ESI BUILT ARCTIC TOUGH

OPERATIONS & MAINTENANCE MANUAL

ESI DESIGNED AND BUILT

Kubota Diesel Engine
Sykes Pump

APPLICABLE MODELS

ES-SP60
ES-SP60-ENC
ES-SP61

WWW.ESIALASKA.COM

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ESIalaska.com

General Information
&
Warranty

Anchorage:
7780 Old Seward Hwy
Anchorage, AK 99518
(907) 341-2250 | (877) 341-2250

Fairbanks:
1919 Van Horn Road
Fairbanks, AK 99701
(907) 458-9049 | (888) 868-9049

Seattle:
17660 W. Valley Hwy
Tukwilla, WA 98188
(425) 251-6119

Williston:
5064 Bennett Loop
Williston, ND 58801
(701) 774-5312

Equipment Source, Inc.

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ESI BUILT ARCTIC TOUGH

ES-SP60

6" TRAILER-MOUNTED PUMP

ESIAlaska.com

PUMPS

THE HIGH-VOLUME, SELF-PRIMING, MOBILE PUMPING SOLUTION THAT WON'T QUIT.

ES-SP60 FEATURES:

- Sykes CP150 pump-powered by Kubota diesel engine
- 2400 gpm flow rate with 3-inch solids handling
- 50 CFM vacuum assisted, run-dry priming system
- Durable ESI trailer with built-in fuel tank

SEE ALL SPECS & PICS

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EARTH MOVING | PUMPS | GENERATORS | HEATERS | PARTS

ES-SP60

6” TRAILER-MOUNTED PUMP

PUMP

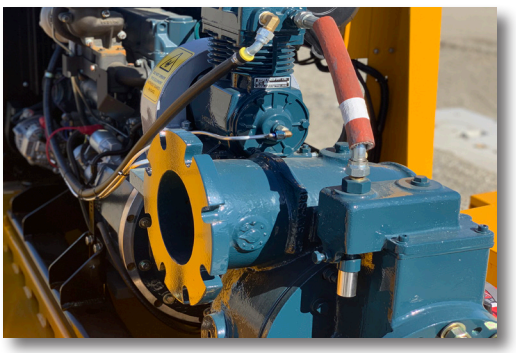
- Sykes CP150 series pump
- 6-inch suction and discharge flanges
- Maximum flow rate of 2400 gallons per minute
- 3-inch solids handling capabilities for application flexibility
- Up to 160-foot lift to move liquid to higher discharge points
- Priming system with vacuum assist pump provides run-dry operation
- Automatic self-priming in cases of lost suction
- Heavy-duty construction for reduced maintenance costs
- High efficiency design for reduced fuel costs

ENGINE

- Kubota V3800T 4-cycle, turbocharged diesel engine
- Maximum shaft power of 95 hp
- DSE control panel for ease of operation and engine speed monitoring
- Optima Spiral Cell technology for superior starting performance

TRAILER

- Powder coated trailer and components
- 115 gallon built-in fuel tank
- Rear drop legs for stability during operation
- Front stone guard to protect engine during transport



Specifications	
Connections	6” x 6” Class 150 ANSI flanges
Max flow rate	2400 gpm (9000 lpm)
Max solids handling	3” (76 mm)
Max lift	160’ (48 meters)
Max operating speed	2200 rpm
Fuel capacity	115 gal (435 L) ULSD
Fuel consumption	4.3 gph @ 2200 rpm (max) 2.9 gph @ 1800 rpm

OPERATORS MANUAL

Water Trash Pumps

Kubota Powered Pumps by ESI

www.ESIalaska.com

For Parts & Service:

Fairbanks, Alaska
907.458.9049
FAI-Parts@ESIalaska.com

Anchorage, Alaska
907.341.2250
ANC-Parts@ESIalaska.com

Seattle, Washington
425.251.6119
FAI-Parts@ESIalaska.com

Williston, North Dakota
701.774.5312
Williston-Sales@ESIalaska.com

SPECIFICATIONS

See product specification sheet for product specifications

1 Introduction

⚠WARNING Read and understand this manual before operating the machine to avoid serious injury or death.

1.1 General Description

ESI built KPG generators come in a variety of configurations and sizes. Refer to unit specifications and manual components for specific details. General operation and maintenance remains the same for all of these units.

1.2 Manual Applicability

This manual is applicable to the following Equipment Source Incorporated (ESI) machine models:

Model	Description
ES-CP40	4” Skid Mounted or Mobile Pump. Kubota V1703 Power Water Trash Pump with Cornell Pump. Wet Prime System.
ES-CP41	4” Skid Mounted or Mobile Pump. Kubota V1505 Power Water Trash Pump with Cornell Pump. Wet Prime System.
ES-PP60	6” Mobile Kubota V3600 Powered Water Trash Pump with Pioneer Pump. Diaphragm Dry Priming System
ES-PP61	6” Mobile Kubota V3600 Powered Water Trash Pump with Pioneer Pump. Compressor Dry Priming System
ES-SP60	6” Mobile Kubota V3800 Powered Water Trash Pump with Sykes Pump. Compressor Dry Priming System
ES-SP61-ENC	6” Mobile Kubota V3600 Powered Water Trash Pump with Sykes Pump. Compressor Dry Priming System. Arctic Enclosure
ES-SP60-ENC	6” Mobile Kubota V3800 Powered Water Trash Pump with Sykes Pump. Compressor Dry Priming System. Arctic Enclosure

This manual should be kept with the machine at all times. Immediately contact Equipment Source Incorporated (manufacturer) or an authorized dealer to obtain a copy of this manual if missing or damaged. Refer to www.equipmentsourceinc.com for current contact information.

1.3 Manual Scope

This manual contains basic operating and maintenance instructions for the above listed product. For detailed service instructions concerning specific electrical or mechanical components, refer to the operation and maintenance manual provided by the manufacture of the specific component or contact an authorized service provider.

1.4 Warranty

Review the warranty before operating or working on the unit. The warranty contains important safety and operational requirements. Contact ESI for the latest warranty information.

2 IMPORTANT SAFETY INSTRUCTIONS

⚠WARNING

- SAVE THESE INSTRUCTIONS. This manual contains important instructions that should be followed during the operation and maintenance of the pump and engine.

2.1 Training

- Never allow untrained personnel to operate or service the machine. Take time to read the manual and discuss safe practices with jobsite personnel.
- Read and understand the operating section of this manual.
- Take time to familiarize yourself with the controls and instructional placards before operating or servicing.
- Contact your dealer or service provider if additional training is necessary.

2.2 Operating

- Some components are hot while in operation. Keep clothing and combustibles away.
- Wear protective clothing, such as gloves, appropriate to the jobsite.
- Observe changes in the operating environment and respond accordingly.
- Pumps vibrate in normal use. During and after the use of the pump, inspect the generator as well as extension cords and power supply cords connected to it for damage resulting from vibration. Have damaged items repaired or replaced as necessary. Do not use plugs or cords that show signs of damage such as broken or cracked insulation or damaged blades.

2.3 Service

- Only trained service technicians should attempt to service the machine.
- Properly shutdown the machine and let cool completely before attempting to service any component.
- Never defeat the safety devices
- Never modify the machine

3 Transporting

3.1 Lifting

⚠CAUTION

- Ensure that any equipment used to lift the unit is rated for the weight of the unit.

3.2 Transporting

1. Lift the machine following the guidelines presented below.
2. If applicable: ensure all doors are closed and latched.
3. Remove any hoods in the way before lifting.
4. Lift the unit using ONLY designated lifting points or fork pockets.

3.3 Storage

Units placed in storage must be stored out of the elements and protected from rain, snow and sunlight. The warranty will be voided for units left exposed to the elements during storage. ESI built unit enclosures provide sufficient protection when properly closed.

3.3.1 Short-Term Storage (less than 90 days)

1. Shutdown the machine
2. Verify that the 12V disconnect and control switches are in the off position
3. Drain water from pump and priming system
4. Close all doors (if applicable)

3.3.2 Long-Term Storage (greater than 90 days)

1. Shutdown the machine
2. Verify that the 12V disconnect and control switches are in the off position
3. Drain water from pump and priming system
4. Disconnect the battery
5. Drain water from fuel filters.
6. Secure/Close vents and openings (if applicable).

3.3.3 Cold Weather Storage

1. Open drain valves
    a. These may include
        i. Valve at bottom of pump
        ii. Valve at bottom of backflow preventor
        iii. Valve on diaphragm priming systems
        iv. Follow instructions posted on unit for further drain locations
2. THE FOLLOW IS FOR DRY PRIME PUMP ONLY:
    a. Run the pump for two minutes with water supply disconnected. The pump is designed for run dry operation.
    b. Follow Short-Term or Long-Term Storage instructions.

3. THE FOLLOW IS FOR WET PRIME PUMP ONLY:
    a. Once pump is drained, follow Short-Term or Long-Term Storage instructions.

4 Operation

4.1 System Operation

Refer to individual component manuals for operation of those components. This unit should only be operated by trained personnel familiar with the operation of the entire system. Refer to the PRE-OPERATION CHECK portion of the Engine Manual

4.2 Access and Clearance

- Ensure adequate clearance around the perimeter of the machine.
- The operator should be able to walk around the machine with minimal obstruction

4.3 Leveling

Ensure the machine is placed on firm ground and the wheels are chocked, the pump should be close to level across the width of the machine.

Use the trailer jack and rear drop legs to stabilize the trailer

To adjust the drop legs:

- Remove the hitch pin
- Set leg height to a suitable position
- Re-insert the hitch pin to lock the drop leg in place

Once the trailer is stabilized, you can prepare the pump for startup

- The operator should be able to walk around the machine with minimal obstruction

4.4 Pre-Startup Checklist

Use the following checklist to determine whether the machine can be safely started and operated:

- Machine is level on stable ground
- Wheels are chocked
- Exhaust is free of obstruction
- Adequate clearance around the perimeter of the machine
- Water is drained from fuel/water separator
- Engine oil and coolant levels are normal
- Fuel tank filled with recommended fuel type
- Ensure the ball valve on the vacuum prime assist is in the “open” position
- Ensure the throttle control is turned clockwise to idle

- The operator should be able to walk around the machine with minimal obstruction

4.5 Startup

- Turn on the battery disconnect switch at the back of the control box
- Turn the key switch on the control panel to position I and wait for the glow plug light to turn off
- Turn the key switch to position II to start the engine
- Allow the engine to warm up for 5-10 minutes depending on outside temperature
- After the engine has warmed up, you may turn the throttle dial counterclockwise to increase RPM while monitoring the analog tachometer

- The operator should be able to walk around the machine with minimal obstruction

4.6 Shutdown

- To shut down the pump, first return the throttle control to the idle position and allow the engine to run for 5 minutes before switching off the ignition & battery disconnect switch

4.7 Recommended Fuels and Fueling Instructions

⚠CAUTION Do not overfill tank. Tank should be filled to only 90% of the full volume to allow thermal expansion.

Use ULSD No.1 or ULSD No.2. For continuous duty operation, a refilling schedule should be established.

4.8 Engine Heat - 120V Power Input

If a cold start is required, use the 120V engine pre-heat circuit to warm the engine block and engine oil prior to starting. The engine should be pre-heated for approximately 4-hours if the ambient temperature is below -7°C (20°F). Longer preheat cycles may become necessary in extremely cold conditions.

Use a grounded flexible extension cord rated at 15A minimum to connect the machine to a 120V power supply. There is an orange, three-prong “Y” located on each of the generators.

4.9 Monitoring and Operation

4.9.1 Daily Inspection & Startup Inspection (required)

- Conduct general inspection of the unit
- Listen for abnormal sounds
- Check fluid levels
- Check all hoses for damage (including but not limited to fuel lines and coolant lines)
- Check engine temperature
- Check containment for accumulation of liquids.
- Check vents for icing or other obstructions (if applicable)
- Observe recommended maintenance schedule
- Check for error codes on control units for pump and any other equipment associated with the unit.

5 Maintenance

⚠CAUTION Some of the following maintenance operations should only be completed by a trained technician. Do not attempt to open electrical panels unless you are a trained technician. Maintenance schedule must be adhered to and documented in order to maintain warranty. Maintenance programs should be tailored to the specific generator, environment and operating conditions.

5.1 Maintenance Schedule

Table 1. Maintenance Schedule

Interval	Maintenance Instruction	Notes
Daily	▪ See section 4.9.1 of this manual for additional requirements	Complete at every inspection
Every 50 hours	▪ Check of fuel pipes and clamp bands ▪ Check radiator hoses and clamp bands ▪ Drain water separator	
Varies by model	Engine Oil Change and Oil Replacement Intervals ▪ Standard Oil Pan (Kubota Recommendation) ○ Initial Oil Change: 50 hours ○ Interval: ▪ 4” Pumps: 200 hours 6” Pumps: 500 hours	Engine oil must meet API Spec: CF, CF-4, CG-4, CH-4 or CI-4
Every 200 hours (4” Pumps)	▪ Clean air cleaner element ▪ Change Engine Oil and Oil Filter ▪ Check and clean fuel filter ▪ Check battery electrolyte level ▪ Check fan belt tightness ▪ Check intake air line ▪ Inspect pump and engine	
Every 400 hours (4” Pumps)	▪ Replace fuel filter cartridge ▪ Clean air cleaner element	
Every 500 hours (6” Pumps)	▪ Clean air cleaner element ▪ Change Engine Oil and Oil Filter ▪ Replace fuel filter ▪ Check battery electrolyte level ▪ Check fan belt tightness ▪ Check intake air line ▪ Inspect pump and engine	
Every one or two months	▪ Charge battery as needed	

Every Year	▪ Replace air cleaner element ▪ Clean Generator (blow out with air) and inspect ▪ Change Engine Oil and Oil Filter ▪ Remove sediment in fuel tank ▪ Clean water jacket (radiator interior) ▪ Replace fan belt ▪ Clean water separator ▪ Replace fan belt	Air filter element may need cleaning more frequently depending on environmental conditions
Every 800 hours	▪ Check valve clearance	
Every 1500 hours	▪ Check fuel injectors	
Every 3000 hours	▪ Check turbo charge (if unit is equipped with a turbo) ▪ Check fuel supply pump	
Every Two Years	▪ Change radiator coolant ▪ Replace battery ▪ Replace radiator hoses and clamp bands ▪ Replace fuel pipes and clamp bands ▪ Replace intake air line ▪ Replace fan belt (or every 500 hours, whichever occurs first)	

5.2 Engine Service

Use engine operator's or service manual provided for further instruction on how to complete routine service or trouble shooting.

5.3 Battery Service

The engine starting circuit is supplied by a single 12V battery. No maintenance is required other than normal charging and occasional replacement.

To replace the battery, sequentially remove the negative ground lead, positive power lead and the bracket holding the battery in the tray. Replace the battery by securing in the tray, connecting the positive lead and then connecting the ground lead.

6 Maintenance Records

Table 2. Machine Data

Machine Serial Number	
Engine Serial Number	
Pump Serial Number	

Table 3. Maintenance Records

▪ Date ▪ Engine Hours ▪ Service Personnel ▪ Service Location	**Description of work completed**

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COMMON PARTS
ESI PUMPS

See Pump Manual for commonly replaced pump end parts (Pioneer / Cornell / Sykes)

Model	ES-CP40	ES-CP41	ES-CP43	ES-PP60	ES-PP61	ES-SP60 & ES-SP60-ENC	ES-SP61-ENC
Pump Size	4”	4”	4”	6”	6”	6”	6”
Pump End Manufacturer	Cornell 4STX		Cornell	Pioneer SC66S10	Pioneer	Sykes CP150iPE	
Pump Priming System	N/A	N/A	Compressor	Diaphragm	Compressor	Compressor	
Engine	Kubota V1703	Kubota V1505	Kubota V2403	Kubota V3600		Kubota V3800	Kubota V3600
Oil Filter (Engine)	HH164-32430 (200 hrs)	HH160-32093 (200 hrs)	HH164-32430 (200 hrs)	HH1C0-32430 (500 hrs)		HH1C0-32430 (500 hrs)*	HH1C0-32430 (500 hrs)
Outer Air Filter (Engine)	70000-11081 (400 hrs)	K1211-82320 (400 hrs)	70000-11080 (400 hrs)	59700-26112 (500 hrs)		59700-26112 (500 hrs)*	59700-26112 (500 hrs0
Inner Air Filter (Engine)	N/A	N/A	N/A	R2401-42280 (500 hrs)		R2401-42280 (500 hrs)*	R2401-42280 (500 hrs)
Air Filter (Compressor)	N/A	N/A	100696-N (400 hrs)	N/A		54-0557-9912 (500 hrs)*	
Fuel Filters	HH166-43560 & R60S (400 hrs)	HH166-43560 & R60S (400 hrs)	HH166-43560 & R60S (400 hrs)	HH166-43560 & R60S (500 hrs)		H116-43560 & R60S (500 hrs)*	HH166-43560 & R60S (500 hrs)
Oil Capacity 15w40 –or—Full Synthetic 0W30	7.0 Liters / 1.85 Gal (200 hrs)	5.7 Liters / 1.50 Gal (200 hrs)	9.5 Liters / 2.50 Gal (200 hrs)	13.2 Liters / 3.50 Gal (500 hrs)		13.2 Liters / 3.50 Gal (500 hrs)*	13.2 Liters / 3.50 Gal (500 hrs)

Part numbers may vary for non-standard products. Always have unit Stock # and engine serial number available when calling for parts.

**1,000 hours for units equipped with long run oil filtration system*

Anchorage:
7780 Old Seward Hwy
Anchorage, AK 99518
(907) 341-2250 | (877) 341-2250

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Williston, ND 58801
(701) 774-5312

Equipment Source, Inc.

WARRANTY

EQUIPMENT SOURCE INC.
LIMITED WARRANTY

INFORMATION

Equipment Source Inc. (ESI) 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). Warranty periods are from invoice date. Not all of the following components are applicable to every product. All warranty time periods begin at invoice date:

1. Engine – 2 (two) years / 2,000 hours, whichever occurs first (please refer to the Kubota Engine Warranty sheet enclosed in this manual).
2. Generator and Controls – Free from defects in materials or workmanship for 1 (one) year / 2,000 hours.
3. Flagro Heater / Fire Box - 1 (one) year / 2,000 hours
4. ESI Manufactured Firebox– free from defects in materials or workmanship for 3 (three).
5. Pump – 1 (one) year (please refer to the pump warranty sheet enclosed in this manual), wear parts are not covered under warranty.
6. Buderus Boiler – 2 (two) years limited warranty, please refer to Buderus warranty sheet enclosed in this manual.

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 (907.458.9049) or 7780 Old Seward Highway, Anchorage, AK 99518 (907.341.2250). Call 907.458.9049 from outside Alaska. Offsite warranty may be performed if customer pays all travel and shipping expenses.

No person, agent or dealer is authorized to give any warranties on the behalf of ESI, nor is to assume for this company any other liability in connection with any of ESI's products unless made in writing and signed by an officer of ESI. This warranty supersedes and is in leu of all other warranties, expressed or implied including terms and conditions of Purchase Orders. The company must be notified within 5 (five) business days, in writing of any product failure and warranty claim.

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. Damage, malfunction or failures resulting from underloading of the engine (also known as wet stacking) voids the warranty. Refer to the Operations and Maintenance manual for proper engine loading requirements.
3. Normal maintenance services or replacement of maintenance items such as light bulbs, preheater plugs, heater nozzles, filter elements, lubricants, oils, coolant, belts, tires, or other wear items.
4. This warranty does not cover cosmetic damage.
5. 3rd party parts installed on ESI products. Unauthorized modifications to the unit will void the warranty and may impair function.
6. Failure of or damage caused by ancillary systems. These include but are not limited to failures of the fuel or oil system (not provided by ESI), HVAC system, building / structure or other systems.
7. Units placed in storage must be stored out of the elements and protected from rain, snow and sunlight. The warranty will be voided for units left exposed to the elements during storage. ESI built unit enclosures provide sufficient protection when properly closed.
8. Improperly installed products. Operating the unit on or in the packing pallet or crate or improperly mounted skid generator (including installation of isolators between the skid and mounting surface) voids the warranty. Consult the product operator's manual for required installation procedures.
9. Installation of electrical components by anyone other than a licensed electrician voids the warranty.

10. Use of the unit for application other than what the product was meant for voids the warranty.
11. Warranty coverage expires whenever the client, for whatever reason, is late in payment.
12. 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 and use is expected and does not warrant repairs.

LIMITATION ON ESI's 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 sole responsibility of the end user. In no event shall ESI's liability ever exceed the purchase price of the specific unit in questions.

MONITORING REQUIREMENTS

Frequent monitoring of equipment is vital for proper operation and maintenance of the equipment. All equipment must be monitored daily by trained technicians (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). The following unit conditions must be monitored on a daily basis, failure to do so will void all warranties. Additional monitoring may be required depending on site specific requirements.

- General inspection of unit to include: inspection for leaks, damage to unit, improper operation, malfunctioning equipment, error codes or other issues.
- Inspect coolant level and condition. Add coolant as needed to maintain proper coolant levels. Replace coolant if coolant condition has degraded.
- Inspect oil level and condition. Add oil as needed to maintain proper oil levels. Replace oil at recommended service intervals or if oil is found to have degraded.
- Inspect Engine temperature and engine speed.
- Inspect containment, check for leaks and presence of fluids in containment

Maintenance logs must be maintained for the unit and provided to ESI for warranty claims. ESI offers monitoring equipment for electronic monitoring.

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.
- Learn how to operate and work safely. Know your equipment and its limitations. Always keep the engine in good condition.
- 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.
- For Trailer Mounted Units:
  - Ensure that the trailer is registered with an applicable transport authority before towing.
  - Complete a thorough walk around inspection of the unit before towing. Inspect for damage or abnormalities and repair as needed before travel.
  - Disconnect the trailer from the tow vehicle, place wheel chocks behind the wheels and level prior to running or operating the unit.
- Refer to the various component sections of the Operator's Manual for proper maintenance and service intervals.

Failure to adhere to any of the above requirements or the requirements of Installation Instructions or Operations and Maintenance Manual will void all warranties. ESI reserves the right to update or modify this warranty at time. Contact ESI for a current warranty.

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ESIalaska.com

Pump Manual

Anchorage:
7780 Old Seward Hwy
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Equipment Source, Inc.

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SYKES

PUMPS INSTALLATION, OPERATION & BASIC SERVICE MANUAL

Venturi Range of Pumps

READ BEFORE INSTALLING OR OPERATING THIS EQUIPMENT

Revision 07 **Valid from May16**

ALLIGHTSYKES

AllightSykes
42 Munibung Rd, Cardiff, NSW, 2285
Postal Address: 42 Munibung Rd, Cardiff, NSW, 2285
Tel 1300 ALLIGHT | +61 (2) 4954 1400 | fax +61 (2) 4954 3226
email: sales@allightsykes.com | web: www.allightsykes.com

Table of Contents

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1. INTRODUCTION

1.1 GENERAL

Congratulations on the purchase of your new Sykes / Primax Pump

With AllightSykes/AllightPrimax's established quality control systems you can be assured your pump was manufactured with a high level of control and has undergone extensive testing on AllightSykes' certified test facility.

AllightSykes/AllightPrimax/Dealer are pleased to offer a 12 month or 2,000hrs warranty, whichever occurs first, on your new pump. As with all warranties, AllightSykes' warranty is subject to regular maintenance. To ensure your warranty is maintained, make sure your pump is regularly serviced. AllightSykes/Dealer offer maintenance and repairs on our entire range and are able to offer regular service agreements if required.

AllightSykes/AllightPrimax/Dealer provide local service through a highly trained network of branches and are able to meet your service and spare parts requirements around the clock.

Turnaround on parts is rapid with AllightSykes/AllightPrimax/Dealer customer service ready to meet your needs 24 hours a day with spare parts located at branches Australia wide and around the globe.

Our AllightSykes/AllightPrimax/Dealer trained staff will assess your application and help to set up optimum operating settings which will help to reduce unnecessary wear and tear on the pump whilst ensuring the pump is operating at its most efficient duty point.

1.2 DISCLAIMER

Information in this Installation, Operation & Basic Service Manual is believed to be reliable. In spite of all the efforts of AllightSykes Pty Ltd to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by AllightSykes as to its completeness or accuracy.

1.3 COPYRIGHT

1.4 PUMP NAMEPLATE INFORMATION

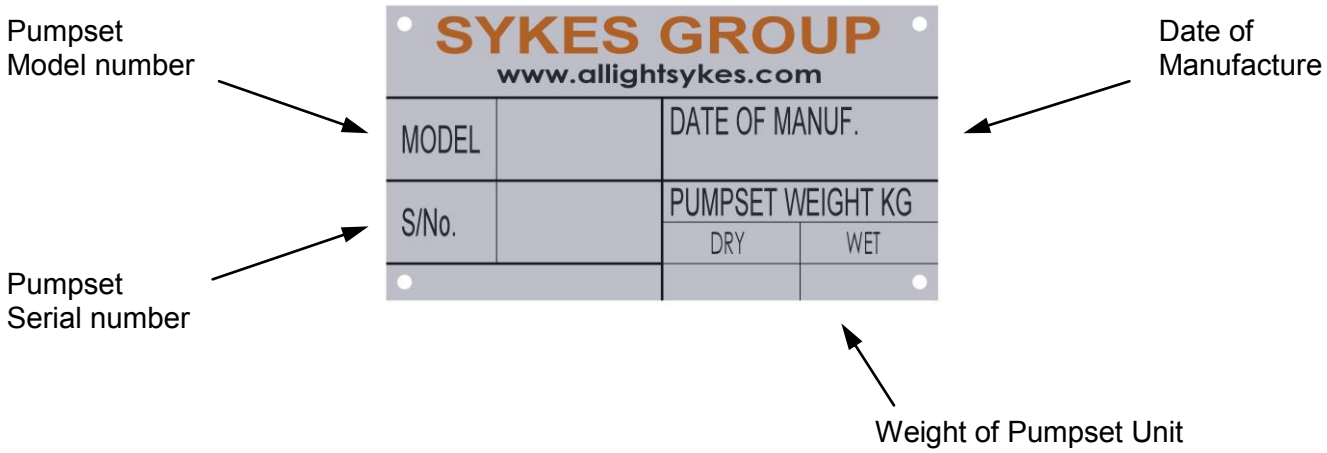
Important information for enquires or ordering

Every Pumpend or Pumpset has a nameplate that provides information about the pump unit.

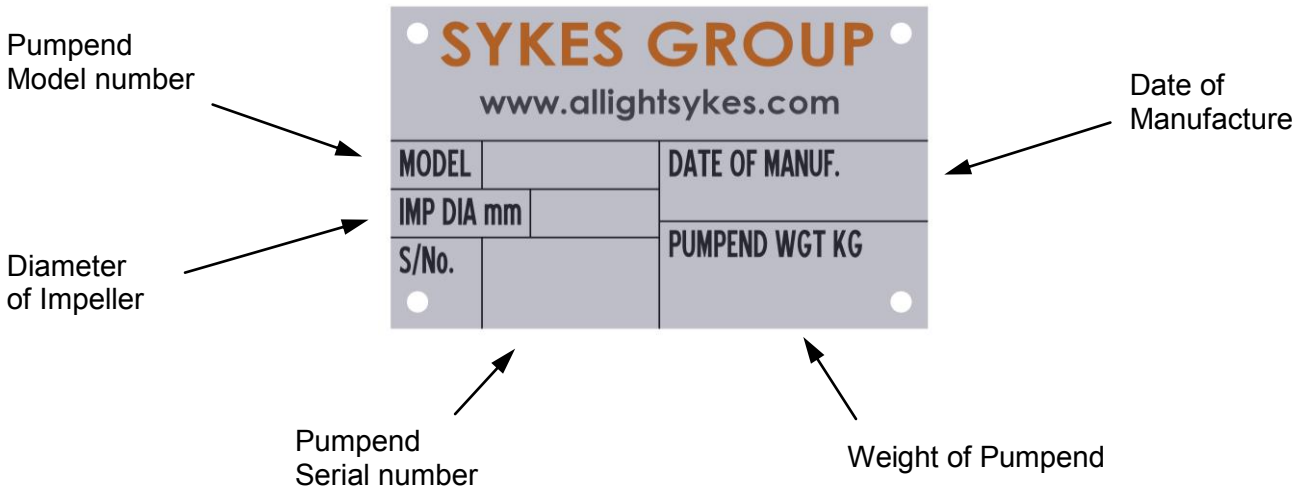
The nameplate is generally located:

- for pumpend – on pump casing
- for pumpset with lifting frame – on lifting frame
- for pumpset without lifting frame – on chassis/base frame

Quoting the Model number and Serial number will help in any enquiry for spares or service.



Example of Pumpset Nameplate



Example of Pumpend Nameplate

2. Transportation, Handling and Storage

2.1 CONSIGNMENT RECEIPT AND UNPACKING

Upon receipt verify that the equipment received is in exact compliance with the list on the packing list and if there has been no damage in transportation. Any shortage and/or damaged must be reported immediately to the transport company and to AllightSykes/AllightPrimax.

Check any crate, boxes or wrappings for any accessories or spare parts that may be packed separately with the equipment or attached to side walls of the box or equipment.

Discard through controlled disposals all packing materials which may constitute personal injury (sharp objects, nails, etc…)

2.2 HANDLING / LIFTING METHODS

Caution
This section is added for information purposes only and not to be used as a Handling/Lifting Manual.

AllightSykes encourages thorough training and maintenance of high safety standards in the use of this equipment, but responsibility for complying with the proper handling/lifting instructions resets with the owner of the product.

Warning
All necessary tie down/moving/lifting should only be carried out by suitably trained personnel, in accordance with local regulations. If not strictly observed, could result in severe personal injury or loss of life.

The pump unit must **ALWAYS** be tied down/moved/lifted and transported in the horizontal position. Prior to moving/lifting the unit find the following:

- total weight (refer nameplate information)
- centre of gravity
- maximum outside dimensions
- lifting points location
- towing points location
- tie down points location
- forklift pockets location

All personal must wear clean, correctly fitted clothing and safety footwear.

Whilst moving/lifting the equipment keep all personal well away and never allow people underneath.

Assembled units and their components are heavy. Failure to properly tie down/move/lift and support this equipment can result in serious physical injury and/or equipment damage. Tie down/move/lift equipment only at the specifically identified tie down/towing/lifting points.

Tie down/moving/lifting equipment eyebolts, slings and spreaders bars must be rated, selected and used for the entire load being tie downed/moved/lifted.

Care must be taken to move/lift the equipment above centre of gravity to prevent the unit from flipping.

Do not lift equipment with forklift unless forklift pockets are provided.

Lifting eyebolts if fitted on single components of the assembly (e.g. pump or motor) should not be used to lift the total assembly.

Do not attach sling to shaft ends.

Maximum lift angle from vertical about lifting eye to be +/- 5°.

Avoid lifts whereby the slings, form a triangle with the top angle over 90°.

Hoisting acceleration should not exceed 0.6m/sec^2.

Lifting Frame Certifications
All lifting frames fitted to Pumpset units are certified and attached with WLL label. If require further information contact AllightSykes/AllightPrimax.

