Equipment Source Inc.

ES-CP41
4” Water Pump

Cornell plus Kubota equals power, performance, and durability without compromise

- Cornell centrifugal pump powered by a Kubota diesel engine
- 900+ gpm flow rate with 3-inch solids handling and 90-foot head
- Self-priming, run-dry pump with patented Cycloseal® sealing system to keep seal area clear of debris
- Rugged ESI-built skid or trailer-mounted options with built-in 25-gallon fuel tank

PUMPS

CORNELL®

Kubota®

BUILT ARCTIC TOUGH

www.EquipmentSourceInc.com

Equipment Source Inc.

ES-CP41
4” Water Pump

Pump
- Cornell STX-Series premium efficiency, self-priming pump
- Ductile iron construction
- Heavy-duty bearings with separate oil reserve
- External seal leakage monitor for dual bearing protection
- Back pull out design for ease of maintenance
- Self-cleaning adjustable wear plate
- Easily-replaceable suction check valve
- Shimless impeller

Engine
- Kubota V1505 or V1703 (ES-CP40), variable speed diesel engine
- DSE control panel for ease of operation and engine speed monitoring
- Racor fuel and water separator

Skid/Trailer
- Rugged, Arctic Tough designs by ESI
- 25-gallon built-in fuel tank

Specifications	
Suction/Discharge	4” (102mm)
Max flow	900 gpm
Max solids handling	3” (76 mm)
Max head	90’ (27.4 m)
Max speed	2100 rpm
Max shaft power	24.8 hp
Fuel type	ULSD
Fuel capacity	25 gal (94.6 L)
Fuel consumption	1.3 gph @ 2000 rpm
Skid-mounted weight	Dry: 1523 lb (691 kg) Wet: 1722 lb (781 kg)
Trailer-mounted weight	Dry: 1743 lb (791 kg) Wet: 1941 lb (880 kg)

Anchorage, AK
7780 Old Seward Hwy.
907-341-2250

Fairbanks, AK
1919 Van Horn Rd.
907-458-9049

Renton, WA
1010 SW 41st St.
425-251-6119

Williston, ND
5064 Bennet Loop
701-774-5312

EQUIPMENT SOURCE INC.
LIMITED WARRANTY

WARRANTY INFORMATION

We warrant to you, the original purchaser, that all parts (except those 3rd party components listed below) of your new ESI product purchased from an Authorized ESI Distributer or from ESI directly will be free from defects in materials or workmanship for 1 (one) year/2,000 hours (whichever occurs first) from invoice date. Additional component warranties are listed below.

Summary of major component warranties (see component sections of this manual for further details and additional warranties):

1. Engine – 2 years/2,000 hours, whichever occurs first (please refer to the Kubota Engine Warranty sheet enclosed in this manual)
2. Pump – 1 year (please refer to the pump warranty sheet enclosed in this manual), wear parts are not covered under warranty.

In order to obtain warranty repairs, you must deliver the product, at your expense, together with proof of purchase to 1919 Van Horn Road, Fairbanks, AK 99701 or 7780 Old Seward Highway, Anchorage, AK 99518. Offsite warranty may be performed if customer pays all travel expenses.

WHAT THE WARRANTY DOES NOT COVER

This warranty **does not** cover:

1. Damage, malfunction or failures resulting from accidents, abuse, misuse, modifications, alteration, improper servicing or lack of performance of required maintenance service voids the warranty including but not limited to regularly scheduled oil changes and filter changes.
2. Normal maintenance services or replacement of maintenance items such as light bulbs, preheater plugs, filter elements, lubricants, oils, coolant, belts, tires, or other wear items.
3. 3rd party parts installed on ESI products. Unauthorized modifications to the unit will void the warranty and may impair function.
4. Use of the unit for application other than what the product was meant for voids the warranty.
5. Warranty coverage expires whenever the client, for whatever reason, is late in payment.
6. The warranty does not cover repairs or modifications for small oil weeps on Long Run Oil Tanks (if installed). A small amounting of weeping during break in is expected and does not warrant repairs.

LIMITATION ON OUR RESPONSIBILITY

Our responsibility for any and all losses and damages resulting from any cause whatsoever, including our negligence, alleged damage or defective goods, whether such defects are discoverable or latent, shall be limited to the repair or replacement of defective parts. IN NO EVENT WILL ESI BE LIABLE FOR LOSS OF USE, LOSS OF PROFITS, LOSS OF OR DAMAGE TO OTHER PROPERTY, INCONVENIENCE, COMMERCIAL LOSS, ENVIRONMENTAL CLEANUP OR OTHER SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER. ESI will in no event be liable for fuel, oil, coolant or other spills or cleanup regardless of cause or fault. Proper containment and monitoring is the responsibility of the end user.

OPERATION & SAFETY REQUIREMENTS

Failure to adhere to these requirements will void all warranties.

- Read and understand carefully all components of the Operator's Manual prior to starting or operating the unit.
- All equipment must be monitored daily (or more frequently if indicated in the Operation Manual). Monitoring can be achieved via electronic monitoring systems for remote

installations (unless otherwise noted in the Operation Manual).

- Learn how to operate and work safely. Know your equipment and its limitations. Always keep the engine in good condition.
- Disconnect the trailer from the tow vehicle and place wheel chocks behind the wheels prior to running or operating the unit.
- Do not carry out maintenance on a running or hot unit. Keep hands away from moving parts.
- Do not climb on top of the unit to perform work of any kind.
- When lifting the unit, ensure that the lifting device is rated for the unit weight. Only lift the unit with provided lifting rings or fork pockets.
- In case of emergency, shut off the engine and notify the person in responsible charge.
- Follow all applicable laws and regulations regarding operation and maintenance of the unit.
- Ensure that the trailer is registered with an applicable transport authority before towing.
- Refer to the various component sections of the Operator's Manual for proper maintenance and service intervals.

DSEGenset

DSE402 MKII
WATERPROOF MANUAL/AUTO START CONTROL MODULE

FEATURES

The DSE402 MKII is a waterproof Manual/Automatic Start Control Module designed for genset and other applications. The module is designed to start and stop the engine via a manual waterproof key switch on the front panel. It will provide a number of engine protections, automatically shutting down the engine on detection of a fault condition. Provision is also made for an overspeed shutdown from either the MPU or AC Hz (to be specified on ordering).

First-up shutdown alarm is indicated by a steady red LED.

ENVIRONMENTAL TESTING STANDARDS

ELECTRO MAGNETIC COMPATIBILITY
BS EN 61000-6-2
EMC Generic Immunity Standard for the Industrial Environment
BS EN 61000-6-4
EMC Generic Emission Standard for the Industrial Environment

ELECTRICAL SAFETY
BS EN 60950
Safety of Information Technology Equipment, including Electrical Business Equipment

TEMPERATURE
BS EN 60068-2-1
Ab/Ae Cold Test -30°C
BS EN 60068-2-2
Bb/Be Dry Heat +70°C

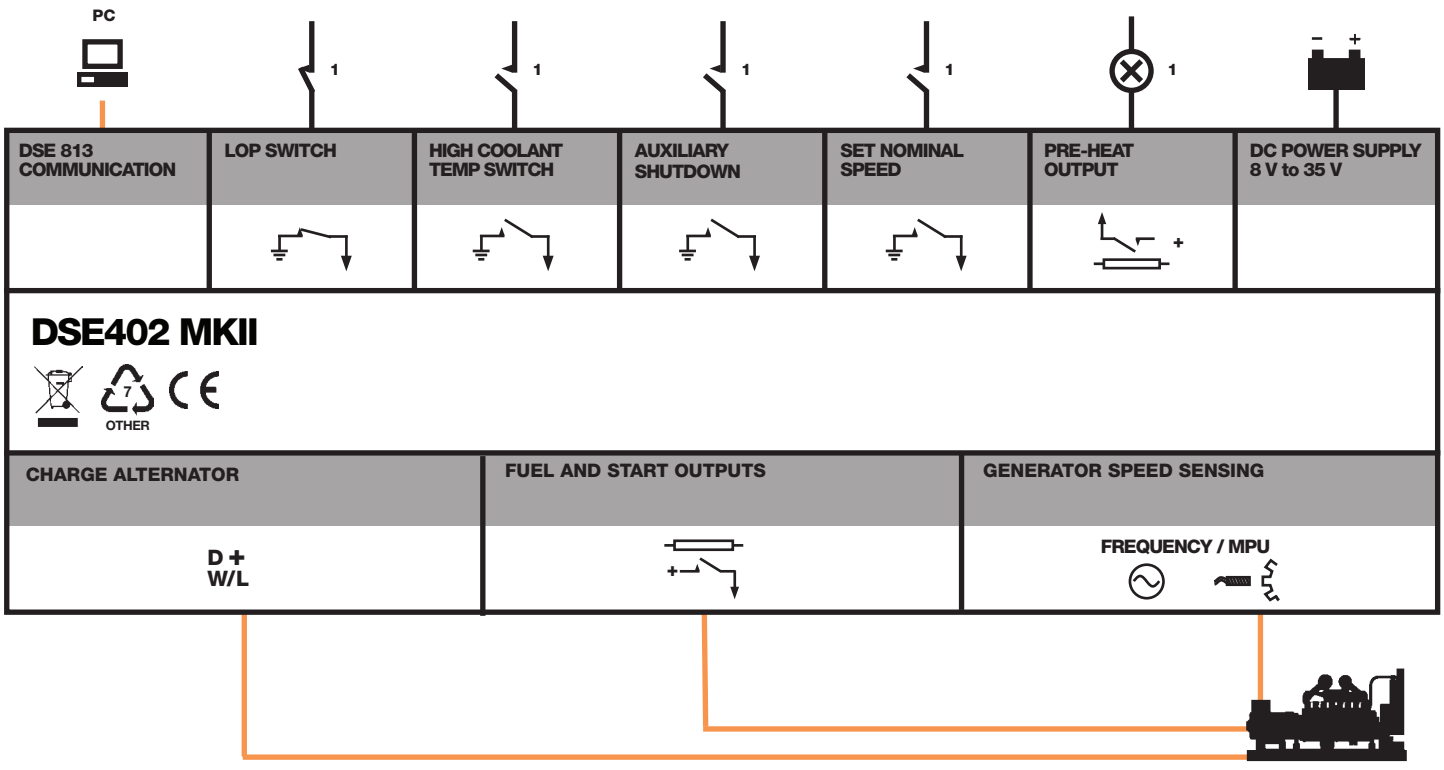
VIBRATION
BS EN 60068-2-6
Ten sweeps in each of three major axes
5Hz to 8Hz @ +/-7.5mm, 8Hz to 500Hz @ 2gn

HUMIDITY
BS EN 60068-2-30
Db Damp Heat Cyclic 20/55°C @ 95% RH
48 Hours
BS EN 60068-2-78
Cab Damp Heat Static 40°C @ 93% RH
48 Hours

SHOCK
BS EN 60068-2-27
Three shocks in each of three major axes
15gn in 11mS

DEGREES OF PROTECTION PROVIDED BY ENCLOSURES
BS EN 60529
IP66

COMPREHENSIVE FEATURE LIST TO SUIT A WIDE VARIETY OF GEN-SET APPLICATIONS



ISSUE 1

DSEGenset

DSE402 MKII
WATERPROOF MANUAL/AUTO START CONTROL MODULE

FEATURES

KEY FEATURES

- Key start
- Low oil pressure protection
- High engine temperature protection
- Auxiliary shutdown
- PC configurable via DSE813 interface and DSE Configuration Suite PC Software
- Automatic engine pre-heat
- Overspeed protection

KEY BENEFITS

- IP66 rating makes this module ideal for outdoor use
- Potted electronics prevents vibration and water damage
- Licence-free PC Software
- User friendly set up and fascia layout
- Uses DSE Configuration Suite PC Software for simple configuration

SPECIFICATION

DC SUPPLY

CONTINUOUS VOLTAGE RATING
8 V to 35 V continuous

CRANKING DROPOUTS
Able to survive 0 V for 50 mS, providing supply was at least 10 V before dropout and supply recovers to 5 V. This is achieved without the need for internal batteries.

MAXIMUM OPERATING CURRENT
120 mA at 12 V, 170 mA at 24 V

TYPICAL OPERATING CURRENT
60 mA at 12 V, 75 mA at 24 V
In stop position consumption is zero.

CHARGE/FAIL EXCITATION RANGE
0 V to 35 V

OUTPUTS

FUEL
15 A DC at supply voltage

START
15 A DC at supply voltage

PRE-HEAT
2 A DC at supply voltage

DIMENSIONS

OVERALL
157 mm x 111 mm x 60 mm
6.2” x 4.4” x 2.4”

PANEL CUT-OUT
132 mm x 84 mm

STORAGE TEMPERATURE RANGE
-40°C TO +85°C

OPERATING TEMPERATURE RANGE
-30°C TO +70°C

RELATED MATERIALS

TITLE	PART NO’S
DSE402 MKII Installation Instructions	053-087
DSE402 MKII Operator Manual	057-137
DSE402 MKII Configuration Suite Lite Software Manual	057-138
DSE813 USB Communications Adaptor Data Sheet	055-100

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DEEP SEA ELECTRONICS PLC
DSE402 MKII WATERPROOF KEYSTART CONTROLLER

Document number 057-137

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DSE Model DSE402 MKII WATERPROOF KEYSTART CONTROLLER Operators Manual

Amendments since last publication

Issue no.	Comments
1	First Release
2	Amended dimensions of Panel cut out & drawing dimensions

Clarification of notation used within this publication.

NOTE:	Highlights an essential element of a procedure to ensure correctness.
CAUTION!	Indicates a procedure or practice, which, if not strictly observed, could result in damage or destruction of equipment.
WARNING!	Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.

TABLE OF CONTENTS

Section **Page**

1 BIBLIOGRAPHY

This document refers to and is referred to by the following DSE publications which can be obtained from the DSE website www.deepseaplc.com

1.1 INSTALLATION INSTRUCTIONS

Installation instructions are supplied with the product in the box and are intended as a 'quick start' guide only.

DSE PART	DESCRIPTION
053-087	DSE402 MKII Installation Instruction

1.2 MANUALS

DSE PART	DESCRIPTION
057-138	DSE402 MKII Configuration Suite Lite Software Manual

2 INTRODUCTION

This document details the installation and operation requirements of the DSE 402 MKII controller is part of the DSEGenset ® range of products.
The manual forms part of the product and should be kept for the entire life of the product. If the product is passed or supplied to another party, ensure that this document is passed to them for reference purposes.
This is not a *controlled document.* You will not be automatically informed of updates. Any future updates of this document will be included on the DSE website at www.deepseaplc.com

The model 402 is a waterproof key start controller. The controller is used to start and stop a engine, indicating fault conditions, automatically shutting down the engine for configured conditions and indicating the engine fault by a steady (WARNING) Shutdown (FLASHING) red LED.

Operation of the module is via a 3 position 'waterproof' key-switch with STOP (O), RUN (I) and START (II) positions. Turning the switch to the 'I' position will initiate a pre-heat relay . Pre-heat operation is indicated by a LED. Once the timer has expired the pre-heat relay will de-energise and the LED will extinguish. The preheat timer output can be configured.

The FUEL relay will then energise and on crank disconnect the Safety On delay timer will commence.

Pre-heat mode can be overridden at any time by turning the switch from the 'I' position to the 'II' position while the preheat LED is illuminated.

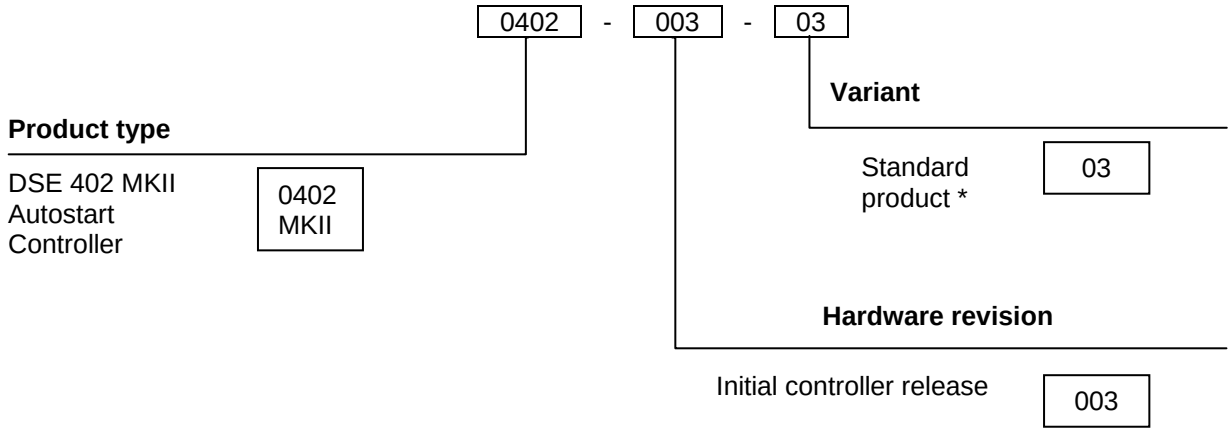
The Model 402 as described above can be configured for (AUTO), when the key position is left in RUN (I) a remote switch can be operated away from the controller to start and stop the engine.

Using a PC and the Configuration Suite Lite software along with the P813 interface allows configuration of selected operational sequences.

The Model 402 is resin encapsulated in a robust plastic case, designed for front panel mounting and supplied with a silicone seal to give IP 66 protection for the front of controller. Connections are via locking plug to Key switch and ¼ inch spade connectors.

3 SPECIFICATIONS

3.1 PART NUMBERING



* Standard product is Magnetic Pickup that can also be configured to sense frequency Hz or RPM using P813 interface and DSE Configuration Suite Lite software.

At the time of this document production, there are no variants of DSE402 MK II product.

3.2 TERMINAL SPECIFICATION

Connection type	Two part connector. • Male part fitted to controller • Female part is via ¼" Crimp Connectors (not supplied)
Minimum cable size	0.5mm² (AWG 24) (check crimp specification)
Maximum cable size	2.5mm² (AWG 10) (check crimp specification)

3.3 POWER SUPPLY REQUIREMENTS

Minimum supply voltage	8V continuous
Cranking dropouts	Able to survive 0V for 50mS providing the supply was at least 10V before the dropout and recovers to 5V afterwards. This is more than sufficient to allow the controller to operate during engine cranking where the battery supply often falls as low as 4V (on a 12V system!) This is achieved without the need for internal batteries or other external requirements.
Maximum supply voltage	35V continuous (60V protection for surges)
Reverse polarity protection	-35V continuous
Maximum operating current	170mA at 24V 120mA at 12V
Maximum standby current	In stop position consumption is zero

3.4 INPUTS

Number	(4) Auxiliary, Oil Pressure, Coolant Temp, Set Nominal Speed
Arrangement	Contact between terminal and ground
Low level threshold	2.1V minimum
High level threshold	6.6V maximum
Maximum input voltage	+50V DC with respect to plant supply negative
Minimum input voltage	-24V DC with respect to plant supply negative
Contact wetting current	2.5mA typical
Open circuit voltage	12V typical

3.4.1 FREQUENCY SENSING INPUT HZ , RPM

Measurement type	Frequency
Input Impedance	900K Ω ph-N
Phase to Neutral	15V to 333V AC (max)
Minimum frequency	3.5Hz
Maximum frequency	75.0Hz
Frequency resolution	0.1Hz
Frequency accuracy	±0.2Hz

3.4.2 MAGNETIC PICKUP

Type	Differential input
Minimum voltage	0.6V RMS
Max common mode voltage	±2V
Maximum frequency	10,000Hz
Resolution	6.25 RPM
Accuracy	±25 RPM

NOTE : DSE can supply a suitable magnetic pickup device, available in two body thread lengths :
DSE Part number 020-012 - Magnetic Pickup probe 5/8 UNF 2½" thread length
DSE Part number 020-013 - Magnetic Pickup probe 5/8 UNF 4" thread length

Magnetic Pickup devices can often be 'shared' between two or more devices. For example, one device can often supply the signal to both the DSE402 MKII speed switch and the engine governor. The possibility of this depends upon the amount of current that the magnetic pickup can supply.

3.5 CHARGE FAIL INPUT/OUTPUT

Minimum voltage	0V
Maximum voltage	35V (plant supply)
Resolution	0.2V
Accuracy	±1% of max measured voltage (±0.35V)
Excitation	Active circuit constant power output
Output Power	2.5W Nominal @12V and 24V
Current at 12V	210mA
Current at 24V	104mA

The charge fail input is actually a combined input and output.
Whenever the generator is required to run, the terminal provides excitation current to the charge alternator field winding.
When the charge alternator is correctly charging the battery, the voltage of the terminal is close to the plant battery supply voltage. In a failed charge situation, the voltage of this terminal is pulled down to a low voltage. It is this drop in voltage that triggers the *charge failure* alarm. The level at which this operates and whether this triggers a warning or shutdown alarm is configurable using the DSE Config Suite Lite Software.

3.6 OUTPUTS

3.6.1 FUEL (A), CRANK (B),

Type	Normally used for Preheat, Fuel and Start outputs.
Rating	15A resistive @ 35V

3.6.2 PRE-HEAT

Type	configurable output (Common Alarm, Energise to stop, Pre-heat)
Rating	2A resistive @ 35V

4 PC CONFIGURATION

P813 Interface	USB2.0 Device for connection to PC running DSE configuration suite Lite only Max distance 6m (yards)

4.1.1 PC COMMUNICATION

Using the DSE (P813 interface lead package available from Deep Sea PLC) with all the below items, the DSE 402 MKII controller can be connected to a computer to enable simple configuration of parameters. Connection details can be seen in the DSE 402 MKII Configuration Suite Lite software manual (Part no 057-138).

To connect a DSE402 MKII controller to a PC by USB, the following items are required:

- DSE402 MKII Controller

- P813 PC Interface (USB) DSE Part number 016-125

- DSE 402 MKII DSE configuration Suite Lite software
- Available from the DSE Website www.deepseaplc.com
- The software CD will be supplied with the P813 PC Interface (USB)

NOTE:- The DC supply must be connected to the controller for configuration by PC.

NOTE:- Refer to DSE402 MKII PC Software Manual (DSE part) for further details on connecting the P813 to the controller and PC.

4.2 DIMENSIONS AND MOUNTING

4.2.1.1 DIMENSIONS

158 mm x 112 mm x 87 mm*
(6.2” x 4.4” x 3.4”*)
* excluding key switch

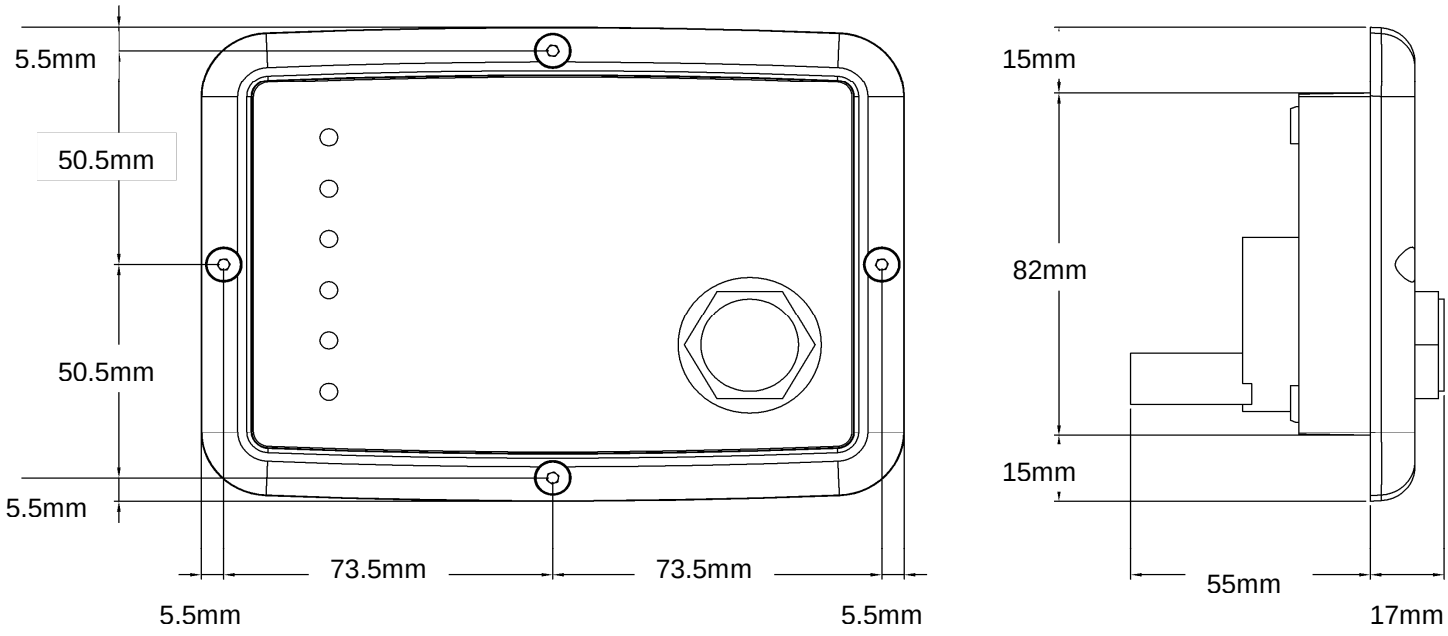
PANEL CUTOUT
132 mm x 84 mm
(5.2” x 3.3”)

Mounting
Waterproof sealing gasket for details see elsewhere in this manual.

The key-switch barrel has a drain hole which exits on the underside of the switch behind the mounting flange. Ensure suitable arrangements are made if mounting the controller within an enclosure.

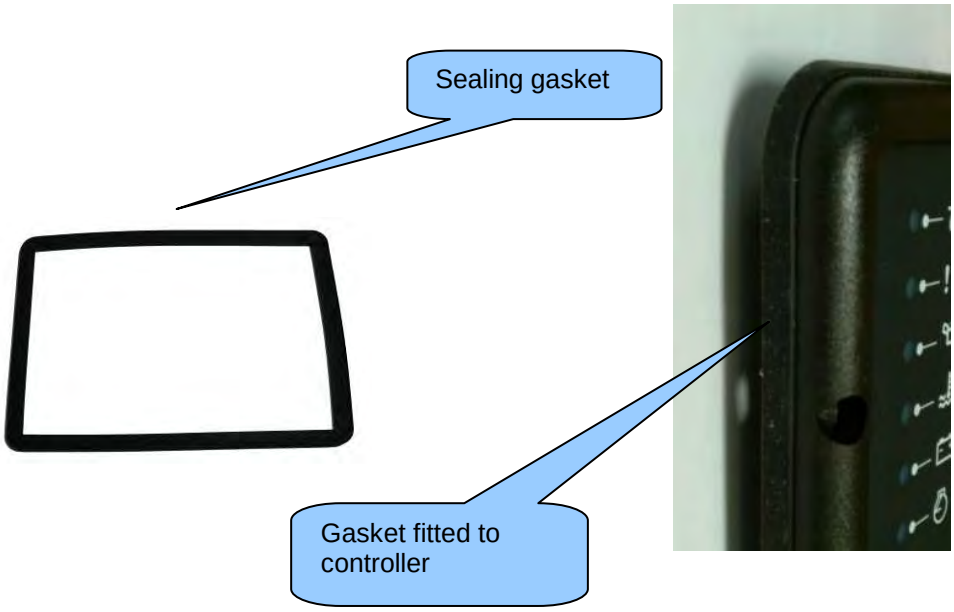
Screw Size: M4
Torque Rating: 0.60 Nm

WEIGHT
0.3 Kg (0.661 lb)



4.2.2 SILICON SEALING GASKET

The supplied silicon gasket provides improved sealing between the DSE402 MKII controller and the panel fascia.
The gasket is fitted to the controller before installation into the panel fascia.
Take care to ensure the gasket is correctly fitted to the controller to maintain the integrity of the seal.



4.3 APPLICABLE STANDARDS

BS 4884-1	This document conforms to BS4884-1 1992 Specification for presentation of essential information.
BS 4884-2	This document conforms to BS4884-2 1993 Guide to content
BS 4884-3	This document conforms to BS4884-3 1993 Guide to presentation
BS EN 60068-2-1 (Minimum temperature)	-30°C (-22°F)
BS EN 60068-2-2 (Maximum temperature)	+70°C (158°F)
BS EN 60950	Safety of information technology equipment, including electrical business equipment
BS EN 61000-6-2	EMC Generic Immunity Standard (Industrial)
BS EN 61000-6-4	EMC Generic Emission Standard (Industrial)
BS EN 60529 (Degrees of protection provided by enclosures) (see overleaf)	IP66 (front of controller when installed into the control panel with the supplied sealing gasket) IP42 (front of controller when installed into the control panel WITHOUT being sealed to the panel)
UL508 **NEMA rating** (Approximate) (see overleaf)	12 (Front of controller when installed into the control panel with the supplied sealing gasket). 2 (Front of controller when installed into the control panel WITHOUT being sealed to the panel)
IEEE C37.2 (Standard Electrical Power System Device Function Numbers and Contact Designations)	Under the scope of IEEE 37.2, *function numbers can also be used to represent functions in microprocessor devices and software programs*. As the controller is configurable by the generator OEM, the functions covered by the controller will vary. Under the controller's factory configuration, the device numbers included within the controller are : 2 – Time delay starting or closing relay 6 – Starting circuit breaker 30 – annunciator relay 54 – turning gear engaging device 62 – time delay stopping or opening relay 63 – pressure switch 74– alarm relay 81 – frequency relay 86 – lockout relay

In line with our policy of continual development, Deep Sea Electronics, reserve the right to change specification without notice.

4.3.1 ENCLOSURE CLASSIFICATIONS

IP CLASSIFICATIONS

DSE402 MKII **BS EN 60529** Degrees of protection provided by enclosures

IP66 (Front of controller when controller is installed into the control panel with the optional sealing gasket).
IP42 (front of controller when controller is installed into the control panel WITHOUT being sealed to the panel)
IP54 Rear of controller(suitable grease should be applied to terminals if exposed to a harsh environment

First Digit Protection against contact and ingress of solid objects		Second Digit Protection against ingress of water	
0	No protection	0	No protection
1	Protected against ingress solid objects with a diameter of more than 50 mm. No protection against deliberate access, e.g. with a hand, but large surfaces of the body are prevented from approach.	1	Protection against dripping water falling vertically. No harmful effect must be produced (vertically falling drops).
2	Protected against penetration by solid objects with a diameter of more than 12 mm. Fingers or similar objects prevented from approach.	2	Protection against dripping water falling vertically. There must be no harmful effect when the equipment (enclosure) is tilted at an angle up to 15° from it s normal position (drops falling at an angle).
3	Protected against ingress of solid objects with a diameter of more than 2.5 mm. Tools, wires etc. with a thickness of more than 2.5 mm are prevented from approach.	3	Protection against water falling at any angle up to 60° from the vertical. There must be no harmful effect (spray water).
4	Protected against ingress of solid objects with a diameter of more than 1 mm. Tools, wires etc. with a thickness of more than 1 mm are prevented from approach.	4	Protection against water splashed against the equipment (enclosure) from any direction. There must be no harmful effect (splashing water).
5	Protected against harmful dust deposits. Ingress of dust is not totally prevented but the dust must not enter in sufficient quantity to interface with satisfactory operation of the equipment. Complete protection against contact.	5	Protection against water projected from a nozzle against the equipment (enclosure) from any direction. There must be no harmful effect (water jet).
6	Protection against ingress of dust (dust tight). Complete protection against contact.	6	Protection against heavy seas or powerful water jets. Water must not enter the equipment (enclosure) in harmful quantities (splashing over).

NEMA CLASSIFICATIONS

402 MKII NEMA Rating (Approximate)

4 (Front of controller when controller is installed into the control panel with the optional sealing gasket).
3 (front of controller when controller is installed into the control panel WITHOUT being sealed to the panel)
2 Rear of controller (suitable grease should be applied to terminals if exposed to a harsh environment)

NOTE: - There is no direct equivalence between IP / NEMA ratings. IP figures shown are approximate only.

1 **IP30**	Provides a degree of protection against contact with the enclosure equipment and against a limited amount of falling dirt.
2 **IP31**	Provides a degree of protection against limited amounts of falling water and dirt.
3 **IP64**	Provides a degree of protection against windblown dust, rain and sleet; undamaged by the formation of ice on the enclosure.
3R **IP32**	Provides a degree of protection against rain and sleet:; undamaged by the formation of ice on the enclosure.
4 (X) **IP66**	Provides a degree of protection against splashing water, windblown dust and rain, hose directed water; undamaged by the formation of ice on the enclosure. (Resist corrosion).
12/12K **IP65**	Provides a degree of protection against dust, falling dirt and dripping non corrosive liquids.
13 **IP65**	Provides a degree of protection against dust and spraying of water, oil and non corrosive coolants.

5 INSTALLATION

The DSE402 MKII controller is designed to be mounted on the panel fascia. For dimension and mounting details, see the section entitled *Specification, Dimension and mounting* elsewhere in this document.

5.1 TERMINAL DESCRIPTION

5.1.1 DC SUPPLY, FUEL AND START OUTPUTS

Icon	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	1	DC Plant Supply Input (Positive) Minimum 8V to 35V	2.5mm² AWG 13	Recommended Maximum Fuse 30A anti-surge)
	2	Output relay (B) (Crank)	2.5 mm² AWG 13	Plant Supply Positive from terminal 1. 15 Amp rated.
	3	Output relay (C) (PRE-HEAT)	2.5mm² AWG 13	Plant Supply Positive from terminal 1. 2 Amp rated.
	4	Output relay (A) (FUEL)	2.5mm² AWG 13	Plant Supply Positive from terminal 1. 15 Amp rated.
	5	DC Plant Supply Input (Negative)	2.5mm² AWG 13	
	6	Auxiliary shutdown	1.0mm² AWG 18	Configurable input
	7	Oil Pressure	0.5mm² AWG 20	Connect to Oil pressure switch
	8	Coolant Temperature	0.5mm² AWG 20	Connect to Coolant Temperature switch
D + W/L	9	Charge fail / excite	1.0mm² AWG 18	
	10	Signal +	0.5mm² AWG 20	Magnetic pickup Positive / Frequency Hz or RPM sensing
Hz	11	Signal -	0.5mm² AWG 20	Magnetic pickup Negative / Frequency Hz or RPM sensing
	12	SET NOMINAL SPEED	1.0mm² AWG 18	Configurable Input

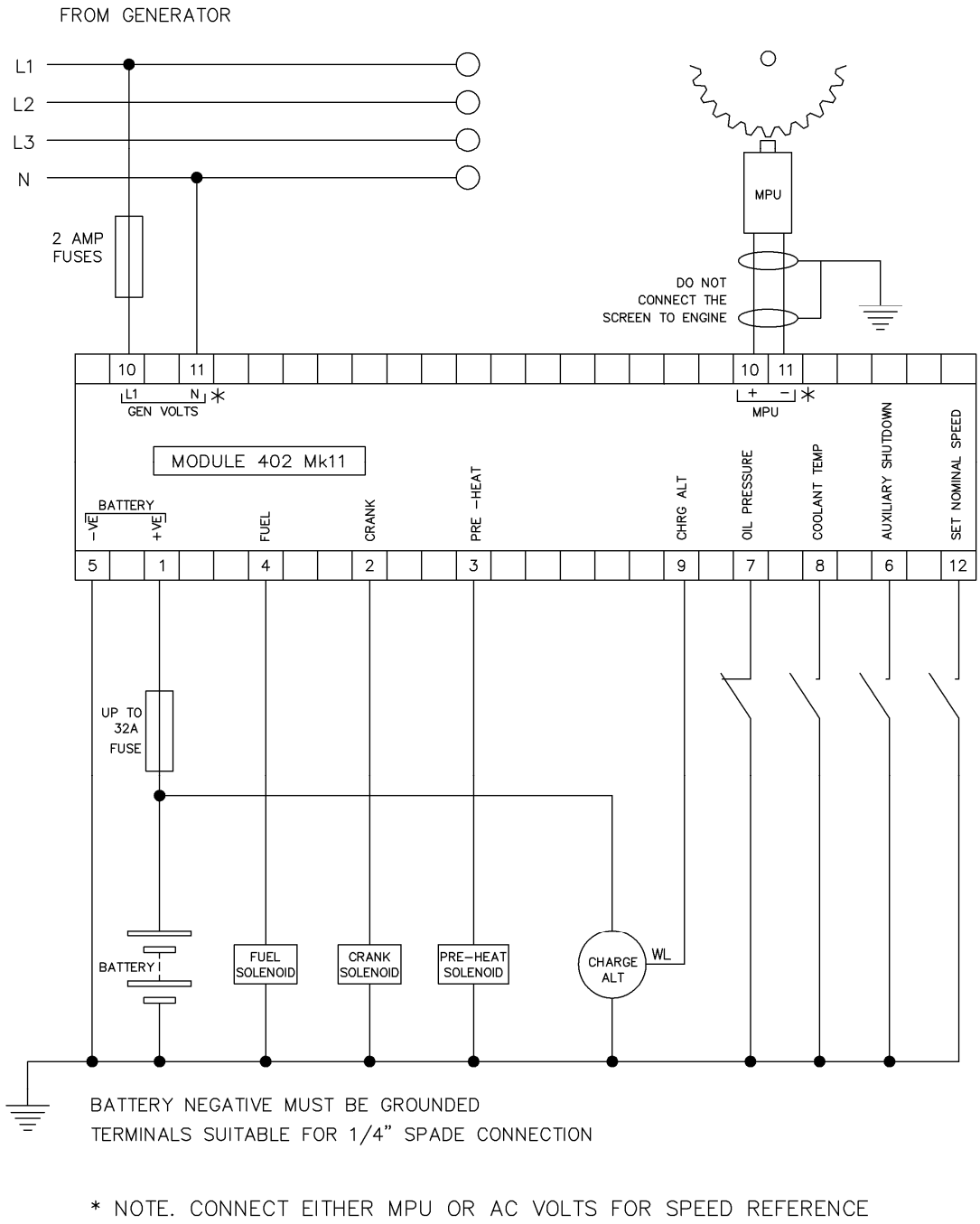
NOTE: - If you use PTFE insulating tape on the Oil pressure or Temperature switch thread when using earth return switches, ensure you do not insulate the entire thread, as this will prevent the switch body from being earthed via the engine block.

NOTE:- Screened cable must be used for connecting the Magnetic Pickup, ensuring that the screen is earthed at one end ONLY other wise the cable will act as an aerial.

5.2 TYPICAL WIRING DIAGRAMS

As every system has different requirements, these diagrams show only a TYPICAL system and do not intend to show a complete system.

Further wiring suggestions are available in the following DSE publications, available at www.deepseaplc.com to website members.



5.2.1 EARTH SYSTEMS

5.2.1.1 NEGATIVE EARTH

The typical wiring diagrams located within this document show connections for a negative earth system (the battery negative connects to Earth)

5.2.1.2 POSITIVE EARTH

When using a DSE controller with a Positive Earth System (the battery positive connects to Earth), the following points must be followed:

- Follow the typical wiring diagram as normal for all sections EXCEPT the earth points
- All points shown as Earth on the typical wiring diagram should connect to BATTERY NEGATIVE (not earth).

5.2.1.3 FLOATING EARTH

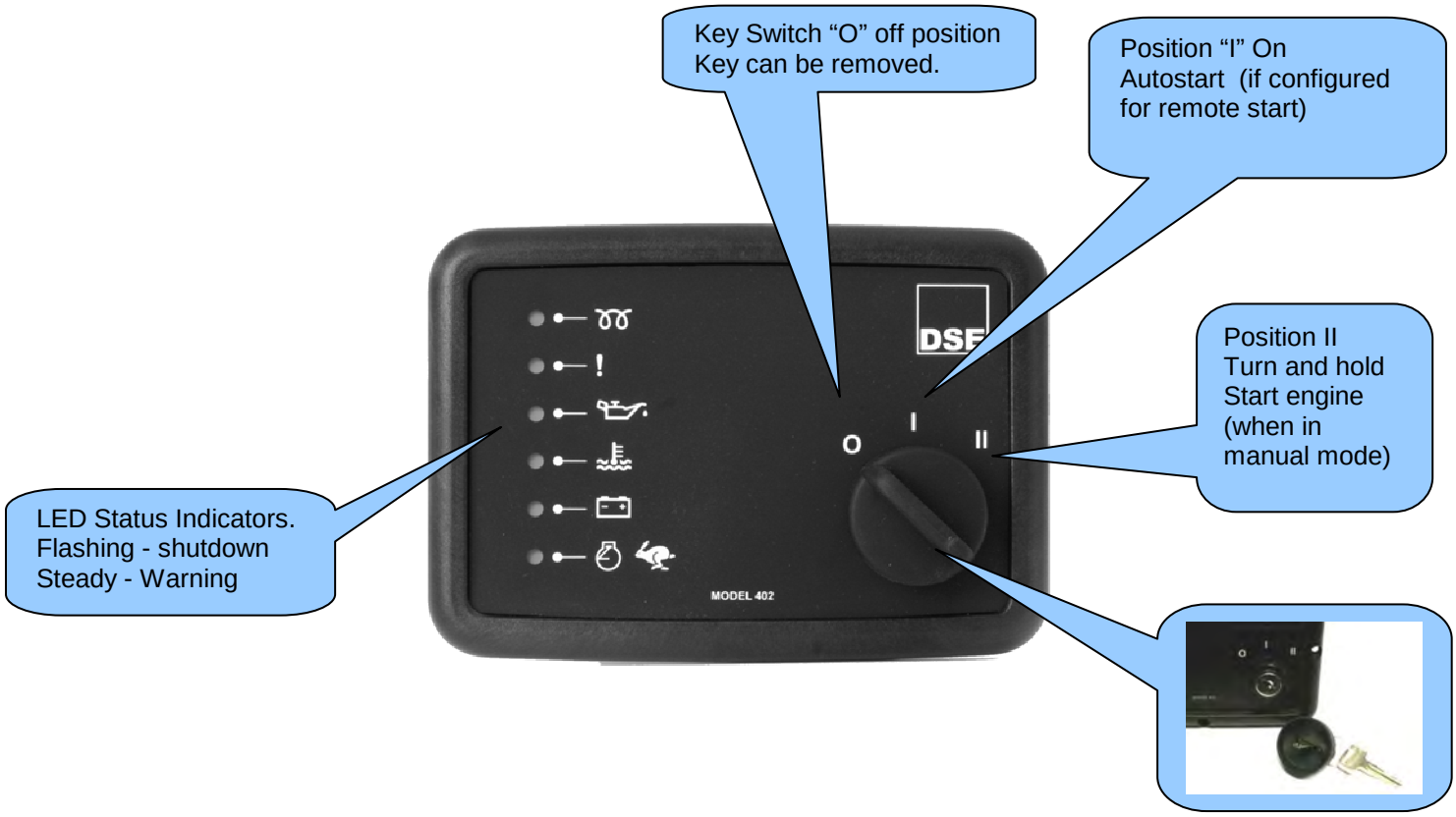
Where neither the battery positive nor battery negative terminals are connected to earth the following points must to be followed

- Follow the typical wiring diagram as normal for all sections EXCEPT the earth points
- All points shown as Earth on the typical wiring diagram should connect to BATTERY NEGATIVE (not earth).

5.3 DESCRIPTION OF CONTROLS

The following section details the function and meaning of the various controls on the controller.

5.4 DSE 402 MKII AUTOSTART CONTROL CONTROLLER



ICON	DESCRIPTION	
	Pre Heat	The Pre heat output The auxiliary charge alternator voltage is low as measured from the W/L terminal.
	Auxiliary Alarm	An external alarm condition has occurred. Example Emergency Stop
	LOW OIL PRESSURE	The controller detects that the engine oil pressure has fallen below the low oil pressure pre-alarm setting level after the *Safety On* timer has expired.
	ENGINE HIGH TEMPERATURE	The controller detects that the engine coolant temperature has exceeded the high engine temperature pre-alarm setting level after the *Safety On* timer has expired.
	BATTERY UNDER VOLTAGE / BATTERY OVER VOLTAGE	The DC supply has fallen below or risen above the low/high volts setting level.
	OVERSPEED	The engine speed has risen above the over speed pre alarm setting

5.5 QUICKSTART GUIDE

This section provides a quick start guide to the controller's operation

5.1 CONTROLS

Stop / Reset Turning the keyswitch to this position places the controller into its **Stop/Reset** mode. This will clear any alarm conditions unless the alarm condition is still present.	
Run. *Moving the Keyswitch into this position.* *Controller in manual or auto mode (auto mode if remote start configured).* *Preheat timer commences and gives pre-heat output.*	
Turn and hold In this position will send the Fuel and crank signals to start the engine, The preheat will continue if the timer has not expired this is indicated by the preheat led.	

6 SETTINGS AND ADJUSTMENTS

The setting of nominal speed and adjustment of trip points can be set using the following method.

6.1.1.1 SETTING OF NOMINAL SPEED

- With the DSE402 MKII connected, run the engine at nominal speed. Connect the 'Set Nominal Speed' input to battery negative to set the nominal speed.

6.1.1.2 ADJUSTMENT OF TRIP POINTS

- Turn the pre-set potentiometers to set the trip point. The factory setting for the Trip is 90% to 140% . The range is adjusted from 0% to 400% of nominal engine speed via the DSE Configuration Suite Lite PC Software.
- Turn the pre-set potentionmeters clockwise to increase the trip point, turn it anti-clockwise to decrease the trip point.
- The *'Engine Overspeed LED'* will illuminate when the trip has been achieved.

6.2 SHUTDOWNS / WARNINGS

Shutdowns are latching alarms and stop the Generator. Clear the alarm and remove the fault then switch the Keyswitch to "O" to reset the controller.
A flashing LED indicates a shutdown condition
A steady LED indicates a warning.

NOTE:- The alarm condition must be rectified before a reset will take place. If the alarm condition remains, it will not be possible to reset the unit (The exception to this is the Low Oil Pressure alarm and similar 'active from safety on' alarms, as the oil pressure will be low with the engine at rest).

Display	Reason
LOW OIL PRESSURE	The engine oil pressure has fallen below the low oil pressure trip setting level after the *Safety On* timer has expired.
ENGINE HIGH TEMPERATURE	The engine coolant temperature has exceeded the high engine temperature trip setting level after the *Safety On* timer has expired.
OVERSPEED	The engine speed has exceeded the pre-set trip
UNDERSPEED	The engine speed has fallen below the pre-set trip after the ***Safety On*** timer has expired.

7 COMMISSIONING

7.1.1 PRE-COMMISSIONING

Before the system is started, it is recommended that the following checks are made:-

10.1. The unit is adequately cooled and all the wiring to the controller is of a standard and rating compatible with the system. Check all mechanical parts are fitted correctly and that all electrical connections (including earths) are sound.

10.2. The unit **DC** supply is fused and connected to the battery and that it is of the correct polarity.

10.3. Make all checks on the engine and alternator as detailed by their respective manufacturer documentation.
10.4. Check all other parts in the system according to the manufacturer documentation.
10.5. Thoroughly review the configuration of the DSE controller and check that all parameters meet the requirements of your system.

10.6. +To check the start cycle operation, take appropriate measures to prevent the engine from starting (disable the operation of the fuel solenoid). After a visual inspection to ensure it is safe to proceed, connect the battery supply. Put the Keyswitch into the "**I"** position and then "**II",** the unit start sequence will commence.

10.7. The starter will engage and operate for the pre-set crank period. After the starter motor has attempted to start the engine the explanation mark will illuminate.

10.8. Restore the engine to operational status (reconnect the fuel solenoid). Turn the Ketswitch to the off position and then to the **"I " then "II"**. This time the engine will start and the starter motor will disengage automatically. If not then check the engine is fully operational (fuel available, etc.) and the fuel solenoid is operating. The engine will now run up to operating speed. If not, and an alarm is present, check the alarm condition for validity, and check input wiring. The engine will continue to run for an indefinite period.

10.9. Fully commission the engine/alternator and any other parts in the system as detailed in the respective manufacturer documentation. This could includes load bank testing, load acceptance, breaker control and more.

10.10. If despite repeated checking of the connections between the **DSE402 MKII** controller and the customer's system, satisfactory operation cannot be achieved, then the customer is requested to contact the factory for further advice on:-

INTERNATIONAL TEL: +44 (0) 1723 890099
INTERNATIONAL FAX: +44 (0) 1723 893303
E-mail: Support@Deepseaplc.com
Website : www.deepseaplc.com

FAULT FINDING

SYMPTOM	POSSIBLE REMEDY
Unit is inoperative Read/Write configuration does not operate	Check the battery and wiring to the unit. Check the DC supply. Check the DC fuse.
Unit shuts down	Check DC supply voltage is not above 35 Volts or below 9 Volts Check the operating temperature is not above 70℃. Check the DC fuse.
Intermittent Magnetic Pick-up sensor fault	Ensure that Magnetic pick-up screen only connects to earth at one end, if connected at both ends, this enables the screen to act as an aerial and will pick up random voltages. Check pickup is correct distance from the flywheel teeth.
Low oil Pressure fault operates after engine has fired	Check engine oil pressure. Check oil pressure switch and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed)
High engine temperature fault operates after engine has fired.	Check engine temperature. Check switch and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) .
common fault operates	Check relevant switch and wiring of fault indicated by LED. Check configuration of input.
Fail to Start is activated after pre-set number of attempts to start	Check wiring of fuel solenoid. Check fuel. Check battery supply. Check battery supply is present on the Fuel output of the controller. Check the speed-sensing signal is present on the controller's inputs. Refer to engine manual.
Continuous starting of generator when in **AUTO**	Check that there is no signal present on the "Remote Start" input. Check configured polarity is correct.
Generator fails to start on receipt of Remote Start signal.	Check Start Delay timer has timed out. Check signal is on "Remote Start" input. Confirm correct configuration of input Check that the oil pressure switch is indicating low oil pressure to the controller. Depending upon configuration, then set will not start if oil pressure is not low.
Pre-heat inoperative	Check wiring to engine heater plugs. Check battery supply. Check battery supply is present on the Pre-heat output of controller. Check pre-heat configuration is correct.
Starter motor inoperative	Check wiring to starter solenoid. Check battery supply. Check battery supply is present on the Starter output of controller. Ensure that the Emergency Stop input is at Positive. Ensure oil pressure switch or sensor is indicating the "low oil pressure" state to the controller.
Controller appears to 'revert' to an earlier configuration	When editing a configuration using the PC software it is vital that the configuration is first 'read' from the controller before editing it. This edited configuration must then be "written" back to the controller for the changes to take effect.

