
Manifold Boost Pressure – in. Hg (kPa)	69 (234)
BMEP – $lb/in.^2$ (kPa)	326 (22.5)
Friction Power:	
Rated Speed – fhp (kW)	240 (179)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	12.7 (0.80)
25% Power	38.6 (2.43)
50% Power	67.2 (4.24)
75% Power	96.7 (6.10)
100% Power	133.2 (8.40)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data	
Smoke – Bosch Number	0.7
Noise – dB(A) @ 1m	108.0

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1988	7424	15284	21271	21218
CO – g/hr	2476	984	829	1183	2740
HC – g/hr	983	1489	1461	1515	1305
SO_2 – g/hr (0.1% fuel)	82	249	434	624	859

† Revised

UNCONTROLLED COPY

Curve No. E4-T165-32-1
Rev. / Date: 4 / 24 Jun 98
Sheet No. 2 of 4

GENERATOR SPECIFICATION SHEET

PRIME POWER - 1800 r/min

General Data	
Application Group	3B
Application Designation	G80
Model	T1637K16
Power Output – bhp	2670
Power Output – kW	1990
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in³ (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14556 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear, Maximum:	
Face of Block – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	119.1 (7.51)
Fuel Consumption – lb/hr (kg/hr)	846.5 (384.0)
Fuel Spill Rate – gal/hr (L/min)	188 (11.9)
Fuel Spill Heat Rejection – Btu/min (kW)	500 (8.8)
Total Fuel Flow – gal/hr (L/min)	307.1 (19.4) †
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in.² (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	42050 (739)
Aftercooler Circuit to Coolant. – Btu/min (kW)	30972 (545)
Engine Radiated Heat – Btu/min (kW)	4005 (70)
Coolant Flow:	
Engine Circuit – gal/min (m³/hr)	450 (102)
Engine Circuit External Restriction – lb/in.² (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m³/min)	200 (45)
Aftercooler Circuit External Restriction – lb/in.² (kPa)	12.8 (88)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warm-up Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.² (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.² (kPa)	50 (345)
Intercooler Circuit – lb/in.² (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft³/min (m³/s)	5500 (2.60)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	443 (201)
Exhaust Temperature – °F (°C)	770 (410)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.² (kPa)	87 (600)
Oil Pressure at Low Idle – lb/in.² (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	15000 (4572)
Manifold Boost Pressure – in. Hg (kPa)	66 (224)
BMEP – lb/in.² (kPa)	296 (20.4)
Friction Power:	
Rated Speed – fhp (kW)	240 (179)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	12.7 (0.80)
25% Power	35.9 (2.27)
50% Power	62.0 (3.91)
75% Power	88.9 (5.61)
100% Power	119.1 (7.51)

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data	
Smoke – Bosch Number	0.4
Noise – dB(A) @ 1m	107.9

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1976	6765	13881	20072	22197
CO – g/hr	2633	1102	778	1067	1835
HC – g/hr	979	1480	1466	1494	1475
SO_2 – g/hr (0.1% fuel)	82	232	400	573	768

† Revised

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

UNCONTROLLED COPY

Curve No. E4-T165-32-1
Rev. / Date: 4 / 24 Jun 98
Sheet No. 3 of 4

All information subject to change without notice.

GENERATOR SPECIFICATION SHEET

CONTINUOUS POWER - 1800 r/min

General Data	
Application Group	3A
Application Designation	G80
Model	T1637K16
Power Output – bhp	2000
Power Output – kW	1495
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Maximum Vertical Load at Rear of Crankshaft – lb (kN)	2250 (10.0)
Maximum Static Bending Moment at Rear Face of Block – lb·ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	88.9 (5.61)
Fuel Consumption – lb/hr (kg/hr)	631.9 (286.6)
Fuel Spill Rate – gal/hr (L/min)	170 (10.7)
Fuel Spill Heat Rejection – Btu/min (kW)	420 (7.4)
Total Fuel Flow – gal/hr (L/min)	258.9 (16.3) †
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Pump Return Pressure, Maximum – lb/in.^{2} (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	35600 (626)
Aftercooler Circuit to Coolant. – Btu/min (kW)	20100 (353)
Engine Radiated Heat – Btu/min (kW)	3000 (53)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	450 (102)
Engine Circuit External Restriction – lb/in.^{2} (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m^3/min)	200 (45)
Aftercooler Circuit External Restriction – lb/in.^{2} (kPa)	12.8 (88)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant In Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warm-up Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.^{2} (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.^{2} (kPa)	50 (345)
Intercooler Circuit – lb/in.^{2} (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4397 (2.08)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	353 (160)
Exhaust Temperature – °F (°C)	716 (380)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.^{2} (kPa)	87 (600)
Oil Pressure at Low Idle – lb/in.^{2} (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	26000 (792
Manifold Boost Pressure – in. Hg (kPa)	46 (155)
BMEP – lb/in.^{2} (kPa)	222 (15.3)
Friction Power:	
Rated Speed – fhp (kW)	240 (170) †
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	12.8 (0.80)
25% Power	28.6 (1.80)
50% Power	49.1 (3.10)
75% Power	68.5 (4.32)
100% Power	88.9 (5.61)

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number 0.4
Noise – dB(A) @ 1m 107.5

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1946	5204	10229	15619	20054
CO – g/hr	3073	1547	752	843	1066
HC – g/hr	968	1434	1490	1461	1494
SO_2 – g/hr (0.1% fuel)	82	184	317	442	573

† Revised

Note: This engine is able to develop more than continuous power. If this engine is allowed to operate at higher than continuous power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

UNCONTROLLED COPY

Curve No. E4-T165-32-1
Rev. / Date: 4 / 24 Jun 98
Sheet No. 4 of 4

MTU/DDC Series 4000™

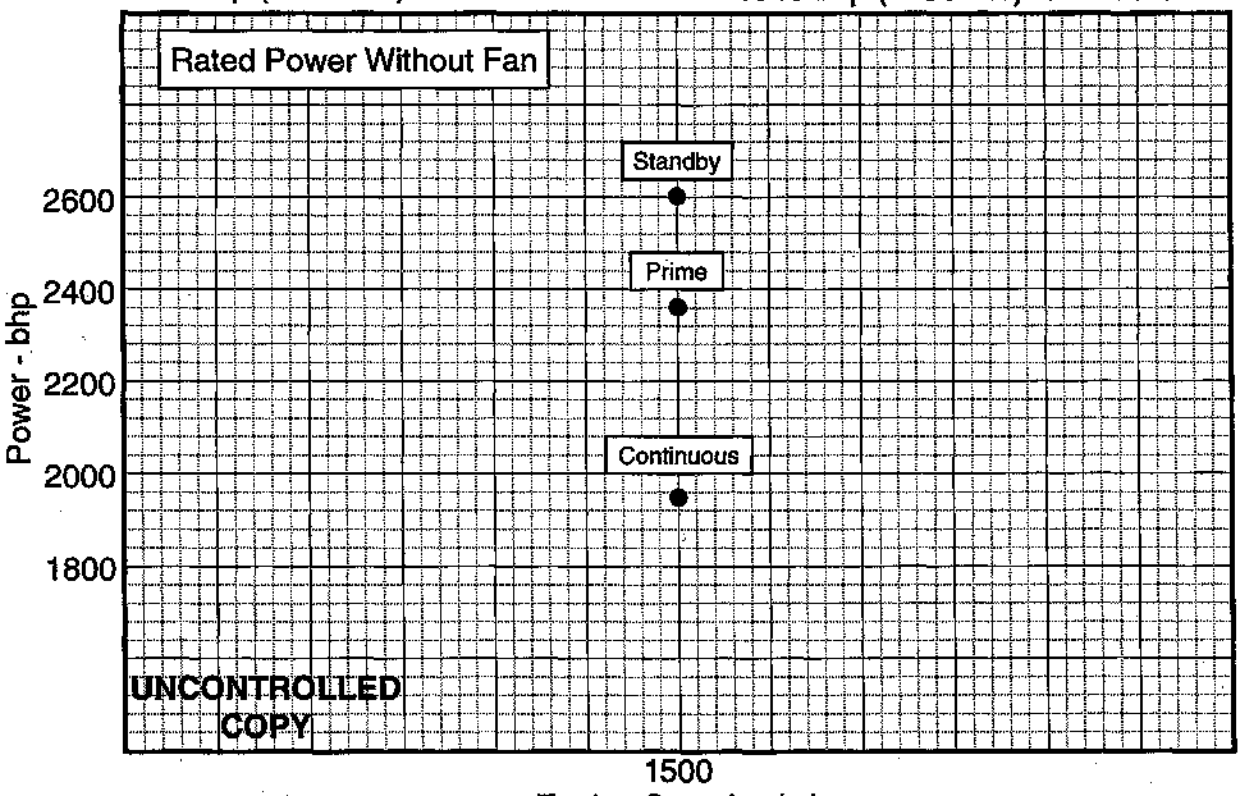
Generator Set Power

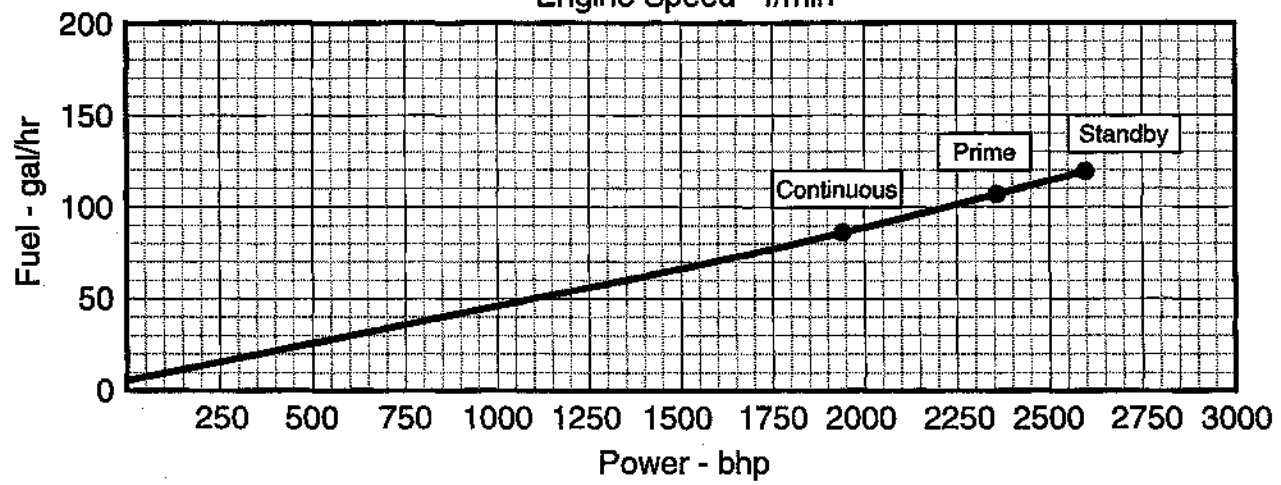
Model: Series 16V-4000

Standby Rating:
2600 bhp (1940 kW) @ 1500 r/min

Prime Rating:
2360 bhp (1760 kW) @ 1500 r/min

Continuous Rating:
1945 bhp (1450 kW) @ 1500 r/min





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb); 7.11 lb/gal Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV7506 **Injector:** Electronic

Certified by: John Hober

Curve No. E4-T165-32-3
Rev. / Date: 4 / 24 Jun 98
Sheet No. 1 of 4

Performance Curve

GENERATOR SPECIFICATION SHEET

STANDBY POWER - 1500 r/min

General Data	
Application Group	3D
Application Designation	G60
Model	T1637K16
Power Output – bhp	2600
Power Output – kW	1940
Rated Speed – r/min	1500
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.5)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee – 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	118.9 (7.50)
Fuel Consumption – lb/hr (kg/hr)	845.4 (383.5)
Fuel Spill Rate – gal/hr (L/min)	183 (11.5
Fuel Spill Heat Rejection – Btu/min (kW)	597 (10.5)
Total Fuel Flow – gal/hr (L/min)	301.9 (19.0)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	43708 (769)
Aftercooler Circuit to Coolant. – Btu/min (kW)	25115 (442)
Engine Radiated Heat – Btu/min (kW)	3900 (69)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	375 (85)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – $lb/in.^2$ (kPa)	8.7 (60)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	36 (248)
Intercooler Circuit, Maximum – $lb/in.^2$ (kPa)	22 (152)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4873 (2.30)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	364 (165)
Exhaust Temperature – °F (°C)	937 (503)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in.(mm)	14 (360)
Double – in.(mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	83 (572)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	108 (410)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in.H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	13000 (396
Manifold Boost Pressure – in. Hg (kPa)	66 (222)
BMEP – $lb/in.^2$ (kPa)	346 (23.9)
Friction Power:	
Rated Speed – fhp (kW)	165 (123)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	6.7 (0.42)
25% Power	32.7 (2.06)
50% Power	58.9 (3.72)
75% Power	86.2 (5.44)
100% Power	118.9 (7.50)

* Fuel consumption tolerance of +5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	0.7
Noise – dB(A) @ 1m	107.4

Load	0%	25%	50%	75%	100%
NO_x – g/hr	2000	5465	11870	15962	16298
CO – g/hr	3475	565	748	1038	3487
HC – g/hr	975	953	993	962	726
SO_2 – g/hr (0.1% fuel)	43	210	380	556	767

† Revised

UNCONTROLLED COPY

Curve No. E4-T165-32-3
Rev. / Date: 4 / 24 Jun 98
Sheet No. 2 of 4

All information subject to change without notice.
Detroit Diesel® and MTU ® are registered trademarks.

GENERATOR SPECIFICATION SHEET

PRIME POWER - 1500 r/min

General Data	
Application Group	3B
Application Designation	G60
Model	T1637K16
Power Output – bhp	2360
Power Output – kW	1760
Rated Speed – r/min	1500
Number of Cylinders	16
Total Displacement – in³ (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.5)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	106.7 (6.73)
Fuel Consumption – lb/hr (kg/hr)	758.5 (344.0)
Fuel Spill Rate – gal/hr (L/min)	171.0 (10.8)
Fuel Spill Heat Rejection – Btu/min (kW)	520 (9.1)
Total Fuel Flow – gal/hr (L/min)	277.7 (17.5)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in.² (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	40173 (706)
Aftercooler Circuit to Coolant. – Btu/min (kW)	21001 (369)
Engine Radiated Heat – Btu/min (kW)	3540 (62)
Coolant Flow:	
Engine Circuit – gal/min (m³/hr)	375 (85)
Engine Circuit External Restriction – lb/in.² (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m³/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in² (kPa)	8.7 (60)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.² (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – lb/in.² (kPa)	36 (248)
Intercooler Circuit – lb/in.² (kPa)	22 (152)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft³/min (m³/s)	4556 (2.51)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	328 (149)
Exhaust Temperature – °F (°C)	881 (472)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter Recommended:	
Single – in.(mm)	14 (360)
Double – in.(mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.² (kPa)	83 (572)
Oil Pressure at Low Idle – lb/in.² (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	108 (410)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in.H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	15000
Manifold Boost Pressure – in. Hg (kPa)	56 (190)
BMEP – lb/in.² (kPa)	314 (21.7)
Friction Power:	
Rated Speed – fhp (kW)	165 (123)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	6.7 (0.42)
25% Power	30.5 (1.92)
50% Power	54.0 (3.41)
75% Power	78.2 (4.93)
100% Power	106.7 (6.73)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	0.5
Noise – dB(A) @ 1m	107.3

Load	0%	25%	50%	75%	100%
NO_x – g/hr	2000	5076	10528	15620	15287
CO – g/hr	3475	618	685	921	1992
HC – g/hr	975	950	987	986	846
SO_2 – g/hr (0.1% fuel)	43	197	348	504	688

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T165-32-3
Rev. / Date: 4 / 24 Jun 98
Sheet No. 3 of 4

All information subject to change without notice.
Detroit Diesel® and MTU ® are registered trademarks.

GENERATOR SPECIFICATION SHEET

CONTINUOUS POWER - 1500 r/min

General Data	
Application Group	3A
Application Designation	G60
Model	T1637K16
Power Output – bhp	1945
Power Output – kW	1450
Rated Speed – r/min	1500
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.5)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	85.9 (5.42)
Fuel Consumption – lb/hr (kg/hr)	611.1 (277.2)
Fuel Spill Rate – gal/hr (L/min)	159 (10.0)
Fuel Spill Heat Rejection – Btu/min (kW)	402 (7.1)
Total Fuel Flow – gal/hr (L/min)	244.9 (15.4)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	34373 (604)
Aftercooler Circuit to Coolant. – Btu/min (kW)	14690 (258)
Engine Radiated Heat – Btu/min (kW)	2918 (51)
Coolant Flow:	
Engine Circuit – gal/min (m^3/hr)	375 (85)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	8.7 (60)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant In Temperature, Maximum – °F (°C)	153 (67)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	36 (248)
Intercooler Circuit – $lb/in.^2$ (kPa)	22 (152)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration , Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	3835 (1.81)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Recommended:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	295 (134)
Exhaust Temperature – °F (°C)	827 (442)
Back Pressure, Recommended – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in.(mm)	14 (360)
Double – in.(mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	83 (572)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	108 (410)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	20000 (609
Manifold Boost Pressure – in. Hg (kPa)	45 (154)
BMEP – $lb/in.^2$ (kPa)	259 (17.8)
Friction Power:	
Rated Speed – fhp (kW)	165 (123)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	6.7 (0.42)
25% Power	26.7 (1.68)
50% Power	46.1 (2.91)
75% Power	65.5 (4.13)
100% Power	85.9 (5.42)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data	
Smoke – Bosch Number	0.5
Noise – dB(A) @ 1m	105.8

Load	0%	25%	50%	75%	100%
NO_x – g/hr	2000	4470	8251	13503	15961
CO – g/hr	3475	777	573	815	1033
HC – g/hr	975	947	973	998	963
SO_2 – g/hr (0.1% fuel)	43	172	259	422	554

Note: This engine is able to develop more than continuous power. If this engine is allowed to operate at higher than continuous power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T165-32-3
Rev. / Date: 4 / 24 Jun 98
Sheet No. 4 of 4

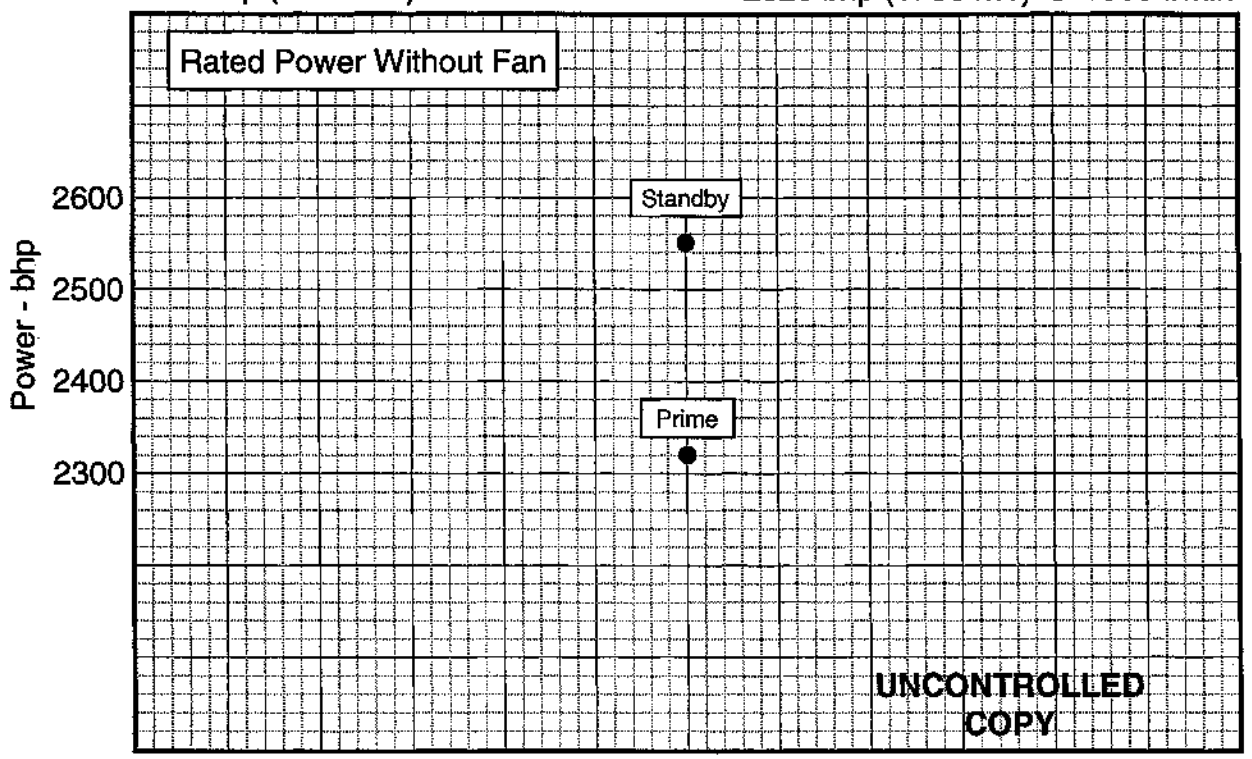
MTU/DDC Series 4000™

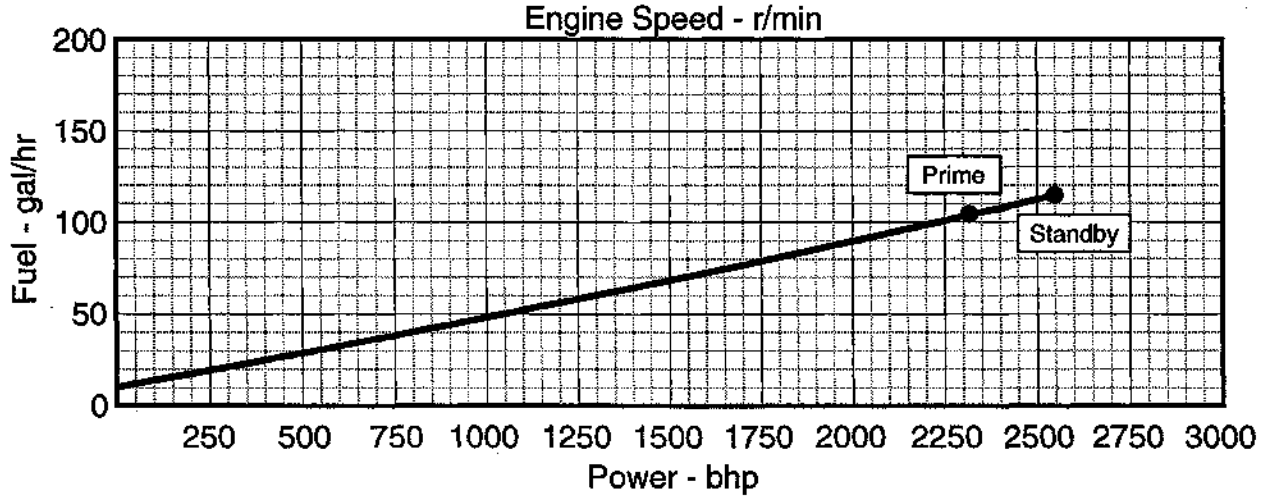
Generator Set Power

Model: Series 16V-4000

Standby Rating:
2550 bhp (1900 kW) @ 1800 r/min

Prime Rating:
2320 bhp (1730 kW) @ 1800 r/min





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42800 kJ/kg (18390 Btu/lb); 7.11 lb/gal Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV8506 **Injector:** Electronic