Below are figures showing recommended means of moving/lifting methods. They are intended for guidance only. If in doubt, consult AllightSykes/AllightPrimax or a local lifting expert.

Figure 1: Typical SAE #3 & 4 Bearing Bracket without Non-Return Valve

Figure 2: Typical SAE #3 & 4 Bearing Bracket c/w Non-Return Valve

Figure 3: Typical SAE #1 Bearing Bracket without Non-Return Valve

Figure 4: Typical SAE #1 Bearing Bracket c/w Non-Return Valve

Figure 5: *Typical Small Pumpset Unit c/w Single Point Lifting Frame*

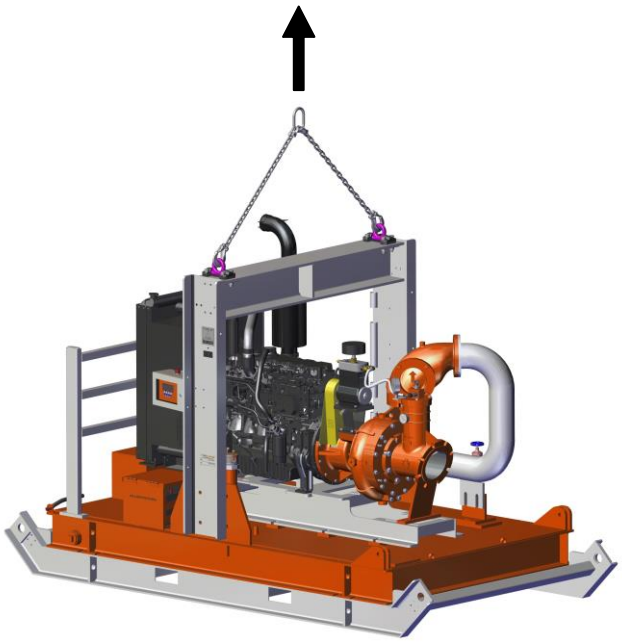


Figure 6: *Typical Large Pumpset Unit c/w Double Point Lifting Frame*

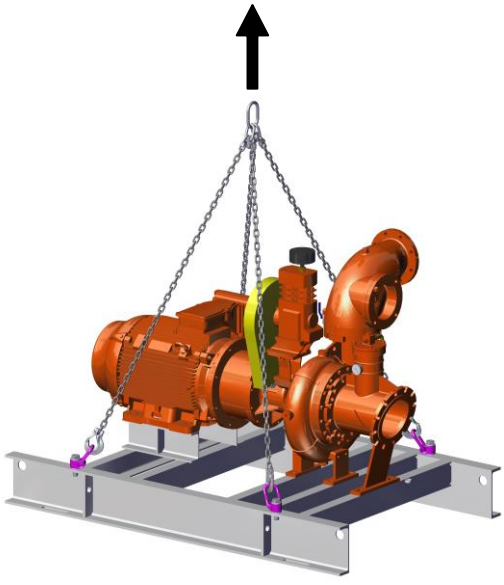


Figure 7: *Typical Small Pumpset Unit without Lifting Frame*

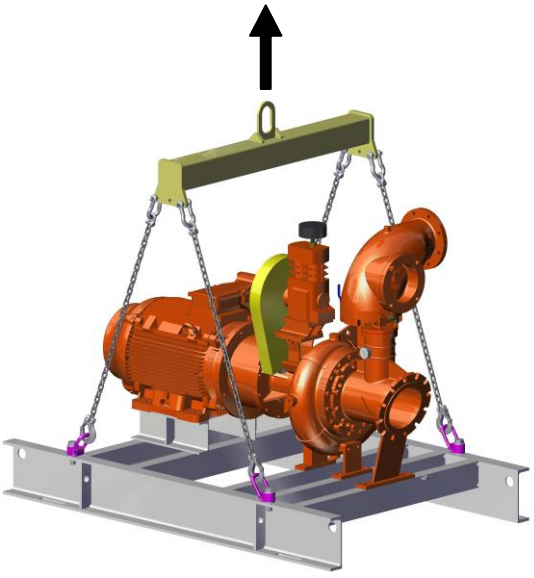


Figure 8: *Typical Small Pumpset Unit without Lifting Frame, using Spreader Bar*

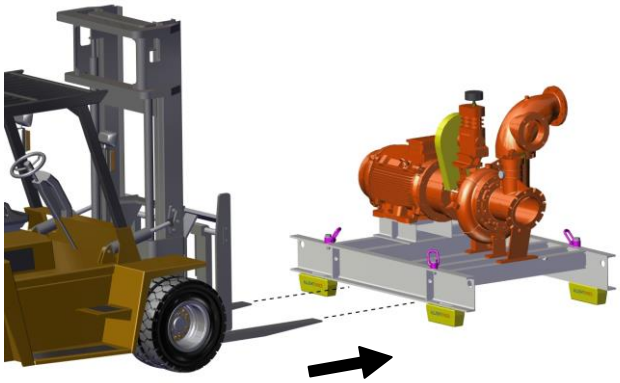


Figure 9: Typical Small Pumpset Unit c/w Fork Pockets

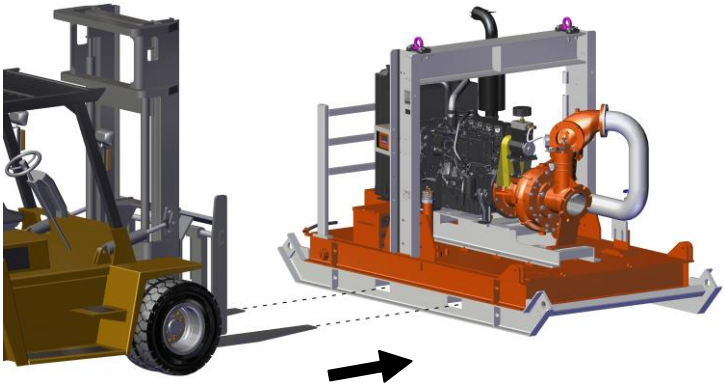


Figure 10: Typical Large Pumpset Unit c/w Fork Pockets

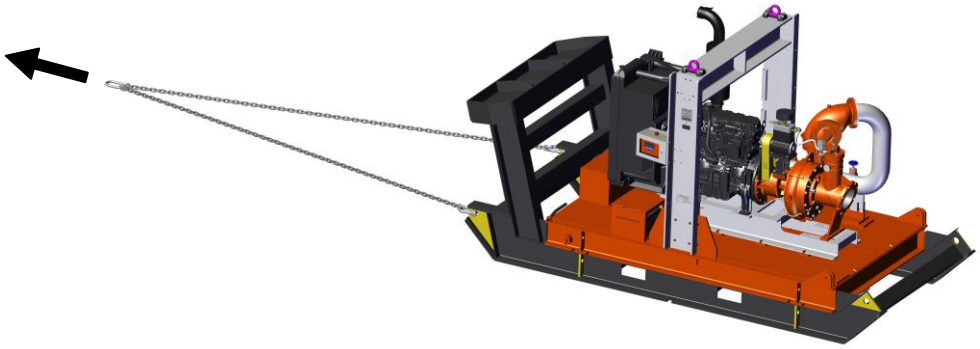


Figure 11: Towing Typical Large Pumpset Unit

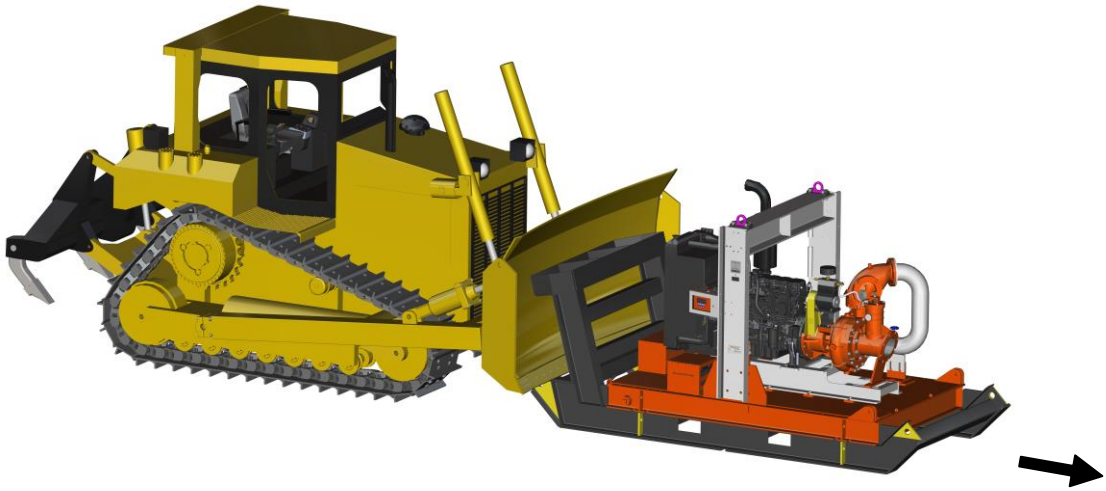


Figure 12: Pushing Typical Large Pumpset Unit

3. SAFETY INFORMATION

3.1 SAFETY PRECAUTIONS

This section is added for information purposes only and not to be used as a Safety Manual.

Caution
AllightSykes encourages thorough training and maintenance of high safety standards in the use of this equipment, but responsibility for complying with the proper safety instructions resets with the owner of the product.

For queries, please contact AllightSykes personnel at your nearest branch.

3.1.1 GENERAL

Pumpsets are designed to be safe when used in the correct manner. Responsibility for safety, however, rests with the personnel who install, use and maintain the equipment. The following safety precautions, if followed, will minimize the possibility of accidents. Before performing any procedure or operating technique, it is up to the user to ensure that it is safe. The pumpset should only be operated by personnel who are authorized and trained. Refer to **Job Safety Analysis** (**JSA**) for details.

Read and understand all safety precautions and warnings before operating or performing maintenance on the pumpset.

Ensure that all of the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the pictures are not visible.

Failure to follow the instructions, procedures, and safety precautions in this manual may increase the possibility of accidents and injuries.

General Hazard Information

Attach a “Do Not Operate” warning tag to the start switch or controls before the pumpset is serviced or repaired. Attach the warning tags to the control panel. When appropriate isolate at the battery isolator.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- Grease fittings
- Pressure taps
- Breathers
- Drain plugs
- Wear a hard hat, protective glasses, and other protective equipment as required.
- When work is performed around a Pumpset that is operating, wear protective devices for ears in order to help prevent damage to hearing.
- Do not wear loose clothing or jewellery that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.
- Use all cleaning solutions with care.

Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine or energy sources is stopped. Ensure that the pumpset cannot be started. Allow engine to cool down.
- The protective locks or the controls are in the applied position.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.
- Start the engine with the operator controls. Never short across the starting motor terminals or the batteries. This method of starting the engine could bypass the engine neutral start system and/or the electrical system could be damaged.

Remote Starting of Pumpset

- Some pumpsets have been set up with the ability to be remotely started without warning.
- Ensure unit is isolated before servicing.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out or pumped out. This could result in personal injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

Lines, Tubes and Hoses

Do not bend or strike high pressure lines. Do not install lines, tubes, or hoses that are damaged.

Repair any fuel lines, oil lines, tubes, or hoses that are loose or damaged. Leaks can cause fires.

Inspect all lines, tubes and hoses carefully. Do not use bare hands to check for leaks. Always use a board or cardboard for checking engine components for leaks. Tighten all connections to the recommended torque.

Check for the following conditions:

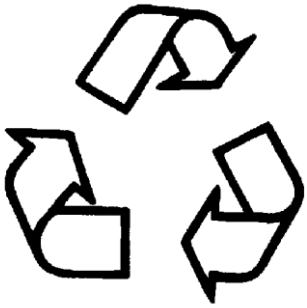
- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Wire that is exposed in reinforced hose
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armouring that is embedded in the outer covering

Ensure that all of the clamps, the guards, and the heat shields are installed correctly. Correct installation of these components will help to prevent these effects: vibration, rubbing against other parts, and excessive heat during operation.

Inhalation

Exhaust
Use caution. Exhaust fumes can be hazardous to your health. If you operate the equipment in an enclosed area, adequate ventilation is necessary.

Dispose of Engine Coolants & Fluids Properly



Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.
Always use leak proof containers when you drain fluids during inspection, maintenance, testing, adjusting and repair. Be prepared to collect the fluid with suitable containers before disassembling any component containing fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

Burn Prevention
Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine.

Relieve all pressure in system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant
When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the compressors or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth

Oils
Hot oil and hot lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Slip & Trips
Ground conditions may change quickly. Poor footing conditions may cause slips and falls from equipment and loss of balance. Use extreme caution when maneuvering on or near loose materials or uneven surfaces.

For secure footing, slip resistant boots should be worn. Consider conditions that often lead to slips such as rain, mud, steep terrain, debris and use three points of contact when mounting and dismounting. Make sure the access area is free of tools, gloves and loose objects

Mounting and Dismounting Equipment

Inspect the steps, the handholds, and the work area before mounting. Keep these items clean and keep these items in good repair.

Mount and dismount at locations that have steps and/or handholds.

Face the unit in order to mount and dismount the pumpset. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Engine Starting

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Engine Stopping

Stop the engine according to the procedure in the Operation and Maintenance Manual, “Engine Stopping (Operation Section)” in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

Trailer Style Pumps

- Take care not to reverse vehicle into trailer, as this may damage brake components.
- Check vehicle towing hitch load rating and ball/hitch size and type are compatible with trailer.
- Check doors are latched closed.
- Check tyres are correctly inflated as per the trailer vin plate
- Check all stabilizer legs are raised.
- Connect hitch, safety chains and electrical plug (if fitted) to vehicle.
- Check jockey wheel is fully retracted and secured horizontally.
- Store wheel chocks (if supplied).
- Check that the brake reversing lock tab on hitch is open (if brakes are fitted).
- Check brake fluid level, brake operation, cables are not frayed, and that adjustment is correct (if brakes are fitted). Check brake fluid pressure by pulling on the brake handle - pressure should be felt on the first stroke. Rectify if necessary.
- Check tail light operation (if lights are fitted).

When towing a trailer observe all codes, standards or other regulations and traffic laws. These include those regulations specifying required equipment, maximum and minimum speeds.

Maximum recommended towing speed on sealed surfaces is 80km/h (dependent on conditions and local limits).

Maximum recommended towing speed is reduced on unsealed surfaces (dependent on conditions and local limits).

Do not permit personnel to ride in or on the trailer. Do not permit personnel to stand or ride on the drawbar or to stand or walk between the trailer and the towing vehicle.

Unhitching Trailer

- Check that the ground is level, the surface secure, and the position is not too close to a dropping embankment.
- Check parking brake is applied on the towing vehicle, and apply parking brake on trailer.
- Install wheel chocks (if supplied) ensuring that the trailer will not roll down any incline.
- Remove chains and electrical plug (if fitted).
- Set the jockey wheel in place ensuring that the swivel plate locks into the vertical position.
- Raise trailer from hitch using the jockey wheel.
- Lower stabilizer legs.

Pontoon Safety

- Ensure that the pontoon is not overloaded with people and equipment.
- Know the location of emergency firefighting equipment
- Use three points of contact if accessing pontoon ladder from boat
- Avoid accessing pontoon in adverse weather conditions.
- Know the location of the life buoy (floatation ring)

Fire and Explosion Prevention

Fuels and fumes associated with pumpsets are combustible and potentially explosive. Proper care in handling these materials can dramatically reduce the risk of fire or explosion. However, safety dictates that fully charged fire extinguishers are kept on hand. Personnel must know how to operate them.

Always perform a Walk-Around Inspection, which may help you identify a fire hazard. Do not operate a product when a fire hazard exists.
Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

Wiring must be kept in good condition. Properly route and attach all electrical wires. Check all electrical wires. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear of for deterioration. Properly route all hoses. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Use caution when you are refuelling pumpset. Do not smoke while you are refuelling. Do not refuel near open flames or sparks. Always stop the engine before refuelling.

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- Outer covers have embedded armouring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly in order to prevent vibration, rubbing against other parts, and excessive heat.

⚠ Never store flammable liquids near the engine.

⚠ Do not smoke or allow sparks, flames or other sources of ignition around fuel or batteries. Fuel vapours are explosive.

⚠ Do not refill the fuel tank while the engine is running.

- If unit is with a fire suppression system or fire extinguisher ensure fire equipment is maintained and serviceable.
- Access environment surrounding pump unit and application before operating or servicing the pumpset.
- Ensure pump unit is operated within the pump operating range.
- With canopy style pump units ensure the ventilation inlet & out take vents are unobstructed and free of debris.
- Ensure areas inside canopy enclosures are free from spills and leaks
- Maintain and service unit at recommended service intervals.
- Stop pumpset before refueling unit if using a manual fill, if other fuel system is used follow their safe operating procedure.

Mechanical

The pump unit is designed with guards for protection from moving parts. Care must still be taken to protect personnel and equipment from other mechanical hazards when working around the equipment.

⚠ Do not attempt to operate the pump with any safety guards or panels removed. While the pump is running, do not attempt to reach under or around the guards for any reason.

⚠ Ensure that the engine is operated only from the control panel.

⚠ Keep hands, arms, long hair, loose clothing and jewellery away from pulleys, belts and other moving parts.

⚠ Attention: Some moving parts cannot be seen clearly when the set is running.

⚠ Keep access doors on enclosures, if equipped, closed and locked when not required to be opened.

⚠ Avoid contact with hot oil, hot coolant, hot exhaust gases and hot surfaces.

⚠ If your skin comes into contact with high pressure fuel/hydraulic oil, obtain medical assistance immediately.

⚠ Wear protective clothing including glove when working around the pump unit.

⚠ Do not remove the radiator filler cap until the coolant has cooled. Then loosen the cap slowly to relieve any excess pressure before removing the cap completely.

⚠ Ethyl Ether starting aids must not be used on engines with combustion air preheating devices. In general, these starting aids are not recommended on any engine as they will reduce the efficient working life of the engine.

Chemicals

Fuels, oils, coolants, lubricants and battery electrolyte used in pump units are typical of the industry.
However they can be hazardous to personnel if not treated properly.

⚠ Do not swallow or have skin contact with fuel, oil, coolant, lubricants or battery electrolyte. If swallowed, seek medical treatment immediately. Do not induce vomiting if fuel is swallowed. For skin contact, wash with soap and water.

⚠ Do not wear clothing that has been contaminated by fuel or lube oil.

⚠ Wear an acid resistant apron and face shield or goggles when servicing the battery. If electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.

Noise

Pump sets that are not equipped with sound attenuating enclosures can produce noise levels in excess of 85 dBA. Prolonged exposure to noise levels above 85 dBA is hazardous to hearing.

⚠ Ear protection must be worn when operating or working around the pump unit.

Biological Hazards

Depending on pump application pump may have been previously exposed to contaminated or hazardous substances.

Be aware of possible hand contact with use needles. Needle stick injuries can result from used needles be caught inside suction hoses and strainers etc.

Natural Environment (Snake Bite)

Snakes are known to live in and around water areas such as dams, rivers and creeks. If a snake is present stand clear, wait for the snake to leave. Wear long trousers and suitable foot wear. Carry snake bit kits in high-risk areas or in remote are

3.2 TRAILER MAINTENANCE

Warning
All necessary service work should only be carried out by suitably trained personnel

3.2.1 HITCH MAINTENANCE

Check

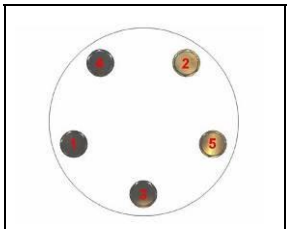
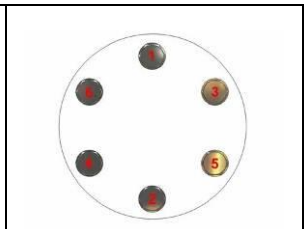
- ✓ All moving parts operate smoothly.
- ✓ Positive lock mechanism is functional (if fitted).
- ✓ Lightly grease moving components.

3.2.2 TYRES AND WHEELS

Regular maintenance of tyres and wheels is essential to safe operation of the machine and to maximize component life. Tyre or wheel failure will result in unsafe towing conditions, increasing risk of machine tip-over. Component damage may also result if problems are not discovered and resolved.

Check

- ✓ Tyre tread and sidewalls for damage (including cuts, punctures, cracks or uneven wear patterns).
- ✓ Tyre air pressure of each tyre. Refer to Specifications on sidewall or on machine placard
- ✓ Each wheel for damage (including bends and cracked welds).
- ✓ Ensure that the wheel and hub/brake drum are dimensionally compatible. This means that the P.C.D., wheel bolts and inset must all be compatible with both the hub/brake drum and the wheel rim.
- ✓ Each wheel nut or lug bolt is tightened to vendor's recommended specifications using a torque wrench or similar and in the correct sequence. (shown below).

	
5 Stud Pattern	6 Stud Pattern

Warning
It is essential to check the torque settings prior to first use after the first 50km (30mi) for the first 350km. Over/under tightening of the nuts/bolts may result in the nuts/bolts working loose and possible damage or shearing of the nut/bolt, causing wheel separation from the vehicle.

Warning
Use a torque wrench to tighten to specified values. Improper torque can cause component failure which could result in property damage, serious personal injury, or loss of life

3.2.3 CHECKING BRAKE LINING (IF FITTED)

Checks must be performed on the wheel brake linings after every 5000 km (3000 mi) or every 3 months - adjust as necessary. Where continuous travel in hilly regions or high mileage is experienced, earlier inspection and adjustment may be necessary.

Check

- ✓ For gouging on any components
- ✓ Thickness on shoes (drum) or pads.
- ✓ Maintain greater than 1mm clearance from rivets; replace if necessary
- ✓ Brake adjustment

Warning
Brake adjustment is required if travel of mechanical override shaft is more than 60%.

Replace and adjust as required

3.2.4 MAINTENANCE AND CARE OF GALVANISED VEHICLE PARTS

The formation of white rust is only a blemish and can never be excluded completely.

Procedure recommended to minimize formation of white rust

- ensure an adequate air circulation during storage.
- clean the galvanized surfaces with clear water (e.g. steam clean) after journeys in winter.
- regularly re-grease and/or oil joints and bearing points

3.2.5 STABILIZER LEGS AND JOCKEY WHEEL MAINTENANCE

Inspect the jockey wheel every 3 months.

Check

- ✓ Free operation of the winding mechanism and rotation of the wheel
- ✓ Free rotation of swivel plate
- ✓ Drop down legs operate smoothly
- ✓ Check jock stands operate correctly and lock into place
- ✓ No slack in mechanism
- ✓ Condition of wheel (if fitted). Ensure no flat spots.
- ✓ Wheel pressure for pneumatic tyres

Replace faulty components as required

Spray all moving parts with silicon based lubricant every 12 months

3.3 BATTERY

The battery is an assembly of "cells" containing a number of plates, immersed in an electrically conductive fluid. The electrical energy from the battery comes from chemical reactions taking place within the cells. These reactions are reversible which means that the battery can be repeatedly charged and discharged.

3.3.1 BATTERY MAINTENANCE

Warning
Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. Do not smoke when batteries are being serviced.

Electrolyte
The electrically conductive fluid, called electrolyte, in a lead-acid battery is a diluted sulphuric acid solution. It aids the chemical reactions occurring at the plates and it acts as the carrier for the electrical current.

Specific Gravity
Specific gravity is a unit of measurement for determining the sulphuric acid content of the electrolyte which compares the weight of the electrolyte compared to the weight of pure water. At 25° C (77° F) a fully charged battery should have a specific gravity of 1.270. The concentration of sulphuric acid will be lowered when the specific gravity lowered.

As the battery is discharged, the chemical reactions lower the specific gravity of the electrolyte. Therefore, this measurement can be used as a guide to the state of charge of the battery.

Hydrometer
Specific gravity can be measured directly using a hydrometer. This device is a bulb- type syringe which will extract electrolyte from a cell in the battery. A glass float in the hydrometer barrel is calibrated to indicate the specific gravity. Hydrometer readings should not be taken immediately after water is added to the cell. The water must be thoroughly mixed with the underlying electrolyte, by charging, before hydrometer readings are reliable. Also, if the reading is being taken immediately after the battery has been subjected to prolonged cranking, the reading will be higher than the true value. The water formed in the plates during the rapid discharge will not have had time to mix with the electrolyte above the plates.

Warning
Wear an acid resistant apron and face shield or goggles when servicing the battery. Flush immediately with large quantities of water if the electrolyte is spilled on skin or clothing.

Filling
The battery will often be shipped dry. Pre- mixed electrolyte of the correct specific gravity will have to be added.

Topping Up
Occasional topping up of the battery is required, as normal operation and charging of the battery will cause some of the water to evaporate.

Clean the batter first to avoid contamination and remove the vent plugs. Add distilled water, until the level is 8mm (5/16 inch) above the separators. Replace vent plugs.

3.3.2 CHARGING THE BATTERY

Warning
Always ensure battery charging is carried out in a well-ventilated area away from sparks and naked flames.

Never operate a battery charger where unprotected from rain or snow. The charger should never be used near water. Always switch the charger off prior to disconnecting the battery.

3.4 FIRST AID FOR ELECTRICAL INJURIES

Caution
This section is added for information purposes only and not to be used as a First Aid Manual.

In case of emergency, medical advice should always be sought immediately.

While Allight Sykes encourages thorough training of First Aid personnel, responsibility for complying with adequate First Aid instructions rests with the owner of the product.

Check the Victim's Response
When it is safe, check whether the victim is conscious. Speak loudly to the victim and gently touch the shoulder. Ask, "Can you hear me?" or "Squeeze my hand". If the victim does not respond to your voice or touch, assume unconsciousness and follow the ABC of resuscitation.

Remove the vent plugs and fill each cell with the electrolyte until the level is 8 mm (5/16 inch) above the top edge of the separators. Allow the battery to stand for 15 minutes. Check and adjust the level as necessary.

A Airway – Clear and Open
B Breathing – Check and be prepared to start EAR.
C Circulation – Check for circulation and use CPR if there is no pulse.

Clear and Open the Airway
If there is no response, quickly turn the victim onto one side into the recovery position.
Using two fingers clear the mouth of any food or fluids. Then, gently tilt back the head and support the jaw, keeping the face turned slightly downwards for drainage.

Check for Breathing
Look and feel over the lower ribs for any chest movement. Listen & feel for the escape of air from the mouth or nose. If there is no sign of breathing, resuscitation is needed, so quickly roll the victim onto their back. Begin mouth to mouth resuscitation if you know how. Otherwise, call for help from a trained bystander.

Expired Air Resuscitation (EAR):
Whilst maintaining head tilt and jaw support, make a tight seal around the victim's mouth with your mouth close the victim's nostrils with your cheek and give five initial breaths in about 10 seconds. Breathe into the victim until you see the chest rise. Allow the chest to empty whilst your mouth and nose are turned to the side to avoid the exhaled air.

Check for Circulation
After five breaths have been given, check the pulse in the neck to feel if the heart is beating. If a pulse can be felt, continue EAR at the slower rate of 1 breath every 4 seconds. Recheck the pulse every two minutes to be sure that the heart is still beating. If you cannot feel a pulse, begin cardiopulmonary resuscitation (CPR) if you have been trained.

Cardiopulmonary Resuscitation (CPR):

Find the lower edge of victim's rib cage with your lower hand. Slide your index finger up the edge of the rib cage to the notch where the ribs meet the sternum. Leave your index finger on this notch. With the index finger of your upper hand, find the notch at the top of the sternum where the collarbones join it. Leave your index finger on this notch. Extend both thumbs equally to find the middle of the sternum. Place the heel of your compressing hand on the sternum just below the midpoint. Grasp the wrist of the hand on the chest with your other hand and compress the chest.

CPR is given in cycles of 15 compressions and 2 breaths. This cycle should take about 15 seconds.

After 4 cycles (1 minute), check for a pulse. If there is no pulse continue CPR and check for a pulse every two minutes until emergency personnel arrive.

Shock

Most injured people show the signs and symptoms of shock. These are:

- Pale, cool, moist skin.
- A weak, rapid pulse.
- Altered conscious states.
- Rapid breathing.
- Nausea / vomiting.
- Restlessness / irritability.
- Extreme thirst.

Do not give any food, fluids or stimulants. Where possible, the conscious victim should be assisted to lie down in the most comfortable position with all injured parts supported. If injuries permit, raise both legs to boost the circulation to the heart and brain. The unconscious victim should be placed in the recovery position. Maintain the victim's body temperature.

Burns

Electrical burns are often deep, and the victim will have both an entrance and exit wound. Although these wounds may look superficial, the tissues below may be severely damaged. After ensuring the scene is safe:

- Cool burns by flushing with cool water
- Remove victims rings and jewellery (metal retains heat)
- Cover the burn with a dry, sterile dressing
- Take steps to minimize shock

In all emergencies, call Emergency Services as soon as possible.

Australian Red Cross

Information supplied by Australian Red Cross. To respond appropriately in a first aid emergency, Australian Red Cross recommends that you complete a first aid course.
Call 1300 367 428 (Australia).

3.5 JOB SAFETY ANALYSIS (JSA)

No.	Task or type of Exposure	Hazard	Risk Rating	Controls	Skid Pumpset	Trailer Pumpset	Sound Attenuating Enclosures Pumpset	Hydraulics/ Pumpset	Pontoon	Electric Pumpset
1	Operating Pump Unit	Operation of pumpset without referring to operating instructions and reading **Operation JSA** may cause damage to tower or personal injury.	2	Ensure all service personnel have access to and have read operation instructions and JSA.	X	X	X	X	X	X
2	Access to Site	Site workers un-aware of your presence on site.	2	Ensure to sign on & obtain permission to enter site.	X	X	X	X	X	X
3	Induction & Training	Being untrained on site operations & procedures pose a safety risk.	2	Complete Induction for each site operation and enforce requirements for special site licenses.	X	X	X	X	X	X
4	First Aid & Safety Awareness	Not following correct First Aid and Safety procedures in the event of an accident or injury.	5	Check vehicle First Aid Kit is located at the nearest Site First Aid Centre and identify site First Aid Officers.	X	X	X	X	X	X
5	Travelling on Site	Conditions and vehicle access may impose on site vehicles causing accident.	4	Be aware which roads are accessible to service vehicles and monitor ground and weather conditions.	X	X	X	X	X	X
6	Personal Safety	Injury caused by not wearing correct Personal Protection Equipment.	4	Wear correct PPE appropriate for each task and check for any special site requirements.	X	X	X	X	X	X
7	Inspection of Work Area	Area around site may pose safety risks.	4	Inspect work area before commencing work, clean up if required & park work vehicles out of traffic area.	X	X	X	X	X	X
8	Isolation of Equipment	Machine must be electrically mechanically isolated before work can commence.	2	Tag and Lock-out equipment before work commences.	X	X	X	X	X	X
9	Permits	Without Site Permits for different operations, NO Work can commence.	2	Ensure all Work Permits are in place before commencing work.	X	X	X	X	X	X
10	Avoid Spillage of Liquids	May result in environmental pollution.	9	Ensure all Work Permits are in place before commencing work.	X	X	X	X	X	X
11	Isolation Tags, Locks & Open Permits	Failure to remove or sign out these will result in the equipment being unavailable for use. Unauthorised removal may result in operation of unsafe machinery.	2	Remove Tags and sign off open permits once work is complete. DO NOT remove tags or locks or sign off on permits unless authorised to do so.	X	X	X	X	X	X
12	Hot Engine Parts	Hot engine parts may cause serious burns to exposed skin.	5	Wear correct PPE appropriate for each task and check any special site requirements.	X	X	X	X	X	
13	Clean Up	Debris and liquid spills may result in environmental pollution.	9	Clean up area after servicing and dispose of all waste products according to site procedures.	X	X	X	X	X	X
14	Safety Warnings	Failure to observe safety warnings in individual procedures may result in serious injury or damage to machine	5	Ensure all staff involved in maintenance procedures observe safety warnings and take measures to reduce risk.	X	X	X	X	X	X
15	Drawing (Pontoon)	Failure to wear flotation devices	2	Ensure that staff have available life rings and personal flotation devise when working on Pontoon mounted pumpsets						

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4. RISK ASSESSMENT GUIDE

The following RISK CLASSIFICATION table should be used to assess the degree of risk presented by hazardous situations identified when carrying out the assessment.