NOTE:- The above fault finding is provided as a guide check-list only. As the controller is configurable for a range of different features, always refer to the source of your controller configuration if in doubt.

8 MAINTENANCE, SPARES, REPAIR AND SERVICING

The DSE402 MKII controller is *Fit and Forget*. As such, there are no user serviceable parts within the controller. In the case of malfunction, you should contact your original equipment manufacturer (OEM).

8.1 PURCHASING ADDITIONAL SEALING GASKET FROM DSE

Item	Description	Part No.
	DSE402 MKII silicon sealing gasket	020-016

9 WARRANTY

DSE provides limited warranty to the equipment purchaser at the point of sale. For full details of any applicable warranty, you are referred to your original equipment supplier (OEM).

10 DISPOSAL

10.1 WEEE (WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT)

Directive 2002/96/EC
If you use electrical and electronic equipment you must store, collect, treat, recycle and dispose of WEEE separately from your other waste.

10.2 ROHS (RESTRICTION OF HAZARDOUS SUBSTANCES)

Directive 2002/95/EC: 2006
To remove specified hazardous substances (Lead, Mercury, Hexavalent Chromium, Cadmium, PBB & PBDE´s)

Exemption Note: Category 9. (Monitoring & Control Instruments) as defined in Annex 1B of the WEEE directive will be exempt from the RoHS legislation. This was confirmed in the August 2005 UK´s Department of Trade and Industry RoHS REGULATIONS Guide (Para 11).

Despite this exemption, DSE has been carefully removing all non RoHS compliant components from our supply chain and products.
When this is completed, a Lead Free & RoHS compatible manufacturing process will be phased into DSE production.

This process is almost complete and is being phased through different product groups.

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California Proposition 65

⚠ WARNING ⚠

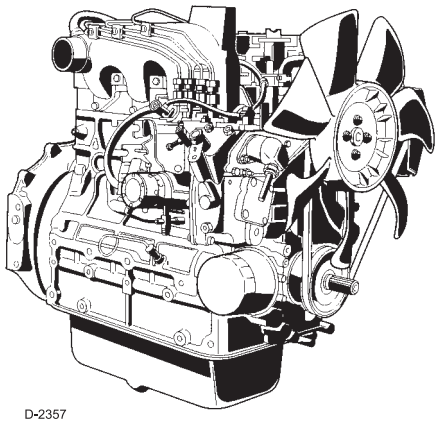
Engine exhaust, some of its constituents, certain vehicle components and fluids, contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

ENGLISH

OPERATOR'S MANUAL

KUBOTA
DIESEL ENGINE

MODELS
D1503-M-E3·D1703-M-E3·D1803-M-E3
V2003-M-E3·V2203-M-E3·V2403-M-E3·V2403-M-T-E3
D1703-M-E3BG·V2003-M-E3BG·V2003-M-T-E3BG
V2203-M-E3BG·V2403-M-E3BG



D-2357

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READ AND SAVE THIS BOOK

Kubota

FOREWORD

You are now the proud owner of a KUBOTA Engine. This engine is a product of KUBOTA quality engineering and manufacturing. It is made of fine materials and under a rigid quality control system. It will give you long, satisfactory service. To obtain the best use of your engine, please read this manual carefully. It will help you become familiar with the operation of the engine and contains many helpful hints about engine maintenance. It is KUBOTA's policy to utilize as quickly as possible every advance in our research. The immediate use of new techniques in the manufacture of products may cause some small parts of this manual to be outdated. KUBOTA distributors and dealers will have the most up-to-date information. Please do not hesitate to consult with them.

SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully. It is essential that you read the instructions and safety regulations before you attempt to assemble or use this unit.

DANGER :	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING :	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION :	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
IMPORTANT :	Indicates that equipment or property damage could result if instructions are not followed.
NOTE :	Gives helpful information.

ENGLISH

CONTENTS

ENGLISH

SAFE OPERATION

Careful operation is your best assurance against an accident. Read and understand this section carefully before operating the engine. All operators, no matter how much experience they may have, should read this and other related manuals before operating the engine or any equipment attached to it. It is the owner's obligation to provide all operators with this information and instruct them on safe operation.

Be sure to observe the following for safe operation.

1. OBSERVE SAFETY INSTRUCTIONS

- Read and understand carefully this "OPERATOR'S MANUAL" and "LABELS ON THE ENGINE" before attempting to start and operate the engine.
- Learn how to operate and work safely. Know your equipment and its limitations. Always keep the engine in good condition.
- Before allowing other people to use your engine, explain how to operate and have them read this manual before operation.
- DO NOT modify the engine. UNAUTHORIZED MODIFICATIONS to the engine may impair the function and/or safety and affect engine life. If the engine does not perform properly, consult your local Kubota Engine Distributor first.

1AAACAAAP008B

2. WEAR SAFE CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

- DO NOT wear loose, torn or bulky clothing around the machine that may catch on working controls and projections or into fans, pulleys and other moving parts causing personal injury.
- Use additional safety items-PPE, e.g. hard hat, safety protection, safety goggles, gloves, etc., as appropriate or required.
- DO NOT operate the machine or any equipment attached to it while under the influence of alcohol, medication, or other drugs, or while fatigued.
- DO NOT wear radio or music headphones while operating the engine.


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3. CHECK BEFORE STARTING & OPERATING THE ENGINE

- Be sure to inspect the engine before operation. Do not operate the engine if there is something wrong with it. Repair it immediately.
- Ensure all guards and shields are in place before operating the engine. Replace any that are damaged or missing.
- Check to see that you and others are a safe distance from the engine before starting.
- Always keep the engine at least 3 feet (1 meter) away from buildings and other facilities.
- DO NOT allow children or livestock to approach the machine while the engine is running.
- DO NOT start the engine by shorting across starter terminals. The machine may start in gear and move. Do not bypass or defeat any safety devices.

1BAABADAP0010

4. KEEP THE ENGINE AND SURROUNDINGS CLEAN

- Be sure to stop the engine before cleaning.
- Keep the engine clean and free of accumulated dirt, grease and trash to avoid a fire. Store flammable fluids in proper containers and cabinets away from sparks and heat.
- Check for and repair leaks immediately.
- DO NOT stop the engine without idling; Allow the engine to cool down, first. Keep the engine idling for about 5 minutes before stopping unless there is a safety problem that requires immediate shut down.

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5. SAFE HANDLING OF FUEL AND LUBRICANTS -KEEP AWAY FROM FIRE

- Always stop the engine before refueling and/or lubricating.
- DO NOT smoke or allow flames or sparks in your work area. Fuel is extremely flammable and explosive under certain conditions.
- Refuel at a well ventilated and open place. When fuel and/or lubricants are spilled, refuel after letting the engine cool down.
- DO NOT mix gasoline or alcohol with diesel fuel. The mixture can cause a fire or severe engine damage.
- Do not use unapproved containers e.g. buckets, bottles, jars. Use approved fuel storage containers and dispensers.

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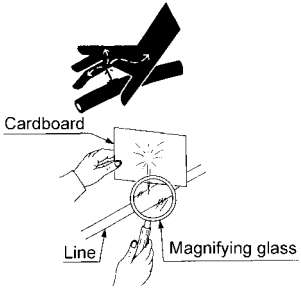
6. EXHAUST GASES & FIRE PREVENTION

- Engine exhaust fumes can be very harmful if allowed to accumulate. Be sure to run the engine in a well ventilated location and where there are no people or livestock near the engine.
- The exhaust gas from the muffler is very hot. To prevent a fire, do not expose dry grass, mowed grass, oil or any other combustible materials to exhaust gas. Keep the engine and muffler clean at all times.
- To avoid a fire, be alert for leaks of flammable substances from hoses and lines. Be sure to check for leaks from hoses or pipes, such as fuel and hydraulic fluid by following the maintenance check list.
- To avoid a fire, do not short across power cables and wires. Check to see that all power cables and wirings are in good condition. Keep all electrical connections clean. Bare wire or frayed insulation can cause a dangerous electrical shock and personal injury.

7. ESCAPING FLUID

- Relieve all pressure in the air, the oil and the cooling systems before disconnecting any lines, fittings or related items.
- Be cautious of possible pressure relief when disconnecting any device from a pressurized system that utilizes pressure. DO NOT check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- Escaping fluid under pressure has sufficient force to penetrate skin causing serious personal injury.
- Fluid escaping from pinholes may be invisible. Use a piece of cardboard or wood to search for suspected leaks: do not use hands and body. Use safety goggles or other eye protection when checking for leaks.
- If injured by escaping fluid, see a medical doctor immediately. This fluid can produce gangrene or severe allergic reaction.



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8. CAUTIONS AGAINST BURNS & BATTERY EXPLOSION

- To avoid burns, be cautious of hot components, e.g. muffler, muffler cover, radiator, hoses, engine body, coolants, engine oil, etc. during operation and after the engine has been shut off.
- DO NOT remove the radiator cap while the engine is running or immediately after stopping. Otherwise hot water will spout out from the radiator. Wait until the radiator is completely cool to the touch before removing the cap. Wear safety goggles.
- Be sure to close the coolant drain valve, secure the pressure cap, and fasten the pipe band before operating. If these parts are taken off, or loosened, it will result in serious personal injury.
- The battery presents an explosive hazard. When the battery is being charged, hydrogen and oxygen gases are extremely explosive.
- DO NOT use or charge the battery if its fluid level is below the LOWER mark.
  Otherwise, the component parts may deteriorate earlier than expected, which may shorten the service life or cause an explosion. Immediately, add distilled water until the fluid level is between the UPPER and LOWER marks.
- Keep sparks and open flames away from the battery, especially during charging. DO NOT strike a match near the battery.
- DO NOT check the battery charge by placing a metal object across the terminals. Use a voltmeter or hydrometer.
- DO NOT charge a frozen battery. There is a risk of explosion. When frozen, warm the battery up to at least 16°C (61°F).

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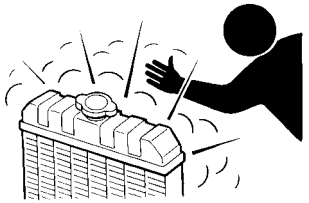

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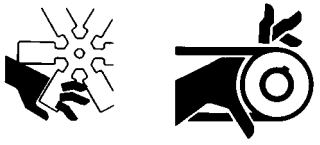
9. KEEP HANDS AND BODY AWAY FROM ROTATING PARTS

- Be sure to stop the engine before checking or adjusting the belt tension and cooling fan.
- Keep your hands and body away from rotating parts, such as the cooling fan, V-belt, fan drive pulley or flywheel. Contact with rotating parts can cause severe personal injury.
- DO NOT run the engine without safety guards. Install safety guards securely before operation.



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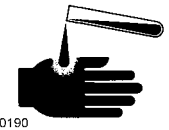
10. ANTI-FREEZE & DISPOSAL OF FLUIDS

- Anti-freeze contains poison. Wear rubber gloves to avoid personal injury. In case of contact with skin, wash it off immediately.
- DO NOT mix different types of Anti-freeze. The mixture can produce a chemical reaction causing harmful substances. Use approved or genuine KUBOTA Anti-freeze.
- Be mindful of the environment and the ecology. Before draining any fluids, determine the correct way to dispose of them. Observe the relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters and batteries.
- When draining fluids from the engine, place a suitable container underneath the engine body.
- DO NOT pour waste onto the ground, down a drain, or into any water source. Dispose of waste fluids according to environmental regulations.



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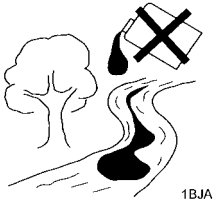

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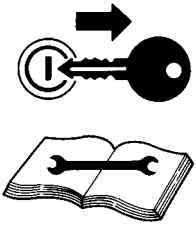
11. CONDUCTING SAFETY CHECKS & MAINTENANCE

- When inspecting the engine or servicing, place the engine on a large flat surface. DO NOT work on anything that is supported ONLY by lift jacks or a hoist. Always use blocks or the correct stands to support the engine before servicing.
- Disconnect the battery from the engine before conducting service. Put a "DO NOT OPERATE!" tag on the key switch to avoid accidental starting.
- To avoid sparks from an accidental short circuit always disconnect the battery's ground cable (-) first and reconnect it last.
- Be sure to stop the engine and remove the key when conducting daily and periodic maintenance, service and cleaning.
- Check or conduct maintenance after the engine, coolant, muffler, or muffler cover have cooled off completely.
- Always use the appropriate tools and fixtures. Verify that they are in good condition before performing any service work. Make sure you understand how to use them before service.
- Use ONLY correct engine barring techniques for manually rotating the engine. DO NOT attempt to rotate the engine by pulling or prying on the cooling fan and V-belt. This practice can cause serious personal injury or premature damage to the cooling fan and belt.



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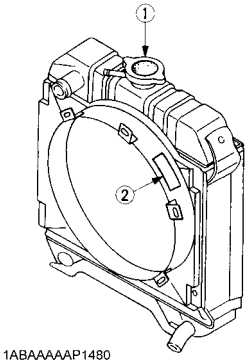
- Replace fuel pipes and lubricant pipes with their hose clamps every 2 years or earlier whether they are damaged or not. They are made of rubber and age gradually.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Keep a first aid kit and fire extinguisher handy at all times.

12. WARNING AND CAUTION LABELS



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① Part No.19077-8724-1 or 16667-8724-1
(55mm in diameter) (37mm in diameter)

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② Part No.TA040-4957-1
Do not get your hands close to engine fan and fan belt.


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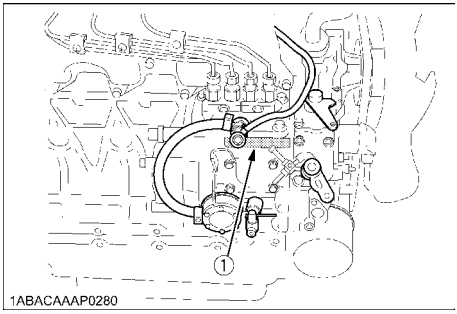
13. CARE OF WARNING AND CAUTION LABELS

1. Keep warning and caution labels clean and free from obstructing material.
2. Clean warning and caution labels with soap and water, dry with a soft cloth.
3. Replace damaged or missing warning and caution labels with new labels from your local KUBOTA dealer.
4. If a component with warning and caution label(s) affixed is replaced with a new part, make sure the new label(s) is (are) attached in the same location(s) as the replaced component.
5. Mount new warning and caution labels by applying to a clean dry surface and pressing any bubbles to the outside edge.

SERVICING OF THE ENGINE

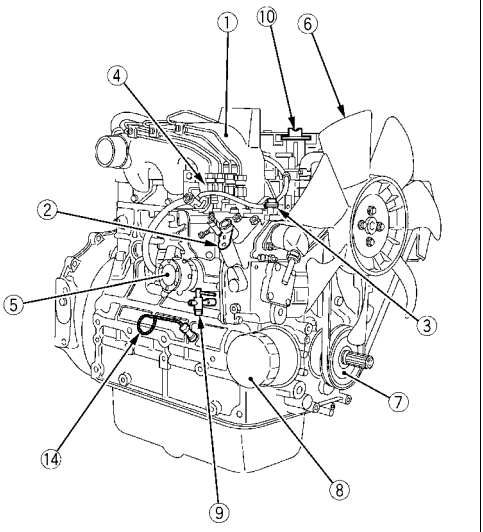
Your dealer is interested in your new engine and has the desire to help you get the most value from it. After reading this manual thoroughly, you will find that you can do some of the regular maintenance yourself.
However, when in need of parts or major service, be sure to see your KUBOTA dealer.
For service, contact the KUBOTA Dealership from which you purchased your engine or your local KUBOTA dealer.
When in need of parts, be prepared to give your dealer the engine serial number.
Locate the serial number now and record them in the space provided.

	Type	Serial No.
Engine		
Date of Purchase		
Name of Dealer		
(To be filled in by purchaser)		



(1) Engine serial number

NAMES OF PARTS



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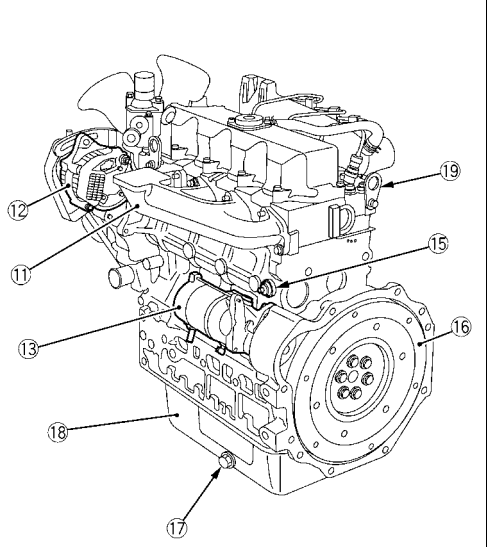

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(1) Intake manifold
(2) Speed control lever
(3) Engine stop lever
(4) Injection pump
(5) Fuel feed pump
(6) Cooling fan
(7) Fan drive pulley
(8) Oil filter cartridge
(9) Water drain cock
(10) Oil filler plug
(11) Exhaust manifold
(12) Alternator
(13) Starter
(14) Oil level gauge
(15) Oil pressure switch
(16) Flywheel
(17) Oil drain plug
(18) Oil pan
(19) Engine hook

PRE-OPERATION CHECK

BREAK-IN

During the engine break-in period, observe the following by all means:

1. Change engine oil and oil filter cartridge after the first 50 hours of operation. (See "ENGINE OIL" in "PERIODIC SERVICE" section.)
2. When ambient temperature is low, operate the machine after the engine has been completely warmed up.

DAILY CHECK

To prevent trouble from occurring, it is important to know the conditions of the engine well. Check it before starting.

CAUTION

To avoid personal injury:

- **Be sure to install shields and safeguards attached to the engine when operating.**
- **Stop the engine at a flat and wide space when checking.**
- **Keep dust or fuel away from the battery, wiring, muffler and engine to prevent a fire. Check and clear them before operating everyday. Pay attention to the heat of the exhaust pipe or exhaust gas so that it can not ignite trash.**

Item		Ref. page
1. Parts which had trouble in previous operation		-
2. By walking around the machine	(1) Oil or water leaks	15 to 20
	(2) Engine oil level and contamination	15,16
	(3) Amount of fuel	12
	(4) Amount of coolant	18 to 20
	(5) Dust in air cleaner dust cup	21
	(6) Damaged parts and loosened bolts and nuts	-
3. By inserting the key into the starter switch	(1) Proper functions of meters and pilot lamps; no stains on these parts	-
	(2) Proper function of glow lamp timer	-
4. By starting the engine	(1) Color of exhaust fumes	7
	(2) Unusual engine noise	7
	(3) Engine start-up condition	5
	(4) Slow-down and acceleration behavior	7

OPERATING THE ENGINE

STARTING THE ENGINE(NORMAL)

CAUTION

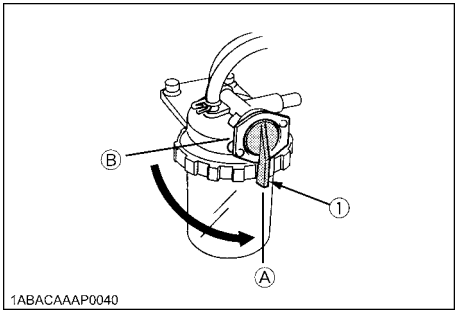
To avoid personal injury:

- **Do not allow children to approach the machine while the engine is running.**
- **Be sure to install the machine on which the engine is installed, on a flat place.**
- **Do not run the engine on gradients.**
- **Do not run the engine in an enclosed area. Exhaust gas can cause air pollution and exhaust gas poisoning.**
- **Keep your hands away from rotating parts (such as fan, pulley, belt, flywheel etc.) during operation.**
- **Do not operate the machine while under the influence of alcohol or drugs.**
- **Do not wear loose, torn or bulky clothing around the machine. It may catch on moving parts or controls, leading to the risk of accident. Use additional safety items, e.g. hard hat, safety boots or shoes, eye and hearing protection, gloves, etc., as appropriate or required.**
- **Do not wear radio or music headphones while operating engine.**
- **Check to see if it is safe around the engine before starting.**
- **Reinstall safeguards and shields securely and clear all maintenance tools when starting the engine after maintenance.**

IMPORTANT :

- Do not use ether or any starting fluid for starting the engine, or a severe damage will occur.
- When starting the engine after a long storage (of more than 3 months), first set the stop lever to the "STOP" position and then activate the starter for about 10 seconds to allow oil to reach every engine part.

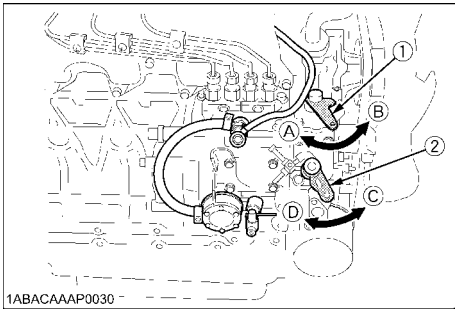
1. Set the fuel lever to the "ON" position.



(1) Fuel lever
(A) "ON"
(B) "OFF"

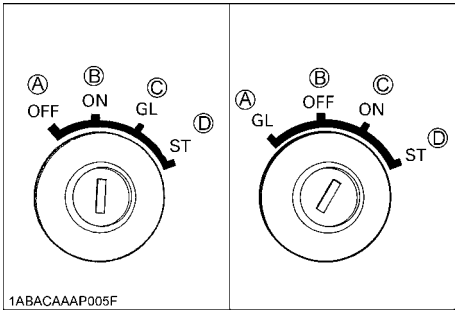
2. Place the engine stop lever to the "START" position.

3. Place the speed control lever at more than half "OPERATION".



(1) Engine stop lever
(2) Speed Control lever
(A) "STOP"
(B) "START"
(C) "IDLING"
(D) "OPERATION"

4. Insert the key into the key switch and turn it to the "OPERATION" position.



(A) "OFF" SWITCHED OFF
(B) "ON" OPERATION
(C) "GL" PREHEATING
(D) "ST" STARTING

(A) "GL" PREHEATING
(B) "OFF" SWITCHED OFF
(C) "ON" OPERATION
(D) "ST" STARTING

5. Turn the starter switch to the "PREHEATING" position to allow the glow lamp to redden.

NOTE :
(with lamp timer in use)
- The glow lamp goes out in about 5 seconds when the lamp timer is up. Refer to this for pre-heating.
  Even with the glow lamp off, the glow plug can be pre-heated by turning the starter switch to the "PREHEATING" position.

6. Turn the key to the "STARTING" position and the engine should start. Release the key immediately when the engine starts.

7. Check to see that the oil pressure lamp and charge lamp are off. If the lamps are still on, immediately stop the engine, and determine the cause.
(See "CHECKS DURING OPERATION" in "OPERATING THE ENGINE" section.)

NOTE :
- If the oil pressure lamp should be still on, immediately stop the engine and check;
  - if there is enough engine oil.
  - if the engine oil has dirt in it.
  - if the wiring is faulty.

8. Warm up the engine at medium speed without load.

IMPORTANT :
- If the glow lamp should redden too quickly or too slowly, immediately ask your KUBOTA dealer to check and repair it.
- If the engine does not catch or start at 10 seconds after the starter switch is set at "STARTING" position, wait for another 30 seconds and then begin the engine starting sequence again. Do not allow the starter motor to run continuously for more than 20 seconds.

COLD WEATHER STARTING

If the ambient temperature is below -5°C(23°F)* and the engine is very cold, start it in the following manner:
Take steps (1) through (4) above.

5. Turn the key to the "PREHEATING" position and keep it there for a certain period mentioned below.

IMPORTANT :
- Shown below are the standard preheating times for various temperatures. This operation, however, is not required, when the engine is warmed up.

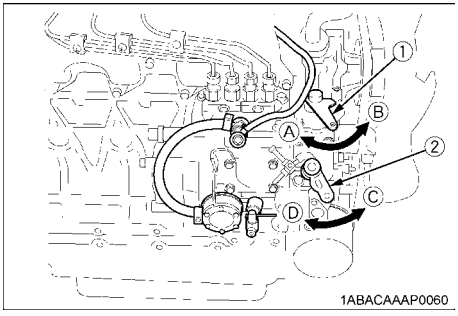
Ambient temperature	Preheating time
Above 10°C (50°F)	NO NEED
10°C (50°F) to -5°C (23°F)	Approx. 5 seconds
*Below -5°C (23°F)	Approx. 10 seconds
Limit of continuous use	20 seconds

6. Turn the key to the "STARTING" position and the engine should start.
(If the engine fails to start after 10 seconds, turn off the key for 5 to 30 seconds. Then repeat steps (5) and (6).)

IMPORTANT :
- Do not allow the starter motor to run continuously for more than 20 seconds.
- Be sure to warm up the engine, not only in winter, but also in warmer seasons. An insufficiently warmed-up engine can shorten its service life.
- When there is fear of temperature dropping below -15°C (5°F) detach the battery from the machine, and keep it indoors in a safe area, to be reinstalled just before the next operation.

STOPPING THE ENGINE

1. **Return the speed control lever to low idle, and run the engine under idling conditions.**
2. **Set the engine stop lever to the "STOP" position.**
3. **With the starter switch placed to the "SWITCHED OFF" position, remove the key. (Be sure to return the engine stop lever to the "START" position to be ready for the next start.)**



(1) Engine stop lever
(2) Speed control lever
(A) "STOP"
(B) "START"
(C) "IDLING"
(D) "OPERATION"

IMPORTANT :

- If equipped with a turbo-charger, allow the engine to idle for 5 minutes before shutting it off after a full load operation.
  Failure to do so may lead to turbo-charger trouble.

CHECKS DURING OPERATION

While running, make the following checks to see that all parts are working correctly.

■Radiator Cooling water(Coolant)

WARNING

To avoid personal injury:

- **Do not remove radiator cap until coolant temperature is well below its boiling point. Then loosen cap slightly to the stop position, to relieve any pressure, before removing cap completely.**

If the coolant temperature warning lamp lights up or if steam or coolant does not stop squirting from the radiator overflow pipe, turn off the load and **keep the engine idling (COOLING-DOWN) for at least 5 minutes** to let it cool down gradually. Then stop the engine and take the following inspection and servicing.

1. Check to see if the coolant runs short or if there is any coolant leak;
2. Check to see if there is any obstacle around the cooling air inlet or outlet;
3. Check to see if there is any dirt or dust between radiator fins and tube;
4. Check to see if the fan belt is too loose; and
5. Check to see if radiator water pipe is clogged.

■Oil pressure lamp

The lamp lights up to warn the operator that the engine oil pressure has dropped below the prescribed level. If this should happen during operation or should not go off even after the engine is accelerated more than 1000rpm, immediately stop the engine and check the following:

1. Engine oil level (See "ENGINE OIL" in "PERIODIC SERVICE" section.)

■Fuel

CAUTION

To avoid personal injury:

- **Fluid escaping from pinholes may be invisible. Do not use hands to search for suspected leaks; Use a piece of cardboard or wood, instead. If injured by escaping fluid, see a medical doctor at once. This fluid can produce gangrene or a severe allergic reaction.**
- **Check any leaks from fuel pipes or fuel injection pipes. Use eye protection when checking for leaks.**

Be careful not to empty the fuel tank. Otherwise air may enter the fuel system, requiring fuel system bleeding. (See "FUEL" in "PERIODIC SERVICE" section.)

■Color of exhaust

While the engine is run within the rated output range:

- The color of exhaust remains colorless.
- If the output slightly exceeds the rated level, exhaust may become a little colored with the output level kept constant.
- If the engine is run continuously with dark exhaust emission, it may lead to trouble with the engine.

■Immediately stop the engine if;

- The engine suddenly slows down or accelerates.
- Unusual noises are suddenly heard.
- Exhaust fumes suddenly become very dark.
- The oil pressure lamp or the water temperature alarm lamp lights up.

REVERSED ENGINE REVOLUTION AND REMEDIES

CAUTION

To avoid personal injury:

- **Reversed engine operation can make the machine reverse and run it backwards. It may lead to serious trouble.**
- **Reversed engine operation may make exhaust gas gush out into the intake side and ignite the air cleaner; It could catch fire.**

Reversed engine revolution must be stopped immediately since engine oil circulation is cut quickly, leading to serious trouble.

■How to tell when the engine starts running backwards

1. Lubricating oil pressure drops sharply. Oil pressure warning light, if used, will light.
2. Since the intake and exhaust sides are reversed, the sound of the engine changes, and exhaust gas will come out of the air cleaner.
3. A louder knocking sound will be heard when the engine starts running backwards.

■Remedies

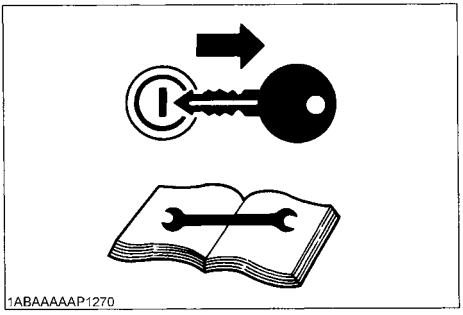
1. Immediately set the engine stop lever to the "STOP" position to stop the engine.
2. After stopping the engine, check the air cleaner, intake rubber tube and other parts, and then replace parts as needed.

MAINTENANCE

CAUTION

To avoid personal injury:

- **Be sure to conduct daily checks, periodic maintenance, refueling or cleaning on a level surface with the engine shut off and remove the key.**
- **Before allowing other people to use your engine, explain how to operate, and have them read this manual before operation.**
- **When cleaning any parts, do not use gasoline but use regular cleanser.**
- **Always use proper tools, that are in good condition. Make sure you understand how to use them, before performing any service work.**
- **When installing, be sure to tighten all bolts lest they should be loose. Tighten the bolts by the specified torque.**
- **Do not put any tools on the battery, or battery terminals may short out. Severe burns or fire could result. Detach the battery from the engine before maintenance.**
- **Do not touch muffler or exhaust pipes while they are hot; Severe burns could result.**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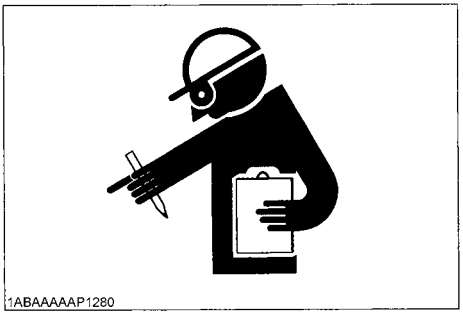
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SERVICE INTERVALS

Observe the following for service and maintenance.

Interval	Item	Ref. page		
Every 50 hours	Check of fuel pipes and clamp bands	14		@
See NOTE	Change of engine oil (depending on the oil pan)	15 to 17	◎	
Every 100 hours	Cleaning of air cleaner element	21	*1	@
	Cleaning of fuel filter	14		
	Check of fan belt tightness	22		
	Draining water separator	-		
Every 200 hours	Replacement of oil filter cartridge (depending on the oil pan)	17	◎	
	Check of intake air line	-		@
Every 200 hours of operation or six months	Check of radiator hoses and clamp bands	19		
Every 400 hours	Replacement of fuel filter cartridge	15		@
	Cleaning of water separator	-		
Every 500 hours	Removal of sediment in fuel tank	-		
	Cleaning of water jacket (radiator interior)	18 to 20		
	Replacement of fan belt	22		
Every year	Replacement of air cleaner element	21	*2	@
Every 800 hours	Check of valve clearance	-	*3	
Every 1500 hours	Check of fuel injection nozzle injection pressure	-	*3	@
Every 3000 hours	Check of turbo charger	-	*3	@
	Check of injection pump	-	*3	@
Every two years	Change of radiator coolant (L.L.C.)	18 to 20		
	Replacement of radiator hoses and clamp bands	19		
	Replacement of fuel pipes and clamp bands	14	*3	@
	Replacement of intake air line	-	*4	@

IMPORTANT :
- The jobs indicated by ○ must be done after the first 50 hours of operation.

*1 Air cleaner should be cleaned more often in dusty conditions than in normal conditions.
*2 After 6 times of cleaning.
*3 Consult your local KUBOTA Dealer for this service.
*4 Replace only if necessary.

- The items listed above (@ marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.
  Please see the Warranty Statement in detail.

NOTE :
- **Changing interval of engine oil**

Models	*Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
All models	200 Hrs	150 Hrs
Initial	50 Hrs	

* 90 mm (3.54 in.) oil pan depth is optional.
(Standard replacement interval)

- American Petroleum Institute (API) classification: above CF-4 grade
- Ambient temperature: below 35°C (95°F)

NOTE :

Lubricating oil

With strict emission control regulations now in effect, the CF-4 and CG-4 engine oils have been developed for use with low sulfur fuels, for On-Highway vehicle engines. When a Non-Road engine runs on high sulfur fuel, it is advisable to use a "CF or better" classification engine oil with a high Total Base Number (a minimum TBN of 10 is recommended).

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

○ : Recommendable X : Not recommendable

Lubricating oil classification	**Fuel		Remarks
	Low-sulfur	High-sulfur	
CF	○	○	*TBN≧ 10
CF-4	○	X	
CG-4	○	X	
CH-4	○	X	
CI-4	○	X	

* TBN: Total Base Number
**Fuel

- Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.
- Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.
- If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half).
- DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).
- Since KUBOTA diesel engines of less than 56 kW (75 hp) utilize EPA Tier 4 and Interim Tier 4 standards, the use of ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S15 diesel fuel as an alternative to No.2-D, and use No.1-D S15 diesel fuel as an alternative to No.1-D for ambient temperatures below -10 ℃ (14 ℉).
  No.1-D or No.2-D, S15 : Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt.%

- CJ-4 classification oil is intended for use in engines equipped with DPF (Diesel Particulate Filter) and is Not Recommended for use in Kubota E3 specification engines.

- Oil used in the engine should have API classification and Proper SAE Engine Oil according to the ambient temperatures as shown below:

Above 25℃ (77℉)	SAE30, SAE10W-30 or 15W-40
-10℃ to 25℃ (14℉ to 77℉)	SAE10W-30 or 15W-40
Below -10℃ (14℉)	SAE10W-30

- Recommended API classification
  Refer to the following table for the suitable American Petroleum Institute (API) classification of engine oil according to the engine type (with internal EGR, external EGR or non-EGR) and the Fuel Type Used : (Ultra Low Sulfur or High Sulfur Fuels).

Fuel type	Engine oil classification (API classification)	
	Engines with non-EGR Engines with internal EGR	Engines with external EGR
High Sulfur Fuel [0.05 % (500 ppm) ≤ Sulfur Content < 0.50 % (5000 ppm)]	**CF** (If the "CF-4, CG-4, CH-4 or CI-4" engine oil is used with a high-sulfur fuel, change the engine oil at shorter intervals. (approximately half))	---
Ultra Low Sulfur Fuel [Sulfur Content < 0.0015 % (15 ppm)]	**CF, CF-4, CG-4, CH-4 or CI-4**	**CF or CI-4** (Class CF-4, CG-4 and CH-4 engine, oils cannot be used on EGR type engines.)

EGR: Exhaust Gas Re-circulation

PERIODIC SERVICE

FUEL

Fuel is flammable and can be dangerous. You should handle fuel with care.

CAUTION

To avoid personal injury:

- **Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.**
- **Be careful not to spill fuel during refueling. If fuel should spill, wipe it off at once, or it may cause a fire.**
- **Do not fail to stop the engine before refueling. Keep the engine away from the fire.**
- **Be sure to stop the engine while refueling or bleeding and when cleaning or changing fuel filter or fuel pipes. Do not smoke when working around the battery or when refueling.**
- **Check the fuel systems at a well ventilated and wide place.**
- **When fuel and lubricant are spilled, refuel after letting the engine cool off.**
- **Always keep spilled fuel and lubricant away from engine.**

■Fuel level check and refueling

1. Check to see that the fuel level is above the lower limit of the fuel level gauge.
2. If the fuel is too low, add fuel to the upper limit. Do not overfill.

Flash Point, ℃ (℉)	Water and Sediment, volume %	Carbon Residue on, 10 percent Residuum, %	Ash, weight %
Min	Max	Max	Max
52 (125)	0.05	0.35	0.01

Distillation Temperatures, ℃ (℉) 90% Point		Viscosity Kinematic cSt or mm²/s at 40 ℃		Viscosity Saybolt, SUS at 37.8 ℃ (100 ℉)	
Min	Max	Min	Max	Min	Max
282 (540)	338 (640)	1.9	4.1	32.6	40.1

Sulfur, weight %	Copper Strip Corrosion	Cetane Number
Max	Max	Min
0.50	No. 3	40

- Cetane Rating : The minimum recommended Fuel Cetane Rating is 45. A cetane rating greater than 50 is preferred, especially for ambient temperatures below -20℃ (-4℉) or elevations above 1500 m (5000 ft).
- Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.
- Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.
- If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half).
- DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).
- Diesel fuels specified to EN 590 or ASTM D975 are recommended.
- No.2-D is a distillate fuel of lower volatility for engines in industrial and heavy mobile service. (SAE J313 JUN87)
- Since KUBOTA diesel engines of less than 56 kW (75 hp) utilize EPA Tier 4 and Interim Tier 4 standards, the use of ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S15 diesel fuel as an alternative to No.2-D, and use No.1-D S15 diesel fuel as an alternative to No.1-D for ambient temperatures below -10 ℃ (14 ℉).
  1) SAE : Society of Automotive Engineers
  2) EN : European Norm
  3) ASTM : American Society of Testing and Materials
  4) US EPA : United States Environmental Protection Agency
  5) No.1-D or No.2-D, S15 : Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt.%

IMPORTANT :
- Be sure to use a strainer when filling the fuel tank, or dirt or sand in the fuel may cause trouble in the fuel injection pump.
- For fuel, always use diesel fuel. You are required not to use alternative fuel, because its quality is unknown or it may be inferior in quality. Kerosene, which is very low in cetane rating, adversely affects the engine. Diesel fuel differs in grades depending on the temperature.
- Be careful not to let the fuel tank become empty, or air can enter the fuel system, necessitating bleeding before next engine start.

■Air bleeding the fuel system

CAUTION

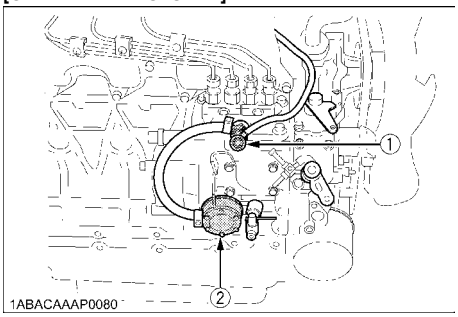
To avoid personal injury;
- **Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.**

Air bleeding of the fuel system is required if;
- after the fuel filter and pipes have been detached and refitted;
- after the fuel tank has become empty; or
- before the engine is to be used after a long storage.

[PROCEDURE Ⓐ] (gravity feed fuel tanks only)
1. Fill the fuel tank to the fullest extent. Open the fuel filter lever.
2. Open the air vent cock on top of the fuel injection pump.
3. Turn the engine, continue it for about 10 seconds, then stop it, or move the fuel feed pump lever by hand (optional).
4. Close the air vent cock on top of the fuel injection pump.

IMPORTANT :
- Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.

[GRAVITY FEED SYSTEM]

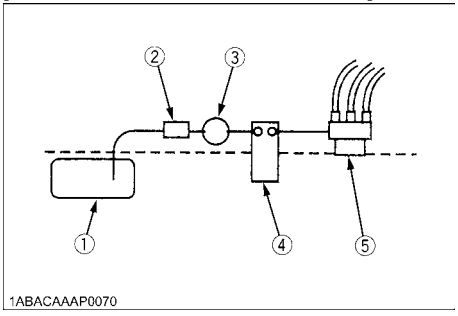


(1) Air vent cock
(2) Fuel feed pump

[PROCEDURE Ⓑ] (fuel tanks lower than injection pump)
1. For fuel tanks that are lower than the injection pump. The fuel system must be pressurized by the fuel system electric fuel pump.
2. If an electric fuel pump is not used, you must manually actuate the pump by lever to bleed.
3. The primary fuel filter must be on the pressure side of the pump if the fuel tank is lower than the injection pump.
4. To bleed, follow (2) through (4) above.

IMPORTANT :
- Tighten air vent plug of the fuel injection pump except when bleeding, or it may stop the engine suddenly.

[TANK BELOW INJECTION PUMP SYSTEM]



(1) Fuel tank below injection pump
(2) Pre-filter
(3) Electric or Mechanical pump
(4) Main Filter
(5) Injection pump

■Checking the fuel pipes

CAUTION

To avoid personal injury;

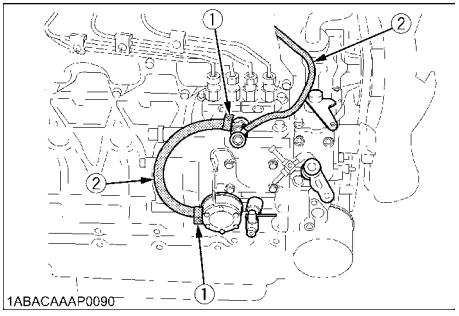
- **Check or replace the fuel pipes after stopping the engine. Broken fuel pipes can cause fires.**

Check the fuel pipes every 50 hours of operation. When if;

1. If the clamp band is loose, apply oil to the screw of the band, and tighten the band securely.
2. If the fuel pipes, made of rubber, become worn out, replace them and clamp bands every 2 years.
3. If the fuel pipes and clamp bands are found worn or damaged before 2 years' pass, replace or repair them at once.
4. After replacement of the pipes and bands, air-bleed the fuel system.

IMPORTANT :

- When the fuel pipes are not installed, plug them at both ends with clean cloth or paper to prevent dirt from entering. Dirt in the pipes can cause fuel injection pump malfunction.

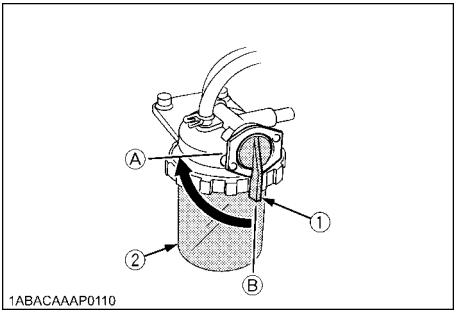


(1) Clamp band
(2) Fuel pipe

■Cleaning the fuel filter pot

Every 100 hours of operation, clean the fuel filter in a clean place to prevent dust intrusion.

1. Close the fuel filter lever.

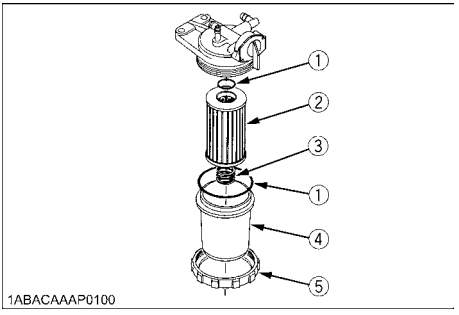


(1) Fuel filter lever
(2) Fuel filter pot
(A) "OFF"
(B) "ON"

2. Remove the top cap, and rinse the inside with diesel fuel.
3. Take out the element, and rinse it with diesel fuel.
4. After cleaning, reinstall the fuel filter, keeping out of dust and dirt.
5. Air-bleed the injection pump.

IMPORTANT :

- Entrance of dust and dirt can cause a malfunction of the fuel injection pump and the injection nozzle. Wash the fuel filter cup periodically.



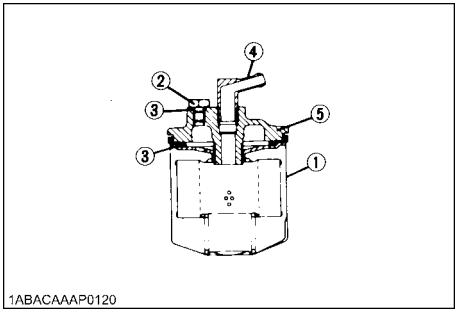
(1) O ring
(2) Filter element
(3) Spring
(4) Filter bowl
(5) Screw ring

■Fuel filter cartridge replacement

1. Replace the fuel filter cartridge with a new one every 400 operating hours.
2. Apply fuel oil thinly over the gasket and tighten the cartridge into position by hand-tightening only.
3. Finally, vent the air.

IMPORTANT :

- Replace the fuel filter cartridge periodically to prevent wear of the fuel injection pump plunger or the injection nozzle, due to dirt in the fuel.



(1) Fuel filter cartridge
(2) Air vent plug
(3) O ring
(4) Pipe joint
(5) Cover

ENGINE OIL

⚠ CAUTION

To avoid personal injury:

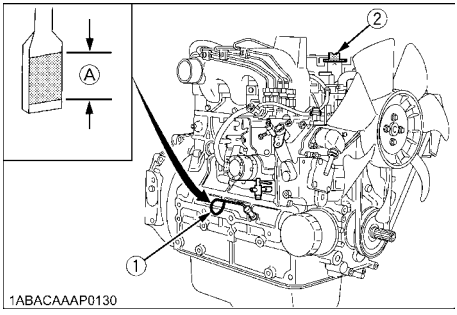
- **Be sure to stop the engine before checking and changing the engine oil and the oil filter cartridge.**
- **Do not touch muffler or exhaust pipes while they are hot; Severe burns could result. Always stop the engine and allow it to cool before conducting inspections, maintenance, or for a cleaning procedure.**
- **Contact with engine oil can damage your skin. Put on gloves when using engine oil. If you come in contact with engine oil, wash it off immediately.**

NOTE :

- Be sure to inspect the engine, locating it on a level place. If placed on gradients accurately, oil quantity may not be measured.

■Checking oil level and adding engine oil

1. Check the engine oil level before starting or more than 5 minutes after stopping the engine.
2. Remove the oil level gauge, wipe it clean and reinstall it.
3. Take the oil level gauge out again, and check the oil level.



(1) Oil filler plug
(2) Oil level gauge

[Lower end of oil level gauge]
(A) Engine oil level within this range is proper.

4. If the oil level is too low, remove the oil filler plug, and add new oil to the prescribed level.
5. After adding oil, wait more than 5 minutes and check the oil level again. It takes some time for the oil to drain down to the oil pan.

Engine oil quantity

Models	*Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
D1503-M-E3 D1703-M-E3 D1803-M-E3 D1703-M-E3BG	7.0 L (1.85 U.S.gals.)	5.6 L (1.48 U.S.gals.)
V2003-M-E3 V2203-M-E3 V2403-M-E3 V2403-M-T-E3 V2003-M-E3BG V2003-M-T-E3BG V2203-M-E3BG V2403-M-E3BG	9.5 L (2.51 U.S.gals.)	7.6 L (2.01 U.S.gals.)

* 90 mm (3.54 in.) oil pan depth is optional.
Oil quantities shown are for standard oil pans.

IMPORTANT :
- Engine oil should be MIL-L-2104C or have properties of API classification CF or higher.
  Change the type of engine oil according to the ambient temperature.

Above 25°C (77°F)	SAE30 or SAE10W-30 SAE15W-40
-10°C to 25°C (14°F to 77°F)	SAE10W-30 or SAE15W-40
Below -10°C (32°F)	SAE10W-30

- When using oil of different brands from the previous one, be sure to drain all the previous oil before adding the new engine oil.

■Changing engine oil

CAUTION

To avoid personal injury:
- **Be sure to stop the engine before draining engine oil.**
- **When draining engine oil, place some container underneath the engine and dispose it according to local regulations.**
- **Do not drain oil after running the engine. Allow engine to cool down sufficiently.**

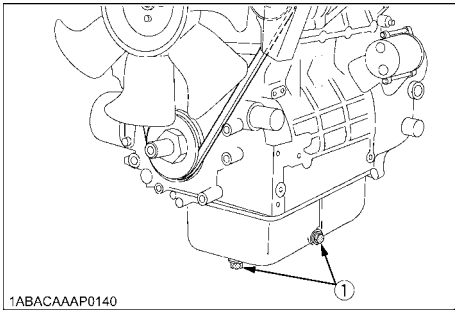
1. Change oil after the initial 50 hours of operation and every 200 hours thereafter. (See table below.)

NOTE :
- **Changing interval thereafter**

Models	*Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
All models	200 Hrs	150 Hrs
Initial	50 Hrs	

* 90 mm (3.54 in) oil pan depth is optional.
(Standard replacement interval)
- API classification : above CF
- Ambient temperature : below 35°C (95°F)

2. Remove the drain plug at the bottom of the engine, and drain all the old oil. Drain oil will drain easier when the oil is warm.



(1) Oil drain plug

3. Add new engine oil up to the upper limit of the oil level gauge.

■Replacing the oil filter cartridge

CAUTION

To avoid personal injury:

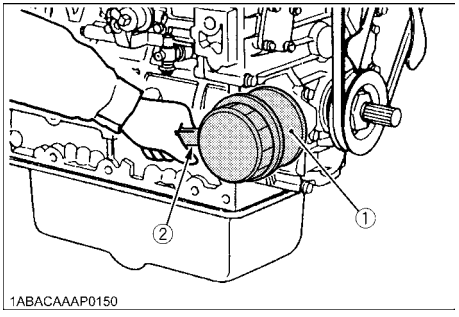
- **Be sure to stop the engine before changing the oil filter cartridge.**
- **Allow engine to cool down sufficiently, oil can be hot and cause burns.**

1. Replace the oil filter cartridge. Oil filter cartridge should be replaced, as following operation hours.

Models	*Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
All models	200 Hrs	150 Hrs
Initial	50 Hrs	

* 90 mm (3.54 in.) oil pan depth is optional.

2. Remove the old oil filter cartridge with a filter wrench.
3. Apply a film of oil to the gasket for the new cartridge.
4. Screw in the cartridge by hand. When the gasket contacts the seal surface, tighten the cartridge enough by hand. Because, if you tighten the cartridge with a wrench, it will be tightened too much.



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(1) Oil filter cartridge
(2) Remove with a filter wrench
(Tighten with your hand)

5. After the new cartridge has been replaced, the engine oil level normally decreases a little. Thus, run the engine for a while and check for oil leaks through the seal before checking the engine oil level. Add oil if necessary.