Certified by: Kevin Sisk

Curve No. E4-T165-32-2
Rev. / Date: 6 / 07 June 99
Sheet No. 1 of 3

Performance Curve

Generator Specification Sheet

STANDBY POWER - 1800 r/min

General Data

Application Group	3D
Application Designation	G40
Model	T1637K16
Power Output – bhp	2550
Power Output – kW	1900
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506

Engine Configuration

Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open

Dimensions

Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †

Center of Gravity Wet

From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available

Mechanical Limits

Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)

Fuel System

Fuel Consumption – gal/hr (L/min)	114.9 (7.25)
Fuel Consumption – lb/hr (kg/hr)	817.0 (370.6)
Fuel Spill Rate – gal/hr (L/min)	188 (11.9)
Fuel Spill Heat Rejection – Btu/min (kW)	490 (8.6)
Total Fuel Flow – gal/hr (L/min)	302.9 (19.1) †
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	107851 †

Cooling System

Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	44600 (784)
Aftercooler Circuit to Coolant. – Btu/min (kW)	25110 (442)
Engine Radiated Heat – Btu/min (kW)	3825 (67)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	450 (102)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m^3/min)	200 (45)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	8.6 (59)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	50 (345)
Intercooler Circuit – $lb/in.^2$ (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling Coolant	8
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)

Intake Air System

Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	5212 (2.46)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)

Exhaust System

Exhaust Flow – lb/min (kg/min)	430 (195)
Exhaust Temperature – °F (°C)	831 (444)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)

Lubrication System

Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	87 (600)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left / Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)

Electrical

Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	1900 †
24 Volt System, Cold Climate	2500 †
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002

Performance Data

Altitude Capability – ft (m)	15500 (472
Manifold Boost Pressure – in. Hg (kPa)	63.5 (215)
BMEP – $lb/in.^2$ (bar)	283 (19.5)
Friction Power:	
Rated Speed – fhp (kW)	240 (179)

Part Load Fuel Consumption *

Fuel – gal /hr (L/min) – 0% Power	12.7 (0.80)
25% Power	36.1 (2.22)
50% Power	62.6 (3.83)
75% Power	86.5 (5.46)
100% Power	114.9 (7.25)

Emission Data ‡

Smoke – Bosch Number	0.4
Noise – dB(A) @ 1m	107.8

Load	0%	25%	50%	75%	100%
NO_x – g/hr	1950	6700	13300	19500	21700
CO – g/hr	2800	1250	800	1000	1800
HC – g/hr	970	1460	1470	1500	1460
SO_2 – g/hr (0.1% fuel)	82	220	380	550	735

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

† Revised

‡ Estimated

UNCONTROLLED COPY

Curve No. E4-T165-32-2
Rev. / Date: 6 / 07 June 99
Sheet No. 2 of 3

Generator Specification Sheet

PRIME POWER - 1800 r/min

General Data	
Application Group	3B
Application Designation	G40
Model	T1637K16
Power Output – bhp	2320
Power Output – kW	1730
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	104.1 (6.57)
Fuel Consumption – lb/hr (kg/hr)	740.0 (335.7)
Fuel Spill Rate – gal/hr (L/min)	182 (11.5)
Fuel Spill Heat Rejection – Btu/min (kW)	460 (8.1)
Total Fuel Flow – gal/hr (L/min)	286.1(18.0) †
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	41900 (737)
Aftercooler Circuit to Coolant. – Btu/min (kW)	20222 (356)
Engine Radiated Heat – Btu/min (kW)	3480 (61)
Coolant Flow, Rated: (minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	450 (102)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m^3/min)	200 (45)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	8.6 (59)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	50 (345)
Intercooler Circuit – $lb/in.^2$ (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4844 (2.29)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	401 (182)
Exhaust Temperature – °F (°C)	819 (437)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	87 (600)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	1900 †
24 Volt System, Cold Climate	2500 †
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	19500 (5944)
Manifold Boost Pressure – in. Hg (kPa)	56.7 (192)
BMEP – $lb/in.^2$ (bar)	257 (17.7)
Friction Power:	
Rated Speed – hp (kW)	240 (179)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	12.7 (0.80)
25% Power	32.5 (2.05)
50% Power	56.1 (3.54)
75% Power	79.4 (5.01)
100% Power	104.1 (6.57)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number 0.4
Noise – dB(A) @ 1m 107.4

Load	0%	25%	50%	75%	100%
NO_x – g/hr					
CO – g/hr					
HC – g/hr					
SO_2 – g/hr (0.1% fuel)					

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

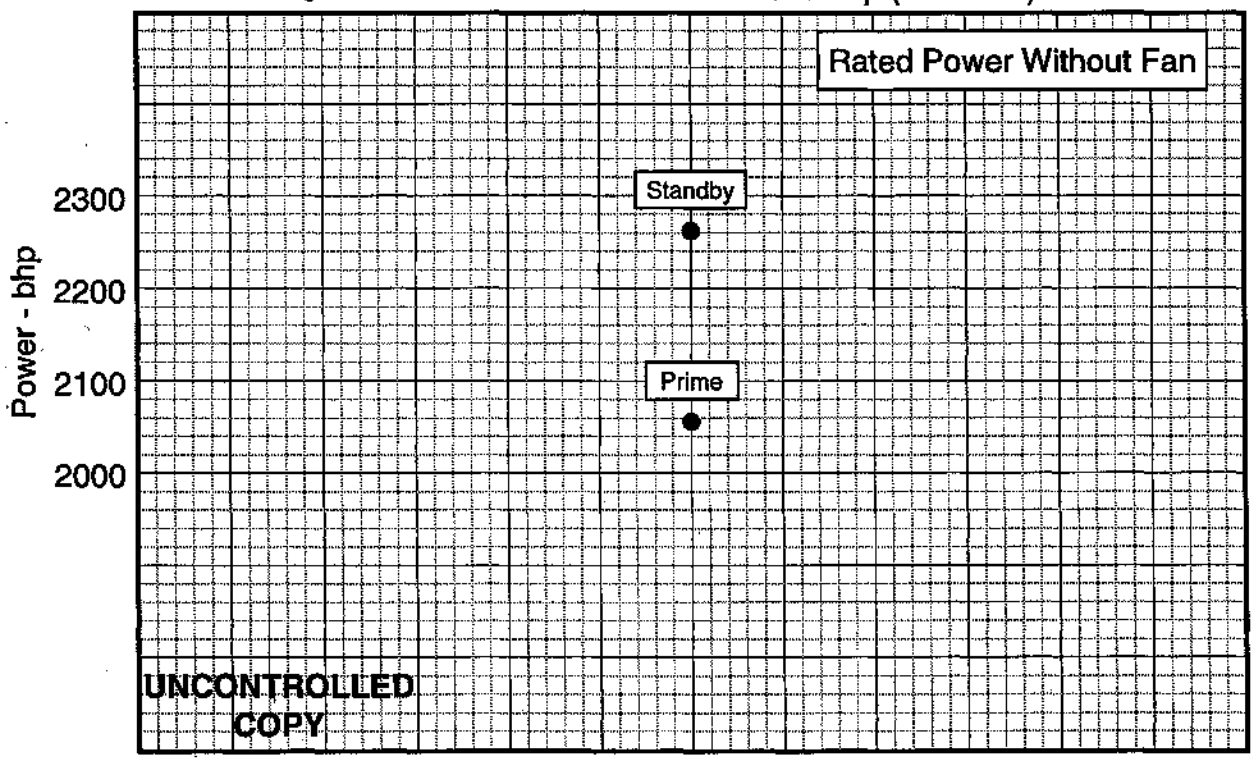
Curve No. E4-T165-32-2
Rev. / Date: 6 / 07 June 99
Sheet No. 3 of 3

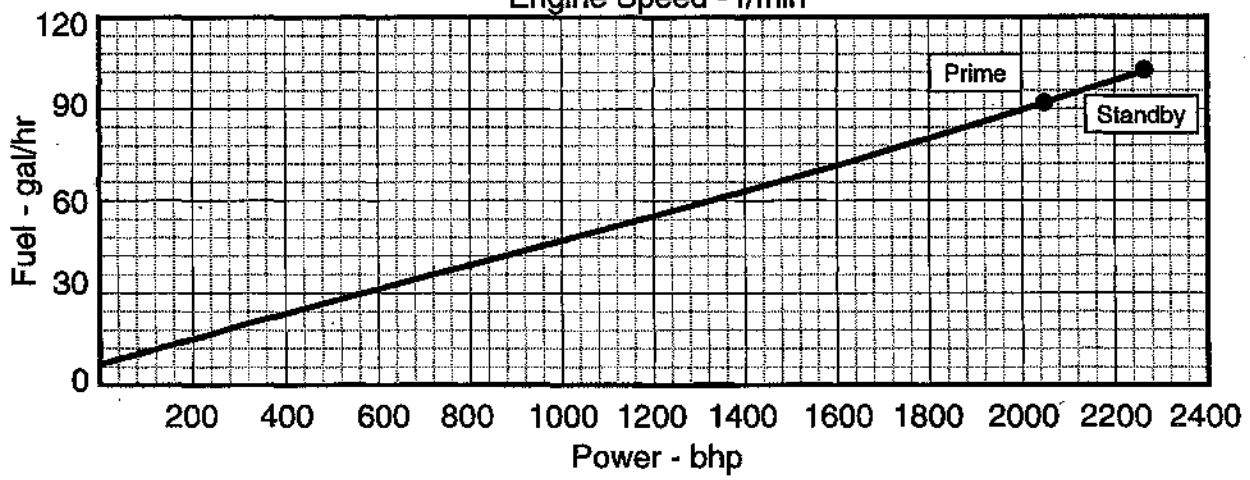
MTU/DDC Series 4000™

Generator Set Power

Standby Rating:
2260 bhp (1686 kW) @ 1500 r/min
Prime Rating:
2055 bhp (1533 kW) @ 1500 r/min

Model: Series 16V-4000
Single Core Radiator





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42600 kJ/kg (18390 Btu/lb); 7.11 lb/gal Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**Turbo:** BTV7506 **Injector:** Electronic

Certified by: John Holden

Curve No. E4-T165-32-4
Rev. / Date: 5 / 24 Jun 98
Sheet No. 1 of 3

Performance Curve

GENERATOR SPECIFICATION SHEET

STANDBY POWER - 1500 r/min (SINGLE CORE RADIATOR)

General Data	
Application Group	3D
Application Designation	G21
Model	T1637K16
Power Output – bhp	2260
Power Output – kW	1686
Rated Speed – r/min	1500
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.50)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N·m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	102.6 (6.48)
Fuel Consumption – lb/hr (kg/hr)	729.5 (330.9)
Fuel Spill Rate – gal/hr (L/min)	180.6 (11.4)
Fuel Spill Heat Rejection – Btu/min (kW)	490 (8.6)
Total Fuel Flow – gal/hr (L/min)	282.6 (17.8)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	40120 (705)
Aftercooler Circuit to Coolant. – Btu/min (kW)	18290 (322)
Engine Radiated Heat – Btu/min (kW)	3390 (60)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	375 (85)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – lb/in^2 (kPa)	5.8 (40)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	36 (248)
Intercooler Circuit – $lb/in.^2$ (kPa)	22 (152)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4414 (2.08)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Maximum Intake Temperature Rise (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	326 (148)
Exhaust Temperature – °F (°C)	945 (507)
Maximum Back Pressure – in. Hg (kPa)	1.5 (5.1)
Recommended Exhaust Pipe Inner Diameter:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	83 (572)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	108 (410)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left / Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	18000 (548
Manifold Boost Pressure – in. Hg (kPa)	57 (193)
BMEP – $lb/in.^2$ (bar)	301 (20.7)
Friction Power:	
Rated Speed – fhp (kW)	165 (123)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.7 (0.42)
25% Power	29.7 (1.88)
50% Power	52.7 (3.32)
75% Power	75.8 (4.78)
100% Power	102.6 (6.48)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data	
Smoke – Bosch Number	0.5
Noise – dB(A) @ 1m	107.3

Load	0%	25%	50%	75%	100%
NO_x – g/hr					
CO – g/hr					
HC – g/hr					
SO_2 – g/hr (0.1% fuel)					

† Revised

UNCONTROLLED COPY

Curve No. E4-T165-32-4
Rev. / Date: 5 / 24 Jun 98
Sheet No. 2 of 3

GENERATOR SPECIFICATION SHEET

PRIME POWER - 1500 r/min (SINGLE CORE RADIATOR)

General Data	
Application Group	3B
Application Designation	G21
Model	T1637K16
Power Output – bhp	2055
Power Output – kW	1533
Rated Speed – r/min	1500
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	14:1
Piston Speed – ft/min (m/s)	1870 (9.50)
Turbocharger	BTV7506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603) †
Weight, Wet – lb (kg)	15398 (6984) †
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	Not Available
Above Crankshaft (y axis) – in. (mm)	Not Available
Right of Crankshaft (z axis) – in. (mm)	Not Available
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	92.4 (5.83)
Fuel Consumption – lb/hr (kg/hr)	657 (298.0)
Fuel Spill Rate – gal/hr (L/min)	169.2 (10.7)
Fuel Spill Heat Rejection – Btu/min (kW)	432 (7.6)
Total Fuel Flow – gal/hr (L/min)	261.4 (16.5)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – $lb/in.^2$ (kPa)	7 (50)
Fuel Filter Size, Secondary – Microns	8
Fuel Injector – Part Number	107851 †
Cooling System	
Heat Rejection:	
Engine Circuit to Coolant – Btu/min (kW)	37031(651)
Aftercooler Circuit to Coolant. – Btu/min (kW)	14632 (257)
Engine Radiated Heat – Btu/min (kW)	3083 (54)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	375 (85)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Aftercooler Circuit – gal/min (m^3/min)	160 (36)
Aftercooler Circuit External Restriction – $lb/in.^2$ (kPa)	5.8 (40)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant in Temperature, Maximum – °F (°C)	171 (77)
Engine Coolant Temperature, Minimum – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	160 (151)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Min. (w/o pressure cap):	
Rapid Warmup Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Pressure, Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	36 (248)
Intercooler Circuit – $lb/in.^2$ (kPa)	22 (152)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – Minutes	30
Remote Pressurization – psi (kPa)	7-10 (48-69)

Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	4061 (1.92)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Flow – lb/min (kg/min)	300 (136)
Exhaust Temperature – °F (°C)	914 (490)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	83 (572)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	108 (410)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left / Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Maximum Resistance of Starting Circuit:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	23000 (7010)
Manifold Boost Pressure – in. Hg (kPa)	50 (171)
BMEP – $lb/in.^2$ (bar)	273 (18.8)
Friction Power:	
Rated Speed – fhp (kW)	165 (123)
Part Load Fuel Consumption *	
Fuel – gal /hr (L/min) – 0% Power	6.7 (0.42)
25% Power	27.4 (1.73)
50% Power	48.7 (3.07)
75% Power	69.2 (4.36)
100% Power	92.4 (5.83)

* Fuel consumption tolerance of + 5% per DIN ISO 3046. Diesel fuel to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390).

Emission Data

Smoke – Bosch Number	0.4
Noise – dB(A) @ 1m	107.2

Load	0%	25%	50%	75%	100%
NO_x – g/hr					
CO – g/hr					
HC – g/hr					
SO_2 – g/hr (0.1% fuel)					

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

† Revised

UNCONTROLLED COPY

Curve No. E4-T165-32-4
Rev. / Date: 5 / 24 Jun 98
Sheet No. 3 of 3

MTU/DDC Series 4000™

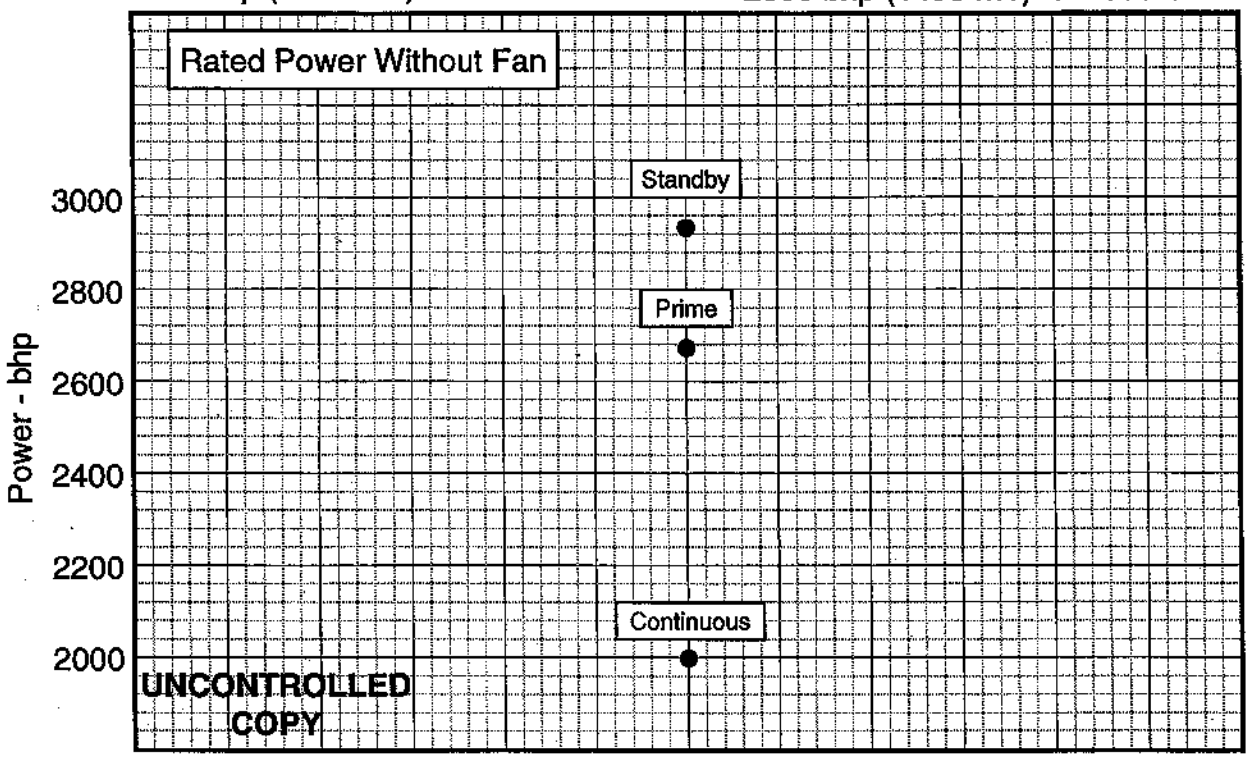
Generator Set Power

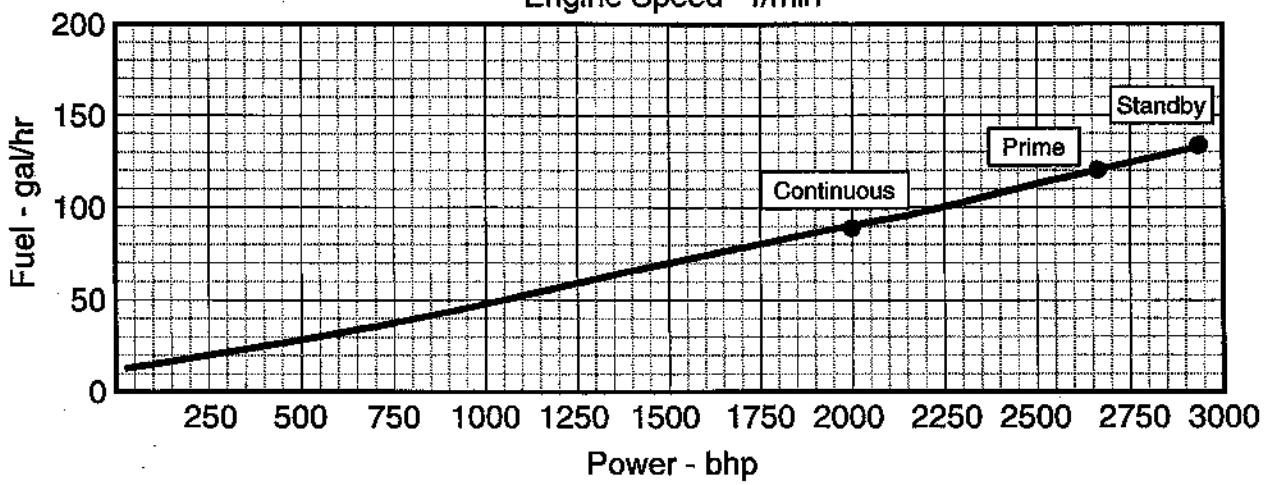
Model: Series 16V-4000

Standby Rating: Certified Year 2000
2935 bhp (2190 kW) @ 1800 r/min

Prime Rating:
2670 bhp (1990 kW) @ 1800 r/min

Continuous Rating:
2000 bhp (1495 kW) @ 1800 r/min





Power output guaranteed at ISO 3046 conditions: 77°F (25°C) air inlet temperature; 29.31 in. Hg (99kPa) dry barometer; Fuel consumption tolerance of +5% per ISO 3046. Diesel fuel to DIN EN 590 with a minimum LHV 42600 kJ/kg (18390 Btu/lb); 7.11 lb/gal Air intake restriction: 10 in. H_2O (2.5 kPa) Exhaust Back Pressure: 15 in. H_2O (3.7 kPa)	*Conversion Factors:* Power: kW = bhp x 0.746 Fuel: L/hr = gal/hr x 3.785	**6N04M:** 1340 **Injector:** 23526589