Consider:

Electrical	Thermal	Noise	Mechanical	Gravity
Pressure	Chemical	Radiant	Biochemical	

The numbers indicate how important it is to do something.

1 = Top priority – do something immediately

25 = Low priority – do something when possible

The table does not provide for control actions to be taken to minimise the risk and it is very important that these are documented, along with time frame and responsibilities.

CONSEQUENCES	PROBABILITY				
	A	B	C	D	E
1	1	2	4	7	11
2	3	5	8	12	16
3	6	9	13	17	20
4	10	14	18	21	23
5	15	19	22	24	25

Number & Colour	Risk
1 to 3 - Red	Critical
4 to 10 - Yellow	High
11 to 15 - Blue	Medium
16 to 25 - Green	Low

Probability	
A	Almost Certain
B	Likely
C	Occasional
D	Unlikely
E	Rare

	Injury	Environmental
5	Could cause injury	No detrimental effect
4	Could cause 1st Aid Injury	Temporary or minor damage e.g. minor oil spill
3	Could cause typical MTC/LTI	Substantial temporary or minor permanent damage e.g Minor water discharge
2	Could cause serious injury (major LTI)	Substantial and permanent damage which would result in prosecution, adverse local publicity and complaints
1	Could kill, permanently disable	Major event creating loss of company creditability with key audiences, national publicity & complaints & which could close the operation permanently.

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5. RISK ASSESSMENT – GENERIC DIESEL PUMPSET

Activity	Hazard	Initial Risk			Current Control Measures & Action Required – New Press	Residual Risk		
		P	C	Risk		P	C	Risk
Lifting of Pumpset by single/double point lifting frame	Excessive lateral movement of unit – crushing	C	1	4	• Wear correct PPE • Stop & think • Only qualified personnel to use lifting equipment • Hoisting acceleration should not exceed 0.6m/sec^2 • Ensure lifting equipment is in good condition • Keep all personnel away from Pumpset when it is suspended • Do not lift Pumpset by any other method than the central lifting eye • Do not lift in extreme weather conditions	E	4	23
Setting of the Pumpset	Slips, trips, strain, sprains and pinch points	B	3	9	• Wear correct PPE • Stop & think • Inspect area to ensure safe working conditions • Set up on level ground • Communicate with personnel located/working in vicinity of Pumpset • Clean up any spillages causing trip hazards • Do not operate Pumpset in known unsafe conditions • Do not use Pumpset in any classification of hazardous environment unless it has been specifically designed to do so • Do not operate within a confined space	C	3	13
Operation of Pumpset	Excessive Noise – hearing loss	B	2	5	• Wear correctly fitting hearing protection at all times when working or operating around the Pumpset • Stop & think	E	2	16

Activity	Hazard	Initial Risk			Current Control Measures & Action Required – New Press	Residual Risk		
		P	C	Risk		P	C	Risk
Operation of Pumpset	Boom movement (Suction Hose Boom) – pinch points and crushing	C	2	8	• Wear correct PPE • Stop & think • Do not operate Pumpset in known unsafe conditions • Do not use Pumpset in any classification of hazardous environment unless it has been specifically designed to do so • Keep all personnel away from Pumpset when boom is tilted, raised or lowered • Do not move Pumpset whilst operating the boom • Ensure boom lifting equipment is in good condition • Do not operate Boom in known unsafe conditions • Communicate with personnel located/working in vicinity of Pumpset	D	2	12
Operation of Pumpset	Running engine and pump unit – moving parts, hot pump parts, hot exhaust and manifolds on engine – possible burns, pinch points, cuts, abrasions and fire	B	2	5	• Wear correct PPE • Stop & think • Educate employees of burn hazards on engines • Keep access door on enclosures closed and locked when not required to be open • Ensure that the engine is operated only from the control panel or from the operator's position by one person only • Keep hands, arms, long hair, loose clothing and jewellery away from pulleys, belts and other moving parts • Do not remove any safety guards or panel • Ensure pump unit is operated within its operating range • If QS style canopy ensure ventilation inlet and outlet vents are free of obstruction and debris • Ensure pre start checks are carried out • Ensure area inside canopy enclosure is free from any spills, leaks and debris	D	2	12

Activity	Hazard	Initial Risk			Current Control Measures & Action Required – New Press	Residual Risk		
		P	C	Risk		P	C	Risk
Operation of Pumpset	Hydraulic, fuel, grease, oil, radiator coolant, water pressure, movement of pump water hose and battery electrolyte leaks – environmental pollution, poisoning, burns and skin irritation	C	2	8	• Wear correct PPE • Stop & think • Check all hoses for cracks and leaks • Check that all covers and caps are secure on alternator, cooling fan/radiator, engine & fuel tank • Ensure spillages are contained • MSDS available for all items used in Pumpset • Educate employees of burn hazards • Ensure pump unit is operated within its operating range • If QS style canopy ensure ventilation inlet and outlet vents are free of obstruction and debris • Ensure pre start checks are carried out • Ensure area inside canopy enclosure is free from any spills, leaks and debris	D	3	17
Operation of Pumpset (Diesel Driven)	Possible electrocution – electric shock and burns	C	3	13	• Wear correct PPE • Stop & think • Only Authorised Personnel to work on electrical equipment • Check all conduits for splits, bare wires or unsecured conduit fitting prior to operation of Pumpset • Check all circuit breaker boards are secure and sealed • Check all guards covering electrical section are secured correctly • Do not attempt to connect or disconnect load while standing in water or on wet or soggy ground • Ensure all electrical power is isolated from electrical equipment being serviced • Keep all electrical equipment clean and dry • Keep terminals clean and tight • Test earth leakage equipment regularly • Ensure correct fire extinguisher is available • Ensure area inside canopy enclosure is free from any spills, leaks and debris	D	4	21

Activity	Hazard	Initial Risk			Current Control Measures & Action Required – New Press	Residual Risk		
		P	C	Risk		P	C	Risk
Operation of Pumpset	Possible electrocution – electric shock and burns	B	2	5	• Wear correct PPE • Stop & think • Only Authorised Personnel to work on electrical equipment • Check all conduits for splits, bare wires or unsecured conduit fitting prior to operation of Pumpset • Check all circuit breaker boards are secure and sealed • Check all guards covering electrical section are secured correctly • Do not attempt to connect or disconnect load while standing in water or on wet or soggy ground • Ensure all electrical power is isolated from electrical equipment being serviced • Keep all electrical equipment clean and dry • Keep terminals clean and tight • Test earth leakage equipment regularly • Ensure correct fire extinguisher is available	D	3	17
Maintenance – Electrical battery charging	Possible explosion – burns and bodily injuries	B	1	2	• Wear correct PPE • Stop & think • Correctly isolate equipment • Do not smoke or allow sparks, flames or other sources of ignition around batteries • To avoid arcing keep grounded conductive objects, such as tools, away from exposed live electrical parts, such as terminals • When disconnecting battery disconnect the negative battery terminal first • When reconnecting battery connect the negative battery terminal last • Ensure adequate ventilation • Turn off power or disconnect the power to the battery charger before making or breaking connections with the battery	D	3	17

Activity	Hazard	Initial Risk			Current Control Measures & Action Required – New Press	Residual Risk		
		P	C	Risk		P	C	Risk
Maintenance – Electrical	Possible electrocution – electric shock and burns	B	3	9	• Wear correct PPE • Stop & think • Correctly isolate equipment • Only Authorised Personnel to work on electrical equipment • Do not attempt to connect or disconnect load while standing in water or on wet or soggy ground • Ensure all electrical power is isolated from electrical equipment being serviced • Keep all electrical equipment clean and dry • Keep terminals clean and tight • Test earth leakage equipment regularly • Ensure correct fire extinguisher is available	D	4	21
Maintenance – refilling fuel tank	Fuel leaks – environmental pollution, poisoning, burns and skin irritation	B	3	9	• Wear correct PPE • Stop & think • Correctly isolate equipment • Check all hoses and fittings for cracks and leaks • Ensure spillages are contained • MSDS available for fuel used in lighting tower • Educate employees of burn hazards	D	4	21

Activity	Hazard	Initial Risk			Current Control Measures & Action Required – New Press	Residual Risk		
		P	C	Risk		P	C	Risk
Maintenance – Mechanical	Engine, hydraulic pump and centrifugal pumpend maintenance – explosion, burns, pinch points, skin irritation and biological hazards	C	4	18	• Wear correct PPE • Stop & think • Correctly isolate equipment • MSDS available for items used in Pumpset • Ensure spillages are contained • Check all hoses and fittings for cracks and leaks • Correctly de-energise hydraulic system • Ensure guarding is in place and secure after maintenance is finished • Do not remove the radiator filler cap until the coolant has cooled. Then loosen the cap slowly to relieve any excess pressure before removing the cap completely • Educate employees on hazards of hot coolant and oil under pressure • Bleed Hydraulic Pressure before carrying out maintenance. • Allow Hydraulic Oil to cool before maintenance. • Educate employees of burn hazards • Ensure correct fire extinguisher is available • Ensure hands are protected from possible needle stick injuries when checking and inspecting suction hoses and strainers • Avoid contact with contaminated or hazardous substances residuals that may remain in pump internals • Ensure fire extinguisher is maintained and serviceable • Access environment surrounding pump unit before servicing	D	4	21

6. PUMP UNIT INFORMATION

6.1 Description of Standard Pump Unit

The pump is basically a simple end suction pump which has a completely automatic priming system built into the design. This enables the pump to self-prime from a completely dry condition even with a long suction line. No liquid of any nature is required to prime the pump.

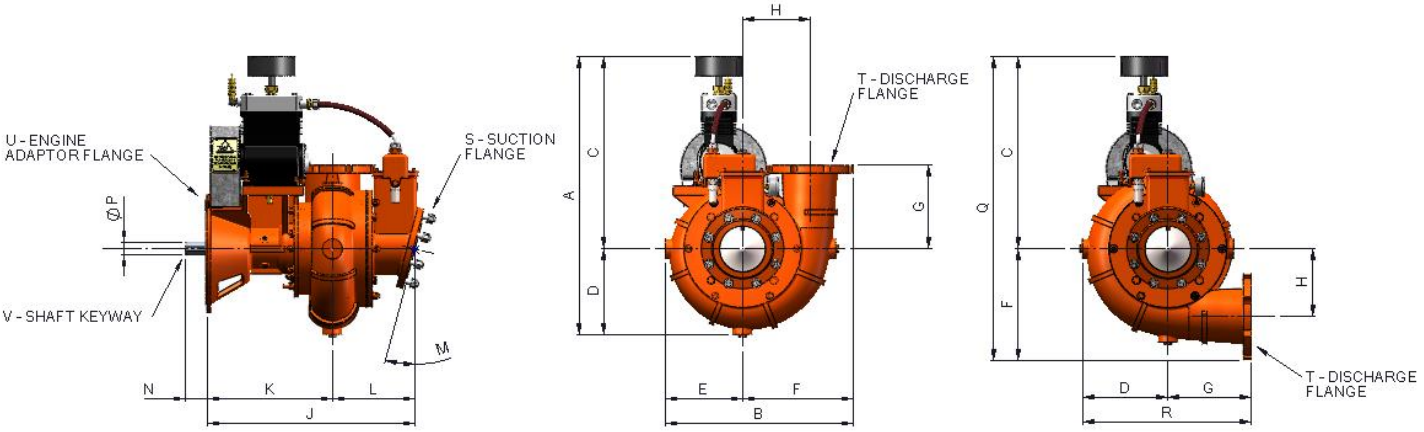
Notes

- *If your pumpset has been mounted on a trailer chassis, it is recommended that after approximately 5 km of travel that all wheel nuts be inspected and re-tightened.*
- *Guards are fitted as standard to all moving parts.*

Pump Type	Solids Handling (mm)	Suction Flange (mm)	Suction Flange Rating			Discharge Flange (mm)	Discharge Flange Rating					
			Table 'D'	Table 'E'	ANSI 150		Table 'D'	Table 'E'	Table 'F'	Table 'H'	ANSI 150	ANSI 300
CP80i	38	80	✓		✓	80	✓				✓	
CP100i	45	100	✓		✓	100	✓	✓			✓	
CP150iC	77	150	✓		✓	150	✓	✓			✓	
CP150i	77	150	✓		✓	150	✓	✓			✓	
CP220i	80	200		✓	✓	200	✓	✓			✓	
CP250i	60	250		✓	✓	200		✓			✓	
CP300i	90	300		✓	✓	300		✓			✓	
FBP300	75	300		✓		150					✓	
HH80	25	80	✓		✓	80	✓				✓	
HH130i	30	150		✓	✓	150		✓			✓	
HH160i	65	200		✓	✓	150		✓			✓	
HH220i	55	200		✓	✓	200		✓			✓	
HD100i	45	n/a	n/a	n/a	n/a	100	✓	✓			✓	
HD150iC	77	n/a	n/a	n/a	n/a	150	✓	✓			✓	
HD150i	77	n/a	n/a	n/a	n/a	150	✓	✓			✓	
HD220i	80	n/a	n/a	n/a	n/a	200		✓			✓	
HD250i	60	n/a	n/a	n/a	n/a	200		✓			✓	
HDHH130i	30	n/a	n/a	n/a	n/a	150		✓			✓	
HDMH130i	30	n/a	n/a	n/a	n/a	150		✓			✓	
HDMH150i	50	n/a	n/a	n/a	n/a	150		✓			✓	
MH130i	30	150		✓	✓	150		✓			✓	
MH150i	50	200		✓	✓	150		✓			✓	
MH220i	55	200		✓	✓	200		✓			✓	
MH300i	90	300		✓	✓	300		✓			✓	
SW100	75	100	✓		✓	100	✓	✓			✓	
SW150	90	150	✓		✓	150	✓	✓			✓	
WD100i	45	100		✓	✓	100	✓	✓			✓	
WD150iC	77	150		✓	✓	150	✓	✓			✓	
XH80	18	100	✓		✓	80				✓		✓
XH100	22	150		✓	✓	100				✓		✓
XH150	43	200		✓	✓	150				✓		✓
XH200	31	250		✓	✓	200				✓		✓
Yakka100	45	100	✓		✓	100	✓	✓			✓	
Yakka150	77	150	✓		✓	150	✓	✓			✓	
YakkaHH80	25	80	✓		✓	80	✓				✓	

6.2 Basic Pump Specification

6.2.1 Pump Dimensions – SAE #4 Bearing Bracket



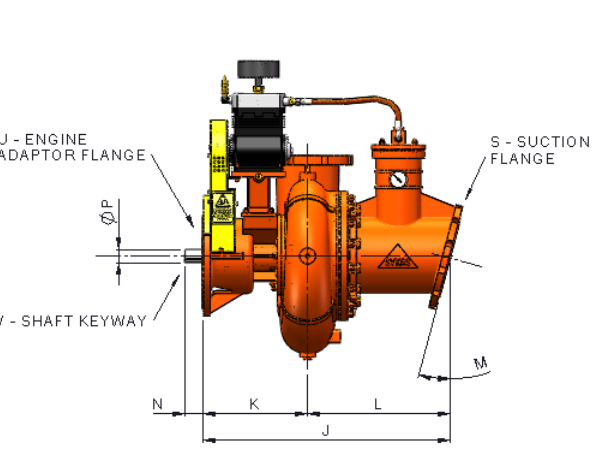
Vertical Discharge

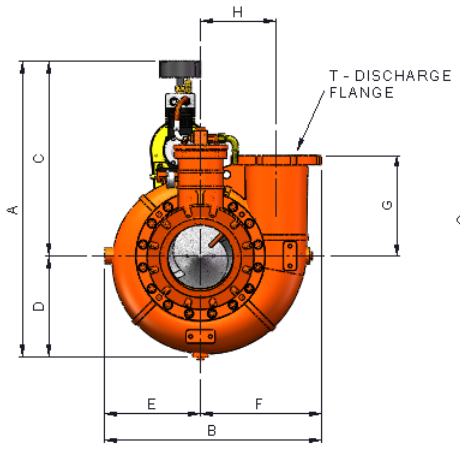
Underslung Discharge

	CP80i		CP100i / SW100		CP150i/iC / SW150		CP220i		HH80	
	Metric	Imperial	Metric	Imperial	Metric	Imperial	Metric	Imperial	Metric	Imperial
A	805	31.69	837	32.95	897	35.31	945	37.21	840	33.07
B	455	17.91	485	19.09	610	24.01	719	28.31	480	18.90
C	620	24.41	620	24.41	620	24.41	620	24.41	620	24.41
D	185	7.28	217	8.54	277	10.90	325	12.80	220	8.66
E	175	6.89	200	7.87	250	9.84	292	11.50	212	8.35
F	280	11.02	285	11.22	360	14.17	427	16.81	268	10.55
G	160	6.30	250	9.84	270	10.63	325	12.80	215	8.46
H	185	7.28	170	6.69	220	8.66	255	10.04	176	6.93
J	567	22.32	614	24.17	670	26.38	726	28.58	638	25.12
K	367	14.45	379	14.92	407	16.02	406	15.98	382	15.04
L	200	7.87	235	9.25	263	10.36	320	12.60	256	10.08
M	15°		15°		15°		15°		0°	
N	70	2.76	70	2.76	70	2.76	70	2.76	70	2.76
P	Ø42		Ø42		Ø42		Ø42		Ø42	
Q	900	35.43	905	35.63	980	38.58	1047	41.22	888	34.96
R	345	13.58	467	18.38	547	21.53	650	25.60	435	17.12
S	75mm TABLE 'D'	3" ANSI 150	100mm TABLE 'D'	4" ANSI 150	150mm TABLE 'D'	6" ANSI 150	200mm TABLE 'E'	8" ANSI 150	75mm TABLE 'D'	3" ANSI 150
T	75mm TABLE 'D'	3" ANSI 150	100mm TABLE 'E'	4" ANSI 150	150mm TABLE 'E'	6" ANSI 150	200mm TABLE 'E'	8" ANSI 150	75mm TABLE 'D'	3" ANSI 150
U	SAE #4									
V	Keysteel dimensions (width x height x length) 12mm x 8mm x 160mm									
Weight	180 Kg's	396 lbs	240 Kg's	529 lbs	260 Kg's	573 lbs	310 Kg's	683 lbs	225 Kg's	496 lbs

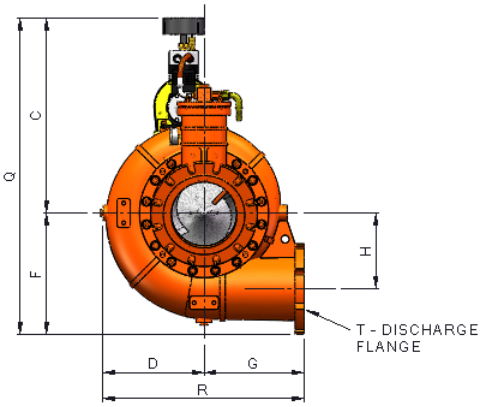
Metric Dimensions in mm, Imperial Dimensions in inches U.N.O.
All dimensions and weights are approx. only and are subject to change without notice.

6.2.2 Pump Dimensions – SAE #3 Bearing Bracket





Vertical Discharge

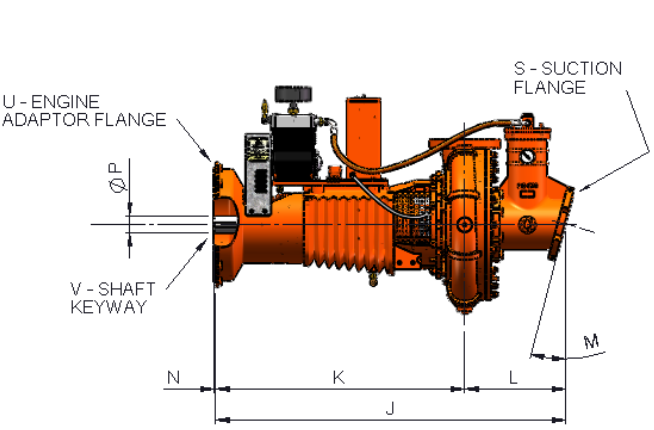


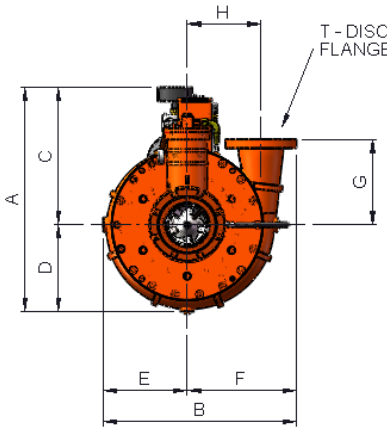
Underslung Discharge

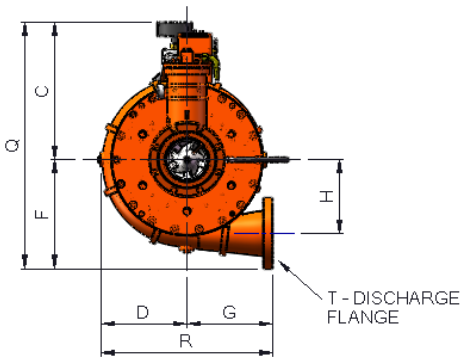
	CP250i		MH / HH130i		MH150i	
	Metric	Imperial	Metric	Imperial	Metric	Imperial
A	1123	44.21	1064	41.89	1064	41.89
B	824	32.44	725	28.54	695	27.36
C	740	29.13	739	29.09	739	29.09
D	383	15.08	325	12.80	325	12.80
E	364	14.33	315	12.40	305	12.01
F	460	18.11	410	16.14	390	15.35
G	380	14.96	425	16.73	335	13.19
H	288	11.35	270	10.63	250	9.84
J	935	36.81	797	31.38	864	34.01
K	395	15.55	385	15.16	391	15.39
L	540	21.26	412	16.22	473	18.62
M	15°		15°		15°	
N	72	2.83	72	2.83	72	2.83
P	Ø50		Ø50		Ø50	
Q	1200	47.24	1149	45.23	1129	44.45
R	763	30.04	750	29.53	660	25.99
S	250mm TABLE 'E'	10" ANSI 150	150mm TABLE 'E'	6" ANSI 150	200mm TABLE 'E'	8" ANSI 150
T	200mm TABLE 'E'	8" ANSI 150	150mm TABLE 'E'	6" ANSI 150	150mm TABLE 'E'	6" ANSI 150
U	SAE #3					
V	Keysteel dimensions (width x height x length) 14mm x 9mm x 180mm					
Weight	465 Kg's	1025 lbs	395 Kg's	870 lbs	380 Kg's	840 lbs

Metric Dimensions in mm, Imperial Dimensions in inches U.N.O.
All dimensions and weights are approx. only and are subject to change without notice.

6.2.3 Pump Dimensions – SAE #1 Bearing Bracket







Vertical Discharge

Underslung Discharge

	CP / MH300i		HH160i		MH / HH220i		XH80		XH100		XH150		XH200	
	Metric	Imperial	Metric	Imperial	Metric	Imperial	Metric	Imperial	Metric	Imperial	Metric	Imperial	Metric	Imperial
A	1171	46.10	966	38.03	978	38.50	986	38.82	990	38.97	1004	39.53	1086	42.75
B	1159	45.63	770	30.31	836	32.91	702	27.64	810	31.89	864	34.01	1013	39.88
C	616	24.25	616	24.25	616	24.25	666	26.22	616	24.25	616	24.25	616	24.25
D	555	21.85	350	13.78	362	14.25	320	12.60	374	14.72	388	15.28	470	18.50
E	492	19.37	330	12.99	379	14.92	315	12.40	362	14.25	375	14.76	440	17.32
F	667	26.26	440	17.32	457	17.99	387	15.24	448	17.64	489	19.25	573	22.56
G	450	17.72	400	15.75	370	14.57	300	11.81	353	13.90	383	15.08	530	20.87
H	425	16.73	300	11.81	285	11.22	282	11.10	321	12.64	330	12.99	382	15.04
J	1668	65.66	1606	63.23	1655	65.16	1495	58.86	1488	58.58	1580	62.20	1633	64.29
K	1130	44.48	1118	44.02	1183	46.58	1140	44.88	1111	43.73	1127	44.37	1109	43.66
L	538	21.18	488	19.21	472	18.58	355	13.98	377	14.85	453	17.83	524	20.63
M	15°		15°		15°		15°		15°		15°		15°	
N	8	0.31	8	0.31	10	0.37	6	0.24	18	0.73	8	0.33	8	0.31
P	Ø75		Ø75		Ø75		Ø75		Ø75		Ø75		Ø75	
Q	1283	50.51	1056	41.57	1073	42.24	1053	41.46	1064	41.89	1105	43.50	1189	46.81
R	1005	39.57	750	29.53	732	28.82	620	24.41	727	28.62	771	30.36	1000	39.37
S	300mm TABLE 'E'	12" ANSI150	200mm TABLE 'E'	8" ANSI 150	200mm TABLE 'E'	8" ANSI 150	100mm TABLE 'D'	4" ANSI150	150mm TABLE 'E'	6" ANSI150	200mm TABLE 'E'	8" ANSI150	250mm TABLE 'E'	10" ANSI150
T	300mm TABLE 'E'	12" ANSI 150	150mm TABLE 'E'	6" ANSI 150	200mm TABLE 'E'	8" ANSI 150	80mm TABLE 'H'	3" ANSI 300	100mm TABLE 'H'	4" ANSI 300	150mm TABLE 'H'	6" ANSI 300	200mm TABLE 'H'	8" ANSI 300
U	SAE #1													
V	Keysteel dimensions (width x height x length) 20mm x 12mm x 250mm													
Weight	1320 Kg's	2910 lbs	900 Kg's	1985 lbs	800 Kg's	1765 lbs	870 Kg's	1920 lbs	1020 Kg's	2250 lbs	1050 Kg's	2315 lbs	1310 Kg's	2890 lbs

Metric Dimensions in mm, Imperial Dimensions in inches U.N.O.
All dimensions and weights are approx. only and are subject to change without notice.