NOTE :

- Wipe off any oil sticking to the machine completely.

RADIATOR

Coolant will last for one day's work if filled all the way up before operation start. Make it a rule to check the coolant level before every operation.

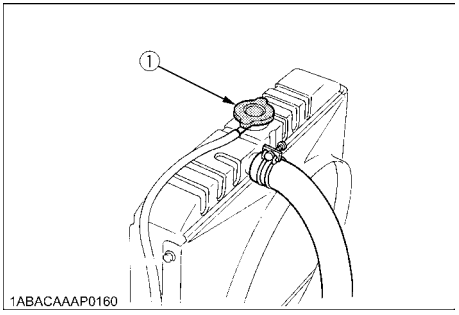
WARNING

To avoid personal injury:

- **Do not stop the engine suddenly, stop it after about 5 minutes of unloaded idling.**
- **Work only after letting the engine and radiator cool off completely (more than 30 minutes after it has been stopped).**
- **Do not remove the radiator cap while coolant is hot. When cool to the touch, rotate cap to the first stop to allow excess pressure to escape. Then remove cap completely.**
  If overheats should occur, steam may gush out from the radiator or recovery tank; Severe burns could result.

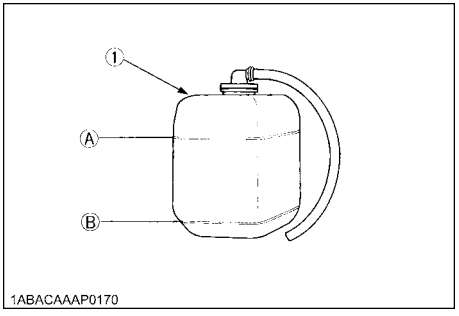
■Checking coolant level, adding coolant

1. Remove the radiator cap, after the engine has completely cooled, and check to see that coolant reaches the supply port.



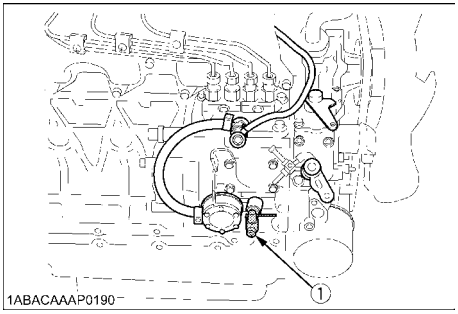
(1) Radiator pressure cap

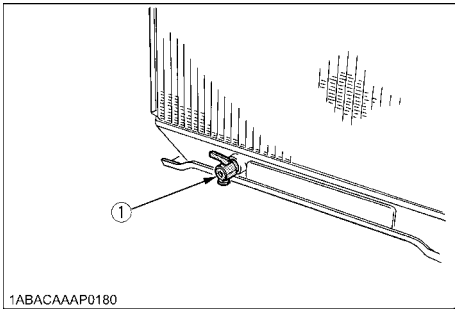
2. If the radiator is provided with a recovery tank, check the coolant level of the recovery tank. When it is between the "FULL" and "LOW" marks, the coolant will last for one day's work.



(1) Recovery tank (A) "FULL"
(B) "LOW"

3. When the coolant level drops due to evaporation, add water only up to the full level.
4. Check to see that two drain cocks; one is at the crankcase side and the other is at the lower part of the radiator as figures below.





(1) Coolant drain cock

IMPORTANT :

- If the radiator cap has to be removed, follow the caution and securely retighten the cap.
- If coolant should be leak, consult your local KUBOTA dealer.
- Make sure that muddy or sea water does not enter the radiator.
- Use clean, fresh water and 50% anti-freeze to fill the recovery tank.
- Do not refill recovery tank with coolant over the "FULL" level mark.
- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and decrease quickly.

■Changing coolant

1. To drain coolant, always open both drain cocks and simultaneously open the radiator cap as well. With the radiator cap kept closed, a complete drain of water is impossible.
2. Remove the overflow pipe of the radiator pressure cap to drain the recovery tank.
3. Prescribed coolant volume (U.S.gallons)

Models	Quantity
D1503-M-E3 D1703-M-E3 D1703-M-E3BG	5.5 L (1.45 U.S.gals.)
D1803-M-E3	5.8 L (1.53 U.S.gals.)
V2003-M-E3 V2203-M-E3 V2003-M-E3BG V2003-M-T-E3BG V2203-M-E3BG	8.1 L (2.14 U.S.gals.)
V2403-M-E3 V2403-M-T-E3 V2403-M-E3BG	8.4 L (2.22 U.S.gals.)

NOTE :
- Coolant quantities shown are for standard radiators.

4. An improperly tightened radiator cap or a gap between the cap and the seat quickens loss of coolant.
5. Coolant (Radiator cleaner and anti-freeze)

Season	Coolant
All seasons	Pure water and anti-freeze (See "Anti-freeze" in “RADIATOR” section.)

■Remedies for quick decrease of coolant

1. Check any dust and dirt between the radiator fins and tube. If any, remove them from the fins and the tube.
2. Check the tightness of the fan belt. If loose, tighten it securely.
3. Check the internal blockage in the radiator hose. If scale forms in the hose, clean with the scale inhibitor or its equivalent.

■Checking radiator hoses and clamp bands

CAUTION

To avoid personal injury:

- **Be sure to check radiator hoses and clamp bands periodically. If radiator hose is damaged or coolant leaks, overheats or severe burns could occur.**

Check to see if radiator hoses are properly fixed every 200 hours of operation or 6 months, whichever comes first.

1. If hose clamps are loose or water leaks, tighten hose clamp securely.
2. Replace hoses and tighten hose clamps securely, if radiator hoses are swollen, hardened or cracked.

Replace hoses and hose clamps every 2 years or earlier, if checked and found that hoses are swollen, hardened or cracked.

■Precaution at overheating

The event that the coolant temperature is nearly or more than the boiling point is called **"OVERHEATING"**.
While running, make the following checks to see that all parts are working correctly. **If anything is unusual, inspect it, referring to the relevant description in "MAINTENANCE" and "PERIODIC SERVICE" section**.

◆ Coolant

If the coolant temperature warning lamp lights up or if steam or coolant does not stop squirting from the radiator overflow pipe, turn off the load and **keep the engine idling (COOLING-DOWN) for at least 5 minutes** to let it cool down gradually. Then stop the engine and take the following inspection and servicing.

1. Check to see if the coolant runs short or if there is any coolant leak;
2. Check to see if there is any obstacle around the cooling air inlet or outlet;
3. Check to see if there is any dirt or dust between radiator fins and tube;
4. Check to see if the fan belt is too loose; and
5. Check to see if radiator water pipe is clogged.

■Cleaning radiator core (outside)

If dust is between the fin and tube, wash it away with running water.

IMPORTANT :
- Do not clean radiator with firm tools such as spatulas or screwdrivers. They may damage specified fin or tube. It can cause coolant leaks or decrease cooling performance.

■Cleaning the radiator (inside)

1. Clean up the coolant line inside in the following cases.
   - As per the SERVICE INTERVALS list.
   - When changing the coolant.
2. Use a **radiator cleaning agent**. This helps wash away scale deposits.

■Anti-freeze

⚠ CAUTION

To avoid personal injury:

- **When using anti-freeze, put on some protection such as rubber gloves (Anti-freeze contains poison.).**
- **If should drink anti-freeze, throw up at once and take medical attention.**
- **When anti-freeze comes in contact with the skin or clothing, wash it off immediately.**
- **Do not mix different types of anti-freeze. The mixture can produce chemical reaction causing harmful substances.**
- **Anti-freeze is extremely flammable and explosive under certain conditions. Keep fire and children away from anti-freeze.**
- **When draining fluids from the engine, place some container underneath the engine body.**
- **Do not pour waste onto the grounds, down a drain, or into any water source.**
- **Also, observe the relevant environmental protection regulations when disposing of anti-freeze.**

Always use a 50/50 mix of long-life coolant and clean soft water in KUBOTA engines.

Contact KUBOTA concerning coolant for extreme conditions.

1. Long-life coolant (hereafter LLC) comes in several types. Use ethylene glycol (EG) type for this engine.
2. Before employing LLC-mixed cooling water, flush the radiator with fresh water. Repeat this procedure 2 or 3 times to clean up the radiator and engine block from inside.
3. Mixing the LLC
   Premix 50% LLC with 50% clean soft water. When mixing, stir it up well, and then fill into the radiator.
4. The procedure for the mixing of water and anti-freeze differs according to the make of the anti-freeze. Refer to SAE J1034 standard, more specifically also to SAE J814c.

Vol % Anti-freeze	Freezing Point		Boiling Point *	
	℃	℉	℃	℉
50	-37	-34	108	226

*At 1.013 x 10^5Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

5. Adding the LLC
   (1) Add only water if the coolant level reduces in the cooling system by evaporation.
   (2) If there is a coolant leak, add the LLC of the same manufacturer and type in the same coolant percentage.
   *Never add any long-life coolant of different manufacturer. (Different brands may have different additive components, and the engine may fail to perform as specified.)
6. When the LLC is mixed, do not employ any radiator cleaning agent. The LLC contains anti-corrosive agent. If mixed with the cleaning agent, sludge may build up, adversely affecting the engine parts.
7. Kubota's genuine long-life coolant has a service life of 2 years. Be sure to change the coolant every 2 years.

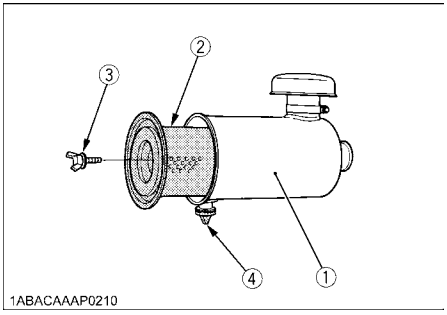
NOTE :

- The above data represents industry standards that necessitate minimum glycol content in the concentrated anti-freeze.

AIR CLEANER

Since the air cleaner employed on this engine is a dry type, never apply oil to it.

1. Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place. This will get rid of large particles of dust and dirt.
2. Wipe the inside air cleaner clean with cloth if it is dirty or wet.
3. Avoid touching the element except when cleaning.
4. When dry dust adheres to the element, blow compressed air from the inside turning the element. Pressure of compressed air must be under 205 kPa (2.1 kgf/cm², 30 psi).
5. Replace the element every year or every 6 cleanings.



(1) Air cleaner body
(2) Element
(3) Wing bolt
(4) Evacuator valve

IMPORTANT :

- Make sure the wing bolt for the element is tight enough. If it is loose, dust and dirt may be sucked in, wearing down the cylinder liner and piston ring earlier and thereby resulting in poor power output.
- Do not overservice the air cleaner element. Overservicing may cause dirt to enter the engine causing premature wear. Use the dust indicator as a guide on when to service.

■Evacuator valve

Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place - to get rid of large particles of dust and dirt.

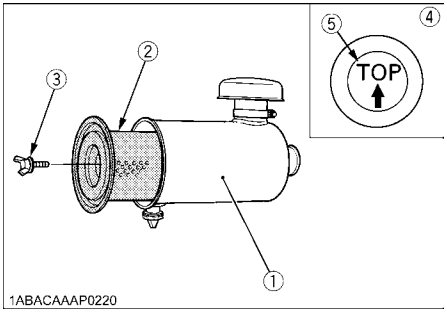
■For the air cleaner with a dust cup (optional)

Remove and clean out the dust cup before it becomes half full with dust; usually once a week, or even every day if the working surroundings are dusty.

Install the air cleaner dust cup with "TOP" indicated on the rear of the cup in the up position. (However, it may be installed in either direction when the cover is placed at the lower part.)

IMPORTANT :

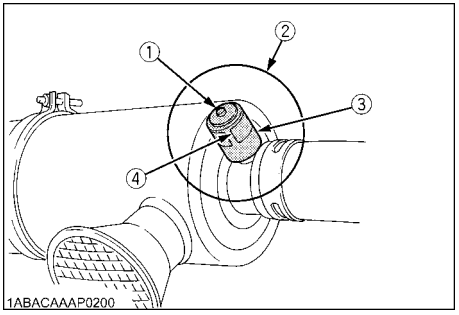
- If the dust cup is mounted incorrectly, dust or dirt does not collect in the cup, and direct attachments of the dust to the element will cause its lifetime to shorten to a great extent.



(1) Air cleaner body
(2) Element
(3) Wing bolt
(4) Dust cup
(5) "TOP" mark

■Dust indicator (optional)

If the red signal on the dust indicator attached to the air cleaner is visible, the air cleaner has reached the service level.
Clean the element immediately, and reset the signal with the "RESET" button.



(1) "RESET" button
(2) Dust indicator
(3) Service level
(4) Signal

ELECTRIC WIRING

CAUTION

To avoid personal injury:

- **◆ Shorting of electric cable or wiring may cause a fire.**
  - **● Check to see if electric cables and wiring are swollen, hardened or cracked.**
  - **● Keep dust and water away from all power connections.**
    Loose wiring terminal parts, make bad connections. Be sure to repair them before starting the engine.

Damaged wiring reduces the capacity of electrical parts. Change or repair damaged wiring immediately.

FAN BELT

■Adjusting Fan Belt Tension

CAUTION

To avoid personal injury:

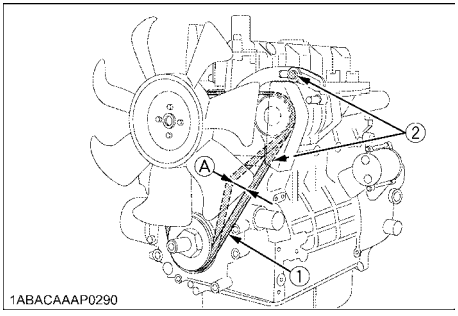
- **● Be sure to stop the engine and remove the key before checking the belt tension.**
- **● Be sure to reinstall the detached safety shield after maintenance or checking.**

Proper fan belt tension	A deflection of between 7 to 9 mm (0.28 to 0.35 in.) when the belt is pressed in the middle of the span.

1. Stop the engine and remove the key.
2. Apply moderate thumb pressure to belt between the pulleys.
3. If tension is incorrect, loosen the alternator mounting bolts and, using a lever placed between the alternator and the engine block, pull the alternator out until the deflection of the belt falls within acceptable limits.
4. Replace fan belt if it is damaged.

IMPORTANT :

- If belt is loosen or damaged and the fan is damaged, it could result in overheats or insufficient charging. Correct or replace belt.



(1) Fan belt
(2) Bolt and nut
(A) 7 to 9 mm (0.28 to 0.35 in.) (under load of 10 kgf (22.1 lbs))

CARRIAGE AND STORAGE

CARRIAGE

CAUTION

To avoid personal injury:

- **Fix the engine securely not to fall during operation.**
- **Do not stand near or under the engine while carrying it.**
- **The engine is heavy. In handling it, be very alert not to get your hands and body caught in.**

1. Use carrier such as crane when carrying the engine, or hurt your waist and yourself. Support the engine securely with rope not to fall while carrying it.
2. When lifting the engine, put the hook securely to metal fittings attached to the engine. Use strong hook and fittings enough to hang the engine.

STORAGE

CAUTION

To avoid personal injury:

- **Do not clean the machine with engine running.**
- **To avoid the danger of exhaust fume poisoning, do not operate the engine in a closed building without proper ventilation.**
- **When storing the engine just after running, let the engine cool off.**

Before storing the engine for more than a few months, remove any dirt on the machine, and:

1. Drain the coolant in the radiator. Open the cock at the bottom of the radiator, and remove the pressure cap to drain water completely. Leave the cock open. Hang a note written "No water" on the pressure cap. Since water may freeze when the temperature drops below 0°C (32°F), it is very important that no water is left in the machine.

NOTE :

- When using anti-freeze, it is not necessary to take step (1) above.

2. Remove dirty engine oil, fill with new oil and run the engine for about 5 minutes to let the oil penetrate to all the parts.
3. Check all the bolts and nuts, and tighten if necessary.
4. Remove the battery from the engine, adjust the electrolyte level, and recharge it. Store the battery in a dry and dark place.
5. When the engine is not used for a long period of time, run it for about 5 minutes under no load every 2 to 3 months to keep it free from rust. If the engine is stored without any running, moisture in the air may condense into dew over the sliding parts of the engine, resulting in rust there.
6. If you forget to run the engine for longer than 5 to 6 months, apply enough engine oil to the valve guide and valve stem seal and make sure the valve works smoothly before starting the engine.
7. Store the engine in a flat place and remove the key from engine.
8. Do not store the engine in a place where has flammable materials such as dry grass or straw.
9. When covering the engine for storage, let engine and muffler cool off completely.
10. Operate the engine after checking and repairing damaged wirings or pipes, and clearing flammable materials carried by mouse.

TROUBLESHOOTING

If the engine does not function properly, use the following chart to identify and correct the cause.

■ When it is difficult to start the engine

Cause	Countermeasures
Fuel is thick and doesn't flow.	* Check the fuel tank and fuel filter. * Remove water, dirt and other impurities. * As all fuel will be filtered by the filter, if there should be water or other foreign matters on the filter, clean the filter with kerosene.
Air or water mixed in fuel system	* If air is in the fuel filter or injection lines, the fuel pump will not work properly. * To attain proper fuel injection pressure, check carefully for loosened fuel line coupling, loose cap nut, etc. * Loosen joint bolt stop fuel filter and air vent screws of fuel injection pump to eliminate all the air in the fuel system.
Engine oil becomes thick in cold weather and engine cranks slow.	* Change grade of oil according to the weather (temperature.)
Battery is discharged and the engine will not crank.	* Charge battery. * In winter, always remove battery from machine, charge fully and keep indoors. Install in machine at time of use.

■ When output is insufficient

Cause	Countermeasures
Fuel is insufficient.	* Check fuel system.
Overheating of moving parts	* Check lubricating oil system. * Check to see if lubricating oil filter is working properly. * Filter element deposited with impurities would cause poor lubrication. Change element.
Air cleaner is dirty	* Clean the element every 100 hours of operation.
Injection pump wear	* Do not use poor quality fuel as it will cause wear of the pump. Only use No. 2-D diesel fuel.(See "FUEL" in "PERIODIC SERVICE" Section)

■ When engine suddenly stops

Cause	Countermeasures
Lack of fuel	* Check the fuel tank and refill the fuel, if necessary. * Also check the fuel system for air or leaks.
Bad nozzle	* If necessary, replace with a new nozzle.
Moving parts are overheated due to shortage of lubrication oil or improper lubrication.	* Check amount of engine oil with oil level gauge. * Check lubricating oil system. * At every 2 times of oil change, oil filter cartridge should be replaced.

■ When color of exhaust is especially bad

Cause	Countermeasures
Fuel is of extremely poor quality.	* Select good quality fuel. Use No. 2-D diesel fuel only.
Nozzle is bad.	* If necessary, replace with new nozzle.

■ When engine must be stopped immediately

Cause	Countermeasures
Color of exhaust suddenly turns dark.	* Check the fuel injection system, especially the fuel injection nozzle.
Bearing parts are overheated.	* Check the lubricating system.
Oil lamp lights up during operation.	* Check the lubricating system. * Check the function of the relieve valve in the lubricating system. * Check pressure switch. * Check filter base gasket.

NOTE :
- If the cause of trouble can not be found, contact your KUBOTA dealer.

■ **When engine overheats**

Cause	Countermeasures
Engine oil insufficient	* Check oil level. Replenish oil as required.
Fan belt broken or elongated	* Change belt or adjust belt tension.
Coolant insufficient	* Replenish coolant.
Excessive concentration of antifreeze	* Add water only or change to coolant with the specified mixing ratio.
Radiator net or radiator fin clogged with dust	* Clean net or fin carefully.
Inside of radiator or coolant flow route corroded	* Clean or replace radiator and parts.
Fan or radiator or radiator cap defective	* Replace defective parts.
Thermostat defective	* Check thermostat and replace if necessary.
Temperature gauge or sensor defective	* Check temperature with thermometer and replace if necessary.
Overload running	* Reduce load.
Head gasket defective or water leakage	* Replace parts.
Unsuitable fuel used	* Use the specified fuel.

SPECIFICATIONS

Model	D1503-M-E3	D1703-M-E3	D1803-M-E3
Type	Vertical, water-cooled, 4-cycle diesel engine		
Number of cylinders	3		
Bore and stroke mm (in.)	83 x 92.4 (3.27 x 3.64)	87 x 92.4 (3.43 x 3.64)	87 x 102.4 (3.43 x 4.04)
Total displacement L (cu.in.)	1.499 (91.44)	1.647 (100.51)	1.826 (111.43)
Combustion chamber	Spherical Type (E-TVCS)		
SAE NET Intermittent kW / rpm H.P. (SAEJ1349) (HP / rpm)	21.7 / 2800 (29.1 / 2800)	24.3 / 2800 (32.6 / 2800)	26.5 / 2700 (35.5 / 2700)
SAE NET Continuous kW / rpm H.P. (SAEJ1349) (HP / rpm)	18.8 / 2800 (25.2 / 2800)	21.1 / 2800 (28.3 / 2800)	23.0 / 2700 (30.8 / 2700)
Maximum bare speed rpm	3000		2900
Minimum bare idling speed rpm	750 to 850		
Order of firing	1-2-3		
Direction of rotation	Counter-clockwise (viewed from flywheel side)		
Injection pump	Bosch Type mini pump		
Injection pressure	13.73 MPa, 1991 psi (140 kgf/cm²)		
Injection timing (Before T.D.C.)	0.28 rad (16.25°)	0.30 rad (17.25°)	
Compression ratio	22.8	22.0	24.3
Fuel	Diesel Fuel No.2-D		
Lubricant (API classification)	above CF		
Dimension mm (in.) (length x width x height)	572.1 x 499.0 x 643.0 (22.5 x 19.8 x 25.3)		575.9 x 499.0 x 684.0 (22.7 x 19.8 x 27.0)
Dry weight (BB Spec.) kg (lbs.)	148 (326.3)		151 (332.9)
Starting system	Cell starter (with glow plug)		
Starting motor	12 V, 1.4 kW		12 V, 2.0 kW
Charging generator	12 V, 480 W		
Recommended battery capacity	12 V, 70 to 80 AH		12 V, 100 to 120 AH

NOTE :
- Specifications are subject to change without notice.

Model	V2003-M-E3	V2203-M-E3
Type	Vertical, water-cooled, 4-cycle diesel engine	
Number of cylinders	4	
Bore and stroke mm (in.)	83 x 92.4 (3.27 x 3.64)	87 x 92.4 (3.43 x 3.64)
Total displacement L (cu.in.)	1.999 (121.94)	2.197 (134.07)
Combustion chamber	Spherical Type (E-TVCS)	
SAE NET Intermittent kW / rpm H.P. (SAEJ1349) (HP / rpm)	29.8 / 2800 (39.9 / 2800)	33.1 / 2800 (44.4 / 2800)
SAE NET Continuous kW / rpm H.P. (SAEJ1349) (HP / rpm)	25.9 / 2800 (34.7 / 2800)	28.7 / 2800 (38.5 / 2800)
Maximum bare speed rpm	3000	
Minimum bare idling speed rpm	750 to 850	
Order of firing	1-3-4-2	
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch Type mini pump	
Injection pressure	13.73 MPa, 1991 psi (140 kgf/cm²)	
Injection timing (Before T.D.C.)	0.30 rad (17.25°)	
Compression ratio	22.8	22.0
Fuel	Diesel Fuel No.2-D	
Lubricant (API classification)	above CF	
Dimension mm (in.) (length x width x height)	667.1 x 499.0 x 633.5 (26.3 x 19.8 x 24.9)	
Dry weight (BB Spec.) kg (lbs.)	180 (396.9)	
Starting system	Cell starter (with glow plug)	
Starting motor	12 V, 1.4 kW	
Charging generator	12 V, 480 W	
Recommended battery capacity	12 V, 100 to 120 AH	

NOTE :
- Specifications are subject to change without notice.

Model	V2403-M-E3	V2403-M-T-E3
Type	Vertical, water-cooled, 4-cycle diesel engine	
Number of cylinders	4	
Bore and stroke mm (in.)	87 x 102.4 (3.43 x 4.04)	
Total displacement L (cu.in.)	2.434 (148.53)	
Combustion chamber	Spherical Type (E-TVCS)	
SAE NET Intermittent kW / rpm H.P. (SAEJ1349) (HP / rpm)	33.9 / 2700 (45.4 / 2700)	41.2 / 2700 (55.2 / 2700)
SAE NET Continuous kW / rpm H.P. (SAEJ1349) (HP / rpm)	29.4 / 2700 (39.4 / 2700)	35.8 / 2700 (47.9 / 2700)
Maximum bare speed rpm	2900	2950
Minimum bare idling speed rpm	750 to 850	850 to 950
Order of firing	1-3-4-2	
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch Type mini pump	
Injection pressure	13.73 MPa, 1991 psi (140 kgf/cm²)	
Injection timing (Before T.D.C.)	0.30 rad (17.25°)	0.16 rad (9.25°)
Compression ratio	23.2	22.5
Fuel	Diesel Fuel No.2-D	
Lubricant (API classification)	above CF	
Dimension mm (in.) (length x width x height)	670.9 x 499.0 x 684.0 (26.4 x 19.8 x 26.9)	670.9 x 499.0 x 724.6 (26.4 x 19.8 x 28.5)
Dry weight (BB Spec.) kg (lbs.)	184.0 (405.7)	188.0 (414.5)
Starting system	Cell starter (with glow plug)	
Starting motor	12 V, 2.0 kW	
Charging generator	12 V, 480 W	
Recommended battery capacity	12 V, 100 to 120 AH	

NOTE :
- Specifications are subject to change without notice.

Model	D1703-M-E3BG	V2003-M-E3BG
Type	Vertical, water-cooled, 4-cycle diesel engine	
Number of cylinders	3	4
Bore and stroke mm (in.)	87 x 92.4 (3.43 x 3.64)	83 x 92.4 (3.27 x 3.64)
Total displacement L (cu.in.)	1.647 (100.51)	1.999 (121.94)
Combustion chamber	Spherical Type (E-TVCS)	
SAE NET Continuous H.P. (SAEJ1349) kW / rpm (HP / rpm)	15.1 / 1800 (20.2 / 1800)	18.2 / 1800 (24.4 / 1800)
	12.8 / 1500 (17.2 / 1500)	15.5 / 1500 (20.8 / 1500)
SAE NET Standby H.P. (SAEJ1349) kW / rpm (HP / rpm)	18.1 / 1800 (24.3 / 1800)	21.8 / 1800 (29.2 / 1800)
	15.0 / 1500 (20.1 / 1500)	18.1 / 1500 (24.3 / 1500)
Maximum bare speed rpm	1800 / 1500	
Order of firing	1-2-3	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch Type mini pump	
Governor	Electronic Governor	
Injection pressure Mpa (kgf/cm², psi)	13.73 (140, 1991)	
Injection timing (Before T.D.C.)	0.27 rad (15.25°)	
Compression ratio	22.0	22.8
Fuel	Diesel Fuel No.2-D (ASTM D975)	
Lubricant (API classification)	above CF	
Dimension mm (in.) (length x width x height)	608.4 x 490 x 642.8 (24.0 x 19.3 x 25.3)	700.6 x 490 x 633.3 (27.6 x 19.3 x 24.9)
Dry weight (BB Spec.) kg (lbs.)	164 (361.6)	195 (430.0)
Starting system	Cell starter (with glow plug)	
Starting motor	12 V, 1.4 kW	
Charging generator	12 V, 480 W	
Recommended battery capacity	12 V, 70 to 80 AH, equivalent	12 V, 100 to 120 AH, equivalent

NOTE :
- Flywheel type is SAE clutch No. 7-1/2 or its equivalent.
- Flywheel housing type is SAE No. 4 or its equivalent.
- Continuous will operate at the stated rating continuously and have a 10% overload capability for one hour in 12 hours.
- Standby will operate at the stated full rating for one hour in 12 hours. No overload capacity is specified for this rating.
- Specifications are subject to change without notice.

Model	V2003-M-T-E3BG	V2203-M-E3BG
Type	Vertical, water-cooled, 4-cycle diesel engine	
Number of cylinders	4	
Bore and stroke mm (in.)	83 x 92.4 (3.27 x 3.64)	87 x 92.4 (3.43 x 3.64)
Total displacement L (cu.in.)	1.999 (121.94)	2.197 (134.07)
Combustion chamber	Spherical Type (E-TVCS)	
SAE NET Continuous H.P. (SAEJ1349) kW / rpm	24.5 / 1800 (32.8 / 1800)	20.2 / 1800 (27.1 / 1800)
SAE NET Continuous H.P. (SAEJ1349) (HP / rpm)	20.4 / 1500 (27.3 / 1500)	17.2 / 1500 (23.1 / 1500)
SAE NET Standby H.P. (SAEJ1349) kW / rpm	27.1 / 1800 (36.3 / 1800)	24.2 / 1800 (32.4 / 1800)
SAE NET Standby H.P. (SAEJ1349) (HP / rpm)	22.5 / 1500 (30.2 / 1500)	20.1 / 1500 (26.9 / 1500)
Maximum bare speed rpm	1800 / 1500	
Order of firing	1-3-4-2	
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch Type mini pump	
Governor	Electronic Governor	
Injection pressure Mpa (kgf/cm², psi)	13.73 (140, 1991)	
Injection timing (Before T.D.C.)	0.28 rad (16.25°)	0.27 rad (15.25°)
Compression ratio	21.7	22.0
Fuel	Diesel Fuel No.2-D (ASTM D975)	
Lubricant (API classification)	above CF	
Dimension mm (in.) (length x width x height)	700.6 x 490 x 674 (27.6 x 19.3 x 26.5)	700.6 x 490 x 633.3 (27.6 x 19.3 x 24.9)
Dry weight (BB Spec.) kg (lbs.)	208 (458.6)	195 (430.0)
Starting system	Cell starter (with glow plug)	
Starting motor	12 V, 1.4 kW	
Charging generator	12 V, 480 W	
Recommended battery capacity	12 V, 100 to 120 AH, equivalent	

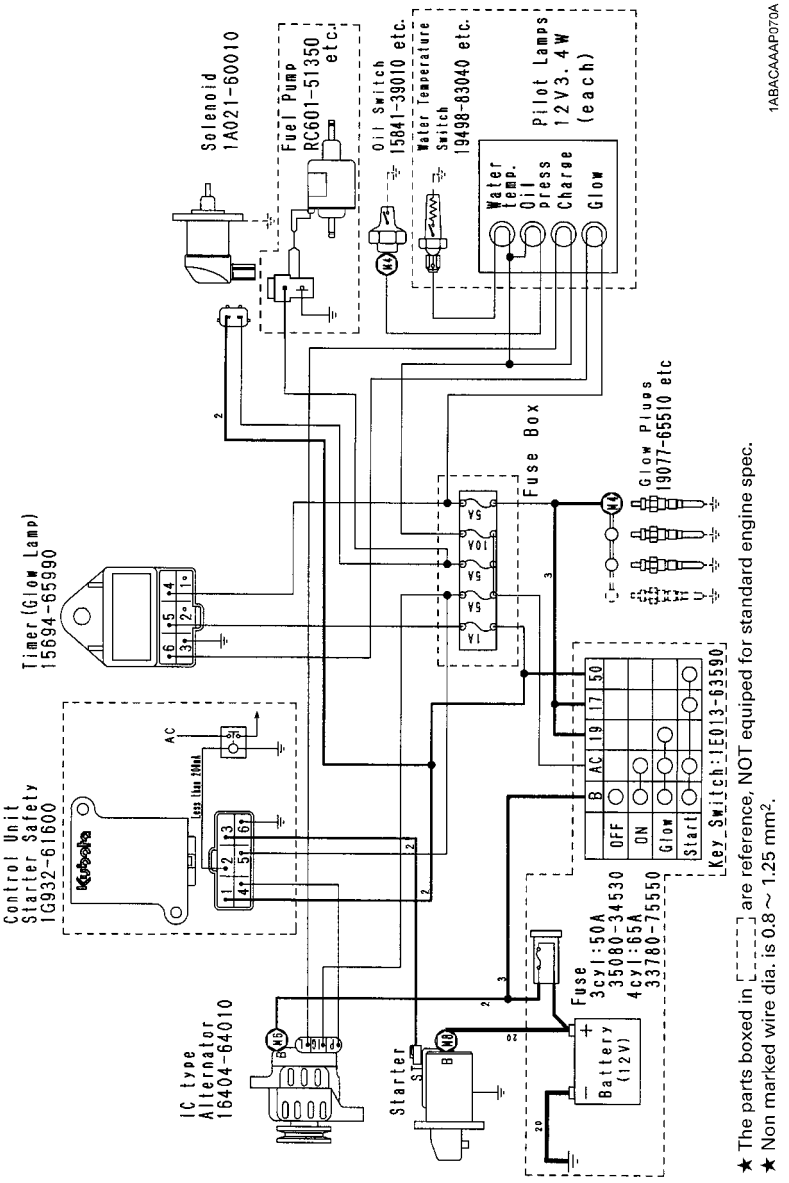
NOTE :
- Flywheel type is SAE clutch No. 7-1/2 or its equivalent.
- Flywheel housing type is SAE No. 4 or its equivalent.
- Continuous will operate at the stated rating continuously and have a 10% overload capability for one hour in 12 hours.
- Standby will operate at the stated full rating for one hour in 12 hours. No overload capacity is specified for this rating.
- Specifications are subject to change without notice.

Model	V2403-M-E3BG
Type	Vertical, water-cooled, 4-cycle diesel engine
Number of cylinders	4
Bore and stroke mm (in.)	87 x 102.4 (3.47 x 4.04)
Total displacement L (cu.in.)	2.434 (148.53)
Combustion chamber	Spherical Type (E-TVCS)
SAE NET Continuous H.P. (SAEJ1349) kW / rpm	22.1 / 1800 (29.6 / 1800)
SAE NET Continuous H.P. (SAEJ1349) (HP / rpm)	18.8 / 1500 (25.2 / 1500)
SAE NET Standby H.P. (SAEJ1349) kW / rpm	26.5 / 1800 (35.5 / 1800)
SAE NET Standby H.P. (SAEJ1349) (HP / rpm)	22.0 / 1500 (29.5 / 1500)
Maximum bare speed rpm	1800 / 1500
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch Type mini pump
Governor	Electronic Governor
Injection pressure Mpa (kgf/cm², psi)	13.73 (140, 1991)
Injection timing (Before T.D.C.)	0.27 rad (15.25°)
Compression ratio	23.2
Fuel	Diesel Fuel No.2-D (ASTM D975)
Lubricant (API classification)	above CF
Dimension mm (in.) (length x width x height)	700.6 x 490 x 684 (27.6 x 19.3 x 26.9)
Dry weight (BB Spec.) kg (lbs.)	199 (438.7)
Starting system	Cell starter (with glow plug)
Starting motor	12 V, 2.0 kW
Charging generator	12 V, 480 W
Recommended battery capacity	12 V, 100 to 120 AH, equivalent

NOTE :
- Flywheel type is SAE clutch No. 7-1/2 or its equivalent.
- Flywheel housing type is SAE No. 4 or its equivalent.
- Continuous will operate at the stated rating continuously and have a 10% overload capability for one hour in 12 hours.
- Standby will operate at the stated full rating for one hour in 12 hours. No overload capacity is specified for this rating.
- Specifications are subject to change without notice.

ENGLISH

WIRING DIAGRAMS

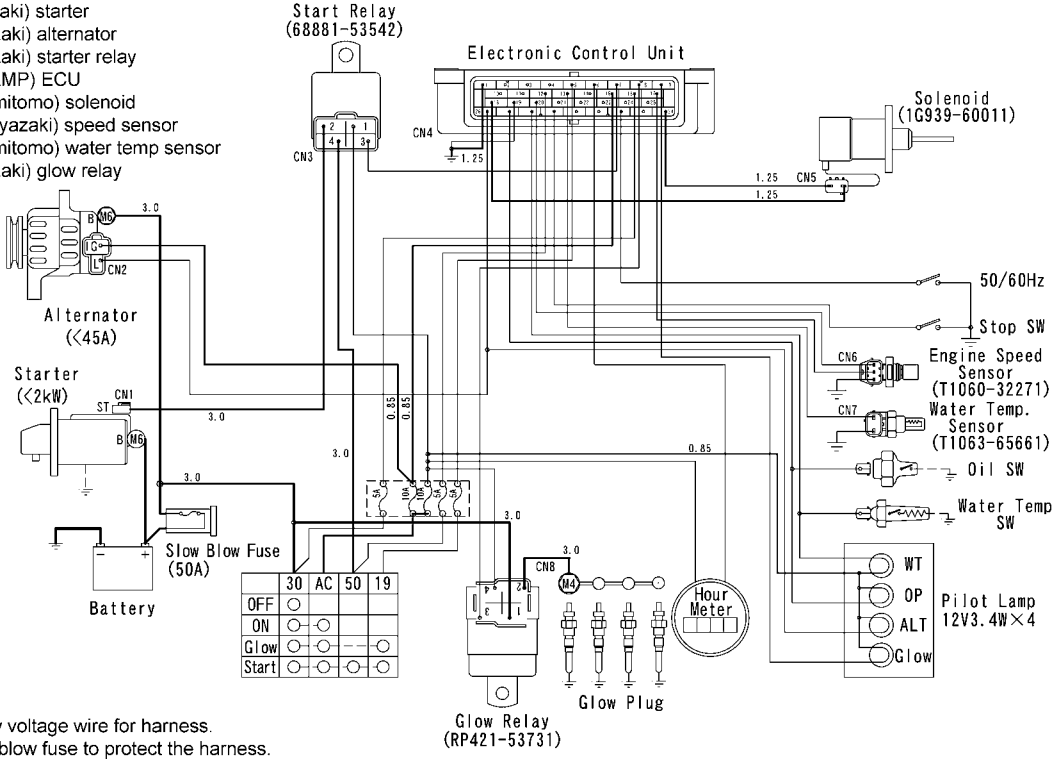


★ The parts boxed in [ ] are reference, NOT equiped for standard engine spec.
★ Non marked wire dia. is 0.8 ~ 1.25 mm².

[D1703-M-E3BG, V2003-M-E3BG, V2003-M-T-E3BG, V2203-M-E3BG, V2403-M-E3BG]

Harness Side Connector Number

CN1 : 7123-2115 (yazaki) starter
CN2 : 7123-2128 (yazaki) alternator
CN3 : 7123-2249 (yazaki) starter relay
CN4 : 3-1437290-9 (AMP) ECU
CN5 : 6189-0249 (sumitomo) solenoid
CN6 : 7283-8732-40 (yazaki) speed sensor
CN7 : 6189-0552 (sumitomo) water temp sensor
CN8 : 7123-9246 (yazaki) glow relay



1. Use automotive low voltage wire for harness.
2. Use fuse and slow-blow fuse to protect the harness.
3. The wire and fuse size shown in this drawing are our recommendation, consider wire length and condition for actual production.
4. Allocate slow-blow fuse close to battery, fuse box close to key switch.
5. Do not directly connect induction device, such as moter, to AC line.
6. Use more than 0.5 mm^2 wire for unspecified wires in this drawing.

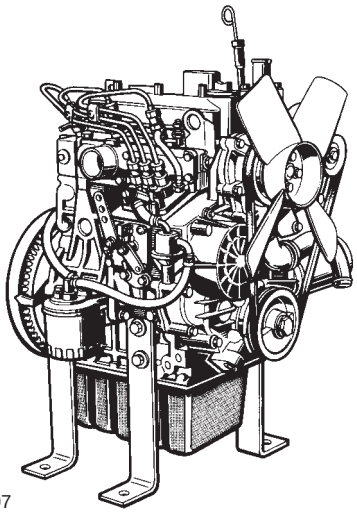
1ABACAAAP069A

OPERATOR'S MANUAL

ENGLISH

KUBOTA
MOTORE DIESEL

MODELS **D905-E·D1105-TE·V1305-E**
D1005-E·V1205-E·V1505-E
D1105-E·V1205-TE·V1505-TE



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READ AND SAVE THIS BOOK

Kubota

California Proposition 65

⚠ WARNING ⚠

Engine exhaust, some of its constituents, certain vehicle components and fluids, contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

ENGLISH

FOREWORD

You are now the proud owner of a KUBOTA Engine. This engine is a product of KUBOTA quality engineering and manufacturing. It is made of fine materials and under a rigid quality control system. It will give you long, satisfactory service. To obtain the best use of your engine, please read this manual carefully. It will help you become familiar with the operation of the engine and contains many helpful hints about engine maintenance. It is KUBOTA's policy to utilize as quickly as possible every advance in our research. The immediate use of new techniques in the manufacture of products may cause some small parts of this manual to be outdated. KUBOTA distributors and dealers will have the most up-to-date information. Please do not hesitate to consult with them.

SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully. It is essential that you read the instructions and safety regulations before you attempt to assemble or use this unit.

DANGER : Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING : Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

CAUTION : Indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury.

IMPORTANT : Indicates that equipment or property damage could result if instructions are not followed.

NOTE : Gives helpful information.

ENGLISH

CONTENTS

ENGLISH

SAFE OPERATION

Careful operation is your best assurance against an accident. Read and understand this section carefully before operating the engine. All operators, no matter how much experience they may have, should read this and other related manuals before operating the engine or any equipment attached to it. It is the owner's obligation to provide all operators with this information and instruct them on safe operation.

Be sure to observe the following for safe operation.

OBSERVE SAFETY INSTRUCTIONS

- Read and understand carefully this "OPERATOR'S MANUAL" and "LABELS ON THE ENGINE" before attempting to start and operate the engine.
- Learn how to operate and work safely. Know your equipment and its limitations. Always keep the engine in good condition.
- Before allowing other people to use your engine, explain how to operate and have them read this manual before operation.
- DO NOT modify the engine. UNAUTHORIZED MODIFICATIONS to the engine may impair the function and/or safety and affect engine life. If the engine does not perform properly, consult your local Kubota Engine Distributor first.

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WEAR SAFE CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

- DO NOT wear loose, torn or bulky clothing around the machine that may catch on working controls and projections or into fans, pulleys and other moving parts causing personal injury.
- Use additional safety items-PPE, e.g. hard hat, safety protection, safety goggles, gloves, etc., as appropriate or required.
- DO NOT operate the machine or any equipment attached to it while under the influence of alcohol, medication, or other drugs, or while fatigued.
- DO NOT wear radio or music headphones while operating the engine.


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CHECK BEFORE STARTING & OPERATING THE ENGINE

- Be sure to inspect the engine before operation. Do not operate the engine if there is something wrong with it. Repair it immediately.
- Ensure all guards and shields are in place before operating the engine. Replace any that are damaged or missing.
- Check to see that you and others are a safe distance from the engine before starting.
- Always keep the engine at least 3 feet (1 meter) away from buildings and other facilities.
- DO NOT allow children or livestock to approach the machine while the engine is running.
- DO NOT start the engine by shorting across starter terminals. The machine may start in gear and move. Do not bypass or defeat any safety devices.

1BAABADAP0010

KEEP THE ENGINE AND SURROUNDINGS CLEAN

- Be sure to stop the engine before cleaning.
- Keep the engine clean and free of accumulated dirt, grease and trash to avoid a fire. Store flammable fluids in proper containers and cabinets away from sparks and heat.
- Check for and repair leaks immediately.
- DO NOT stop the engine without idling; Allow the engine to cool down, first. Keep the engine idling for about 5 minutes before stopping unless there is a safety problem that requires immediate shut down.

1AEAAAAAP0120

SAFE HANDLING OF FUEL AND LUBRICANTS -KEEP AWAY FROM FIRE

- Always stop the engine before refueling and/or lubricating.
- DO NOT smoke or allow flames or sparks in your work area. Fuel is extremely flammable and explosive under certain conditions.
- Refuel at a well ventilated and open place. When fuel and/or lubricants are spilled, refuel after letting the engine cool down.
- DO NOT mix gasoline or alcohol with diesel fuel. The mixture can cause a fire or severe engine damage.
- Do not use unapproved containers e.g. buckets, bottles, jars. Use approved fuel storage containers and dispensers.

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EXHAUST GASES & FIRE PREVENTION

- Engine exhaust fumes can be very harmful if allowed to accumulate. Be sure to run the engine in a well ventilated location and where there are no people or livestock near the engine.
- The exhaust gas from the muffler is very hot. To prevent a fire, do not expose dry grass, mowed grass, oil or any other combustible materials to exhaust gas. Keep the engine and muffler clean at all times.
- To avoid a fire, be alert for leaks of flammable substances from hoses and lines. Be sure to check for leaks from hoses or pipes, such as fuel and hydraulic fluid by following the maintenance check list.
- To avoid a fire, do not short across power cables and wires. Check to see that all power cables and wirings are in good condition. Keep all electrical connections clean. Bare wire or frayed insulation can cause a dangerous electrical shock and personal injury.

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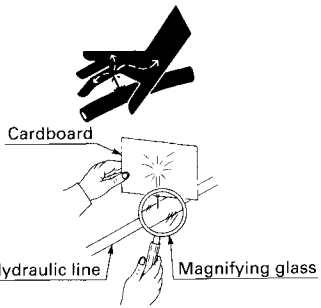
ESCAPING FLUID

- Relieve all pressure in the air, the oil and the cooling systems before disconnecting any lines, fittings or related items.
- Be cautious of possible pressure relief when disconnecting any device from a pressurized system that utilizes pressure. DO NOT check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- Escaping fluid under pressure has sufficient force to penetrate skin causing serious personal injury.
- Fluid escaping from pinholes may be invisible. Use a piece of cardboard or wood to search for suspected leaks: do not use hands and body. Use safety goggles or other eye protection when checking for leaks.
- If injured by escaping fluid, see a medical doctor immediately. This fluid can produce gangrene or severe allergic reaction.



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CAUTIONS AGAINST BURNS & BATTERY EXPLOSION

- To avoid burns, be cautious of hot components, e.g. muffler, muffler cover, radiator, hoses, engine body, coolants, engine oil, etc. during operation and after the engine has been shut off.
- DO NOT remove the radiator cap while the engine is running or immediately after stopping. Otherwise hot water will spout out from the radiator. Wait until the radiator is completely cool to the touch before removing the cap. Wear safety goggles.
- Be sure to close the coolant drain valve, secure the pressure cap, and fasten the pipe band before operating. If these parts are taken off, or loosened, it will result in serious personal injury.
- The battery presents an explosive hazard. When the battery is being charged, hydrogen and oxygen gases are extremely explosive.
- DO NOT use or charge the battery if its fluid level is below the LOWER mark.
  Otherwise, the component parts may deteriorate earlier than expected, which may shorten the service life or cause an explosion. Immediately, add distilled water until the fluid level is between the UPPER and LOWER marks.
- Keep sparks and open flames away from the battery, especially during charging. DO NOT strike a match near the battery.
- DO NOT check the battery charge by placing a metal object across the terminals. Use a voltmeter or hydrometer.
- DO NOT charge a frozen battery. There is a risk of explosion. When frozen, warm the battery up to at least 16°C (61°F).

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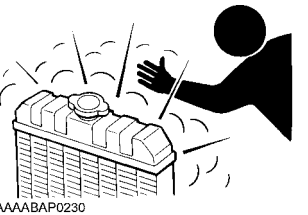

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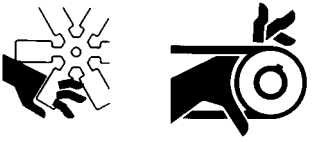
KEEP HANDS AND BODY AWAY FROM ROTATING PARTS

- Be sure to stop the engine before checking or adjusting the belt tension and cooling fan.
- Keep your hands and body away from rotating parts, such as the cooling fan, V-belt, fan drive pulley or flywheel. Contact with rotating parts can cause severe personal injury.
- DO NOT run the engine without safety guards. Install safety guards securely before operation.



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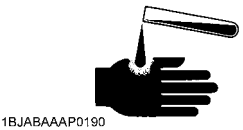
ANTI-FREEZE & DISPOSAL OF FLUIDS

- Anti-freeze contains poison. Wear rubber gloves to avoid personal injury. In case of contact with skin, wash it off immediately.
- DO NOT mix different types of Anti-freeze. The mixture can produce a chemical reaction causing harmful substances. Use approved or genuine KUBOTA Anti-freeze.
- Be mindful of the environment and the ecology. Before draining any fluids, determine the correct way to dispose of them. Observe the relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters and batteries.
- When draining fluids from the engine, place a suitable container underneath the engine body.
- DO NOT pour waste onto the ground, down a drain, or into any water source. Dispose of waste fluids according to environmental regulations.



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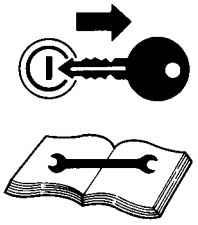
CONDUCTING SAFETY CHECKS & MAINTENANCE

- When inspecting the engine or servicing, place the engine on a large flat surface. DO NOT work on anything that is supported ONLY by lift jacks or a hoist. Always use blocks or the correct stands to support the engine before servicing.
- Disconnect the battery from the engine before conducting service. Put a "DO NOT OPERATE!" tag on the key switch to avoid accidental starting.
- To avoid sparks from an accidental short circuit always disconnect the battery's ground cable (-) first and reconnect it last.
- Be sure to stop the engine and remove the key when conducting daily and periodic maintenance, service and cleaning.
- Check or conduct maintenance after the engine, coolant, muffler, or muffler cover have cooled off completely.



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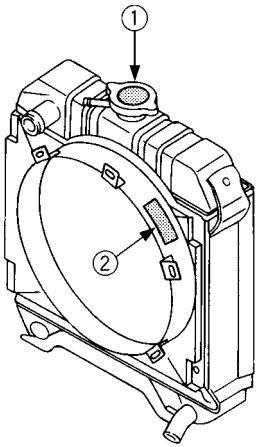
- Always use the appropriate tools and fixtures. Verify that they are in good condition before performing any service work. Make sure you understand how to use them before service.
- Use ONLY correct engine barring techniques for manually rotating the engine. DO NOT attempt to rotate the engine by pulling or prying on the cooling fan and V-belt. This practice can cause serious personal injury or premature damage to the cooling fan and belt.
- Replace fuel pipes and lubricant pipes with their hose clamps every 2 years or earlier whether they are damaged or not. They are made of rubber and age gradually.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Keep a first aid kit and fire extinguisher handy at all times.