Certified by: Kevin Sisk

Curve No. E4-T165-32-06
Rev. / Date: 1 / 02-11- 00
Sheet No. 1 of 4

Performance Curve

Generator Specification Sheet

Standby Power - 1800 r/min

General Data	
Application Group	3D
Application Designation	G80
Model	T1637K36
Power Output – bhp	2935
Power Output – kW	2190
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	13.7:1
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603)
Weight, Wet – lb (kg)	15514 (7037)
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	42.3 (1074)
Above Crankshaft (y axis) – in. (mm)	9.1 (225)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	134.5 (8.48)
Fuel Consumption – lb/hr (kg/hr)	956.0 (433.6)
Fuel Spill Rate – gal/hr (L/min)	135 (8.5)
Fuel Spill Heat Rejection – Btu/min (kW)	348 (6.13)
Total Fuel Flow – gal/hr (L/min)	269.5 (16.98)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in.^{2} (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	23526589
Cooling System	
Heat Rejection:	
Eng. Coolant @ Aft. Cool Inlet Temp < 135 °F – Btu/min (kW)	**
Eng. Coolant @ Aft. Cool Inlet Temp > 135 °F – Btu/min (kW)	**
Aftercooler to Coolant @ Aftercooler Temperature < 135 °F – Btu/min (kW)	
Aftercooler to Coolant @ Aftercooler Temperature > 135 °F – Btu/min (kW)	
Engine Radiated Heat – Btu/min (kW)	4403 (77)
Coolant Flow, Rated: (*Minimum 95% of Rated Required*)	
Engine Circuit – gal/min (m^3/hr)	441 (100)
Engine Circuit External Restriction – lb/in.^{2} (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m^3/hr)	171 (39)
Aftercooler Circuit External Restriction – lb/in.^{2} (kPa)	10.4 (72)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant Out Temperature, Maximum – °F (°C)	174 (79)
Engine Coolant Temperature, – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	218 (206)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warm-up Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.^{2} (kPa)	14 (97)
Water Pump Discharge Press., Max. (w/o pressure cap):	
Engine Circuit – lb/in.^{2} (kPa)	50 (345)
Intercooler Circuit – lb/in.^{2} (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)

Cooling System (continued)	
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – minutes	30
Remote Pressurization – psi (kPa)	N/A
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	6660 (3.14)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum: (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	507 (230)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	6855 (3.24)
Exhaust Temperature – °F (°C)	835 (447)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.^{2} (kPa)	87 (600)
Oil Pressure at Low Idle – lb/in.^{2} (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	10500 (3200)
Manifold Boost Pressure – in. Hg (kPa)	77 (261)
BMEP – lb/in.^{2} (kPa)	326 (22.5)
Friction Power:	
Rated Speed – hp (kW)	240 (179)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	11.5 (0.72)
25% Power	37.7 (2.38)
50% Power	68.8 (4.34)
75% Power	99.1 (6.25)
100% Power	134.5 (8.48)
Certification Information	
Certification Approval	Yes †
(CWC) Certification Word Code	5408
Smoke – Bosch Number	N/A
Noise – dB(A) @ 1m	108.0 ‡

* Fuel consumption tolerance of + 5% per DIN ISO 3046 diesel fuel to to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390)

† Meets Year 2000 Nonroad Emissions Standards: NO_x 6.9 gm/hp-hr, CO 8.5 gm/hp-hr, HC 1.0 gm/hp-hr, Particulates 0.40 gm/hp-hr

‡ Estimated

N/A = Not Applicable

** At ambient conditions of 100 °F (and less) the aftercooler inlet temperature must not exceed 130 °F

UNCONTROLLED COPY

Curve No. E4-T165-32-0[illegible]
Rev. / Date: 1 / 02-11-00
Sheet No. 2 of 4

Generator Specification Sheet

Prime Power - 1800 r/min

General Data	
Application Group	3B
Application Designation	G80
Model	T1637K36
Power Output – bhp	2670
Power Output – kW	1990
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	13:7
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603)
Weight, Wet – lb (kg)	15514 (7037)
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	42.3 (1074)
Above Crankshaft (y axis) – in. (mm)	9.1 (225)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	120.2 (7.58) *
Fuel Consumption – lb/hr (kg/hr)	854.6 (387.6) *
Fuel Spill Rate – gal/hr (L/min)	133 (8.4)
Fuel Spill Heat Rejection – Btu/min (kW)	333 (5.86)
Total Fuel Flow – gal/hr (L/min)	253 (16)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	23526589
Cooling System	
Heat Rejection:	
Eng. Coolant @ Aft. Cool Inlet Temp < 135 °F – Btu/min (kW)	**
Eng. Coolant @ Aft. Cool Inlet Temp > 135 °F – Btu/min (kW)	**
Aftercooler to Coolant @ Aftercooler Temperature < 135 °F – Btu/min (kW)	
Aftercooler to Coolant @ Aftercooler Temperature > 135 °F – Btu/min (kW)	
Engine Radiated Heat – Btu/min (kW)	4005 (70)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	441 (100)
Engine Circuit External Restriction – $lb/in.^2$ (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m^3/hr)	171 (39)
Aftercooler Circuit External Restriction – $lb/in.^2$ (kPa)	10.4 (72)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant Out Temperature, Maximum – °F (°C)	174 (79)
Engine Coolant Temperature, – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	218 (206)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warm-up Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – $lb/in.^2$ (kPa)	14 (97)
Water Pump Discharge Press., Max. (w/o pressure cap):	
Engine Circuit – $lb/in.^2$ (kPa)	50 (345)
Intercooler Circuit – $lb/in.^2$ (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)
Cooling System (continued)	
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – minutes	30
Remote Pressurization – psi (kPa)	N/A
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	6370 (3.00)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum: (Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	484 (219)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	6543 (3.09)
Exhaust Temperature – °F (°C)	785 (418)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – $lb/in.^2$ (kPa)	87 (600)
Oil Pressure at Low Idle – $lb/in.^2$ (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	15000 (4572)
Manifold Boost Pressure – in. Hg (kPa)	71.3 (241)
BMEP – $lb/in.^2$ (kPa)	296 (20.4)
Friction Power:	
Rated Speed – hp (kW)	240 (179)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	11.5 (0.72)
25% Power	34.9 (2.20)
50% Power	63.2 (3.99)
75% Power	90.8 (5.73)
100% Power	120.2 (7.58)
Certification Information	
Certification Approval	Yes †
(CWC) Certification Word Code	5408
Smoke – Bosch Number	N/A
Noise – dB(A) @ 1m	108.0 ‡

* Fuel consumption tolerance of + 5% per DIN ISO 3046 diesel fuel to to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390)

† Meets Year 2000 Nonroad Emissions Standards: NO_x 6.9 gm/hp-hr, CO 8.5 gm/hp-hr, HC 1.0 gm/hp-hr, Particulates 0.40 gm/hp-hr

‡ Estimated

** At ambient conditions of 100°F (and less) the aftercooler inlet temperature must not exceed 130 °F

N/A = Not Applicable

Note: This engine is able to develop more than prime power. If this engine is allowed to operate at higher than prime power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

UNCONTROLLED COPY

Curve No. E4-T165-32-06
Rev. / Date: 1 / 02-11-00
Sheet No. 3 of 4

Generator Specification Sheet

Continuous Power - 1800 r/min

General Data	
Application Group	3B
Application Designation	G80
Model	T1637K36
Power Output – bhp	2000
Power Output – kW	1495
Rated Speed – r/min	1800
Number of Cylinders	16
Total Displacement – in^3 (L)	3967 (65.0)
Compression Ratio	13:7
Piston Speed – ft/min (m/s)	2244 (11.40)
Turbocharger	BTV8506
Engine Configuration	
Engine Type	90° Vee 4 Cycle
Bore and Stroke – in. (mm)	6.50 x 7.48 (165 x 190)
Intake Valves Per Cylinder	2
Exhaust Valves Per Cylinder	2
Combustion System	Direct Injection
Injection Device	Electronic Common Rail
Charge Air Cooling System	SCCC
Engine Crankcase Vent System	Open
Dimensions	
Length – in. (mm)	113.3 (2879)
Width – in. (mm)	55.1 (1400)
Height – in. (mm)	68.3 (1735)
Weight, Dry – lb (kg)	14558 (6603)
Weight, Wet – lb (kg)	15514 (7037)
Center of Gravity Wet	
From R.F.O.B. (x axis) – in. (mm)	42.3 (1074)
Above Crankshaft (y axis) – in. (mm)	9.1 (225)
Right of Crankshaft (z axis) – in. (mm)	0 (0)
Mechanical Limits	
Thrust Bearing Load Limit, Continuous – lb (kN)	1596 (7.1)
Thrust Bearing Load Limit, Intermittent – lb (kN)	3844 (17.7)
Vertical Load at Rear of Crankshaft, Maximum – lb (kN)	2250 (10.0)
Static Bending Moment at Rear Face of Block, Maximum – lb-ft (N-m)	1000 (1356)
Fuel System	
Fuel Consumption – gal/hr (L/min)	90.9 (5.73) *
Fuel Consumption – lb/hr (kg/hr)	646.3 (293.2) *
Fuel Spill Rate – gal/hr (L/min)	129 (8.15)
Fuel Spill Heat Rejection – Btu/min (kW)	295 (5.19)
Total Fuel Flow – gal/hr (L/min)	219.9 (13.9)
Fuel Inlet Temperature, Maximum – °F (°C)	140 (60)
Fuel Pump Suction, Maximum – in. Hg (kPa)	6 (20)
Fuel Return Pressure, Maximum – lb/in^2 (kPa)	7 (50)
Fuel Filter Size, Secondary – microns	8
Fuel Injector – Part Number	23526589
Cooling System	
Heat Rejection:	
Eng. Coolant @ Aft. Cool Inlet Temp < 135 °F – Btu/min (kW)	**
Eng. Coolant @ Aft. Cool Inlet Temp > 135 °F – Btu/min (kW)	**
Aftercooler to Coolant @ Aftercooler Temperature < 135 °F – Btu/min (kW)	
Aftercooler to Coolant @ Aftercooler Temperature > 135 °F – Btu/min (kW)	
Engine Radiated Heat – Btu/min (kW)	3000 (53)
Coolant Flow, Rated: (Minimum 95% of Rated Required)	
Engine Circuit – gal/min (m^3/hr)	441 (100)
Engine Circuit External Restriction – lb/in.^{2} (kPa)	8.6 (59)
Aftercooler Circuit – gal/min (m^3/hr)	171 (39)
Aftercooler Circuit External Restriction – lb/in.^{2} (kPa)	10.4 (72)
Engine Coolant Out Temperature, Maximum – °F (°C)	203 (95)
Aftercooler Coolant Out Temperature, Maximum – °F (°C)	174 (79)
Engine Coolant Temperature, – °F (°C)	160 (71)
Engine Coolant Capacity – qt (L)	218 (206)
Thermostat:	
HTC Start to Open – °F (°C)	170 (77)
HTC Fully Open – °F (°C)	185 (85)
LTC Start to Open – °F (°C)	90 (32)
LTC Fully Open – °F (°C)	112 (44)
Water Pump(s) Inlet Pressure, Minimum (w/o pressure cap):	
Rapid Warm-up Radiator	Positive
Conventional Radiator – in. Hg (kPa)	-3 (-10)
Pressure Cap, Minimum – lb/in.^{2} (kPa)	14 (97)
Water Pump Discharge Press., Max. (w/o pressure cap):	
Engine Circuit – lb/in.^{2} (kPa)	50 (345)
Intercooler Circuit – lb/in.^{2} (kPa)	28 (193)
Static Head, Maximum – ft H_2O (kPa)	50 (149)

Cooling System (continued)	
Coolant Fill Rate, Minimum – gal/min (L/min)	5 (19)
Drawdown, Minimum – Percentage of Total Cooling	8%
Deaeration, Maximum Time – minutes	30
Remote Pressurization – psi (kPa)	N/A
Intake Air System	
Intake Air Flow @ Rated Maximum Power – ft^3/min (m^3/s)	5450 (2.57)
Turbocharger Compressor Inlet Temperature – °F (°C)	77 (25)
Air Intake Restriction, Maximum:	
Clean Air Cleaner – in. H_2O (kPa)	12 (3.0)
Dirty Air Cleaner – in. H_2O (kPa)	20 (5.0)
Intake Pipe Inner Diameter, Recommended:	
Each Bank – in. (mm)	12 (305)
Each Turbo – in. (mm)	8 (203)
Intake Temperature Rise, Maximum:	
(Ambient to Engine Air Inlet) – °F (°C)	30 (17)
Exhaust System	
Exhaust Mass Flow – lb/min (kg/min)	413 (187)
Exhaust Volume Flow at STP – ft^3/min (m^3/s)	5583 (2.63)
Exhaust Temperature – °F (°C)	695 (369)
Back Pressure, Maximum – in. Hg (kPa)	1.5 (5.1)
Exhaust Pipe Inner Diameter, Recommended:	
Single – in. (mm)	14 (360)
Double – in. (mm)	10 (250)
Lubrication System	
Oil Pressure at Rated Speed – lb/in.^{2} (kPa)	87 (600)
Oil Pressure at Low Idle – lb/in.^{2} (kPa)	50 (345)
Oil Flow @ Rated Speed – gal/min (L/min)	119 (450)
Oil Flow @ Low Idle Speed – gal/min (L/min)	63 (240)
Gallery Oil Temperature, Maximum – °F (°C)	210 (99)
Oil Pan Capacity: Static High Mark – qt (L)	243 (230)
Static Low Mark – qt (L)	201 (190)
Total Engine Oil Capacity with Filters – qt (L)	264 (250)
Engine Angularity Limits, Front Up – Degrees	15
Engine Angularity Limits, Front Down – Degrees	15
Engine Angularity Limits, Left/Right Down – Degrees	15
Crankcase Pressure, Maximum – in. H_2O (kPa)	10 (2.5)
Electrical	
Battery Capacity, Recommended (CCA @ 0°F):	
24 Volt System, Warm Climate	950
24 Volt System, Cold Climate	1250
Resistance of Starting Circuit Per Starter, Maximum:	
24 Volt System – ohms	0.002
Performance Data	
Altitude Capability – ft (m)	15000 (4572)
Manifold Boost Pressure – in. Hg (kPa)	53.3 (181)
BMEP – lb/in.^{2} (kPa)	222 (15.3)
Friction Power:	
Rated Speed – hp (kW)	240 (179)
Part Load Fuel Consumption *	
Fuel – gal/hr (L/min) – 0% Power	11.5 (0.72)
25% Power	28.1 (1.77)
50% Power	49.1 (3.10)
75% Power	70.3 (4.43)
100% Power	90.9 (5.73)
Certification Information	
Certification Approval	Yes †
(CWC) Certification Word Code	5408
Smoke – Bosch Number	N/A
Noise – dB(A) @ 1m	108.0 ‡

* Fuel consumption tolerance of + 5% per DIN ISO 3046 diesel fuel to to DIN EN 590 with a minimum L.H.V. of 42800 kJ/kg (18390)

† Meets Year 2000 Nonroad Emissions Standards: NO_x 6.9 gm/hp-hr, CO 8.5 gm/hp-hr, HC 1.0 gm/hp-hr, Particulates 0.40 gm/hp-hr

‡ Estimated

N/A = Not Applicable

** At ambient conditions of 100°F (and less) the aftercooler inlet temperature must not exceed 130°F

Note: This engine is able to develop more than continuous power. If this engine is allowed to operate at higher than continuous power, even for short periods of time, the cooling system must be sized accordingly. Refer to the standby power for heat rejection, altitude limitations, and other performance data.

UNCONTROLLED COPY

Curve No.	E4-T165-32-06
Rev. / Date:	1 / 02-11-00
Sheet No.	4 of 4

ENGINE SERVICE FLUID AND FILTER REQUIREMENTS

DETROIT DIESEL

Lubricating Oil, Fuel, and Filters

Engine Requirements

Copyright Information

Table of Contents

Introduction

This publication specifies the type of fuels, lubricants, filters, and related maintenance intervals required for most diesel-fueled engines manufactured and marketed by Detroit Diesel Corporation. For information on fuels, lubricants, and filters required for DDC® engines using alternate fuels (other than diesel fuel), and other engine products not covered in this publication, refer to the specific publications for those engines.

Selection of the proper quality of fuel, lubricating oil and filters in conjunction with required oil and filter maintenance is required to achieve the long and trouble-free service which Detroit Diesel® engines are designed to provide. Conversely, operation with improper fuels, lubricants, and filters can degrade engine performance and may void the manufacturer's warranty.

It is Detroit Diesel Corporation policy to build engines that will operate satisfactorily with fuels and lubricants generally available in the commercial market. However, not all fuels and lubricants are adequate. Product selection should be based on these requirements and consultation with a reliable supplier who understands the equipment and its application.

Lubricating Oil Requirements

Hundreds of commercial oils are marketed today, but labeling terminology differs among suppliers and can be confusing. Some marketers may claim their lubricant is suitable for all makes of diesel engines and may list the make and type, including Detroit Diesel, on their containers. Such claims by themselves are insufficient as a method of lubricant selection for Detroit Diesel engines.

The proper lubricating oil for all Detroit Diesel engines is selected based on SAE (Society of Automotive Engineers) Viscosity Grade and API (American Petroleum Institute) Service Designation. Both of these properties are displayed in the API symbol which is illustrated within the specific requirements. For most Detroit Diesel engines, the proper lubricant must possess additional requirements. Refer to the specific requirements that follow.

Four-Stroke Cycle Engines
Detroit Diesel Series 40, 40E, 50, 55, 60, 638, D700, 2000 and 4000

Lubricant Requirements

API Symbol:

SAE Viscosity Grade: 15W-40[1]
API Classification: CH-4

Figure 1. API Symbol: 4-Stroke Cycle Engine Oils

1. At ambient temperatures below -20°C (-4°F) when sufficient starter speed cannot be achieved with SAE 15W-40 oils, 5W-XX and 10W-XX oils, where XX is 30 or 40, may be used to improve startability, provided they are API CH-4 and have demonstrated field performance in DDC engines. These oils must possess a HT/HS Viscosity of 3.7 minimum. See the section titled "High Temperature / High Shear Viscosity" later in this publication.
2. TBN, ASTM D2896, minimum 8.0 recommended for all engines, required for Series 2000 and Series 4000 engines.
3. Engine oils meeting EMA LRG-1 and Global DHD-1 qualify for oil drain extension. See Oil Drain Interval Table 5 and sections pertaining to these specifications under Lubricating Oil Selection for more information.
4. Only API licensed oils may be used in Detroit Diesel Engines.

Lubricants meeting these criteria have provided maximum engine life when used in conjunction with specified oil drain and filter maintenance schedules.

API Service Category CH-4 is intended for use with engines meeting 1998 and later exhaust emission regulations. Compared to the older API CG-4 category, the new API CH-4 engine oils have improved performance in wear protection at higher used oil soot levels and extended oil drain capability. Lubricants meeting API Service category CH-4 are required for use in 1998 and newer engines, and recommended for use in all Detroit Diesel Series 40™, 40E™, 50®, 55® 60®, 638™, D700™, 2000™, and 4000™ engines.

API CG-4 oils may be used when CH-4 oils are not available, however their use may requires a reduction in oil drain interval of up to 50%, depending upon the application and the fuel sulfur level. If oils of lower performance than API CH-4 are required, contact DDC for guidance.

Monograde oils, irrespective of API category, should not be used in on-road applications in any DDC 4-cycle engines, or in on- or off-road applications in Series 40E, 50, or 60 engines. Monograde oils may be used in Series 2000 and Series 4000 marine, and off-road and generator applications with closed breather systems. These oils must meet API CF or be listed in DDC Technical Service Bulletin 01-TS-07, "Oils for Closed Breather Applications."

When the use of high sulfur fuel (greater than 0.5% mass sulfur) is unavoidable, higher alkalinity (TBN) lubricants are recommended. High sulfur fuels require modification to oil drain intervals. For further information, refer to the section titled, "The Use of High Sulfur Fuels."

Two-Stroke Cycle Engines
Detroit Diesel Series 53, 71, 92, 149

Lubricant Requirements

The selection of the correct engine oil for DDC two-stroke cycle engines is dependent upon the application and fuel sulfur levels. Listed in Table 1 and listed in Table 2 are the proper engine oils. These tables should be used to select the proper engine oil.

Engine Series	Fuel Sulfur	Recommended Oil Type	
		Primary	Secondary
53, 71, 92 All Applications	Less than 0.5%	1	2, 3 or 4
	0.5 to 1.0%	1#	4
149 Marine Only	Less than 0.5%	2 or 3	4
	0.5 to 1.0%	1#	3# or 4
149 All Applications, Except Marine	Less than 0.4%	3	4
	0.4 to 1.0%	4	None

 # The use of oils under these conditions requires a reduction in oil drain interval. Refer to the sections of this publication titled, "Oil Drain Intervals" and "The Use of High Sulfur Fuel."

Table 1. DDC Two-Stroke Cycle Engine Requirements

After determining the required oil type for the application and anticipated fuel sulfur content, use Table 2 to identify the type of lubricant required. These are listed in Table 2. The numbers refer to notes of explanation provided beneath the table.

Oil Type	1	2	3	4
API Classification[1]	CF-2	CF-2	CF-2	CF-2 or LMOA[2]
Viscosity Grade[3]	40[4]	40[4]	50[5]	50[5]
Sulfated Ash[6]	1.0% max.	0.8% max.	0.8% max.	NS
Alkalinity (ASTM D2896)	7.0 min.[7]	7.0 min.[7]	7.0 min.[7]	13.0 min.
Calcium, ppm	NS	NS	500 max.	NS
Zinc, ppm	NS[8]	NS[8]	NS[8]	100 max.
Phosphorous, ppm	NS[8]	NS[8]	NS[8]	100 max.