6.2.4 Impeller Clearance and Shaft End Float

Pump Type	Impeller Clearances - min / max		Shaft End Float - min / max (mm)
	Front (mm)	Back (mm)	
CP80i	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
CP100i	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
CP150iC	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
CP150i	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
CP220i	0.50 - 0.70	0.50 - 0.70	0.051 - 0.076
CP250i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
CP300i	1.00 - 1.20	1.00 - 1.20	0.000 - 0.000
HH80	0.50 - 0.70	0.50 - 0.70	0.051 - 0.076
HH130i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
HH160i	0.70 - 0.90	0.90 - 1.10	0.000 - 0.000
HH220i	0.60 - 0.80	0.90 - 1.10	0.000 - 0.000
HD100i	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
HD150iC	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
HD150i	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
HD220i	0.50 - 0.70	0.50 - 0.70	0.051 - 0.076
HD250i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
HDHH130i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
HDMH130i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
HDMH150i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
MH130i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
MH150i	0.70 - 0.90	0.70 - 0.90	0.000 - 0.050
MH220i	0.60 - 0.80	0.90 - 1.10	0.000 - 0.000
MH300i	1.00 - 1.20	1.00 - 1.20	0.000 - 0.000
SW100	0.55 - 0.80	0.60 - 0.80	0.051 - 0.076
SW150	0.55 - 0.80	0.60 - 0.80	0.051 - 0.076
WD100i	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
WD150iC	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
XH80	0.80 - 1.00	0.90 - 1.10	0.000 - 0.000
XH100	1.00 - 1.20	1.00 - 1.20	0.000 - 0.200
XH150	1.00 - 1.20	1.00 - 1.20	0.000 - 0.200
XH200	1.00 - 1.20	1.00 - 1.20	0.000 - 0.200
Yakka100	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
Yakka150	0.45 - 0.70	0.50 - 0.70	0.051 - 0.076
YakkaHH80	0.50 - 0.70	0.50 - 0.70	0.051 - 0.076

6.2.5 *Pump Bearing Lubrication*

Grease Set Up

Grease Type	Operating Temperature Range
Multi Lube Lithium Grease EP Additives NLGI#2	-25 / +160 ^{0}C*
Advanced Multi Purpose Aviation Grease^ MIL-G-23827B (US) G-354 (NATO)	-73 / +149 ^{0}C*

Oil Set Up

Oil Type	Operating Temperature Range
Hydraulic ISO Grade 68	-10 / +60 ^{0}C*
Royal Purple FDA34^	-50 / +50 ^{0}C*

* = Use as a guide only, Confirm with vendor in regards specifications

^ = Or equivalent product

Pump Type	Pump Bearing Lubrication Type (Standard)
CP80i	Grease
CP100i	Grease
CP150iC	Grease
CP150i	Grease
CP220i	Grease
CP250i	Grease
CP300i	Grease
FBP300	Grease
HH80	Grease
HH130i	Grease
HH160i	Oil
HH220i	Oil
HD100i	Oil
HD150iC	Oil
HD150i	Oil
HD220i	Oil
HD250i	Oil
HDHH130i	Oil

Pump Type	Pump Bearing Lubrication Type (Standard)
HDMH130i	Oil
HDMH150i	Oil
MH130i	Grease
MH150i	Grease
MH220i	Oil
MH300i	Oil
SW100	Grease
SW150	Grease
WD100i	Grease
WD150iC	Grease
XH80	Oil
XH100	Oil
XH150	Oil
XH200	Oil
Yakka100	Grease
Yakka150	Grease
YakkaHH80	Grease

6.2.6 Mechanical Seal

Pump Type	Mechanical Seal Shaft Size	Mechanical Seal Reservoir Capacity	Mechanical Seal	Maximum Mechanical Seal Pressure		Maximum Allowable Combined Pressure (Suction & Discharge) in Volute	
		Litres	Fluid	kPa	psi	kPa	psi
CP80i	40mm	0.85	Barrier Fluid FDA 34^ ^= or equivalent product	1000	145	1000	145
CP100i	40mm	0.85		1000	145	1000	145
CP150iC	40mm	0.85		1000	145	1000	145
CP150i	40mm	0.85		1000	145	1000	145
CP220i	40mm	0.85		1000	145	1000	145
CP250i	50mm	0.90		1000	145	1000	145
CP300i	75mm	7.30		2500	363	1400	203
HH80	40mm	1.60		1000	145	1000	145
HH130i	50mm	0.90		1000	145	1000	145
HH160i	75mm	7.30		2500	363	1400	203
HH220i	69.80mm	7.30		2500	363	1400	203
HD100i	40mm	n/a	Hydraulic ISO Grade 68* *= use as a guide only, Confirm with vendor in regards specification	1000	145	1000	145
HD150iC	40mm	n/a		1000	145	1000	145
HD150i	40mm	n/a		1000	145	1000	145
HD220i	40mm	n/a		1000	145	1000	145
HD250i	50mm	n/a		1000	145	1000	145
HDHH130i	50mm	n/a		1000	145	1000	145
HDMH130i	50mm	n/a		1000	145	1000	145
HDMH150i	50mm	n/a		1000	145	1000	145

Pump Type	Mechanical Seal Shaft Size	Mechanical Seal Reservoir Capacity	Mechanical Seal	Maximum Mechanical Seal Pressure		Maximum Allowable Combined Pressure (Suction & Discharge) in Volute	
		Litres	Fluid	kPa	psi	kPa	psi
MH130i	50mm	0.90	Barrier Fluid FDA 34^ ^= or equivalent product	1000	145	1000	145
MH150i	50mm	0.90		1000	145	1000	145
MH220i	69.80mm	7.30		2500	363	1400	203
MH300i	75mm	7.30		2500	363	1400	203
SW100	40mm	0.85		1000	145	1000	145
SW150	40mm	0.85		1000	145	1000	145
WD100i	40mm	0.85		1000	145	1000	145
WD150iC	40mm	0.85		1000	145	1000	145
XH80	75mm	7.30		2500	363	2500	363
XH100	90mm	7.50		2500	363	2100	305
XH150	90mm	7.50		2500	363	2100	305
XH200	90mm	7.50		2500	363	2500	363
Yakka100	40mm	0.85		1000	145	1000	145
Yakka150	40mm	0.85		1000	145	1000	145
YakkaHH80	40mm	1.60		1000	145	1000	145

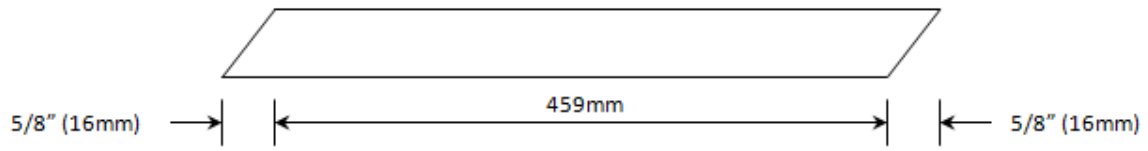
Pump Type	Mechanical Seal Part Numbers				
	722 704	726 350	38-0300-2100	001-1007JC	720 618
CP80i	*				
CP100i	*				
CP150iC	*				
CP150i	*				
CP220i	*				
CP250i		*			
CP300i			*		
HH80	*				
HH130i		*			
HH160i			*		
HH220i				*	
HD100i	*				
HD150iC	*				
HD150i	*				
HD220i	*				
HD250i		*			
HDHH130i		*			
HDMH130i		*			
HDMH150i		*			
MH130i		*			
MH150i		*			
MH220i				*	
MH300i			*		
SW100	*				
SW150	*				
WD100i	*				
WD150iC	*				
XH80			*		
XH100					*
XH150					*
XH200					*
Yakka100	*				
Yakka150	*				
YakkaHH80	*				

6.2.7 Gland Packing

Pump Type	Gland Packing Size	Number of Rings	Ring Length (mm)	Maximum Allowable Combined Pressure (Suction & Discharge) in Volute	
				kPa	psi
CP300i	1/2"	5	366	1400	203
HH160i	1/2"	5	366	1400	203
HH220i	1/2"	6	328	1400	203
MH220i	1/2"	6	328	1400	203
MH300i	1/2"	5	366	1400	203
XH100	5/8"	5	491**	2100	305
XH150	5/8"	5	491**	2100	305
XH200	5/8'	5	491**	2500	363

Note : Gland packing option only available to Pump Types shown above

**** = Ring Length cutting + measuring method example**



6.2.8 Mass Moment of Inertia

Pump Type	Impeller Diameter	Pump Mass Moment of Inertia
	mm	kg.m2
CP80i	185	0.006
	171	0.005
CP100i	243	0.050
CP150iC	255	0.107
CP150i	285	0.149
CP220i	320	0.217
CP250i	380	0.440
	355	0.361
CP300i	536	2.222
HH80	325	0.077
	270	0.044
HH130i	465	0.809
HH160i	456	1.006
HH220i	432	0.521
HD100i	243	0.050
HD150iC	255	0.106
HD150i	285	0.148
HD220i	320	0.216
HD250i	380	0.438
	355	0.359
HDHH130i	465	0.807

Pump Type	Impeller Diameter	Pump Mass Moment of Inertia
	mm	kg.m2
HDMH130i	435	0.780
HDMH150i	394	0.506
MH130i	435	0.782
MH150i	394	0.508
MH220i	395	0.456
MH300i	510	2.009
	490	1.787
SW100	243	0.045
SW150	285	0.112
WD100i	243	0.050
WD150iC	255	0.107
XH80	480	1.289
XH100	560	2.924
	530	2.408
	510	2.103
XH150	560	3.272
	530	2.710
	510	2.375
XH200	636	5.963
Yakka100	243	0.050
Yakka150	255	0.107
YakkaHH80	325	0.077

6.2.9 Generic Torque Rating

Sykes uses the following bolts and studs in their pump builds and it is recommended to use the following torque settings

HIGH TENSILE BOLT CLASS 8.8		
Size	**Recommended Assembly Torques**	
	Nm	***ft.lbs***
M8	22	16
M10	44	32
M12	77	57
M16	190	140
M20	370	270
M24	640	470

ENGINEERING STUD CLASS 4.6		
Size	**Recommended Assembly Torques**	
	Nm	***ft.lbs***
M8	8.5	6.3
M10	17	12
M12	30	22
M16	73	54
M20	143	106
M24	248	183

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7. SAFE OPERATING PROCEDURES

7.1 Safe Operating Procedure (SOP) – Fuel Filling

DO NOT start until you have read and understood the SOP

This SOP does not necessarily cover all possible hazards associated with the machine and should be used in conjunction with other references
It is designed to be used as an adjunct to teaching Safety Procedures and to act as a reminder to users prior to machine use

Safety glasses must be worn at all times in work areas displaying this sign.

Sturdy footwear must be worn at All times in work areas.

Always wear the correct gloves

Close fitting, HI VIS protective clothing must be worn.

Hearing protection must be used in areas displaying this sign.

PRE-OPERATIONAL SAFETY CHECKS

1. Ensure no slip/trip hazards are present in workspaces and walkways.
2. Check that all guards are in position.
3. Locate and ensure you are familiar with the operation of the ON/OFF starter and E-Stop (if fitted).
4. Faulty equipment must not be used. Immediately report suspect machinery.

OPERATIONAL SAFETY CHECKS

1. Ensure dispensing hose and nozzle are in good condition.
2. Ensure fuel has finished flowing before removing from filler nozzle.
3. DO NOT overfill
4. When using automatic systems ensure manual fill points are isolated and locked

HOUSEKEEPING

1. Leave the machine in a safe, clean and tidy state.
2. Maintain clear access
3. Keep work area clean and tidy
4. Clean any spills with the appropriate spill kit materials

POTENTIAL HAZARDS

- Spillage may produce slippery surfaces
- Spillage entering drainage system
- Splashes (avoid splashing while filling)
- Ignition sources
- Movement of mobile equipment
- Exposure to diesel
- Heat sources

MANUAL HANDLING

Aim to eliminate or reduce manual handling wherever possible.
Use mechanical devices where possible

FIRE PROTECTION

Know the location of emergency fire equipment and emergency shut off switches.

EMERGENCY CONTAINMENT

1. Know the location of emergency spill kits
2. Contact your area Supervisor

JOB STEPS

1. **Shut Down Pump**
   - Follow operating manual procedure to shut down pump
   - If pump cannot be shut down a risk assessment must be completed.

2. **Diesel Dispensing**
   - Check operating manual to ensure correct nozzle is used.
   - Secure nozzle by hand.
   - Don't jam open dispensing nozzle.
   - Carefully monitor the filling rate to avoid over filling.
   - Do not remove nozzle hose until discharge flow has stopped.
   - Thoroughly clean up any surface spills

3. **Return Dispensing Nozzle**
   - Return nozzle to holder on storage tank.
   - On completion of refuelling reinstate filler cap to mobile fuel tank

4. **Security**
   - Secure storage tank door with padlock to prevent unauthorized access

7.2 Fuel Fast Fill System – Wiggins Z Series

The Wiggins Z-Series diesel refueling system is a pressurizing system that enables 'fast-fuel' automatic shut-off refueling with Wiggins or other compatible fuel nozzles at flow rates up to 570 liters/min (with ZZ9A1 nozzle) or 800 liters/min (with ZZ9A2 nozzle).

ZZ9A1 NOZZLE (75 to 575 litres/min.)

ZZ9A2 NOZZLE (75 to 800 litres/min.)

SAFETY NOTE:

The following procedure includes notes in red text for routine visual condition and leakage checks that we recommend are carried out during the refueling process on a regular basis.

If any faults or leaks are encountered it is the responsibility of the operator to ensure they are reported to the appropriate party and corrected before conducting any further refueling activity with the faulty equipment.

1. Remove the dust cover from the Wiggins receiver-nipple on the tank to be refueled and wipe any collected dust from the front sealing face of the receiver-nipple.

2. Visually check the receiver-nipple for excessive wear or scoring, particularly the front sealing face. If the receiver nipple is leaking or damaged arrange for it to be replaced.

3. Before switching on the fuel pump, pick up the fuel nozzle by the handle and ensure its rear operating lever is latched down in the closed position; otherwise head pressure in the fuel hose will make it difficult or impossible to couple the nozzle to the receiver-nipple.

4. Using the fingers of the hand holding the nozzles handle, fully retract the spring-loaded black polymer actuating ring (to allow radial movement of the fingers of the "elasto-dog" coupling mechanism), pull out the dust plug from at the front end of the nozzle (if fitted), visually verify that the elast-o-dog fingers are not broken off and are in serviceable condition, and release the actuating ring.

5. Align the front end of the nozzle with the receiver-nipple, push it partially onto the nipple, retract and hold back the actuating ring, push the nozzle fully and firmly onto the receiver-nipple and release the actuating ring (to lock the nozzle onto the receiver-nipple).

6. Check the nozzle is firmly locked onto the receiver-nipple by attempting to pull it off with moderate force. If it can be pulled repeat step 4 ensuring the procedure is correctly followed.

7. Switch on the fuel pump.
   Check that there are no fuel leaks from any part of the fuel nozzle or equipment.

8. To commence filling the tank, while holding the nozzles handle in one hand, with the other hand on the rear operating lever, disconnect the operating lever latching pin from its slot by squeezing back the red-colored latching lugs and push the operating lever up and forward towards the receiver. Hold the operating lever forward for several seconds until it stays forward without being held. This is necessary to allow sufficient time for the fuel flow to stabilize.
   Check for any leakage from the nozzle/receiver-nipple connection.

9. If there is a leak, shut the nozzle by pulling the operating lever back and down and latch it in the closed position. Switch off the fuel pump. Disconnect the fuel nozzle from the receiver-nipple by retracting the fuel nozzle's actuating ring and pulling the nozzle completely away from the receiver-nipple then release the actuating ring. Arrange for repair or replacement of the fuel nozzle and/or receiver-nipple.

10. While fuel is being pumped into the tank, for maximum safety and to avoid being sprayed with fuel should a fuel leak or hose rupture occur, step away from the fuel nozzle and do not stand directly behind it.

11. When fuel in the tank has reached the required level the fuel nozzle will auto-shut and the fuel nozzle's operating lever will move backwards to the closed position.

NOTE: On auto shut-off, the nozzle's operating lever will move from the open to closed position in one to three seconds, depending on the flow rate and tank set-up. If the operating lever slams off harshly this indicates that the fuel tank on the machine being refueled has insufficient ullage (air space above the fuel cut-off level), and the tank is being excessively pressurized on shut-off. Insufficient ullage can also result in fuel discharging from the vent's discharge port or hose. This can result in tank damage, fuel leakage and excessive wear and tear on the fuel nozzle, and should be corrected promptly. Normally fitment of a tank vent with a longer stem will correct the problem. Report such problems to the appropriate parties.

12. Push the nozzle's operating lever down to lock it in the closed position and switch off the fuel pump.

    NOTE: When the fuel nozzle auto-shuts, although it will be in the "off" position the operating lever will not will not usually have moved back far enough for the latching pin to lock the operating lever in the closed position. The only reason why the operating lever should be locked off is to enable the nozzle to be connected to the receiver-nipple the next time it is used. Therefore it is good practice to ensure the nozzle's operating lever is latched in the closed position at the conclusion of each refueling operation.

13. Disconnect the fuel nozzle from the receiver-nipple by retracting the fuel nozzle's actuating ring and pulling the nozzle completely away from the receiver-nipple, then release the actuating ring. Re-fit the nozzles dust plug by retracting the nozzle's actuating ring.

    NOTE: If the dust plug is missing arrange for a new dust plug to be fitted to minimize fuel contamination and wear to the fuel nozzle and receiver.

14. Rewind the fuel hose if applicable and place the nozzle in its holster or usual storage location.

15. Report any wear, damage or leakage or other issues to the appropriate parties to minimize future problems and safety issues.

MAINTENANCE AND TROUBLE-SHOOTING

MAINTENANCE

The service life of Wiggins ZZ9A1 and ZZ9A2 nozzles and receivers (i.e. the number of refueling cycles) will vary depending on the following factors:

1. Re-fitting of dust caps and plugs after use
2. Cleaning accumulated dirt from the coupling faces prior to use
3. The type of pump used (positive displacement vane pumps with correctly adjusted by-pass pressure relief valve are best; diaphragm pumps not fitted with surge arrestors or accumulators accelerate wear)
4. Fuel tanks with insufficient ullage cause pressure spikes that accelerate wear

While there are no components on the nozzles or receivers that require regular lubrication or servicing, the incidence of fuel leaks and spills can be minimized by:

1. Training operators in the procedures outlined in this manual, including inspecting the equipment at each refueling event and immediately reporting signs of wear and leakage, and
2. Conducting plant surveys on a regular basis at appropriate time intervals

We recommend that one or more spare nozzles and receivers are held in stock so that units showing signs of leakage can be immediately replaced to minimize the chance of major failures and delays in reinstating equipment.

Wiggins pressurizing system vents and non-pressurizing system vent/jet-sensor units are extremely long-lived and reliable, however if ZV13 series filtered vents are used, spare filter units should be kept as spares and the vents inspected say annually.

With ZZ9A1 and ZZ9A2 nozzles, the most frequently used part is the CCN101-31B Wiper Seal located in the front end of the nozzle. This is also the one part that can be easily replaced in situ, so we recommend that these seals are replaced whenever a small amount of leakage from the front end of the nozzle is noticed, as this will reduce the frequency of nozzle re-builds required.

Housing handle kits and Latching mechanism kits are available to facilitate on-site repairs if required.

Cooper Fluid Systems offer complete nozzle rebuilds for about half the cost of a new nozzle. All wearing parts are replaced and rebuilt nozzles are warrantied.

TROUBLESHOOTING GUIDE

The following table lists and describes possible situations and problems associated with normal wear and use of the ZZ9A1 and ZZ9A2 refueling system.

Troubleshooting Guide		
Problem	**Possible Cause**	**Corrective Actions**
1) Nozzle leaks from the front during fueling.	1) CCN101-31B Wiper Seal is damaged or missing.	1) Replace the CCN101-31B Wiper Seal. (Can be done in-situ).
	2) Excessive dirt or debris on mating receiver and/or nozzle causing severe misalignment.	2) Clean receiver (particularly the front sealing face) and nozzle.
	3) Receiver is worn or the front sealing face is scored.	3) Check receiver for excessive wear or scoring. Replace receiver.
	4) Internal dynamic o-ring seals worn or damaged.	4) Replace nozzle and return for re-manufacturing.
	5) Body is loose from Housing.	5) Replace nozzle and return for re-manufacturing.

Troubleshooting Guide		
Problem	**Possible Cause**	**Corrective Actions**
2) Nozzle fails to remain connected to receiver.	1) R9021 Elastodog is worn or damaged.	1) Purchase and install a KR92-Latching Mechanism Kit.
3) Nozzle leaks from back end during refueling and/or when disconnected and pressurized.	1) Internal R9013 Piston Seal or O-ring is worn or damaged.	1) Replace nozzle and return for re-manufacturing.
4) Nozzle leaks when disconnected and pressurized.	1) Internal dynamic o-ring seal is worn or damaged.	1) Replace nozzle and return for re-manufacturing
5) Nozzle shuts off prior to complete fill.	1) Vent is clogged or blocked.	1) Check if any hose or pipe leading from end of vent is blocked, clogged or kinked. Clean and replace as required.
	2) If receiver is remotely mounted, either the receiver spring is too heavy and/or the head pressure is too high due to undersized hose and/or excessive flow restriction from elbows, fittings and valves.	2) Replace receiver with a ZN2B receiver. Use larger bore hose. Minimise use of elbows and fittings. Verify application with authorized Distributor
6) Nozzle fails to shut off, overfill results and fuel over-shoots or discharges from vent outlet.	1) Tank is not completely sealed.	1) Inspect tank for any possible air leak paths. If fitted, replace vented cap on top-fill port with sealed cap. THE TANK MUST BE COMPLETELY SEALED EXCEPT FOR A WIGGINS VENT, IN ORDER FOR THE SYSTEM TO PROPERLY FUNCTION.
	2) Stem o-ring seal from ZV series vent is missing or damaged.	2) Remove ZV series vent from vehicle and inspect for o-ring at bottom of vent stem. Replace if missing or damaged.
	3) Vent ball cage is missing or floatation balls are cracked and full of fuel.	3) Remove ZV series vent from vehicle and inspect ball cage and floating balls at bottom of vent stem. Replace if missing or damaged.

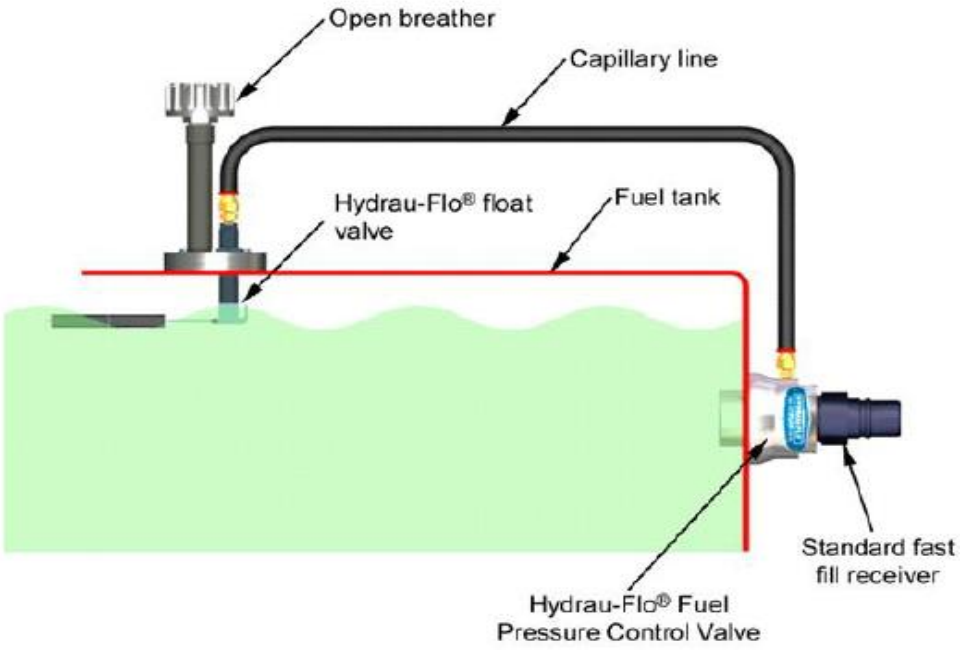
Troubleshooting Guide		
Problem	**Possible Cause**	**Corrective Actions**
	4) Inadequate amount of ullage. (Ullage is the tank volume above the bottom of the vents polymer stem tube).	4) Replace ZV series short-stem vent with a ZV series long-stem vent. Ideally ullage should be the greater of 50 litres of 5% of tank volume.
	5) ZN2A medium spring receiver mounted on top of the tank.	5) Replace ZN2A receiver with ZN2D heavy spring receiver to compensate for low or negative head downstream of the nozzle.
	6) Excessive dirt accumulation on the nozzle rear end cap. (R9004)	6) Clean rear cap and pin.
	7) Nozzle is worn or damaged.	7) Actuate flow control handle open and closed. If there is excessive resistance, lack of smooth movement, or failure to actuate send, replace and return nozzle for remanufacturing.
	8) Low flow rate.	8) The nozzle requires a minimum of 75 litres/minute for proper function, increase flow rate.
7) Some fuel discharging with air from the vent outlet.	1) Excessive foaming of fuel caused by high fill rate in a small tank.	1) Reduce flow rate.
	2) Excessive foaming of fuel caused by top-filling the tank.	2) Install a drop-tube in the tank from the fuel inlet extending down to within 75mm of the bottom of the tank.
8) Nozzle shuts immediately after opening when filling a Wiggins JNX Ultra-Safe non-pressurising system.	1) Jet-sensor hoses have not been primed after being installed or re-installed.	1) Hold fuel nozzle open manually until hoses are primed and the nozzle remains open unassisted.

Troubleshooting Guide		
Problem	**Possible Cause**	**Corrective Actions**
	2) Jet-sensor hoses are either broken, leaking or kinked, or Y-strainer is blocked.	2) Repair Jet-sensor hoses. Clean Y-strainer.

7.3 Fuel Fast Fill System – Hydrau-Flo

The Hydrau-Flo valve system provides flow rates up to 1,000 litres/min (265 gallons/min) and pressures up to 100 kilopascals (20 psi).

The system consists of fuel filling valve, a float valve and a pilot line. The Hydrau-Flo valve is activated via fuel level.

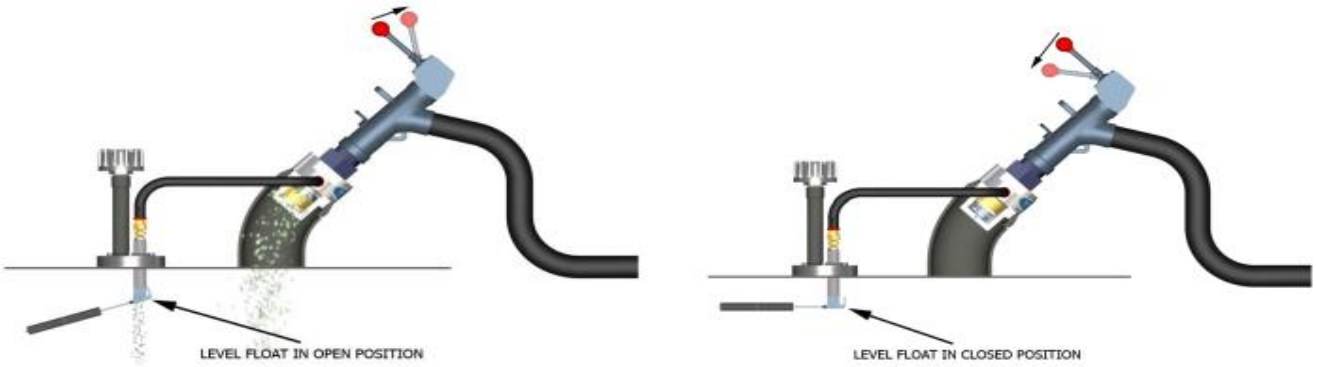


Working principle of a stationary fuel filling set-up

Fuel enters the system through a “fast fill” receiver and into the Hydrau-Flo valve body.

Fuel pressure forces the shut-off piston open against spring pressure, allowing fuel to flow through the porting into the fuel tank.

An orifice in the piston also allows a metered amount of fuel to bleed off through a capillary line to a float valve located in the tank. This creates a pressure drop under the piston.



Operation

When the fuel level in the tank rises and closes the float valve, thus stopping the bleed and pressure leak, the fuel pressure is equalised on both sides of the piston.
Spring pressure will force the piston back to close the fuel ports, preventing any extra fuel from entering the fuel tank.
By preventing over filling above the pre-set float level in the tank, an air space is maintained to allow for fuel expansion (due to temperature rise) and thus prevent the possibility of fuel weeping through the air vent.

7.4 Safe Operating Procedure (SOP) – Battery Charging

DO NOT start until you have read and understood the SOP

This SOP does not necessarily cover all possible hazards associated with the machine and should be used in conjunction with other references
It is designed to be used as an adjunct to teaching Safety Procedures and to act as a reminder to users prior to machine use

Safety glasses must be worn at all times in work areas displaying this sign.

Close fitting, HI VIS protective clothing must be worn.

Sturdy footwear must be worn at all times in work areas.

Hearing protection must be used in areas displaying this sign.

Always wear the correct gloves

Rings and jewellery must not be worn.

PRE-OPERATIONAL SAFETY CHECKS

1. Check workspaces and walkways to ensure no slip/trip hazards are present.
2. Wear eye protection when working around batteries
3. Ensure charger is not used near ignition sources, there is good ventilation and avoid producing sparks.

OPERATIONAL SAFETY CHECKS

1. Use suitable battery tester/hydrometer to check battery charge.
2. Assess size and weight of battery and determine suitable lifting/ removal technique.
3. Remove from plant as per manufacturer's instructions.
4. Do NOT carry by terminal posts- use strap or cradle. Do not carry against body. Keep upright.
5. Check battery condition before charging, if terminals/casing are severely rusted, or battery damaged, do NOT recharge. Place in battery recycling area.
6. Check the acid levels before recharging.
7. If acid covering the top of the plates, do not use water. Clean first then use distilled water for refilling.
8. If battery has sealed vents, do NOT recharge the battery with a current greater than 25amps. Follow manufacturer's instructions for voltage (6v or 12v), for fast charge (30amps), do NOT exceed 1 hour.
9. Follow manufacturer's instructions for attaching and removing cables. Example: Unplugging or turning off the charger before connecting or disconnecting the clamp connections. Carefully attach the clamps to the battery with proper polarity (positive + clamp, usually red, to the positive terminal and negative – clamp, usually black to the negative terminal).
10. If battery becomes hot or if acid spills from the vent, turn OFF the charger temporarily. Resume recharging using a lower current or charge rate.
11. Recheck fluid level after battery has been charged and disconnected.

HOUSEKEEPING

1. Leave the battery charger and work area in a safe, clean and tidy state.

POTENTIAL HAZARDS

- **Exposure to electricity**
- **Sparks**
- **Fire**
- **Explosion**
- **Slips, Trips, Falls**
- **Manual Handling**
- **Eye injuries**
- **Burns**

FORBIDDEN

- Never leave a battery on charge overnight.