WARNING AND CAUTION LABELS



①Part No.19077-8724-1 or 16667-8724-1
(55mm in diameter) (37mm in diameter)

②Part No.TA040-4957-1
Stay clear of engine fan and fan belt.

CARE OF WARNING AND CAUTION LABELS

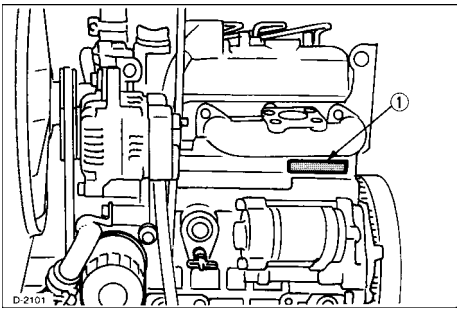
1. Keep warning and caution labels clean and free from obstructing material.
2. Clean warning and caution labels with soap and water, dry with a soft cloth.
3. Replace damaged or missing warning and caution labels with new labels from your local KUBOTA dealer.
4. If a component with warning and caution label(s) affixed is replaced with a new part, make sure the new label(s) is (are) attached in the same location(s) as the replaced component.
5. Mount new warning and caution labels by applying to a clean dry surface and pressing any bubbles to the outside edge.

ENGLISH

SERVICING OF THE ENGINE

Your dealer is interested in your new engine and has the desire to help you get the most value from it. After reading this manual thoroughly, you will find that you can do some of the regular maintenance yourself.
However, when in need of parts or major service, be sure to see your KUBOTA dealer.
For service, contact the KUBOTA Dealership from which you purchased your engine or your local KUBOTA dealer.
When in need of parts, be prepared to give your dealer the engine serial number.
Locate the serial number now and record them in the space provided.

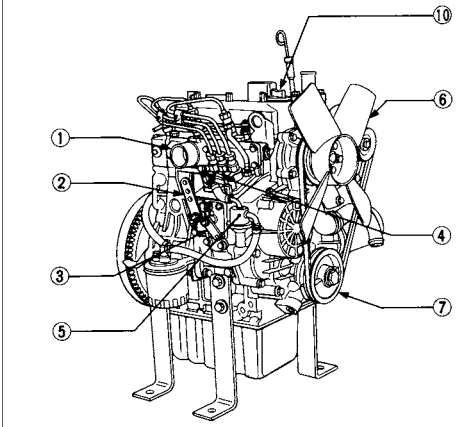
	Type	Serial No.
Engine		
Date of Purchase		
Name of Dealer		
(To be filled in by purchaser)		



(1) Engine serial number

ENGLISH

NAMES OF PARTS



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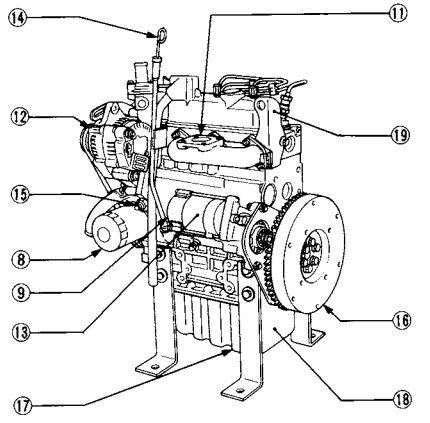


D-2105

(1) Intake manifold
(2) Speed control lever
(3) Engine stop lever
(4) Injection pump
(5) Fuel feed pump
(6) Cooling fan
(7) Fan drive pulley
(8) Oil filter cartridge
(9) Water drain cock
(10) Oil filler plug
(11) Exhaust manifold
(12) Alternator
(13) Starter
(14) Oil level gauge
(15) Oil pressure switch
(16) Flywheel
(17) Oil drain plug
(18) Oil pan
(19) Engine hook

PRE-OPERATION CHECK

BREAK-IN

During the engine break-in period, observe the following by all means:

1. Change engine oil and oil filter cartridge after the first 50 hours of operation (See "ENGINE OIL" in "PERIODIC SERVICE" Section).
2. When ambient temperature is low, operate the machine after the engine has been completely warmed up.

DAILY CHECK

To prevent trouble from occurring, it is important to know the conditions of the engine well. Check it before starting.

CAUTION

To avoid personal injury:

- **Be sure to install shields and safeguards attached to the engine when operating.**
- **Stop the engine at a flat and wide space when checking.**
- **Keep dust or fuel away from the battery, wiring, muffler and engine to prevent a fire. Check and clear them before operating everyday. Pay attention to the heat of the exhaust pipe or exhaust gas so that it can not ignite trash.**

Item		Ref. page
1. Parts which had trouble in previous operation		-
2. By walking around the machine	(1) Oil or water leaks	14 to 19
	(2) Engine oil level and contamination	14, 16
	(3) Amount of fuel	11
	(4) Amount of coolant	17 to 18
	(5) Dust in air cleaner dust cup	20, 21
	(6) Damaged parts and loosened bolts and nuts	-
3. By inserting the key into the starter switch	(1) Proper functions of meters and pilot lamps; no stains on these parts	-
	(2) Proper functions of glow lamp timer	-
4. By starting the engine	(1) Color of exhaust fumes	7
	(2) Unusual engine noise	7

ENGLISH

OPERATING THE ENGINE

STARTING THE ENGINE (NORMAL)

CAUTION

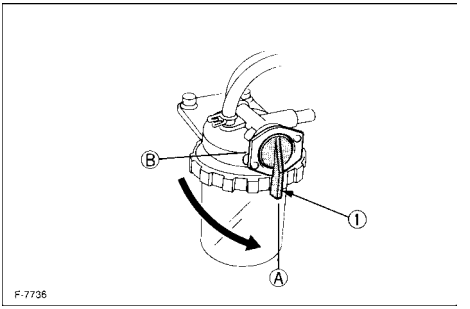
To avoid personal injury:

- **Do not allow children to approach the machine while the engine is running.**
- **Be sure to install the machine on which the engine is installed, on a flat place.**
- **Do not run the engine on gradients.**
- **Do not run the engine in an enclosed area. Exhaust gas can cause air pollution and exhaust gas poisoning.**
- **Keep your hands away from rotating parts (such as fan, pulley, belt, flywheel etc.) during operation.**
- **Do not operate the machine while under the influence of alcohol or drugs.**
- **Do not wear loose, torn or bulky clothing around the machine. It may catch on moving parts or controls, leading to the risk of accident. Use additional safety items, e.g. hard hat, safety boots or shoes, eye and hearing protection, gloves, etc., as appropriate or required.**
- **Do not wear radio or music headphones while operating engine.**
- **Check to see if it is safe around the engine before starting.**
- **Reinstall safeguards and shields securely and clear all maintenance tools when starting the engine after maintenance.**

IMPORTANT :

- Do not use ether or any starting fluid for starting the engine, or a severe damage will occur.
- When starting the engine after a long storage (of morer than 3 months), first set the stop lever to the "STOP" position and then activate the starter for about 10 seconds to allow oil to reach every engine part.

1. Set the fuel lever to "ON".

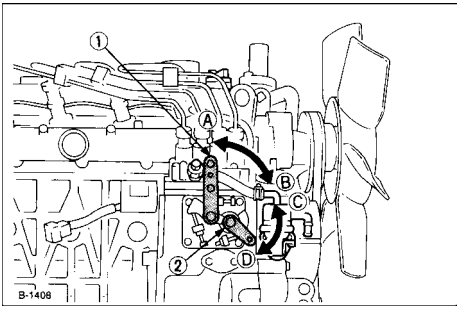


(1) Fuel lever

(A) "ON"
(B) "OFF"

2. Place the engine stop lever in the "START" position.

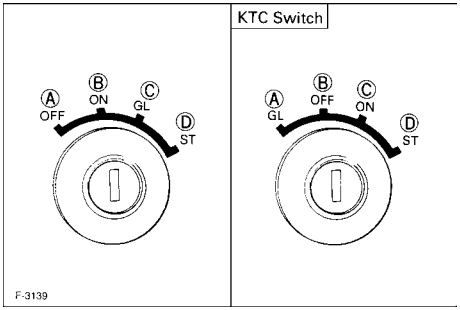
3. Place the speed control lever at more than half "OPERATION".



(1) Speed control lever
(2) Engine stop lever

(A) "IDLING"
(B) "OPERATION"
(C) "START"
(D) "STOP"

4. Insert the key into the key switch and turn it "ON".



(A) "SWITCHED OFF"
(B) "OPERATION"
(C) "PREHEATING"
(D) "STARTING"

(A) "PREHEATING"
(B) "SWITCHED OFF"
(C) "OPERATION"
(D) "STARTING"

5. Turn the starter switch to the "PREHEATING" position to allow the glow lamp to redden.

6. Turn the key to the "STARTING" position and the engine should start. Release the key immediately when the engine starts.

7. Check to see that the oil pressure lamp and charge lamp are off. If the lamps are still on, immediately stop the engine, and determine the cause.
(See "CHECKS DURING OPERATION" in OPERATING THE ENGINE Section)

NOTE :
- If the oil pressure lamp should be still on, immediately stop the engine and check;
  - if there is enough engine oil.
  - if the engine oil has dirt in it.
  - if the wiring is faulty.

8. Warm up the engine at medium speed without load.

IMPORTANT :
- If the glow lamp should redden too quickly or too slowly, immediately ask your KUBOTA dealer to check and repair it.
- If the engine does not catch or start at 10 seconds after the starter switch is set at "STARTING", wait for another 30 seconds and then begin the engine starting sequence again. Do not allow the starter motor to run continuously for more than 20 seconds.

COLD WEATHER STARTING

If the ambient temperature is below -5°C(23°F)* and the engine is very cold, start it in the following manner: Take steps (1) through (4) left.

5. Turn the key to the "PREHEATING (GLOW)" position and keep it there for a certain period mentioned below.

IMPORTANT :
- Shown below are the standard preheating times for various temperatures. This operation, however, is not required, when the engine is warmed up.

Ambient temperature	Preheating time	
	Ordinary heat type	With glow lamp timer
Above 10°C (50°F)	NO NEED	See NOTE:
10°C (50°F) to -5°C (23°F)	Approx. 5 seconds	
*Below -5°C (23°F)	Approx. 10 seconds	
Limit of continuous use	20 seconds	

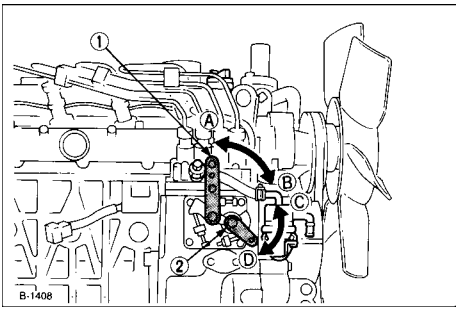
NOTE :
- In case of installing standard glow lamp, glow lamp goes off after about 6 seconds, when the starter switch key is turned to preheating position. However if necessary, keep the starter switch key at preheating position for longer time, according to the left recommendation.

6. Turn the key to the "ST (STARTING)" position and the engine should start.
(If the engine fails to start after 10 seconds, turn off the key for 5 to 30 seconds. Then repeat steps (5) and (6).)

IMPORTANT :
- Do not allow the starter motor to run continuously for more than 20 seconds.
- Be sure to warm up the engine, not only in winter, but also in warmer seasons. An insufficiently warmed-up engine can shorten its service life.
- When there is a fear of temperature dropping below -15°C (5°F), daetach the battery from the machine, and keep it indoors in a safe area to be reinstalled just before the next operation.

STOPPING THE ENGINE

1. **Return the speed control lever to low idle, and run the engine under idling conditions.**
2. **Set the engine stop lever to the "STOP" position.**
3. **With the starter switch placed at the "OFF" position, remove the key. (Be sure to return the engine stop lever to the "START" position to be ready for the next start.)**



(1) Speed control lever
(2) Engine stop lever
(A) "IDLING"
(B) "OPERATION"
(C) "START"
(D) "STOP"

IMPORTANT :

- If equipped with a turbo-charger, allow the engine to idle for 5 minutes before shutting it off after a full load operation.
  Failure to do so may lead to turbo-charger trouble.

CHECKS DURING OPERATION

While running, make the following checks to see that all parts are working correctly.

■Radiator cooling water(Coolant)

WARNING

To avoid personal injury:

- **Do not remove radiator cap until coolant temperature is well below its boiling point. Then loosen cap slightly to the stop position, to relieve any pressure, before removing cap completely.**

If the water temperature warning lamp lights up or overflow of steam or water from the overflow pipe does not stop, stop loading and let the engine “COOL DOWN” by idling for at least 5 min. Allow the engine to cool down gradually, stop the engine and proceed to the next inspection and maintenance work according to “RADIATOR” section.

Check item

1. Check to see if there is any coolant leak;
2. Check to see if there is any obstacle around the cooling air inlet or outlet;
3. Check to see if there is any dirt or dust between radiator fins and tube;
4. Check to see if the fan belt is too loose;
5. Check to see if radiator water pipe is clogged; and
6. Check to see if anti-freeze is mixed to a 50/50% mix of water and anti-freeze.

■Oil pressure lamp

The lamp lights up to warn the operator that the engine oil pressure has dropped below the prescribed level. If this should happen during operation or should not go off even after the engine is accelerated more than 1000rpm, immediately stop the engine and check the following:

1. Engine oil level (See "ENGINE OIL" in MAINTENANCE Section).

■**Fuel**

CAUTION

To avoid personal injury:

- **Fluid escaping from pinholes may be invisible. Do not use hands to search for suspected leaks; Use a piece of cardboard or wood, instead. If injured by escaping fluid, see a medical doctor at once. This fluid can produce gangrene or a severe allergic reaction.**
- **Check any leaks from fuel pipes or fuel injection pipes. Use eye protection when checking for leaks.**

Be careful not to empty the fuel tank. Otherwise air may enter the fuel system, requiring fuel system bleeding. (See "FUEL" in MAINTENANCE Section.)

■**Color of exhaust**

While the engine is run within the rated output range:

- The color of exhaust remains colorless.
- If the output slightly exceeds the rated level, exhaust may become a little colored with the output level kept constant.
- If the engine is run continuously with dark exhaust emission, it may lead to trouble with the engine.

■**Immediately stop the engine if;**

- The engine suddenly slows down or accelerates.
- Unusual noises suddenly appear.
- Exhaust fumes suddenly become very dark.
- The oil pressure lamp or the water temperature alarm lamp lights up.

REVERSED ENGINE REVOLUTION AND REMEDIES

CAUTION

To avoid personal injury:

- **Reversed engine operation can make the machine reverse and run it backwards. It may lead to serious trouble.**
- **Reversed engine operation may make exhaust gas gush out into the intake side and ignite the air cleaner; It could catch fire.**

Reversed engine revolution must be stopped immediately since engine oil circulation is cut quickly, leading to serious trouble.

■**How to tell when the engine starts running backwards**

1. Lubricating oil pressure drops sharply. Oil pressure warning light, if used, will light.
2. Since the intake and exhaust sides are reversed, the sound of the engine changes, and exhaust gas will come out of the air cleaner.
3. A louder knocking sound will be heard when the engine starts running backwards.

■**Remedies**

1. Immediately set the engine stop lever to the "STOP" position to stop the engine.
2. After stopping the engine, check the air cleaner, intake rubber tube and other parts and replace parts as needed.

PRECAUTIONS ON GENERATOR-EQUIPPED ENGINE

CAUTION

To avoid personal injury:

If the engine is kept running under no load or light load (load factor below 30%), unburnt fuel or carbon builds up in the exhaust system. As a result, the engine may get damaged or cause a fire. Run the engine under enough load at regular intervals to remove unburnt fuel and carbon deposits.

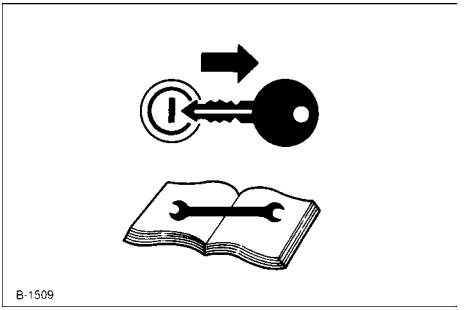
- **Before doing the load operation, make sure there is nothing flammable around the engine.**
- **Do not put a load all at once on the engine, but gradually.**
- **If by any chance, spark rises out of the muffler outlet, DO NOT GET THE ENGINE UNLOADED, BUT INTERRUPT IT IMMEDIATELY.**

MAINTENANCE

CAUTION

To avoid personal injury:

- **Be sure to conduct daily checks, periodic maintenance, refueling or cleaning on a level surface with the engine shut off and remove the key.**
- **Before allowing other people to use your engine, explain how to operate, and have them read this manual before operation.**
- **When cleaning any parts, do not use gasoline but use regular cleanser.**
- **Always use proper tools, that are in good condition. Make sure you understand how to use them, before performing any service work.**
- **When installing, be sure to tighten all bolts lest they should be loose. Tighten the bolts by the specified torque.**
- **Do not put any tools on the battery, or battery terminals may short out. Severe burns or fire could result. Detach the battery from the engine before maintenance.**
- **Do not touch muffler or exhaust pipes while they are hot; Severe burns could result.**



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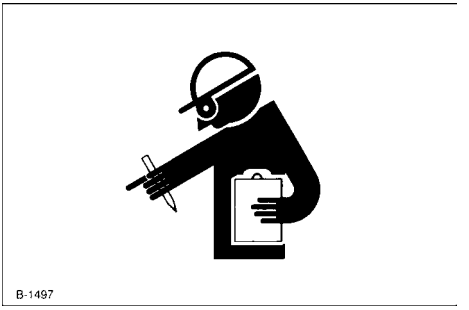

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SERVICE INTERVALS

Observe the following for service and maintenance.

Interval	Item	Ref.Page		
Every 50 hours	Check of fuel pipes and clamp bands	13		@
See NOTE:	Change of engine oil	15	◎	
Every 100 hours	Cleaning of air cleaner element	20	*1	@
	Cleaning of fuel filter	13		
	Check of fan belt tightness	21		
Every 200 hours	Check of radiator hoses and clamp bands	18		
	Replacement of oil filter cartridge	16	◎	
	Check of intake air line	-		@
Every 400 hours	Replacement of fuel filter cartridge	14		@
Every 500 hours	Removal of sediment in fuel tank	-		
	Cleaning of water jacket (radiator interior)	17 to 18		
	Replacement of fan belt	21		
Every year	Replacement of air cleaner element	20	*2	@
	Check of damage in electric wiring and loose connections	-		
Every 800 hours	Check of valve clearance	20		
Every 1500 hours	Check of fuel injection nozzle injection pressure	-	*3	@
Every 3000 hours	Check of turbo charger	-	*3	@
	Check of injection pump	-	*3	@
	Check of fuel injection timer	-	*3	@
Every two years	Change of radiator coolant (L.L.C.)	18		
	Replacement of radiator hoses and clamp bands	18		
	Replacement of fuel pipes and clamp bands	13	*3	@
	Replacement of intake air line	-	*4	@

IMPORTANT :

- The jobs indicated by ◎ must be done after the first 50 hours of operation.

*1 Air cleaner should be cleaned more often in dusty conditions than in normal conditions.
*2 After 6 times of cleaning.
*3 Consult your local KUBOTA Dealer for this service.
*4 Replace only if necessary.

- The items listed above (@ marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.
  Please see the Warranty Statement in detail.

NOTE :

- Changing interval of engine oil depends on the conditions below.

Models	Oil pan depth	
	Above 125 mm (4.9 in.)	*below 101 mm (4.0 in.)
All models	200 Hrs	150 Hrs
Initial	50 Hrs	

* 101mm oil pan depth is optional.
** Standard replacement interval
- API service classification: above CD grade
- Ambient temperature: below 35°C (95°F)

NOTE :

Lubricating oil

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

○ : Recommendable × : Not recommendable

Fuel / lubricating oil class	Low sulfur	High sulfur	Remarks
CF	○	○	TBN≧10
CF-4	○	×	
CG-4	○	×	

PERIODIC SERVICE

FUEL

Fuel is flammable and can be dangerous. You should handle fuel with care.

CAUTION

To avoid personal injury:

- **Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.**
- **Be careful not to spill fuel during refueling. If fuel should spill, wipe it off at once, or it may cause a fire.**
- **Do not fail to stop the engine before refueling. Keep the engine away from the fire.**
- **Be sure to stop the engine while refueling or bleeding and when cleaning or changing fuel filter or fuel pipes. Do not smoke when working around the battery or when refueling.**
- **Check the above fuel systems at a well ventilated and wide place.**
- **When fuel and lubricant are spilled, refuel after letting the engine cool off.**
- **Always keep spilled fuel and lubricant away from engine.**

■Fuel level check and refueling

1. Check to see that the fuel level is above the lower limit of the fuel level gauge.
2. If the fuel is too low, add fuel to the upper limit. Do not overfill.

No.2-D is a distillate fuel oil of lower volatility for engines in industrial and heavy mobile service.
(SAE J313 JUN87)
Grade of Diesel Fuel Oil According to ASTM D975.

Flash Point, °C (°F)	Water and Sediment, volume %	Carbon Residue on, 10 percent Residuum, %	Ash, weight %
Min	Max	Max	Max
52 (125)	0.05	0.35	0.01

Distillation Temperatures, °C(°F) 90% Point		Viscosity Kinematic cSt or mm^2/s at 40°C		Viscosity Saybolt, SUS at 100°F		Sulfur, weight %	Copper Strip Corrosion	Cetane Number
Min	Max	Min	Max	Min	Max	Max	Max	Min
282 (540)	338 (640)	1.9	4.1	32.6	40.1	0.50	No. 3	40

The cetane number is required not to be less than 45.

IMPORTANT :

- Be sure to use a strainer when filling the fuel tank, or dirt or sand in the fuel may cause trouble in the fuel injection pump.
- For fuel, always use diesel fuel. You are required not to use alternative fuel, because its quality is unknown or it may be inferior in quality. Kerosene, which is very low in cetane rating, adversely affects the engine. Diesel fuel differs in grades depending on the temperature.
- Be careful not to let the fuel tank become empty, or air can enter the fuel system, necessitating bleeding before next engine start.

■Air bleeding the fuel system

CAUTION

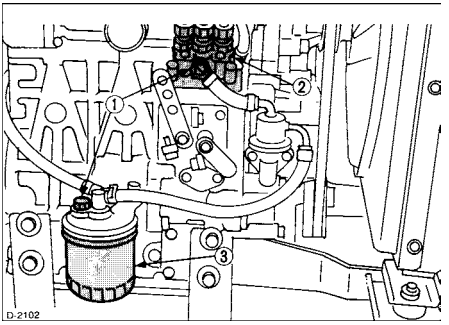
To avoid personal injury:

- **Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.**

Air bleeding of the fuel system is required if;
- after the fuel filter and pipes have been detached and refitted;
- after the fuel tank has become empty; or
- before the engine is to be used after a long storage.

[PROCEDURE Ⓐ] (gravity feed fuel tanks only)
1. Fill the fuel tank to the fullest extent. Open the fuel filter lever.
2. Loosen air vent plug of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent plug on top of the fuel injection pump.
5. Retighten the plug when bubbles do not come up any more.

[GRAVITY FEED SYSTEM]

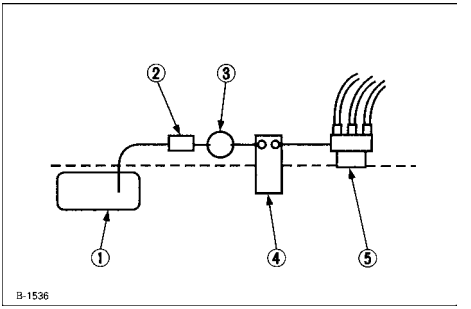


(1) Air vent plug
(2) Injection pump
(3) Fuel filter

[PROCEDURE Ⓑ] (fuel tanks lower than injection pump)
1. For fuel tanks that are lower than the injection pump. The fuel system must be pressurized by the fuel system electric fuel pump.
2. If an electric fuel pump is not used, you must manually actuate the pump by lever to bleed.
3. The primary fuel filter ③ must be on the pressure side of the pump if the fuel tank is lower than the injection pump.
4. To bleed follow (2) through (5) above. (PROCEDURE Ⓐ)

IMPORTANT :
- Tighten air vent plug of the fuel injection pump except when bleeding, or it may stop the engine suddenly.

[TANK BELOW INJECTION PUMP SYSTEM]



(1) Fuel tank below injection pump
(2) Pre-filter
(3) Electric or Mechanical pump
(4) Main Filter
(5) Injection pump

■Check of fuel pipes and clamp bands

CAUTION

To avoid personal injury:

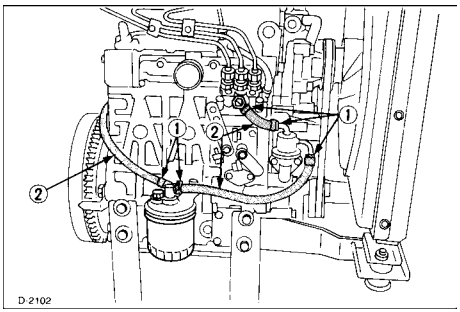
- **Check or replace the fuel pipes after stopping the engine. Broken fuel pipes can cause fires.**

Check the fuel pipes every 50 hours of operation. When if;

1. If the clamp band is loose, apply oil to the screw of the band, and tighten the band securely.
2. If the fuel pipes, made of rubber, become worn out, replace them and the clamp bands every two years.
3. If the fuel pipes and clamp bands are found worn or damaged before two years'time, replace or repair them at once.
4. After replacement of the pipes and bands, air-bleed the fuel system.

IMPORTANT :

- When the fuel pipes are not installed, plug them at both ends with clean cloth or paper to prevent dirt from entering. Dirt in the pipes can cause fuel injection pump malfunction.

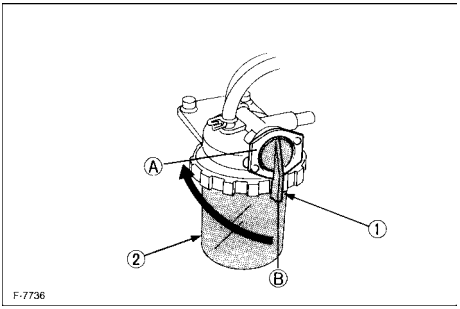


(1) Clamp band
(2) Fuel pipe

■Cleaning of fuel filter

Every 100 hours of operation, clean the fuel filter in a clean place to prevent dust intrusion.

1. Close the fuel filter lever.

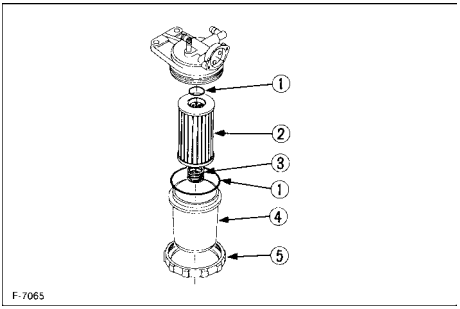


(1) Fuel filter lever *(A) "OFF"*
(2) Fuel filter pot *(B) "ON"*

2. Remove the top cap, and rinse the inside with diesel fuel.
3. Take out the element, and rinse it with diesel fuel.
4. After cleaning, reinstall the fuel filter, keeping out of dust and dirt.
5. Air-bleed the injection pump.

IMPORTANT :

- Entrance of dust and dirt can cause a malfunction of the fuel injection pump and the injection nozzle. Wash the fuel filter cup periodically.



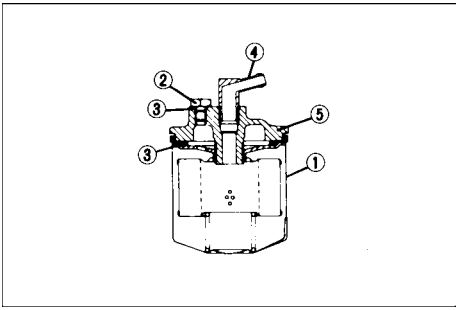
(1) O ring
(2) Filter element
(3) Spring
(4) Filter bowl
(5) Screw ring

■Replacement of fuel filter cartridge

1. Replace the fuel filter cartridge with a new one every 400 operating hours.
2. Apply fuel oil thinly over the gasket and tighten the cartridge into position by hand-tightening only.
3. Finally, vent the air.

IMPORTANT :

- Replace the fuel filter cartridge periodically to prevent wear of the fuel injection pump plunger or the injection nozzle, due to dirt in the fuel.



(1) Fuel filter cartridge
(2) Air vent plug
(3) O ring
(4) Pipe joint
(5) Cover

ENGINE OIL

⚠ CAUTION

To avoid personal injury:

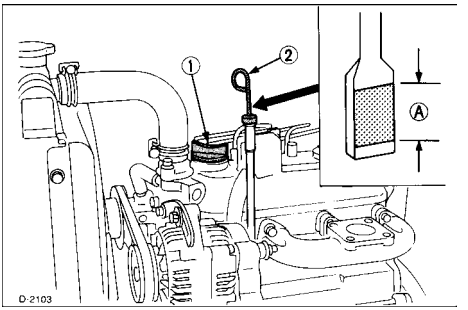
- **Be sure to stop the engine before checking and changing the engine oil and the oil filter cartridge.**
- **Do not touch muffler or exhaust pipes while they are hot; Severe burns could result. Always stop the engine and allow it to cool before conducting inspections, maintenance, or for a cleaning procedure.**
- **Contact with engine oil can damage your skin.**
  Put on gloves when using engine oil. If you come in contact with engine oil, wash it off immediately.

NOTE :

- Be sure to inspect the engine, locating it on a level place. If placed on gradients accurately, oil quantity may not be measured.

■Checking oil level and adding engine oil

1. Check the engine oil level before starting or more than 5 minutes after stopping the engine.
2. Remove the oil level gauge, wipe it clean and reinstall it.
3. Take the oil level gauge out again, and check the oil level.



(1) Oil filler plug
(2) Oil level gauge
[Lower end of oil level gauge]
(A) Engine oil level within this range is proper.

4. If the oil level is too low, remove the oil filler plug, and add new oil to the prescribed level.
5. After adding oil, wait more than 5 minutes and check the oil level again. It takes some time for the oil to drain down to the oil pan.

Engine oil quantity

Models	Quantity
D905-E, D1005-E, D1105-E, D1105-TE	5.1 L (1.35 U.S.gals.)
V1205-E, V1305-E, V1505-E	6.0 L (1.59 U.S.gals.)
V1205-TE, V1505-TE	6.7 L (1.77 U.S.gals.)

Oil quantities shown are for standard oil pans.

IMPORTANT :

- Engine oil should be MIL-L-2104C or have properties of API classification CD grades or higher. Change the type of engine oil according to the ambient temperature.

above 25°C (77°F)	SAE30 or SAE10W-30 SAE15W-40
-10°C to 25°C (14 to 77°F)	SAE10W-30 or SAE15W-40
below -10°C (14°F)	SAE10W-30

- When using oil of different brands from the previous one, be sure to drain all the previous oil before adding the new engine oil.

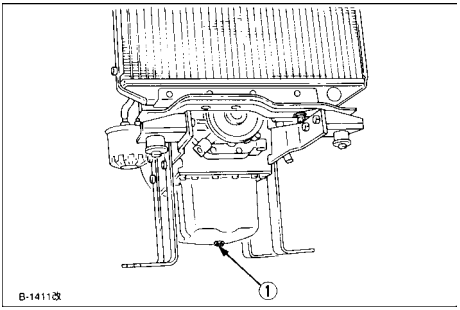
■Change of engine oil

CAUTION

To avoid personal injury:

- **Be sure to stop the engine before draining engine oil.**
- **When draining engine oil, place some container underneath the engine and dispose it according to local regulations.**
- **Do not drain oil after running the engine. Allow engine to cool down sufficiently.**

1. Change oil after the initial 50 hours of operation and every 200 hours thereafter.
2. Remove the drain plug at the bottom of the engine, and drain all the old oil. Drain oil will drain easier when the oil is warm.



(1) Oil drain plug

3. Add new engine oil up to the upper limit of the oil level gauge.

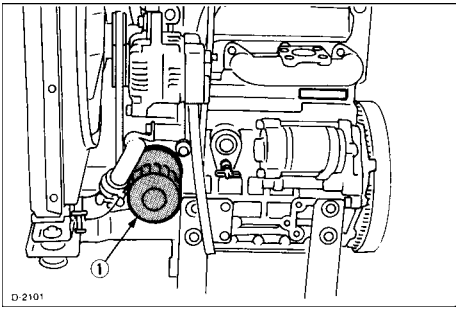
■**Replacement of oil filter cartridge**

CAUTION

To avoid personal injury:

- **Be sure to stop the engine before changing the oil filter cartridge.**
- **Allow engine to cool down sufficiently, oil can be hot and cause burns.**

1. Replace the oil filter cartridge after the initial 50 hours of operation and every 200 hours thereafter.
2. Remove the old oil filter cartridge with a filter wrench.
3. Apply a film of oil to the gasket for the new cartridge.
4. Screw in the cartridge by hand. When the gasket contacts the seal surface, tighten the cartridge enough by hand. Because, if you tighten the cartridge with a wrench, it will be tightened too much.



(1) Oil filter cartridge
Remove with a filter wrench
(Tighten with your hand)

5. After the new cartridge has been replaced, the engine oil level normally decreases a little. Thus, run the engine for a while and check for oil leaks through the seal before checking the engine oil level. Add oil if necessary.

NOTE :

- Wipe off any oil sticking to the machine completely.

RADIATOR

Coolant will last for one day's work if filled all the way up before operation. Make it a rule to check the coolant level before every operation.

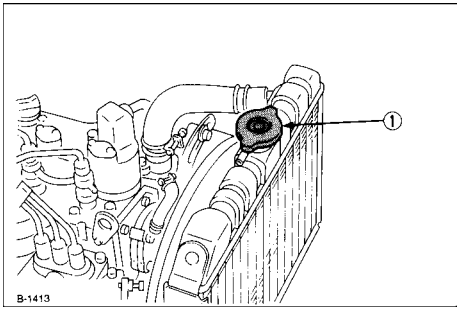
WARNING

To avoid personal injury:

- **Do not stop the engine suddenly, stop it after about 5 minutes of unloaded idling.**
- **Work only after letting the engine and radiator cool off completely (more than 30 minutes after it has been stopped).**
- **Do not remove the radiator cap while coolant is hot. When cool to the touch, rotate cap to the first stop to allow excess pressure to escape. Then remove cap completely.**
  If overheats should occur, steam may gush out from the radiator or reserve tank; Severe burns could result.

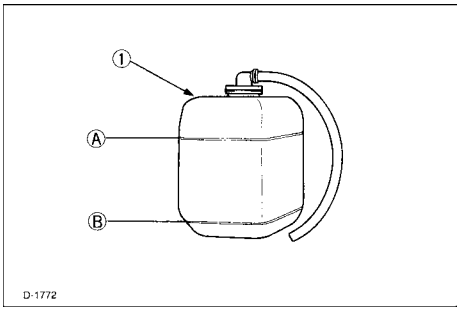
■Checking coolant level, adding coolant

1. Remove the radiator cap after the engine has completely cooled, and check to see that coolant reaches the supply port.



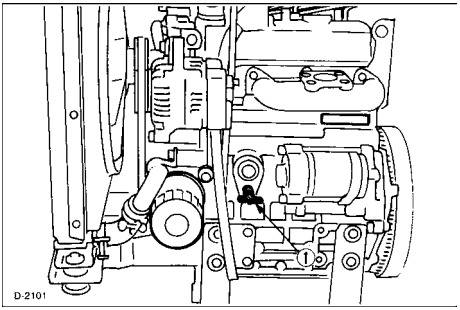
(1) Radiator pressure cap

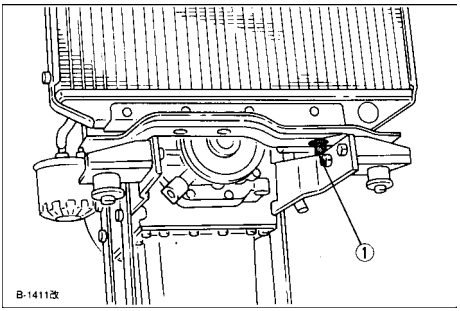
2. If the radiator is provided with a reserve tank, check the coolant level of the reserve tank. When it is between the "FULL" and "LOW" marks, the coolant will last for one day's work.



(1) Reserve tank *(A) "FULL"* *(B) "LOW"*

3. When the coolant level drops due to evaporation, add water only up to the full level.
4. Check to see that two drain cocks; one is at the crankcase side and the other is at the lower part of the radiator as figures below.





(1) Coolant drain cock

IMPORTANT :

- If the radiator cap has to be removed, follow the caution and securely retighten the cap.
- If coolant should be leak, consult your local KUBOTA dealer.
- Make sure that muddy or sea water does not enter the radiator.
- Use clean, fresh water and 50% anti-freeze to fill the recovery tank.
- Do not refill reserve tank with coolant over the "FULL" level mark.
- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and decrease quickly.

■Change of radiator coolant (L.L.C.)

1. To drain coolant, always open both drain cocks and simultaneously open the radiator cap as well. With the radiator cap kept closed, a complete drain of water is impossible.
2. Remove the overflow pipe of the radiator pressure cap to drain the reserve tank.
3. Prescribed coolant volume (U.S.gallons)

Models	Quantity
D905-E, D1005-E, D1105-E, D1105-TE	3.1 L (0.82 U.S.gals.)
V1205-E, V1305-E, V1505-E	4.0 L (1.06 U.S.gals.)
V1205-TE, V1505-TE	5.0 L (1.32 U.S.gals.)

NOTE :

- Coolant quantities shown are for standard radiators.

4. An improperly tightened radiator cap or a gap between the cap and the seat quickens loss of coolant.
5. Coolant (Anti-freeze)

Season	Coolant
All seasons	Pure water and anti-freeze (See "Anti-freeze" in "RADIATOR" section.)

■Remedies for quick decrease of coolant

1. Check any dust and dirt between the radiator fins and tube. If any, remove them from the fins and the tube.
2. Check the tightness of the fan belt. If loose, tighten it securely.
3. Check the internal blockage in the radiator hose. If scale forms in the hose, clean with the scale inhibitor or its equivalent.

■Replacement of radiator hoses and clamp bands

⚠ CAUTION

To avoid personal injury:

- **Be sure to check radiator hoses and hose clamps periodically. If radiator hose is damaged or coolant leaks, overheats or severe burns could occur.**

Check to see if radiator hoses are properly fixed every 200 hours of operation or 6 months, whichever comes first.

1. If hose clamps are loose or water leaks, tighten hose clamp securely.
2. Replace hoses and tighten hose clamps securely, if radiator hoses are swollen, hardened or cracked.

Replace hoses and hose clamp every 2 years, or earlier, if checked and found that hoses are swollen, hardened or cracked.

■Precaution at overheating

Take the following actions in the event the coolant temperature is nearly or more than the boiling point, what is called "Overheating". Take these actions if the engine's alarm buzzer sounds or the alarm lamp lights up.

1. Stop the engine operation in a safe place and keep the engine unloaded idling.
2. Do not stop the engine suddenly. Stop it after about 5 minutes of unloaded idling.
3. If the engine stalls within about 5 minutes of running under no load, immediately leave and keep yourself away from the machine. Do not open the hood and any other part.
4. Keep yourself and others well away from the engine for further 10 minutes or while the steam blown out.
5. Checking that there gets no danger such as burn, get rid of the causes of overheating according to the manual, see "TROUBLESHOOTING" section. And then, start again the engine.

■Cleaning radiator core(outside)

If dust is between the fin and tube, wash it away with running water.

IMPORTANT :

- Do not clean radiator with firm tools such as spatulas or screwdrivers. They may damage specified fin or tube. It can cause coolant leaks or decrease coolings performance.

■**Anti-freeze**

CAUTION

To avoid personal injury:

- When using anti-freeze, put on some protection such as rubber gloves (Anti-freeze contains poison.).
- If should drink anti-freeze, throw up at once and take medical attention.
- When anti-freeze comes in contact with the skin or clothing, wash it off immediately.
- Do not mix different types of anti-freeze. The mixture can produce chemical reaction causing harmful substances.
- Anti-freeze is extremely flammable and explosive under certain conditions. Keep fire and children away from anti-freeze.
- When draining fluids from the engine, place some container underneath the engine body.
- Do not pour waste onto the grounds, down a drain, or into any water source.
- Also, observe the relevant environmental protection regulations when disposing of anti-freeze.

Always use a 50/50 mix of long-life coolant and clean soft water in KUBOTA engines.
Contact KUBOTA concerning coolant for extreme conditions.

1. Long-life coolant (hereafter LLC) comes in several types. Use ethylene glycol (EG) type for this engine.
2. Before employing LLC-mixed cooling water, flush the radiator with fresh water. Repeat this procedure 2 or 3 times to clean up the radiator and engine block from inside.
3. Mixing the LLC
   Premix 50% LLC with 50% clean soft water. When mixing, stir it up well, and then fill into the radiator.
4. The procedure for the mixing of water and anti-freeze differs according to the make of the anti-freeze. Refer to SAE J1034 standard, more specifically also to SAE J814c.

Vol % Anti-freeze	Freezing Point		Boiling Point *	
	°C	°F	°C	°F
50	-37	-34	108	226

*At 1.013×10^5Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

5. Adding the LLC
   (1) Add only water if the coolant level reduces in the cooling system by evaporation.
   (2) If there is a coolant leak, add the LLC of the same manufacturer and type in the same coolant percentage.
   *Never add any long-life coolant of different manufacturer. (Different brands may have different additive components, and the engine may fail to perform as specified.)
6. When the LLC is mixed, do not employ any radiator cleaning agent. The LLC contains anti-corrosive agent. If mixed with the cleaning agent, sludge may build up, adversely affecting the engine parts.
7. Kubota's genuine long-life coolant has a service life of 2 years. Be sure to change the coolant every 2 years.

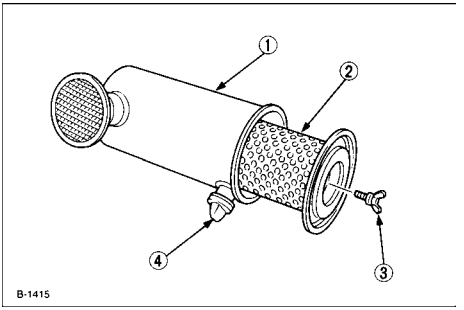
NOTE :

- The above data represent industry standards that necessitate a minimum glycol content in the concentrated anti-freeze.

AIR CLEANER

Since the air cleaner employed on this engine is a dry type, never apply oil to it.

1. Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place. This will get rid of large particles of dust and dirt.
2. Wipe the inside air cleaner clean with cloth if it is dirty or wet.
3. Avoid touching the element except when cleaning.
4. When dry dust adheres to the element, blow compressed air from the inside turning the element. Pressure of compressed air must be under 205kPa (2.1kgf/cm^2, 30psi).
5. When carbon or oil adheres to the element, soak the element in detergent for 15 minutes, then wash it several times in water, rinse with clean water and dry it naturally.
6. After the element is fully dried, inspect the inside of the element with a light, and check if it is damaged or not. (referring to the instructions on the label attached to the element.)
7. Replace the element every year or every 6 cleanings.



(1) Air cleaner body
(2) Element
(3) Wing bolt
(4) Evacuator valve

IMPORTANT :

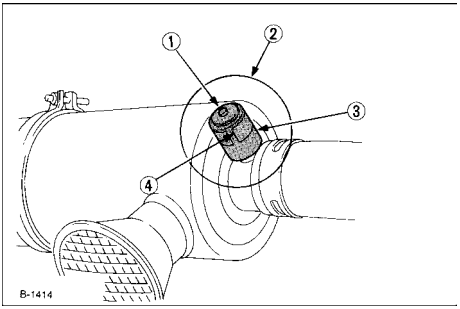
- Make sure the wing bolt for the element is tight enough. If it is loose, dust and dirt may be sucked in, wearing down the cylinder liner and piston ring earlier, and thereby resulting in poor power output.
- Do not overservice the air cleaner element. Overservicing may cause dirt to enter the engine causing premature wear. Use the dust indicator as a guide on when to service.

■Evacuator valve

Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place - to get rid of large particles of dust and dirt.

■Dust indicator (optional)

If the red signal on the dust indicator attached to the air cleaner is visible, the air cleaner has reached the service level.
Clean the element immediately, and reset the signal with the "RESET" button.



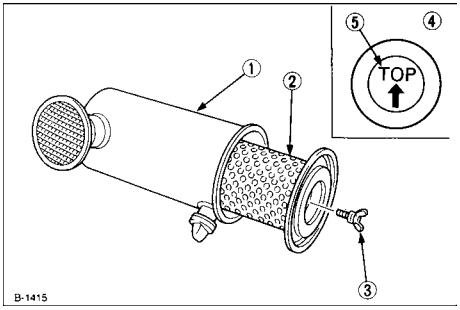
(1) "RESET" button
(2) Dust indicator
(3) Service level
(4) Signal

■For the air cleaner with a dust cup (optional)

Remove and clean out the dust cup before it becomes half full with dust; usually once a week, or even every day if the working surroundings are dusty.
Install the air cleaner dust cup with "TOP" indicated on the rear of the cup in the up position. (However, it may be installed in either direction when the cover is placed at the lower part.)

IMPORTANT :

- If the dust cup is mounted incorrectly, dust or dirt does not collect in the cup, and direct attachments of the dust to the element will cause its lifetime to shorten to a great extent.



(1) Air cleaner body
(2) Element
(3) Wing bolt
(4) Dust cup
(5) "TOP" mark

ELECTRIC WIRING

CAUTION

To avoid personal injury:

Shorting of electric cable or wiring may cause a fire.

- **Check to see if electric cables and wiring are swollen, hardened or cracked.**
- **Keep dust and water away from all power connections.**
  Loose wiring terminal parts, make bad connections. Be sure to repair them before starting the engine.

Damaged wiring reduces the capacity of electrical parts. Change or repair damaged wiring immediately.

FAN BELT

■Adjusting fan belt tension

CAUTION

To avoid personal injury:

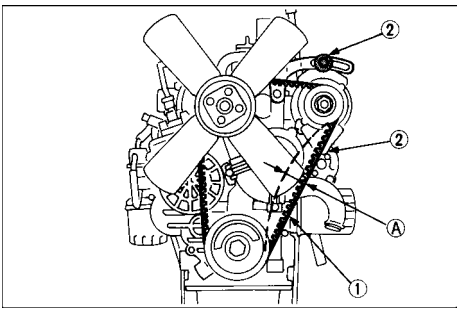
- **Be sure to stop the engine and remove the key before checking the belt tension.**
- **Be sure to reinstall the detached safety shield after maintenance or checking.**

Proper fan belt tension	A deflection of between 7 to 9 mm (0.28 to 0.35 in.) when the belt is pressed in the middle of the span.

1. Stop the engine and remove the key.
2. Apply moderate thumb pressure to belt between pulleys.
3. If tension is incorrect, loosen the alternator mounting bolts and, using a lever placed between the alternator and the engine block, pull the alternator out until the deflection of the belt falls within acceptable limits.
4. Replace fan belt if it is damaged.

IMPORTANT :

- If belt is loosen or damaged and the fan is damaged, it could result in overheats or insufficient charging. Correct or replace belt.



(1) Fan belt
(2) Bolt and nut
(A) 7 to 9 mm (0.28 to 0.35 in.) (under load of 10kgf (22.1 lbs))

CARRIAGE AND STORAGE

CARRIAGE

CAUTION

To avoid personal injury:

- **Fix the engine securely not to fall during operation.**
- **Do not stand near or under the engine while carrying it.**
- **The engine is heavy. In handling it, be very alert not to get your hands and body caught in.**

1. Use carrier such as crane when carrying the engine, or hurt your waist and yourself. Support the engine securely with rope not to fall while carrying it.
2. When lifting the engine, put the hook securely to metal fittings attached to the engine. Use strong hook and fittings enough to hang the engine.

STORAGE

CAUTION

To avoid personal injury:

- **Do not clean the machine with engine running.**
- **To avoid the danger of exhaust fume poisoning, do not operate the engine in a closed building without proper ventilation.**
- **When storing the engine just after running, let the engine cool off.**

Before storing the engine for more than a few months, remove any dirt on the machine, and:

1. Drain the coolant in the radiator. Open the cock at the bottom of the radiator, and remove the pressure cap to drain water completely. Leave the cock open. Hang a note written "No water" on the pressure cap. Since water may freeze when the temperature drops below 0°C (32°F), it is very important that no water is left in the machine.
2. Remove dirty engine oil, fill with new oil and run the engine for about 5 minutes to let the oil penetrate to all the parts.
3. Check all the bolts and nuts, and tighten if necessary.
4. Remove the battery from the engine, adjust the electrolyte level, and recharge it. Store the battery in a dry and dark place.
5. When the engine is not used for a long period of time, run it for about 5 minutes under no load every 2-3 months to keep it free from rust. If the engine is stored without any running, moisture in the air may condense into dew over the sliding parts of the engine, resulting in rust there.
6. If you forget to run the engine for longer than 5-6 months, apply enough engine oil to the valve guide and valve stem seal and make sure the valve works smoothly before starting the engine.
7. Store the engine in a flat place and remove the key from engine.
8. Do not store the engine in a place where has flammable materials such as dry grass or straw.
9. When covering the engine for storage, let engine and muffler cool off completely.
10. Operate the engine after checking and repairing damaged wirings or pipes, and clearing flammable materials carried by mouse.

TROUBLESHOOTING

If the engine does not function properly, use the following chart to identify and correct the cause.

■When it is difficult to start the engine

Cause	Countermeasures
Fuel is thick and doesn't flow.	* Check the fuel tank and fuel filter. Remove water, dirt and other impurities. * As all fuel will be filtered by the filter, if there should be water or other foreign matters on the filter, clean the filter with kerosene.
Air or water mixed in fuel system	* If air is in the fuel filter or injection lines, the fuel pump will not work properly. To attain proper fuel injection pressure, check carefully for loosened fuel line coupling, loose cap nut, etc. * Loosen joint bolt stop fuel filter and air vent screws of fuel injection pump to eliminate all the air in the fuel system.
Thick carbon deposits on orifice of injection nozzle.	* This is caused when water or dirt is mixed in the fuel. Clean the nozzle injection piece, being careful not to damege the orifice. * Check to see if nozzle is working properly or not. If not, install a new nozzle.
Engine oil becomes thick in cold weather and engine cranks slow.	* Change grade of oil according to the weather (temperature.)