Table 2. Oil Type Specifications

1. Only oils licensed by the American Petroleum Institute are recommended in Detroit Diesel two-stroke cycle engines. Licensed oils display the API Symbol. See Figure 2.

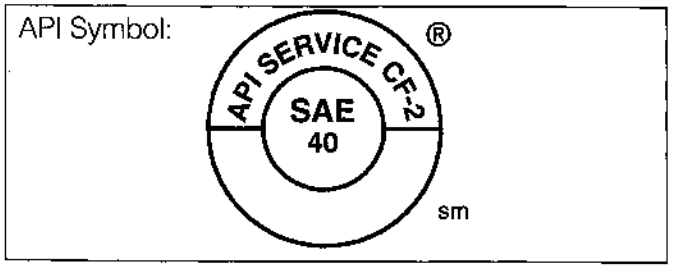


Figure 2. API Symbol: 2-Stroke Cycle Engine Oils

2. LMOA = Locomotive Maintenance Officers' Association

3. For continuous high temperature operation (over 200°F or 94°C Coolant Out), the use of an SAE grade 50 lubricant in DDC two-stroke cycle Series 53, 71, and 92 engines is required. SAE grade 50 lubricants are also required for all Series 149 engines where ambient temperatures are above 95°F (35°C).

4. At ambient temperatures below freezing (32°F or 0°C) sufficient starter cranking speed may not be achieved to start the engine with SAE 40 grade oils. Where starting aids are not available or at very cold temperatures (0 to -25°F or -18 to -32°C) even if starting aids are available, the use of multigrade SAE 15W-40 or monograde SAE 30 lubricants will improve startability. These lubricants must possess a High Temperature - High Shear Rate Viscosity (measured by ASTM D 4741 or equivalent) of 3.70 cP minimum. **These oils must be replaced with monograde SAE 40 lubricants as soon as ambient conditions permit. Do not use multigrade or SAE 30 grade lubricants in two-stroke cycle marine engines under any circumstances.**

5. At lower ambient temperatures where sufficient starter cranking speed may not be achieved to start the engine with SAE 50 grade oils, SAE 40 grade oils may be used. SAE 50 grade oils are not recommended below 45°F ambient. ***Do not use multigrade or SAE 30 grade lubricants in Series 149 engines under any circumstances.***

6. Sulfated Ash to be determined by ASTM D874. NS = Not Specified

7. Engine oils with Alkalinity between 6.5 and 7.0 may be used with demonstration of satisfactory performance and review by Detroit Diesel.

8. Not Specified, 700 ppm minimum recommended

Lubricants meeting these criteria have provided maximum engine life when used in conjunction with recommended oil drain and filter maintenance schedules.

Military specified oils (Mil-L-2104 suffixes A through G) should not be used in commercial DDC two-stroke cycle engines *unless they are API CF-2 licensed.* Engine oils meeting military specification Mil-L-2104 are intended for use in military engines. Due to the specific operating and life cycle requirements of military engines, the oils for these engines tend to be specialized toward that application. Refer to a later section titled Military Engine Oil Requirements.

A more detailed description of each of these selection criteria may be found in further sections of this publication.

Lubricating Oil Selection Criteria

Closed Breather Applications

In some applications, such as marine and power generation, engine crankcase vapors are routed into the air intake system. Some multigrade engine oil formulations have a tendency to generate vapors that condense on turbocharger and intercooler components adversely affecting the operation of the engine. The volume and composition of these vapors are dependent on the oil formulation. Monograde oils tend not to make these deposits.

A laboratory test, MTV 5040, has been found effective in predicting vaporization tendencies. The test was developed by MTU and has a passing limit of 110 mg. Since this performance test is not included as part of an API Service Category, oils meeting this requirement are listed separately in Technical Service Bulletin 01-TS-07 titled, "Oils for Closed Breather Applications."

EMA LRG-1

The Engine Manufacturers' Association has developed a *Lubricant Recommended Guideline* (LRG-1), which supports API CH-4. This guideline was developed to assist in identifying engine oils with more restrictive testing protocol than supported in API CH-4. Engine oils that meet both EMA LRG-1 and API CH-4 are preferred and should be the primary selection criteria.

Global DHD-1 Specification

Engine and equipment manufacturers from the United States, Europe, and Japan have jointly developed a global heavy duty diesel engine oil specification designated "Global DHD-1." Oils meeting this specification provide premium performance beyond API CH-4, and are recommended by Detroit Diesel for use in all 4-cycle engine products throughout the world. Engine oils meeting Global DHD-1 and EMA LRG-1 will permit extension of oil drain intervals 50% beyond those listed in Table 3.

SAE Viscosity Grade

Viscosity is a measure of an oil's ability to flow at various temperatures. The SAE Viscosity Grade system is defined in SAE Standard J300 that designates a viscosity range with a grade number. Lubricants with two grade numbers separated by a "W," such as 15W-40, are classified as multigrade, while those with a single number are monograde. The higher the number, the higher the viscosity.

The kinematic viscosity ranges with the associated SAE viscosity grade are listed in Table 3. This information is taken from SAE Standard J300 (Dec99) and is important in selecting the best viscosity grade for the anticipated temperature range. It should be used only as a guideline, since actual operating conditions of the engine may determine the lowest practical temperature at which an engine will start and operate. Note that grades designated with a "W" are required to meet both low temperature and high temperature viscosity requirements.

SAE Viscosity Grade	Viscosity (cP) at Temp. (°C), Max.		Viscosity (cSt) ASTM D445 t 100°C		High Temperature High Shear Rate Visc. @ 150°C & 10^5 sec.
	Cranking ASTM D 5293	Pumping ASTM D 4684	Min.	Max.	
0W	6200 at -35	60,000 at -40	3.8	—	—
5W	6600 at -30	60,000 at -35	3.8	—	—
10W	7000 at -25	60,000 at -30	4.1	—	—
15W	7000 at -20	60,000 at -25	5.6	—	—
20W	9500 at -15	60,000 at -20	5.6	—	—
25W	13,000 at -10	60,000 at -15	9.3	—	—
20			5.6	9.3	> 2.6
30			9.3	12.5	> 2.9
40			12.5	16.3	> 3.7
50			16.3	21.9	> 3.7
60			21.9	26.1	>3.7

Table 3. SAE Viscosity Grades for Engine Oils

High Temperature / High Shear Viscosity

Unlike Kinematic Viscosity, High Temperature / High Shear (HT/HS) Viscosity is measured under conditions similar to those of an operating engine. The test is conducted at 150°C under shear stress conditions similar to very thin film lubrication areas such as found at the piston ring-to-cylinder wall interface. The value obtained from this test provides an indication of temporary shear stability of the viscosity index improver used in multigrade oils. In 15W-40 grade oils a High Temperature/High Shear viscosity below 3.7 centipoise (cP) indicates that the oil will not perform as a 40 grade oil at engine operating conditions.

API Service Classification

The American Petroleum Institute (API) has established a means of classifying lubricant performance suitable for different types of engines and types of service. Each performance classification is substantiated through engine testing. To differentiate the performance requirements of two and four stroke diesel engines, a suffix of "-2" or "-4" is used in newer diesel engine categories. Categories without a suffix may be used in either engine type under certain operating conditions, for example, with high sulfur fuel. Engine oils intended for gasoline engines begin with "S," while those intended for diesel engines begin with "C". When both "S" and "C" categories are used, the category listed *first* identifies the primary intended usage of the oil.

The higher performance or quality for diesel engines includes API CF, CF-2, CG-4 and CH-4. Detroit Diesel does not recommend the use of older and lower performance classifications such as API CF-4, CE, CD, CC, CB, and CA due to the discontinuance of the qualifying tests.

When multiple API Service Classifications are used, make sure that the classification specified by Detroit Diesel Corporation is among those listed. Oils designated SG or SH are intended for passenger car applications. Oils without these designations are preferred in Detroit Diesel engines.

API Symbol

Lubricant marketers have adopted a uniform method of displaying the SAE viscosity and API service classification on product containers and in produc literature. The three- segment "donut" contains the SAE grade number in the center and the API service in the top segment. The lower segment is used to

designate energy-conserving status for gasoline engines and has no significance for diesel engine use.

A marketer is required to license his oil with API in order to display the symbol. Be aware that some marketers may indicate their products "meet" API requirements. This is not adequate. Although the licensing process does not guarantee good oil performance, the marketer must be able to produce support data and follow established testing guidelines to substantiate that the service classification is met. *Only oils licensed by API should be used in Detroit Diesel engines. A directory of API licensees is available at the API website. See section titled "Supplemental Information" for details.*

Purchasing Engine Oil

To assure continuing quality of engine oil purchased in bulk quantities, procurement specifications should include a requirement that the supplier follow *API Recommended Practice 1525* for handling bulk engine oils. This voluntary practice contains guidelines for quality control tracking within the supplier's process. In addition, customers are advised to obtain a control sample prior to any actual receipts to which future shipments may be compared.

Sulfated Ash and Total Base Number

Sulfated ash is a lubricant property measured by a laboratory test (ASTM D 874) to determine the potential for formation of metallic ash. The ash residue is related to the oil's additive composition and is significant in predicting lubricants which may cause valve distress, cylinder kit scuffing, or exhaust catalyst plugging under certain operating conditions. Sulfated ash is related to Total Base Number (TBN), which measures an oil's alkalinity and ability to neutralize acid using a laboratory test (ASTM D 2896 or D 4739). As TBN increases, sulfated ash also increases to where lubricants with TBN's above 10 will likely have sulfated ash contents above 1.0% mass.

Total Base Number is important to deposit control in four-stroke cycle diesel engines and to neutralize the effects of high sulfur fuel in all diesel engines. When the use of a high ash oil is required, such as with high sulfur fuel, the oil selected should have the highest TBN (D 2896) to Ash (D 874) ratio possible. For example, an oil with a TBN of 10 and an Ash of 1.2% mass is less desirable than an oil with the same TBN and 1.0% Ash. Also refer to section titled "Oil Change Intervals."

Universal Oils

Universal Oils are designed for use with both gasoline and diesel engines and provide an operational convenience in mixed engine fleets. These products are identified with combination API category designations such as SJ/CF or CG-4/SH. Although such products can be used in Detroit Diesel engines (provided they satisfy all Detroit Diesel requirements), their use is not as desirable as lubricants formulated specifically for diesel engines and having API CF-2 or CG-4 / CH-4 designations. When selecting a universal oil, select one with the "C" category *first* as this should be primarily intended for diesel service.

Synthetic Oils

Synthetic oils may be used in Detroit Diesel engines, provided they are API licensed and meet the performance and chemical requirements outlined in this publication. Synthetic oils are formulated with special base oils that offer improved low temperature flow properties and high temperature oxidation resistance. Due to their increased cost, marketers of synthetic oils often promote extended oil drain intervals. Such claims must be accompanied with proof of performance at the drain interval being considered. Refer to the section titled "Extending Oil Drain Intervals." Although synthetic oils are generally capable of extended oil drains, there are no industry specifications, i.e. API categories, which provide verification of such performance.

Today's "synthetic" oils may include a variety of base oils, as well as combinations of base oils. Some oils are also referred to as "semi-synthetic" oils. They may be marketed in viscosity grades different than those recommended in this publication. It is important to review data supporting their performance to assure that the oil meets their intended use. Only synthetic oils which do not contain viscosity improver additives may be used in Detroit Diesel two-stroke cycle engines.

Low Zinc, High TBN Industrial Diesel Lubricants (Oil Type 4 for Two-Stroke Cycle Engines)

The petroleum industry markets specialty lubricants for diesel engines which are characterized by their high TBN and the absence of magnesium and zinc in their composition. These lubricants take into consideration the unique environments and operational characteristics of marine propulsion and railroad

locomotive applications. Consequently, they are formulated quite differently from the types of lubricants specified by Detroit Diesel.

Marine and railroad lubricants are recommended for use in Series 149 and other DDC two-stroke cycle engines where fuel sulfur content exceeds 0.5%. These oils may also be selected for use when one of the following situations exists:

- They are required in other equipment and only a single engine lubricant can be inventoried.
- Where there is a risk of resulting exhaust valve distress with conventional high ash oil.

Selection should be based on demonstrated satisfactory field performance in Detroit Diesel engines as provided by the oil supplier. ***These oils are not recommended for use in DDC 4-cycle engines, unless API licensed as CH-4.***

The Use of Supplemental Additives

Lubricants meeting the Detroit Diesel specifications outlined in this publication contain a carefully balanced additive treatment. The use of supplemental additives, such as break-in oils, top oils, graphitizers and friction-reducing compounds, in these fully formulated lubricants are not necessary and can upset the oil's formulation, causing a deterioration in performance. These supplemental additives may be marketed as either oil treatments or engine treatments and should not be used in Detroit Diesel engines. Their use will not void your Detroit Diesel Corporation product warranty; however, engine damage resulting from the use of such materials is not covered. The use of such additives is at the customer's risk. Detroit Diesel will not provide statements relative to their use beyond this publication.

Lubricant Selection Outside North America

Engine Oils meeting EMA LRG-1 and Global DHD-1 are preferred for all DDC 4-cycle engines worldwide and permit extended oil drain intervals as listed in Table 5. If these lubricants are not available, lubricants meeting European ACEA E2-96, E3-96, or E5-99 and API CG-4 or CH-4 may be used at the oil drain intervals shown in Table 5. Oils of lower performance may only be used at a 50% oil drain interval reduction.

Oils meeting API CF may be used in DDC 2-cycle products, provided they also meet military specification Mil-L-2104 F.

Contact Detroit Diesel Corporation for further guidance.

Military Engine Oil Requirements

For military engine applications worldwide an engine oil meeting the latest military specification SAE J 2357 (MIL-PRF-2104G), is required. While other branches of the military may have similar engine oil specifications, only oils meeting this specification should be used in DDC engines.

Waste Oil Disposal and Re-refined Oils

CAUTION:

To avoid injury from contact with the contaminants in used engine oil, wear protective gloves and apron.

With over one billion gallons of waste oil generated annually in the U.S. alone, disposal of waste oil has become a serious environmental concern. Rerefining waste oils provides an environmentally viable way of handling this material. Several states have established collection and recycling programs. A few states have also designated used oil as a hazardous waste requiring special handling and disposal. Detroit Diesel favors the recycling of waste oil and permits the use of rerefined oils in all engine product lines, provided the rerefined oil meets the SAE Viscosity and API specifications previously mentioned.

Several processes are used to rerefine oil. The only true rerefining process is one which treats the used oil as a crude oil, subjecting it to the same refinery processes normally used for geological crude, such as dehydration, vacuum distillation, and hydrogenation. Waste oil provides a more consistent feedstock, compared to the geological crudes that a refinery typically processes. As a result, the finished oil should also be consistent in properties and quality. Unfortunately, this is not the norm. It is the inconsistencies of the processing and product quality which make most users reluctant to utilize rerefined products.

Consideration for the disposal of waste oil should begin when negotiating the purchase of new oil. Oil supplier selection criteria should include a proposal for handling waste oil. It is important to know exactly how

the oil will be disposed of, since it is the generator, not the hauler, that is ultimately responsible for its proper disposal.

Brand Name Approved Lubricants

Detroit Diesel does not maintain a list of brand name approved products. All lubricants which meet the qualifications listed in this publication will provide satisfactory performance when used in conjunction with the oil drain and filter requirements. To ensure the selected lubricant meets these qualifications, the customer should verify the candidate oil's current API license number. Although the lubricant supplier should be able to supply this information, it may also be obtained from other sources. Refer to section titled "Supplemental Information."

Typical Properties

Listed in Table 4 are the typical chemical and physical properties of a lubricant meeting Detroit Diesel requirements in normal applications. Exceptions to these requirements were noted in previous sections. This table is for information purposes only. It should neither be construed as being a specification, nor used alone in selection of an engine lubricant.

Engine Type	**2-Cycle**			**4-Stroke Cycle**	
Viscosity Grade **API Service**	**30** **CF-2**	**40** **CF-2**	**50** **CF-2**	**15W-40** **CF-4/CG-4/CH-4**	**10W-30** **CH-4**
Viscosity, Kinematic, cSt: 40°C 100°C	 100 - 120 9.3 - 12.5	 130 - 150 12.5 - 16.3	 200 - 230 16.3 - 21.9	 95 - 115 12.5 - 16.3	 75 - 85 9.3 - 12.5
HT/HS, cP 150°C	—	—	—	3.7 min.	3.7 min HD 3.5 min. LD
Viscosity Index	95	95	95	130	130
Pour Point °C, Max.	-18	-15	-10	-23	-30
Flash Point °C, Min.	220	225	230	215	205
Sulfated Ash, % mass	—	1.0 Max.	—	2.0 Max.	2.0 Max.
Total Base Number ASTM D 2896	—	7.0 - 10.0	—	Above 8	Above 8
Zinc, ppm	—	Above 700	—	Above 1000	Above 1000

Table 4. Typical Properties of a DDC-Recommended Engine Oil

Additional Information

The Engine Manufacturers' Association publishes the *EMA Lubricating Oils DataBook,* which contains information on several hundred engine oils. The data in the DataBook is provided by oil companies in response to a questionnaire. Information includes viscosity grade, API category, ash content, and other useful engine oil properties. It may be obtained directly from EMA. Refer to section titled "Supplemental Information."

Oil Change Intervals

During use, engine lubricating oil undergoes deterioration from combustion by-products and contamination by the engine. Certain components in a lubricant additive package are designed to deplete with use. For this reason, regardless of the oil formulation, regular oil drain intervals are required. These intervals may vary in length, depending on engine operation, fuel quality, and lubricant quality. Generally, shorter oil drain intervals extend engine life through prompt replenishment of the protection qualities in the lubricant. Conversely, extending oil drain intervals beyond the useful life of the lubricant can significantly reduce engine life.

The oil drain intervals listed in Table 5 (normal operation with low sulfur fuel) and the oil change intervals listed in Table 8 (normal operation with high sulfur fuel) should be considered **maximum** and should not be exceeded. If the fuel used does not meet all the properties listed in Table 11 titled, "Diesel Fuel Specification Table," the oil drain intervals listed in Table 6 apply. Always install new engine oil filters when the oil is changed.

Service Application	Engine Series	Oil Drain Interval
Highway Truck & Motor Coach	40	12,000 Miles (19,200 km)
	50, 55, 60, 71, 92	15,000 Miles (24,000 km)
Highway Truck	638	9,000 Miles (24,000 km)
City Transit Coaches#	40	12,000 Miles (19,200 km)
	50, 53, 60, 71 & 92	6,000 Miles (9,600 km) 300 hours or 3 months*
Fire Fighting / Crash Rescue Vehicles	50, 60	6000 Miles (9,600 km), 300 hours, or 1 year*
Pick-up & Delivery	40, 40E, 50, 53, 71	12,000 Miles (19,000 km)
	638	6,000 Miles (9,600 km)
Stop & Go, Short Trip	50	6,000 Miles (9,600 km)
Construction / Industrial, Agricultural and Continuous Marine	40, 40E	450 Hours or 1 Year*
	50 / 60	250 Hours or 1 Year*
	SUN / D700	250 Hours or 1 Year*+
	2000 / 4000	500 Hours or 1 Year*+
	149	300 Hours or 1 Year*
	53, 71 & 92	150 Hours or 1 Year*
Marine, Pleasurecraft and Commercial	60 / MD700	250 Hours of 1 Year*
	2000 / 4000	250 Hours or 1 Year*+
	149	300 Hours or 1 Year*
	53, 71 & 92	150 Hours or 1 Year*
Stationary Electrical Generator Units, Standby	40	450 Hours or 1 Year*
	2000	500 Hours or 1 Year*
	4000	500 Hours or 1 Year*+
	60	250 Hours or 3 Months*
	53, 50, 60, 71, 92 & 149	150 Hours or 1 Year*
Stationary Electrical Generator Units, Prime or Continuous	40	450 Hours or 6 Months*
	2000	500 Hours or 1 Year*+
	4000	500 Hours or 1 Year*+
	50, 53, 60, 71, 92 & 149	300 Hours or 3 Months*

* Whichever comes first.

+ Change oil filters every 250 hours maximum, and service the centrifugal filter based on filter cake thickness. See the Operator's Guide for further details.

Note: Oil drain intervals may be increased 50% with the use of oil meeting EMA LRG-1 and Global DHD-1. Increased filter capacity may be required. See "Extending Oil Drain Intervals" for additional information.

Table 5. Maximum Allowable Oil Drain Intervals (Normal Operation with Low Sulfur Fuel)

Oil Drain Intervals for 1998 and Newer Series 50 and Series 60 On-Highway Engines

Beginning in 1998, more stringent exhaust emission requirements were implemented for on-highway engines. To meet these requirements, engine fuel injection timing has been changed, resulting in higher rates of soot accumulation in the engine oils. The new API CH-4 engine oils have been formulated to handle these higher soot concentrations by providing improved dispersency and wear protection. While it is anticipated that these new oils provide the capability of maintaining the oil drain intervals listed in Table 5 and listed in Table 8, certain applications may involve engine operation which require an adjustment to oil drain intervals.

Adjusted oil drain intervals will depend on the engine's rate of soot production and the engine oil's capability to protect the engine. In some cases, it will be necessary to shorten oil drain intervals from the baseline oil drains, while in others, it may be possible to operate at the maximum oil drain intervals listed in Table 5. Soot accumulations in the engine oil exceeding the capability of the oil formulation can result in increased wear and reduced engine durability. DDC recommends used oil analysis to determine the proper oil drain interval for these engines and oils. The oil analysis properties and limits listed in Table 6 should be considered when establishing oil drain intervals for these engines.