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8. PUMP INSTALLATION & OPERATING INSTRUCTIONS

8.1 Pump Commissioning / Installation and Operating Front Sheet

Pump Commissioning / Installation and Operating Front Sheet		
Customer Name		
Customer Representative		
AllightSykes Representative		
Pump Type		
Pump Serial Number		
Date of Commissioning		
Commission / Installation & Operation Completed Satisfactory	**YES**	**NO**
Customer Representative Sign		
AllightSykes Representative Sign		
Date (Day/Month/Year)		

8.2 Generic Diesel Driven Pumpset Installation and Operating Instructions

PUMP x DIESEL ENGINE INSTALLATION & OPERATING INSTRUCTIONS - GENERIC VERSION				
CODE	**STEP**	**ITEM**	**INSTRUCTIONS**	**CHECKED (√)**
POI1	Pre Start	Pump Application	Ensure pump selected is correct for duty required	
POI2	Pre Start	HSE Compliance	Carry out and comply with relevant HSE site, government rules, acts, regulations and codes of practice	
POI3	Pre Start	Delivery Inspection	Pump and associated equipment has been supplied in full and in operational condition	
POI4	Pre Start	Pumpset Set Up	Pumpset is level and on firm ground	
POI5	Pre Start	Pumpset Set Up	Pumpset and associated equipment is accessible by service vehicles and/or relevant equipment	
POI6	Pre Start	Suction Hose	Hose is non-collapsible type, free of kinks and internal blockages	
POI7	Pre Start	Suction Hose	Hose size at least to be equal or larger than pump inlet size	
POI8	Pre Start	Suction Hose	Hose set up to be short and straight as possible	
POI9	Pre Start	Suction Hose	No elbow fitted directly to pump inlet	
POI10	Pre Start	Suction Hose	No undulating suction hose set up (i.e. no possibility of trapped air in suction hose set up)	
POI11	Pre Start	Suction Hose	No excessive static suction lift	
POI12	Pre Start	Suction Hose	Strainer hole size to be less than pump solids handling capability	
POI13	Pre Start	Suction Hose	Strainer position to avoid air intake and clogging due to silt/mud etc. from floor of tank/pond/dam etc.	
POI14	Pre Start	Suction Hose	Strainer open area to be at least four times the area of the suction hose	
POI15	Pre Start	Suction Hose	No foot valve in suction hose set up, please contact AllightSykes for assistance.	
POI16	Pre Start	Discharge Hose	Hose diameter at least the same diameter as pump outlet	
POI17	Pre Start	Discharge Hose	Correctly rated discharge hose and fittings (non-return valves, gearbox butterfly valves etc.)	
POI18	Pre Start	Discharge Hose	Control valve has fine adjustment capabilities and is designed for throttling conditions	
POI19	Pre Start	Discharge Hose	Pressure gauge fitted in discharge pipe work as close as possible to pump outlet	
POI20	Pre Start	Discharge Hose	Suitable rated pressure bleed valve	

PUMP x DIESEL ENGINE INSTALLATION & OPERATING INSTRUCTIONS - GENERIC VERSION				
CODE	**STEP**	**ITEM**	**INSTRUCTIONS**	**CHECKED (√)**
POI21	Pre Start	Discharge Hose	Free from air leaks, kinks and internal blockages	
POI22	Pre Start	Discharge Hose	Discharge hose straight and short as possible	
POI23	Pre Start	Operator Expertise	Operator familiar with pumpset stop / start operating procedures	
POI24	Daily Checks	Pump Area	Ensure the area is clean and free of debris	
POI25	Daily Checks	Pump	Check for any oil, coolant, quench fluid or water leaks	
POI26	Daily Checks	Gland Packing	Inspect gland packing, check for wear and burn marks	
POI27	Daily Checks	Mechanical Seal	Check for mechanical seal fittings, and hoses leaks.	
POI28	Daily Checks	Mechanical Seal	Inspect for mechanical seal reservoir leaks	
POI29	Daily Checks	Mechanical Seal	Check mechanical seal oil for milkiness/contamination or coolant contamination. Change mechanical seal oil or coolant radiator fluid.	
POI30	Daily Checks	Volute	Inspect pressure gauge/sender; indication needle operation, glycerine level, glycerine contamination, clearness of gauge viewing glass	
POI31	Daily Checks	Tee Piece	Inspect vacuum gauge/sender; indication needle operation, glycerine level, glycerine contamination, clearness of gauge viewing glass	
POI32	Daily Checks	Radiator Coolant	Inspect and fill as required.	
POI33	Daily Checks	Fuel	Inspect and fill as required.	
POI34	Daily Checks	Radiator Coolant, Lube and Fuel Quick Fill	Visually inspect for leaks. Ensure that protective caps are in place.	
POI35	Daily Checks	Engine	Check for any oil, coolant, quench fluid and water leaks	
POI36	Daily Checks	Radiator Fins	Inspect for blockages and clean as required	
POI37	Daily Checks	Gearbox	Visually inspect for leaks. Ensure that protective caps are in place.	
POI38	Daily Checks	Guards	Check that all guards and covers are in place and secure.	
POI39	Start	Control valves	Pump Suction and Discharge isolation/control valves are fully **OPEN** for initial prime and pump operating stages	
POI40	Start	Battery Power	Switch battery isolator **ON**	
MANUAL OPERATION				
POI41	Operation	Default Setting	The default setting on the diesel engine control panel is "MANUAL"	

PUMP x DIESEL ENGINE INSTALLATION & OPERATING INSTRUCTIONS - GENERIC VERSION				
CODE	**STEP**	**ITEM**	**INSTRUCTIONS**	**CHECKED (√)**
POI42	Operation	Start Engine	To start press Manual/Start on Control Panel (engine will start in 5 seconds) and allow to warm up at idle; the engine control panel screen will display the engine data (diesel engine speed, oil pressure, run hours, voltage and temperature). Other engine and pump data can be displayed on the engine control panel depending on pump monitoring options fitted.	
POI43	Operation	Pump Duty	Slowly increase RPM to operating speed required to ensure correct pump/engine operation by either adjusting the vernier control mechanism (mechanical diesel engines) or toggle switch (electronic diesel engines) located on the engine control panel; once the pump is primed ensure flow and pressure are set and maintained within the pump's recommended operating range.	
POI44	Operation	Pump Duty	Allow 2-5 minutes for pump operation to stabilise	
POI45	Operation	Pump Monitoring	**Monitor and record for a minimum period of 10 minutes;**	**CHECKED (√)**
POI46	Operation	Pump Monitoring	Pump bearing temperatures	
POI47		Pump Monitoring	Pump bearing bracket oil level	
POI48	Operation	Pump Monitoring	Mechanical seal quench level	
POI49	Operation	Pump Monitoring	Mechanical seal quench contamination	
POI50	Operation	Pump Monitoring	Check gland packing drip rate, ensure enough fluid is coming out of gland	
POI51	Operation	Pump Monitoring	Pump pressure gauge reading	
POI52	Operation	Pump Monitoring	Pump suction gauge reading	
POI53	Operation	Pump Monitoring	Pump flow meter reading	
POI54	Operation	Engine Monitoring	Engine speed reading	
POI55	Operation	Pump Monitoring	Other pump monitoring devices fitted	
POI56	Operation	Pump Monitoring	Pump system leaks - pump / control valves / suction & discharge pipe systems)	
POI57	Operation	Pump Monitoring	Pump system leaks - control valves / suction & discharge pipe systems)	
POI58	Operation	Pump Monitoring	Pump system leaks - suction pipe systems	
POI59	Operation	Pump Monitoring	Suction hose / strainer set up (no vortex, i.e. no air being sucked into suction pipe)	
POI60	Operation	Pump Monitoring	Pump system leaks - discharge pipe systems	
POI61	Operation	Pump Monitoring	Pump system leaks - discharge pipe systems	

PUMP x DIESEL ENGINE INSTALLATION & OPERATING INSTRUCTIONS - GENERIC VERSION				
CODE	**STEP**	**ITEM**	**INSTRUCTIONS**	**CHECKED (√)**
POI62	Operation	Engine Monitoring	Engine temperature reading	
POI63	Operation	Engine Monitoring	Engine voltage reading	
POI64	Operation	Engine Monitoring	Engine load reading	
POI65	Operation	Engine Monitoring	Engine pressure reading	
POI66	Operation	Engine Monitoring	Engine emissions	
POI67	Operation	Engine Monitoring	Other engine monitoring devices fitted	
POI68	Operation	Gearbox Monitoring	Gearbox pressure reading	
POI69	Operation	Gearbox Monitoring	Gearbox temperature reading	
POI70	Operation	Air Comp Monitoring	Compressor relief valve is not blowing off (relieving), sounds like a rattle gun	
POI71			***Special Note:*** *Any abnormal noises need to be investigated immediately*	
POI72	Operation	Shutdown	To shut down pump reduce the speed to diesel engine idle RPM by either adjusting the vernier control mechanism (mechanical diesel engines) or toggle switch (electronic diesel engines) located on the engine control panel; and press stop once for cool down timer, basically the engine will operate at diesel engine idle speed for a set period before shutting down, or press stop a second time to bypass cool down timer process (not recommended)	
POI73	Operation	Shutdown Timer	Shutdown Timer is available for required run time	
AUTOMATIC OPERATION				
POI74	Operation	Automatic Stop/Start	Auto Operation is available if required but due to the numerous Automatic start up triggers and functions it is recommended to consult your local AllightSykes / AllightPrimax representative for these set ups.	

Special Note:
For additional MANUAL and AUTOMATIC diesel engine control panel operation and setting information please refer to Engine Control Panel Manuals and /or your local AllightSykes / AllightPrimax representative

8.3 Defects – Pumpset Service and Inspection

DEFECTS - PUMPSET SERVICE & INSPECTION DOCUMENT		
Service Engineering Report #		
Service Work Order		
Defect Component	**Detail**	**Can Machine go to Work YES or NO**
Reviewed by (name):		
Supervisor (signature):		
Date:		

8.4 Air Compressor

8.4.1 General Description

Application

These compressors are positive displacement type, reciprocating and single acting. The cylinder barrels are air-cooled while the cylinder head is cooled by water circulated from the vehicle engine cooling system.

The salient features of these compressors are robust overhung design crankshaft for reliability & easy maintenance, solid end connecting rods, highly thermal efficient interfolding, totally reliable splash lubrication & force feed lubrication for smooth vibration free operation.

Single Stage Compressor

These compressors have cylinders of the same size. The principle of operation is as follows: On the suction stroke of the individual piston, air at atmospheric pressure enters the crankcase/cylinder through the inlet filter and the valve located in airhead. On the compression stroke of the each piston, air is forced out through the valve and passes into a common discharge.

General Specifications

Bore	75	mm
Stroke	50	mm
Swept Volume	37.4	CFM
Maximum Recommended Speed	2400	rpm
Maximum Recommended Delivery Pressure	9 / 130	BAR / PSI
Operating Temperature Range	-40 to +80	^{0}C
Maximum Continuous delivery Air Temperature	200	^{0}C
Weight	20	kg

8.4.2 Operation

The following instructions should be used by the operator as a guide for the general operation of the compressor. As the operator gains experience with the compressor under actual conditions, a set routine should be established. After a general overhauling or installation of new parts, the operator should be guided by the instructions as though the compressor was new.

Initial Start:

IMPORTANT

It is very important that the intake piping be clean and properly installed. It is essential that this be done after installation or relocation of the compressor and after a long shutdown or new parts installation

Preparation

When the installation of the compressor has been completed in accordance to the instructions given, carry out the following procedure before starting the machine.

1. Remove oil, dirt and dust from the exterior of the compressor.

2. Remove the air head and clean out with safety solvent every portion of the interior and the crankcase oil sump to ensure a clean interior, free from dust and dirt, which may have entered during shipping and installation. Never use waste or a linty cloth to clean the interior of the machine.

The running and finished parts inside the crankcase are covered with a heavy anti-rust compound previous to shipment. It is not necessary to remove this coating before starting the compressor, as it is soluble in the pump lubricating oil.

3. Fill the crankcase to the proper oil level on the oil sight glass with the recommended grade of crankcase lubricating oil. Pour oil over all the bearings, which can be easily reached through the frame or openings. On lubricated units, fill the cylinder lubricator with the recommended grade of air cylinder lubricating oil.

4. Prime the frame lubricating oil pump.

5. On lubricated units each cylinder force feed lubricator line must be disconnected at the point where it is attached to the oil inlet side of the check valve. The lubricator feeds must then be operated manually until all the air is forced out of the lines and oil appears. The lines should now be reconnected and the lubricator given several additional turns to assure proper lubrication of the cylinder as soon as the compressor is started. Once the compressor is started, the oil lines will remain full of oil and require no further attention.

6. Drain the air intake pipe of any moisture, which may have accumulated. Be sure that the air-intake filter is properly installed and protected.

7. Before starting a new compressor be sure you are familiar with the starting and stopping controls, and with the regulation and regulator controlling the load and no-load operation.

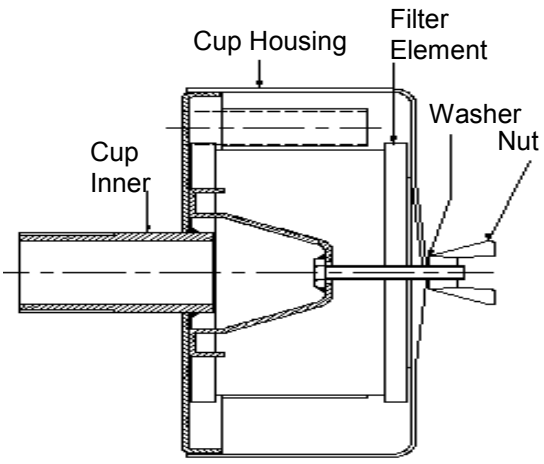
8. Check the machines thoroughly to be sure there are no loose parts and that the machine has not been tampered with since its erection.

9. The compressor lubricating oil is circulated under pressure from the vehicle engine lubricating oil system.

8.4.3 Accessories

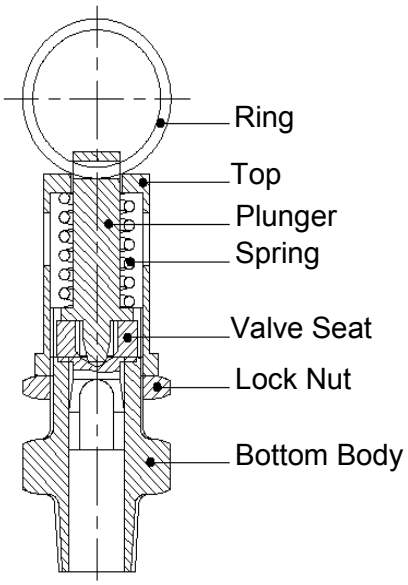
Inlet Air Filter

The air that is drawn into a compressor should be free from dust, dirt and abrasive or gritty particles that could damage cylinders, valves & moving parts. It is the purpose of the inlet filter to remove all such particles from the ambient air, in order to safeguard the performance of the compressor and prevent what might otherwise results in high maintenance costs and needless compressor down time. Suction air filters also helps in reducing the noise level of the compressors.



Safety Valve

This is provided as standard on air compressor. Safety valve is set to open, when the delivery pressure of the compressor has exceeded 630Kpa (90 PSI), thus protecting compressor.



8.4.4 Piping

Discharge piping is considered to be the piping between the compressor and the system.

The discharge pipe should be of the full size as of the compressor outlet or larger and it should run directly to the system.

The discharge should be as short and direct as possible with long radius elbows, where bends are necessary.

All pipe fittings must be considered for the operating pressure. All pipe joints should be tight and having no leaks in discharge system, leaks will reduce output of the compressor. Leaks are easily located by squirting soap and water solution around all joints and watching for bubbles.

Where a bare compressor is supplied, it is very important to observe the following when installing the piping between the compressor and the system.

1. Never install a shut off valve (such as a gate or globe valve) between the compressor and the system unless a safety valve is put in the piping between the valve and the compressor.

The compressor should be mounted where the maximum air flow will pass over it to help in ensuring that the delivered air temperature does not exceed 220˚C.

WARNING

DO NOT USE PLASTIC PIPE OR RUBBER HOSE AS DISCHARGE PIPE, AS THEY CAN RESULT IN MECHANICAL FAILURE, PROPERTY DAMAGE & SEVERE INJURY OR DEATH

8.5 Link Belt Installation and Maintenance Procedure

8.5.1 Link Belt Description

Nut link belts are detachable 'V' belts

Material
Detachable 'V' belts are made from polyester / polyurethane composites

Benefits

- High resistance to extreme temperatures (-40^0 to $+100^0$C)
- High resistance to abrasive materials
- High resistance to water, steam, oil and most chemicals
- Fit in minutes, no need to break pump / engine coupling arrangement
- Reduce vibration and noise by up to 50%

8.5.2 Link Belt Installation Procedure

1. Measure the belt by pulling the belt tight around the pulley to check hand tight length, overlapping the two holes on end of belt with corresponding studs in the opposite end to determine start length – refer to Fig. 13.

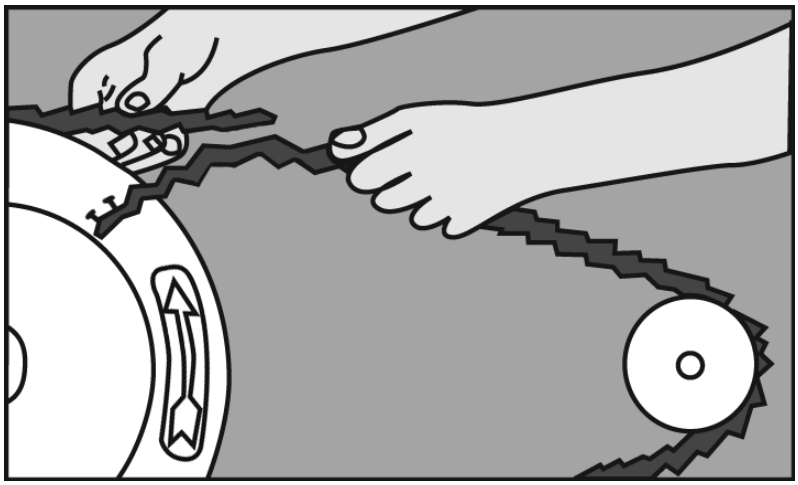


Figure 13

2. Count the total number of link and remove the appropriate number of link to obtain the necessary pre-tension.
    a. SPA & SPB – 1 in 15 links
    b. On multi belt drives ensure that each belt has the same number of links

3. Turn 2 adjacent stud heads 90^0 to fasten belt – refer to Fig. 14.

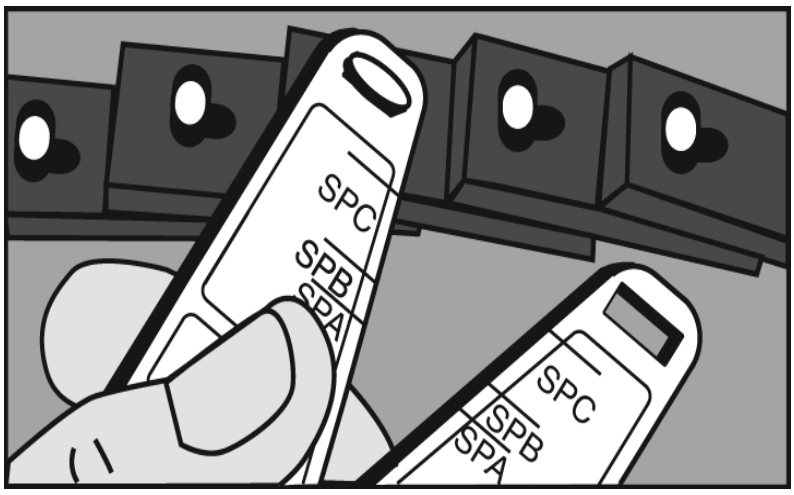


Figure 14

4. Use tool or pliers to twist stud heads

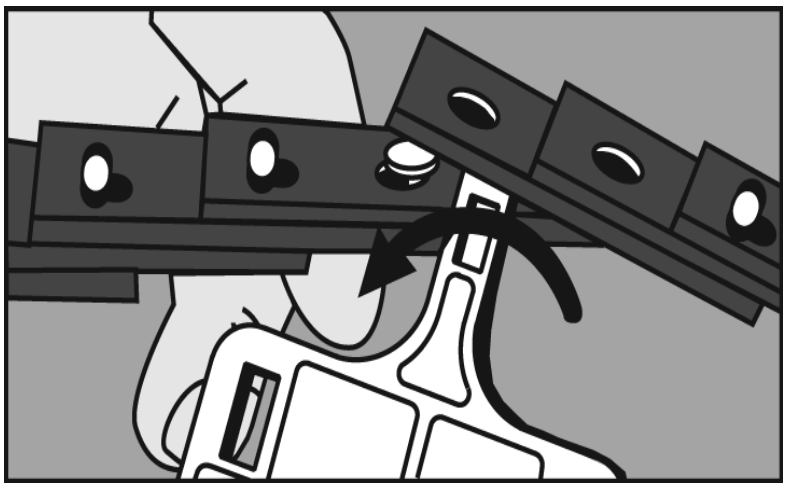


Figure 15

5. Ensure that multiple belt drives run in the same direction

6. Make belt endless, around pulley shaft if necessary, by inserting the stud heads of the last link into the corresponding holes and turning heads 90^0

7. Fit belt into nearest groove of the smallest pulley and roll / push belt onto larger pulley using a round bar or equivalent rounded tool (no sharp edges that could damage pulley or belt during belt fitting stage) – refer to Fig. 16. The belt may seem very tight, this is normal. DO NOT JOG MOTOR.

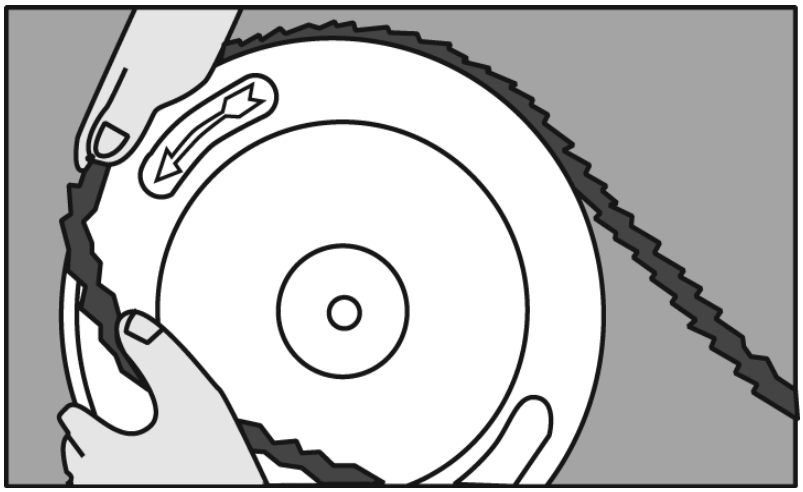


Figure 16

8. For close ratio drives additional links may need to be added back in to ease installation
9. Drive tension should be checked after 20 – 30 minutes operating at full load
10. Another re-tension should be carried after 24 hours
11. Belt tension should be checked periodically and adjusted when necessary
12. Fit all guarding and check the belts and pulleys are free to rotate

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9. BASIC SERVICE INFORMATION

9.1 Pumpset Service Schedule – Generic

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
PUMP									
PU1	Pump Area	Ensure the area is clean and free of debris	X						
PU2	Pump	Check for any oil, coolant, quench fluid or water leaks	X						
PU3	Pump	Check gland packing drip rate, ensure enough fluid is coming out of gland but not excessively	X						
PU4	Gland Packing	Inspect gland packing, check for wear and burn marks	X						
PU5	Gland Packing	Change gland packing; all of the installed rings						X	
PU6	Gland Packing	Inspect gland packing sleeve look for worn areas or grooves		X	X	X	X		
PU7	Gland Packing	Inspect gland followers look for corrosion and excessive wear and damage		X	X	X	X		
PU8	Gland Packing	Inspect gland housing look for corrosion and excessive wear and damage		X	X	X	X		
PU9	Gland Packing	Inspect fasteners are secure, studs are not excessively corroded		X	X	X	X		
PU10	Mechanical Seal	Check for mechanical seal fittings, and hoses leaks.	X						
PU11	Mechanical Seal	Inspect for mechanical seal reservoir leaks	X						

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
PU12	Mechanical Seal	Inspect mechanical seal temperature / level gauge, gauge is readable		X	X	X	X		
PU13	Mechanical Seal	Change mechanical seal lubrication fluid, check information sign near mechanical seal for lubrication fluid type		X	X	X	X		
PU14	Mechanical Seal	Check mechanical seal oil for milkiness/contamination or coolant contamination. Change mechanical seal oil or coolant radiator fluid.	X						
PU15	Bearing Bracket	Inspect bearing bracket guards for cracking, security and damage		X	X	X	X		
PU16	Bearing - Oil & Grease Lubed	Check bearing temperature & record in comments box		X	X	X	X		
PU17	Bearing - Oil Lubed	Inspect pump shaft seals (bearing isolators) for oil leaks		X	X	X	X		
PU18	Bearing - Oil Lubed	Inspect bearing bracket oil filler, ensures cap is sealing		X	X	X	X		
PU19	Bearing - Oil Lubed	Change bearing chamber oil Use Hydraulic ISO Grade 68		X	X	X	X		
PU20	Bearing - Oil Lubed	Inspect bearing bracket temperature/level gauge, gauge is readable		X	X	X	X		
PU21	Bearing - Grease Lubed	Inspect bearing grease nipples, ensure that they are not blocked or cracked		X	X	X	X		
PU22	Bearing - Grease Lubed	Grease bearing as per service manual instructions		X	X	X	X		
PU23	Pump	Check pump mounts are secure		X	X	X	X		
PU24	Volute / Tee Piece	Inspect balance pipe/hose for leaks and kinks		X	X	X	X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
PU25	Volute	Inspect gauge; indication needle operation, glycerine level, glycerine contamination, clearness of gauge viewing glass	X						
PU26	Tee Piece	Inspect gauge; indication needle operation, glycerine level, glycerine contamination, clearness of gauge viewing glass	X						
PU27	Pipework	Inspect gearbox butterfly valve handle and stem for looseness and operation			X		X		
PU28	Pipework	Inspect pump bleed valve for looseness and operation			X		X		
PU29	Pump	Check pump recommended operating sign is readable		X	X	X	X		
PU30	Non Return Valve	Clean and inspect non return valve, check for ball or flap, seat and internal wear		X	X	X	X		
AIR COMPRESSOR									
AC1	Compressor Air Relief valve	Test operation to determine if working		X	X	X	X		
AC2	Priming Compressor	Check compressor drive belt for tooth or wedge wear and signs of fraying		X	X	X	X		
AC3	Priming Compressor	Check compressor pulleys for tooth or groove wear			X		X		
AC4	Priming Compressor	Check air supply hose heat sleeve for damage		X	X	X	X		
AC5	Priming Compressor	Inspect for air supply hose kinks etc		X	X	X	X		
AC6	Priming Compressor	Inspect oil supply and drain hoses for leaks, cracks and damage			X		X		
AC7	Priming Compressor	Check coolant supply and drain hoses for leaks, cracks and damage			X		X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
AC8	Priming Compressor	Inspect compressor relief valve, cleaniness of spring and pin mechanism		X	X	X	X		
DRIVE LINE									
DL1	Drive Line	Inspect drive coupling; condition of rubber, drive ring and fasteners			X		X		
GEARBOX									
GB1	Gearbox	Run machine to warm up oil. Take live sample. Use Oil test sample bottle.		X	X	X	X		
GB2	Gearbox	Check bearing temperature & record in comments box		X	X	X	X		
GB3	Gearbox	Listen for abnormal noise	X						
GB4	Gearbox	Clean the filter core and pick up filter			X		X		
GB5	Gearbox	Clean the hydraulic control system		X	X	X	X		
GB6	Gearbox	Inspect the inlet seals			X		X		
GB7	Gearbox	Inspect gearbox / pump coupling; condition of rubber, drive ring and fasteners			X		X		
GB8	Gearbox	Remove the inspection cover, turn coupling by hand and check the gear and clutches			X		X		
GB9	Gearbox	Check and renew oil		X					
OIL COOLER									
OC1	Oil Cooler	Inspect oil cooler main body for security, leaks, cracks and damage		X					
OC2	Oil Cooler	Inspect radiator core for evidence of leaks			X		X		
OC3	Oil Cooler	Inspect header tank for evidence of leaks			X		X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
OC4	Oil Cooler	Inspect radiator fins for blockages and clean as required		X	X	X	X		
OC5	Oil Cooler	Inspect hoses and connections for leaks, cracks and damage		X	X	X	X		
DIESEL ENGINE LUBE SERVICE									
DELS1	Engine Oil	Change Engine oil		X	X	X	X		
DELS2	Engine Oil Filters	Replace. Cut and inspect. Report any debris to the supervisor		X	X	X	X		
DELS3	Radiator Coolant	Inspect and fill as required.	X						
DELS4	Radiator Coolant	Change if coolant is discoloured.						X	
DELS5	Fuel Filter Primary	Replace		X	X	X	X		
DELS6	Fuel Filter Secondary	Replace		X	X	X	X		
DELS7	Radiator Coolant, Lube and Fuel Quick Fill	Visually inspect for leaks. Ensure that protective caps are in place.	X						
DELS8	Fuel Tank	Fill						X	
DIESEL ENGINE									
DE1	Engine	Check for any oil, coolant, quench fluid and water leaks	X						
DE2	Engine	Check vernier control operation (mechanical type engine) or toggle switch (electronic type of engine) engine control panel, shut down operations engine and pump		X	X	X	X		
DE3	Controls	Test operation of all gauges, warning, alarms and shutdowns		X	X	X	X		
DE4	Radiator Core and Header Tank	Inspect for evidence of coolant leaks.			X		X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs	500 hrs	750 hrs	1,000 hrs	As Required	Comments
				3 months	6 months	9 months	12 months		
DE5	Radiator Fins	Inspect for blockages and clean as required	X						
DE6	Radiator Pressure Relief	Ensure valve relieves pressure from radiator			X		X		
DE7	Radiator Hoses	Inspect for cracks and damage. Inspect for evidence of coolant leaks		X	X	X	X		
DE8	Fan Blades and Guards	Inspect for signs of cracking, damage and security			X		X		
DE9	Fan / Alternator Drive Belts	Inspect for evidence of cracking and wear. Inspect tension		X	X	X	X		
DE10	Alternator Mounting Brackets	Inspect for security and alignment. Inspect the guard for signs of cracking or damage			X		X		
DE11	Starter Motor	Inspect starter motor mounts for security		X	X	X	X		
DE12	Engine Mounts	Inspect mounts are secure			X		X		
DE13	Exhaust Manifold Pipes and Clamps	Inspect for exhaust leaks and evidence of cracking			X		X		
DE14	Exhaust Shields	Inspect for condition and security			X		X		
DE15	Engine Exhaust Rain Cap	Test operation to determine if working		X	X	X	X		
DE16	Turbo Oil Feed Lines	Inspect condition of oil lines			X		X		
DE17	Air Intake Hoses	Inspect for evidence of perishing and cracking. Inspect clamps are in place and secure			X		X		
DE18	Fuel Hoses and Pipes	Inspect for leaks and correctly secured		X	X	X	X		
DE19	Engine Area	Ensure the engine area is clean and free of debris		X	X	X	X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
DE20	Hoses and Pipes	Inspect for evidence of oil leaks, wear or chaffing. Inspect that all clamping are secure.			X		X		
ELECTRIC MOTOR									
EM1	Motor and Coupling	Check if abnormal noises, vibrations, excessive heating, wear signs, misalignment or damaged parts	X						
EM2	Motor	Check condition of lifting eye		X	X	X	X		
EM3	Motor	Measure and record the insulation resistance		X	X	X	X		
EM4	Motor Enclosure	Clean the motor enclosure			X		X		
EM5	Motor Frame	Remove oil spills and dust accumulation from the motor frame surface			X		X		This is to ensure better heat transfer to the surrounding ambient
EM6	Cooling Fan	Check cooling fan condition and clean the air inlet & outlet openings	X						This is to ensure free air flow over the motor
EM7	Motor Seals	Check condition of seals		X	X	X	X		
EM8	Motor Drain	Drain the condensed water from the inside the motor		X	X	X	X		After draining, reinstall the drain plugs to ensure the degree of IP protection stated on the name plate. The motor must always be positioned so the drain hole is at the lowest position.
EM9	Terminal Box	Check condition of Lifting eye			X		X		
EM10	Terminal Box	Check condition of terminal box		X	X	X	X		
EM11	Terminal Box	Check terminal box seals		X	X	X	X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
EM12	Power Cables	Check the connections of the power supply cables	X						Ensuring the correct distance between live and grounded parts
EM13	Bolted Connections	Check if the tightening torque of the bolted connections and fixations meets tightening torque			X		X		
EM14	Power Cables	Check the status of the cable passages, the cable gland seals and the seals inside the terminal box	X						
EM15	Bearings	Check the bearing operating conditions. Check for the presence of any abnormal noise, vibration or other abnormal operating conditions, like motor temperature rise	X						
EM16	Bearings	Check and record the oil level, the lube conditions and compare the working hours with the informed life time		X	X	X	X		
EM17	Bearing - Grease Lubed	Grease bearing as per service manual instructions		X	X	X	X		
EM18	Bearing - Oil Lubed	Oil bearing as per service manual instructions		X	X	X	X		
EM19	Bearing - Oil Mist Lubed	Carry out maintenance plan as per service manual instructions		X	X	X	X		
ELECTRICAL									
EL1	Batteries	Clean batteries and enclosure. Ensure batteries are securely clamped. Inspect cabling and conduit for damage and security.			X		X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
EL2	Battery Terminal Connections	Inspect for security and terminal cleanliness. Inspect terminals are covered with insulators. Coat terminals with Korode Kure.			X		X		
EL3	Battery Isolator	Inspect cabling and conduit for damage and security. Check operation. Inspect terminal are secure and in good condition.		X	X	X	X		
EL4	Jump Start Receptacle	Inspect cabling and conduit for damage and security. Check operation. Inspect terminal are secure and in good condition.			X		X		
EL5	Alternator Connections	Inspect for evidence of overheating and check for security. Inspect terminal shrouds are secure and in good condition.			X		X		
EL6	Starter Motor	Inspect cabling and conduit for damage and security. Ensure terminals are insulated.		X	X	X	X		
EL7	Starter Motor Isolator	Inspect cabling and conduit for damage and security. Check operation. Inspect terminal are secure and in good condition.		X	X	X	X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
EL8	Engine/Pump Control Panel	Inspect cabling and conduit for damage and security. Check operation. Check control panel still complies with relevant IP rating. Check controls and switches. Inspect terminals, plugs and cables are secure and in good condition.		X	X	X	X		
EL9	Pressure Transducer	Inspect pressure transducer unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation		X	X	X	X		
EL10	Vacuum Transducer	Inspect vacuum transducer unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation		X	X	X	X		
EL11	Temperature Probe	Inspect temperature probe unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation		X	X	X	X		
EL12	Temperature Gauges	Inspect temperature gauge unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display		X	X	X	X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
EL13	Flow Meter	Inspect flow meter main body, flow meter control panel unit (including vibration mounts), cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation			X		X		
EL14	Flow Switch	Inspect flow switch unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation		X	X	X	X		
EL15	Trailing Wire Switch	Inspect trailing wire switch unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation		X	X	X	X		
EL16	Inclinometer / Tilt Switch	Inspect inclinometer / tilt switch unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation			X		X		
EL17	Dam Level Transducer	Inspect dam level transducer unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display			X		X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs 3 months	500 hrs 6 months	750 hrs 9 months	1,000 hrs 12 months	As Required	Comments
EL18	Dam Level Floats	Inspect dam level floats, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel display Check operation			X		X		
EL19	Emergency Stops	Inspect cabling and conduit for damage and security. Check operation. Inspect terminal are secure and in good condition.		X	X	X	X		
EL20	Work Lights	Inspect work light units, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel operation		X	X	X	X		
EL21	Flashing Light	Inspect flashing light unit, cabling, plugs and conduit for damage and security. Ensure terminals are insulated. Check control panel operation Check operation			X		X		
MISCELLANEOUS									
MISC1	Skid Base	Check structure for any damage, wear and general condition.			X		X		
MISC2	Single point Lifting Frame	Check structure for any damage, wear and general condition.			X		X		
MISC3	Bull (Push) Bar	Check structure for any damage, wear and general condition.			X		X		
MISC4	Skid Wear Strips	Check for any damage, wear and general condition.			X		X		
MISC5	Boom (A-frame)	Check structure for any damage, wear and general condition.			X		X		