■When output is insufficient

Cause	Countermeasures
Carbon stuck around orifice of nozzle piece	* Clean orifice and needle valve, being very careful not to damage the nozzle orifice. * Check nozzle to see if good. If not, replace with new parts.
Fuel is insufficient.	* Check fuel system.
Overheating of moving parts	* Check lubricating oil system. * Check to see if lubricating oil filter is working properly. * Filter element deposited with impurities would cause poor lubrication. Change element.
Air cleaner is dirty	* Clean the element every 100 hours of operation.
Injection pump wear	* Do not use poor quality fuel as it will cause wear of the pump. Only use No. 2-D diesel fuel.

NOTE :

- If the cause of trouble can not be found, contact your KUBOTA dealer.

■When engine suddenly stops

Cause	Countermeasures
Lack of fuel	* Check the fuel tank and refill the fuel, if necessary. * Also check the fuel system for air or leaks.
Bad nozzle	* If necessary, replace with a new nozzle.
Moving parts are overheated due to shortage of lubrication oil or improper lubrication.	* Check amount of engine oil with oil level gauge. * Check lubricating oil system. * At every 2 times of oil change, oil filter cartridge should be replaced.

■When color of exhaust is especially bad

Cause	Countermeasures
Fuel is of extremely poor quality.	* Select good quality fuel. Use No. 2-D diesel fuel only.
Nozzle is bad.	* If necessary, replace with new nozzle.

■When engine must be stopped immediately

Cause	Countermeasures
Color of exhaust suddenly turns dark.	* Check the fuel injection system, especially the fuel injection nozzle.
Bearing parts are overheated.	* Check the lubricating system.
Oil lamp lights up during operation.	* Check the lubricating system. * Check the function of the relieve valve in the lubricating system. * Check pressure switch. * Check filter base gasket.

■When engine overheats

Cause	Countermeasures
Engine oil insufficient	* Check oil level. Replenish oil as required.
Fan belt broken or elongated	* Change belt or adjust belt tension.
Coolant insufficient	* Replenish coolant.
Excessive concentration of antifreeze	* Add water only or change to coolant with the specified mixing ratio.
Radiator net or radiator fin clogged with dust	* Clean net or fin carefully.
Inside of radiator or coolant flow route corroded	* Clean or replace radiator and parts.
Fan or radiator or radiator cap defective	* Replace defective part.
Thermostat defective	* Check thermostat and replace if necessary.
Temperature gauge or sensor defective	* Check temperature with thermometer and replace if necessary.
Overload running	* Reduce load.
Head gasket defective or water leakage	* Replace parts.
Unsuitable fuel used	* Use the specified fuel.

SPECIFICATIONS

Model		D905-E		D1005-E		D1105-E	D1105-TE
Type		Vertical, water-cooled, 4-cycle diesel engine					
Number of cylinders		3					
Bore and stroke	mm (in.)	72 × 73.6 (2.83 × 2.90)		76 × 73.6 (2.99 × 2.90)		78 × 78.4 (3.07 × 3.09)	
Total displacement	cm^3 (cu.in.)	898 (54.80)		1001 (61.08)		1123 (68.53)	
Combustion chamber		Spherical Type (E-TVCS)					
SAE NET Intermittent H.P. (SAEJ1349)	kW / min^{-1} (rpm) (HP / min^{-1} (rpm))	14.9 / 3000 (20.0 / 3000)	17.5 / 3600 (23.5 / 3600)	16.8 / 3000 (22.5 / 3000)	19.4 / 3600 (26.0 / 3600)	18.7 / 3000 (25.0 / 3000)	23.5 / 3000 (31.5 / 3000)
SAE NET Continuous H.P. (SAEJ1349)	kW / min^{-1} (rpm) (HP / min^{-1} (rpm))	12.7 / 3000 (17.0 / 3000)	15.3 / 3600 (20.5 / 3600)	14.2 / 3000 (19.0 / 3000)	16.8 / 3600 (22.5 / 3600)	16.4 / 3000 (22.0 / 3000)	20.4 / 3000 (27.4 / 3000)
Maximum bare speed	min^{-1}(rpm)	3200	3800	3200	3800	3200	
Minimum bare idling speed	min^{-1}(rpm)	850~950					
Order of firing		1-2-3					
Direction of rotation		Counter-clockwise (viewed from flywheel side)					
Injection pump		Bosch MD Type Mini Pump					
Injection pressure		13.73 MPa (140 kgf/cm^2, 1991 psi)					
Injection timing (Before T.D.C.)		18°	21°	18°	21°	18°	
Compression ratio		23 : 1		24 : 1			
Fuel		Diesel Fuel No.2-D (ASTM D975)					
Lubricant (API classification)		above CD grade					
Dimensions (length × width × height)	mm (in.)	497.8 × 396 × 608.7 (19.60 × 15.59 × 23.96)					497.8 × 437.7 × 628.8 (19.60 × 17.23 × 24.76)
Dry weight	kg (lbs.)	93 (205.0)					97 (213.8)
Starting system		Cell starter (with glow plug)					
Starting motor		12 V, 1.0 kW					
Charging generator		12 V, 360 W					
Recommended battery capacity		12 V, 65 AH, equivalent					

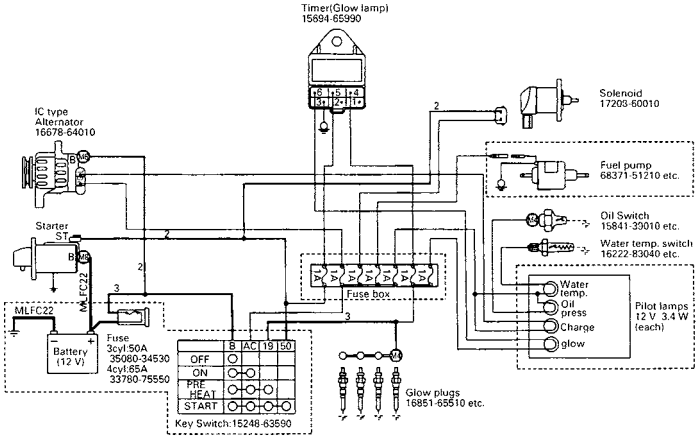
NOTE :

- Specifications are subject to change without notice.

V1205-E		V1205-TE		V1305-E		V1505-E	V1505-TE
Vertical, water-cooled, 4-cycle diesel engine							
4							
72 × 73.6 (2.83 × 2.90)				76 × 73.6 (2.99 × 2.90)		78 × 78.4 (3.07 × 3.09)	
1198 (73.11)				1335 (81.47)		1498 (91.41)	
Spherical Type (E-TVCS)							
20.1 / 3000 (27.0 / 3000)	23.5 / 3600 (31.5 / 3600)	25.4 / 3000 (34.0 / 3000)	29.8 / 3600 (40.0 / 3600)	22.4 / 3000 (30.0 / 3000)	25.7/ 3600 (34.5 / 3600)	25.0 / 3000 (33.5 / 3000)	31.3 / 3000 (42.0 / 3000)
17.2 / 3000 (23.0 / 3000)	20.1 / 3600 (27.0 / 3600)	21.6 / 3000 (29.0 / 3000)	25.7 / 3600 (34.5 / 3600)	19.0 / 3000 (25.5 / 3000)	22.4 / 3600 (30.0 / 3600)	21.6 / 3000 (29.0 / 3000)	27.2 / 3000 (36.5 / 3000)
3200	3800	3200	3800	3200	3800	3200	
800~900							
1-3-4-2							
Counter-clockwise (viewed from flywheel side)							
Bosch MD Type Mini Pump							
13.73 MPa (140 kgf/cm^2 , 1991 psi)							
19°	22°	19°	22°	18°	21°	18°	
23 : 1		22.5 : 1		24 : 1			23.5 : 1
Diesel Fuel No.2-D (ASTM D975)							
above CD grade							
583.8 × 396 × 613.7 (22.98 × 15.59 × 24.16)		591.3 × 439.2 × 613.7 (23.28 × 17.29 × 24.16)		583.8 × 396 × 613.7 (22.98 × 15.59 × 24.16)		591.3 × 396 × 613.7 (23.28 × 15.59 × 24.16)	591.3 × 439.2 × 613.7 (23.18 × 17.29 × 24.16)
110 (242.5)		114 (251.3)		110 (242.5)			114 (251.3)
Cell starter (with glow plug)							
12 V, 1.2 kW							
12 V, 360 W							
12 V, 70 AH, equivalent							

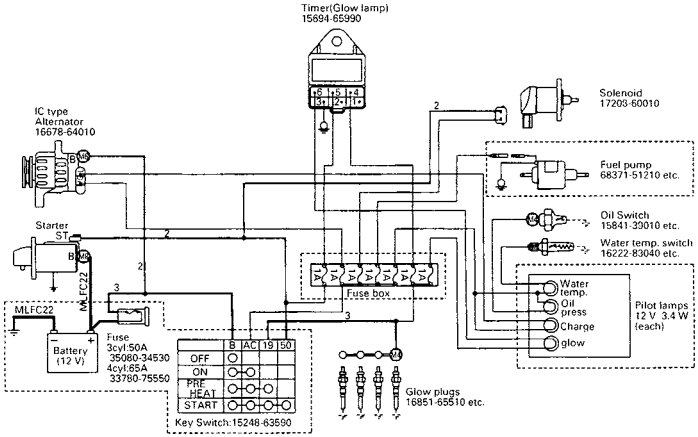
WIRING DIAGRAMS

EU standard
(Energize to run)



★ The parts boxed in ⋯⋯ are reference, NOT equiped for standard engine spec.
★ Non marked wire dia. is 0.8~1.25 mm².

KEA/SAE standard
(Energize to run)



★ The parts boxed in ⋯⋯ are reference, NOT equiped for standard engine spec.
★ Non marked wire dia. is 0.8~1.25 mm².

KUBOTA

FEDERAL & CALIFORNIA EMISSION CONTROL SYSTEMS LIMITED WARRANTY for NON-ROAD ENGINES (CI)

The U.S. Environmental Protection Agency (EPA), the California Air Resources Board (CARB), and KUBOTA Corporation are pleased to explain the Federal and California Emission Control System Warranty on your non-road engine. In California, new 2007 and later off-road engines must be designed, built and equipped to meet California's stringent anti-smog standards adopted by the Air Resources Board pursuant to its authority in Chapter 1 and 2, Part 5, Division 26 of the California Health and Safety Code. In other states of the U.S.A., new non-road engines subject to the provisions of 40 CFR 89 or 40 CFR 1039 subpart A must be designed, built and equipped, at the time of sale, to meet the U.S. EPA regulations for nonroad engines.

KUBOTA must warrant the emission control system on your Compression Ignition engine for the period of time listed below provided there has been no abuse, vandalism, neglect, improper maintenance or unapproved modifications to your engine. This emission warranty is applicable in all states of the U.S.A., its provinces and territories regardless of whether an individual state, province, or territory has enacted warranty provisions that differ from the Federal warranty provisions. This emission warranty is also applicable in all provinces and territories of CANADA.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, KUBOTA will repair your engine at no cost to you, including diagnosis (if the diagnostic work is performed at an authorized dealer), parts and labor.

EMISSION DESIGN AND DEFECT WARRANTY COVERAGE

The emissions warranty period for the engine begins on the original date of sale to the initial purchaser and continues for each subsequent purchaser for the period mentioned below.

The emissions warranty period for all engines rated under 19kW (25 Hp) is 1500 hours of operation or two (2) years of use, whichever first occurs.

The emissions warranty period for constant speed engines rated under 37kW (50Hp) with rated speeds greater than or equal to 3000 rpm is 1500 hours of operation or two (2) years of use, whichever first occurs.

The emissions warranty period for all other engines not already listed is 3000 hours of operation or five (5) years of use, whichever first occurs.

If any emission related part on your engine is defective, the part will be repaired or replaced by KUBOTA free of charge.

OWNER'S WARRANTY RESPONSIBILITIES

(a) As the engine owner, you are responsible for the performance of the required maintenance listed in your KUBOTA operator's manual. KUBOTA recommends that you retain all receipts covering maintenance on your engine, but KUBOTA cannot deny a warranty claim solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance.

(b) As the engine owner, you should be aware, however, that KUBOTA may deny your warranty coverage if your engine or a part has failed due to abuse, vandalism, neglect, improper maintenance or unapproved modifications.

(c) Your engine is designed to operate on Low Sulfur Diesel Fuel or Ultra Low Sulfur Diesel Fuel only. Use of any other fuel may result in your engine no longer operating in compliance with Federal or California's emissions requirements.

(d) You are responsible for presenting your engine with proof of purchase to the nearest dealer or service station authorized by KUBOTA when a problem exists. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

(e) If you have any questions regarding your warranty rights and responsibilities or the location of the

nearest authorized dealer or distributor, you should contact:

KUBOTA ENGINE AMERICA CORPORATION, Service Department at (847) 955-2500 or
KUBOTA TRACTOR CORPORATION, National Service Department at (310) 370-3370 or
KUBOTA CANADA LTD at (905) 294-7477.

COVERAGE

KUBOTA warrants to the initial purchaser and each subsequent purchaser that your engine will be designed, built and equipped, at the time of sale, to meet all applicable regulations. KUBOTA also warrants to the initial purchaser and each subsequent purchaser that your engine shall be free from defects in materials and workmanship which cause the engine to fail to conform to applicable regulations for the period mentioned above from the original date of sale.

KUBOTA shall remedy warranty defects at any authorized KUBOTA engine dealer or warranty station. Any authorized work done at an authorized dealer or warranty station shall be free of charge to the owner if such work determines that a warranted part is defective. Any KUBOTA approved or equivalent replacement part (including any KUBOTA approved aftermarket part) may be used for any warranty maintenance or repairs on emission related parts, and must be provided free of charge to the owner if the part is still under warranty.

KUBOTA is liable for damages to other engine components caused by the failure of a warranted part still under warranty. The use of replacement parts not equivalent to the original parts may impair the effectiveness of your engine emission control system. If such a replacement part is used in the repair or maintenance of your engine, and KUBOTA determines it is defective or causes a failure of a warranted part, your claim for repair of your engine may be denied.

Listed below are the parts covered by the Federal and California Emission Control Systems Warranty. Some parts listed below may require scheduled maintenance and are warranted up to the first scheduled replacement point for that part. The warranted parts are (if applicable):

1) Air-Induction System
   a) Intake Manifold
   b) Turbocharger System
   c) Charge Air Cooling System (Intercooler)

2) Exhaust Manifold

3) Fuel Injection System
   a) Fuel Supply Pump
   b) Injector
   c) Injection Pipe
   d) Common Rail
   e) Smoke Puff Limiter
   f) Speed Timer
   g) Cold Advance Timer
   h) Injection Pump

4) Electronic Control System
   a) ECU
   b) Engine Speed / Timing Sensor
   c) Accelerator Position Sensor
   d) Coolant Temperature Sensor
   e) Atmospheric Pressure Sensor
   f) Intake Pressure Sensor
   g) Intake Manifold Temperature Sensor
   h) Common Rail Pressure Sensor

5) Exhaust Gas Recirculation System
   a) EGR Valve
   b) EGR Cooler
   c) EGR Valve Opening Rate Sensor

6) Miscellaneous Items
   a) Closed Breather System
   b) Hoses*, Clamps*, Fittings, Tubing*
   c) Gaskets, Seals
   d) Kubota supplied engine Wiring Harnesses
   e) Kubota supplied engine Elec. Connectors
   f) Air Cleaner Element*, Fuel Filter Element*
   g) Emission Control Information Labels

*Warranty period is equivalent to manufacturer's recommended first replacement interval as stated in the applicable model's operator's manual and/or service (workshop) manual.

MAINTENANCE REQUIREMENTS

The owner is responsible for the performance of the required maintenance as defined by KUBOTA in the operator's manual.

LIMITATIONS

This Emission Control System Warranty shall not cover any of the following;

(a) Repair or replacement required because of misuse or neglect, improper maintenance, repairs improperly performed or replacements not conforming to KUBOTA specifications that adversely affect performance and/or durability, and alteration or modifications not recommended or approved in writing by KUBOTA.

(b) Replacement of parts and other services and adjustments necessary for required maintenance at and after the first scheduled replacement point.

KUBOTA ENGINE AMERICA CORPORATION
LIMITED WARRANTY ON INDUSTRIAL ENGINES
AND REPLACEMENT PARTS EFFECTIVE MAY 1, 2009

OUR WARRANTY TO YOU
We warrant to you, the original purchaser, that all parts (except those referred to below) of your new Kubota industrial engine and replacement parts purchased from an Authorized Kubota Industrial Engine Distributor or OEM Distributor in the United States will be free from defects in materials or workmanship during the following periods. (Refer to Service Policy for further details)

1. Industrial Engines for 2 years or 2,000 hours, whichever occurs first.

2. Industrial Engines Major Component Warranty (MCW), 3 years or 3000 hours, whichever occurs first, parts only.

   MCW covers cylinder block, cylinder head, crankshaft, camshaft, gears, pistons, rods, flywheel, flywheel housing, oil pump, pulleys, governor, intake manifold, oil pan, ignition distributor.

   MCW does not cover rings, bearings, water pump, any electrical component, valve train components, accessory parts, seals, gaskets, carburetors, exhaust manifold, hoses, all fuel system components, muffler, any filters, radiator, fan, belts, thermostat, spark plugs, fuel transfer pumps.

3. Replacement parts for 1 year.

WHAT WE WILL DO
We will, at our option, repair or replace any part covered by this warranty which becomes defective, malfunctions or otherwise fails to conform with this warranty under normal use and service during the term of the warranty at no charge for parts or labor. (Parts only for MCW)

WHAT YOU MUST DO TO OBTAIN WARRANTY SERVICE
In order to obtain warranty repairs, you must deliver the product, together with proof of purchase, to an Authorized Kubota Industrial Engine Distributor or Dealer at your expense. The names and addresses of such Authorized Kubota Industrial Engine Distributors can be found on the internet at www.kubotaengine.com, by calling 1-800-532-9808, via email at EEWRI@kubotaengine.com or by contacting:

Kubota Engine America Corporation
505 Schelter Road
Lincolnshire, IL 60069

WHAT THE WARRANTY DOES NOT COVER
This warranty **does not** cover:

1. Damage, malfunctions or failures resulting from accidents, abuse, misuse, modifications, alteration, improper servicing, or lack of performance of required maintenance service.
2. Normal maintenance services or replacement of maintenance items such as light bulbs, preheater plugs, indicator and resistant coils, filter elements, lubricants, oils, spark plugs, coolant, or belts.
3. Installation of replacement parts, unless originally installed by an Authorized Kubota Industrial Engine Distributor or Dealer.
4. Non-genuine Kubota parts.
5. Any engines damaged by use of ether or any starting aid, or greater than a 50/50% solution of antifreeze and water.
6. Injection nozzle wear or any engine damage caused by injection nozzle wear or sticking.
7. Damage caused by water entering the engine due to any cause.
8. Used Products.
9. Any damage caused by overheating that is not a direct result of a defect in materials or workmanship.
10. Any Engine not application reviewed.

APPLICATION REVIEW PROCESS: The Kubota Engine America (KEA) application review process is intended to assist the OEM with engine installation to optimize functionality/performance within the OEM's equipment in order to maintain durability, customer satisfaction, and reduce warranty failures and expenses. Kubota cannot anticipate all potential failures and issues that may occur with the engine or product in the field during an application review. Therefore, machine durability testing by the OEM either in a test facility and/or in the field is critical to further reduce the potential for field failures.

The amount of time spent by KEA on an application review is significantly less than the amount of time spent by the OEM's design engineers on the application. Because of this, the KEA application review is intended to identify issues that are within the scope of the application review testing performed and in some cases recommend possible solutions. The KEA application review should never take the place of proper design and testing of the finished product by the OEM.

The KEA application review does not in any way express or imply any additional warranty coverage other than what is stated in Kubota's Limited Warranty Agreement. Kubota and its subsidiary companies are not responsible for (including, but not limited to): failures resulting from any components that are not manufactured by Kubota, misrepresented or incorrect information provided from an OEM, any changes made without KEA's knowledge, any decision by the OEM not to follow KEA's recommendations, or any application related problems or deficiencies that may arise that were not found by KEA's limited application review or the OEM's durability testing.

THIS IS THE ONLY EXPRESS WARRANTY ON OUR PRODUCTS
We neither assume nor authorize anyone to assume for us any other express warranty. The Kubota Distributor/ Dealer has no authority to make any representation or promise on behalf of Kubota Engine America Corporation or to modify the terms or limitations of this warranty in any way.

LIMITATIONS ON OUR RESPONSIBILITY WITH RESPECT TO PRODUCTS PURCHASED AND USED FOR PERSONAL, FAMILY OR HOUSEHOLD USE.
Our responsibility is to repair or replace defective parts as stated above. We will not be responsible for any other expenses, losses or inconvenience which you may sustain as a result of the purchase, use, malfunction or defective condition of our products. ANY IMPLIED WARRANTIES INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE SHALL BE LIMITED IN DURATION TO THE PERIOD SET FORTH ABOVE AND IN NO EVENT WILL WE BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER. Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

LIMITATIONS ON OUR RESPONSIBILITY WITH RESPECT TO PRODUCTS USED FOR RENTAL OR FOR COMMERCIAL, INDUSTRIAL OR AGRICULTURAL PURPOSES.
This warranty is in lieu of all other warranties, express or implied, and of any other obligations or liability on our part. IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXCLUDED. Our responsibility for any and all losses and damages resulting from any cause whatsoever, including our negligence, alleged damage or defective goods, whether such defects are discoverable or latent, shall be limited to the repair or replacement of defective parts as stated above. IN NO EVENT WILL WE BE LIABLE FOR LOSS OF USE, LOSS OF PROFITS, LOSS OF OR DAMAGE TO OTHER PROPERTY, INCONVENIENCE, COMMERCIAL LOSS, OR OTHER SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER.

MANUAL 2871

OWNERS MANUAL

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

STX/STH/STL SERIES
SELF-PRIMING PUMPS
WITH CYCLOSEAL & RUN-DRY

PLEASE READ CAREFULLY

YOUR WARRANTY MAY BE VOID IF INSTRUCTIONS ARE NOT FOLLOWED

Note: when ordering parts give pump model and serial number

CORNELL PUMP COMPANY
16261 SE 130th Ave
Clackamas, OR 97015 USA
Phone: 503-653-0330 Fax: 503-653-0338

INDEX
SELF-PRIMERS
FRAME AND ENGINE MOUNT

CORNELL PUMP COMPANY
TERMS AND CONDITIONS OF SALE

LEGAL EFFECT: These Terms and Conditions of Sale ("Terms") and the associated Order Acknowledgement (collectively, the "Agreement") are binding upon Cornell Pump Company ("Cornell") and the purchaser of products and services from Cornell ("Buyer"). Except as otherwise agreed to in writing by Cornell, these Terms shall apply to, and form a part of, all sales of products and services (collectively, "Products"). Additional or different terms shall have no effect unless agreed to in writing by Cornell.

Cornell may suspend its performance of any order if Buyer defaults in the performance of its duties under any order or under any other agreement between Cornell and Buyer.

ACCEPTANCE: The sale of Products by Cornell to Buyer is expressly conditioned on Buyer's acceptance of these Terms.

CHANGES: Any changes proposed by Buyer after formation of this Agreement that affect the delivery schedule or requirements, or otherwise affect the scope of this Agreement, shall be submitted in writing by Buyer to Cornell and shall become binding only if agreed to in writing by Cornell. Any modifications to price or delivery as a result of such changes shall be determined by Cornell in its sole discretion.

CANCELLATION AND REVISION: No order may be cancelled or revised, in whole or in part, without the written consent of Cornell. In the event that Cornell consents to any cancellation or revision, Buyer shall reimburse Cornell for all of Cornell's losses, costs, and damages caused by such cancellation or revision, including, but not limited to, any costs arising from changes in design or specifications.

CREDIT: The amount of credit offered by Cornell to Buyer is based on a number of factors, including, but not limited to, Cornell's opinion of Buyer's capacity, ability, and willingness to promptly pay for Products. Cornell reserves the right to revoke Buyer's credit and/or suspend performance on any order in the event that, in Cornell's opinion, there is a material adverse change in Buyer's financial condition, or Buyer has not, within the agreed upon time, fully paid for Products previously supplied under any other agreement with Cornell.

PAYMENTS: Standard terms for customers who qualify for credit are ½% 15 days, net 30. Unless otherwise agreed to in writing by Cornell, Buyer shall pay all amounts due within thirty (30) days of receipt of invoice. A monthly service charge of 1.5% may be charged on amounts owed by Buyer to Cornell that have not been paid on time, subject to the maximum amount permitted by law.

TITLE AND LIEN RIGHTS: The Products will remain personal property, regardless of how the Products are installed or affixed to any realty or structure. After delivery to Buyer, Cornell will have all such rights, including security interests and liens, in the Products as lawfully may be conferred upon Cornell under any applicable provision of law. Buyer agrees to cooperate fully with Cornell in the filing of any financing statements, including Uniform Commercial Code filings or other documents necessary to perfect such interests and liens. If Buyer breaches this Agreement, or defaults on any obligations, before paying all amounts due for the Products, Cornell may take any and all actions permitted by law to protect its interests, including, where permissible, repossession of such Products.

SHIPMENTS: All sales are ex-works factory. Risk of loss shall pass to Buyer upon shipment. Shipping contracts made by Cornell shall be to Buyer's account. All claims for loss or damage after shipment shall be filed by Buyer with the carrier. Buyer shall be liable to Cornell for the full price of the goods, irrespective of loss or damage in transit. Cornell shall not be required to provide freight cost receipts to Buyer at the time of invoice.

LIMITED WARRANTY: Cornell warrants, to Buyer only, that Products manufactured by Cornell are free from defects in material and workmanship for the periods set forth in Exhibit 1. If a failure to conform to specifications or a defect in materials or workmanship is discovered within the applicable period, Cornell must be promptly notified in writing within thirty (30) days of such discovery. Within a reasonable time after such notification, Cornell shall correct any failure to conform to specifications or any defect in materials or workmanship, or in lieu of such repair, and at Cornell's sole option, shall replace the Products or the applicable portion thereof.

Any such repair shall be performed at Cornell's facility, unless otherwise designated by Cornell. Buyer shall pay any cost incurred as a result of shipping the Products, or any portion thereof, to Cornell. Cornell shall pay any cost incurred in returning the Products, or any portion thereof, to Buyer. For repairs done at Cornell's facility, Cornell will pay for any costs of labor and materials, and any expenses incurred by Cornell in making such repairs.

Cornell may opt to send replacement parts in lieu of repair at Cornell's facility. Cornell may also opt to perform repairs at Buyer's facility or site. If such repairs are performed for the convenience of Buyer, Buyer shall pay for all costs of labor and materials. If such repairs are performed for the convenience of Cornell, Buyer shall, in Cornell's sole discretion, pay a portion of the costs of labor and materials. Cornell shall have no obligation to pay or reimburse Buyer or any third party for any expense incurred as a result of any Products, or any repair or attempted repair of any Products.

The warranty provided herein shall not apply in the event of any (a) defects caused by a failure to provide a suitable installation environment for the Products, (b) damage caused by the use of the Products for purposes other than those for which the Products were designed or intended, (c) damage caused by disasters such as fire, flood, wind, or lightning, (d) damage caused by unauthorized attachments or modifications, (e) other abuse or misuse, including improper installation, (f) reasonable wear and tear, and (g) defects in equipment or components not manufactured by Cornell. Cornell shall pass on any warranties for equipment and components not manufactured by Cornell to the extent that such warranties may be passed on.

CORNELL DISCLAIMS ANY AND ALL WARRANTIES AND REPRESENTATIONS WITH RESPECT TO THE PRODUCTS PROVIDED HEREUNDER, WHETHER EXPRESS OR IMPLIED, ARISING BY LAW, CUSTOM, ORAL OR WRITTEN STATEMENTS OR OTHERWISE, INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR THAT THE PRODUCTS WILL GENERATE CERTAIN RESULTS, WORK IN COMBINATION WITH OTHER COMPONENTS OR AS AN INTEGRATED SYSTEM OR WILL FULFILL ANY OF BUYER'S PARTICULAR PURPOSES OR NEEDS.

COMPLIANCE WITH LAWS: Buyer shall comply with all laws and regulations governing the purchase or license, installation or use of the Products, including, without limitation, obtaining all licenses, permits and registrations and fulfilling all other requirements of governmental agencies, and Cornell shall have no obligation or responsibility of any kind with respect thereto. Buyer shall only export or re-export the Products in compliance with all applicable U.S. export control laws and regulations.

LIMITATION OF LIABILITY: Cornell's aggregate liability for any claim, loss, cost, damage, or liability arising out of or related to this Agreement, including, but not limited to, any liability arising from negligence, warranty, indemnity, contract, strict liability, or operation of law, shall in no event exceed the purchase price paid by Buyer for the affected Products. IN NO EVENT SHALL CORNELL BE LIABLE FOR, OR OBLIGATED IN ANY MANNER TO PAY, SPECIAL, INDIRECT, INCIDENTAL, CONSEQUENTIAL, OR PUNITIVE DAMAGES OF ANY KIND.

INDEMNIFICATION: Buyer shall indemnify, defend and hold harmless Cornell, its affiliates, and their respective directors, officers, members, employees, agents, contractors, successors, and assigns from and against all losses, damages, expenses, claims, demands, suits, judgments, penalties, and costs of any kind whatsoever, including attorneys' fees and expenses arising out of this Agreement or Buyer's use, acts, or omissions in connection with any Products.

GOVERNING LAW AND FORUM: This Agreement shall be governed in all respects by the laws of the State of Oregon, U.S.A. (excluding any conflicts of laws principles that would lead to the application of another state's laws). Buyer submits to the jurisdiction of the state and federal courts of Oregon for the purposes of resolving any dispute arising under or in connection with this Agreement.

CORNELL PUMP COMPANY
TERMS AND CONDITIONS OF SALE

Exhibit 1

Warranty Coverage By Product

PRODUCT	0-12 MONTHS	13-18 MONTHS	18-24 MONTHS	25-36 MONTHS	37-60 MONTHS
REFRIGERATION PUMPS	100%				
IRRIGATION PUMPS*	100%				
FOOD AND HOT OIL PUMPS	100%				
INDUSTRIAL PUMPS*	100%				
MUNICIPAL PUMPS*	100%				
SUBMERSIBLE PUMPS*	100%		50%		25%
PORTABLE PUMPS**	100%	50%		25%	
DAF PUMPS	100% (6 month)				
STX - SELF PRIMER PUMPS	100%				
OTHER PUMPS NOT LISTED	100%				
PARTS	100%				
Warranty for Motors, Controls, and other accessories not manufactured by Cornell are provided by the manufacturer of those products.					

*For permanent Installations

**Pumps used for Rental, Dewatering, and other non-permanent applications

Proration periods are based on months after shipment (unless otherwise agreed upon).

Wear Parts: This limited warranty does not cover parts that by nature of their function require replacement as the result of normal wear and tear (seals, wear rings, wear plates, or other parts subjected to abrasion, cavitation, or corrosion) unless a defect in materials or workmanship can be determined by Cornell.

Effective Date: May 12th, 2013
Supersedes All Previous Warranties

1. GENERAL INSTRUCTIONS

The goods must be examined on arrival to ascertain any damage, particularly that incurred in transit. Also check that the goods correspond exactly to the description on the shipping documents. Report any differences or damage to the forwarding agent, and inform the CORNELL office or local distributor within 48 hours. Always quote the pump type printed on the relevant nameplate, or the serial number.

The pumps must be used only for applications for which the Manufacturer has specified:

- construction materials
- operating conditions (pressure, speed, temperature, etc.)
- fields of application

2. SAFETY RULES AND ACCIDENT PREVENTION

When working near the pump, dress appropriately, avoiding baggy clothes with loose items (ties, scarves, etc.), which could get caught in moving parts. Use overalls made according to safety regulations, gloves, insulating shoes, safety glasses, safety earmuffs and hard hat.

Do not carry out maintenance on the engine/motor while it is running. Keep hands away from moving parts (e.g. belts, couplings, etc.). Keep hands away from parts of the engine/motor that get hot.

Do not climb on top of the engine/motor or pump to perform work of any kind.

3. IN CASE OF EMERGENCY

Disconnect power (for motor pumps).

Shut off the engine (for engine-driven pumps). Notify the person responsible for running the plant.

4. HANDLING AND TRANSPORT

-The unit must be transported horizontally and safely

-Installation

During installation and maintenance, all components used must be handled securely using suitable slings. Handling must be carried out by specialized personnel to avoid damage to the pump and injury of personnel. The lifting rings attached to the various components should only be used to lift the components for which they are supplied.

-Maximum lifting speed: Vmax ≤ 1.5 FT/S

-Do not linger or pass under the pump while it is lifted!

5. STORAGE

Store the pump under cover wherever possible. If the pump must be stored in the open, cover it with a tarpaulin, and lubricate bearings to prevent rust. Provide means to prevent moisture from building up around the pump.

Do not leave liquid in the pump casing. Drain through the drain plug. During winter months and in cold weather, the liquid could freeze and damage the pump. If the liquid is hazardous, take all necessary precautions to avoid damage and injury. At regular intervals, turn the shaft to prevent encrustation inside the pump.

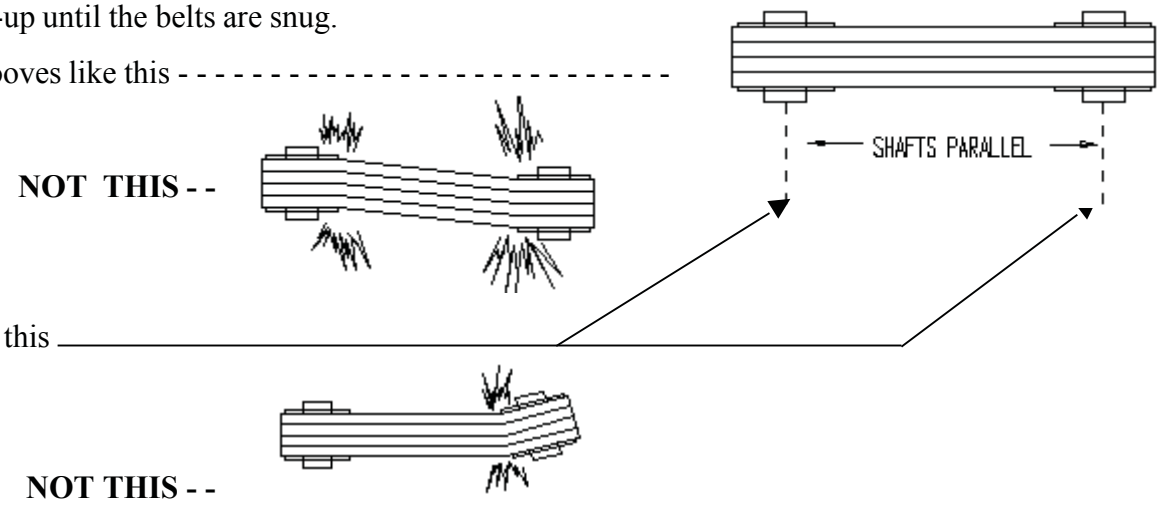
6. ASSEMBLY AND COUPLING

If the pump is supplied in the bare shaft version (pedestal pump), it must be coupled to the electric motor, taking account of the following:

- the coupling must be suitable for the power to be transmitted.
- the coupling must be aligned properly.
- the coupling guard must comply with applicable safety standards.
- rated power of the motor.
- power absorbed by the pump (see pump curve).
- motor speed (see motor's rating plate).
- pump speed.

BELT DRIVE ALIGNMENT

1. Use a matched set of V-Belts.
2. Clean oil and grease from sheaves.
   Remove rust and burrs.
3. Slack off on take-up until belts can be placed in grooves without forcing.
4. Tighten the take-up until the belts are snug.
5. Align sheave grooves like this -



6. Align shafts like this _____

7. Run drive at full speed and adjust take-up until only slight bow appears in slack side of belts. Vertical drives, drives with extremely short centers, and drives carrying pulsating loads must be operated tighter than others.

   Never use belt dressing.

8. Give belts a few days running time to become seated in sheave grooves, then readjust take-up.
9. Store belts in clean, cool, dark place.

WARNING

All rotating parts should be properly protected. Guards should be installed to prevent the operator from coming in contact with shafts, drives, or other rotating elements. Do not operate pumps when the guards are removed.

ALIGNMENT OF FLEXIBLE COUPLINGS

It is not commercially feasible to furnish bed plates which, when placed on an uneven foundation, will not spring and cause misalignment. It is, therefore, necessary to support them on foundations that can furnish the required regidity.

Misalignment causes whipping of the shaft, adds thrust to bearings, leads to excessive maintenance and potential failure of equipment. It is imperative that alignment be carefully checked prior to placing pump in operation. This is done after securing to bed plate or foundation and making pipe connections.

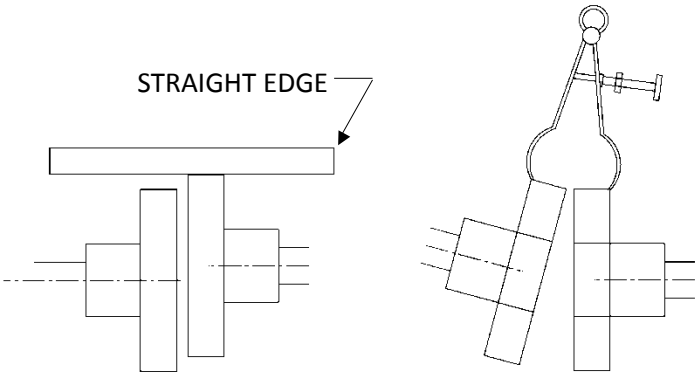
Flexible couplings must permit some lateral floating of the shaft to take care of thermal expansion and so move without excessive thrust on bearings.

Numerous types of flexible couplings are available. Some are easier to align than others, but all serve the purpose of connecting two shafts capable of transmitting torque while allowing for minor misalignment (angular, parallel or a combination).

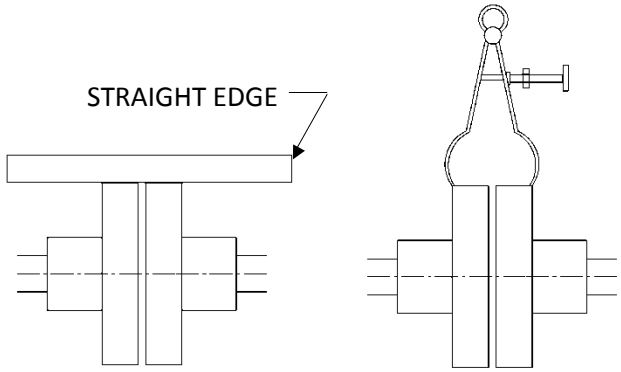
DO NOT assume the word flexible means the couplings are designed for misalignment. Couplings can be lined up by use of a straight edge, inside caliper, thickness gauge or outside caliper. The two ends of the couplings must be concentric and the sides parallel with no angular misalignment.

WARNING: All rotating parts should be properly protected. Guards should be installed to prevent the operator from coming into contact with shafts, drives, or other rotating elements. Do not operate pumps when guards are removed or serious personal injury may result.

INCORRECT ALIGNMENT



CORRECT ALIGNMENT

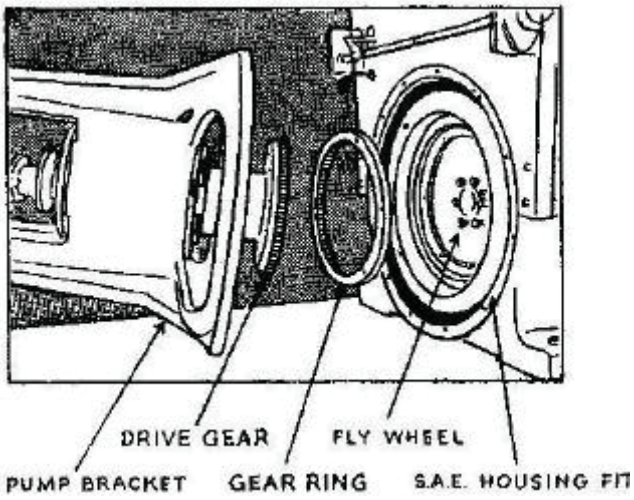


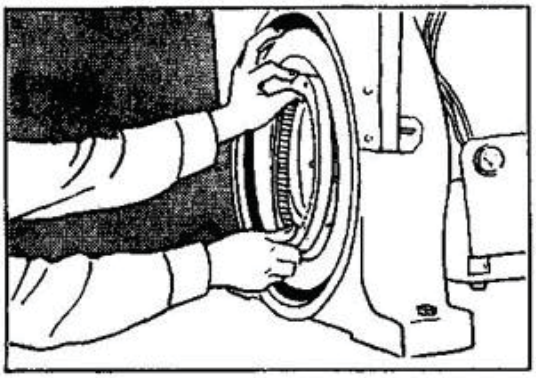
ASSEMBLY OF CORNELL PUMPS TO ENGINES

1. There are three items to consider – the pump and pump bracket as a unit, the engine, and the gear ring. The SAE housing fit on the engine determines the size pump bracket to be furnished. The machining and drilling on the flywheel determines the size gear ring furnished (the gear ring can best be determined by knowing the size of clutch that would fit, or by ordering the flywheel for the gear ring you need).

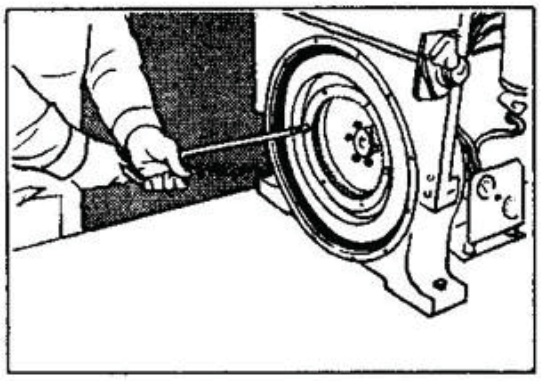
   There are a few engine models that are exceptions. A segment has to be cut out of the adapter ring on the pump bracket in order to clear the starter. The dimension from the outer surface of the housing to the flywheel varies on different engines. The pump shaft is made for the greatest depth so as to be adaptable to all sizes. In some cases it will be necessary to remove the drive hub and shorten the pump shaft, or occasionally the drive hub will have to be shortened.

   Some models and sizes use fiber drive gears, others use a rubber disc drive. The above procedure applies to both systems.

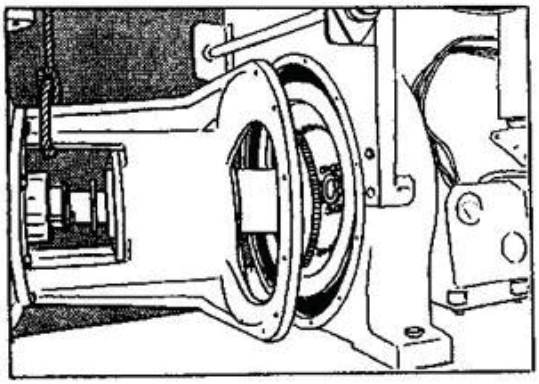




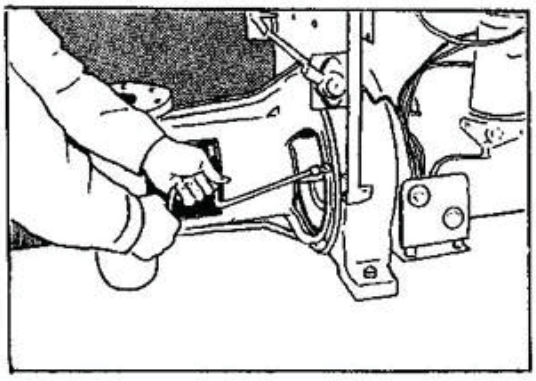
2. Set the gear ring into place on the engine unit.



3. Firmly tighten the cap screws to hold the gear ring in place.



4. With block and tackle, maneuver the pump and bracket into proper alignment and mesh the gear ring and drive gear.



5. Bolt the pump frame to the engine housing, being sure to securely tighten all cap screws.

ASSEMBLY OF CORNELL PUMPS TO ENGINES

Cornell manufactures all engine-frame to fit the standard SAE-type flywheel and housing. For engines that do not have standard SAE flywheels and housings, some alterations may be required.

There are two types of drive and ring gear packages which are furnished with these units: Fiber drive and rubber disc drive. In either case, the following instructions apply:

Assembly Instructions

1. Set the ring gear in place in the flywheel and bolt securely in place (see chart below for bolt requirements).
2. Remove rubber deflector on the drive end shaft and discard before installing drive gear.
3. Place the drive gear on the pump shaft. Secure the drive gear to the pump shaft. Some drive gears are supplied with a tapered locking-type bushing. It is important that the bolts are torqued to the recommendation supplied with the bushing. With block and tackle or hoist, maneuver unit into place on engine, being careful to mesh the drive gear in the ring gear properly.

-- CAUTION --

4. All engine-driven pumps must be supported, and alignment must be assured before bolting frame to the engine flywheel housings.
5. Bolt the pump and frame securely to engine flywheel housing and support. Double check the location of the drive gear in the ring gear and adjust if necessary (see chart below for bolt requirements).

Flywheel Housing and Ring Gear Bolt Requirements

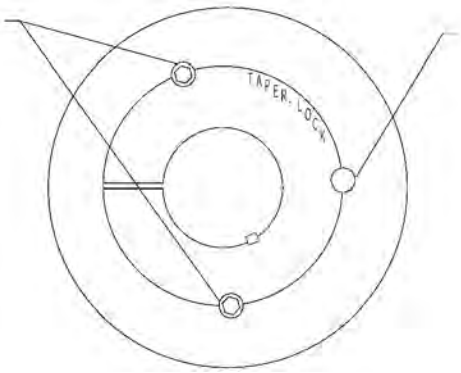
SAE #	Bolt Size	Bolt Grade (SAE)	Bolt Torque	# of Bolts
1	7/16 -14	5	50 Ft-lbs.	12
2, 3, 4	3/8 - 16	5	30 Ft-lbs.	12

Clutch Size	Bolt Size	Bolt Grade (SAE)	Bolt Torque	# of Bolts
6.5, 7.5	5/16 - 18	5	17 Ft-lbs	6, 8
8, 10, 11.5	3/8 - 16	5	30 Ft-lbs	6, 8, 8
14	1/2- 13	5	75 Ft-lbs	8

Taper Lock Bushing Instructions

INSTALL

Insert bushing in hub. Match holes (not threads) and slip entire unit onto shaft. Put screws into the holes that are threaded in hub only. Align the product and tighten screws. As bushing is wedged inward, it contracts – evenly – and grips the shaft.



REMOVE

Take the screws out entirely, insert them into the holes which are threaded in the bushing only, using them as jackscrews. This disengages the bushing. Its grip is "unlocked," permitting quick, easy removal of product. **Note:** For complete instructions, refer to instruction sheet packaged with each bushing.

Torsional Vibration

A torsional vibration analysis is the responsibility of the packager. Engine manufacturers or specialized consulting offices can provide this service. Cornell does not assume responsibility of torsional vibration problems of pump -engine units assembled by others (ISO 3046/V 1978(E) 4.1.1 and .2). Problems due to torsional vibration are not warrantable.

7. LUBRICATION INSTRUCTIONS – ELECTRIC MOTORS

BALL BEARING LUBRICATION

Bearings in motors are greased at the factory before shipment.

Lubrication requirements vary with speed, power, load, ambient temperatures, exposure to contamination and moisture, seasonal or continuous operation and other factors. The brief recommendations which follow are general in nature and must be coupled with good judgement and consideration of the application conditions. For regreasing periods refer to table below. When adding grease be sure the grease and fittings are absolutely clean.

Grease used for these bearings should be equivalent to one of the following manufacturer's products: Exxon

Polyrex EM
Mobil Mobilith SHC 220
Chevron SRI #2
Texaco Polystar RB

CAUTION: These are Polyurea based greases and should never be mixed with lithium base greases. Mixing of the two greases can cause the base thickener to become ineffective allowing the grease to become pure oil and flowing out of the bearings causing bearing failure.

NOTE: If lubrication instructions are shown on motor, they will supersede these general instructions.

To lubricate electric motor bearings, use a hand-operated grease gun only. Pump grease into fitting until new grease appears at pressure relief plug. For minimum possibility of over-greasing, and for best results, lubricate when the motor is not running.

Bearings will become unusually hot until excess grease escapes from the relief plug. End of

season: Pump in grease until old grease is expelled from relief plug. Store. Beginning of

season: Start up motor. Let motor run until surplus grease is expelled.

RECOMMENDED REGREASING PERIODS FOR MOTORS

	HORSEPOWER			
	1.5 TO 7.5	**10 TO 40**	**50 TO 150**	**200+**
Total Running Time	2,000 hours	1,500 hours	1,000 hours	750 hours
8-Hour Day	36 weeks	27 weeks	18 weeks	13 weeks
24-Hour Day	12 weeks	9 weeks	6 weeks	4 weeks

8. INSTALLATION

The base plate of the engine- or electrically-driven pump unit must be anchored on a leveled surface into which anchor bolts have been embedded following the layout supplied with each unit, or available on request. The surface must be heavy duty to absorb any vibration and rigid enough to maintain the alignment of the pump to the motor or engine.

When anchoring the base plate to the mounting surface, Cornell recommends checking levelness with the aid of a level placed on top of the pump's discharge flange. If adjustments are required, always adapt the mounting surface to the base plate, and never the base plate to the mounting surface.