Used Oil Property	Test Method	Limit
Soot	TGA (E1131)[1]	3% max.
Kinematic Viscosity	ASTM D445	25 cSt max. @ 100°C
Iron	ASTM 5185	150 ppm

Table 6. 1998 and Newer On-Road Series 50/60 Engine Used Oil Drain Limits

Extending Oil Drain Intervals

Changing engine oil and filters at regular recommended intervals removes contaminants in the oil and filter and replenishes expendable oil performance additives. The extension of oil change intervals necessitates that an engine can tolerate increased levels of contaminants such as soot, dirt, wear metals, fuel residues, and water. Extending oil filter change intervals requires that filters have sufficient increased capacity to continue collecting these contaminants at a sufficient rate to protect the engine. The engine oils must be formulated with additives capable of extended performance for wear and oxidation, dispersency and detergency, and filterability.

While the extension of oil drain intervals can provide owners and operators of diesel-powered equipment a cost savings in materials (oil and filters), maintenance-related downtime, and waste disposal, there can be a significant reduction of engine life to overhaul. Most currently marketed engine oils and filters are not designed to operate at extended service intervals. These products meet performance requirements of standardized industry tests that are intended to predict actual engine operation under the conditions of standard service intervals.

While some oil companies promote engine lubricants with a claimed longer useful life, Detroit Diesel Corporation does not recommend the extension of oil drain intervals beyond the Maximum Allowable Periods listed in Table 5 unless the oil meets Global DHD-1 and EMA LRG-1. These engine oils are formulated to higher performance requirements and may be used at oil drain intervals 50% higher than the intervals listed in Table 5. Additional oil filter capacity is required for Series 4000 engines.

If oil and filter change interval extension beyond 50% is pursued, the following criteria will help to minimize the detriment to performance and engine life. DDC recommends that oil and filter change intervals not be extended at anytime beyond the used oil analysis limits listed in Table 8, "Single Sample Used Oil Analysis Warning Limits."

1. A rigorous maintenance program which includes used oil sampling, close adherence to maintenance schedules, and consistent make-up oil additions. DDC POWER Trac® used oil analysis kits with TBN P/N 23520989, or equivalent is recommended in determining the proper oil drain interval.
2. Duty cycle severity no greater than defined as 60% maximum load factor, based on fuel consumption and a 40% maximum operating time at idling conditions.

3. The oil and filters should have field test demonstrated performance. Depending on the engine and application, the field test should be conducted at drain intervals at least 30% higher than the intended target for a duration of 500,000 miles or 5,000 hours.
4. The oil and filter suppliers should have a written policy regarding extended service intervals beyond manufacturer recommendations. This policy should clearly state the requirements to be met by the customer and warranty support for early engine wearout resulting from the use of their product in extended service.

The decision to extend oil and filter change intervals beyond those recommended rests with the customers, the oil, and oil filter suppliers. Extending oil drain interval will not void the DDC product warranty. In the event of engine failure or premature wearout when running extended oil and filter change intervals, a determination will be made as to the extent,if any, that DDC workmanship and materials were responsible. If DDC determines that the failure or early wearout is related to workmanship or materials, warranty coverage of the repairs will apply. If the engine fails or wears out within the DDC engine warranty period and this is determined to be a result of extending oil drain intervals, any claim for reimbursement of expenses under the terms of the engine warranty will be denied.

The Use of High Sulfur Fuels

Although diesel fuels containing more than 0.5% sulfur are considered high sulfur fuels, piston ring wear studies have shown that the combustion of fuels containing more than 0.3% sulfur significantly increases ring face wear rates. See Figure 3.

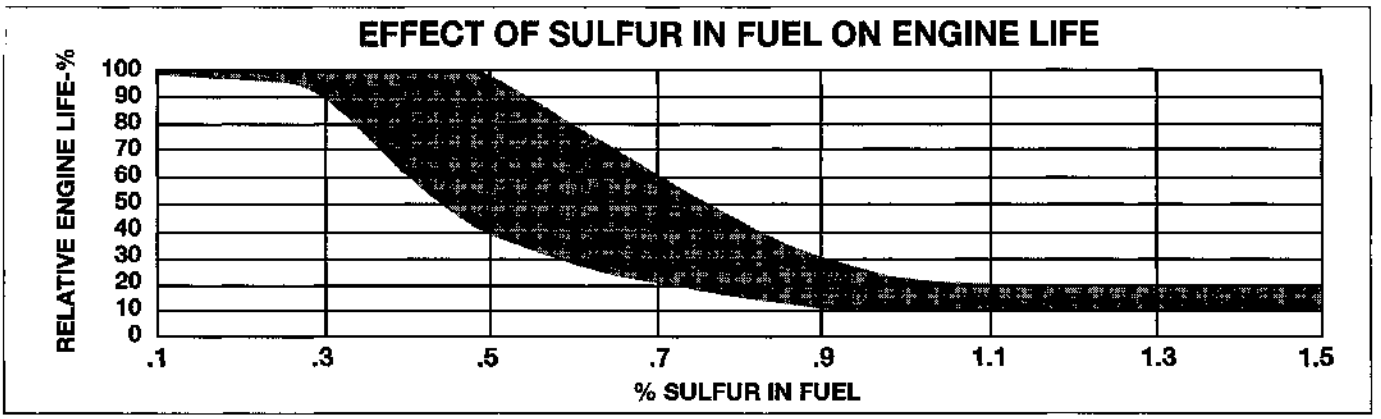


Figure 3. Effect of Sulfur in Fuel on Engine Life

High fuel sulfur forms acids during combustion, particularly during idling and low temperature operation. The best defense against the effects of acid formation is to shorten oil drain intervals. The proper drain interval may be determined by oil analysis or by using the drain intervals listed in Table 7. A reduction in TBN (ASTM D 4739) to one-third of the initial value provides a general drain interval guideline. Marine fuels identified as meeting ASTM D2609, *Specification for Marine Fuels*, should not be used in Detroit Diesel engines due to the high sulfur contents and boiling ranges permitted.

Should it be determined that the oil drain interval is unacceptably short, the selection of a lubricant with a Total Base Number (TBN per ASTM D 2896) above 10 may be appropriate. Experience has shown, however, that a higher TBN oil with a longer oil change interval is not as effective in protecting the engine from wear. Use the intervals listed in Table 7 until the best practical oil drain interval can be established by oil analysis.
Used oil TBN may be determined with DDC POWER Trac, P/N 23520989.

Service Application	Engine Series	Oil Drain Interval New Oil TBN above 10
Highway Truck & Motor Coach	40, 40E, 50, 55, 60, 71 & 92	10,000 Miles (16,000 km)
Highway Truck	638	6,000 Miles (9,600 km)
City Transit Coaches	40, 40E, 50, 55, 60, 71 & 92	4,000 Miles (6,400 km) or 3 Months Maximum*
Fire Fighting / Crash Rescue Vehicles	50, 60	200 Hours, 4,000 Miles, (6,400 km), or 6 Months*
Pick-up & Delivery,	40, 40E, 50, 53, 60, 71 & 92	6,000 Miles (12,500 km)
	638	4,000 Miles (6,400 km)
Construction / Industrial, Agricultural and Continuous Marine	40	200 Hours or 6 Months*
	50, 60, SUN, D700	100 Hours or 6 Months*
	2000, 4000	250 Hours or 1 Year*
	149	300 Hours or 1 Year*
	53, 71 & 92	150 Hours or 1 Year*
Marine, Pleasurecraft and Commercial	60, MD700, 2000, 4000	150 Hours or 1 Year*
	149	300 Hours or 1 Year*
	53, 71 & 92	150 Hours or 1 Year*
Stationary Electrical Generator Units, Standby	2000, 4000	150 Hours or 1 Year*
	40, 50, 53, 60, 71, 92 & 149	150 Hours or 6 Months
Stationary Electrical Generator Units, Prime or Continuous	40	250 Hours or 4 Months*
	50, 60, 71, 92 & 149	150 Hours or 3 Months*
	2000, 4000	200 Hours or 1 Year*

* Whichever comes first

These drain intervals are to used for all engines and applications where the fuel used does not meet the recommended properties shown in Table 5.

Table 7. Maximum Allowable Oil Drain Intervals when Using a Fuel not Meeting DDC Recommendations Listed in Table 9, or Sulfur Above 0.5% (Use oil analysis to determine optimum drain interval)

Used Lubricating Oil Analysis

Detroit Diesel's ***POWER Trac***® used oil analysis program is recommended for monitoring crankcase oil in all engines. Oil analysis consists of a series of laboratory tests conducted on the engine lubricant. Most tests reveal conditions of the engine, while some indicate the condition of the lubricant. The "Warning Limits" listed in Table 8 show what each test evaluates. Since an oil analysis cannot completely assess the lubricating oil for continued service, it should not be used to extend oil drain intervals. An oil analysis program with regular sampling is recommended, and the oil should be changed immediately if contamination is present in concentrations exceeding the warning limits listed in Table 8.

These limits are provided for guidance for a single sample analysis. It should never be concluded that the engine is worn out based on a single measurement that exceeds the warning level. Imminent engine wearout can only be determined through a continuous oil analysis program wherein the change in data or deviation from baseline data can be used to interpret the condition of engine parts. Confirmation for necessity of engine overhaul should be based upon operational data (for example, increasing oil consumption and crankcase pressure) and physical inspection of parts.

Diesel Fuel

Quality and Selection

The quality of fuel used is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels. Detroit Diesel engines are designed to operate on most diesel fuels marketed today. In general, fuels meeting the properties listed in Table 9 are recommended for satisfactory performance. Many fuels marketed today are claimed to meet ASTM Designation D 975. This specification is inadequate in defining the fuel quality necessary for modern low emission diesel engines. For optimum engine operation and maximum service life, diesel fuels meeting the property requirements listed in Table 9, or the properties of EMA FQP-1a or b are recommended for use.

Characteristic	ASTM or DIN Test Method	Condition Measured	Two Cycle		Four Cycle		
		Engine Series	53, 71, 92	149	40, 50, 60	55	2000, 4000
Viscosity	D445 DIN 51562	Engine & Oil					
Kv100C, cSt. min.			12.5 SAE 40	16.0 SAE 50	12.5 SAE 15W-40	12.5 SAE 15W-40	10.0 SAE 15W-40
Kv100C, cSt., max.			16.3 SAE 40	22.0 SAE 50	16.3 (25.0[1]) SAE 15W-40	16.3 (25.0[1]) SAE 15W-40	20.0 SAE 15W-40
Soot, %, max.	E1131 or LEM[2]	Engine Combustion	0.8	0.8	1.5 (3.0)[1]	1.5	1.0
Pentane Insolubles, max.	D83 DIN 51365	Engine Combustion	1.0	1.0	1.0 (N/A)[1]	2.0	2.5
Total Base Number,		Oil					
min.	D4739		1.0 or 1/3 New Oil[3]				
min.	D2896 ISO 3771		2.0 or 1/3 New Oil[3]				50% of new oil value
Glycol max.	D2892 DIN 51375	Engine	Negative				
Water max.	D1744	Engine	0.3%				
Fuel Dilution max.	D3524	Engine	2.5%				5% for Series 2000 2.5% for Series 4000
Flash Point COC °C min.	D92 ISO 2592	Engine & Oil	Not Specified				180
Metals, ppm[4]							
Iron, max.	D5185	Engine Wear	150 (250[5])	35	150	200	30
Copper, max.	D5185	Engine Wear	25	25	30	20	30
Lead, max.	D5185	Engine Wear / Oil Corrosion	10	10	30	40	20

1. With API CH-4 oil
2. LEM℠ is a patented soot measurement process by Analysts, Inc. Infrared spectroscopy may also be used, provided it is calibrated to be equivalent to TGA.
3. Whichever is higher
4. These are general limits. Wear metals limits must be determined for specific application and oil used.
5. Marine engines only

NOTE: These limits are intended as guidance when a single oil sample is tested and are based on the normal oil drain intervals listed in Table 5. Actual limits are dependent on engine, application, drain interval and oil type. Refer to DDC Publication 7SE 398 for determining warning limits specific to your application.

Table 8. Single Sample Used Oil Analysis Warning Limits

Property	Test Method ASTM	ISO	On-road No. 1	No. 2	Off-road
API Gravity, @ 60°F Minimum Maximum	D 287		 40 44	 34 38	 33 43
Specific Gravity, g/ml @ 60°F Minimum Maximum	D 1298	3675	 0.806 0.825	 0.835 0.855	 0.810 0.860
Flash Point, °C, Minimum	D 93	2719	38	52	Note 1
Viscosity, Kinematic cSt @ 40°C Minimum Maximum	D 445	3104	1.3 2.4	1.9 4.1	1.3 4.5
Sulfur, wt% Maximum	D 2622	EN 24260	0.05	0.05	0.4
Cloud Point	D 2500			Note 2	
Filter Plugging Point	D4359	309		Note 3	
Cetane No., Minimum	D 613	5165	45	45	45
Cetane Index, Minimum	D 4737	4264	40	40	40
Distillation % Vol. Recovery, °F (°C) IBP, Typical 10%, Typical 50%, Typical 90%, Maximum 95% Maximum Recovered Volume, % Minimum	D 86	3405	 350 (177) 385 (196) 425 (218) 500 (260) 550 (288) 98	 375 (191) 430 (221) 510 (256) 625 (329) 671 (355) 98	 320 (160) - 392 (200) 437 (225) - 527 (275) 626 (330) 680 (360) 98
Water, % Maximum (Note 4)	D 2709		0.02	0.02	0.02
Sediment > 1 µm, mg/L Maximum	D2276 or D5452		10	10	10
Total Contamination, mg/kg Maximum		DIN 51419	24	24	24
Ash, % mass Maximum	D 482	6245	0.01	0.01	0.01
Carbon Residue, on 10%, % mass	D 524	10370	0.15	0.35	0.3
Copper Corrosion, Maximum	D 130	2160	No. 3a	No. 3a	No. 3a
Accelerated Storage Stability mg/L, Maximum	D 2274		15	15	15
Dupont Pad Test, Reflectance, at 150°C, Minimum	D6468		70	70	70
Heat Content, Net, BTU/gal	D4868		125,000 - 127,300	128,500 130,900	126,600 - 131,500
Lubricity Load, gms, Minimum Wear Scar, µm, Maximum	 D6078 D6069		 3100 460	 3100 460	 3100 460

Table 9. Diesel Fuel Specification Table

Note 1 The flash point temperature is a safety related property which must be established according to applicable local requirements.
Note 2: The cloud point should be 10°F (6°C) below the lowest expected fuel temperature to prevent clogging of fuel filters by wax crystals.
Note 3: The Filter Plugging Point temperature should equal to or below the lowest expected fuel temperature.
Note 4: No free water visible
Note 5: Transit Coach engines are emission certified on either No. 1 or No. 2 fuel. To maintain emission compliance, only the correct certified fuel should be used.
Note 6: When prolonged idling periods or cold weather conditions below 32°F (0°C) are encountered, the use of 1-D fuel is recommended.

Fuel Lubricity

Some fuels, such as those containing kerosene and jet fuel, and some low sulfur fuels have characteristics which may cause operational concerns in some fuel injection systems. To assure trouble-free operation it is recommended that all fuels used in DDC engines meet the minimum lubricity requirements listed in Table 9. Fuels not meeting the lubricity requirements may be additized to meet them.

Biodiesel Fuels

Biodiesel fuel is broadly defined in ASTM specification PS 121. However, this specification does not restrict feedstock types, nor does it include all the properties necessary to assure trouble-free operation. Detroit Diesel permits the use of biodiesel derived from virgin soy methyl ester and rapeseed methyl ester when blended up to 20% maximum in diesel fuel. Use of recycled feedstocks is not recommended. The resulting mixture must meet the fuel properties listed in Table 9.

Although such blends purport to reduce exhaust emission particulates, they increase engine exhaust nitrogen oxides content. They also tend to have poorer thermal stability and may deteriorate engine oil TBN more rapidly than wholly petroleum-based diesel fuels. Little long-term use data exists, but concerns from combustion deposits, fuel injection system durability, and accelerated engine oil degradation warrant a cautious approach when considering the use of biodiesel. Use of these fuels may require a reduction in oil drain interval. Failures attributed to the use of biodiesel fuel or blends of biodiesel will not be covered by the Detroit Diesel product warranty.

Other Fuels

In addition to the diesel fuels listed in Table 9, customers have used other fuels successfully, including fuels marketed as premium diesel fuels, kerosene-based jet fuels, and other fuels listed in Table 10. These fuels have provided economic and availability advantages for some applications, particularly where No. 1 type fuels are required. Since these fuels do not meet all the fuel property requirements in Table 9, successful operating experience must exist. Fuel type specifications and applications are listed in Table 11.

Property	Jet A/A-1 D 1655	JP-5	JP-8#	CONUS DF-1	CONUS DF-2	OCONUS DF-2
API Gravity, @ 60°F	44.3	41.1	45.6	42.3	34.2	38.5
Flash Point, °C	38	62	45	50	74	70
Viscosity, Kin., cSt @ 40°C	—	1.5	1.2	1.6	2.8	3.0
Cloud Point °C	-40	-46	-47	-41	-12	-19
Sulfur, % mass	0.3 Max.	0.4 Max.	0.4 Max.	0.05 Max.	0.05 Max.	0.3 Max.
Cetane Number	—	42	45	44	47	49
Distillation % Vol. Rec., °C						
IBP	—	180	157	174	190	176
10% Typical	205	191	175	196	222	219
50% Typical	Report	215	200	219	265	365
90% Max.	Report	242	236	246	313	311
Final Boiling Point, Max. Temp.	300					
Heat Content, Btu/gal., Net	123,608	125,270	123,069	125,960	131,207	127,820

JP8 + 100 is not recommended in equipment with water-coalescing filters.

Table 10. Selected Typical Fuel Properties

Type	NATO Spec.	Mil Spec.	Application
JP-4	F-40	Mil-T-5624	Jet Fuel, Contains 50% Gasoline, Not Recommended
JP-5	F-44	Mil-T-5624	Jet Fuel, Kerosene based
JP-8	F-34	Mil-T-83133	Jet A-1 with De-Icer and Corrosion Inhibitor
Jet A	None	None	Industry Standard Jet Fuel
Jet A-1	F-35	None	Jet Fuel, ASTM D 1655
DL-1/DL-2	F-54	W-F-800 CONUS	Specified Military Use Inside Continental U.S.
DF-2	F-54	W-F-800 OCONUS	Specified Military Use Outside Continental U.S.

Table 11. Fuel Type Specifications and Applications

Lower density fuels, such as those listed in Table 10 and listed in Table 11 and "winter blended" diesel fuels, have a lower volumetric heat content than the standard No. 2 fuel listed in Table 9, "Diesel Fuel Specification Table." Operating with these fuels will result in reduced engine output and reduced fuel mileage, compared to standard No. 2 fuel. Reductions of 5% are not unusual and may be as high as 10%. A good rule of thumb is this: *The engine power is proportional to the heating value of the fuel.*

Lower density fuels also tend to have lower viscosity and poor lubrication characteristics. Fuel filtration should be changed to that recommended for "Severe Duty Service" to prevent potential injector seizure from dirt contamination of fuel.

Heavy Fuels Not Recommended

Heavy fuels intended for use in slow speed diesel engines and as burner fuel are not recommended for use in any Detroit Diesel engine. Marine fuels specified by ASTM D2609 are examples of such fuels. These fuels are known to cause combustion deposits and will likely reduce engine durability.

Premium Diesel Fuel

Several oil companies market fuels they designate as "premium" diesel fuel. This fuel will typically have a higher cetane number and lower density than ASTM D975 2D fuel. These fuels will also have a performance additive package. Although premium diesel fuels are not covered by any existing industry specification, they may be used in DDC engines. It is recommended that the customer obtain additional information from the fuel marketer and compare properties to those listed in Table 9, "Diesel Fuel Specification Table," before using.

Diesel Fuel Selection Criteria

Distillation

The boiling range indicates the temperature range over which the fuel turns to a vapor and is a very important property in consideration of diesel fuel quality. Lower boiling range fuels, such as No. 1, have a higher volatility, while fuels such as No. 2 are of lower volatility and higher temperature boiling range. Higher volatility fuels are preferred in conditions of prolonged idling, such as city coach applications, or in cold temperatures. The determination of boiling range is made using ASTM Test Method D86 or D2887 (Gas Chromotography Test Method).

Although many specifications contain only a partial listing of the distillation results (Distillation Temperature at 90% Recovered, for example), this is not enough to determine the quality and suitability of the fuel for use in diesel engines. Diesel fuels are blended products which may contain high boiling constituents that can affect combustion. Only fuels with a minimum 98% recovery by distillation should be used. The full boiling range as shown in previous tables should be used for proper selection.

95% Boiling Point

Fuel can be burned in an engine only after it has been completely vaporized. The temperature at which the fuel is completely vaporized is described as the "End Point Temperature" in ASTM D 86 Distillation Test Method. Since this temperature is difficult to measure with good repeatability, the fuel's 90% or 95% distillation point is often used. DDC specifies the 95% temperature because it is closer to the end point than the 90% used by ASTM in D975.

Cetane Number

Cetane Number is a relative measure of the time delay between the beginning of fuel injection and the start of combustion. In cold engine starting a low cetane number will cause difficult starting and white exhaust smoke until the engine warms up. In engines with charge air cooling a low cetane number fuel may also cause white exhaust smoke during light load operation.

A minimum cetane number of 45 is specified for best engine performance. However, the cetane number alone should not be considered when selecting a quality fuel. Other properties, such as 95% distillation temperature and carbon residue, should also be considered.

Calculated Cetane Index is sometimes reported instead of Cetane Number. Cetane Index is an empirical property determined mathematically from boiling range temperatures and specific gravity of the fuel, whereas Cetane Number is determined through an engine test. Additives may be used by the fuel marketer to improve the cetane number; however, they have no effect on cetane index. Both properties should be evaluated when selecting diesel fuel.

Fuel Stability

Diesel fuel oxidizes in the presence of air, heat, and water, particularity if the fuel contains cracked products that are relatively unstable. The oxidation of fuel can result in the formation of undesirable gums and black sediment. Such undesirable products can cause filter plugging, combustion chamber deposit formation, and gumming or lacquering of injection system components, with resultant reduced engine performance and fuel economy. Two tests are specified for fuel stability, ASTM Test Method D 2274 which measures diesel fuel storage oxidative stability and the DuPont Pad Test which measures in-use stability. The DuPont Pad test should be conducted at 302°F(150°C). The results of the DuPont Pad Test are based on a visual rating of the filter pad by the amount of light reflected from the filter pad. A 100% rating is a clean pad, while a 50% rating is very dirty. ASTM D2274 is a weighed measure of the sediment filtered from the fuel after storage. Although the results of D 2274 may vary with actual field storage, it does measure characteristics that will affect fuel storage stability for periods of up to 12 months.