CODE	COMPONENT	INSTRUCTIONS	Daily	250 hrs	500 hrs	750 hrs	1,000 hrs	As Required	Comments
				3 months	6 months	9 months	12 months		
MISC6	Winch	Check suction line winch condition and operation.			X		X		
MISC7	Handrails and Walkways	Inspect for security and damage.			X		X		
MISC8	Hoses (Suction & Discharge)	Inspect for rubbing, hose damage and leaks. Inspect fittings and clamps for security.			X		X		
MISC9	Fuel Tank	Inspect for condition and leaks. Drain water sediment and note the quantity of water (if any).			X		X		
MISC10	Fuel Filler, Pick Up & Return Set Up	Inspect for rubbing, hose damage and leaks. Inspect fittings and clamps for security.		X	X	X	X		
MISC11	Fuel Level Gauge	Inspect level gauge gauge, check glycerine level and needle position or display on control panel			X		X		
MISC12	Tow Chain	Check tow chain for any damage, excessive wear and general condition.			X		X		
MISC13	Guards	Check that all guards and covers are in place and secure.	X						
FIRE EXTINGUISHERS									
FE1	Fire Extinguishers	Inspect for correct charge. Inspect cylinder and mounting bracket for damage and security.		X	X	X	X		Check inspection date

9.2 Pump and Associated Parts - Lubrication & Cooling Fluid

Sykes Pump - Lubrication & Cooling Fluids									
Pump Type	**Pump Bearings**	**Mechanical Seal**	**Gearbox**	**Air Compressor (Sykes)**		**Air Compressor** (Sykes, self contained lubrication reservoir, air cooled)	**Air Compressor** (air cooled, rotary vane, oil lubricated)	**Diesel Engine**	
	Lubrication	*Lubrication Cooling*	*Lubrication Cooling*	*Lubrication*	*Cooling*	*Lubrication*	*Lubrication*	*Lubrication*	*Cooling*
CP80i	1	2	n/a	2	6	5	n/a	2	6
CP100i	1	2	n/a	2	6	5	n/a	2	6
CP150iC	1	2	n/a	2	6	5	n/a	2	6
CP150i	1	2	n/a	2	6	5	n/a	2	6
CP220i	1	2	n/a	2	6	5	n/a	2	6
CP250i	1	2	n/a	2	6	5	n/a	2	6
CP300i	1	6	5	2	6	5	n/a	2	6
HH80	1	2	n/a	2	6	5	n/a	2	6
HH130i	1	2	n/a	2	6	5	n/a	2	6
HH160i	3	6	n/a	2	6	5	n/a	2	6
HH220i	3	6	n/a	2	6	5	n/a	2	6
HD100i	3	3	n/a	n/a	n/a	n/a	n/a	2	6
HD150iC	3	3	n/a	n/a	n/a	n/a	n/a	2	6
HD150i	3	3	n/a	n/a	n/a	n/a	n/a	2	6

Sykes Pump - Lubrication & Cooling Fluids									
Pump Type	**Pump Bearings**	**Mechanical Seal**	**Gearbox**	**Air Compressor (Sykes)**		**Air Compressor** (Sykes, self contained lubrication reservoir, air cooled)	**Air Compressor** (air cooled, rotary vane, oil lubricated)	**Diesel Engine**	
	Lubrication	*Lubrication Cooling*	*Lubrication Cooling*	*Lubrication*	*Cooling*	*Lubrication*	*Lubrication*	*Lubrication*	*Cooling*
HD220i	3	3	n/a	n/a	n/a	n/a	n/a	2	6
HD250i	3	3	n/a	n/a	n/a	n/a	n/a	2	6
HDHH130i	3	3	n/a	n/a	n/a	n/a	n/a	2	6
HDMH130i	3	3	n/a	n/a	n/a	n/a	n/a	2	6
HDMH150i	3	3	n/a	n/a	n/a	n/a	n/a	2	6
MH130i	1	2	n/a	2	6	5	n/a	2	6
MH150i	1	2	n/a	2	6	5	n/a	2	6
MH220i	3	6	n/a	2	6	5	n/a	2	6
MH300i	3	6	n/a	2	6	5	n/a	2	6
SW100	1	2	n/a	2	6	5	n/a	2	6
SW150	1	2	n/a	2	6	5	n/a	2	6
WD100i	1	2	n/a	2	6	5	4	2	6
WD150iC	1	2	n/a	2	6	5	4	2	6
XH80	3	2	n/a	2	6	5	n/a	2	6
XH100	3	2	n/a	2	6	5	n/a	2	6
XH150	3	2	n/a	2	6	5	n/a	2	6

SYKES

Sykes Pump - Lubrication & Cooling Fluids									
Pump Type	**Pump Bearings**	**Mechanical Seal**	**Gearbox**	**Air Compressor (Sykes)**		**Air Compressor** (Sykes, self contained lubrication reservoir, air cooled)	**Air Compressor** (air cooled, rotary vane, oil lubricated)	**Diesel Engine**	
	Lubrication	*Lubrication Cooling*	*Lubrication Cooling*	*Lubrication*	*Cooling*	*Lubrication*	*Lubrication*	*Lubrication*	*Cooling*
XH200	3	2	n/a	2	6	5	n/a	2	6
Yakka100	1	2	n/a	2	6	5	n/a	2	6
Yakka150	1	2	n/a	2	6	5	n/a	2	6
YakkaHH80	1	2	n/a	2	6	5	n/a	2	6

Note: If Ambient temperature < -15^{0}C or >50^{0}C, please contact AllightSykes

1	= Grease Multi Lube Lithium EP Additives NLGI #2
2	= Oil 15W40
3	= Oil ISO 68 Hydraulic
4	= Oil ISO32
5	= Oil SAE30
6	= Engine Coolant, brand specific (Caterpillar, Perkins, Cummins etc), ensure that coolant is compatible with aluminium

9.3 General Service Information

Preventive maintenance is the easiest and least expensive type of maintenance. The purpose of the maintenance is to extend the useful of the equipment. The non-compliance with one of the previous items can cause unexpected machine failures.

Ensure that the safety information, warnings and the instruction are read and understood before performing any maintenance procedures.

Follow the minor and major maintenance schedule outlined in Sykes Maintenance Schedule. Use the service hours or calendar time, whichever occurs first, in order to determine the maintenance intervals.

Sykes uses the latest technology and highest quality components to produce its pumps.

Do not reuse damaged or worn parts. Damaged or worn parts must be replaced by genuine Sykes parts as if they were the original parts.

Use the correct mechanical seal coolant, pump bearing lubricant as specified.

Personnel at AllightSykes/ AllightPrimax / Dealers have been trained to provide expert service and parts support. All repairs, disassembly related services must be carried out only by qualified and well trained personnel by using proper tools and techniques. Ensure maintenance carried out complies with relevant HSE site, government rules, acts, regulations and codes of practice.

The company does not assume any responsibility or liability for repair services or maintenance operations executed by non-authorised Service Centres or by non qualified service personnel. The company shall have no obligation or liability whatsoever to the buyer for any indirect, special, consequential or incidental loss or damage caused or arising from the company's proven negligence.

If the pump is operated in ambient temperatures below -18^{0}C or above 38^{0}C and / or under severe conditions, perform maintenance at shorter intervals.
Severe service includes the following conditions; low and high temperatures, continuous high loads, vibration and dusty conditions.

Record and file all changes performed on pump unit and pump unit related items.

Please contact AllightSykes / AllightPrimax / Dealers for assistance.

9.4 Pump Bearing Lubrication Schedule – Grease Type

Pump Speed Range: 1,400 – 1,900 rpm

PUMP BEARING LUBRICATION SCHEDULE - GREASE															
				QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)											
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)
				1400	44	1500	46	1600	46	1700	48	1800	50	1900	52
CP80i	SAE #4	Refer to Diagram #1	Condition 1	*1.0*		*1.0*		*2.0*		*2.0*		*2.0*		*2.1*	
			Condition 2	*2.0*		*2.0*		*2.0*		*3.0*		*3.0*		*3.0*	
CP100i	SAE #4	Refer to Diagram #1	Condition 1	*1.0*		*1.0*		*2.0*		*2.0*		*2.0*		*2.1*	
			Condition 2	*2.0*		*2.0*		*2.0*		*3.0*		*3.0*		*3.0*	
CP150iC	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*9.4*	
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*25.8*	
CP150i	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*9.4*	
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*25.8*	
CP220i	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*9.4*	
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*25.8*	

PUMP BEARING LUBRICATION SCHEDULE - GREASE																	
				QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)													
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)		
				1400	44	1500	46	1600	46	1700	48	1800	50	1900	52		
CP250i	SAE #3	Refer to Diagram #2	Condition 1	*7.8*		*7.8*		*8.4*		*10.5*		*12.6*		*14.1*			
			Condition 2	*15.6*		*24.0*		*25.2*		*31.8*		*38.1*		*38.7*			
HH80	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*9.4*			
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*25.8*			
HH130i	SAE #3	Refer to Diagram #2	Condition 1	*7.8*		*7.8*		*8.4*		*10.5*		*12.6*		*14.1*			
			Condition 2	*15.6*		*24.0*		*25.2*		*31.8*		*38.1*		*38.7*			
MH130i	SAE #3	Refer to Diagram #2	Condition 1	*7.8*		*7.8*		*8.4*		*10.5*		*12.6*		*14.1*			
			Condition 2	*15.6*		*24.0*		*25.2*		*31.8*		*38.1*		*38.7*			
MH150i	SAE #3	Refer to Diagram #2	Condition 1	*7.8*		*7.8*		*8.4*		*10.5*		*12.6*		*N/A*			
			Condition 2	*15.6*		*24.0*		*25.2*		*31.8*		*38.1*		*N/A*			
SW100	SAE #4	Refer to Diagram #1	Condition 1	*1.0*		*1.0*		*2.0*		*2.0*		*2.0*		*2.1*			
			Condition 2	*2.0*		*2.0*		*2.0*		*3.0*		*3.0*		*3.0*			

PUMP BEARING LUBRICATION SCHEDULE - GREASE																	
				QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)													
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)		
				1400	44	1500	46	1600	46	1700	48	1800	50	1900	52		
SW150	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*9.4*			
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*25.8*			
WD100i	SAE #4	Refer to Diagram #1	Condition 1	*1.0*		*1.0*		*2.0*		*2.0*		*2.0*		*N/A*			
			Condition 2	*2.0*		*2.0*		*2.0*		*3.0*		*3.0*		*N/A*			
WD150iC	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*N/A*			
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*N/A*			
Yakka100	SAE #4	Refer to Diagram #1	Condition 1	*1.0*		*1.0*		*2.0*		*2.0*		*2.0*		*2.1*			
			Condition 2	*2.0*		*2.0*		*2.0*		*3.0*		*3.0*		*3.0*			
Yakka150	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*9.4*			
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*25.8*			
YakkaHH80	SAE #4	Refer to Diagram #1	Condition 1	*5.2*		*5.2*		*5.6*		*7.0*		*8.4*		*9.4*			
			Condition 2	*10.4*		*16.0*		*16.8*		*21.2*		*25.4*		*25.8*			

Pump Speed Range: 2,000 – 2,400 rpm

PUMP BEARING LUBRICATION SCHEDULE - GREASE													
				QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)									
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)
				2000	54	2100	56	2200	60	2300	63	2400	66
CP80i	SAE #4	Refer to Diagram #1	Condition 1	*2.1*		*2.1*		*2.2*		*2.2*		*2.2*	
			Condition 2	*4.0*		*4.0*		*4.0*		*5.0*		*6.0*	
CP100i	SAE #4	Refer to Diagram #1	Condition 1	*2.1*		*2.1*		*2.2*		*2.2*		*2.2*	
			Condition 2	*4.0*		*4.0*		*4.0*		*5.0*		*6.0*	
CP150iC	SAE #4	Refer to Diagram #1	Condition 1	*9.6*		*10.0*		*10.4*		*N/A*		*N/A*	
			Condition 2	*26.0*		*26.6*		*28.0*		*N/A*		*N/A*	
CP150i	SAE #4	Refer to Diagram #1	Condition 1	*9.6*		*10.0*		*10.4*		*N/A*		*N/A*	
			Condition 2	*26.0*		*26.6*		*28.0*		*N/A*		*N/A*	
CP220i	SAE #4	Refer to Diagram #1	Condition 1	*9.6*		*N/A*		*N/A*		*N/A*		*N/A*	
			Condition 2	*26.0*		*N/A*		*N/A*		*N/A*		*N/A*	
CP250i	SAE #3	Refer to Diagram #2	Condition 1	*14.4*		*N/A*		*N/A*		*N/A*		*N/A*	
			Condition 2	*39.0*		*N/A*		*N/A*		*N/A*		*N/A*	

PUMP BEARING LUBRICATION SCHEDULE - GREASE													
				QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)									
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)
				2000	54	2100	56	2200	60	2300	63	2400	66
HH80	SAE #4	Refer to Diagram #1	Condition 1	*9.6*		*10.0*		*10.4*		*10.6*		*10.8*	
			Condition 2	*26.0*		*26.6*		*28.0*		*28.5*		*29.0*	
HH130i	SAE #3	Refer to Diagram #2	Condition 1	*14.4*		*N/A*		*N/A*		*N/A*		*N/A*	
			Condition 2	*39.0*		*N/A*		*N/A*		*N/A*		*N/A*	
MH130i	SAE #3	Refer to Diagram #2	Condition 1	*14.4*		*N/A*		*N/A*		*N/A*		*N/A*	
			Condition 2	*39.0*		*N/A*		*N/A*		*N/A*		*N/A*	
MH150i	SAE #3	Refer to Diagram #2	Condition 1	*N/A*		*N/A*		*N/A*		*N/A*		*N/A*	
			Condition 2	*N/A*		*N/A*		*N/A*		*N/A*		*N/A*	
SW100	SAE #4	Refer to Diagram #1	Condition 1	*2.1*		*2.1*		*2.2*		*2.2*		*2.2*	
			Condition 2	*4.0*		*4.0*		*4.0*		*5.0*		*6.0*	
SW150	SAE #4	Refer to Diagram #1	Condition 1	*9.6*		*10.0*		*10.4*		*N/A*		*N/A*	
			Condition 2	*26.0*		*26.6*		*28.0*		*N/A*		*N/A*	

PUMP BEARING LUBRICATION SCHEDULE - GREASE													
				QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)									
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)
				2000	54	2100	56	2200	60	2300	63	2400	66
WD100i	SAE #4	Refer to Diagram #1	Condition 1	*N/A*		*N/A*		*N/A*		*N/A*		*N/A*	
			Condition 2	*N/A*		*N/A*		*N/A*		*N/A*		*N/A*	
WD150iC	SAE #4	Refer to Diagram #1	Condition 1	*N/A*		*N/A*		*N/A*		*N/A*		*N/A*	
			Condition 2	*N/A*		*N/A*		*N/A*		*N/A*		*N/A*	
Yakka100	SAE #4	Refer to Diagram #1	Condition 1	*2.1*		*2.1*		*2.2*		*2.2*		*2.2*	
			Condition 2	*4.0*		*4.0*		*4.0*		*5.0*		*6.0*	
Yakka150	SAE #4	Refer to Diagram #1	Condition 1	*9.6*		*10.0*		*10.4*		*N/A*		*N/A*	
			Condition 2	*26.0*		*26.6*		*28.0*		*N/A*		*N/A*	
YakkaHH80	SAE #4	Refer to Diagram #1	Condition 1	*9.6*		*10.0*		*10.4*		*10.6*		*10.8*	
			Condition 2	*26.0*		*26.6*		*28.0*		*28.5*		*29.0*	

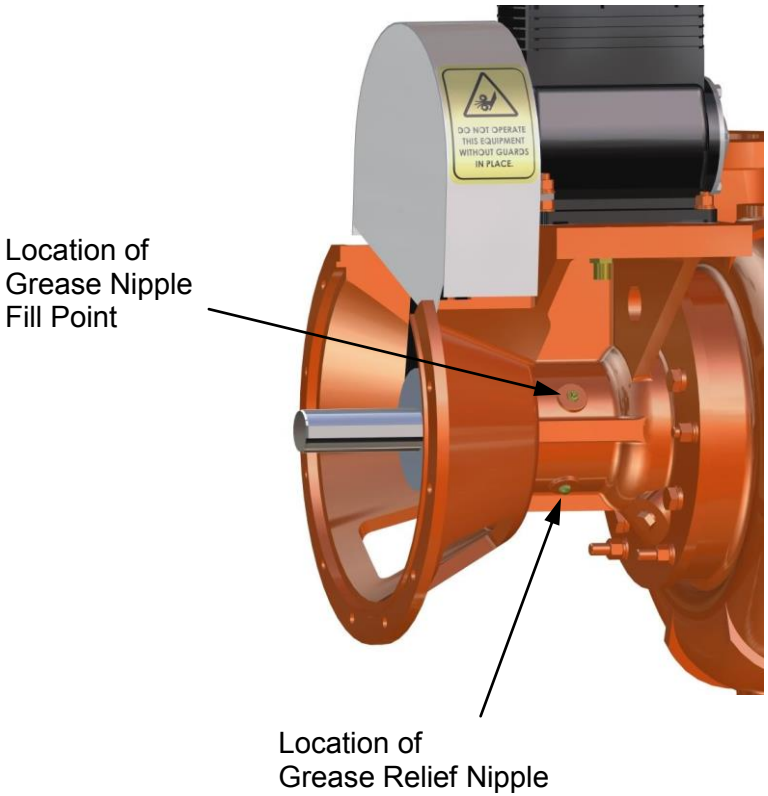


Diagram #1 – Typical SAE #4 Bearing Housing Grease Set Up

Grease Type	Multi Lube Lithium Grease EP Additives NLGI#2

Condition 1		**Condition 2**	
Ambient Temperature	20 ^{0}C	**Ambient Temperature**	40 ^{0}C
Humidity / Dust	Moderate	**Humidity / Dust**	High
Vibration	Moderate	**Vibration**	High
Load	Moderate	**Load**	Heavy

! WARNING !

Use this re-greasing schedule as a guide only

Re-greasing quantities will change due to variances in Operating Conditions.

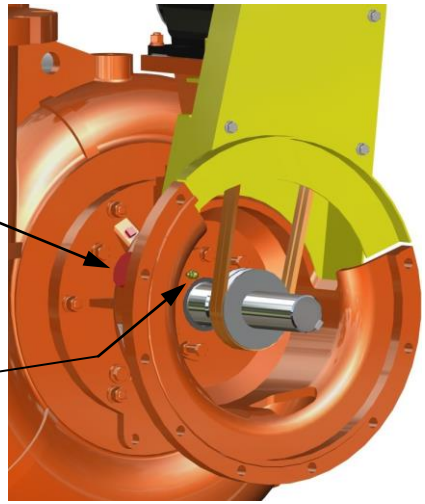
For re-greasing schedules to suit particular Operating Conditions please contact AllightSykes / AllightPrimax for assistance.

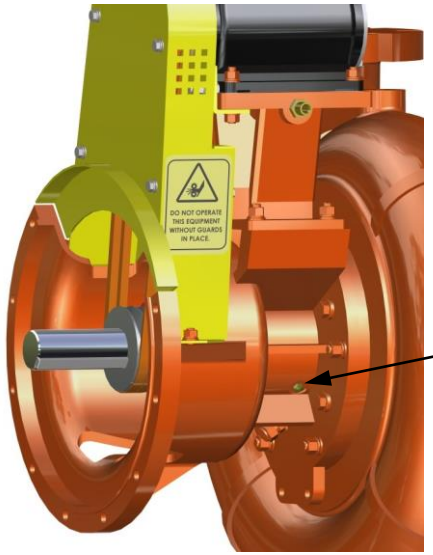
Notes:

1. Single point grease point to grease 2 off bearings.
2. Single point grease relief nipple.
3. Grease relief nipple set at 3 - 5 psi.

Remove Plastic Cap for Access to Fill Point

Location of Grease Nipple Fill Point





Location of Grease Relief Nipple

Diagram #2 – Typical SAE #3 Bearing Housing Grease Set Up

Grease Type	Multi Lube Lithium Grease EP Additives NLGI#2

Condition 1		**Condition 2**	
Ambient Temperature	20 ^{0}C	**Ambient Temperature**	40 ^{0}C
Humidity / Dust	Moderate	**Humidity / Dust**	High
Vibration	Moderate	**Vibration**	High
Load	Moderate	**Load**	Heavy

! WARNING !

Use this re-greasing schedule as a guide only

Re-greasing quantities will change due to variances in Operating Conditions.

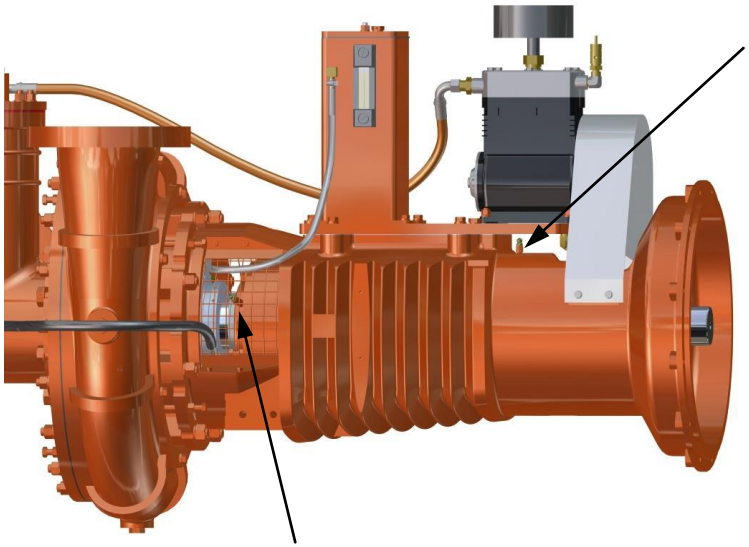
For re-greasing schedules to suit particular Operating Conditions please contact AllightSykes / AllightPrimax for assistance.

Notes:

1. Single point grease point to grease 1 off bearing.
2. Single point grease relief nipple.
3. Grease relief nipple set at 3 - 5 psi.

				NDE (PUMP) QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)									
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)
				900	44	1000	46	1100	48	1200	50	1300	54
CP300i	SAE #1	Refer to Diagram #3	Condition 1	*2.3*		*2.4*		*2.7*		*3.0*		*3.5*	
			Condition 2	*4.2*		*5.0*		*5.5*		*6.0*		*7.0*	

				DE (ENGINE/MOTOR) QTY GREASE REQUIRED PER 250 HOUR INTERVAL (in grams)									
PUMP TYPE	**BEARING HOUSING**	**GREASE SET UP**	**OPERATING CONDITIONS**	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)	**SPEED** (rpm)	**TEMP** (^{O}C)
				900	44	1000	46	1100	48	1200	50	1300	54
CP300i	SAE #1	Refer to Diagram #3	Condition 1	*4.0*		*4.5*		*4.5*		*5.0*		*6.0*	
			Condition 2	*10.0*		*11.0*		*12.0*		*12.6*		*13.5*	



Grease Type	Multi Lube Lithium Grease EP Additives NLGI#2

Condition 1		Condition 2	
Ambient Temperature	20 ^{0}C	Ambient Temperature	40 ^{0}C
Humidity / Dust	Moderate	Humidity / Dust	High
Vibration	Moderate	Vibration	High
Load	Moderate	Load	Heavy

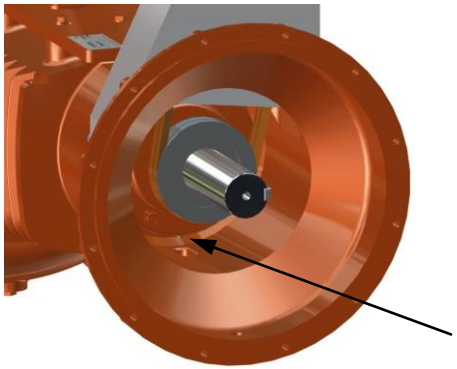


Diagram #3 – CP300i SAE #1 Bearing Housing Grease Set Up

! WARNING !

Use this re-greasing schedule as a guide only

Re-greasing quantities will change due to variances in Operating Conditions.

For re-greasing schedules to suit particular Operating Conditions please contact AllightSykes / AllightPrimax for assistance.

Notes:

1. Grease Point A – NDE (Pump)
2. Grease Point B – DE (Engine / Motor)

9.5 Pump Bearing Lubrication Schedule – Oil Type

PUMP BEARING LUBRICATION SCHEDULE - OIL							
				Oil Change Interval (hours)			
PUMP TYPE	**BEARING HOUSING**	**OIL SET UP**	**OPERATING CONDITIONS**	**TEMP (°C)**	**TEMP (°C)**	**TEMP (°C)**	**TEMP (°C)**
				60	70	80	90
HH160i	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*
HH220i	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*
MH220i	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*
MH300i	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*
XH80	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*

PUMP BEARING LUBRICATION SCHEDULE - OIL							
				Oil Change Interval (hours)			
PUMP TYPE	**BEARING HOUSING**	**OIL SET UP**	**OPERATING CONDITIONS**	**TEMP** (^{O}C)	**TEMP** (^{O}C)	**TEMP** (^{O}C)	**TEMP** (^{O}C)
				60	70	80	90
XH100	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*
XH150	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*
XH200	SAE #1	Refer to Diagram #4	Condition 1	*1000*	*750*	*500*	*250*
			Condition 2	*750*	*500*	*250*	*125*

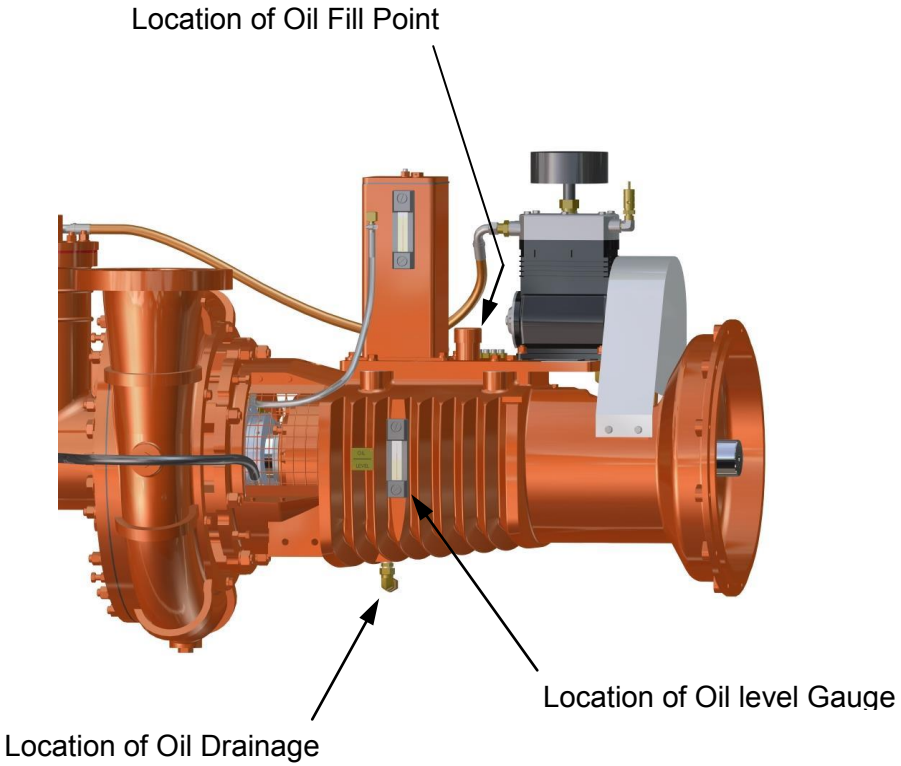


Diagram #4 – Typical SAE #1 Bearing Housing Oil Set Up

Grease Type	Hydraulic ISO Grade 68

Condition 1		Condition 2	
Ambient Temperature	20 ^{0}C	Ambient Temperature	40 ^{0}C
Humidity / Dust	Moderate	Humidity / Dust	High
Vibration	Moderate	Vibration	High
Load	Moderate	Load	Heavy

! WARNING !

Use this oil change schedule as a guide only

Oil change frequency will change due to variances in Operating Conditions.

For oil change schedules to suit particular Operating Conditions please contact AllightSykes / AllightPrimax for assistance.