Clean pipework thoroughly before connecting it to the pump. Suction pipes must have the same diameter as the pump's suction port (for larger diameters, contact CORNELL). Where possible, avoid curves, elbows or constrictions liable to limit the flow of liquid to the pump. Do not install a foot valve: the pump comes with a built-in non return suction check valve. Install the pump as near to the liquid to be pumped as possible. Where possible, try to reduce the length of the suction pipe. Suction pipe connections must be completely airtight: check pipe threads, flange gaskets, quick couplings etc.
The discharge pipe must let air escape from the system while the pump is priming.
The suction and discharge pipes must be fitted so that they do not cause strain on the pump casing.
For engine-driven pumps, it is recommended to have lengths of flexible rubber hose to isolate pipework from vibrations generated by the engine.

9. FILLING UP OIL

Fill oil using cap for the seal and cap for bearings.
Pour in oil until it is half way up oil level sight glass for the seal and oil level sight glass for bearings.
Be careful to keep out dirt and moisture.
Oil level must be maintained; check and fill when pump is not operating.

10. DRAINING OIL

Drain oil using plug for the seal and plug for bearings.

11. STARTING

-Before operating the pump, check that electrical and mechanical parts of the system have been correctly installed.
Make sure all safety devices are operative.
Make sure the pump's direction of rotation is correct
Check oil level in the mechanical seal & bearing cavities through the view gauges. Pumps are shipped with oil in both cavities.

-Mechanical Seal
The mechanical seal is oil-immersed (ISO VG32 OR VG15 TURBINE OIL OR SAE 10W-30). Change oil after 5,000 hours of operation, or once a year.

-Bearing Frame
The bearing frame is oil-immersed (ISO VG32 turbine oil for temperatures less than 150ºF, ISO VG68 turbine oil for temperatures greater than 150ºF).

-Filling the pump casing
Fill the pump casing completely with the liquid to be pumped through the relevant hole on the top of the casing. With the pump stopped, the casing does not empty, meaning you do not need to fill it.

-Priming
Warning: if the pump does not prime, do not operate it for more than 5 minutes to avoid overheating the liquid. Engine-driven pumps should be brought up to running speed gradually. Never change the accelerator lever limit stop: at speeds higher than those for which the engine is set, the pump absorbs more power than the engine can supply. Never exceed the maximum speed given on the pump's performance curve.

-When the pump has primed:
Make sure the current absorbed by the motor does not exceed the motor's rated value, shown on the nameplate.
If the pump does not seem to be operating normally, it is imperative to stop the pump and determine the cause(s) (see pump troubleshooting section).

12. MAINTENANCE

Before maintenance is carried out, the pump must be stopped and the power supply disconnected. The supply must only be switched back on by the operator performing maintenance.
Warning: residual liquid may be found in the pump casing, discharge and suction lines. Take necessary precautions if the liquid is hazardous (flammable, corrosive, poisonous, infected etc.).

-Inspection and checks
Check that the pump is working correctly at regular intervals. Use the instruments installed in the system (pressure gauge, vacuum gauge, flow meter, ammeter etc.) to check the pump is still fit for duty.
We recommend periodic maintenance of the various parts subject to wear, particularly the impeller and wear plate.

13. RESIDUAL RISKS

-Residual risks are any risks that cannot be eliminated through pump design:

knocks
anomalous pressure rises
misuse
maneuvring errors in the pump's vicinity.

14. REPAIRS

-Before carrying out repairs on the unit, it is essential to:

disconnect power
close the pump's suction and discharge valves
if the liquid pumped is hot, allow the pump to cool down to ambient temperature
if the liquid pumped is hazardous, follow the safety procedures for handling hazardous liquids
drain liquid pumped from pump casing.
remove and clean, removing any liquid pumped still inside.

15. DISASSEMBLY FROM SYSTEM

- Follow repairs section
- remove nuts securing the suction and discharge flanges.
- remove bolts fastening the pump to the base plate.
- pull the pump from the coupling, if there is one, or remove it from the electric motor.

16. ASSEMBLY TO SYSTEM

- lift the pump with appropriate hoisting means.
- place pump on the base plate.
- restore connections with the coupling or electric motor, as applicable:
- check alignment.
- fasten pump to the base plate.
- connect pump to pipework.
- refit any coupling guards.

NOTE: Rotating assembly can be removed from casing without disturbing piping.

17. SPARE PARTS

To assure the pump's lasting efficiency, it is advisable, when ordering the pump, to purchase the spare parts recommended for the first maintenance operation. Call the Cornell parts department for a list of spares for your STX pump.

-To order spare parts, specify the following:

type of pump.
the pump's serial number.
reference number and description of the part as shown in the exploded drawing.

18. DISPOSAL

- Do not release to the environment.
- Metal parts can be recycled as scrap.
- Grease and oil must be recovered and stored as prescribed by the relevant legislation for disposal by approved agencies.
- Elastomer gaskets must be kept separate and disposed of through an authorized waste disposal agency.

19. TROUBLESHOOTING: CAUSES AND REMEDIES

Warning: before commencing troubleshooting, make sure testing instruments (vacuum gauge, pressure gauge, tachometer, flow meter, electrical gauges etc.) are working properly.

A) The pump does not prime

1 pump casing is empty or not full enough
fill pump casing through filler hole.

2 liquid inside pump casing overheating
add cold liquid inside the pump casing through the filler hole.

3 air may be getting in at joints or cracks in the suction pipe
check joints are airtight and inspect suction pipe. "soap spray" test may be required.

4 discharge pipe under pressure
bleed delivery pipe.

5 pump speed low

only increase speed once you have checked the contract data and pump performance curves

6 impeller may be worn or broken
check state of impeller through the coverplate or remove the pump casing.

7 cutwater (leading edge of the volute) may be worn
remove pump casing as indicated on. If cutwater is severely worn, replace the casing.

8 suction strainer, where applicable, may be clogged
remove obstructions.

9 excessive suction lift
check pump curve to make sure NPSHA is greater than NPSHR.
reduce suction lift if necessary.

10 air entering through seal
disassemble seal and clean it; if the problem persists, change the seal. Make sure seal faces are aligned properly

11 impeller clogged by foreign matter
disassemble casing and remove foreign matter.

B) Pump does not deliver liquid

1 pump does not prime
see causes given above.

2 head required by the system is greater than the rated head of the pump
revise system design or select a different pump.

3 excessive flow resistance along suction line
revise distribution of elbows, valves, constrictions etc. ; where necessary, increase diameter of pipework.

4 impeller clogged by foreign matter
disassemble casing and remove foreign matter.

5 suction/delivery pipes may be obstructed or clogged
locate the obstructed or clogged area and clean.

C) Pump does not deliver enough liquid

1 air leaks in suction line
check joints are airtight and inspect suction pipe.

2 impeller and/or wear plate may be worn
replace them by disassembling the pump.

3 diameter of the suction pipe too small
replace suction pipe.

D) Pump does not provide enough pressure

1 viscosity of the liquid is higher than expected
contact the pump manufacturer once you have measured the viscosity of the liquid. Viscosity for centrifugal pumps should not exceed 50 cSt.

E) Pump absorbs too much power

1 rotation speed too high
check correct rotation speed.

2 pump operates under conditions that are different from those specified in the contract
check operating conditions of pump and contact CORNELL rep or distributor.

3 density of the liquid is higher than expected
measure density of the liquid and compare it with the agreed value.

4 incorrect unit alignment
check unit is correctly aligned.

5 there may be friction inside the pump between rotating and non-rotating components
disassemble pump casing and check for scratches on surfaces.

6 foreign matter in impeller
remove cover plate and remove foreign matter.

F) Pump vibrates and is noisy

1 pump is operating with a flow rate that is too low
check settings of the valves in the system and readings on the pressure and vacuum gauges and compare to pump curve

2 pump or pipework is not fixed securely
make sure system pipework is correctly clamped.

3 pump cavitates
see: “the pump does not prime” & “pump does not deliver liquid”

4 foreign matter in impeller
remove cover plate and remove foreign matter.

G) Pump jams

1 mechanical breakdown
check shaft, couplings, motor or engine, bearings, pulleys and belts, gearboxes etc. for breakages.

2 foreign matter in impeller
inspect the pump casing inside through the coverplate and remove foreign matter.

H) Bearings do not last

1 lack of lubrication
lubricate bearings

2 foreign matter in bearings
replace bearings

3 bearings are rusted
replace bearings

4 pump not operating within acceptable limits of flow rate
change flow rate to within acceptable limits as listed on pump curve.

I) Mechanical Seal leaks

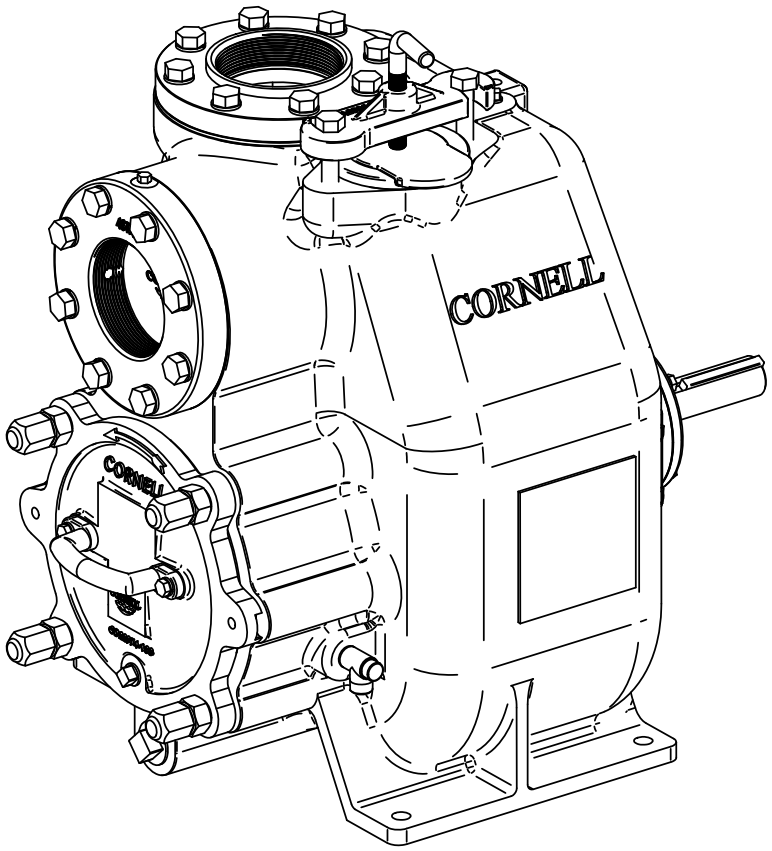
1 poor lubrication
Check oil level. If the mechanical seal leaks during operation, the seal must be replaced.

J) Excessive coupling wear

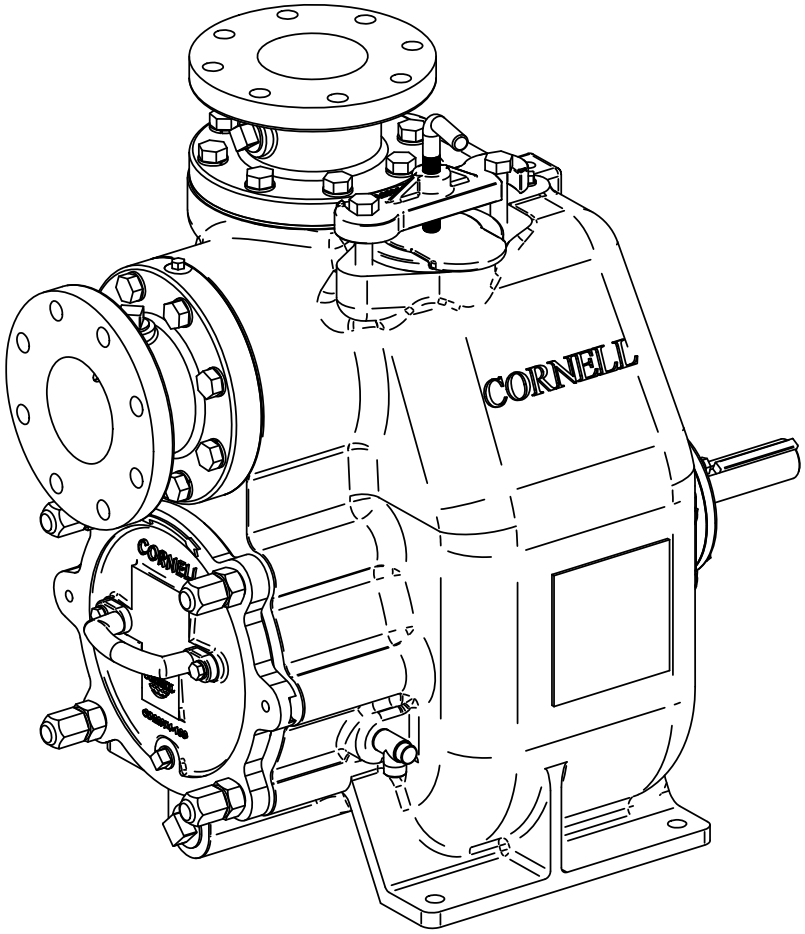
1 Rubber parts of coupling wear down quickly
Check unit is correctly aligned.

2 coupling undersized for application
Check rating of coupling verses the applied torque

SW10977-S



NPT FLANGE DISCHARGE AND SUCTION



ANSI FLANGE DISCHARGE AND SUCTION

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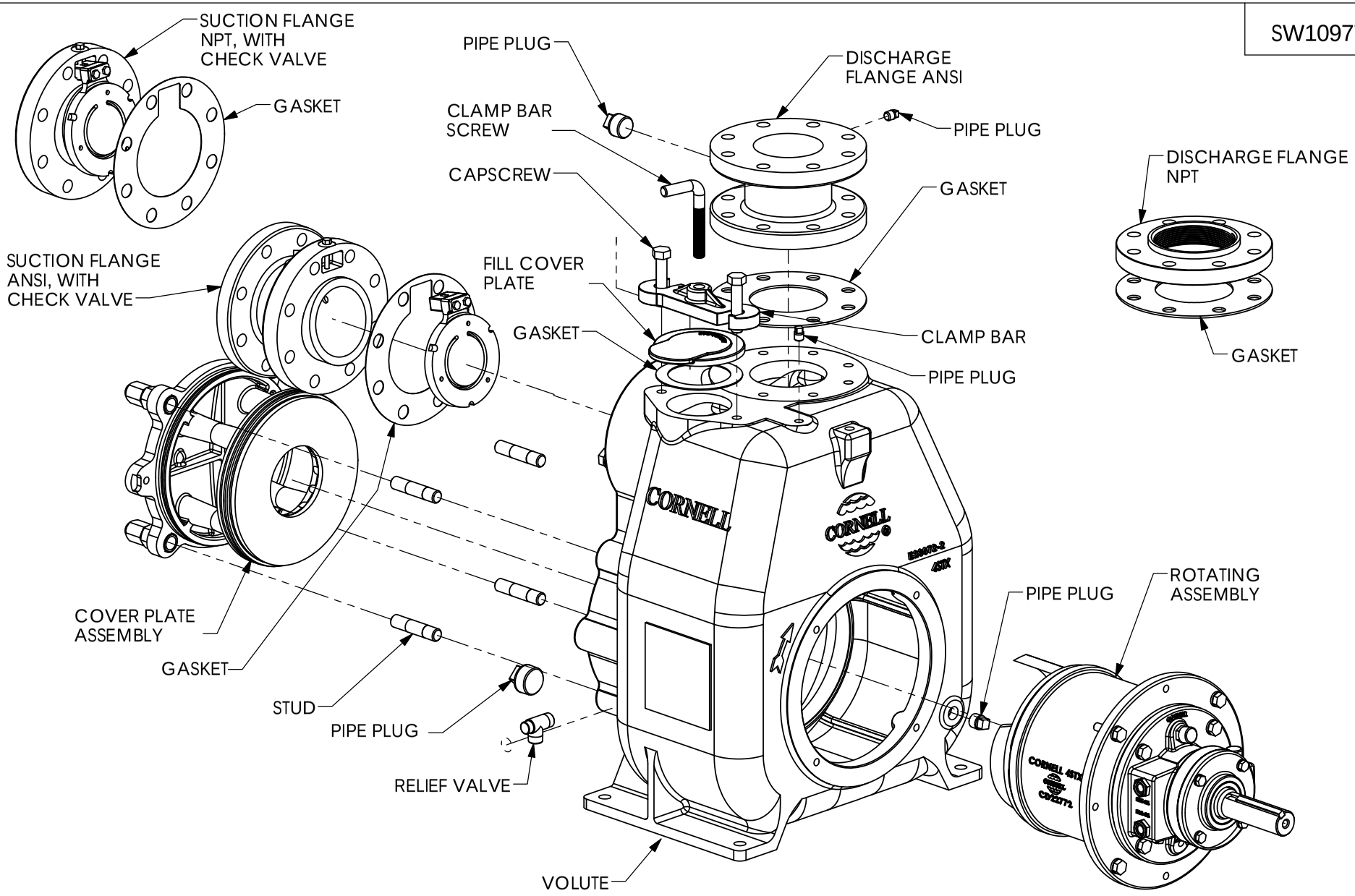
REV. NO.	DESCRIPTION	DATE	BY
	SELF PRIMER ASSEMBLY INSTRUCTIONS	WORK INSTRUCTION:	ASWI-36
		DWG. NO.	REV. NO.
DR. PPC	CHECKED A.E. / DATE 3/26/13 / SCALE TO SCALE	SW10977-S	06
	CORNELL PUMP COMPANY PORTLAND, OREGON	Sheet 1 OF 10	

SW10977-S



NOTES:
1. NUTS AND BOLTS NOT SHOWN.

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REV. NO.	DESCRIPTION	DATE	BY

SELF PRIMER ASSEMBLY INSTRUCTIONS

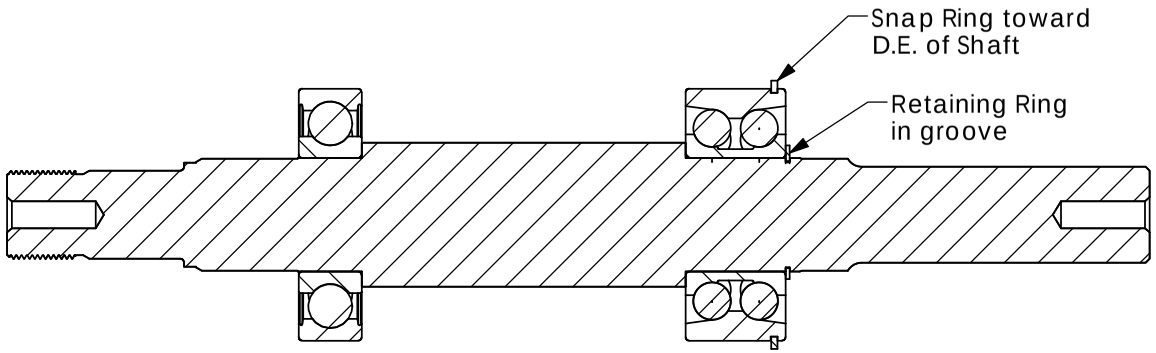
WORK INSTRUCTION: ASWI-36

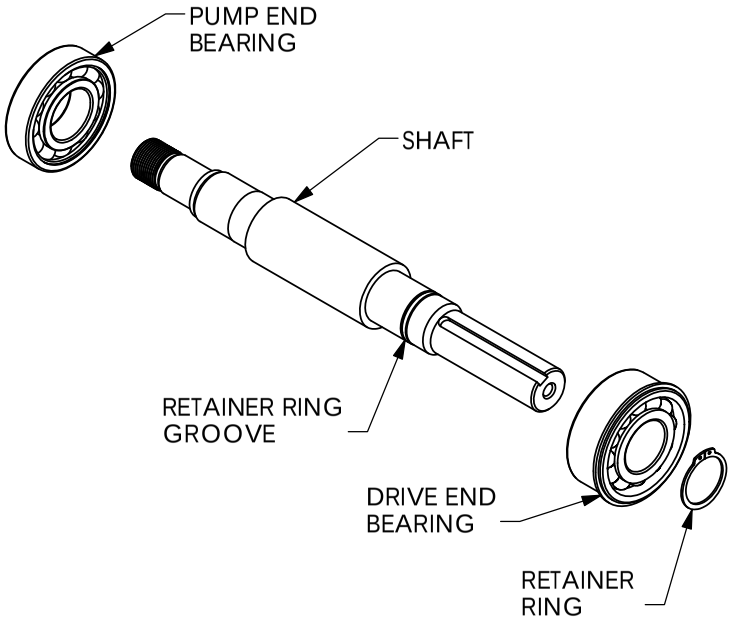
DR.	CHECKED	DATE	SCALE
PPC	A.E.	3/26/13	TO SCALE

DWG. NO. SW10977-S | REV. NO. 06

CORNELL PUMP COMPANY PORTLAND, OREGON

Sheet 2 OF 10





1. Heat the (pump end) bearing to 213 deg. F. (maximum) on an induction bearing heater using a Tempilstik to check the bearing temperature.

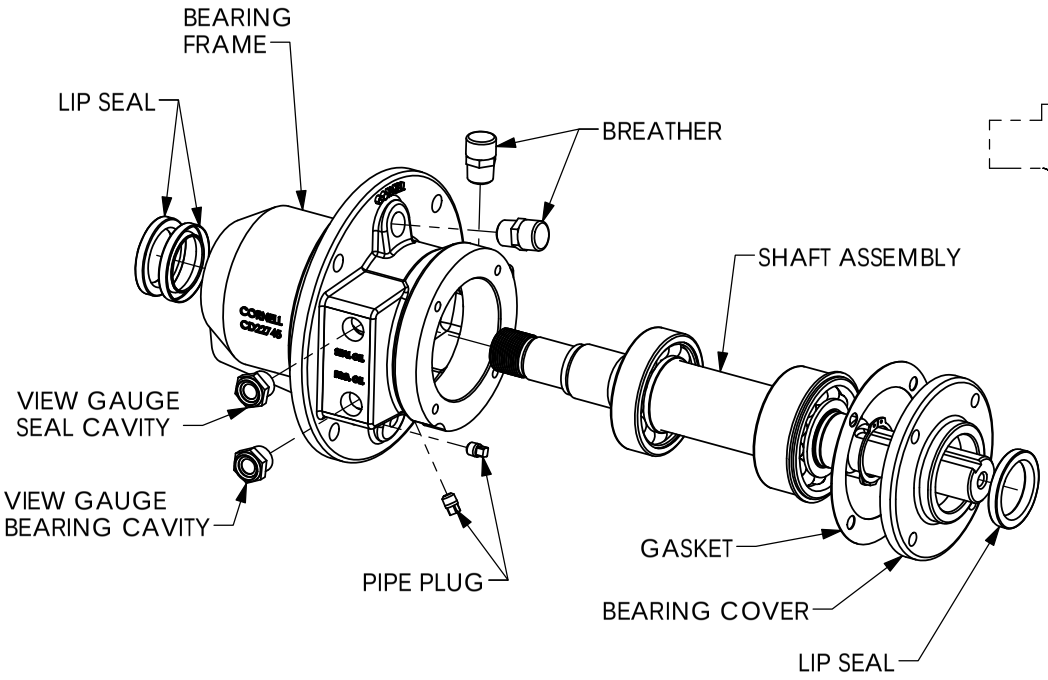
2. Slide the heated bearing onto the pump shaft making sure the bearing is seated against the shaft shoulder.

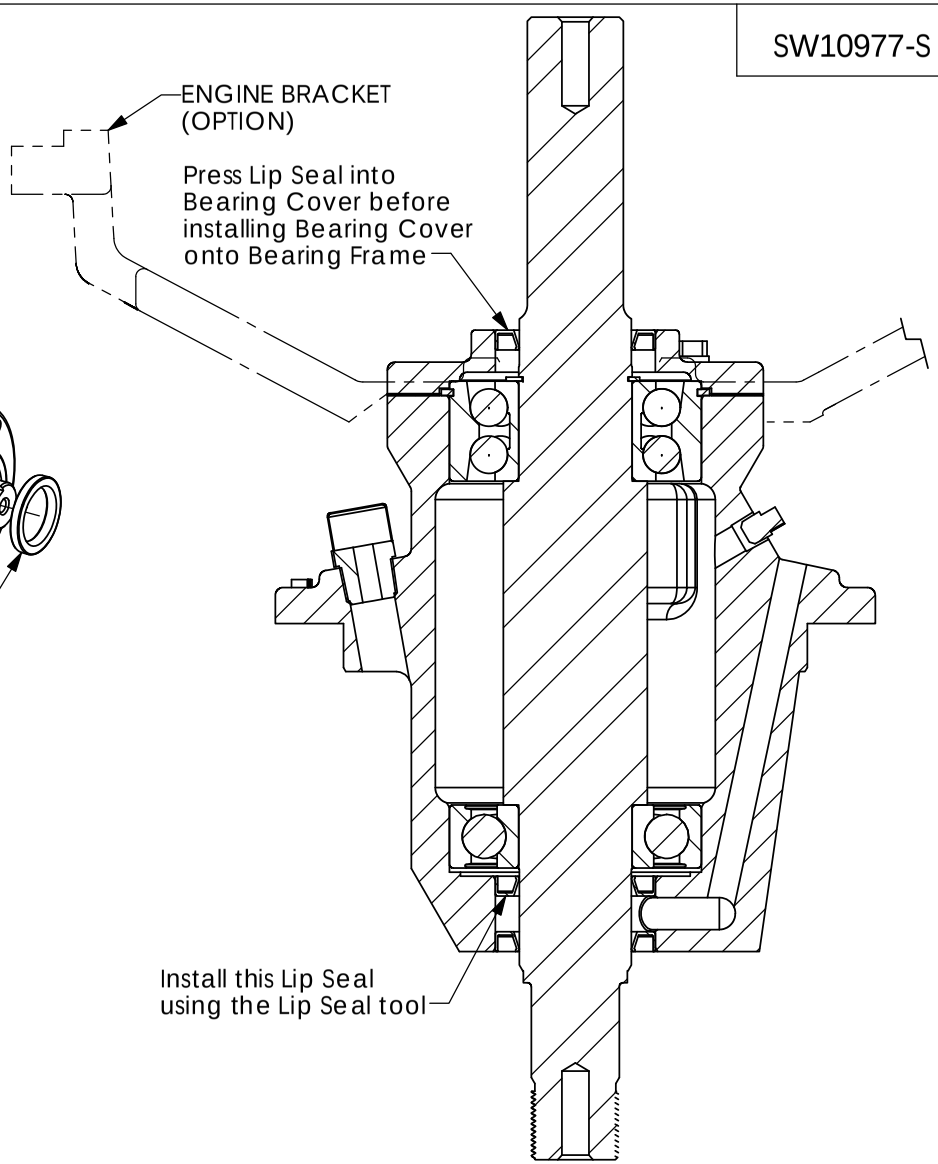
3. Heat the (drive end) bearing to 213 deg. F. (maximum) on an induction bearing heater using a Tempilstik to check the bearing temperature.

4. Slide the heated bearing onto the pump shaft making sure the bearing is seated against the shaft shoulder.

5. Snap the retaining ring into the retaining groove in the shaft as shown.

SW10977-S





1.) Rotate bearing frame upon it's end. Place bearing frame directly over an opening larger than the shaft diameter.

2.) Install Lip Seal in D.E. Bearing Cover (or Engine Bracket). Install the Shaft/Bearing Assembly into the Bearing Frame. Install gasket and bearing cover onto bearing frame. Note: No shimming is requried for bearings. Bearing endplay 0 - .010"

3.) Install the lip seals in the pump end of the frame using lip seal install tool. Lipseal orientation indicated in cross section. Install pump end Lip Seals into frame after shaft bearing assembly.

Note: Lip seals are to be installed in the covers with a thin film of Aviation Sealant to the O.D. of the seal. Lipseals to be installed with springs.

4.) All breathers, plugs and view gauges to be installed as shown on drawing.

NOTES:
1. NUTS AND BOLTS NOT SHOWN.

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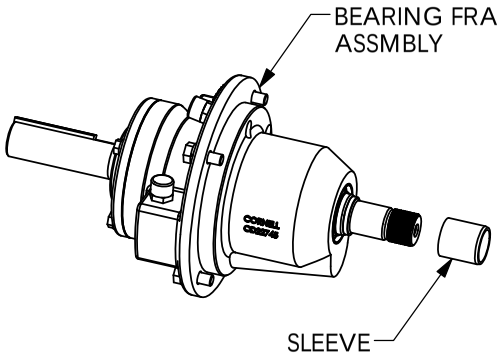
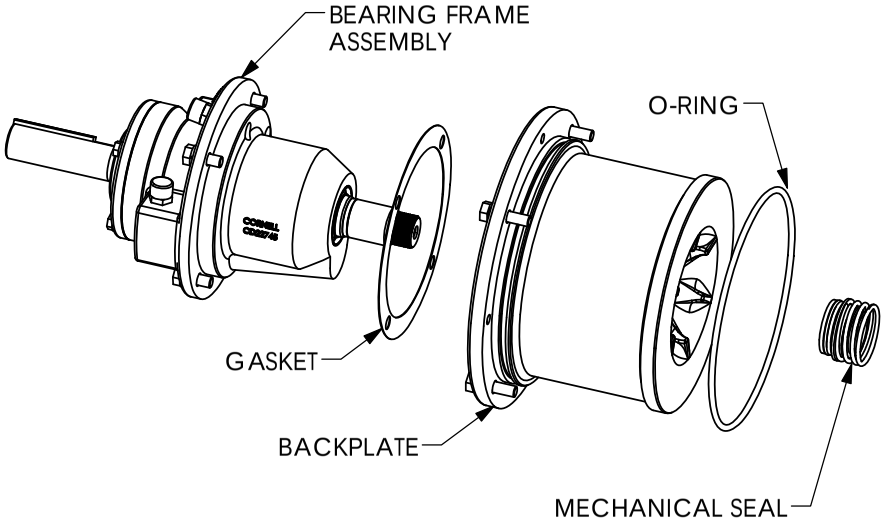
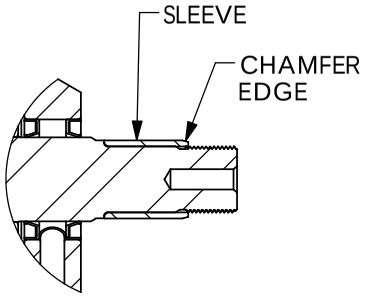
REV. NO.	DESCRIPTION	DATE	BY
	BEARING FRAME ASSEMBLY	WORK INSTRUCTION:	ASWI-36
		DWG. NO. SW10977-S	REV. NO. 06

DR.	CHECKED	DATE	SCALE
PPC	A.E.	3/26/13	TO SCALE

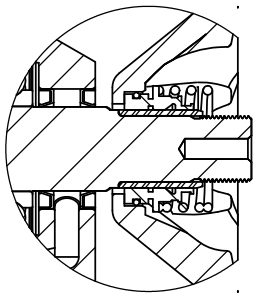
CORNELL PUMP COMPANY PORTLAND, OREGON







SLEEVE DETAIL



Sleeve Installation: Make sure the shaft has no burrs. Remove if necessary. Heat new sleeve to about 400° F for about 10 minutes. Slide it on the shaft quickly until it bottoms on step on shaft.

Install mechanical seal per manufacturer installation guide.

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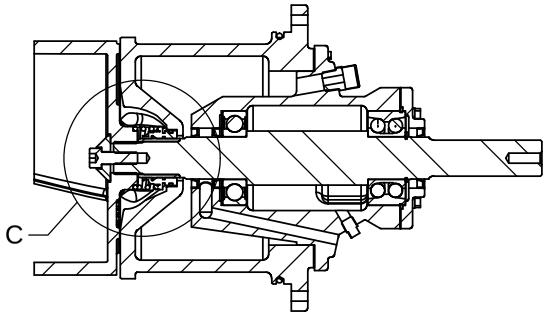
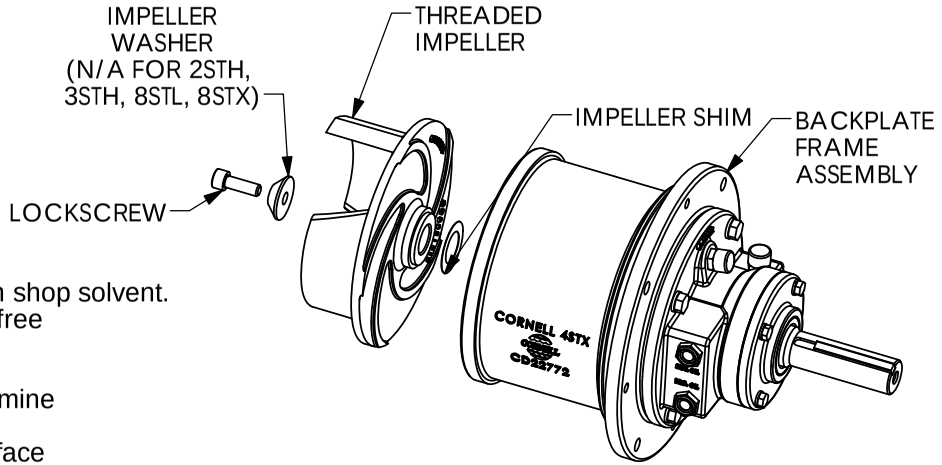
REV. NO.	DESCRIPTION	DATE	BY
	BACKPLATE ASSEMBLY	WORK INSTRUCTION:	ASWI-36
		DWG. NO.	REV. NO.
DR. PPC	CHECKED A.E. / DATE 3/26/13 / SCALE TO SCALE	SW10977-S	06
	CORNELL PUMP COMPANY PORTLAND, OREGON	Sheet 5 of 10	





1. Before attempting to install a threaded impeller, wash the impeller threads with shop solvent. Be sure the threads in the impeller and on the shaft are completely clean and free of all burrs or other debris.

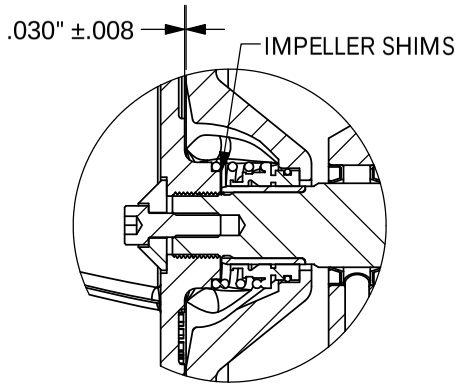
2. Before installing the impeller several measurements need to be taken to determine if any shims are needed to achieve the proper backvane clearance. Using an adjustable square, measure the distance from the end of the sleeve to the surface of the backplate. Compare this dimension with a measurement taken from the impeller hub to the backvane surface to determine how many shims are needed to achieve the proper backvane clearance.

3. Rotate the shaft by hand to install the Impeller paying close attention not to cross thread. Support the Impeller if necessary. Be certain that the drive end or back side of the Impeller is perpendicular and lined up to the shaft threads.

4. When the Impeller bottoms on the sleeve, the backvane clearance should be checked with feeler gauges to obtain .022" - .038" backvane clearance. Adjust Impeller Shims if necessary. Once backvane clearance is within specification, a shaft wrench can be used to tighten shaft into impeller.

5. The shaft wrench is designed to be used on the drive end of the frame shaft. Tighten the Impeller by rotating the shaft counter-clockwise and then back clockwise rapidly until the wrench hits the workbench or other solid surface. This should be done 2-3 times to be sure the Impeller is seated against the sleeve. Do not over tighten the Impeller.

6. After the Impeller is installed, be sure to install the lockscrew (with impeller washer) with a permanent thread locker, such as Loctite ®262 or equivalent. Tighten to the torque listed below in the chart.



DETAIL C
SCALE 1 : 4

Impeller Lockscrew Torque	
.50-13UNC	40 ft-lb 3STX - 2STH - 4STX
.62-11UNC	90 ft-lb 3STH, 4STH, 6STX, 8STL, 8STX

NOTES:
1. NUTS AND BOLTS NOT SHOWN.

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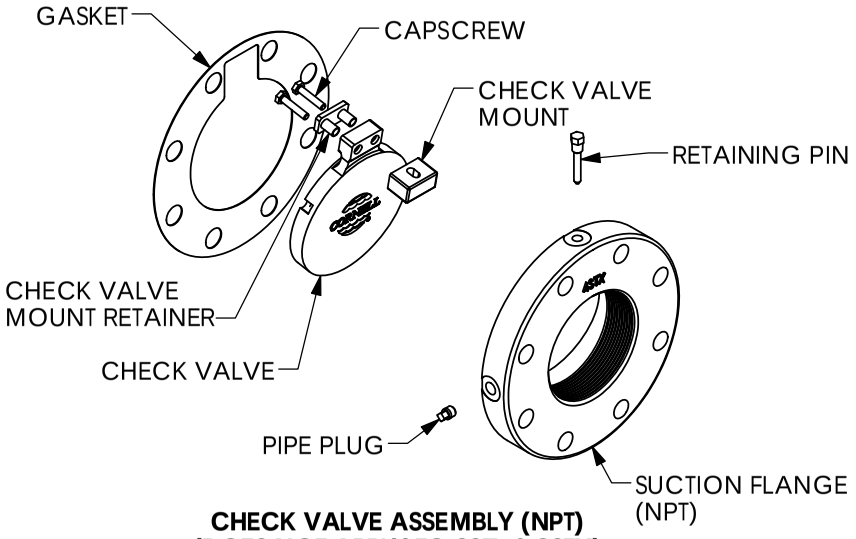
REV. NO.	DESCRIPTION	DATE	BY

ROTATING ASSEMBLY

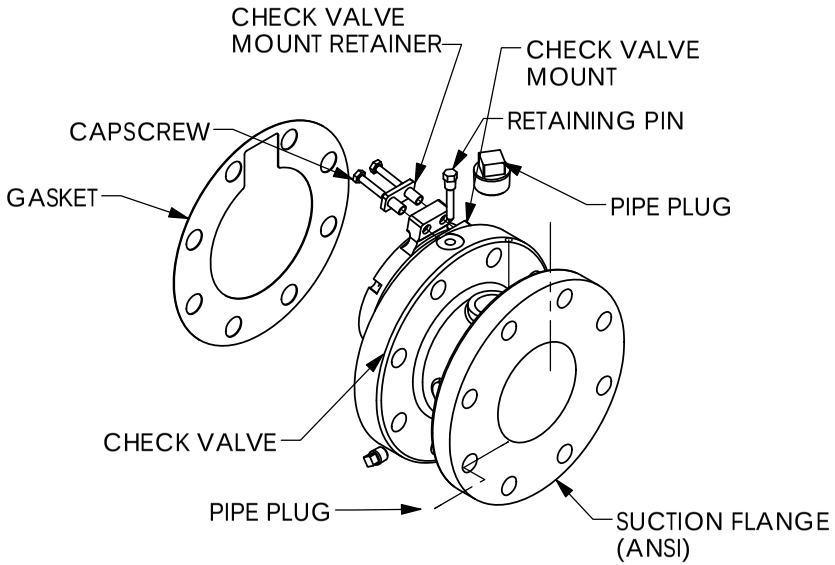
DR.	CHECKED	DATE	SCALE
PPC	A.E.	3/26/13	TO SCALE

WORK INSTRUCTION: ASWI-36
DWG. NO. SW10977-S
REV. NO. 06

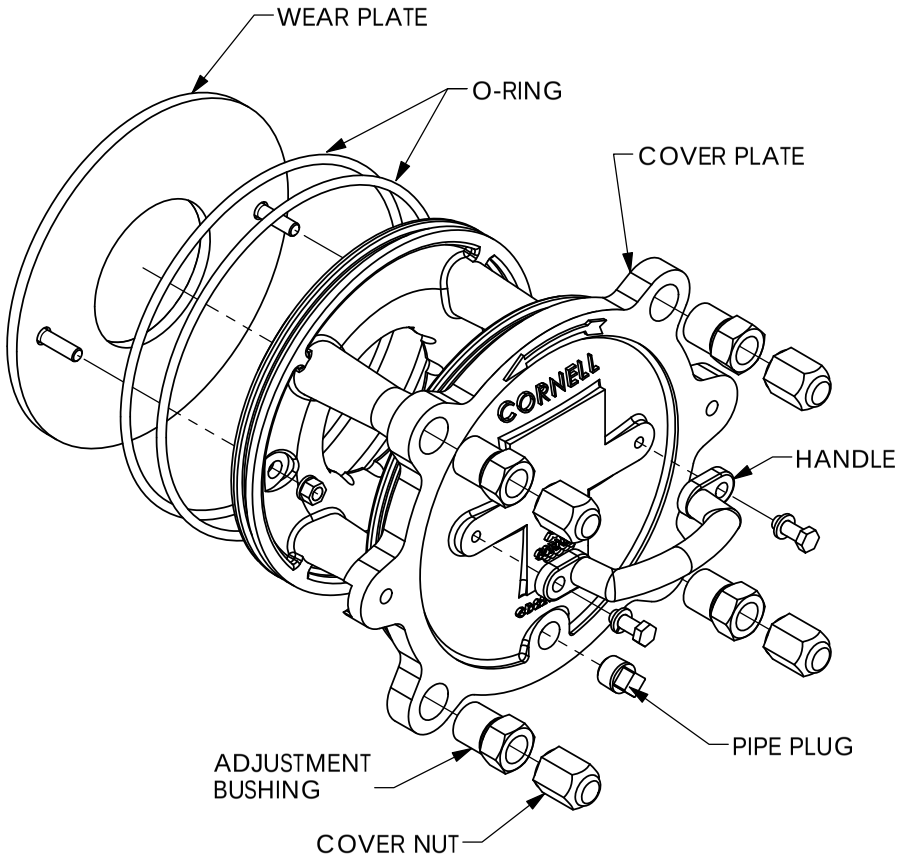
CORNELL PUMP COMPANY PORTLAND, OREGON



CHECK VALVE ASSEMBLY (NPT)
(DOES NOT APPLY TO 8STL & 8STX)



CHECK VALVE ASSEMBLY (ANSI FLANGE)



COVER PLATE ASSEMBLY

NOTES:
1. NUTS AND BOLTS NOT SHOWN.

CORNELL ®

REV. NO.	DESCRIPTION	DATE	BY

CHECK VALVE & COVER PLATE ASSEMBLIES

DR.	CHECKED	DATE	SCALE
PPC	A.E.	3/26/13	TO SCALE

WORK INSTRUCTION: ASWI-36

DWG. NO. SW10977-S | REV. NO. 06

CORNELL PUMP COMPANY PORTLAND, OREGON

Impeller positioning with respect to wear plate.

In all models, the distance between the tip of the Impeller blades and surface of Wear Plate must be between .020" - .028.

To achieve this value, you need to move Wear Plate away from the Impeller by turning the Adjustment Bushings, once you have calcuated "C" as described below.

C = (B-A+R)

A = Distance between Impeller Blades and machined surface of the casing.

B = Distance between Wear Plate and machined surface of the Cover Plate.

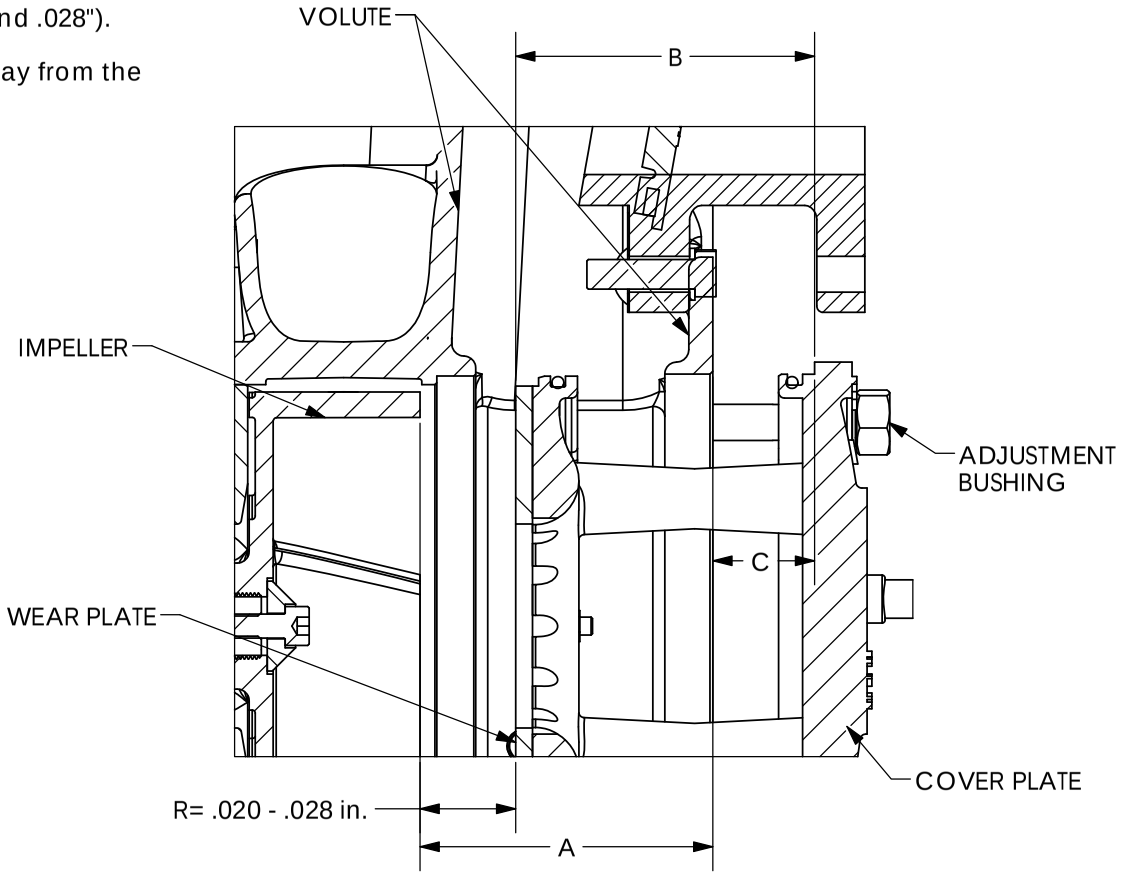
R = Distance between Impeller Blades and Wear Plate (.020" and .028").

*Tightening the Adjustment Bushings to move the cover away from the Casing.

*Be sure all 4 Adjustment Bushings are adjusted evenly.

*After adjusting, be sure Shaft and Impeller rotate freely.

Note: Turning Adjustment Bushing 1 flat (1/6 turn) equals .015" of axial distance.