Fuel Sulfur Content

Diesel fuel sulfur content above 0.3% mass causes premature ring and cylinder wear and deposit formation. It has also been identified as a major contributor to exhaust particulates, which became a federal regulated exhaust constituent in 1988. Fuel sulfur was limited to 0.05% for U.S. on-highway engines beginning in October 1993 to reduce particulate emissions.

Diesel fuels with low sulfur content should be selected. If the use of fuels with sulfur contents above 0.4% are unavoidable, lube oil drain intervals and lubricant selection needs to be reduced. Detroit Diesel recommends that the Total Base Number (TBN D 4739) of the lubricant be monitored and that the oil drain interval be reduced. Refer to section titled "Oil Changes."

Fuel Operating Temperature and Viscosity

Since diesel fuel provides cooling of the injection system, the temperature of the fuel may vary considerably due to engine operating temperature. As fuel temperature increases, fuel viscosity decreases, along with the lubrication capabilities of the fuel. Maintaining proper fuel temperatures and selecting fuels with the viscosity ranges listed in Table 9, "Diesel Fuel Specification Table," will assure proper injection system functioning.

When operating with reduced fuel viscosity or elevated fuel temperatures the injectors will operate at reduced internal clearances. As a result, dirt and smaller particulate material may cause injector durability concerns. Filters on Detroit Diesel two stroke-cycle engines should be changed to those specified for "Severe Duty Service." Installing a fuel cooler or operating with fuel tanks above half full may also help eliminate the concern.

Fuel Additives

Detroit Diesel engines are designed to operate satisfactorily on a wide range of diesel fuels. The regular use of supplemental fuel additives is not required or recommended. Some additives may be beneficial in addressing temporary fuel quality problems but should not replace proper fuel selection and handling.

Water Contamination

Some fuel additives provide temporary benefit when fuel is contaminated with water. They are not intended to replace good fuel handling practices. Where water contamination is a concern, the fuel system should be equipped with a fuel/water separator that should be serviced regularly. In marine and other environments where microbe growth is a problem, a fungicide such as Biobor® JF (or equivalent) may be used. Microbial activity may be confirmed with commercially available test kits. Follow the manufacturer's instructions for treatment. Avoid the use of fungicides containing chlorine, bromine, or fluorine compounds, since these may cause fuel system corrosion.

When small amounts of water are present, supplemental additives containing methyl carbitol or butyl cellusolve are effective. Follow the manufacturer's instructions for their use. The use of isopropyl alcohol is no longer recommended due to its negative effect on fuel lubricity.

The following fuel additives are NOT allowed:

Used Lubricating Oil - Detroit Diesel specifically prohibits the use of drained lubricating oil in diesel fuel. Used lubricating oil contains combustion acids and particulate materials, which erode injector components, resulting in loss of power and increased exhaust emissions. In addition, the use of drained lubricating oil will increase maintenance requirements due to filter plugging and combustion deposits. Refer to the section titled, "Waste Oil Disposal and Rerefined Oils" for recommendations on proper used oil disposal.

Gasoline - The addition of gasoline to diesel fuel will create a serious fire hazard. The presence of gasoline in diesel fuel will reduce the fuel cetane number and increase combustion temperatures. Tanks that contain such mixtures should be drained and cleaned as soon as possible.

Detroit Diesel Corporation will not be responsible for any detrimental effects which it determines resulted from the use of used lubricating oil or gasoline in the diesel fuel.

Evaluation of Supplemental Fuel Additives

Many supplements available today are intended to be added to the fuel by the customer. These include a variety of independently marketed products which claim to be:

- Cetane Improvers
- Emission Control Additives
- Detergents
- Combustion Improvers
- Smoke Suppressants
- Cold Weather Flow Improvers

Should a customer decide that a supplemental additive is required, the following is intended to provide guidance to the customer in evaluating potential safety hazards and deleterious engine effects.

1. A Material Safety Data Sheet (MSDS) should be carefully reviewed for special handling instructions and hazardous material content. Additives containing hazardous materials should not be used due to personal safety risk.

2. A detailed compositional analysis should be provided by the supplier. Ash forming metallic elements and corrosive elements must not be present. Additives containing calcium, barium, zinc, phosphorous, sodium, magnesium, iron, copper, and manganese are known to cause combustion ash deposits that can foul fuel injectors and create deposits which may adversely affect cylinder life. Halogenated compounds containing chloride, fluoride, and bromide are corrosive, as are some sulfur containing compounds. The use of additives with these components should be avoided.

3. Many commercial diesel fuels today contain performance additives, particularly those marketed as premium diesel fuel. Any supplemental additive being considered must be compatible with the fuel it is to be used in. A mixture containing twice the recommended concentration of additive should be evaluated for compatibility to represent an overdosage condition, using the tests listed in Table 9, "Diesel Fuel Specification Table."

4. Performance evaluation of a fuel supplemental additive should be conducted in customer equipment for a minimum of six months. Testing should be a side-by-side comparison with and without the additive to verify performance claims. Testimonials are not substantial claims of performance.

Supplemental fuel additives are not recommended due to potential injector system or engine damage. Our experience has been that such additives increase operating costs without providing benefit. The use of supplemental fuel additives does not necessarily void the engine warranty. However, repair expenses which result from fuel system or engine component malfunctions or damage attributed to their use will not be covered. These products should be accompanied with performance data supporting their merit. Detroit Diesel Corporation will not test or verify the performance of any supplemental additives and will not accept responsibility for use, selection, or hazards relating to the use of such products.

Diesel Fuel Storage

Fuel oil should be clean and free of contamination. Storage tanks and stored fuel should be inspected regularly for dirt, water, and sludge. Tanks should be drained and cleaned, if contaminated. Diesel fuel tanks can be made of monel, stainless steel, black iron, welded steel or reinforced (non-reactive) plastic.

NOTICE:
Do not use galvanized steel or sheet metal tanks and galvanized pipes or fittings in any diesel fuel storage, delivery, or fuel system. The fuel oil will react chemically with the zinc coating, forming a compound which can clog filters and cause engine damage.

Filtration

Filters make up an integral part of fuel and lubricating oil systems. Proper filter selection and maintenance are important to satisfactory engine operation and service life. Filters however, should be used to maintain a clean system, not to clean up a contaminated system.

Filter performance and test specifications vary between manufacturers. These specifications are general in nature and do not reflect the actual performance of genuine DDC POWER GUARD® filters. The user is also cautioned when comparing micron ratings between filter makes. Some filter makers may publish results from tests in which the SAE J1858 test procedure was not used. It is also important to note that capacity and efficiency (micron) ratings should not be the only criteria on which to judge filter performance. Many other important factors, including media strength, resistance to impulse failures and burst strength, often differ greatly between filter makes and should enter into the filter selection process.

Regular and optional service spin-on fuel filters for most DDC engines are listed in Table 12. Fuel Pro® filters are listed in Table 13, and Sea Pro® marine engine fuel filters are listed in Table 14. Cartridge-type fuel filters are listed in Table 15. Spin-on lubricating oil filters are listed in Table 16.

Finer filtration will generally provide increased engine service life, but may require shorter filter change intervals. Detroit Diesel specifies filter performance based on the optimum combination of filter micron rating, filter capacity, and mechanical requirements (assembly integrity).

Aftermarket Filtration

Aftermarket supplemental filtration systems may be used, provided they do not replace the factory-installed system or reduce oil volumes, pressures, or flow rates delivered to the engine. The use of such systems does not address oil degradation from normal use and, therefore, does not permit extension of oil drain intervals. Fuel filters must be properly sized to provide the proper fuel flow to the engine. A fuel/water separator, if used, must be installed between the fuel tank and the inlet side of the engine fuel pump.

Detroit Diesel Maintenance Products

Fuel and Lubricating Oil Filter Applications for Detroit Diesel Engines

Primary Fuel Filter			Secondary Fuel Filter		
Engine	Qty.	Power Guard	Qty.	Power Guard	Power Guard Plus
3-53	1	23518527	1	23518526	23518669
4-53	1	23518527	1	23518526	23518669
6V-53	1	23518481	1	23518482	23518530
3-71	1	23518527	1	23518526	23518669
4-71	1	23518527	1	23518526	23518669
6-71	1	23518481	1	23518482	23518530
6V-71	1	23518481	1	23518482	23518530
8V-71	1	23518481	1	23518482	23518530
12V-71	2	23518528	1	23518532	23518529
16V-71	2	23518528	1	23518532	23518529
6V-92	1	23518481	1	23518482	23518530
8V-92	1	23518481	1	23518482	23518530
12V-92	1	23518528	1	23518532	23518529
16V-92	1	23518528	1	23518532	23518529
8V-149	2	23518528	1	23518532	23518529
12V-149	2	23518528	2	—	23518529
16V-149	2	23518528	2	—	23518529
DDC 500	1	—		23518526	23518669
Series 40	—	—		1 820 479 C1 (6 in.)	—
Series 40	—	—		1 809 789 C1 (8 in.)	—
Series 40	—	—		23523907	—
Series 50	1	23518481		23518482	—
Series 55	—	—		23518482	—
Series 60	1	23518481		23518482	—
Series 2000 C&I	1	23518528	1	23518529	—
Series 2000 Marine	1	23518168	1	5314770301	
Series 4000 C&I	1	23512631	2	23518529	
Series 4000 Marine	1	23519405	1	5314770301	
Series 2000 Series 4000 Optional Service	1	23519404	1	23518182	

NOTE: A fuel water separator assembly may be used in place of the primary filter assembly, but not together with it.
*For Series 50 and Series 60 the fuel/water separator filter number is 23512317.

Table 12. Spin-On Fuel Filter Elements

Detroit Diesel Maintenance Products

Fuel and Lubricating Oil Filter Applications for Detroit Diesel Engines (Cont.)

Fuel Pro® 230	23521527
Fuel Pro 232	23528565
Fuel Pro 321	23518481
Fuel Pro 380/382	23521528 / 23529168#
Fuel Pro 40 Mega Filter™	23512631

#Elemax™ extended service element (optional)

Table 13. Fuel Pro® Fuel Filter Elements

Sea Pro® 50/100 (30 Micron Filter)	23519851
Sea Pro 50/100 (5 Micron Filter)	23519852
Sea Pro 150/300 (20 Micron Filter)	23518169
Sea Pro 150/300 (30 Micron Filter)	23518168
Sea Pro 152/511 (15 Micron Filter)	23521528
Sea Pro 600 (20 Micron Filter)	23519404
Sea Pro 600 (30 Micron Filter)	23519405
Water In-Fuel Sensor Kit	23518182

NOTE: The numbers after the Sea Pro name indicate the gallon per hour (GPH) flow capacity of the filter. (Does not apply to Fuel Pro.)

Table 14. Sea Pro® Fuel Filter Elements

Engine Series	Primary	Secondary
	DDC Part No.	DDC Part No.
3-53	23519148	23519162
4-53	23519148	23519162
6V-53	23519151	23519152
3-71	23519148	23519162
4-71	23519148	23519162
6-71	23519151	23519152
6V-71	23519151	23519152
8V-71	23519151	23519152
12V-71	23519153	23519154
16V-71	23519153	23519154
6V-92	23519151	23519152
8V-92	23519151	23519152
12V-92	23519153	23519154
16V-92	23519153	23519154
8V-149	N/A	N/A
12V-149	23519156	23519154
16V-149	23519156	23519154

Table 15. Cartridge Type Fuel Filter Elements

Engine	Qty.	Power Guard	Power Guard Plus
3-53	1	23518525	—
4-53	1	23518671	23518524
6V-53	1	23518671	23518524
3-71	1	23518671	23518524
4-71	1	23518671	23518524
6-71	1	23518671	23518524
6V-71	1	23518671	23518524
8V-71	1	23518671	23518524
12V-71	2	23518671	23518524
16V-71	2	23518671	23518524
6V-92	1	23518671	23518624
8V-92	1	23518671	23518524
12V-92	2 or 4	23518671	23518524
16V-92	2 or 4	23518671	23518524
8V-149	3	—	23518524
12V-149	4 or 6	—	23518524
16V-149	4 or 6	—	23518524
20V-149	6	—	23518524
DDC 500	2	23518668	—
Series 40	1	23523906	—
Series 50	2	23527033	—
Series 55	1	23540000	—
Series 60	2	23527033	23523701#
Series 60	2	23524251 (High capacity)	
Series 2000	*	23526919	
Series 4000	*	23540000	
Series 4000 Marine	*	23540039	
Series 60 (Pre-1993)			
Full Flow	2	—	—
Bypass	1	—	—

#For use with synthetic lube oil only.
*Refer to the Owner's Guide for the actual number.

Table 16. Spin-On Lubricating Oil Filters

Part No.	Description
23515823	Standard Kit
23517267	Includes Extraction Kit
23520989	Includes Prepaid Test for TBN

Table 17. Power Trac Oil Analysis Kits

Fuel Pro®, Sea Pro®, and Mega Filter™ are registered trademarks of Davco Manufacturing, L.L.C. Elemax™ is a trademark of Davco Manufacturing, L.L.C.

Statement of Detroit Diesel Corporation Warranty

Detroit Diesel Corporation is not responsible for the cost of maintenance or repairs due to the lack of performance of required maintenance services or the failure to use fuel, oil, lubricants and coolants meeting DDC-recommended specifications. Performance of required maintenance and use of proper fuel, oil, lubricants and coolants are the responsibility of the owner. For full details see the Engine Operator's Guide for your engine.

A requirement of Detroit Diesel Corporation's service contract (Power Protection Plan) is that the customer use the lubricants, fuels, and filters described in this publication in conjunction with a used oil analysis program such as the Detroit Diesel *POWER Trac* oil analysis Program.

Supplemental Information

Specifications referred to in this publication and other related information may be obtained by contacting the following sources:

1. SAE Standards

Society of Automotive Engineers
Technical Publications
400 Commonwealth Drive
Warrendale, PA 15096-0001
www.sae.org

2. ASTM Annual Book of Standards, Section 5

ASTM
100 Barr Harbor Dr.
West Conshohocken, PA 19428-2959
www.astm.org

3. EMA Lubricating Oils Databook

Engine Manufacturers' Association
Suite 2200
Two North LaSalle Street
Chicago, IL 60602
www.engine-manufacturers.com

4. API Annual List of Licensees and Other Publications

American Petroleum Institute
1220 L Street Northwest
Washington, D.C. 20005
Directory of Licensees: www.api.org/cgi-bin/eolcs.cgi

DETROIT DIESEL

13400 Outer Drive, West, Detroit, Michigan 48239-4001
Telephone 313-592-5000
www.detroitdiesel.com

COOLANT SELECTIONS

DETROIT DIESEL

Coolant Selections

For Engine Cooling Systems

COOLANT SELECTIONS

COPYRIGHT INFORMATION

GLOSSARY

The following describes terms used in this publication.

Antifreeze

Ethylene Glycol or Propylene Glycol containing a corrosion inhibitor package and which meets an appropriate heavy-duty specification, i.e., TMC RP-329 "Type A" ethylene glycol, TMC RP330 "Type A" propylene glycol or TMC RP-338 organic acid ethylene glycol.

TMC RP Specifications are published by:

The Maintenance Council
American Trucking Association, Inc.
2200 Mill Road
Alexandria, VA 22314-5388
Phone: 703-838-1763

Coolant

The fluid mixture circulating in the engine cooling system, typically a mixture of 50% water and 50% antifreeze.

Drop-Out

Precipitated sludge or deposit formation in or on cooling system components.

ESI Coolant

Extended Service Interval Coolant.

Fully Formulated Antifreeze

Contains all the necessary inhibitors to protect a diesel engine, and does not, therefore, require a pre-charge of SCA before its first use.

Initial-Fill Coolant

The coolant that is used in a new or rebuilt engine, or any time the cooling system is emptied and then refilled with new coolant.

NOAT

Nitrite Organic Acid Technology: an inhibitor system based on nitrite and organic acid inhibitors instead of conventional inhibitor formulations.

OAT

Organic Acid Technology: an inhibitor system based on organic acid inhibitors instead of conventional inhibitor formulations.

SCA

Supplemental Coolant Additives: SCAs are used in a preventative maintenance program to prevent corrosion, cavitation, and the formation of deposits.

TMC

The Maintenance Council of The American Trucking Association.

COOLANT FILL OPTIONS

The coolants recommended for use in Detroit Diesel engines are listed in Table 1. The user is urged to refer to the full text of this publication for a complete explanation of their usage.

NOTICE:
Required specifications for water, ethylene glycol, propylene glycol, inhibitor packages, and inhibitor concentration are included in this publication. To avoid possible engine damage from inadequate or over-concentrated coolant, this publication should be read thoroughly before replacing coolant.

NOTE:
Coolant requirements in this publication apply to all Detroit Diesel engines, except the Series 40 and Series 40E.

Engine Series	Coolant Fill Option	Product
50, 55, 60	Ethylene Glycol and Water + Corrosion Inhibitors[1]	DDC *POWER COOL*
	Commercial Equivalent of DDC *POWER COOL*	Fully Formulated TMC RP-329 Type A Antifreeze and Water
	Propylene Glycol and Water + Corrosion Inhibitors	Fully Formulated TMC RP330 Type A Antifreeze and Water
	Ethylene Glycol and Water + NOAT Inhibitors	DDC *POWER COOL* Plus
	Water Only + Corrosion Inhibitors[2]	Water + DDC *POWER COOL* 3000
	Water Only + NOAT Inhibitors[2]	Water + DDC *POWER COOL* Plus 6000
53, 71, 92	Ethylene Glycol and Water + Corrosion Inhibitors[1]	DDC *POWER COOL*
	Commercial Equivalent of DDC *POWER COOL*	Fully Formulated TMC RP-329 Type A Antifreeze and Water
	Propylene Glycol and Water + Corrosion Inhibitors	Fully Formulated TMC RP330 Type A Antifreeze and Water
	Ethylene Glycol and Water + NOAT Inhibitors	DDC *POWER COOL* Plus
	Water Only + Corrosion Inhibitors[2]	Water + DDC *POWER COOL* 3000
	Water Only + NOAT Inhibitors[2]	Water + DDC *POWER COOL* Plus 6000
149, 2000, 4000 (Except 2000/ 4000 Marine)	Ethylene Glycol and Water + Corrosion Inhibitors[1]	Fully Formulated TMC RP-329 Type A Antifreeze and Water or DDC *POWER COOL*
	Ethylene Glycol and Water + NOAT Inhibitors	DDC *POWER COOL* Plus
	Water Only + Corrosion Inhibitors	Water + DDC *POWER COOL* 3149
	Water Only + NOAT Inhibitors[2]	Water + DDC *POWER COOL* Plus 6000
2000 & 4000 Marine	Ethylene Glycol and Water + NOAT Inhibitors[3]	DDC *POWER COOL* Plus
	Water Only + NOAT Inhibitors[2]	Water + DDC *POWER COOL* Plus 6000

[1]Preferred Coolant

[2]Water-only coolant systems offer no freeze protection and should not be used where ambient temperatures can fall to 32°F (0°C).

[3]If the raw water temperature is over 80°F (27°C), do not use ethylene glycol. Use water only plus NOAT inhibitors.

Table 1 Initial Fill Coolant Options

COOLANTS FOR DETROIT DIESEL ENGINES

The intent of this bulletin is to provide the requirements, directions and information required to ensure cooling system protection for Detroit Diesel engines. These recommendations are general rules and reflect years of experience, technology research, and product development. Specific concerns not covered by this publication should be addressed to your local Detroit Diesel representative.

The coolant used in Detroit Diesel engines must meet the following basic requirements:

- ☐ Provide an adequate heat transfer medium.
- ☐ Protect against cavitation damage to both cylinder liners and water pumps.
- ☐ Provide a corrosion/erosion-resistant environment.
- ☐ Prevent formation of scale or sludge deposits.
- ☐ Be compatible with cooling system hose and seal materials.
- ☐ Provide adequate freeze protection.

The rest of this bulletin will describe the requirements for the proper usage of the water, antifreeze, and corrosion inhibitors. It will also describe the coolants and additives that **are not** recommended by Detroit Diesel and have been proven harmful to Detroit Diesel engines.

DETROIT DIESEL ENGINE INITIAL FILL COOLANTS

Listed in Table 1 are the approved and preferred coolants for each engine series. This section details the proper formulation of these coolants. Once in use, these coolants should be maintained according to procedures found in this publication. Refer to section titled "MAINTENANCE".

Ethylene Glycol / Water + SCA Inhibitor
Propylene Glycol / Water + SCA Inhibitor

These products are available as fully formulated, *Phosphate-Free*, Extended Service Interval (ESI) coolants. They are commercially available from Detroit Diesel (recommended) and other manufacturers, as either a concentrated antifreeze or as a pre-mixed antifreeze. The pre-mixed antifreeze is ready for use, while the concentrated coolant must be mixed with water prior to use. **Do not use this type of coolant in Series 2000 and Series 4000 marine engines.**

Detroit Diesel *POWER COOL*® Engine Coolant (P/N 23512138) is the preferred ethylene glycol coolant. If other commercial brands of ethylene glycol are used, they must be equivalent to *POWER COOL*. Detroit Diesel does not market a propylene glycol coolant. If a propylene glycol coolant is used, it must also meet the following requirements.

- ☐ Fully formulated ethylene glycol-based, low silicate antifreeze or coolant must meet TMC RP-329 "Type A" requirements.
- ☐ Fully formulated propylene glycol-based antifreeze or coolant must meet TMC RP-330 "Type A" requirements.

NOTE:
Fully formulated antifreeze does **not** require a dosage of SCA prior to initial use.