10. PUMP DIAGNOSTICS

10.1 Trouble Shooting Guide

	SYMPTOMS
	Pump Does Not Prime
1	Insufficient available Pump Suction Lift
2	Excessive Static Suction Lift (vertical distance between suction fluid level and pump centre line)
3	Inlet of suction pipe insufficiently submerged in fluid
4	Clogged suction strainer
5	Air pocket in suction line
6	Suction line collapsed (internal / external)
7	Air leaks into suction line
8	Excessive amount of air gas in liquid
9	Air in source of sealing liquid
10	Vortex formation at suction
11	Air leaks into pump through stuffing boxes or through mechanical seal
12	Leak path through tee piece volute plugs or gaskets
13	Non return valve ball or flap not sealing correctly
14	Viscosity / Specific Gravity (SG) of liquid differs from design conditions
15	Pump priming system blocked or worn (venturi or vacuum pump)
16	Pump Tee Piece cover or filter (where venturi assembly is fitted) blocked
17	Pump priming floatation set up blocked / faulty / worn (vacuum pump primed pumps)
18	Faulty / worn pump self priming air compressor or vacuum pump
19	Faulty or worn or loose Self priming air compressor vacuum pulleys or belts
	Pump loses prime after starting
1	Pump suction pipe not completely filled with liquid
2	Excessive amount of air of gas in liquid
3	Air leaks into suction line
4	Air leaks into pump through stuffing boxes or through mechanical seal
5	Air in source of sealing liquid
6	Seal cage improperly mounted in stuffing box
7	Inlet of suction pipe insufficiently submerged
8	Vortex formation at suction

	Pump Does Not Deliver Liquid
1	Pump not primed
2	Pump suction pipe not completely filled with liquid
3	Insufficient available Pump Suction Lift
4	Air pocket in suction line
5	Inlet of suction pipe insufficiently submerged
6	Pump operated with closed or partially closed suction valve - suction and discharge recirculation
7	Clogged suction strainer
8	Obstruction in suction line
9	Clogged impeller
10	Speed of pump too low
11	Wrong direction of pump rotation (only applicable to electric and gearbox pump set ups)
12	Static discharge head (vertical distance between pump centre line and discharge outlet fluid level) higher than shut-off head
13	Total dynamic head of system (suction and discharge static heights + system friction losses) higher than design of pump
14	Parallel operation of pumps unsuitable for the purpose
15	Viscosity of liquid differs from design conditions
	Insufficient Capacity Delivered
1	Pump suction pipe not completely filled with liquid
2	Insufficient available Pump Suction Lift
3	Excessive amount of air gas in liquid
4	Air pocket in suction line
5	Air leaks into suction line
6	Air leaks into pump through stuffing boxes or through mechanical seal
7	Air in source of sealing liquid
8	Inlet of suction pipe insufficiently submerged
9	Vortex formation at suction
10	Pump operated with closed or partially closed suction valve-suction & discharge recirculation
11	Clogged suction strainer
12	Obstruction in suction line
13	Excessive friction losses in suction line
14	Clogged impeller
15	Two elbows in suction piping at 90° to each other, creating swirl and pre-rotation
16	Speed of pump to low
17	Wrong direction of rotation
18	Reverse mounting of double-suction impeller
19	Uncalibrated instruments
20	Friction losses in discharge system higher than design of pump
21	Total head of system higher than design of pump

22	Viscosity of liquid differs from design conditions
23	Excessive wear at internal running clearances
24	Foreign matters in impellers
25	Improper casing gasket material
26	Inadequate installation of gasket
	Insufficient pressure developed
1	Excessive amount of air of gas in liquid
2	Air leaks into suction line
3	Air leaks into pump through stuffing boxes or through mechanical seal
4	Air in source of sealing liquid
5	Inlet of suction pipe insufficiently submerged
6	Vortex formation at suction
7	Pump operated with closed or partially closed suction valve - suction and discharge recirculation
8	Clogged suction strainer
9	Obstruction in suction line
10	Excessive friction losses in suction line system
11	Clogged impeller
12	Two elbows in suction piping at 90° to each other, creating swirl and pre-rotation
13	Speed of pump to low
14	Wrong direction of rotation
15	Uncalibrated instruments
16	Running of pump at too high a flow
17	Specific gravity of liquid differs from design conditions
18	Viscosity of liquid differs from design conditions
19	Excessive wear at internal running clearances (wear plates and impeller)
20	Foreign matters in impellers
21	Improper casing gasket material
22	Inadequate installation of gasket

	Pump requires excessive power
1	Speed of pump too high
2	Wrong direction of rotation
3	Reverse mounting of double-suction impeller
4	Uncalibrated instruments
5	Impeller diameter larger than specified
6	Total head of system higher than design of pump
7	Total head of system lower than design of pump
8	Running of pump at too high a flow
9	Specific gravity of liquid differs from design conditions
10	Viscosity of liquid differs from design conditions
11	Excessive wear at internal running clearances (wear plates and impeller)
12	Foreign matters in impellers
13	Misalignment
14	Rotating part rubbing on stationary part (wear plates and impeller)
15	Incorrect type of packing for operating conditions
16	Packing improperly installed
17	Gland too tight, prevents flow of liquid to lubricate packing
	Pump vibrates or is noisy at all flows
1	Pump suction pipe not completely filled with liquid
2	Clogged impeller
3	Too close a gap between impeller vanes and volute tongue or diffuser vanes
4	Transients at suction source (imbalance between pressure at surface of liquid & vapour pressure at suction flange) - incorrect suction line / sump set up (suction hose too close to the sump wall)
5	Foreign matters in impellers
6	Misalignment
7	Foundation insufficiently rigid
8	Loose foundation bolts
9	Loose pump or motor bolts
10	Inadequate grouting of baseplate
11	Excessive piping forces and movements on pump nozzles
12	Improperly mounted expansion joints
13	Starting the pump without proper warm-up
14	Mounting surfaces of internal fits (at wearing rings, impellers, shaft sleeves, shaft nuts, bearing housings, etc) not perpendicular to shaft axis
15	Bent shaft
16	Rotor out of balance
17	Parts loose on the shaft

18	Shaft running off-centre because of worn bearings
19	Pump running at or near critical speed
20	Resonance between operating speed and natural frequency of foundation, baseplate or piping
21	Rotating part rubbing on stationary part (wear plates and impeller)
22	Excessive axial thrust caused by excessive wear at internal clearances or by failure or, if used, excessive wear of balancing device
23	Wrong grade of grease or oil
24	Excessive grease or oil in anti-friction bearing houses
25	Lack of lubrication
26	Improper installation of anti-friction bearings such as damage during installation, incorrect assembly of stacked bearings, use of unmatched bearings as a pair, etc
27	Dirt getting into bearings
28	Moisture contaminating lubricant
29	Excessive cooling of water-cooled bearings
	Pump vibrates or is noisy at low flows
1	Pump suction pipe not completely filled with liquid
2	Insufficient available Pump Suction Lift
3	Selection of pump with too high a suction specific speed
4	Running the pump against a closed discharge valve without opening a bypass
5	Operating pump below recommended minimum flow
6	Running of pump at too low a flow
7	Parallel operation of pumps unsuitable for the purpose
8	Excessive radial thrust in single-volute pumps

	Pump vibrates or is noisy at high flows
1	Pump suction pipe not completely filled with liquid
2	Insufficient available Pump Suction Lift
3	Inlet of suction pipe insufficiently submerged
4	Vortex formation at suction
5	Pump operated with closed or partially closed suction valve - suction and discharge recirculation
6	Clogged suction strainer
7	Obstruction in suction line
8	Excessive friction losses in suction line system
9	Clogged Impeller
10	Two elbows in suction piping at 90° to each other, creating swirl and pre-rotation
11	Total dynamic head of system (suction and discharge static heights + system friction losses) higher than design of pump
12	Running of pump at too high a flow (for low specific speed pumps)
13	Excessive wear at internal running clearances (wear plates and impeller)
	Shaft oscillates axially
1	Two elbows in suction piping at 90° to each other, creating swirl and pre-rotation
2	Selection of pump with too high a suction specific speed
3	Impeller selection with abnormally high head coefficient
4	Operating pump below recommended minimum flow
5	Parallel operation of pumps unsuitable for the purpose
	Impeller vanes are eroded on visible side
1	Insufficient available Pump Suction Lift
2	Pump operated with closed or partially closed suction valve - suction and discharge recirculation - suction and discharge recirculation
3	Clogged suction strainer
4	Obstruction in suction line
5	Excessive friction losses in suction line system
6	Excessive wear at internal running clearances (wear plates and impeller)
	Impeller vanes are eroded on invisible side
1	Pump operated with closed or partially closed suction valve - suction and discharge recirculation
2	Selection of pump with too high a suction specific speed
3	Operating pump below recommended minimum flow
	Impeller vanes are eroded at discharge near centre
1	Too close a gap between impeller vanes and volute tongue or diffuser vanes

	Impeller vanes are eroded at discharge near shrouds or at shroud/vane fillets
1	Impeller selection with abnormally high head coefficient
2	Operating pump below recommended minimum flow
	Impeller shrouds bowed out or fractured
1	Impeller selection with abnormally high head coefficient
2	Operating pump below recommended minimum flow
	Pump overheats and seizes
1	Pump not primed
2	Insufficient available Pump Suction Lift
3	Pump operated with closed or partially closed suction valve - suction and discharge recirculation
4	Running the pump against a closed discharge valve without opening a bypass
5	Operating pump below recommended minimum flow
6	Parallel operation of pumps unsuitable for the purpose
7	Obstruction in balancing device leak-off line
8	Transients at suction source (imbalance between pressure at surface of liquid & vapour pressure at suction flange) - incorrect suction line / sump set up (suction hose too close to the sump wall)
9	Misalignment
10	Excessive piping forces and movements on pump nozzles
11	Improperly mounted expansion joints
12	Starting the pump without proper warm-up
13	Mounting surfaces of internal fits (at wearing rings, impellers, shaft sleeves, shaft nuts, bearing housings, etc) not perpendicular to shaft axis
14	Bent shaft
15	Rotor out of balance
16	Shaft running off-centre because of worn bearings
17	Pump running at or near critical speed
18	Too long a shaft span or too small a shaft diameter
19	Resonance between operating speed and natural frequency of foundation, baseplate or piping
20	Rotating part rubbing on stationary part
21	Incursion of hard solid particles into running clearances (wear plates and impeller)
22	Excessive radial thrust in single-volute pumps
23	Excessive axial thrust caused by excessive wear at internal clearances or by failure or, if used excessive wear of balancing device
24	Improper installation of anti-friction bearings such as damage during installation, incorrect assembly of stacked bearings, use of unmatched bearings as a pair, etc
	Internal parts are corroded prematurely
1	Pump materials not suitable for liquid handled

	Internal clearances wear too rapidly
1	Insufficient available Pump Suction Lift
2	Running the pump against a closed discharge valve without opening a bypass
3	Operating pump below recommended minimum flow
4	Misalignment
5	Excessive piping forces and movements on pump nozzles
6	Improperly mounted expansion joints
7	Starting the pump without proper warm-up
8	Mounting surfaces of internal fits (at wearing rings, impellers, shaft sleeves, shaft nuts, bearing housings, etc)
9	Bent shaft
10	Rotor out of balance
11	Shaft running off-centre because of worn bearings
12	Too long a shaft span or too small a shaft diameter
13	Rotating part rubbing on stationary part
14	Incursion of hard solid particles into running clearances (wear plates and impeller)
15	Pump materials not suitable for liquid handled
16	Excessive radial thrust in single-volute pumps
	Internal stationary joints are cut through wire-drawing
1	Mounting surfaces of internal fits (at wearing rings, impellers, shaft sleeves, shaft nuts, bearing housings, etc) not perpendicular to shaft axis
2	Improper volute gasket material
3	Inadequate installation of gasket
4	Inadequate tightening of casing bolts
	Packed box leaks excessively or packing has short life
1	Grease line plugged (grease line that feeds into lantern ring)
2	Seal cage improperly mounted in stuffing box
3	Misalignment
4	Bent shaft
5	Rotor out of balance
6	Shaft running off-centre because of worn bearings
7	Shaft or sleeves worn or scored at packing
8	Incorrect type of packing for operating conditions
9	Packing improperly installed
10	Gland too tight, prevents flow of liquid to lubricate packing
11	Excessive clearance at bottom of stuffing box allows packing to be forced into pump interior
12	Dirt or grit in sealing liquid
13	Failure to provide adequate cooling liquid to water-cooled stuffing boxes

	Packed box sleeve is scored
1	Grease line plugged (grease line that feeds into lantern ring)
2	Seal cage improperly mounted in stuffing box
	Mechanical seal leaks excessively
1	Misalignment
2	Bent shaft
3	Pump duty outside recommended pump range
4	Rotor out of balance
5	Shaft running off-centre because of worn bearings
6	Pump running at or near critical speed
7	Incursion of hard solid particles into running clearances
8	Incorrect type of mechanical seal for prevailing conditions
9	Mechanical seal improperly installed
	Mechanical seal has damaged faces, sleeve bellows
1	Misalignment
2	Bent shaft
3	Pump duty outside recommended pump range
4	Rotor out of balance
5	Shaft running off-centre because of worn bearings
6	Pump running at or near critical speed
7	Incursion of hard solid particles into running clearances
8	Incorrect type of mechanical seal for prevailing conditions
9	Mechanical seal improperly installed
	Bearings have short life
1	Insufficient available Pump Suction Lift
2	Operating pump below recommended minimum flow
3	Excessive wear at internal running clearances
4	Obstruction in balancing device leak-off line
5	Misalignment
6	Excessive piping forces and movements on pump nozzles
7	Improperly mounted expansion joints
8	Bent shaft
9	Rotor out of balance
10	Pump running at or near critical speed
11	Excessive radial thrust in single-volute pumps
12	Excessive axial thrust caused by excessive wear at internal clearances or by failure or, if used excessive wear of balancing device
13	Wrong grade of grease or oil

14	Excessive grease or oil in anti-friction bearing houses
15	Lack of lubrication
16	Improper installation of anti-friction bearings such as damage during installation, incorrect assembly of stacked bearings, use of unmatched bearings as a pair, etc
17	Dirt getting into bearings
18	Moisture contaminating lubricant
19	Excessive cooling of water-cooled bearings
	Drive Coupling Fails
1	Misalignment
2	Excessive piping forces and movements on pump nozzles
3	Excessive power transfer, greater than coupling power rating
4	Torsional vibration
5	Improperly mounted expansion joints
6	Bent shaft

11. WARRANTY CLAIM PROCEDURE

AllightSykes/AllightPrimax Group warrants all manufactured product against faulty workmanship or material for a period of twelve (12) months or 2,000 hours from the invoice date.

The obligation, statutory or otherwise, of this warranty is limited to replacement or repair at AllightSykes/AllightPrimax Facility, or at appoint designated by AllightSykes, of parts which are found upon inspection by AllightSykes at such point and completion of correct warranty claim forms, to be defective in materials or workmanship.

Assemblies and components purchase and installed on the product by AllightSykes/AllightPrimax are included within this warranty, but will not be considered defective as units, and repair or replacement will be limited to the individual part proven defective. Any part so replaced will become property of AllightSykes/AllightPrimax.

Excluded from this warranty are:

1. Lip seals, “O” rings and other “rubber” components which age / degrade naturally over time if the failure is a result of natural ageing/degrading.

2. Any product which has been altered or repaired in such a way, in AllightSykes’ judgement, as to affect the product adversely.

3. Repair or replacement of any parts which has, in AllightSykes’ judgement, been subjected to damage through negligence, accident, abuse, improper use or storage.

4. Any product which has not been operated or maintained in accordance with normal practice and with the recommendation of AllightSykes.

5. Use of non-genuine spare parts.

6. Normal wear and tear.

7. Products damaged in shipment or otherwise without the fault of AllightSykes.

This warranty does not obligate AllightSykes/AllightPrimax to bear costs of labour, overtime labour, travel time, travel expenses or freight charges in connection with the replacement or repair of defective parts.

AllightSykes/AllightPrimax will not consider any warranty claim for warranty unless notified fourteen (14) days of the defect or end of warranty period, and parts subject to warranty are returned to AllightSykes/AllightPrimax facility for assessment at the purchasers risk and expense.

Warranty Notification Procedure

1. Upon determining a failure, the end user will advise an AllightSykes/AllightPrimax representative of the failure and cause.

2. A decision will be made as to if a service person is sent to site or the unit is returned to AllightSykes/AllightPrimax.

3. Freight is to be covered by the customer and a nil value order number is raised to cover any non-warranty issues.

4. The end user will then be required to complete an AllightSykes/AllightPrimax warranty claim form, with all relevant information completed.

5. Digital photos, if applicable, will be taken and attached to the warranted claim form, to document failure and allow for a clearer interpretation of the failure.

6. Upon receiving the warranty claim form and relevant documentation AllightSykes/AllightPrimax will review the cause of failure and advise the end user of the status within a reasonable period of time.

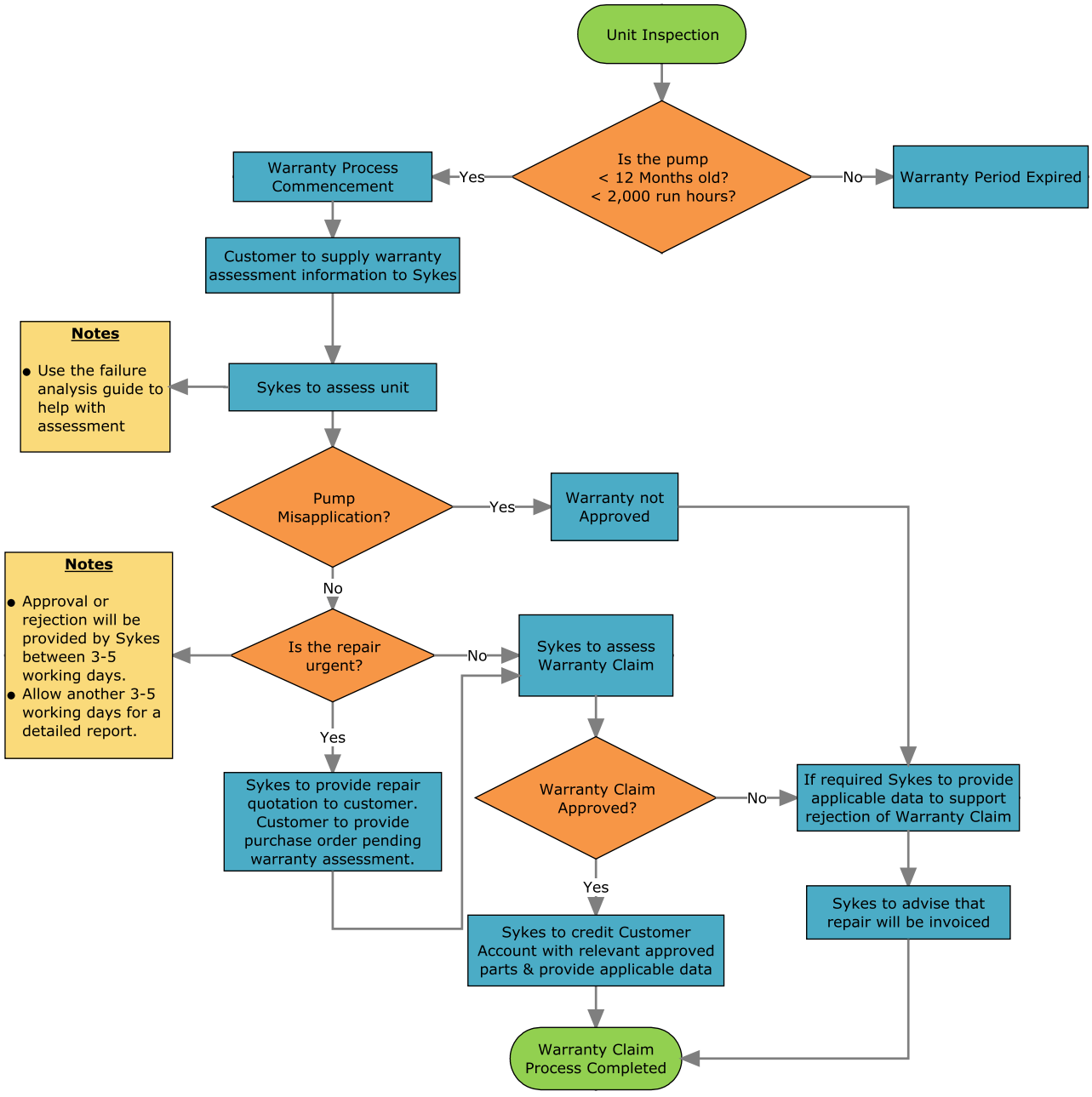
Warranty claim processing procedure

1. The Service Manager will be the primary contact between the end user and AllightSykes/AllightPrimax for all matters relating to warranty.

2. All correspondence will be done by or backed up by e-mail.

3. The local AllightSykes/AllightPrimax Representative will be copied in on any warranty correspondence in their region.

11.1 Warranty Claim Process Flow



11.2 Warranty Claim Forms

11.2.1 Warranty Claim Form – Part A

Waranty Number	
Job Number	
Service Order Number	
Service Work Order	

CUSTOMER DETAILS

Customer Name		Account Number	
Contact Name		Date	
Name of Sykes Group Person Notified of Claim			

PRODUCT DETAILS

Code		Description		Quantity	
Date Supplied		Serial Number			
Invoice Number					
Date of Failure		Operating Hours			

REASON FOR RETURN / CLAIM Please TICK one of the following options and supply relevant details

☐ **RETURN OF STOCK (20% Restocking Fee applies)**

Please note that returns are approved at Sykes Group discretion only if goods are in new saleable condition

☐ **INCORRECT SUPPLY** Has a replacement been organised? No ☐ Yes ☐

☐ **WARRANTY CLAIM** Distributor Order Number (Warranty Pending) _____

HAS ITEM BEEN

☐ Returned to Sykes Group →

Date	
Con Note	
Carrier	
Return Authorised by	

☐ Retained by Distributor for Inspection

☐ Scrapped

☐ Repaired on Site

Details of Claim

Failed Parts

Part Number	Description	Quantity

Please use Sykes Group Part Numbers

THIS SECTION TO BE COMPLETED BY SYKES GROUP - OFFICE USE ONLY

DECISION

Decision pending upon inspection of defective parts

Claim Approved YES / NO Name _____ Date _____

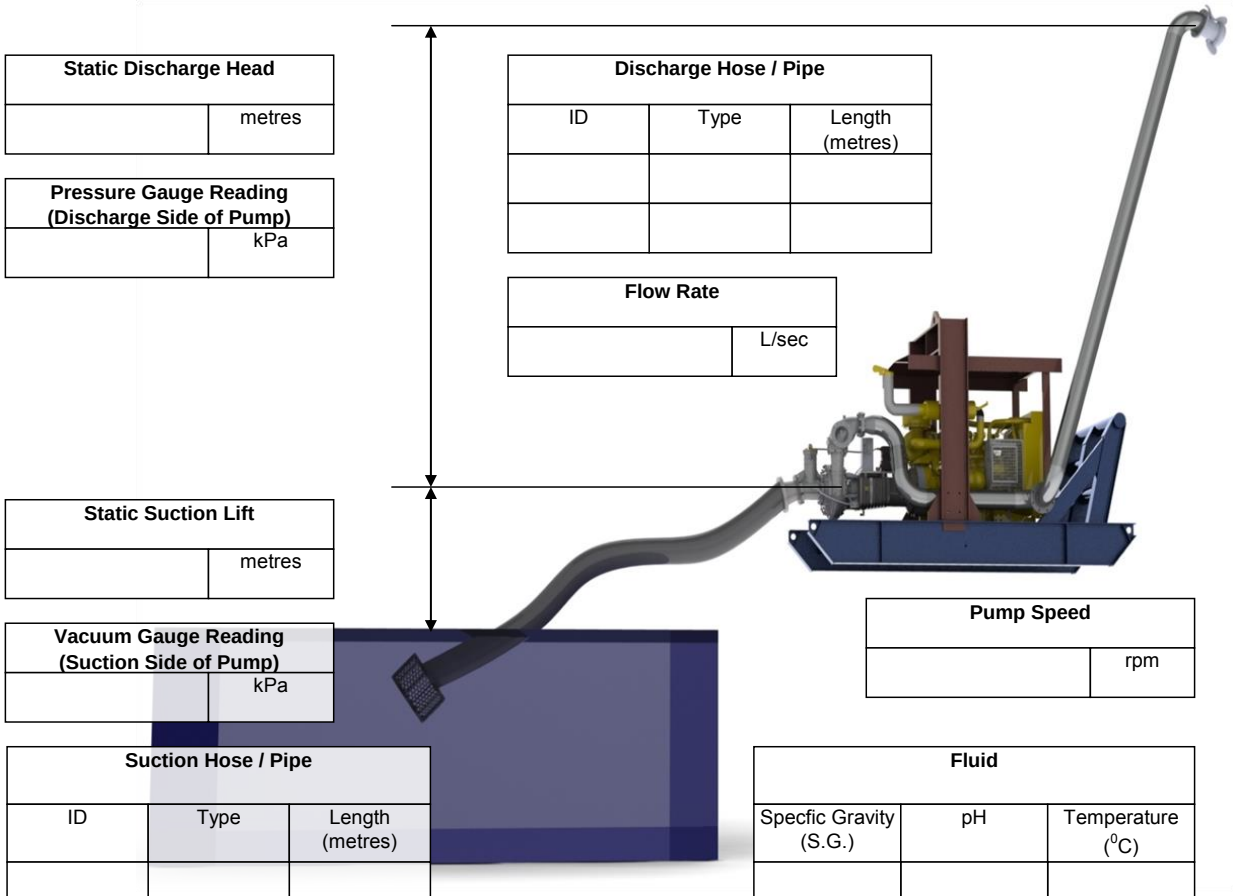
Total Costs	**Amount A$**	**Comments**
Type of Cost		
Parts Used		
Other		
TOTAL		

11.2.2 Warranty Claim Form – Part B

Warranty / Failure Report Number:	

Pump Application Data

	Suction Fitting Set Up			**Discharge Fitting Set Up**		
	Type	*Size*	*Quantity*	*Type*	*Size*	*Quantity*
Strainer						
Foot Valve						
Suction Manifold						
Elbow						
Reducer						
Non Return Valve						
Discharge Manifold						
Gate Valve						
Butterfly Valve						



Static Discharge Head	
	metres

Pressure Gauge Reading (Discharge Side of Pump)	
	kPa

Discharge Hose / Pipe		
ID	Type	Length (metres)

Flow Rate	
	L/sec

Static Suction Lift	
	metres

Vacuum Gauge Reading (Suction Side of Pump)	
	kPa

Pump Speed	
	rpm

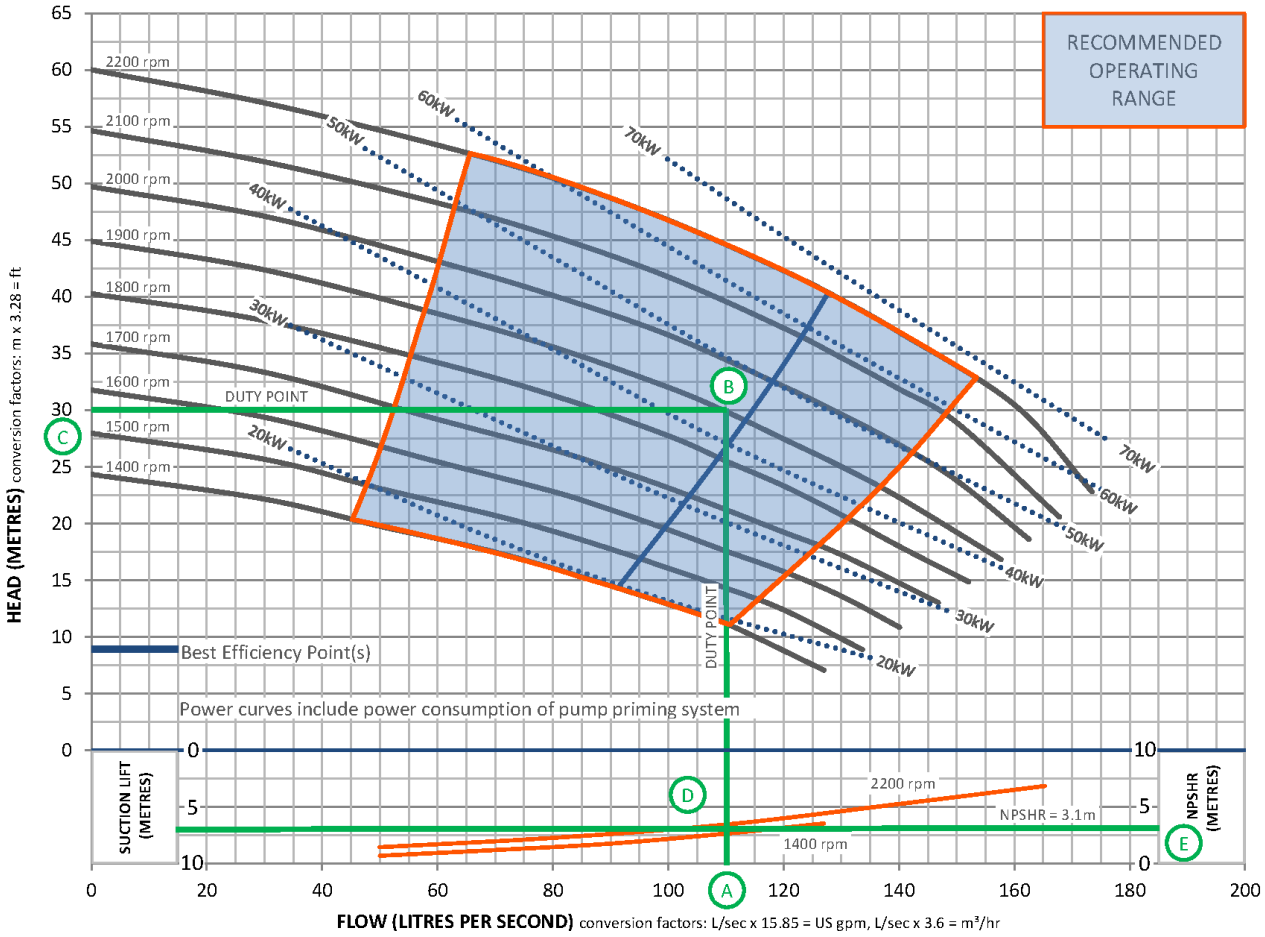
Suction Hose / Pipe		
ID	Type	Length (metres)

Fluid		
Specfic Gravity (S.G.)	pH	Temperature (^{0}C)

12. MISCELLANEOUS ENGINEERING INFORMATION

12.1 How to Read a Performance Curve

Example AllightSykes' CP150i Pump Curve



The lines sloping downwards from left to right represent the varying quantities of liquid delivered by the pump with variations in head. The intersection of this line at 1900rpm with the zero flow line shows the shut off head (45m) of pressure developed by the pump.

Total Dynamic Head (m) = Static Suction lift (m) + Static Discharge Head (m) + Friction Head (m)

Where:

Static Suction Lift:	Difference in elevation between liquid level of the suction and the centre line of the pump.
Static Discharge Head:	Difference in elevation between liquid levels of the centre line of the pump and the discharge.
Friction Head:	Equivalent head necessary to overcome friction on the interior surfaces of the pipework system including all valves, bends and fittings.

Duty Point: A pump operating at **110l/s at 30m (Total Dynamic Head)**.

1) Draw a line upwards from Flow (x-axis) at 110l/s (point A).

2) Draw a line across from Total Head (y-axis) at 30m (point C)

3) Where the vertical line of 110l/s intersects the horizontal line of 30m (point B) determines the pump rpm speed and power required at this duty.

4) ∴ Pump Speed Curve = **1900rpm.**

5) ∴ Power Requirement = **50kW** to run the whole of the 1900rpm curve.

6) To obtain NPSHR (Net Positive Suction Head Required), draw a line across from where the vertical line of the 95l/s intersects the NPSHR curve (point D).

7) ∴ NPSHR = **3.1m** (point E).