CORNELL ®

REV. NO.	DESCRIPTION	DATE	BY

IMPELLER POSITION TO WEAR PLATE

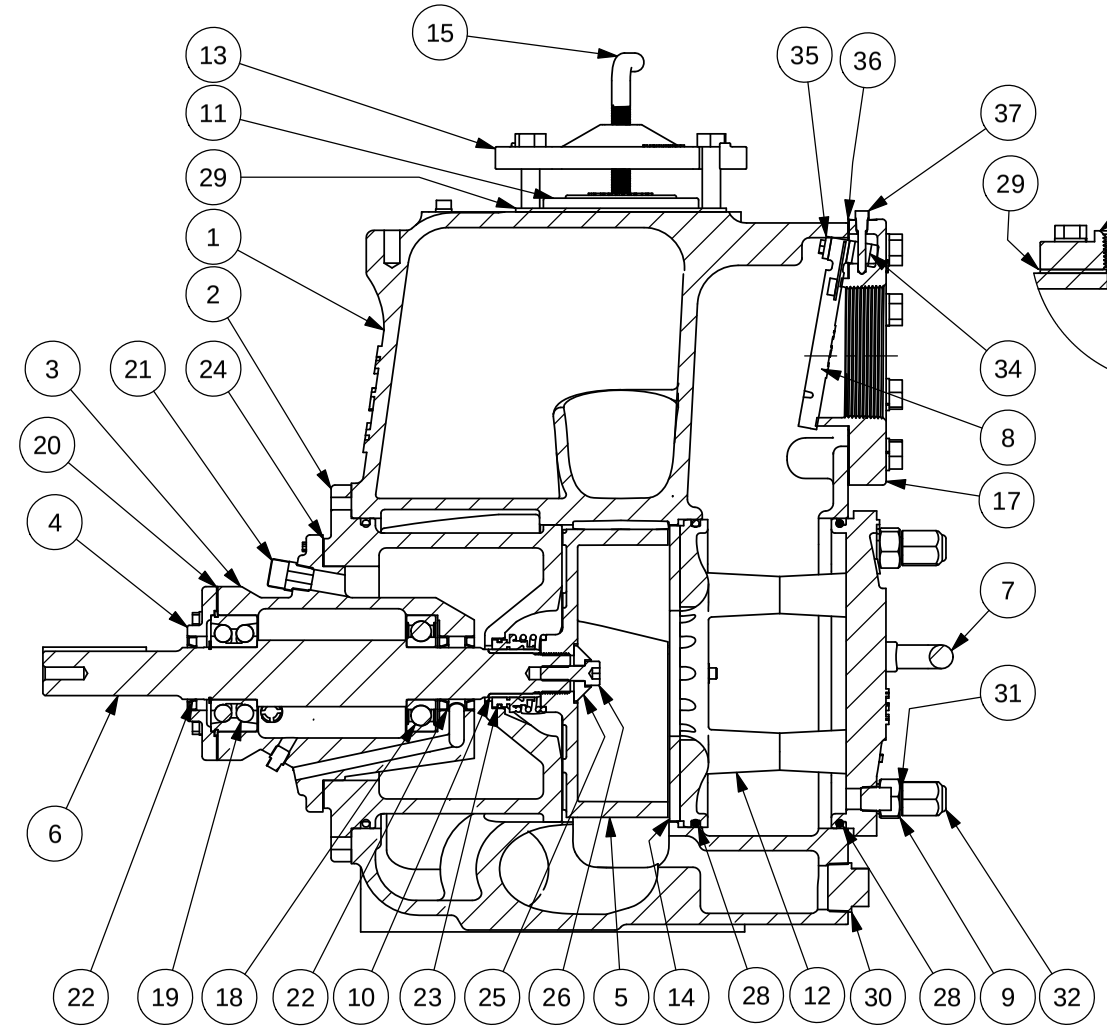
DR.	CHECKED	DATE	SCALE
PPC	A.E.	3/26/13	TO SCALE

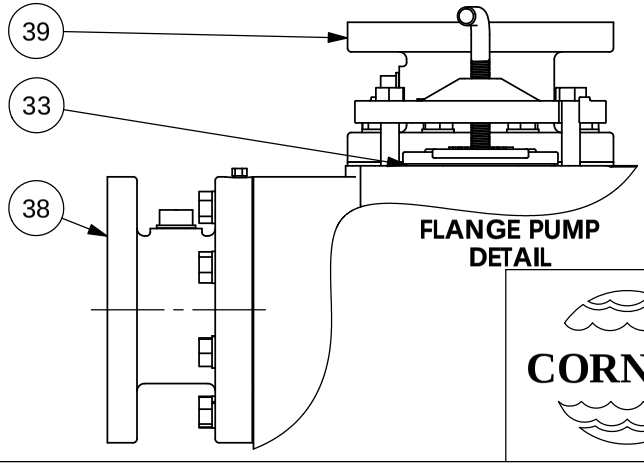
WORK INSTRUCTION: ASWI-36

DWG. NO. SW10977-S | REV. NO. 06

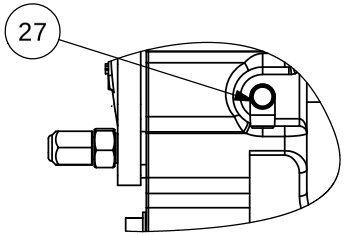
CORNELL PUMP COMPANY PORTLAND, OREGON

SW10977-S





FLANGE PUMP DETAIL



ITEM	QTY.	DESCRIPTION
1	1	VOLUTE
2	1	BACKPLATE/BRACKET
3	1	BEARING FRAME
4	1	BEARING COVER
5	1	IMPELLER (MACHINE)
6	1	SHAFT
7	1	HANDLE, COVER PLATE
8	1	CHECK VALVE (SUCTION)
9	4	ADJUSTMENT BUSH. COVER PL.
10	1	SLEEVE
11	1	FILL COVER PLATE
12	1	COVER PLATE
13	1	CLAMP BAR
14	1	WEAR PLATE
15	1	CLAMP BAR SCREW
16	1	DISCHARGE FLANGE NPT
17	1	SUCTION FLANGE (NPT)
18	1	P.E. BEARING
19	1	D.E. BEARING (DOUBLE)
20	1	BEARING COVER GASKET
21	2	BREATHER
22	3	LIP SEAL VANSEAL 1.75 X 2.50 X .313
23	1	SEAL, TYPE 2 SINGLE - KINESEAL KL2-1.625"
24	1	D.E. GASKET
25	1	IMPELLER WASHER
26	1	LOCKSCREW
27	1	RELIEF VALVE
28	3	O-RING, 1/4" THICK
29	1	GASKET 4" FULL FACE 1/8" THK
30	7	PIPE PLUG, .25 NPT
31	4	STUD, 3/4X 3-1/2"
32	4	NUT, COVER PLATE
33	1	GASKET, FILL COVER
34	1	CHECK VALVE MOUNT
35	1	CHECK VALVE MT. RETAINER
36	1	GASKET, STX, SUCTION
37	1	RETAINING PIN
38	1	SUCTION FLANGE ANSI
39	1	DISCHARGE FLANGE ANSI

CORNELL ®

REV. NO.	DESCRIPTION	DATE	BY

SELF PRIMER PARTS PAGE (CROSS SECTION)

WORK INSTRUCTION: ASWI-36

DR.	CHECKED	DATE	SCALE	DWG. NO.	REV. NO.
PPC	A.E.	3/26/13	TO SCALE	SW10977-S	06

CORNELL PUMP COMPANY PORTLAND, OREGON

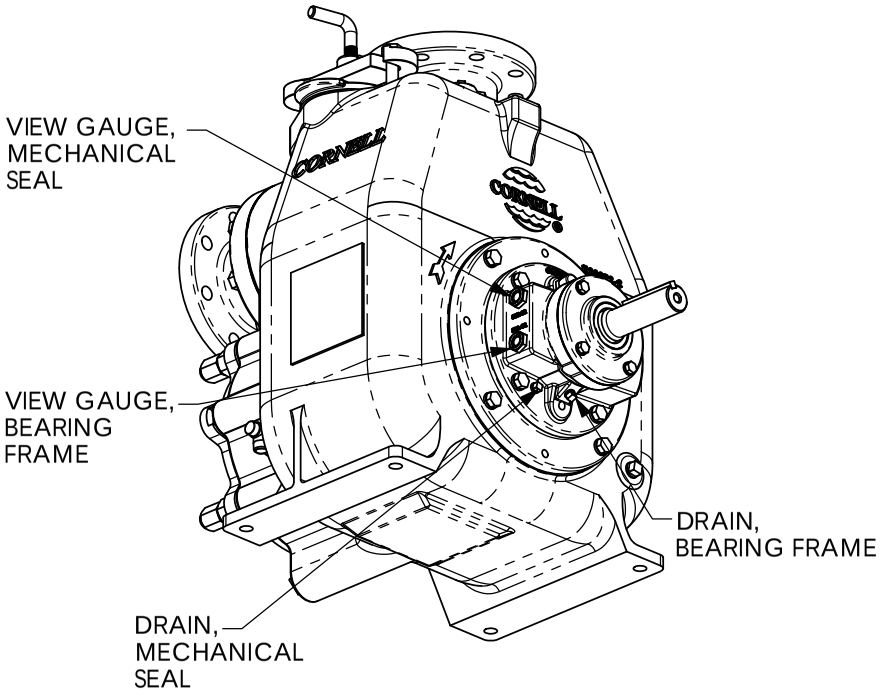
SW10977-S

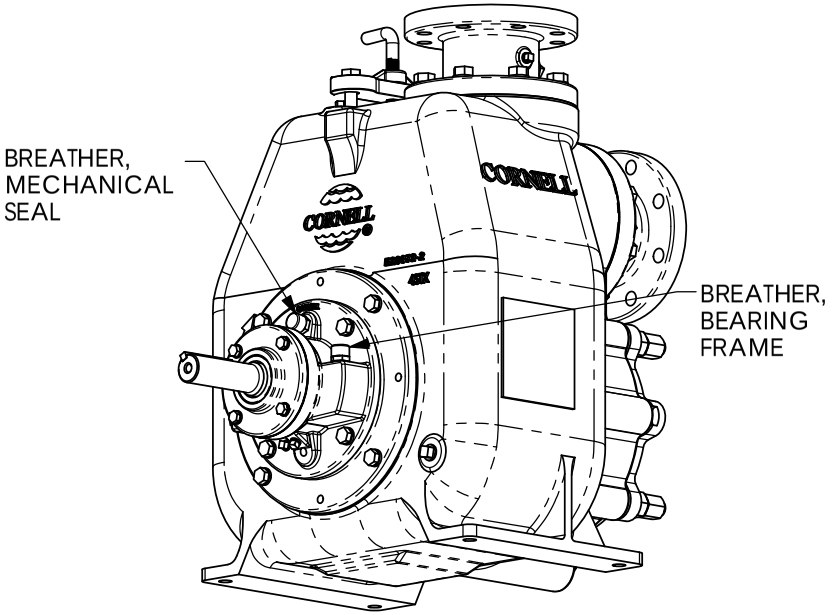
Filling Oil

1. Filling the Oil in the Bearing Frame and Mechanical Seal housing is the final step in finishing this pump.
2. Remove the Air Breather in the Bearing Frame and add oil until hallway up the sightglass (View Gauge).
3. Remove the Air Breather in the Mechanical Seal and add oil until hallway up the sightglass (View Gauge).
4. Rotating assembly only (lessVolute) pumps to be shipped with pipe plugs in place of breathers.

MODEL	MECHANICAL SEAL	BEARING FRAME
2STH 3STX	60 oz	16 oz
4STX	84 oz	16 oz
3STH 4STH 6STX 8STL	144 oz	48 oz
8STX	160 oz	64 oz

Mechanical Seal = ISO VG32 or VG15 Turbine Oil or SAE 10w-30
Bearing Frame = ISO VG32 Turbine Oil (Up to 150° F) (Stanard)
ISO VG68 Turbine Oil (Over 150° F) (Special case)





CORNELL ®

REV. NO.	DESCRIPTION	DATE	BY
	SELF PRIMER PARTS PAGE (FILLING OIL)	WORK INSTRUCTION:	ASWI-36
		DWG. NO.	REV. NO.
DR. PPC	CHECKED A.E. DATE 3/26/13 SCALE TO SCALE	SW10977-S	06
	CORNELL PUMP COMPANY PORTLAND, OREGON	Sheet 10 OF 10	

CAUTION **CAUTION** **CAUTION**

GASOLINE IS INVOLVED AND VAPORS WILL SETTLE IN LOW AREAS. WORK IN A WELL VENTILATED SPACE AWAY FROM SPARKS OR OPEN FLAME SUCH AS A PILOT LIGHT. HAVE A CLASS 'B' FIRE EXTINGUISHER CLOSE BY.

TO ELIMINATE THE CHANCE OF FIRE OR PERSONAL INJURY, THE FUEL SYSTEM PRESSURE MUST BE RELIEVED BEFORE SERVICING ANY FUEL SYSTEM COMPONENT.

INSTALLATION INSTRUCTIONS FOR UNIVERSAL ELECTRIC FUEL PUMP

NOTE:

-Before replacing any electric fuel pump diagnose the cause of failure.
-Dirt is the major cause of pump failure, so the tank must be cleaned out or dirt may cause the replacement pump to fail as well.
-Exercise care so that no dirt falls into the tank during disassembly or reassembly.

-For safety reasons, it is recommended an Oil Pressure Safety Switch be installed. This will prevent engine damage and reduce the chance of fire in the case that the engine stops without the ignition switch in the "off" position.

-Installation of the replacement pump may require some of the mounting or electrical components be reused. Do not discard any parts.
-To prevent fuel pump failure, installation of a high quality fuel filter on the inlet side of the pump, is required.

A. FUEL PUMP INSTALLATION

1. Disconnect the negative battery cable.

2. Mount the fuel pump close to the existing fuel lines and tank, but away from any exhaust system component. Place the pump and bracket assembly as near to the bottom of the fuel tank as possible, but never more than 24 inches above the top of the tank.

3. Remove a section of fuel line where the pump is to be mounted. (A tube cutter is recommended when cutting fuel lines. Flush the fuel line to prevent metal chips from entering the fuel system.)

4. If pump has rubber hose fittings proceed to next step. If using a pump with threaded inlet/outlet fittings, assemble the (supplied) fuel fittings to the fuel pump (See Fig. A). (This pump is equipped with dry-seal fuel fittings. Do not use Teflon tape or pipe sealant on pipe fittings, or pump breakage will occur.)

5. Install mounting bracket onto vehicle's chassis/frame with self-tapping screw(s).

6. Install the fuel pump on the mounting bracket with the outlet towards the engine. Place ground (-) wire from pump under mounting screw or bolt.

7. Connect the fuel lines to the fuel pump, using supplied rubber fuel line and clamps provided. (To prevent fuel pump failure, installation of a high quality fuel filter on the inlet side of the pump, is required.) (See Fig. A.)

8. Using #14 or larger (lower gauge #) gauge wire, follow the wiring diagram (See Fig. A & B) and connect the pump to the vehicle's electrical system. If the vehicle has a pre-existing oil pressure safety switch which operates either a warning light or gauge, it is recommended that a T-adapter be installed into the engine block and both the O.E. and the Oil Pressure Safety Switch be used (See Fig. C). A 10-amp fuse should be installed between the pressure safety switch and the electric pump. (Route wires away from heat and road hazards, and anchor securely to prevent vibration and chafing. Full battery voltage must be available to the pump when the ignition switch is "on". Pump ground must be the same as the battery ground.)

9. If this pump is being used to replace a defective in tank pump, and it is not going to be removed, make sure the defective pump does not restrict the fuel supply.

10. If this pump is being used to replace a defective mechanical pump, the fuel lines should bypass the mechanical pump. Fuel pushed through a defective mechanical pump can cause severe engine damage. If mechanical pump is not removed from the engine, the mechanical pump inlet should be plugged.

WARNING **WARNING** **WARNING**

NOT FOR USE IN AIRCRAFT OR OTHER NON-AUTOMOTIVE USE. THE USE OF A PUMP FOR OTHER THAN THE APPLICATIONS LISTED WILL VOID THE WARRANTY AND COULD DO SEVERE ENGINE DAMAGE.

Fig. A

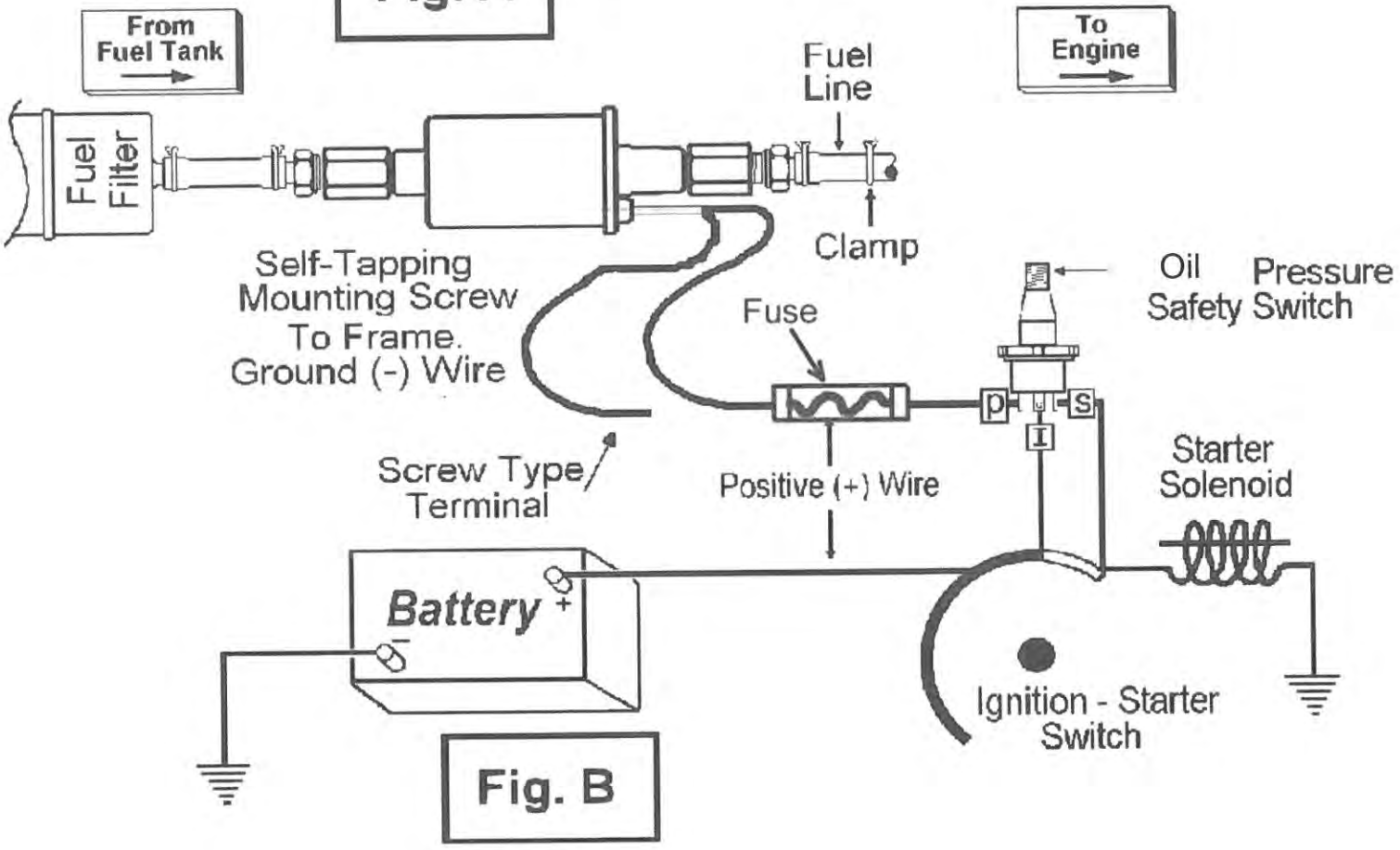
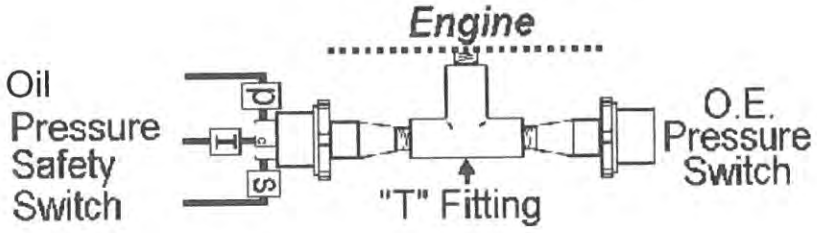

From Fuel Tank
To Engine
Fuel Line
Fuel Filter
Clamp
Self-Tapping Mounting Screw To Frame. Ground (-) Wire
Fuse
Oil Pressure Safety Switch
p
s
I
Screw Type Terminal
Positive (+) Wire
Starter Solenoid
Battery
+
-
Ignition - Starter Switch

Fig. B


Engine
Oil Pressure Safety Switch
p
I
s
"T" Fitting
O.E. Pressure Switch

600 Series

Spin-on Fuel Filter/Water Separators

Instruction Part Number 22249 Rev B

600 Series fuel filter/water separators are specifically designed to handle today's tough fuel filtration problems and can handle flow rates up to 120 GPH (454 LPH), depending on the model used.

Filter replacement intervals depend on fuel type, fuel quality, the application, and operating conditions. All filters eventually clog with contaminants; tracking a fuel filter's restriction saves money and avoids problems.

Model 690R1230 shown.

Contact Information:

Parker Hannifin Corporation
Racor Division
P.O. Box 3208
3400 Finch Road
Modesto, CA 95353

phone 800 344 3286
209 521 7860
fax 209 529 3278
racor@parker.com

www.parker.com/racor

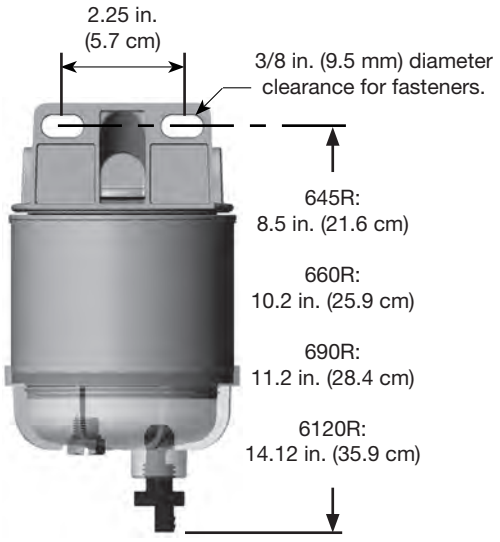
Product Features:

- **Proprietary, high-capacity, water-repelling Aquabloc® filters available in 2, 10, and 30 micron**
- **7-port die-cast aluminum head (four inlets, three outlets) and a unitized mounting bracket for installation convenience**
- **Reusable contaminant collection bowl with self-venting drain**
- **Optional 12 or 24 volt DC, 200 watt, in-bowl fuel heater, water detection kit -** *Danger! Not for use with gasoline applications.*
- **Optional water detection probes/kits also available**

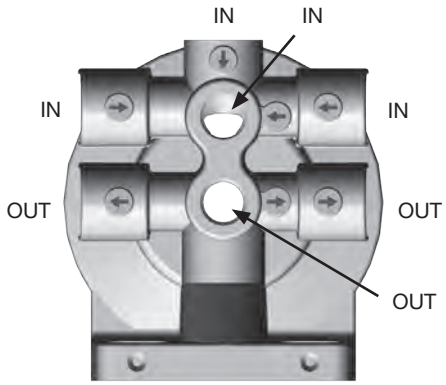
Parker | Racor

ENGINEERING YOUR SUCCESS.

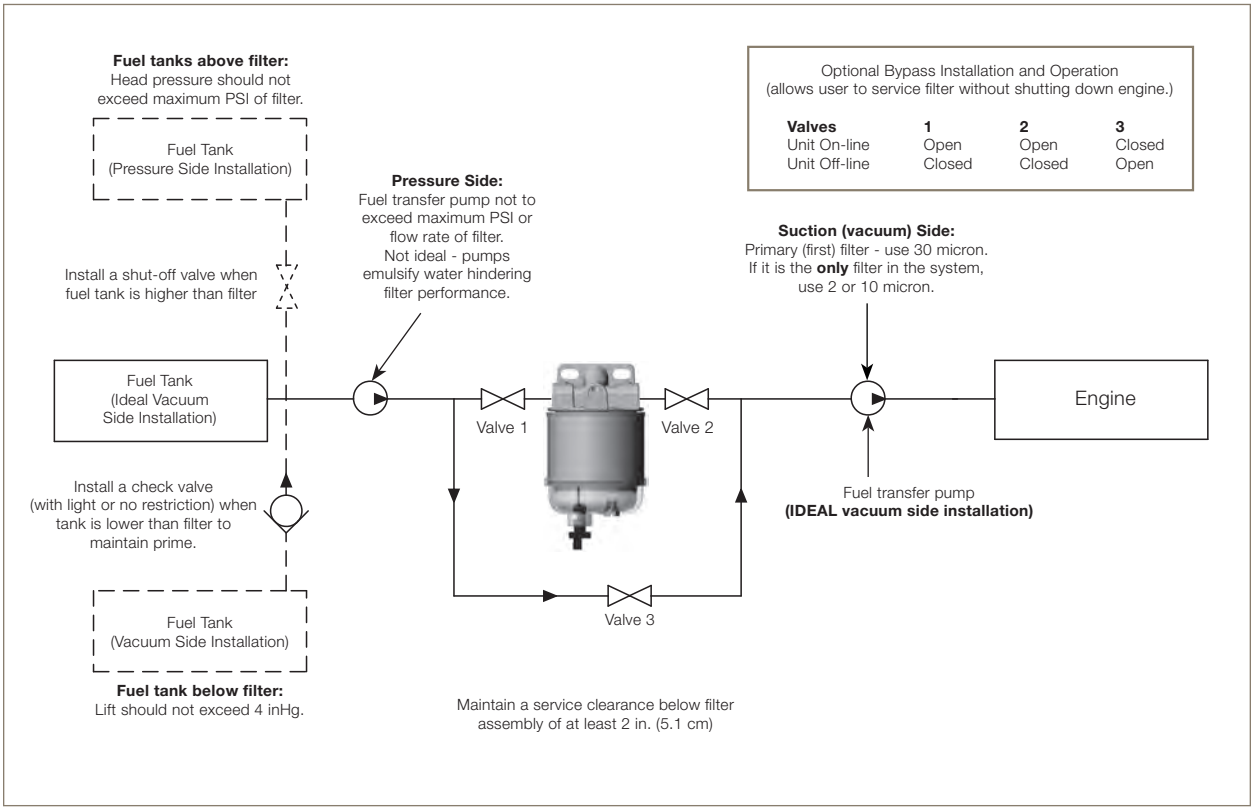
Mounting



Note: When installing mounting bolts (mounting head to frame/engine), limit impact wrench to 30 ft-lbs.



Installation Diagram



Installation Guidelines

READ ALL INSTRUCTIONS FIRST BEFORE BEGINNING INSTALLATION.

For new installations, refer to Mounting and Installation Diagram on previous page and install as follows:

1. Engine should be off and cool to touch. Ignition switch should be in the OFF position.
2. Apply thread sealant to NPT fittings (do not use thread tapes as particles may break off and contribute to clogging filter).
3. Thread fittings into appropriate fuel ports and tighten snugly. Plug unused ports (if any) with port plugs and tighten snugly.

   Important Note: Do not use impact wrenches when installing fittings into the mounting head.

4. Mount filter vertically in a protected area and away from heat sources. Maintain at least 2.0˝ (5.1 cm) of clearance below filter for draining water and servicing filter.
5. Attach fuel lines to filter (3/8˝ or larger is recommended). Avoid tight bends and rubbing areas when routing hoses.
6. Follow “Priming” instructions on this page.
7. Connect water probe and heater wires (if equipped).
8. Verify all other connections are tight and secure.
9. Start engine, inspect installation and correct any leaks with the engine off.

Service

Filter replacement frequency is determined by contamination level in fuels. Fuel flow to engine becomes restricted as filter gradually plugs with contaminants, resulting in noticeable power loss and/or hard starting. As a guideline, change filter every 500 hours, 10,000 miles, every other oil change, annually, or at first indication of power loss, whichever occurs first. Always carry extra replacement filters as one tankful of excessively dirty fuel can quickly plug a filter.

1. Engine should be off and cool to touch. Ignition switch should be in the OFF position.
2. Close all fuel valves, if applicable, to make sure excess fuel does not spill during servicing.
3. Disconnect water probe and heater connectors, if equipped.
4. Drain unit of fuel by opening the drain at the bottom of the filter bowl.
5. Remove bowl and filter. Dispose of filter properly. Bowl is reusable.
6. Lubricate new filter seals with motor oil or clean fuel and install only on new filter.
7. Re-install bowl onto new filter and tighten snugly with Racor bowl wrench (part number RK 22628).
8. To prime, fill filter (with bowl attached) with clean fuel.
9. Spin filter/bowl back onto mounting head. Tighten snugly with Racor bowl wrench (part number RK 22628).
10. Connect water probe and heater connectors, if equipped.
11. Open all fuel valves, if applicable.
12. Verify all other connections are tight and secure.
13. Start engine, inspect installation and correct any leaks with the engine off.

Draining the Collection Bowl

Water is heavier than fuel and will settle to bottom of bowl and appear different in color. In high humidity environments, check bowl frequently (daily if a poor fuel source is suspected). 600 Series bowls are equipped with a water sensor port that will accept a water probe (sold separately) and will alert operator of a high water condition in the filter.

1. Engine should be off and cool to touch. Ignition switch should be in the OFF position.
2. Drain water from filter by opening self-venting drain. Close as soon as all water has evacuated.

CAUTION! If drain is open too long, the entire filter may drain completely of water and fuel.

3. Follow Priming instructions below.

Priming

1. Always consult engine manufacturer’s priming instructions for priming the engine.
2. Remove filter and bowl from mounting head if not already off. Fill filter (with bowl attached) with clean fuel, lubricate filter gasket with motor oil or clean fuel and spin filter/bowl back onto mounting head. Tighten snugly with Racor bowl wrench (part number RK 22628).
3. Verify all other connections are tight.

Trouble Shooting

If filter fails to hold prime, first check drain valve, fittings, head, filter, and bowl are properly tightened. Next, check fuel line connections and verify they are free of pinches or unnecessary bends and check to see if fuel tank strainer (or pick-up tube) is clogged. If problems persist and filter is new, call Racor Technical Support at 800-344-3286, 8 AM to 5 PM, Pacific Time.

Installing the In-bowl Heater (if equipped)

CAUTION! Do not use electric heater in gasoline applications. Do not operate heater if no fuel is inside bowl. Ensure the filter is primed with fuel prior to applying power to the heater.

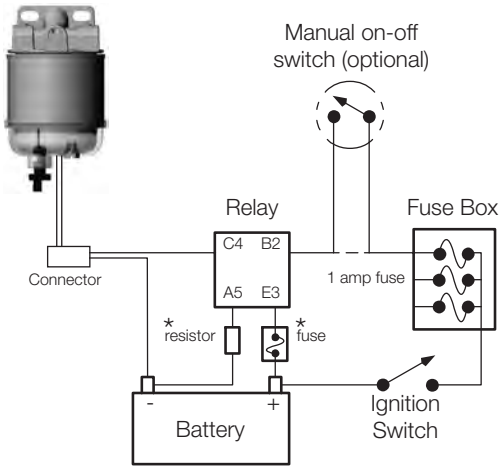
The in-bowl heater is a cold weather starting aid with an internal automatic thermostat that turns the heater on if fuel temperature drops below 45°F (7°C). Heat is supplied just below the filter to melt wax crystals and allow fuel to efficiently pass through. The heater will automatically turn off at about 75°F (24°C). The 200 watt heater is available in 12 or 24 vdc (volts, direct current). The heater is operated by turning on the ignition switch for a minimum of 5 minutes prior to starting the engine.

Customer Supplied Items

1. Because of the heater power demand, 20 amps for the 12 vdc and 10 amps for the 24 vdc, an additional relay is recommended for the safest method of installation. Racor offers two relay kits, available from your dealer, RK 11861 for the 12 vdc systems or RK 11862 for the 24 vdc systems. These kits include an in-line fuse holder (and fuse) and the RK 11862 kit also includes a resistor. Use the 25 amp fuse with the 12 vdc and the 15 amp fuse (and resistor) with the 24 vdc systems. See page 11 for more details.
2. Use an on-off toggle switch to control power to heater relay. This allows operator to cut power to heater relay in warmer climates.
3. All wires should be 14 AWG (American Wire Gauge), minimum.

Installation

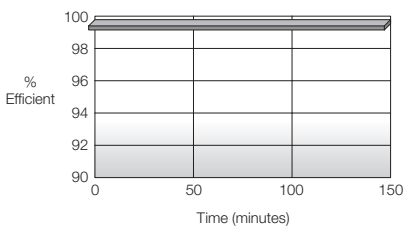
1. Either heater wire may be used for Hot (+) or Ground (-).
2. Wire/terminal connections should be soldered and crimped.
3. Run wires in protected locations. Avoid hot surfaces and places that could pinch or rub on the wires.



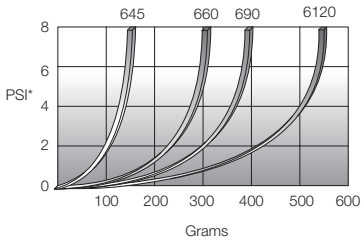
* Use 15 amp fuse and resistor with 24 vdc systems.

Performance Information

Test results are from controlled laboratory testing. Field results may vary.



SAE J1839 Water Separation



SAE J905 SOFTC-2A Contaminant Capacity, 10 micron Aquabloc® media

*PSI x 2.036 = inHg. (PSI x 6.895 = kPa)

Specifications

	645R	660R	690R	6120R
Max. Flow Rate	45 GPH (170 LPH)	60 GPH (227 LPH)	90 GPH (341 LPH)	120 GPH (454 LPH)
Fuel Port Size	3/8"-18 NPTF (SAE J476)	3/8"-18 NPTF (SAE J476)	3/8"-18 NPTF (SAE J476)	3/8"-18 NPTF (SAE J476)
Total Number of Ports: **(total inlets)** **(total outlets)**	7 4 3	7 4 3	7 4 3	7 4 3
Min. Service Clearance	2.0 in. (5.1 cm)	2.0 in. (5.1 cm)	2.0 in. (5.1 cm)	2.0 in. (5.1 cm)
Center Threads	1"-14	1"-14	1"-14	1"-14
Height	8.5 in. (21.6 cm)	10.2 in. (25.9 cm)	11.2 in. (28.4 cm)	14.1 in. (35.8 cm)
Width	4.5 in. (11.4 cm)	4.5 in. (11.4 cm)	4.5 in. (11.4 cm)	4.5 in. (11.4 cm)
Depth	4.5 in. (11.4 cm)	4.5 in. (11.4 cm)	4.5 in. (11.4 cm)	4.5 in. (11.4 cm)
Weight (dry)	2.4 lb (1.09 kg)	2.6 lb (1.18 kg)	2.7 lb (1.22 kg)	3.9 lb (1.8 kg)
Clean Pressure Drop	0.01 PSI (0.001 bar)	0.05 PSI (0.003 bar)	0.29 PSI (0.02 bar)	2.65 PSI (0.18 bar)
Max. Working Pressure[1]	30 PSI (2.07 bar)	30 PSI (2.07 bar)	30 PSI (2.07 bar)	15 PSI (1.03 bar)
Available Options:[2] **(water sensor)** **(heater)**[3]	 Yes Yes	 Yes Yes	 Yes Yes	 Yes Yes
Bowl Capacity **(water)** **(with heater)**	 4.0 oz. (118 ml) 3.5 oz. (104 ml)	 4.0 oz. (118 ml) 3.5 oz. (104 ml)	 4.0 oz. (118 ml) 3.5 oz. (104 ml)	 2.8 oz. (82 ml) 2.4 oz. (70 ml)
Water Removal Efficiency	99%			
Ambient Temp. Range	-40° to +255°F (-40° to +121°C)			
Max. Fuel Temp.	190°F (88°C)			

1 Pressure installations are applicable up to maximum PSI shown. Vacuum installations are recommended.
2 Do not use with gasoline applications.
3 Maximum power requirements for in-bowl heater option: 12 vdc (200 watt) = 16.6 amps, 24 vdc (200 watt) = 8.3 amps. See section on heater relay kits, if needed.

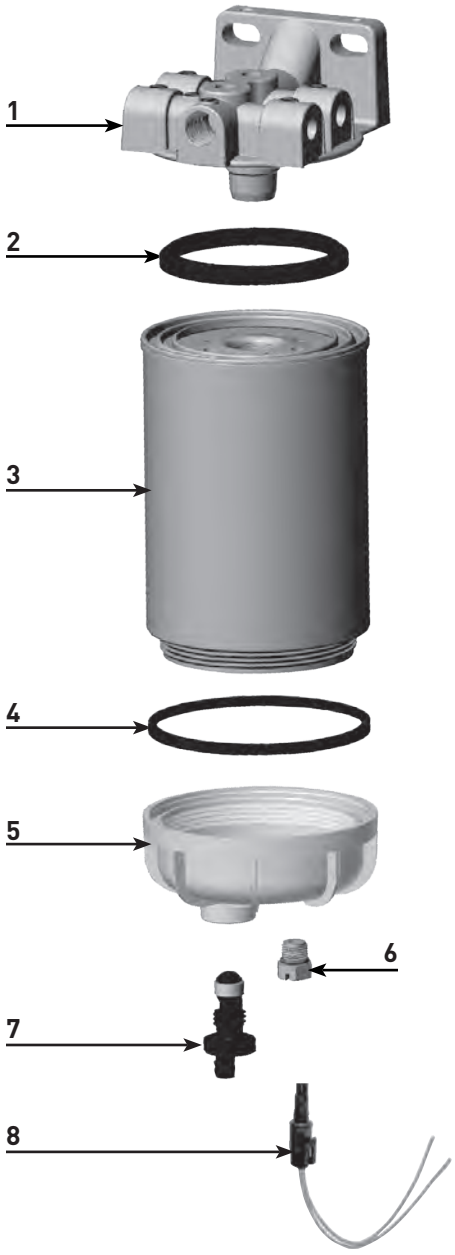
645R, 660R, and 690R Replacement Parts

Part Number	Description	
1. RK 22098	Mounting Head Kit (with 3/8”-18 NPTF fuel ports)	
2. RK22998	Filter Gasket Kit	
3. Replacement Filters		
645R	R45S or R47S	2 micron
	R45T	10 micron
	R45P	30 micron
660R	R60S	2 micron
	R60T	10 micron
	R60P	30 micron
690R	R90S	2 micron
	R90T	10 micron
	R90P	30 micron
4. RK 22333	Bowl Gasket Kit	
5. Replacement Bowl Kits		
RK 21113-13-11	Clear Bowl Kit	
RK 22616-01[1]	Heated Bowl Kit (Clear bowl with 12 vdc heater)	
RK 22616-02[1]	Heated Bowl Kit (Clear bowl with 24 vdc heater)	
6. RK 20126	Bowl Plug Kit (1/2”-20 SAE)	
7. RK 30476	Self-Venting Drain Kit	
8. RK 30964	Water Probe/Sensor Kit	

Additional Parts (not shown)

RK 22323[1]	Heater Connector Kit
01SP-6S	Metal Port Plug (3/8” NPTF)

[1] In-bowl heater may require a Heater Relay Kit.
Maximum power requirements: 12 vdc = 16.6 amps, 24 vdc = 8.3 amps.
Note: Do not use heater in gasoline applications.



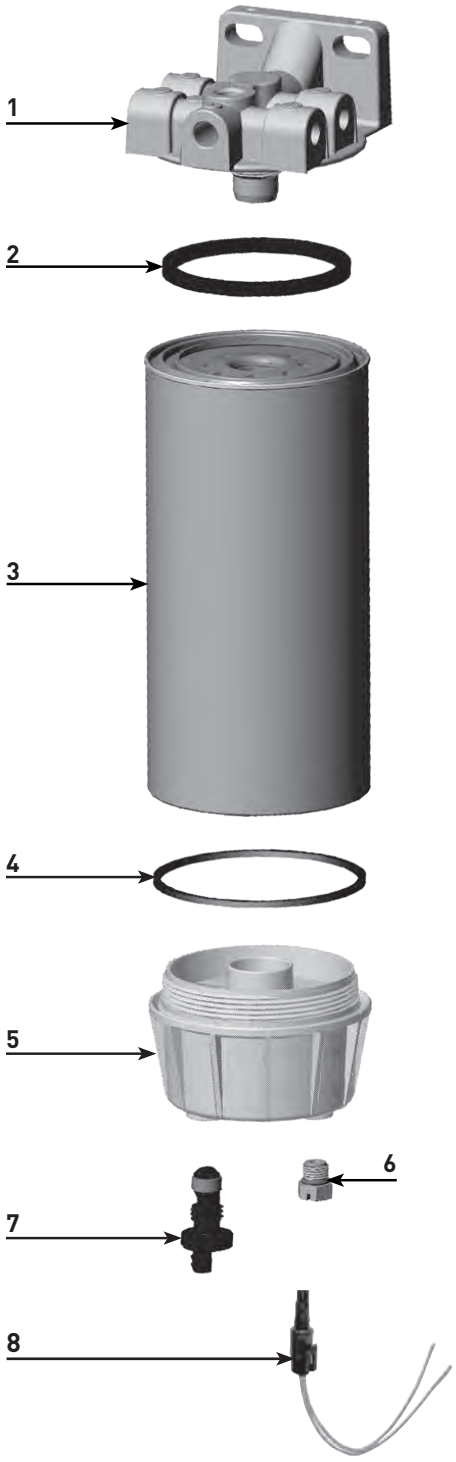
6120R
Replacement Parts

Part Number	Description	
1. RK 22098	Mounting Head Kit (with 3/8”-18 NPTF fuel ports)	
2. RK22998	Filter Gasket Kit	
3. Replacement Filters	R120S	2 micron
	R120T	10 micron
	R120P	30 micron
4. RK 30965	Bowl Gasket Kit	
5. Replacement Bowl Kits		
RK 30063	Clear Bowl Kit	
RK 30900[1]	Heated Bowl Kit (Clear bowl with 12 vdc heater)	
RK 30925[1]	Heated Bowl Kit (Clear bowl with 24 vdc heater)	
6. RK 20126	Plug Kit (1/2”-20 SAE)	
7. RK 30476	Self-Venting Drain Kit	
8. RK 30964	Water Probe/Sensor Kit	

Additional Parts (not shown)

RK 30876[1]	Heater Connector Kit
01SP-6S	Metal Port Plug (3/8” NPTF)

[1] In-bowl heater may require a Heater Relay Kit.
Maximum power requirements: 12 vdc = 16.6 amps, 24 vdc = 8.3 amps.
Note: Do not use heater in gasoline applications.



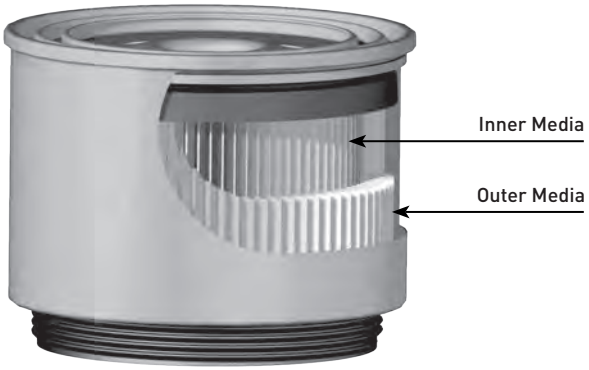
Replacement Filters

Model Number	2 micron (Final Filtration)	10 micron (Secondary Filtration)	30 micron (Primary Filtration)
645R	R45S or R47S	R45T	R45P
660R	R60S	R60T	R60P
690R	R90S	R90T	R90P
6120R	R120S	R120T	R120P

Optional Dual Layer Media Filter

Dual-layer media offers enhanced dirt-holding capacity, extended filter life, and ensures a more complete removal of all size contaminants. The R47S filter replaces the R45S and provides removal efficiencies of 99.98% (nominal) on 2 micron particles, still much greater than the 50-90% efficiency of most single-stage filters.

R47S



Remote Vacuum Gauges

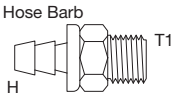
Vacuum gauges are available to monitor filter condition and as the filter slowly becomes clogged with contaminates the restriction (resistance to flow) increases. The fuel pump tries to draw fuel (suction) but because of restriction, less fuel is delivered to engine and instead more air is pulled from it (fuel de-gassing). Results can cause engine to lose power and eventually stall.

By installing a vacuum gauge in the fuel system on the outlet side of the filter, visual monitoring of filter condition is possible.

Specifications	RK 11233	1606B
Description	Silicone dampened, 0-30 inHg. Instrument panel installation.	Includes gauge and two fittings. Instrument panel installation.
Threads	1/4” NPT back bracket mount.	1/4” NPT back bracket mount.
Dimensions	2.0” W x 1.9” D	2.0” W x 1.9” D
Dial	2 in.	2 in.
Weight	0.4 lb (0.2 kg)	0.4 lb (0.2 kg)

Special Notes: For severe vibration applications, mount gauge on stable, remote location and connect using flexible tubing. Additional gauges available - contact your local distributor.

Fittings

Filter Part Number	Description	Hose (H)/ Thread (T)	T1	Part No.
For all models		3/8” 1/2”	3/8” NPT 3/8” NPT	951-N6-H6 951-N6-H8

Note: The T1 side of the fitting threads into the mounting head ports.

Water Probe Kits

Racor offers a wide selection of water probes, each designed for use with particular models and installation requirements. These probes are available in various configurations to fit every Racor filter/ separator. The water probe is only a component in the water detection system and will not work without a Racor electronic detection module.

RK 30880E has an electronic detection module built-in to its design and has the simplest installation procedure. Wiring instructions are supplied with each water detection module.

Specifications	RK 30964	RK 30880E
Threads	1/2”-20 Threads	1/2”-20 Threads
Description	Includes detachable 2-wire connector. Requires a detection module.	Includes detachable 3-wire connector, built-in detection electronics and under-dash warning light. Probe sends ground signal to light.
Voltage	12 or 24 vdc	12 or 24 vdc
Power Draw: ***(12 volt)*** ***(24 volt)***	N/A	5 Milliamps 10 Milliamps
Maximum Load	N/A	1 Amp
Weight	0.02 lb (0.01 kg)	0.4 lb (0.2 kg)

CAUTION! Never wire a water probe directly to voltage or another brand of detection module.

Water Detection Modules

Racor Water Detection Kits are available for under dash, in-dash and remote mount installation. These units may be used with any Racor fuel filter/water separator and water probe. An electric detection module analyzes electrical resistance at the water probe and determines if water is present. Units reset automatically after removing water (unless specified). All water detection module kits include an RK 21069 water probe.

Under Dash Modules

Specifications	RK 12870	RK 12871
Voltage	12 vdc	24 vdc
Features	Light and Buzzer	Same as RK 12870
Description	Lamp illuminates and buzzer sounds when water is detected. Water must be drained to reset light and stop buzzer.	
Dimensions	1.4" H x 1.25" D x 1.4" W	
Power Draw	1 Milliamp	
Max. Internal Load	30 Milliamps	
Weight	0.2 lb (0.1 kg)	

Note: Additional modules available - contact your Racor distributor.

In-Dash Modules

Specifications	RK 20726
Voltage	12 or 24 vdc
Features	Light and Buzzer
Description	Red DRAIN lamp illuminates continuously and buzzer sounds momentarily when water is detected. Power-up self diagnosis feature and circuit protection included.
Dimensions[1]	2.2" Diameter x 3.2" Depth
Power Draw: *(12 volt)* *(24 volt)*	 3 Milliamps 13 Milliamps
Max. Internal Load	30 Milliamps
Weight	0.4 lb (0.2 kg)

[1] Cut 2.0" diameter hole to mount gauges in instrument panel.

Note: Additional modules available - contact your Racor distributor.

Remote Mount Modules

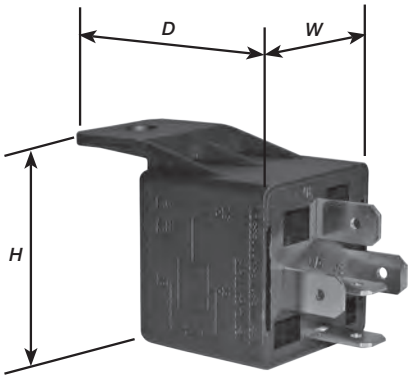
Specifications	RK 14329	RK 14321
Voltage	12 vdc	24 vdc
Features	Sends Hot (+) Signal	Sends Hot (+) Signal
Description	Receives signal from water probe or vacuum switch (not included) then sends a signal to horn or lamp. Must use with relay if power draw is over 1 amp.	Same as RK14329 but sends a 24 vdc hot (+) signal.
Dimensions[1]	0.7" H x 2.5" D x 2.8" W	1.0" H x 1.5" D x 2.0 W
Power Draw:	14 Milliamps	10 Milliamps
Max. Internal Load	30 Milliamps	30 Milliamps
Weight	0.3 lb (0.1 kg)	0.4 lb (0.2 kg)

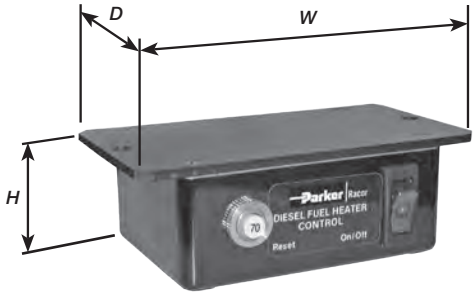
Note: Additional modules available - contact your Racor distributor.

Electrical Heater Relay Kits

CAUTION! Do not use electric heater in gasoline applications. Do not operate heater if no fuel is inside bowl. Ensure the filter is primed with fuel prior to applying power to the heater.

The following relay kits may be necessary when installing Racor Heater Kits due to power demand. Standard OE fuses, wiring and alternators may be unable to carry the load without overheating or shorting, creating a serious condition. Wire/terminal connections should be soldered and crimped.





Specifications	RK 11861	RK 11862	RK 19490-12	RK 19490-24
Description	Heater Relay Kit, Includes fuse and holder.	Heater Relay Kit, Includes fuse and holder.	Heavy-Duty Relay Kit	Heavy-Duty Relay Kit
Voltage	12 vdc	24 vdc	12 vdc	24 vdc
Detection Module	Remote Mount	Remote Mount	Under Dash	Under Dash
Maximum Watts	300	360	600	900
Maximum Amps	25	15	50	37
Dimensions	1.3” H x 1.6” D x 1.1” W	1.3” H x 1.6” D x 1.1” W	1.7” H x 2.9” D x 5.1” W	1.7” H x 2.9” D x 5.1” W
Weight	0.3 lb (0.1 kg)	0.3 lb (0.1 kg)	1.6 lb (0.7 kg)	1.6 lb (0.7 kg)

Caution: If you are uncertain if your electrical system can provide the additional power draw, consult your equipment distributor or qualified electrician.

Limited Warranties Statement

All products manufactured or distributed by Racor are subject to the following, and only the following, LIMITED EXPRESS WARRANTIES, and no others: For a period of one (1) year from and after the date of purchase of a new Racor product, Racor warrants and guarantees only to the original purchaser-user that such a product shall be free from defects of materials and workmanship in the manufacturing process. The warranty period for pumps and motors is specifically limited to ninety (90) days from date of purchase. A product claimed to be defective must be returned to the place of purchase. Racor, at its sole option, shall replace the defective product with a comparable new product or repair the defective product. This express warranty shall be inapplicable to any product not properly installed and properly used by the purchaser-user or to any product damaged or impaired by external forces.

THIS IS THE EXTENT OF WARRANTIES AVAILABLE ON THIS PRODUCT. RACOR SHALL HAVE NO LIABILITY WHATSOEVER FOR CONSEQUENTIAL DAMAGES FLOWING FROM THE USE OF ANY DEFECTIVE PRODUCT OR BY REASON OF THE FAILURE OF ANY PRODUCT. RACOR SPECIFICALLY DISAVOWS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED INCLUDING, WITHOUT LIMITATION, ALL WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE (EXCEPT FOR THOSE WHICH APPLY TO PRODUCT OR PART THEREOF THAT IS USED OR BOUGHT FOR USE PRIMARILY FOR PERSONAL, FAMILY, OR HOUSEHOLD PURPOSES), WARRANTIES OF DESCRIPTION, WARRANTIES OF MERCHANTABILITY, TRADE USAGE OR WARRANTIES OR TRADE USAGE.

Warning

Failure or improper selection or improper use of the products and/or systems described herein or related items can cause death, personal injury and property damage. This document and other information from Parker Hannifin Corporation, its subsidiaries and authorized distributors provide product and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the applications are met. The products described herein, including with limitation, product features, specifications, designs, availability and pricing, are subject to change by Parker Hannifin Corporation and its subsidiaries at any time without notice.

The following statement is required pursuant to proposition 65, applicable in the State of California: 'This product may contain a chemical known to the State of California to cause cancer or reproductive toxicity'.

March 2012

Parker | Racor

ENGINEERING YOUR SUCCESS.

Hourmeters

ETM-97030B
Revised 11-01
Catalog Section 20
(00-02-0259)

TM Series

- 2 in. (51 mm) Diameter Dial
- Tamperproof and Environmentally Sealed
- Mechanical Counter–No Battery Needed to Maintain Elapsed Time
- Reversed Polarity Protected
- Quartz-Crystal Time Base for Accurate Long-Term Timekeeping
- Powered by 12 to 24 VDC

Description

The TM Series hourmeters record the operating time of vehicles or powered equipment. They are electromechanical and have a quartz base time counter that insures accuracy (better than ±0.02% over the entire range). They can record up to 99,999.9 hours (9,999.9 for TM612/624) and include an automatic recycle to zero hours feature. The TM Series models have a shock-proof and tamperproof, totally sealed case made of an engineered plastic. These small, light weight time meters are rugged and durable. They are the answer to applications requiring a low DC power, reliable hourmeter.

The TM612/624 model includes a 3-hole mounting shock ring for extreme-shock protection.