Mixing EG or PG Antifreeze and Water

If a concentrated Ethylene Glycol (EG) or Propylene Glycol (PG) antifreeze is purchased, mix the antifreeze with water meeting the required quality standards and fill the cooling system. Refer to section titled "Water Requirements." If a pre-diluted, fully formulated coolant is purchased, simply fill the cooling system. For best overall performance, a coolant consisting of 50% concentration of antifreeze (50% antifreeze, 50% water) is *recommended.* An antifreeze concentration over 67% (67% antifreeze, 33% water) is *not recommended* due to poor heat transfer, reduced freeze protection (IEG only), and possible silicate dropout. An antifreeze concentration below 33% (33% antifreeze, 67% water) offers too little freeze and/or corrosion protection and is *not recommended.*

See Figure 1 for ethylene glycol-based coolant concentration versus freezing and boiling temperatures.

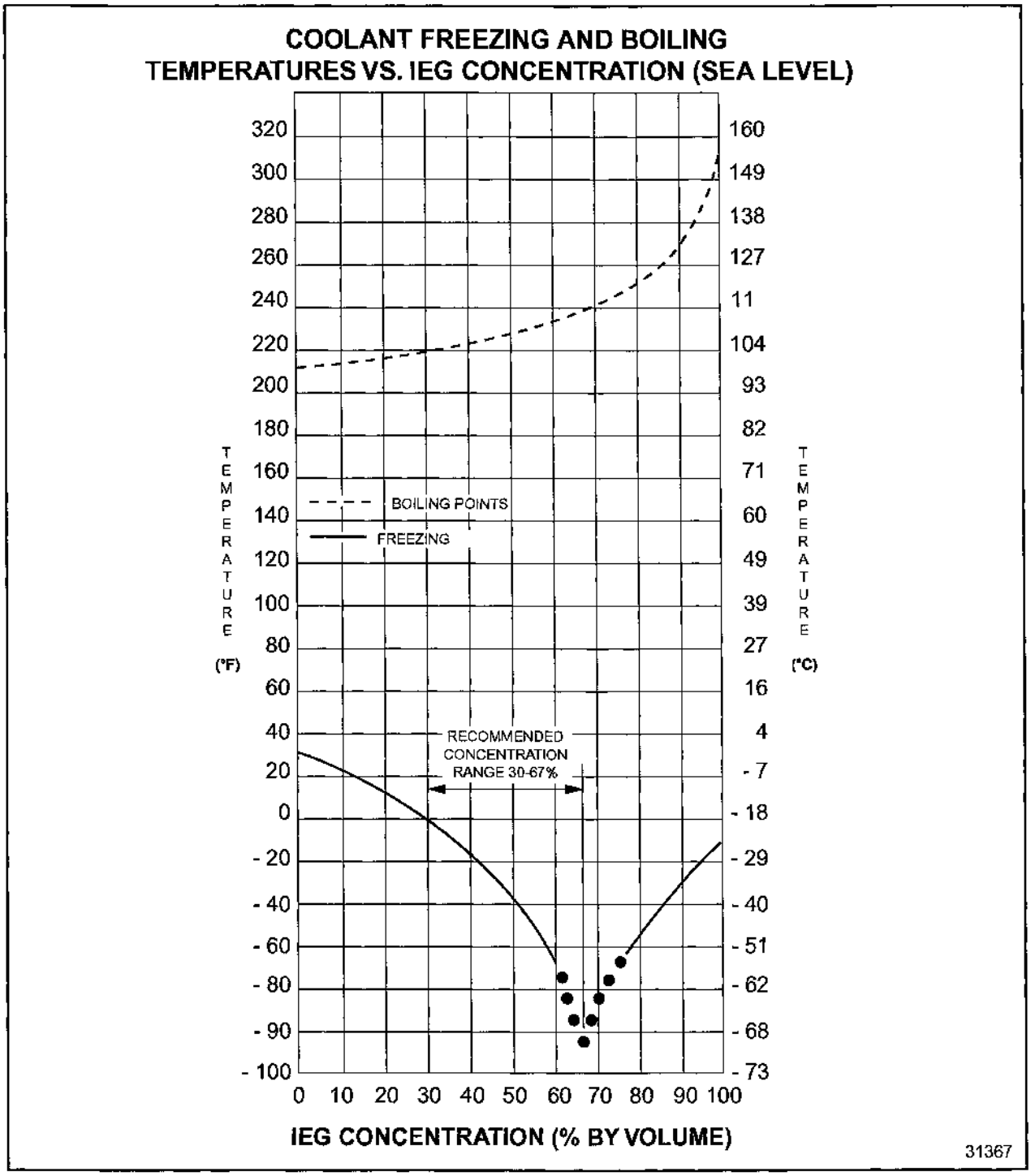


Figure 1 **Coolant Freezing and Boiling Temperatures vs. Inhibited Ethylene Glycol (IEG) Concentration (Sea Level)**

See Figure 2 for propylene glycol-based coolant concentration versus freezing and boiling temperatures.

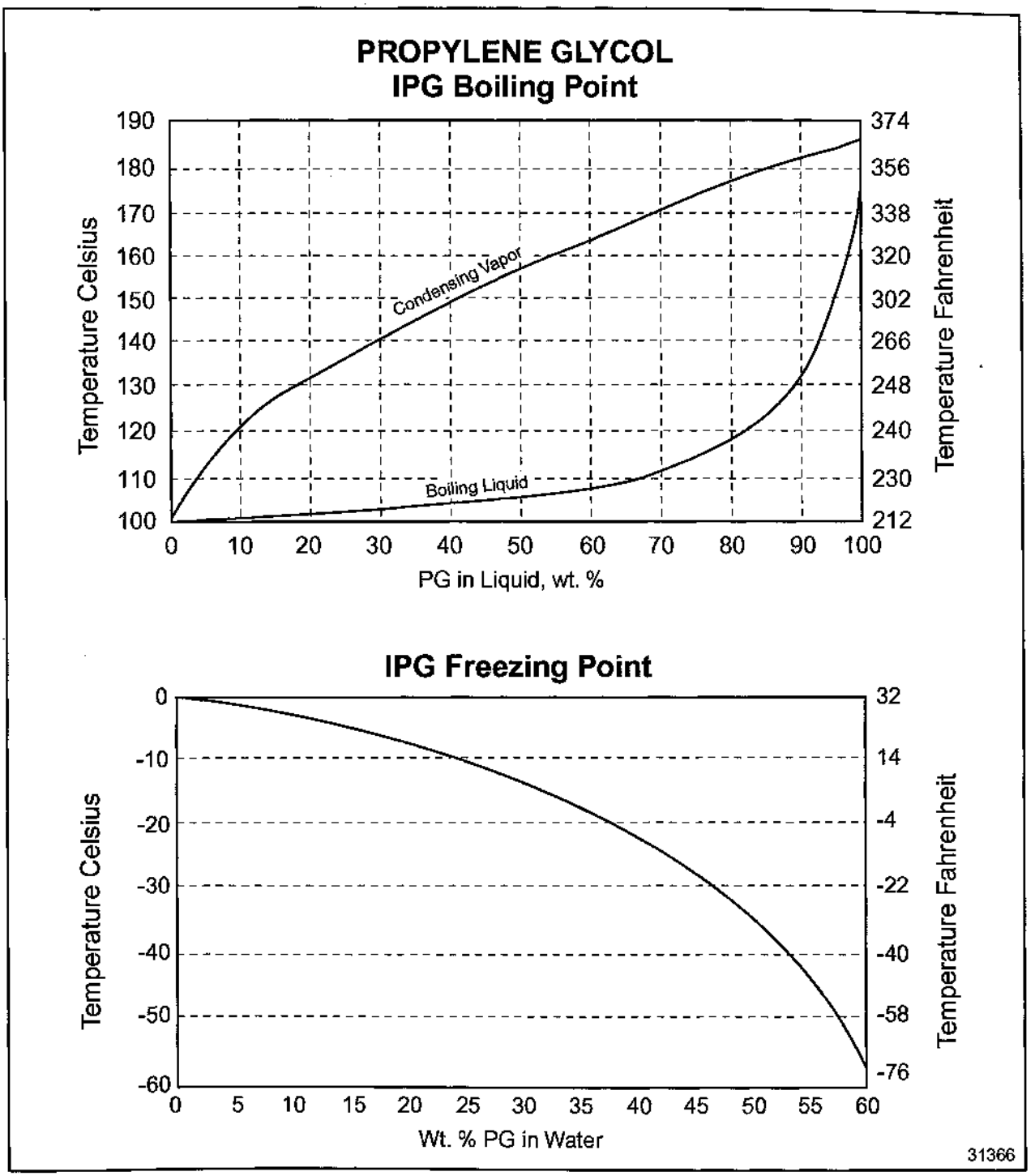


Figure 2 **Coolant Freezing and Boiling Temperatures vs. Inhibited Propylene Glycol (IPG) Concentration (Sea Level)**

Always verify that the freeze point and nitrite concentration of the antifreeze/water mix are correct by using a *Power Trac*® 3-Way Test Strip. If chemical analysis is used, elements in the coolant must fall within the limits listed in Table 2.

Boron	125-500 PPM
Nitrite	800-2400 PPM
Nitrate	200-750 PPM
Silicon	50-250 PPM
Phosphate	0 PPM Max.
pH	8.0-11

Table 2 Fully Formulated Glycol Coolant Limits with TMC RP-329, RP-330, Chemistry Type A (50/50 Coolant/Water Mixture)

Recycled Antifreeze

Antifreeze or coolant recycled by reverse osmosis, distillation, and ion exchange, properly re-inhibited to meet TMC RP-329 "Type A" or RP-330 "Type A" requirements has been demonstrated to provide service equivalent to virgin antifreeze. Recycled antifreeze or coolants of these types are preferred. Other recycled coolants, especially coolants recycled through filtration processes, are not recommended.

Ethylene Glycol / Water + NOAT Inhibitor
Propylene Glycol / Water + NOAT Inhibitor

Ethylene glycol and propylene glycol are also available with a Nitrite Organic Acid Technology (NOAT) corrosion inhibitor package. These coolants require less maintenance over the useful life of the engine. The cooling system should either be equipped with a "blank" coolant filter or the coolant filter and piping may be omitted from the system.

NOAT fully formulated antifreezes are available as concentrated and pre-mixed. Concentrated antifreezes should be mixed at 50% (50% antifreeze/50% water). NOAT coolants should not be mixed with conventional coolants. If NOAT and conventional coolants are mixed, the coolant should be maintained as a fully formulated ESI (Extended Service Interval) coolant, not as a NOAT coolant.

Detroit Diesel markets a NOAT-inhibited ethylene glycol coolant, DDC *POWER COOL*® Plus. *POWER COOL* Plus contains all of the required additives. If a non-DDC® NOAT antifreeze is used, it must conform to TMC RP 338 specification. *Do not add extender to new NOAT antifreeze or coolant.*

Water Only + SCA (*POWER COOL* 3000)
Water Only + NOAT Inhibitor (*POWER COOL* Plus 6000)

In *warm climates* where freeze protection is not required, water only with corrosion inhibitors is approved for use. Water-only systems need to be treated with the proper dosage of corrosion inhibitors. Detroit Diesel-approved SCAs or NOAT corrosion inhibitors *must* be added to the water to provide required corrosion and cavitation erosion protection. NOAT inhibitors such as *POWER COOL* Plus 6000 are available for water-only systems. Inhibitor should be mixed at 7.5% by volume with water. A listing of *POWER COOL* products is provided at the end of this brochure. Refer to section titled "*POWER COOL* ENGINE PRODUCTS." Traditional SCA (*POWER COOL* 3000) can also be used to protect the engine. Listed in Table 3 are *POWER COOL* 3000 coolant concentration limits.

Boron	125-500 PPM
Nitrite	800-2400 PPM
Nitrate	0-750 PPM
Silicon	50-400 PPM
Phosphate	0 PPM
pH	8-11.0

Table 3 *POWER COOL* 3000 Concentration Limits, (5% *POWER COOL* 3000, 95% water)

POWER COOL 3000 SCA inhibitors should be mixed at 5% by volume with water (1 quart per 5 gallons of water). These additions can be made by adding liquid SCAs available in a variety of sizes. Coolant filters are also available for different cooling system capacities. These filters release the proper amount of SCA at initial fill.

NOTE:
In Series 2000™, 4000™, and 149 engines, use a mix of 3% *POWER COOL* 3149 silicate-free SCA and 3% *POWER COOL* 3000 in the coolant water. Use only NOAT inhibitors in Series 2000 and Series 4000 marine engines.

Non-marine water-only systems for Series 2000, Series 4000, and all Series 149 engines should be charged with a mix of 3% *POWER COOL* 3000 and 3% *POWER COOL* 3149, or with *POWER COOL* Plus, after which the inhibitor levels must be maintained with *POWER COOL* 3149 or with *POWER COOL* Plus Extender. Listed in Table 4 are the coolant concentration requirements for these engines. Glycol (EG or PG) based coolant in marine applications (Series 2000 and 4000) may cause overheat problems if raw water temperature is above 80°F (27°C).

Boron	125-500 PPM
Nitrite	1200-2400 PPM
Nitrate	0-750 PPM
Silicon	0 PPM
Phosphate	0 PPM
pH	8.0-11.0

Table 4 *POWER COOL* 3149 Concentration Limits

Water Requirements

Distilled or de-ionized water which eliminates the adverse effects of minerals in tap water is preferred. High levels of dissolved chlorides, sulfates, magnesium, and calcium in some tap water causes scale deposits, sludge deposits and/or corrosion. These deposits have been shown to result in water pump failures and poor heat transfer, resulting in over-heating. If tap water is used, the mineral content in the water must be below the maximum allowable limits listed in Table 5.

NOTICE:

Do not add additional SCA to new, fully formulated antifreeze or coolant. This can result in drop-out and/or the formation of deposits.

	Maximum Allowable	
	Parts per Million	Grains per Gallon
Chlorides*	40	2.5
Sulfates*	100	5.8
Total Dissolved Solids	340	20
Total Hardness Magnesium & Calcium	170	10

*Limits currently under review

Table 5 Satisfactory Water Limits

See Figure 3 for the procedure for evaluating the quality of water.

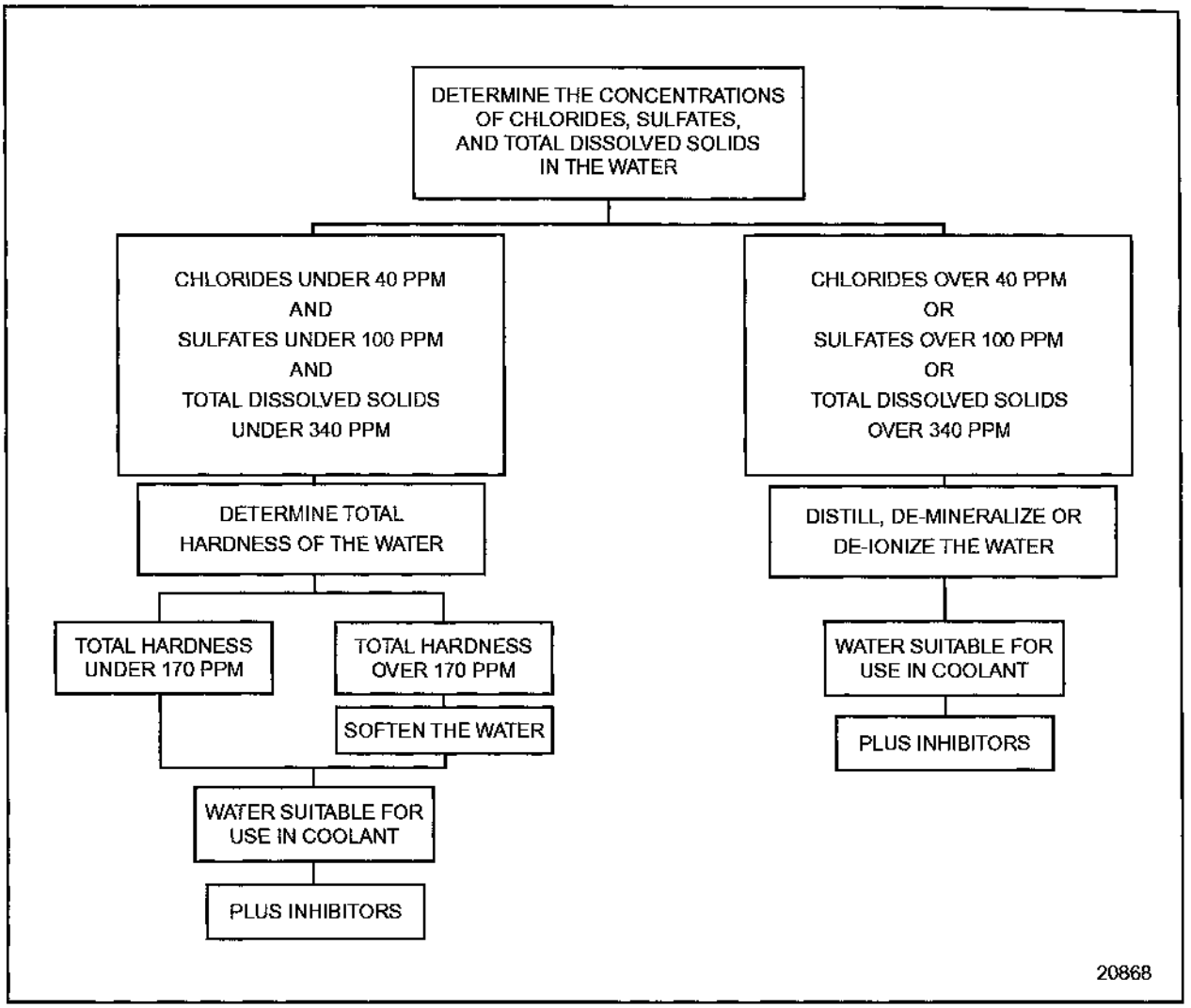


Figure 3 Procedure for Evaluating Water

COOLANTS NOT RECOMMENDED

The following describes the types of coolants not recommended for use in Detroit Diesel engines:

- ☐ **All antifreezes and coolants containing phosphate** should be avoided. Drop-out, overheating, and water pump seal failures can result from use of coolant or inhibitor packages based on phosphate.
- ☐ **Automotive type coolants** generally contain high levels of phosphate and silicate, offer no liner pitting protection, and are *not suitable* for use in Detroit Diesel engines.
- ☐ **Methyl alcohol-based antifreeze** must not be used in Detroit Diesel engines because of its effect on the non-metallic components of the cooling system and its low boiling point.
- ☐ **Methoxy propanol-based antifreeze** must not be used in Detroit Diesel engines because it is not compatible with fluoroelastomer seals found in the cooling system.
- ☐ **Glycol-based coolants formulated for heating/ventilation/air conditioning (HVAC)** should not be used in Detroit Diesel engines. These coolants generally contain high levels of phosphates, which can deposit on hot internal engine surfaces, reduce heat transfer, and cause water pump seal leaks.

ADDITIVES NOT RECOMMENDED

The following describes the types of additives not recommended for use in Detroit Diesel engines:

Soluble Oils

- ☐ Soluble oil additives are not approved for use in Detroit Diesel engine cooling systems. A small amount of oil adversely affects heat transfer. For example, a 1.25% concentration of soluble oil increases the fire deck temperature 6%. A 2.50% concentration increases the fire deck temperature 15%. The use of soluble oil additives may result in engine overheating and/or failure.

Chromates

- ☐ Chromate additives are not approved for use in Detroit Diesel engine cooling systems. Chromate additives can form chromium hydroxide, commonly called "green slime." This, in turn, can result in engine damage due to poor heat transfer. Cooling systems operated with chromate-inhibited coolant must be chemically cleaned with *POWER COOL* Twin Pack cooling system cleaner/conditioner (or equivalent sulfamic acid/sodium carbonate cleaner) and flushed.

MAINTENANCE

This section describes procedures needed for maintaining coolant level and proper concentration.

Topping Off Coolant

Coolant level should be checked at each maintenance interval. If topping off is needed, add coolant which is identical to the initial fill coolant.

Supplemental Coolant Additives For Fully Formulated Coolant

The concentrations of some inhibitors will gradually deplete during normal engine operation. SCAs replenish the protection for cooling system components. The coolant *must* be maintained with the proper concentration of SCA. Detroit Diesel *POWER COOL* maintenance products are recommended for use in all Detroit Diesel engines.

The proper application of SCA will provide:

- ☐ pH control.
- ☐ Restored Inhibitor levels to prevent corrosion.
- ☐ Water-softening to deter formation of mineral deposits.
- ☐ Cavitation protection to protect wet sleeve cylinder liners.

Check the nitrite concentration at the regular intervals listed in Table 6 with a *Power Trac* 3-Way Test Strip. Additional SCA *must* be added to the coolant when it becomes depleted, as indicated by a nitrite concentration of 800 PPM or less.

Service Application	Inhibitor Test Interval
On Highway Trucks and Motor Coaches	20,000 Miles (32,000 Kilometers)
City Transit Coaches, Pick-up and Delivery, Short Trip, and Emergency Vehicles	6,000 Miles (9,600 Kilometers) or three months, whichever comes first
Industrial, Marine, Generator Set, and all other Applications	200 Hours (300 Hours for Series 149) or yearly, whichever comes first

This table does not apply to organic acid technology-based inhibitor systems.

Table 6 Required IEG and IPG Coolant Inhibitor Test Intervals for Traditional Nitrite-based SCA

If the nitrite concentration is greater than 800 PPM, do not add additional SCA. Listed in Table 7 and listed in Table 8 are concentration limits. If the nitrite concentration is above 2400 PPM, the system is over-inhibited. The system should be partially drained, and filled with a 50/50 mix of water and EG or PG. In this case the EG or PG should contain no inhibitors, and should conform to ASTM D4985 or ASTM D5223. This will dilute the over-concentrated inhibitors.

Boron	125-500 PPM
Nitrite	800-2400 PPM
Nitrate	0-750 PPM
Silicon	50-400 PPM
Phosphate	0 PPM
pH	8.0-11.0

Table 7 *POWER COOL* 3000 Concentration Limits, (5% *POWER COOL* 3000, 95% water)

Boron	125-500 PPM
Nitrite	1200-2400 PPM
Nitrate	0-750 PPM
Silicon	0 PPM
Phosphate	0 PPM
pH	8.0-11.0

Table 8 *POWER COOL* 3149 Concentration Limits

Silicate-Free SCAs for Series 149, 2000 and 4000 Construction and Industrial Engines

The high thermal gradients experienced by coolants in high *horsepower* construction and industrial engines causes silicates to drop-out if maintained with traditional SCAs. This drop-out accumulates in the radiator tubes, reducing heat transfer and overheating the engine.