Basic Models

6-Digits Hourmeters

Model	*Bezel Type*
TM4592	Bright Stainless Steel Bezel
TM4593	Black Stainless Steel Bezel
TM4594	SAE Bright Stainless Steel Bezel
TM4595	SAE Stainless Steel Black Bezel

5-Digits Hourmeter with Shock Ring Mounting

TM612/624	3-Hole Mount, Black Bezel

Applications

These hourmeters can be used on any engine where operating time needs to be recorded. All it requires is a DC power source (refer to Specifications, at right).

Outstanding Features

- Solid-State Electronic Drive Circuit
- Quartz-Crystal for Accurate Timing
- Quiet Operation–Permanently Lubricated
- High-Impact, Tamperproof Plastic Case
- Sealed Against Moisture and Dirt
- Indicates Operating Time in Hours and Tenths
- No Battery Back Up Required
- Made in the U.S.A.

Specifications

Power Input: 12 to 24 VDC
Power Consumption: Less than 0.03 W @ 12 VDC; 0.4 W @ 24 VDC.
Accuracy: ± 0.02% over entire range.
Temperature Range: -40°F to 185°F (-40°C to +85°C).
Dial (Face Plate): White numerals (over black background).
Time Scale: TM4592-95 models: 6-digits 99,999.9 hours; TM612/624 models: 5-digits 9,999.9 hours. Automatic recycle to zero.
Vibration Resistance: Withstands 10 to 75 Hz @ 1 to 8 G's.
Case Material: Plastic.
Bezel: Stainless Steel.
Terminations: 1/4 in. (6 mm) male blade terminals.
TM4592/4595 Shipping Weight: 5 ozs. (140 g).
Shipping Dimensions: 3-1/8 x 3 x 3 in. (79 x 76 x 76 mm) approximately.
TM612/624 Shipping Weight: 8 ozs. (230 g).
TM612/624 Shipping Shipping Dimensions: 5 x 5 x 3-1/4 in. (127 x 127 x 83 mm) approx.

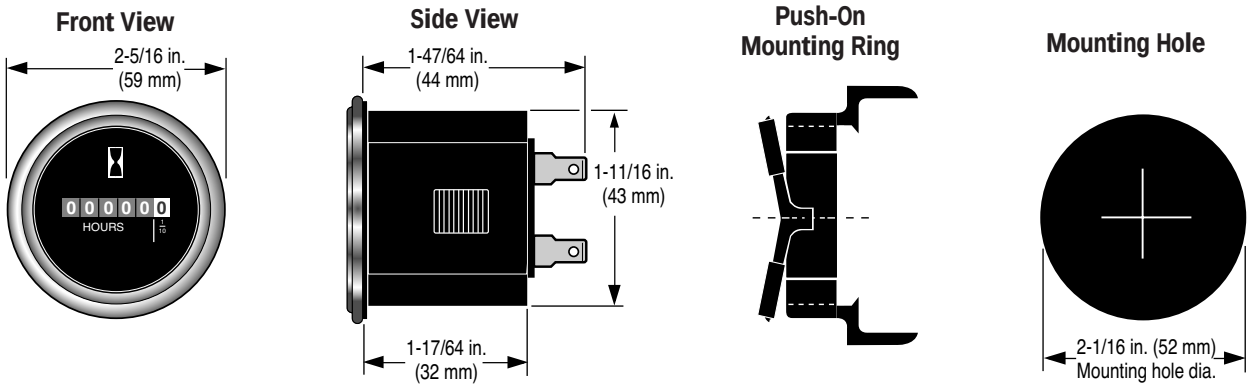
Warranty

A limited warranty on materials and workmanship is given with this FW Murphy product. A copy of the warranty may be viewed or printed by going to www.fwmurphy.com/support/warranty.htm

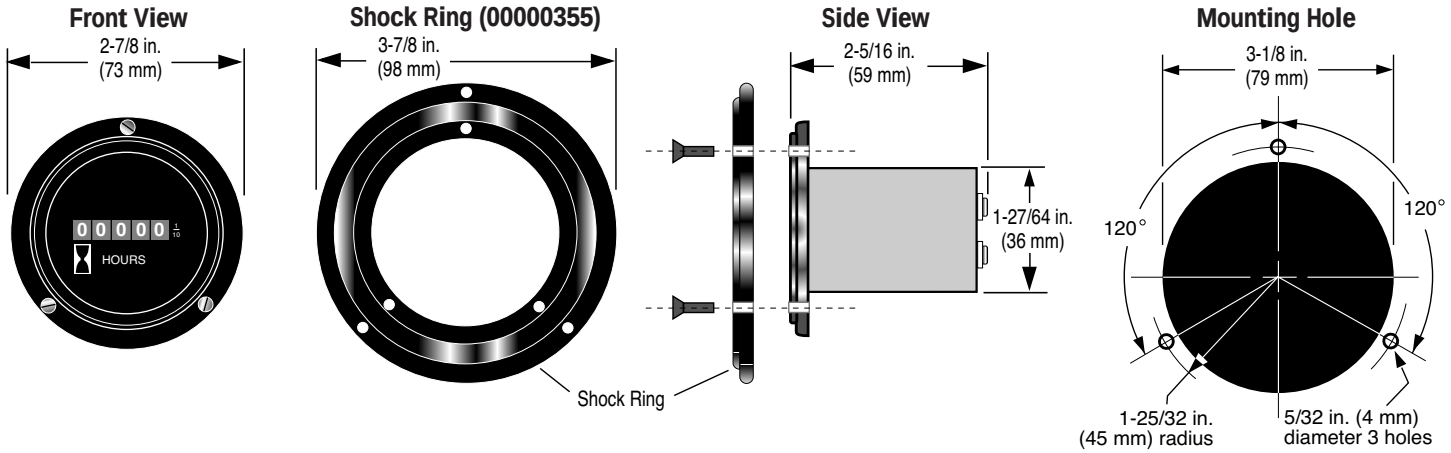
* Products covered by this bulletin comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted. The CE mark does not apply to the TM612 and TM624 models.

MURPHY®

TM4592–TM4595 Models

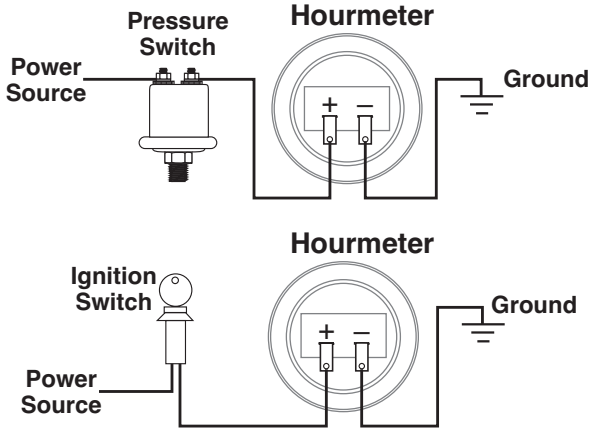


TM612/624 Model with Shock Ring



Typical Wiring Diagrams

WARNING: Turn the power source OFF before wiring.



How to Order

Example: **TM4592**

Model Designation

Model	*Description*
TM4592	6-digits w/Bright Stainless Steel Bezel
TM4593	6-digits w/Black Stainless Steel Bezel
TM4594	6-digits w/SAE Bright Stainless Steel Bezel
TM4595	6-digits w/SAE Stainless Steel Black Bezel
TM612/624	5-digits w/Shock Ring Mount Black Bezel
00000355	Shock Ring only for TM612/624

MURPHY
www.fwmurphy.com
918.317.4100 Email: sales@fwmurphy.com

MURPHY®

Tachometers and Tach/Hourmeters

AT and ATH Series

Installation Instructions

IMPORTANT! These instructions are specific to tachometer models with a power input operating range of 11-28 VDC and calibration using dip switches. If your tachometer is a type using selector switch calibration, please locate installation instructions in the discontinued product literature section of the FW Murphy Website (www.fwmurphy.com). Refer to Tachometer and Tach/Hourmeter Installation Instructions Series: ATS, ATHS, ATA, ATHA, ATHI (00-02-0258).

CE

00-02-0260
2012-05-18
Section 20

Warranty - A limited warranty on materials and workmanship is given with this FW Murphy product.
A copy of the warranty may be viewed or printed by going to http://www.fwmurphy.com/warranty

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT:

- A visual inspection of this product for damage during shipping is recommended before installation.
- It is your responsibility to ensure that qualified mechanical and electrical technicians install this product.
- Disconnect all electrical power to the machine.
- Make sure machine cannot operate during installation.
- Follow all safety warnings of the machine manufacturer.
- Read and follow all installation instructions.
- Please contact FW MURPHY immediately if you have any questions.

Table of Contents

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General Information

These tachometers are indicators of engine speed, in revolutions per minute (RPM). Models equipped with hourmeters also record elapsed engine running time. The hourmeter counts when the engine speed is greater than 100 RPM.

For magnetic sensor (pickup) driven models, the pulses are obtained from the ring gear of an engine flywheel (having from 50 to 304 teeth). Alternator driven models function from pulses generated by the engine driven alternator that charges the battery. The alternator must have a terminal for the tachometer.

Ignition models get their signal from the ignition system. This can be from the coil, or a tachometer output from the ignition.

All units are for negative ground or isolated electrical systems. If the instrument is connected to reverse polarity, it will not operate until proper connections are made. All units are powered by a voltage range of 11 to 28 VDC.

Case Mounting Instructions

It is preferred that the units are mounted in a place where they will be protected from rain and splashing water. A minimum distance of 12 in. (305mm) from any coil, coil leads, or high voltage wiring should be maintained. These units are intended for mounting on a flat panel with a cut out of 3-3/8 in. (86mm), diameter hole as shown below. The maximum panel thickness recommended is ½ in. (12.7mm). Remove the mounting bracket from the back of the unit. Insert the instrument from the front side of the panel and place the mounting bracket to secure the instrument in place.

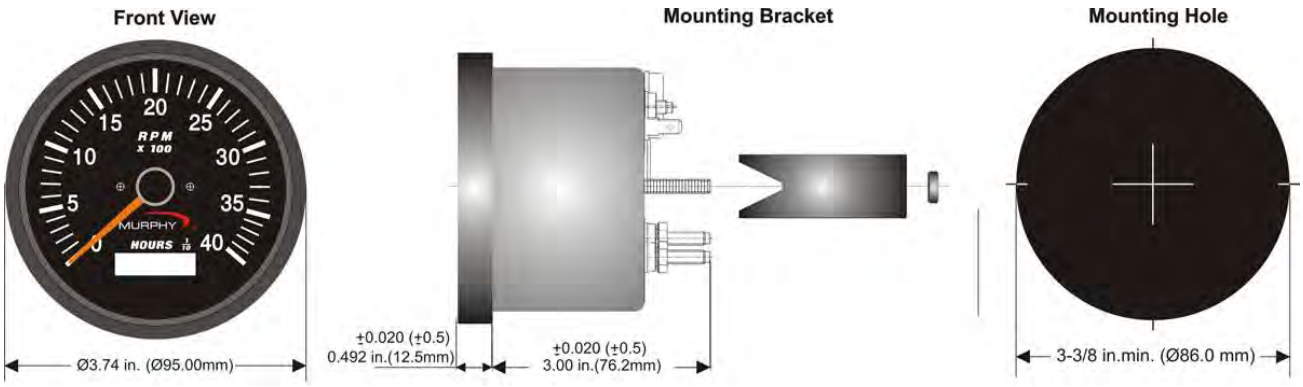


Figure 1

Mounting Requirements

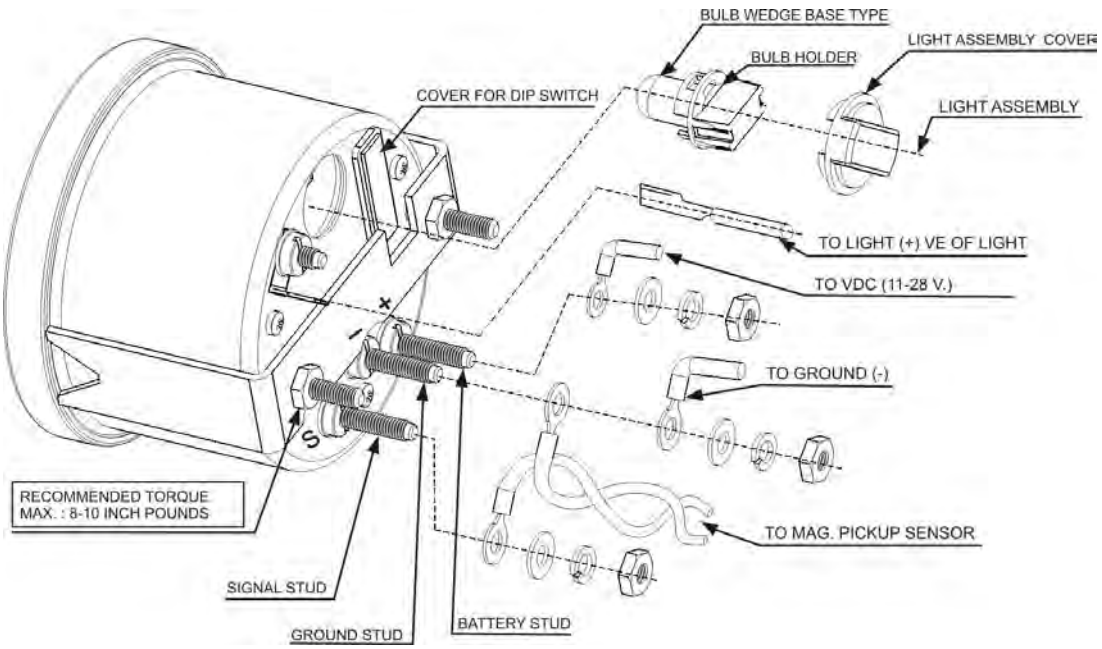


Figure 2 - Back of AT TACH

Tools and Supplies Required for Installation

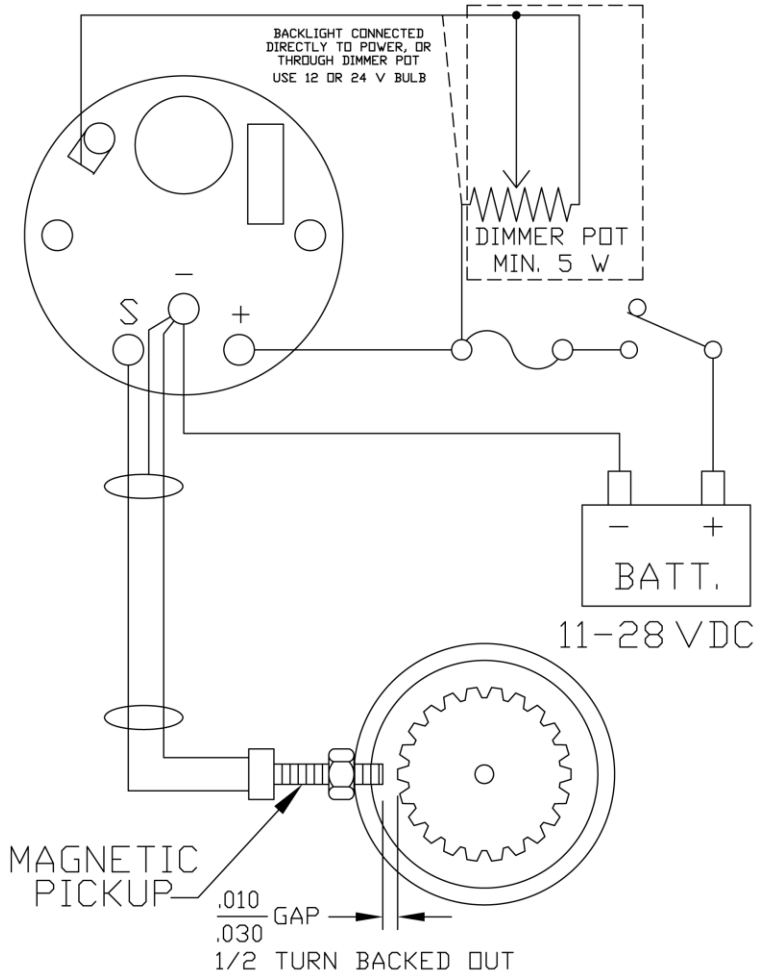
1.	11/32” and 3/8” Nut Drivers
2.	Wire Cutting & Stripping Tool
3.	Wire terminal Crimping Tool
4.	#10 crimp on ring terminals, and Faston™ or slip-on crimp terminals (for backlight)

Connection Instructions

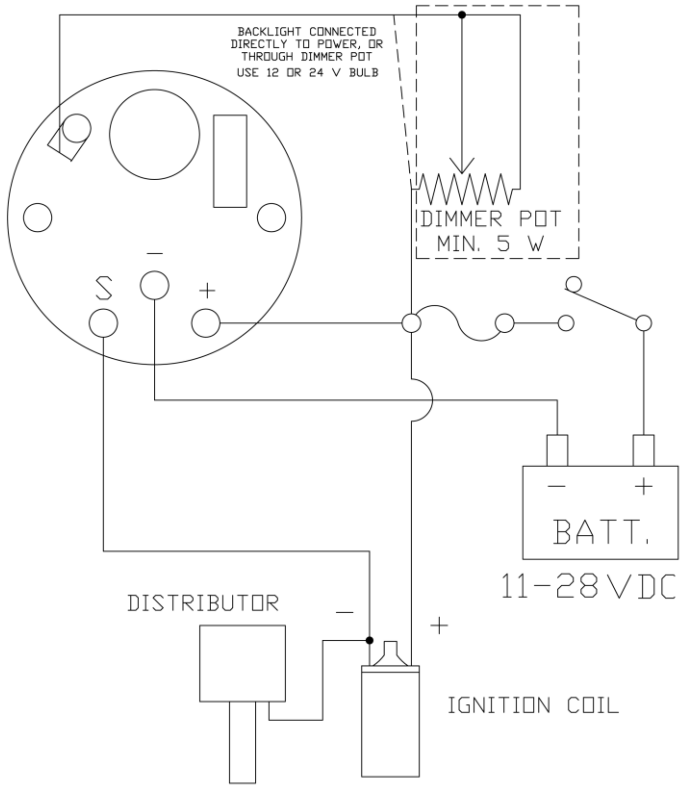
CAUTION: For safety of both personnel and equipment, disconnect the battery/power source before beginning installation.

Determine voltage and polarity of the application before wiring the unit. Use the appropriate wire size. To wire the magnetic sensor pickup, use 18 AWG (1.0mm) twisted pair, shielded cable. Use insulated crimp-on (solderless) ring-type wire terminals. Allow a few inches of extra wire (service loops) for ease of servicing.

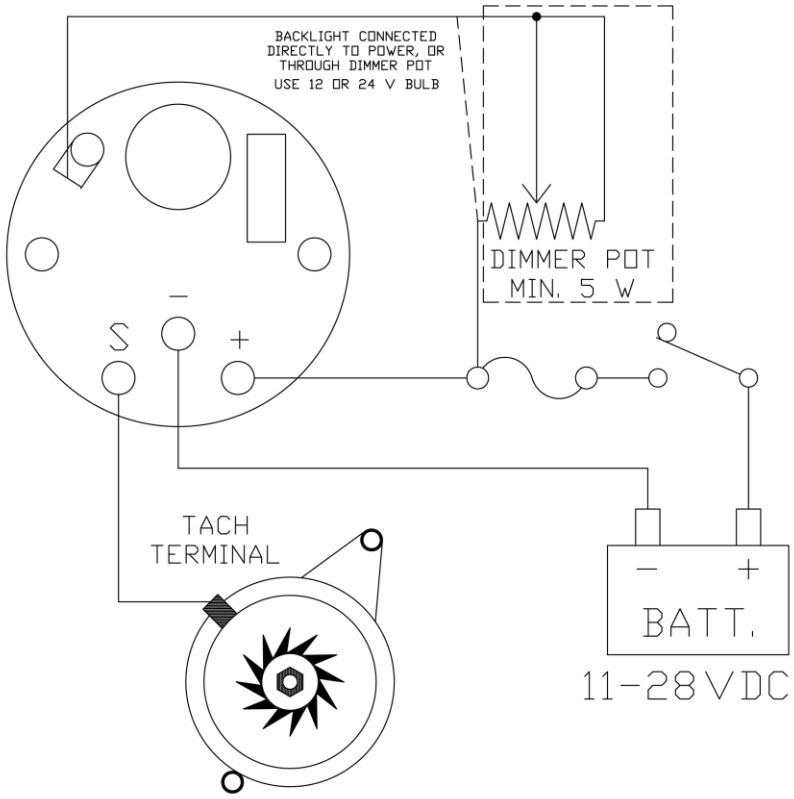
Typical Wiring Diagrams – Hookup for Magnetic Pickup



Typical Wiring Diagrams – Hookup for Ignition



Typical Wiring Diagrams - Hookup for Alternator



Connecting to Power (All Models)

> **IMPORTANT**: The operating voltage range of these units is 11-28VDC only. Always ensure circuits have a fuse or a circuit breaker to protect wiring. Never connect the unit directly to a battery without a fuse or circuit breaker.

1. Connect a wire from "**+**" to Battery or Power Supply "**+**" through a fuse and the ignition switch.
2. Connect a wire from the "**-**" terminal to the negative voltage source (electrical ground).This is shown in Figure 2 as the 'ground stud' (Figure 2 is found in the section: Case Mounting Instructions under Mounting Requirements in this document).

Installing or Replacing Light Bulbs (All Models)

1. Pull out the black rubber protective cap (Light Assembly Cover) provided at back as shown in Figure 2.
2. Twist the bulb holder about 1/8 turn counter-clockwise and remove the bulb holder and bulb. (See Figure 2.)
3. To replace the bulb, pull the bulb from the socket and replace with a new 12V or 24V bulb as required.

Connecting to Magnetic Sensor (Magnetic Sensor Driven Models)

The magnetic sensor (pickup) usually has two connections (terminals or wires) exiting from it. These connections are not polarized; either connection can be considered positive or negative signals. These two connections must be routed directly to the unit. Do NOT ground one of the connections at the engine. (See Figure 2)

1. Connect one of the wires in the twisted pair (from magnetic sensor) to the "S" terminal.
2. Connect the other wire in the twisted pair (from the magnetic sensor) to the negative (**-**) terminal (also noted in Figure 2 as the 'ground stud').

Connecting to Alternator (Alternator Driven Models)

Connect a wire from the "S" terminal to AC phase terminal (sometimes marked "STA" or "R" on the alternator.

Connecting to Ignition Coil (Ignition Driven Models)

Connect wire from the "S" terminal to the negative (**-**) side of the ignition coil or to the terminal marked "TACH" on solid state ignition systems (See Figure 2 – found in this document under the section Case Mounting Instructions, Mounting Requirements).

Calibration Instructions

Magnetic Sensor Driven Models

These models have been designed to function with flywheels having 50 to 304 teeth. Any number in this range can be set using the dip switches provided on the back (see Figure 3 - following). For more details, also refer to Table 1 (In the section: Dip Switch Setting Charts, Magnetic Sensor Driven Models).

If the number of teeth on the flywheel is known, set the calibration by using a pin to adjust the dip switches (see Figure 3, following).

> **IMPORTANT**: DO NOT use a pencil or pen of any type to adjust dip switches. If the pencil breaks while setting the dip positions, graphite can cause a short internally. Leaking ink can do the same.

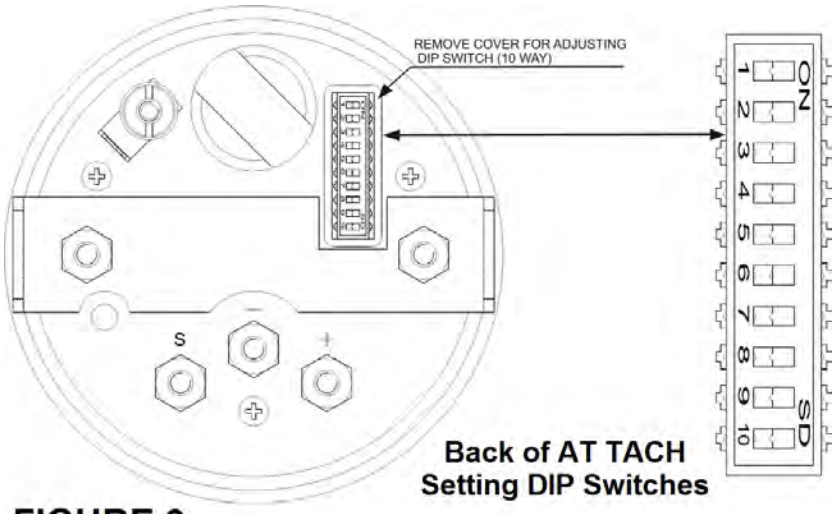


FIGURE 3

Formula for setting dip switches:

- Dip switch setting = binary of decimal equivalent.
- Decimal equivalent = number of flywheel teeth - 49.

> **NOTE:** Dip switches D1 to D8 will be used for setting calibration.
>
> Do not change settings on Dip Switches D9 and D10.
>
> For more details refer to Table 1 - Dip Switch Setting for each model type.
>
> **NOTE**: Make sure the engine has a properly functioning and certified governor before attempting this procedure.

If the number of teeth on the flywheel is not known, set up a calibrated shop tach to monitor the engine's true RPM. Start the engine, and after an appropriate warm-up period increase to normal running RPM as read on the shop tach. If the dip switch was not set previously, set it now to the position that causes the Murphy tach to read closest to the true RPM.

Alternator Driven Models

The alternator-driven tachometer-series models will operate from 3 to 100 pulses per engine revolution. Most applications will be between 3 and 40 pulses per revolution. Obtain the number of pulses per engine revolution:

1. Determine the number of poles on your alternator. Look for the designation/type in the manufacturer's manual.

2. The Alternator Tachometer Chart (Figure 4 – in the section: Pulley Ratios Chart and Alternator Tachometer Chart) lists common alternators and their minimum and maximum pulley ratios. Determine pulley ratio with the following formula:

$$\text{PULLEY RATIO} = \frac{\text{CRANK SHAFT PULLEY DIAMETER}}{\text{ALTERNATOR PULLEY DIAMETER}}$$

3. CHECK that Pulley Ratio falls within the range shown on the Pulley Ratio Chart (Figure 4) for a particular alternator. If ratio falls in the shaded area, the tachometer can be calibrated for the application.

4. To determine the pulses per engine revolution:

$$\frac{\text{NUMBER OF POLES}}{2} \times \text{PULLEY RATIO} = \text{PULSES PER ENGINE REVOLUTION}$$

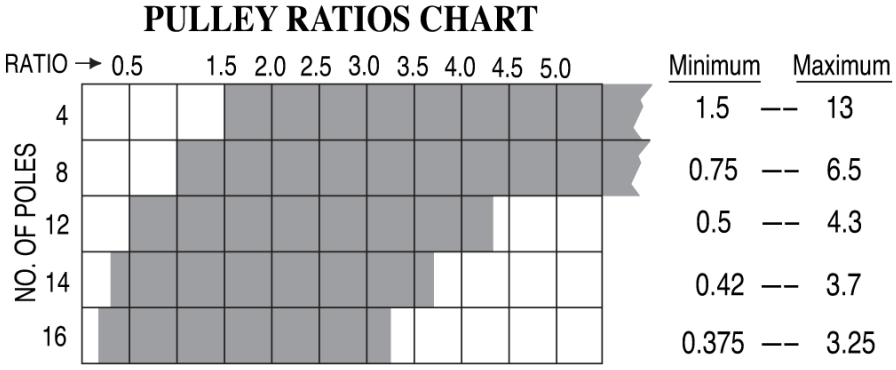
5. If the Pulses per engine revolution is determined, then set the calibration "through selector/dip switches" (See Fig. 3 in the section: Calibration Instructions, Magnetic Sensor Driven Models).

6. Formula for setting Dip switches:

Decimal equivalent = No. of Pulses will be used for setting calibration
Dip switch setting = Binary of decimal equivalent

IMPORTANT
Dip switches D1 to D8 will be used for setting of calibration.
Do not change or disturb settings on Dip Switches D9 and D10.
For more details, see Table 2.

Pulley Ratios Chart and Alternator Tachometer Chart



ALTERNATOR TACHOMETER CHART

Manufacturer	Designation/Type	Poles	Minimum pulley-ratio	Maximum* pulley-ratio
Prestolite	All	8	0.75	6.5
Load Handler	88A, 8LHA, 89C, 8LHC	16	0.375	3.25
Load Handler	All 5 inch models	12	0.5	4.3
Leece Neville	All	12	0.5	4.3
Bosch	G and K Series	12	0.5	4.3
C.E. Neihoff	All	12	0.5	4.3
Delco Remy	30DN	4	1.5	13
Delco Remy	15SI, 21SI, 40DN, 40SI	12	0.5	4.3
Delco Remy	10DN, 10SI, 12SI	14	0.42	3.7
Delco Remy	20DN, 25SI, 27SI	16	0.375	3.25
Delco Remy	29SI, 30SI	16	0.375	3.25
Hitachi	LT125, LT130, LT133	8	0.75	6.5
Hitachi	LT150	12	0.5	4.3
Lucas	All	12	0.5	4.3
Mando	All	12	0.5	4.3
Motorcraft	All	12	0.5	4.3
Nippondenso	All	12	0.5	4.3
Powerline	Series 23	14	0.42	3.7
Powerline	Series 24, 25, 26	12	0.5	4.3
Valeo	All	12	0.5	4.3

Figure 4

NOTE: ***** Although the tach may be calibrated for higher input frequencies in some cases, as shown on the Pulley Ratios Chart, pulley ratios in excess of 5.0 are <u>not</u> recommended nor are they normally used.

Ignition Driven Models

The ignition coil-driven tach series models will operate from 1 to 5 pulses per engine revolution. To obtain the number of pulses per engine revolution:

The ATI and ATHI series models have been designed to function from the ignition signal on 2 through 10-cylinder, 4-cycle engines. Set the calibration using the Dip switches. For more details, see the following formula and information in Table 3 (in the section: DIP Switch Setting Charts, Ignition Driven Models).

Work the following formulas for your Ignition Coil system:

Formula for Setting Dip Switches:

Dip switch setting = Binary of decimal equivalent.

Decimal equivalent = Number of Pulses per engine revolution.

$$\text{Number of Pulses per engine revolution} = \frac{\text{Number of engine cylinders}}{2}$$

For Dip switch settings, please refer Table 3 (in the following section) for ignition speed signals.

> **IMPORTANT**: DO NOT use a pencil or pen of any type to adjust dip switches. If the pencil breaks while setting the dip positions, graphite can cause a short internally. Leaking ink can do the same.

Dip Switch Setting Charts

Table 1 - Magnetic Sensor Driven Models

> **NOTE**
> In the following table, “1” means ON and “0" means OFF.

No. of Flywheel teeth	Decimal equivalent	Dip Switch Position							
		D1	D2	D3	D4	D5	D6	D7	D8
50	01	1	0	0	0	0	0	0	0
51	02	0	1	0	0	0	0	0	0
52	03	1	1	0	0	0	0	0	0
53	04	0	0	1	0	0	0	0	0
54	05	1	0	1	0	0	0	0	0
55	06	0	1	1	0	0	0	0	0
56	07	1	1	1	0	0	0	0	0
57	08	0	0	0	1	0	0	0	0
58	09	1	0	0	1	0	0	0	0
59	10	0	1	0	1	0	0	0	0
60	11	1	1	0	1	0	0	0	0
61	12	0	0	1	1	0	0	0	0
62	13	1	0	1	1	0	0	0	0
63	14	0	1	1	1	0	0	0	0
64	15	1	1	1	1	0	0	0	0
65	16	0	0	0	0	1	0	0	0
66	17	1	0	0	0	1	0	0	0
67	18	0	1	0	0	1	0	0	0
68	19	1	1	0	0	1	0	0	0
69	20	0	0	1	0	1	0	0	0
70	21	1	0	1	0	1	0	0	0
71	22	0	1	1	0	1	0	0	0
72	23	1	1	1	0	1	0	0	0
73	24	0	0	0	1	1	0	0	0
74	25	1	0	0	1	1	0	0	0
75	26	0	1	0	1	1	0	0	0
76	27	1	1	0	1	1	0	0	0
77	28	0	0	1	1	1	0	0	0
78	29	1	0	1	1	1	0	0	0
79	30	0	1	1	1	1	0	0	0
80	31	1	1	1	1	1	0	0	0

No. of Flywheel teeth	Decimal equivalent	Dip Switch Position							
		D1	D2	D3	D4	D5	D6	D7	D8
81	32	0	0	0	0	0	1	0	0
82	33	1	0	0	0	0	1	0	0
83	34	0	1	0	0	0	1	0	0
84	35	1	1	0	0	0	1	0	0
85	36	0	0	1	0	0	1	0	0
86	37	1	0	1	0	0	1	0	0
87	38	0	1	1	0	0	1	0	0
88	39	1	1	1	0	0	1	0	0
89	40	0	0	0	1	0	1	0	0
90	41	1	0	0	1	0	1	0	0
91	42	0	1	0	1	0	1	0	0
92	43	1	1	0	1	0	1	0	0
93	44	0	0	1	1	0	1	0	0
94	45	1	0	1	1	0	1	0	0
95	46	0	1	1	1	0	1	0	0
96	47	1	1	1	1	0	1	0	0
97	48	0	0	0	0	1	1	0	0
98	49	1	0	0	0	1	1	0	0
99	50	0	1	0	0	1	1	0	0
100	51	1	1	0	0	1	1	0	0
101	52	0	0	1	0	1	1	0	0
102	53	1	0	1	0	1	1	0	0
103	54	0	1	1	0	1	1	0	0
104	55	1	1	1	0	1	1	0	0
105	56	0	0	0	1	1	1	0	0
106	57	1	0	0	1	1	1	0	0
107	58	0	1	0	1	1	1	0	0
108	59	1	1	0	1	1	1	0	0
109	60	0	0	1	1	1	1	0	0
110	61	1	0	1	1	1	1	0	0
111	62	0	1	1	1	1	1	0	0

No. of Flywheel teeth	Decimal equivalent	Dip Switch Position							
		D1	D2	D3	D4	D5	D6	D7	D8
112	63	1	1	1	1	1	1	0	0
113	64	0	0	0	0	0	0	1	0
114	65	1	0	0	0	0	0	1	0
115	66	0	1	0	0	0	0	1	0
116	67	1	1	0	0	0	0	1	0
117	68	0	0	1	0	0	0	1	0
118	69	1	0	1	0	0	0	1	0
119	70	0	1	1	0	0	0	1	0
120	71	1	1	1	0	0	0	1	0
121	72	0	0	0	1	0	0	1	0
122	73	1	0	0	1	0	0	1	0
123	74	0	1	0	1	0	0	1	0
124	75	1	1	0	1	0	0	1	0
125	76	0	0	1	1	0	0	1	0
126	77	1	0	1	1	0	0	1	0
127	78	0	1	1	1	0	0	1	0
128	79	1	1	1	1	0	0	1	0
129	80	0	0	0	0	1	0	1	0
130	81	1	0	0	0	1	0	1	0
131	82	0	1	0	0	1	0	1	0
132	83	1	1	0	0	1	0	1	0
133	84	0	0	1	0	1	0	1	0
134	85	1	0	1	0	1	0	1	0
135	86	0	1	1	0	1	0	1	0
136	87	1	1	1		1	0	1	0
137	88	0	0	0	1	1	0	1	0
138	89	1	0	0	1	1	0	1	0
139	90	0	1	0	1	1	0	1	0
140	91	1	1	0	1	1	0	1	0
141	92	0	0	1	1	1	0	1	0
142	93	1	0	1	1	1	0	1	0
143	94	0	1	1	1	1	0	1	0
144	95	1	1	1	1	1	0	1	0
145	96	0	0	0	0	0	1	1	0
146	97	1	0	0	0	0	1	1	0
147	98	0	1	0	0	0	1	1	0
148	99	1	1	0	0	0	1	1	0
149	100	0	0	1	0	0	1	1	0
150	101	1	0	1	0	0	1	1	0
151	102	0	1	1	0	0	1	1	0
152	103	1	1	1	0	0	1	1	0
153	104	0	0	0	1	0	1	1	0
154	105	1	0	0	1	0	1	1	0
155	106	0	1	0	1	0	1	1	0
156	107	1	1	0	1	0	1	1	0
157	108	0	0	1	1	0	1	1	0
158	109	1	0	1	1	0	1	1	0
159	110	0	1	1	1	0	1	1	0
160	111	1	1	1	1	0	1	1	0

No. of Flywheel teeth	Decimal equivalent	Dip Switch Position							
		D1	D2	D3	D4	D5	D6	D7	D8
161	112	0	0	0	0	1	1	1	0
162	113	1	0	0	0	1	1	1	0
163	114	0	1	0	0	1	1	1	0
164	115	1	1	0	0	1	1	1	0
165	116	0	0	1	0	1	1	1	0
166	117	1	0	1	0	1	1	1	0
167	118	0	1	1	0	1	1	1	0
168	119	1	1	1	0	1	1	1	0
169	120	0	0	0	1	1	1	1	0
170	121	1	0	0	1	1	1	1	0
171	122	0	1	0	1	1	1	1	0
172	123	1	1	0	1	1	1	1	0
173	124	0	0	1	1	1	1	1	0
174	125	1	0	1	1	1	1	1	0
175	126	0	1	1	1	1	1	1	0
176	127	1	1	1	1	1	1	1	0
177	128	0	0	0	0	0	0	0	1
178	129	1	0	0	0	0	0	0	1
179	130	0	1	0	0	0	0	0	1
180	131	1	1	0	0	0	0	0	1
181	132	0	0	1	0	0	0	0	1
182	133	1	0	1	0	0	0	0	1
183	134	0	1	1	0	0	0	0	1
184	135	1	1	1	0	0	0	0	1
185	136	0	0	0	1	0	0	0	1
186	137	1	0	0	1	0	0	0	1
187	138	0	1	0	1	0	0	0	1
188	139	1	1	0	1	0	0	0	1
189	140	0	0	1	1	0	0	0	1
190	141	1	0	1	1	0	0	0	1
191	142	0	1	1	1	0	0	0	1
192	143	1	1	1	1	0	0	0	1
193	144	0	0	0	0	1	0	0	1
194	145	1	0	0	0	1	0	0	1
195	146	0	1	0	0	1	0	0	1
196	147	1	1	0	0	1	0	0	1
197	148	0	0	1	0	1	0	0	1
198	149	1	0	1	0	1	0	0	1
199	150	0	1	1	0	1	0	0	1
200	151	1	1	1	0	1	0	0	1
201	152	0	0	0	1	1	0	0	1
202	153	1	0	0	1	1	0	0	1
203	154	0	1	0	1	1	0	0	1
204	155	1	1	0	1	1	0	0	1
205	156	0	0	1	1	1	0	0	1
206	157	1	0	1	1	1	0	0	1
207	158	0	1	1	1	1	0	0	1
208	159	1	1	1	1	1	0	0	1
209	160	0	0	0	0	0	1	0	1

No. of Flywheel teeth	Decimal equivalent	Dip Switch Position							
		D1	D2	D3	D4	D5	D6	D7	D8
210	161	1	0	0	0	0	1	0	1
211	162	0	1	0	0	0	1	0	1
212	163	1	1	0	0	0	1	0	1
213	164	0	0	1	0	0	1	0	1
214	165	1	0	1	0	0	1	0	1
215	166	0	1	1	0	0	1	0	1
216	167	1	1	1	0	0	1	0	1
217	168	0	0	0	1	0	1	0	1
218	169	1	0	0	1	0	1	0	1
219	170	0	1	0	1	0	1	0	1
220	171	1	1	0	1	0	1	0	1
221	172	0	0	1	1	0	1	0	1
222	173	1	0	1	1	0	1	0	1
223	174	0	1	1	1	0	1	0	1
224	175	1	1	1	1	0	1	0	1
225	176	0	0	0	0	1	1	0	1
226	177	1	0	0	0	1	1	0	1
227	178	0	1	0	0	1	1	0	1
228	179	1	1	0	0	1	1	0	1
229	180	0	0	1	0	1	1	0	1
230	181	1	0	1	0	1	1	0	1
231	182	0	1	1	0	1	1	0	1
232	183	1	1	1	0	1	1	0	1
233	184	0	0	0	1	1	1	0	1
234	185	1	0	0	1	1	1	0	1
235	186	0	1	0	1	1	1	0	1
236	187	1	1	0	1	1	1	0	1
237	188	0	0	1	1	1	1	0	1
238	189	1	0	1	1	1	1	0	1
239	190	0	1	1	1	1	1	0	1
240	191	1	1	1	1	1	1	0	1
241	192	0	0	0	0	0	0	1	1
242	193	1	0	0	0	0	0	1	1
243	194	0	1	0	0	0	0	1	1
244	195	1	1	0	0	0	0	1	1
245	196	0	0	1	0	0	0	1	1
246	197	1	0	1	0	0	0	1	1
247	198	0	1	1	0	0	0	1	1
248	199	1	1	1	0	0	0	1	1
249	200	0	0	0	1	0	0	1	1
250	201	1	0	0	1	0	0	1	1
251	202	0	1	0	1	0	0	1	1
252	203	1	1	0	1	0	0	1	1
253	204	0	0	1	1	0	0	1	1
254	205	1	0	1	1	0	0	1	1
255	206	0	1	1	1	0	0	1	1
256	207	1	1	1	1	0	0	1	1
257	208	0	0	0	0	1	0	1	1
258	209	1	0	0	0	1	0	1	1

No. of Flywheel teeth	Decimal equivalent	Dip Switch Position							
		D1	D2	D3	D4	D5	D6	D7	D8
259	210	0	1	0	0	1	0	1	1
260	211	1	1	0	0	1	0	1	1
261	212	0	0	1	0	1	0	1	1
262	213	1	0	1	0	1	0	1	1
263	214	0	1	1	0	1	0	1	1
264	215	1	1	1	0	1	0	1	1
265	216	0	0	0	1	1	0	1	1
266	217	1	0	0	1	1	0	1	1
267	218	0	1	0	1	1	0	1	1
268	219	1	1	0	1	1	0	1	1
269	220	0	0	1	1	1	0	1	1
270	221	1	0	1	1	1	0	1	1
271	222	0	1	1	1	1	0	1	1
272	223	1	1	1	1	1	0	1	1
273	224	0	0	0	0	0	1	1	1
274	225	1	0	0	0	0	1	1	1
275	226	0	1	0	0	0	1	1	1
276	227	1	1	0	0	0	1	1	1
277	228	0	0	1	0	0	1	1	1
278	229	1	0	1	0	0	1	1	1
279	230	0	1	1	0	0	1	1	1
280	231	1	1	1	0	0	1	1	1
281	232	0	0	0	1	0	1	1	1
282	233	1	0	0	1	0	1	1	1
283	234	0	1	0	1	0	1	1	1
284	235	1	1	0	1	0	1	1	1
285	236	0	0	1	1	0	1	1	1
286	237	1	0	1	1	0	1	1	1
287	238	0	1	1	1	0	1	1	1
288	239	1	1	1	1	0	1	1	1
289	240	0	0	0	0	1	1	1	1
290	241	1	0	0	0	1	1	1	1
291	242	0	1	0	0	1	1	1	1
292	243	1	1	0	0	1	1	1	1
293	244	0	0	1	0	1	1	1	1
294	245	1	0	1	0	1	1	1	1
295	246	0	1	1	0	1	1	1	1
296	247	1	1	1	0	1	1	1	1
297	248	0	0	0	1	1	1	1	1
298	249	1	0	0	1	1	1	1	1
299	250	0	1	0	1	1	1	1	1
300	251	1	1	0	1	1	1	1	1
301	252	0	0	1	1	1	1	1	1
302	253	1	0	1	1	1	1	1	1
303	254	0	1	1	1	1	1	1	1
304	255	1	1	1	1	1	1	1	1

Table 2 - Alternator Driven Models

NOTE: In the following table, “1” means ON and “0" means OFF.

No. of Pulses/ Rev.	Decimal equivalent	Dip Switch Position							
		D1	D2	D3	D4	D5	D6	D7	D8
03	03	1	1	0	0	0	0	0	0
04	04	0	0	1	0	0	0	0	0
05	05	1	0	1	0	0	0	0	0
06	06	0	1	1	0	0	0	0	0
07	07	1	1	1	0	0	0	0	0
08	08	0	0	0	1	0	0	0	0
09	09	1	0	0	1	0	0	0	0
10	10	0	1	0	1	0	0	0	0
11	11	1	1	0	1	0	0	0	0
12	12	0	0	1	1	0	0	0	0
13	13	1	0	1	1	0	0	0	0
14	14	0	1	1	1	0	0	0	0
15	15	1	1	1	1	0	0	0	0
16	16	0	0	0	0	1	0	0	0
17	17	1	0	0	0	1	0	0	0
18	18	0	1	0	0	1	0	0	0
19	19	1	1	0	0	1	0	0	0
20	20	0	0	1	0	1	0	0	0
21	21	1	0	1	0	1	0	0	0
22	22	0	1	1	0	1	0	0	0
23	23	1	1	1	0	1	0	0	0
24	24	0	0	0	1	1	0	0	0
25	25	1	0	0	1	1	0	0	0
26	26	0	1	0	1	1	0	0	0
27	27	1	1	0	1	1	0	0	0
28	28	0	0	1	1	1	0	0	0
29	29	1	0	1	1	1	0	0	0
30	30	0	1	1	1	1	0	0	0
31	31	1	1	1	1	1	0	0	0
32	32	0	0	0	0	0	1	0	0
33	33	1	0	0	0	0	1	0	0
34	34	0	1	0	0	0	1	0	0
35	35	1	1	0	0	0	1	0	0
36	36	0	0	1	0	0	1	0	0
37	37	1	0	1	0	0	1	0	0
38	38	0	1	1	0	0	1	0	0
39	39	1	1	1	0	0	1	0	0
40	40	0	0	0	1	0	1	0	0

NOTE: Switch combinations up to 100 pulses per revolution are not shown as the range of 3 – 40 pulses per revolution fits most applications.

Table 3 - Ignition Driven Models

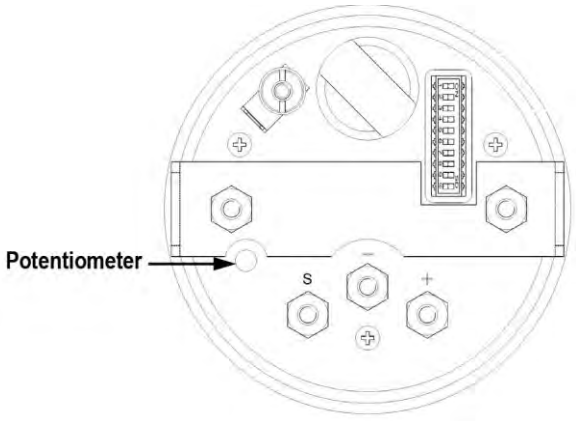
4-Cycle Engines	No. of Pulses per Engine Revolution	Decimal Equivalent	Binary of Decimal Equivalent Dip Switch Position		
			D1	D2	D3
2 cylinder	1	1	1	0	0
4 cylinder	2	2	0	1	0
6 cylinder	3	3	1	1	0
8 cylinder	4	4	0	0	1
10 cylinder	5	5	1	0	1

NOTE: Dip switches D4 through D8 are not used and should be set to OFF.

Potentiometer Fine Adjustment Calibration

You can adjust calibration on all models through the fine adjust potentiometer (pot) located on the back side of the housing.

> **NOTE:** This option is for fine tuning and not for coarse tuning.



The following steps will guide you through the fine adjustment process.

1. Use a duly calibrated optical tach or master tach to determine actual engine RPM.
2. Determine DIP switch settings by calculating and using the table to set the DIP switches provided on the back side of the gauge accordingly. Refer to the preceding calibration instructions.
3. Remove the QC passed sticker to access the fine adjustment hole.
4. Use small flat screw driver (watch maker No. 4) for fine tuning. Make sure the screw driver sits properly in potentiometer slot without touching other parts of the PCB.
5. Rotate the potentiometer such that the reading of the tach matches the actual RPM noted by the master tach. Turning the pot in clockwise direction will increase RPM, while turning the pot in counter-clockwise direction will decrease the RPM.

   IMPORTANT! The fine adjustment potentiometer can only be turned ¾ of a turn. Be gentle and do not force it.

6. The maximum range for increasing and decreasing the RPM through fine adjustment pot is approximately 400 RPM.
7. If unable to match the reading with the master tach using the method above, then recheck the calculations or change the next level DIP switch setting and repeat the calibration procedure.
8. Once the pointer is adjusted to the desired position, it is recommended to cover the fine adjustment hole to protect it from water entry and other atmospheric effects.

Specifications

Magnetic Sensor Driven Models

- **Power Input:** 11-28VDC (70mA – 120mA except lamp load)
- **Backlight:** 3.4W T-10 wedge base bulb
- **RPM Input Signal Voltage:** 1.5Vrms minimum
- **Accuracy:** Tachometer: +2% full scale
  Hourmeter: +0.01% hours, +1 count
- **Temperature Range:** -40°C to +82°C (no permanent damage shall occur)
- **Dial (Face Plate):** 270° sweep with white numerals (over black background)
- **Bezel:** 304 stainless steel for bright and IS 513 E.E.E. CRCA steel for black
- **Scale:** 0-4000RPM
- **Case Material:** Plastic
- **Hourmeter Range:** 99999.9 hours in 0.1 increments.

Alternator Driven and Ignition Driven Models

- **Power Input**: 11-28VDC (70mA-120mA except lamp load)
- **Backlight**: 3.4W T-10 wedge base bulb
- **RPM Input Signal Voltage**: V low: 0.5V max, V high: 8.0V min.
- **Accuracy**: Tachometer: +2% full scale
  Hourmeter: +0.01% hours, +1 count
- **Temperature Range:** -40°C to +82°C (no permanent damage shall occur)
- **Dial (Face Plate):** 270° sweep with white numerals (over black background)
- **Bezel:** 304 stainless steel for bright and IS 513 E.E.E. CRCA steel for black
- **Scale:** 0-4000RPM
- **Case Material:** Plastic
- **Hourmeter Range:** 99999.9 hours in 0.1 increments.

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