NOTICE:
Phosphate-based inhibitor packages should not be used. Overheating and water pump seal failures will result if used.

For this reason, Detroit Diesel has developed an SCA package which is formulated without silicates. The DDC-formulated package is *POWER COOL* 3149 Silicate-Free SCA or *POWER COOL* Plus. Series 149, 2000 and 4000 engines should be initially charged with silicate-free SCAs at initial fill, and should be maintained with the silicate-free SCA.

SCA Test Procedures

Nitrite concentration is an indication of the overall coolant inhibitor concentration. Coolant must be tested for nitrite concentration at the regular intervals listed in Table 9. *Power Trac* 3-Way Test Strips (or equivalent) are recommended. Nitrite levels must be within the ranges listed in Table 9.

Coolant	Interval - Whichever Comes First*	Action
DDC *POWER COOL* Antifreeze/Water	20,000 miles (32,000 km) 3 months or 500 hours	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
DDC *POWER COOL* and Need Release filter (ESI)	120,000 miles (192,000 km) 15 months or 3,000 hours	Test the freeze point and nitrite concentration with a *Power Trac* test strip. Replace the Need Release filter.
Ethylene Glycol Antifreeze/Water + SCA Inhibitor	20,000 miles (32,000 km) 3 months or 500 hours	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	300,000 miles (480,000 km) 2 years or 4,000 hours	Drain and clean system. Replace with new coolant.
Propylene Glycol/Water + SCA Inhibitor	20,000 miles (32,000 km) 3 months or 500 hours	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	300,000 miles (480,000 km) 2 years or 4,000 hours	Drain and clean system. Replace with new coolant.
Ethylene Glycol/Water + NOAT Inhibitor	300,000 miles (480,000 km) 2 years or 5,000 hours	Add *POWER COOL* Plus Extender.
	600,000 miles (960,000 km) 4 years or 10,000 hours	Drain and clean system. Replace with new coolant.
Propylene Glycol/Water + NOAT Inhibitor	300,000 miles (480,000 km) 2 years or 5,000 hours	Add *POWER COOL* Plus Extender.
	600,000 miles (960,000 km) 4 years or 10,000 hours	Drain and clean system. Replace with new coolant.
WATER ONLY + SCA Inhibitor	20,000 miles (32,000 km) 3 months or 500 hours	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	300,000 miles (480,000 km) 2 years or 4,000 hours	Drain and clean system. Replace with new coolant.
WATER ONLY + NOAT Inhibitor	300,000 miles (480,000 km) 2 years or 5,000 hours	Add *POWER COOL* Plus Extender.
	600,000 miles (960,000 km) 4 years or 10,000 hours	Drain and clean system. Replace with new coolant.

*The nitrite inhibitor test intervals shown are general recommendations and do not apply in all instances. Listed in Table 6 are specific inhibitor test intervals according to engine application.

Table 9 Coolant Maintenance Intervals

Use Detroit Diesel *Power Trac* 3-Way Coolant Test Strips to measure nitrite and glycol concentrations. Refer to section titled "*POWER COOL* ENGINE PRODUCTS" for part numbers. Cavitation/corrosion protection is indicated on the strip by the level of nitrite concentration. Freeze/Boil-over protection is determined by glycol concentration.

Use the test strips as follows:

1. Dip the strip into coolant for one second. Remove and shake briskly to eliminate excess fluid.
2. Immediately compare end pad (% Glycol) to the color chart on the container.
3. Sixty seconds (one minute) after dipping, compare the nitrite pad.
4. Color change of additive indicator (middle pad) indicates the presence of inhibitor that is *not approved* by Detroit Diesel.

NOTICE:

Failure to properly maintain coolant with SCA can result in damage to the cooling system and its related components. Conversely, over concentration of SCA inhibitor can result in water pump seal leaks and poor heat transfer, leading to engine damage. Always maintain concentrations at recommended levels. *Do not use traditional SCAs with NOAT coolant.*

For best results make the tests while the coolant is between 50°–140°F (10.0°-60°C). Wait at least 60, but not longer than 75 seconds before reading the nitrite level. Promptly replace and tighten container cap after each use. Discard unused strips if they have turned light pink or tan.

A factory coolant analysis program is available through authorized Detroit Diesel service outlets. Refer to section titled "*POWER COOL* ENGINE PRODUCTS" for part numbers. To verify coolant acceptability, submit a sample for coolant analysis every three (3) years, 300,000 miles, or 5,000 operating hours, whichever comes first

POWER COOL NEED RELEASE COOLANT FILTERS

Spin-on coolant filters are available for Series 50 and 60 engines. Membranes in the filters release SCAs before the coolant approaches a corrosive condition, protecting the engine from corrosion. The elements release the SCA charge as needed, as opposed to the maintenance SCA elements, which instantaneously release the SCA charge. These elements should be replaced after 15 months, 120,000 miles (192,000 km) or 3000 operating hours, whichever comes first.

A program is available for extending coolant life to 600,000 miles (960,000 km) or four years, whichever comes first. Using these filters will eliminate the need for scheduled coolant changes. With a properly maintained system, the coolant and need-release filters will protect the engine for 600,000 miles (960,000 km) or four years, whichever comes first. Prior approval for extending coolant life to this longer interval *must* be obtained from Detroit Diesel Corporation through one of its Regional Offices. Also, annual coolant analysis under part number 23516921 is required.

DROP-OUT

Excessive amounts of some inhibitors in the engine coolant can cause a gel or crystalline deposit that reduces heat transfer and coolant flow. The deposit, called "drop-out," takes the color of the coolant when wet, but appears as a white or gray powder when dry. It can pick up solid particles in the coolant and become gritty, causing excessive wear of water pump seals and other cooling system components. The wet gel can be removed by using a non-acid (alkali) type heavy-duty cleaner such as Detroit Diesel *POWER COOL* On-Line Cleaner (sodium nitrite/sodium tetraborate). Refer to section titled "*POWER COOL* ENGINE PRODUCTS" for part numbers. If the gel is allowed to dry, it is necessary to disassemble the engine and clean it with a caustic solution or physically clean individual components.

COOLANT EXTENDER INHIBITOR ADDITIVE FOR "NOAT" COOLANT

The inhibitors in NOAT must also be maintained, but less often than traditional SCA-type coolants. The concentrations of some inhibitors will gradually deplete during normal engine operation. An organic coolant analysis test is available under part number 23523399. Where this is not used, fleet testing has determined that a NOAT coolant extender package should be added to the coolant at 0.6% by volume at 300,000 miles (480,000 km), 2 years or 5,000 hours, whichever comes first. A properly maintained NOAT-inhibited coolant will last 4 years, 600,000 miles (960,000 km), or 10,000 hours, whichever comes first, at which time the coolant should be drained. This is the only maintenance needed for the NOAT coolants. This dosage should be added to the water-only and the glycol systems at the same interval.

NOTE:
Do not use traditional SCAs in NOAT coolant, and do not use NOAT extender in traditional coolants.

DETROIT DIESEL COOLING SYSTEM MAINTENANCE PRODUCTS

Detroit Diesel *POWER COOL* SCAs are water-soluble chemical compounds. These products are available in coolant filter elements, liquid packages, and in fully formulated *POWER COOL* antifreeze.

Coolant Filter Elements

Replaceable coolant filter elements (spin-on canisters) are available in various sizes suitable for cooling systems of varying capacity. Selection of the proper element size is vital when pre-charging non-fully formulated coolant (i.e. water) at initial fill, and at maintenance intervals. *A fully formulated antifreeze must NOT have SCA added at initial fill. Do not use SCA-containing filters with NOAT antifreeze or coolant.* The need for maintenance elements is determined by the results of the nitrite concentration test performed at each cooling system service interval. Do not automatically install maintenance elements at maintenance intervals unless the nitrite concentration level falls below 800 ppm.

Liquid SCA

POWER COOL 3000 SCA is more compatible with hard water than *POWER COOL* 2000 SCA.

Cleaners

Use *POWER COOL* Liquid On-Line Cleaner for light deposits. Use *POWER COOL* Dry Chemical Cleaner/Conditioner for heavy deposits or scale.

SUMMARY OF COOLANT RECOMMENDATIONS

Observe the following recommendations for proper coolant maintenance:

CAUTION:

To avoid possible personal injury (scalding, eye injury) from the hot coolant, never remove the cooling system fill (pressure) cap while coolant is hot. The system may be under pressure. Remove the cap *slowly* and only when coolant is at ambient temperature.

1. Always maintain the engine coolant to meet Detroit Diesel specifications.
2. Only use water that meets Detroit Diesel specifications listed in Table 10. Distilled, de-mineralized (reverse osmosis) or de-ionized water is preferred.

	Maximum Allowable Parts per Million	Maximum Allowable Grains per Gallon
Chlorides*	40	2.5
Sulfates*	100	5.8
Total Dissolved Solids	340	20
Total Hardness Magnesium & Calcium	170	10

*Limits currently under review

Table 10 Satisfactory Water Limits

3. The proper dosage of inhibitors *must* be included in the coolant at initial fill for all Detroit Diesel engines. This dosage is usually included in the fully formulated antifreeze used, or it may need to be added if water alone or if less than 50% antifreeze is used. The user is urged to refer to the full text of this publication to determine the proper dosage. Mixing of different manufacturers' technologies (brands) could cause cooling system problems.
4. Maintain the inhibitor at the prescribed concentration. Test the nitrite concentration by using a titration kit or Detroit Diesel *Power Trac* 3-Way Coolant Test Strips. Add SCA only if the nitrite concentration is below 800 PPM. *Do not use Power Trac 3-Way Test Strips or SCA in NOAT coolant.*
5. Do not use another manufacturer's test kit to measure the SCA concentration of Detroit Diesel Maintenance Products.
6. Pre-mix coolant makeup solutions to the proper concentration before adding to the cooling system.
7. Do not mix NOAT and other coolants in the same engine.
8. Do not use automotive coolants or coolants with phosphates.

9. Where freeze/boil over protection is required, use only antifreeze that meets TMC RP-329 (EG) "Type A" or TMC RP-330 (PG) "Type A" specifications. *Do not use propylene glycol in Detroit Diesel Series 149, Series 2000, or Series 4000 engines.*
10. Always maintain coolant at the proper level.
11. Coolant Life:

☐ A *properly maintained* cooling system, filled with phosphate-free coolant consisting of a 50/50 mix of antifreeze and water per TMC RP-329 "Type A" or TMC RP-330 "Type A" can be operated until overhaul. The proper maintenance involves periodic evaluation using *Power Trac* 3-Way Test Strips and addition of SCA as needed, as indicated by the strip test. To verify coolant acceptability, submit a sample for coolant analysis every three (3) years, 300,000 miles (480,000 km), 5,000 operating hours, whichever comes first. Submit the sample in a DDC *Power Trac* Coolant Test Bottle. Refer to section titled "*POWER COOL* ENGINE PRODUCTS" for part numbers.

☐ NOAT Coolant: A properly maintained NOAT coolant may be operated 4 years, 600,000 miles (960,000 km) or 10,000 operating hours, whichever comes first. At this time, the system *must* be completely drained and refilled.

☐ NOAT Coolants require the addition of an extender at 300,000 miles (480,000 km) or 5,000 hours or two years, whichever comes first. Use one pint of extender for every 20 gallons of coolant (1:160 ratio).

12. Do not use the following in Detroit Diesel engine cooling systems:

☐ Soluble oil
☐ High silicate, automotive type antifreeze
☐ Chromate SCA
☐ Methoxy propanol-base coolant
☐ Methyl alcohol-base coolant
☐ Sealer additives or coolant containing sealer additives
☐ HVAC coolant
☐ Phosphated coolants

WARRANTY INFORMATION

Any deviations from the coolant formulations or maintenance requirements stated below require prior written approval from Detroit Diesel Corporation.

Defects

The engine warranty offered by Detroit Diesel Corporation covers engine repairs to correct any malfunction occurring during the warranty period resulting from defects in material or workmanship.

Maintenance

Detroit Diesel Corporation is not responsible for the cost of maintenance or repairs due to the lack of performance of required maintenance services as recommended by Detroit Diesel, or the failure to use fuel, oil, lubricants, or coolant meeting DDC-recommended specifications. Performance of the required maintenance and use of the proper fuel, oil, lubricating oil, and coolant are the responsibility of the owner.

POWER COOL ENGINE PRODUCTS

Listed in Table 11 are *POWER COOL* fully formulated IEG coolant product descriptions.

Coolant Type	Part Number	Description
Concentrated	23512138	One Gallon Jug - 6 Per Case
	23512139	55 Gallon Drum
	23512140	Bulk Delivery - 1,000 Gallon Minimum
Pre-Blended 50:50	23518918	55 Gallon Drum
	23513503	Bulk Delivery - 1,000 Gallon Minimum

Table 11 *POWER COOL* Fully Formulated IEG Coolant

Listed in Table 12 are *POWER COOL* 2000 SCA product descriptions.

Coolant Type	Part Number	Description
For *POWER COOL* IEG Coolant	23507858	Pint Bottle - 12 Per Case
	23507859	Half Gallon Jug - 6 Per Case
	23507860	5 Gallon Pail
	23507861	55 Gallon Drum

Table 12 *POWER COOL* 2000 Supplemental Coolant Additive

Listed in Table 13 are *POWER COOL* 3000 SCA product descriptions.

Coolant Type	Part Number	Description
For *POWER COOL* IEG Coolant	23507854	Pint Bottle - 12 Per Case
	23507855	Half Gallon Jug - 6 Per Case
	23507856	5 Gallon Pail
	23507857	55 Gallon Drum

Table 13 *POWER COOL* 3000 Supplemental Coolant Additive

Listed in Table 14 are *POWER COOL* 3000 SCA filter descriptions.

Coolant Type	Part Number	Description
For *POWER COOL* IEG Coolant	23507545	4 Ounce (1 Pint Equivalent)
	23508425	8 Ounce (2 Pint Equivalent)
	23508426	12 Ounce (3 Pint Equivalent)
	23507189	16 Ounce (4 Pint Equivalent)
	23508427	32 Ounce (8 Pint Equivalent)
	23508428	53 Ounce (13 Pint Equivalent)

Table 14 *POWER COOL* 3000 Supplemental Additive Coolant Filters

Listed in Table 15 are *POWER COOL* supplemental need release coolant filter descriptions.

Coolant Type	Part Number	Description
For *POWER COOL* IEG Coolant	23516488	For 0-8 Gallon Systems
	23516489	For 8-20 Gallon Systems

Table 15 *POWER COOL* Supplemental Additive Need Release Coolant Filters

Listed in Table 16 are *POWER COOL* 1349 SCA product descriptions.

Coolant Type	Part Number	Description
For *POWER COOL* IEG Coolant	23518072	1 Gallon Jug - 6 Per Case
	23518073	5 Gallon Pail
	23518074	55 Gallon Drum

Table 16 *POWER COOL* 3149 Supplemental Coolant Additive

Listed in Table 17 are *POWER COOL* 3149 SCA filter descriptions.

Coolant Type	Part Number	Description
For *POWER COOL* IEG Coolant	23518069	4 Ounce Maintenance
	23518070	32 Ounce Pre-Charge
	23518071	53 Ounce Pre-Charge

Table 17 *POWER COOL* 3149 Supplemental Additive Coolant Filters

Listed in Table 18 are *POWER COOL* Plus extended life NOAT coolant product descriptions.

Coolant Type	Part Number	Description
Concentrated	23519397	One Gallon Jug - 6 Per Case
	23519394	55 Gallon Drum
	23519395	Bulk Delivery - 2,000 Gallon Minimum
Pre-Blended 50:50	23519396	One Gallon Jug - 6 Per Case
	23519398	55 Gallon Drum
	23519399	Bulk Delivery - 2,000 Gallon Minimum

Table 18 *POWER COOL* Plus Extended Life NOAT Coolant

Listed in Table 19 is the *POWER COOL* Plus extender product description.

Coolant Type	Part Number	Description
For *POWER COOL* Plus	23519400	One Quart Bottle - 6 Per Case

Table 19 *POWER COOL* Plus Extender for use with *POWER COOL* Plus NOAT Coolant

Listed in Table 20 are *POWER COOL* Plus 6000 NOAT inhibitor product descriptions.

Coolant Type	Part Number	Description
Water Only	23522127	One Gallon Jug - 6 Per Case
	23522128	5 Gallon Pail

Table 20 *POWER COOL* Plus 6000 NOAT Inhibitor for Water-Only Systems

Listed in Table 21 are *POWER COOL* cooling system cleaner product descriptions.

Cleaner Type	Part Number	Description
On-Line Cleaner	23507862	One - Half Gallon Jug - 6 Per Case
	23507863	5 Gallon Pail
	23507864	55 Gallon Drum
Twin Pack	23507867	Twin Pack -2 Per Case

Table 21 *POWER COOL* Cooling System Cleaners

Listed in Table 22 are the *Power Trac* coolant testing, analysis products and descriptions.

Application	Part Number	Description
Indicates Nitrite, Molybdate, and Glycol Levels	23519401	3-Way Coolant Test Strips (Single Foil Packs)
Indicates Nitrite, Molybdate, and Glycol Levels	23519402	3-Way Coolant Test Strips (Bottle of 50)
Indicates Nitrite, Molybdate, and Glycol Levels	23522774	3-Way Coolant Test Strips (Bottle of 10)
Complete Coolant Analysis	23516921	Coolant Analysis Bottle (Carton of 6)
Organic Coolant Analysis	23523398	Laboratory Coolant Analysis
Organic Coolant Analysis	23523399	Field Test Coolant Analysis

Table 22 *Power Trac* Coolant Testing and Analysis Products

Listed in Table 23 are the coolant inhibitor element size requirements.

Cooling System Capacity (Gallons)	Filters Only		Liquid Only
	Filter Quantity	Part Number	Number of Pints*
1-4	1	23507545	1/4 - 1
5-8	1	23508425	1 1/4 - 2
9-12	1	23508426	2 1/4 - 3
13-16	1	23507189	3 1/4 - 4
24-32	1	23508427	6 - 8
47-52	1	23508428	11 3/4 - 13
50-75	2	23508427	12 1/2 - 18 3/4
75-100	2	23508428	18 3/4 - 25
100-125	2	23508428	25 - 31 1/4
125-150	2	23508428	31 1/4 - 37 1/2

Not necessary if *POWER COOL* coolant is used (already pre-charged).

* Listed in Table 13 and listed in Table 14 are *POWER COOL* 3000 part numbers.

Table 23 Coolant Inhibitor Element Size Requirements - Initial Fill Dosage for IEG or IPG Plus Water Coolant Mixtures

Listed in Table 24 are the coolant inhibitor element size requirements.

Cooling System Capacity (Gallons)	Filters			Liquid Only
	Filter Quantity	Part Number	Additional SCA Required	Number of Pints or Quarts Needed *
3	1	23507545	None	2 Pints
4	2	23507545	None	2 Pints
5	1	23508425	None	3 Pints
7	1	23508426	None	4 Pints
10	1	23507189	None	5 Pints
15	2	23508426	None	8 Pints
20	1	23508427	None	10 Pints
25	1	23508427	None	13 Pints
-	1	23507545	-	-
30	1	23508427	None	15 Pints
-	1	23508426	-	-
35	1	23508427	None	18 Pints
-	1	23507189	-	-
40	2	23508427	None	$2^{1}/_{2}$ Quarts
50	2	23508427	None	$3^{1}/_{8}$ Quarts
60	1	23508428	None	$3^{3}/_{4}$ Quarts
-	1	23508427	-	-
70	2	23508428	None	$4^{3}/_{8}$ Quarts
85	2	23508428	1 Gallon **	$5^{3}/_{8}$ Quarts
100	2	23508428	2 Gallons **	$6^{1}/_{4}$ Quarts
125	2	23508428	3 1/4 Gallons **	$7^{7}/_{8}$ Quarts
150	2	23508428	5 Gallons **	$9^{3}/_{8}$ Quarts

** Use *POWER COOL* 2000 and 3000 liquid SCA, or equivalent.

* Listed in Table 12 are *POWER COOL* 2000 part numbers, listed in Table 13 and listed in Table 14 are *POWER COOL* 3000 part numbers.

Table 24 Coolant Inhibitor Element Size Requirements - Initial Dosage for Water-Only Systems

Listed in Table 25 are the coolant inhibitor element size requirements.

Cooling System Capacity (Gallons)	Filters		Liquid Only
	Filter Quantity	Part Number	Number of Pints*
1-4	1	23507545	1/4
5-8	1	23507545	1/4 - 1/2
9-12	1	23507545	1/2 - 3/4
13-16	1	23507545	3/4 - 1
24-32	1	23508425	1 1/2 - 2
47-52	1	23508426	3 - 3 1/4
50-75	2	23508426	3 1/4 - 4 3/4
75-100	2	23507189	4 3/4 - 6 1/4
100-125	2	23507189	6 1/4 - 7 3/4
125-150	2	23508427	7 3/4 - 9 1/4

* Listed in Table 12 are *POWER COOL* 2000 part numbers.

Table 25 Coolant Inhibitor Element Size Requirements - Maintenance Dosage for IEG, IPG, Precharged, and Water-Only Coolant Mixtures

Listed in Table 26 are the need release filters.

Cooling System Capacity (Gallons)	Filter Quantity	Part Number	Number of Pints*
0-8	1	23516488	N/A
8-20	1	23516489	N/A

Need Release: Use only per specific engine operator's guide instructions.

* Listed in Table 12 are *POWER COOL* 2000 part numbers.

Table 26 Need Release Filters

DETROIT DIESEL
CORPORATION

Detroit Diesel Corporation
13400 Outer Drive, West / Detroit, Michigan 48239-4001
Telephone: 313-592-5000
Fax: 313-592-7888
http://www.detroitdiesel.com

TP-6011

MTU Motoren-und Turbinen-Union
Friedrichshafen GmbH
88040 Friedrichshafen, Germany
Fax: 497547 90 3642
www.mtu-friedrichshafen.com

DETROIT DIESEL QS CERTIFIED ORGANIZATION 9000 CORPORATION

Printed in U.S.A.