8) Dynamic Suction Lift Available (DSLA)

DSLA = Atmosphere (m) – Velocity Head (allow 1m) – NPSHR (m)

= 10.3m – 1m –3.1m

= **6.2m**

To determine the actual dynamic lift of pump, it is recommended to fit a vacuum gauge on the suction side of the pump to obtain a vacuum reading. The vacuum gauge, for this example, should read no more than 60.8kPa (6.2m). If the vacuum gauge reading is greater than 60.8kPa then the pump will experience cavitation.

Note:

To ensure minimal losses to the total suction lift:

- *Keep suction pipes as short and straight as possible.*
- *Eliminate all possibility of air pockets being trapped in suction pipework.*
- *When choosing foot valves, strainers, bends etc., select those, which will provide minimal restriction to the flow.*
- *The diameter of the suction pipe should be equal in diameter to the pump inlet connection.*
- *It is recommended to fit eccentric reducer in conjunction with pipe diameters larger than the pump inlet to avoid the possibility of air pockets in the suction pipework.*

12.1.1 Generalisations

(1) Flow (l/s) decreases, as Total Head (m) increases.

(2) Flow (l/s) increases, Power used increases.

It is **not** recommended to operate the pump outside the recommended pump operating range. To operate outside this area will lead to cavitation, vibration and non-uniform radial forces present in the pump. This drastically reduces the operating life of the mechanical seal, bearings and efficiency of the pump. In addition, the pump alignment will also be adversely effected due to excessive vibration. All this will result in an increase of maintenance cost of the pump.

12.1.2 Radial Thrust

When a pump is operated at its best efficiency flow-rate the velocities and hence the pressures acting on the impeller are uniform around the volute. This is shown in *Figure – A*.

At flow rates other than best efficiency point, the pressure distribution is no longer uniform. At reduced flow rates, the pressures increase spirally towards the cutwater resulting in a radial reaction F as shown *Figure – B*.

This will lead to the following operating problems:

- Low efficiency of pump.
- Noise vibration, reduced life of pump.
- Increased radial loads on bearings due to unbalanced volute pressures.
- Temperature rise due to dissipated energy created by low efficiency.

A similar situation exists at flow rates beyond best efficiency flow rates, with an approximate opposite (in direction) reaction.

This also will lead to similar problems associated with the reduced flow rates with an addition of poor suction performance (high NPSHR).

Figure – C shows typical variation of radial thrust with flow rate.

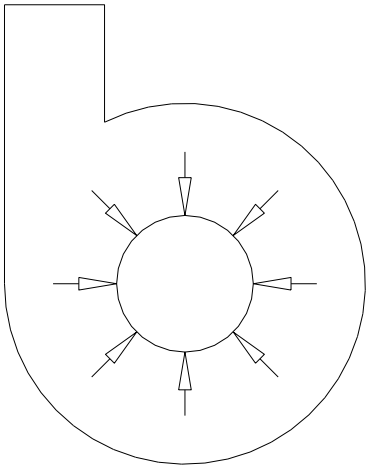


Figure A – 100% Best Efficiency Flow

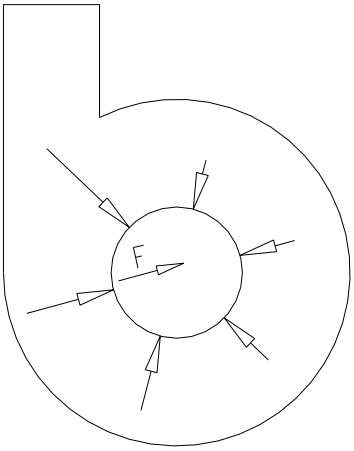


Figure B – Reduced Flow

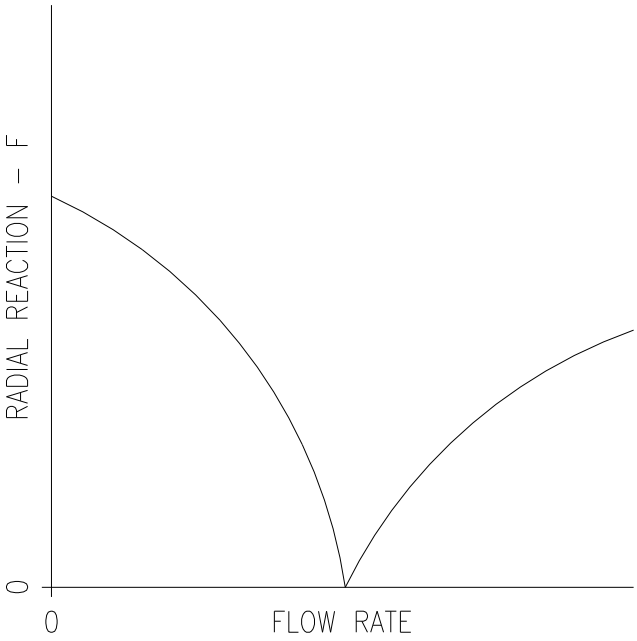


Figure C – Radial Thrust

12.1.3 Cavitation

If the Net Positive Head Available of the pump is less than the Net Positive Head Required, the pumpend liquid will vaporize in the region of the impeller eye i.e. where the local pressure is less than the vapour pressure.

In this region, the fluid will consist of a liquid plus vapour cavities. This can, in the extreme, result in the formation of a vapour lock and the prevention of the fluid entering the impeller.

This phenomenon is called 'cavitation'. The cavitation cycle comprises therefore of two phase changes; one from liquid to vapour during the initiation and the other from vapour back to liquid during cavity collapse.

Cavitation may be caused by excessive suction lift, insufficient NPSHA or operation at too high a speed. The resulting effects include:

1. Pitting of material surfaces due to the continual hammering action of the collapsing vapour cavities.

2. Significant reduction of performance due to vapour formation.

3. The crackling noise (like gravel going through the pump) caused by vapour cavity collapse.

Severe cavitation usually results in excessive noise, vibration and damage to pump, whereas mild cavitation may produce nothing more than a small reduction in pump efficiency and moderate wear of pump components.

12.2 ISO9906 / AS2417-2001 Grade 2 Acceptance Test

AllightSykes tests all their manufactured pumps to meet AS2417-2001 Grade 2 standard. This standard outlines the acceptable performance parameters whilst testing / collecting pump hydraulic performance data.

Please note that all performance test equipment at AllightSykes Head Office testing facility is certified to meet relevant standards.

Pump Test performed to meet AS2417 – 2001 (ISO 9906: 1999 (E)
Rotodynamic pumps – Hydraulic performance acceptance tests – Grade 2.

Permissible amplitude of fluctuations as a percentage of mean value of quantity being measured

Flow Rate	±6%
Pump Total Head	±6%
Speed of Rotation	±2%

Permissible values of overall measurement uncertainties

Flow Rate	±3.5%
Pump Total Head	±5.5%
Speed of Rotation	±2%

Values of tolerance factors

Because of manufacturing uncertainties during completion, geometrical deviations from the drawings are given at every pump. Tolerances shall be allowed, including the possible deviations in operating dates between the tested pump and a pump without any manufacturing uncertainties.

Flow Rate	±8%
Pump Total Head	±5%
Pump Efficiency	-5%

NPSH3

NPSH required for a drop of 3% of the total head of the first stage of the pump as a standard base for use in performance curves.

NPSHR

Minimum NPSH given by the manufacturer for a pump achieving a specified performance at a specified flow rate, speed and pumped liquid (occurrence of visible cavitation, increase of noise and vibration due to cavitation, beginning of head or efficiency drop, head or efficiency drop of a given amount, limitation of cavitation erosion).

Tolerance factor for NPSHR

The maximum permissible value of the difference between measured and guaranteed NPSHR;
Grade 2: NSPHR = +6% or NPSHR = +0.3m (whichever is greater)

12.3 Automatic Priming NRV Function

AllightSykes Automatic Self Priming Pumps are supplied complete with discharge check valves as a part of the pump priming system.

The primary function of the check valve is for sealing the discharge side of the pump during the automatic priming process.

Whilst this check valve is rated for maximum pump performance it is not intended to be used as the discharge system non return valve.

AllightSykes recommend that a suitable system non return valve be installed as part of the discharge pipe work.

12.4 Main Factors Affecting Pump Suction Lift

Pump's Suction Lift / NPSHR curve capabilities can be influenced by various factors in particular altitude (refer to *Table 1 – Effect of Altitude on Available Suction Lift*) and temperature of fluid being pumped (refer to *Table 2 – Effect of Temperature on Available Suction Lift*).

AllightSykes manufacture automatic self-priming pumps where the available suction lift plays a critical part in the pump dynamic system.

Therefore, any increase in fluid temperature or altitude will adversely affect the available suction lift. The higher the temperature or altitude the greater the adverse effects on the available suction lift.

In addition, higher temperature will introduce thermal expansion of pump parts and reduce internal pump clearances.

Pump O-rings, gaskets and associated parts are rated as listed;

Material	Minimum Temperature ^{o}C	Maximum Temperature ^{o}C
Viton	-40	176
Buna N	-4.4	121
Polyurethane	-4.4	93.3
Teadit NA-1002 (Gasket Material)	-29	260
Nylon (Wearlon)	-40	160

AllightSykes recommend contacting AllightSykes Engineering Department with high fluid temperature (> 60 ^{o}C), altitude or any different applications to ensure the pump is correctly rated / set up.

Please note that AllightSykes Pump's Suction Lift / Net Positive Suction Lift Required (NPSHR) curves as published are based on standard clean water at 15^{o} C.

The below table show the effect of altitude on the Pump's Suction Lift / NPSHR curve capabilities;

Altitude (m)	Reduction in Suction Lift (m)
0	0
250	0.30
500	0.60
750	0.89
1000	1.17
1250	1.44
1500	1.71
1750	1.97
2000	2.23
2250	2.48
2500	2.72
2750	2.96
3000	3.19
3250	3.41
3500	3.63
3750	3.84
4000	4.05
4250	4.25
4500	4.45
4750	4.64
5000	4.83
5250	5.01
5500	5.19
5750	5.36
6000	5.53
(International Standard Atmosphere)	

Table 1 - Effect of Altitude on Available Suction Lift

Altitude

In basic terms, the higher the altitude the less atmospheric pressure resulting in a reduction of pressure differential between atmosphere and vacuum created in AllightSykes self priming system resulting in a reduction of available suction lift.

The below table show the effect of temperature on the Pump's Suction Lift / NPSHR curve capabilities;

Temperature (°C)	Reduction in Suction Lift (m)
15	0
20	0.06
30	0.22
40	0.52
50	0.98
55	1.32
60	1.73
65	2.23
70	2.85
75	3.60
80	4.51
85	5.59
90	6.88
95	8.39
100	10.18
(For Water Relative to 15°C)	

Table 2 - Effect of Temperature on Available Suction Lift

Temperature

In basic terms, the higher the water temperature the greater the reduction in suction lift due to changing water vapour pressure and density.

12.5 Pump Suction Pipe Velocity

Achieving correct suction pipe velocity is a significant part in obtaining satisfactory suction lift.
Any increase of velocity (i.e. increase in flow) will result in greater friction losses and adversely affect the available suction lift.

AllightSykes manufacture automatic self-priming pumps where the available suction lift plays a critical part in the pump dynamic system and therefore it is essential to take suction pipe velocity into consideration.

AllightSykes recommend the maximum suction pipe velocity is 4 m/s.

This velocity is on the high side when comparing to other published recommended figures but AllightSykes supply, in most instances, mobile dewatering equipment. To achieve lower velocities would result in large hoses that would be difficult and impractical to transport or install.

For Example
A standard CP150i pump 108 l/sec – BEP at 2200 rpm:
150mm ID Pipe = 6.34 m/s
200mm ID Pipe = 3.57 m/s
250mm ID Pipe = 2.28 m/s

In this example it is recommended to use 200mm ID pipe to ensure satisfactory suction lift performance.

Please note that the suction pipe velocity is an important part of the suction lift set up but other factors also affect suction lift such as static suction lift, elbows, valves, pipe internal roughness etc. All these factors combined determine the available suction lift of the pump.

Please refer to enclosed tables for recommended pipe ID by pump type (refer to Table 1) and a generic flow versus pipe diameter chart (refer to Table 2).

	Suction Hose or Pipe Internal Dimension (Inside Diamter in mm)							
Pump Type	**80**	**100**	**150**	**200**	**250**	**300**	**350**	**400**
CP80i	18	31*						
CP100i		31	71*					
CP150iC			71	126*				
CP150i			71	126	196*			
CP220i				126	196	283*		
CP250i					196	283	385*	
CP300i						283	385	503*
FBP300						283	385*	
HH80	18	31*						
HH130i			71	126	196*			
HH160i				126	196*			
HH220i					196	283	385*	
MH130i			71	126	196*			
MH150i				126	196			
MH220i				126	196	283*		
MH300i						283	385	503*
SW100		31	71*					
SW150			71	126	196*			
WD100i		31	71*					
WD150iC			71	126*				
XH80		31*						
XH100			71	126*				
XH150				126	196*			
XH200					196	283*		
Yakka100		31	71*					
Yakaa150			71	126*				
YakkaHH80	18	31*						

Table 1 – Recommended Pipe ID vs Flow Rates @ velocity of 4m/sec by Pump Type

- Matrix Unit of Measure of Flow = litres / second
- * = Maximum flow for pump type
- Recommendation based on maximum velocity = 4 m/s
- Suction pipe is based on Inside Diameter (ID)
- For high static suction lifts oversized suction pipe / hose may be required even at lower flow rates

This information this should be read in conjuction with the pump curve for reference to the pump's recommended operating flow rates

	PIPE INTERNAL DIMENSION (mm)											
FLOW	2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"
(L/sec)	50	75	100	125	150	200	275	300	350	400	450	500
2	1.02	0.45	0.25	0.16	0.11	0.06	0.03	0.03	0.02	0.02	0.01	0.01
4	2.04	0.91	0.51	0.33	0.23	0.13	0.07	0.06	0.04	0.03	0.03	0.02
6	3.06	1.36	0.76	0.49	0.34	0.19	0.10	0.08	0.06	0.05	0.04	0.03
8	4.07	1.81	1.02	0.65	0.45	0.25	0.13	0.11	0.08	0.06	0.05	0.04
10	5.09	2.26	1.27	0.81	0.57	0.32	0.17	0.14	0.10	0.08	0.06	0.05
12	6.11	2.72	1.53	0.98	0.68	0.38	0.20	0.17	0.12	0.10	0.08	0.06
14	7.13	3.17	1.78	1.14	0.79	0.45	0.24	0.20	0.15	0.11	0.09	0.07
16	8.15	3.62	2.04	1.30	0.91	0.51	0.27	0.23	0.17	0.13	0.10	0.08
18	9.17	4.07	2.29	1.47	1.02	0.57	0.30	0.25	0.19	0.14	0.11	0.09
20	10.19	4.53	2.55	1.63	1.13	0.64	0.34	0.28	0.21	0.16	0.13	0.10
25	12.73	5.66	3.18	2.04	1.41	0.80	0.42	0.35	0.26	0.20	0.16	0.13
30	15.28	6.79	3.82	2.44	1.70	0.95	0.51	0.42	0.31	0.24	0.19	0.15
40	20.37	9.05	5.09	3.26	2.26	1.27	0.67	0.57	0.42	0.32	0.25	0.20
50	25.46	11.32	6.37	4.07	2.83	1.59	0.84	0.71	0.52	0.40	0.31	0.25
60	30.56	13.58	7.64	4.89	3.40	1.91	1.01	0.85	0.62	0.48	0.38	0.31
70	35.65	15.84	8.91	5.70	3.96	2.23	1.18	0.99	0.73	0.56	0.44	0.36
80	40.74	18.11	10.19	6.52	4.53	2.55	1.35	1.13	0.83	0.64	0.50	0.41
90	45.84	20.37	11.46	7.33	5.09	2.86	1.52	1.27	0.94	0.72	0.57	0.46
100	50.93	22.64	12.73	8.15	5.66	3.18	1.68	1.41	1.04	0.80	0.63	0.51
112	57.04	25.35	14.26	9.13	6.34	3.57	1.89	1.58	1.16	0.89	0.70	0.57
120	61.12	27.16	15.28	9.78	6.79	3.82	2.02	1.70	1.25	0.95	0.75	0.61
130	66.21	29.43	16.55	10.59	7.36	4.14	2.19	1.84	1.35	1.03	0.82	0.66
140	71.30	31.69	17.83	11.41	7.92	4.46	2.36	1.98	1.46	1.11	0.88	0.71
150	76.39	33.95	19.10	12.22	8.49	4.77	2.53	2.12	1.56	1.19	0.94	0.76
160	81.49	36.22	20.37	13.04	9.05	5.09	2.69	2.26	1.66	1.27	1.01	0.81
170	86.58	38.48	21.65	13.85	9.62	5.41	2.86	2.41	1.77	1.35	1.07	0.87
180	91.67	40.74	22.92	14.67	10.19	5.73	3.03	2.55	1.87	1.43	1.13	0.92
190	96.77	43.01	24.19	15.48	10.75	6.05	3.20	2.69	1.97	1.51	1.19	0.97
200	101.86	45.27	25.46	16.30	11.32	6.37	3.37	2.83	2.08	1.59	1.26	1.02
210	106.95	47.53	26.74	17.11	11.88	6.68	3.54	2.97	2.18	1.67	1.32	1.07
220	112.05	49.80	28.01	17.93	12.45	7.00	3.70	3.11	2.29	1.75	1.38	1.12
230	117.14	52.06	29.28	18.74	13.02	7.32	3.87	3.25	2.39	1.83	1.45	1.17
240	122.23	54.32	30.56	19.56	13.58	7.64	4.04	3.40	2.49	1.91	1.51	1.22
250	127.32	56.59	31.83	20.37	14.15	7.96	4.21	3.54	2.60	1.99	1.57	1.27
260	132.42	58.85	33.10	21.19	14.71	8.28	4.38	3.68	2.70	2.07	1.63	1.32
270	137.51	61.12	34.38	22.00	15.28	8.59	4.55	3.82	2.81	2.15	1.70	1.38
280	142.60	63.38	35.65	22.82	15.84	8.91	4.71	3.96	2.91	2.23	1.76	1.43
290	147.70	65.64	36.92	23.63	16.41	9.23	4.88	4.10	3.01	2.31	1.82	1.48
300	152.79	67.91	38.20	24.45	16.98	9.55	5.05	4.24	3.12	2.39	1.89	1.53
310	157.88	70.17	39.47	25.26	17.54	9.87	5.22	4.39	3.22	2.47	1.95	1.58
320	162.97	72.43	40.74	26.08	18.11	10.19	5.39	4.53	3.33	2.55	2.01	1.63
330	168.07	74.70	42.02	26.89	18.67	10.50	5.56	4.67	3.43	2.63	2.07	1.68
340	173.16	76.96	43.29	27.71	19.24	10.82	5.72	4.81	3.53	2.71	2.14	1.73
350	178.25	79.22	44.56	28.52	19.81	11.14	5.89	4.95	3.64	2.79	2.20	1.78
360	183.35	81.49	45.84	29.34	20.37	11.46	6.06	5.09	3.74	2.86	2.26	1.83
370	188.44	83.75	47.11	30.15	20.94	11.78	6.23	5.23	3.85	2.94	2.33	1.88
380	193.53	86.01	48.38	30.97	21.50	12.10	6.40	5.38	3.95	3.02	2.39	1.94
390	198.63	88.28	49.66	31.78	22.07	12.41	6.57	5.52	4.05	3.10	2.45	1.99
400	203.72	90.54	50.93	32.59	22.64	12.73	6.73	5.66	4.16	3.18	2.52	2.04
410	208.81	92.81	52.20	33.41	23.20	13.05	6.90	5.80	4.26	3.26	2.58	2.09
420	213.90	95.07	53.48	34.22	23.77	13.37	7.07	5.94	4.37	3.34	2.64	2.14
430	219.00	97.33	54.75	35.04	24.33	13.69	7.24	6.08	4.47	3.42	2.70	2.19
440	224.09	99.60	56.02	35.85	24.90	14.01	7.41	6.22	4.57	3.50	2.77	2.24
450	229.18	101.86	57.30	36.67	25.46	14.32	7.58	6.37	4.68	3.58	2.83	2.29
460	234.28	104.12	58.57	37.48	26.03	14.64	7.74	6.51	4.78	3.66	2.89	2.34
470	239.37	106.39	59.84	38.30	26.60	14.96	7.91	6.65	4.89	3.74	2.96	2.39
480	244.46	108.65	61.12	39.11	27.16	15.28	8.08	6.79	4.99	3.82	3.02	2.44
490	249.55	110.91	62.39	39.93	27.73	15.60	8.25	6.93	5.09	3.90	3.08	2.50
500	254.65	113.18	63.66	40.74	28.29	15.92	8.42	7.07	5.20	3.98	3.14	2.55
510	259.74	115.44	64.94	41.56	28.86	16.23	8.59	7.22	5.30	4.06	3.21	2.60
520	264.83	117.70	66.21	42.37	29.43	16.55	8.75	7.36	5.40	4.14	3.27	2.65
530	269.93	119.97	67.48	43.19	29.99	16.87	8.92	7.50	5.51	4.22	3.33	2.70
540	275.02	122.23	68.75	44.00	30.56	17.19	9.09	7.64	5.61	4.30	3.40	2.75
550	280.11	124.49	70.03	44.82	31.12	17.51	9.26	7.78	5.72	4.38	3.46	2.80
560	285.21	126.76	71.30	45.63	31.69	17.83	9.43	7.92	5.82	4.46	3.52	2.85
570	290.30	129.02	72.57	46.45	32.26	18.14	9.60	8.06	5.92	4.54	3.58	2.90
580	295.39	131.29	73.85	47.26	32.82	18.46	9.77	8.21	6.03	4.62	3.65	2.95
590	300.48	133.55	75.12	48.08	33.39	18.78	9.93	8.35	6.13	4.70	3.71	3.00
600	305.58	135.81	76.39	48.89	33.95	19.10	10.10	8.49	6.24	4.77	3.77	3.06
610	310.67	138.08	77.67	49.71	34.52	19.42	10.27	8.63	6.34	4.85	3.84	3.11
620	315.76	140.34	78.94	50.52	35.08	19.74	10.44	8.77	6.44	4.93	3.90	3.16
630	320.86	142.60	80.21	51.34	35.65	20.05	10.61	8.91	6.55	5.01	3.96	3.21
640	325.95	144.87	81.49	52.15	36.22	20.37	10.78	9.05	6.65	5.09	4.02	3.26
650	331.04	147.13	82.76	52.97	36.78	20.69	10.94	9.20	6.76	5.17	4.09	3.31
660	336.14	149.39	84.03	53.78	37.35	21.01	11.11	9.34	6.86	5.25	4.15	3.36

Matrix Unit of Measure is Velocity = metres / second

= Cells that can be changed - Password = pipe

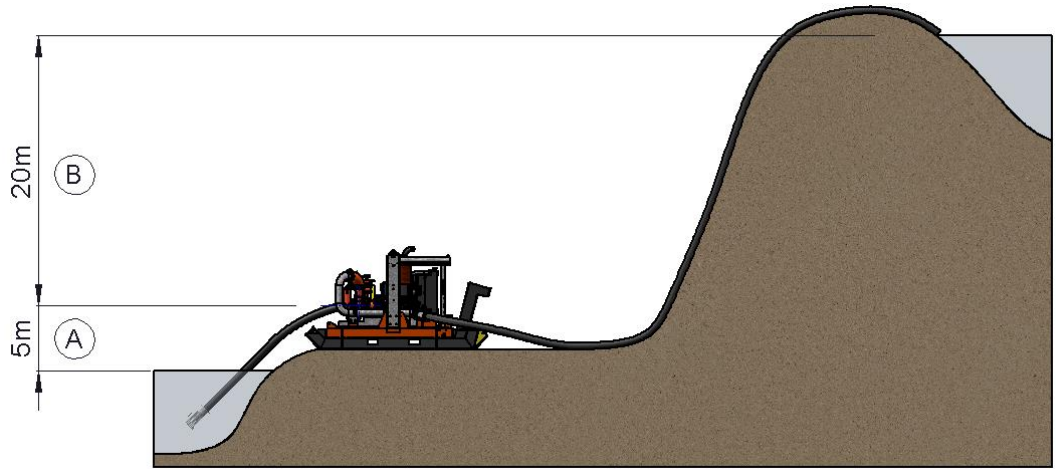
= Cells that can be changed - Password = flow

= Velocity > 4 m/s (in unmodified setting)

= Velocity < 4 m/s (in unmodified setting)

Table 2 – Flow vs Pipe ID Generic

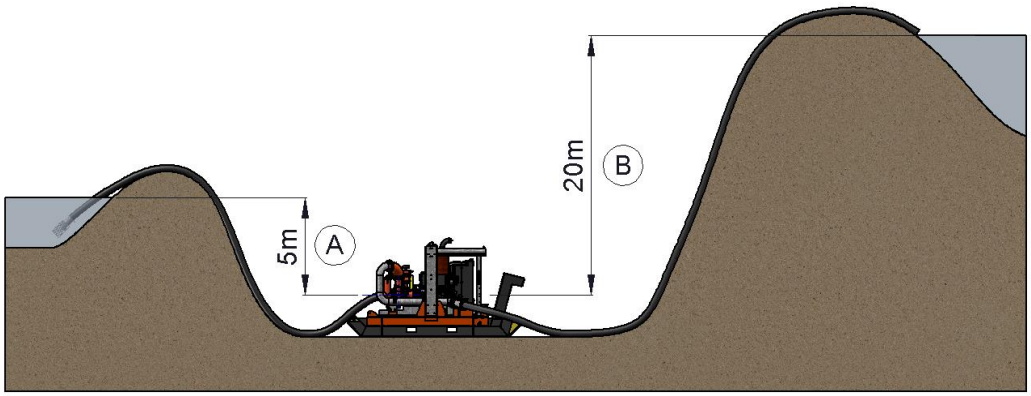
12.6 Total Dynamic head Explanation Diagram



A = Static (5m) + Losses (1m) = 6m
B = Static (20m) + Losses (3m) = 23m

Total Dynamic Head (TDH) = 23 + 6 = 29m

Suction Lift Set Up



A = Static (-5m) + Losses (1m) = -4m
B = Static (20m) + Losses (3m) = 23m

Total Dynamic Head (TDH) = 23 + (-4m) = 19m

Suction Head Set Up

12.7 pH Compatibility Chart

The abbreviation pH means 'hydrogen potential' – or the ability of the liquid to take up acidic hydrogen ions and become more acid.

The numbers used are the logarithms or the actual numbers, which would otherwise be in millions.

pH 7.0 is neutral.

An already acid solution cannot take up as much additional acid. Therefore pH less than 7.0 is acidic.

pH greater than 7.0 is alkaline.

As each change of 1 on the log scale is equivalent to 10 times on the linear scale, a linear scale, a solution of pH5 is ten times more acidic than a solution of pH6.

Similarly, pH4 is 100 times more acidic than pH6, and so on.

Wetted Material Compatibility Guideline for Metals

Fluid	pH Level	Metals
Alkaline	14 13 12 11	Stainless Steels
Caustic Basic	10 9	Cast Iron
Neutral	8 7 6	Aluminium
Acid	5 4	Cast Iron
	3 2 1 0	Stainless Steels

12.8 Pump Specific Venturi Data

The results are for a standard compressor prime pump build with a Bendix Compressor.

Pump Type	Jet P/No.	Nozzle P/No.	Jet P/No.	Nozzle P/No.
	23-0568-2016	23-0571-2016	23-0415-2016S	23-0414-2036S
CP80i	✓	✓		
CP100i	✓	✓		
CP150iC	✓	✓		
CP150i	✓	✓		
CP220i	✓	✓		
CP250i			✓	✓
CP300i			✓	✓
FBP300			✓	✓
HH80	✓	✓		
HH130i			✓	✓
HH160i			✓	✓
HH220i			✓	✓
HD100i	n/a	n/a	n/a	n/a
HD150iC	n/a	n/a	n/a	n/a
HD150i	n/a	n/a	n/a	n/a
HD220i	n/a	n/a	n/a	n/a
HD250i	n/a	n/a	n/a	n/a
HDHH130i	n/a	n/a	n/a	n/a
HDMH130i	n/a	n/a	n/a	n/a
HDMH150i	n/a	n/a	n/a	n/a
MH130i			✓	✓
MH150i			✓	✓
MH220i			✓	✓
MH300i			✓	✓
SW100	✓	✓		
SW150	✓	✓		
WD100i	n/a	n/a	n/a	n/a
WD150iC	n/a	n/a	n/a	n/a
XH80			✓	✓
XH100			✓	✓
XH150			✓	✓
XH200			✓	✓
Yakka100	✓	✓		
Yakka150	✓	✓		
YakkaHH80	✓	✓		

The following tables show the performance data for the complete compressor pump range at nominated speed (normal pump speed) and at maximum pump speed.

These results are for a standard compressor prime pump built (Sykes Air Compressor).

Pump Type	Compressor / Pump Pulley Ratio
CP80i	-1.600 (T)
CP100i	-1.600 (T)
CP150iC	-1.285 (T)
CP150i	-1.285 (T)
CP220i	-1.285 (T)
CP250i	-1.300 (L)
CP300i	+1.538 (L)
FBP300	+1.389 (L)
HH80	-1.285 (T)
HH130i	-1.300 (L)
HH160i	-1.125 (L)
HH220i	-1.125 (L)
HD100i	n/a
HD150iC	n/a
HD150i	n/a
HD220i	n/a
HD250i	n/a
HDHH130i	n/a

Pump Type	Compressor / Pump Pulley Ratio
HDMH130i	n/a
HDMH150i	n/a
MH130i	-1.300 (L)
MH150i	-1.300 (L)
MH220i	-1.125 (L)
MH300i	+1.111 (L)
SW100	-1.600 (T)
SW150	-1.285 (T)
WD100i	-1.440 (L)
WD150iC	-1.440 (L)
XH80	-1.494 (L)
XH100	-1.125 (L)
XH150	-1.125 (L)
XH200	-1.125 (L)
Yakka100	-1.600 (T)
Yakka150	-1.285 (T)
YakkaHH80	-1.285 (T)

Note : - = Reducing Drive Ratio
+ = Increasing Drive Ratio
(L) = Link Belt Set-up
(T) = Timing Belt Set-up

Pump Type	Pump Speed	Compressor Speed	Back Pressure	Vacuum Pressure
	rpm	rpm	psi	kPa
CP80i	2000	1250	50	83.5
	2400	1500	58	81.0
CP100i	2000	1250	50	83.5
	2400	1500	58	81.0
CP150iC	1800	1400	54	82.0
	2200	1712	66	79.5
CP150i	1800	1400	54	82.0
	2200	1712	66	79.5
CP220i	1800	1400	54	82.0
	2000	1556	59	81.0
CP250i	1600	1230	47	78.0
	1800	1385	52	81.0
CP300i	1000	1538	58	82.0
	1300	2000	58	82.0
FBP300	900	1250	47	78.5
	1200	1667	62	82.5
HH80	2000	1556	59	81.0
	2400	1868	70	78.5
HH130i	1600	1230	47	78.0
	2000	1538	58	82.0
HH160i	1600	1422	54	81.0
	2000	1778	66	82.0
HH220i	1800	1600	60	83.0
	2200	1956	60	82.0
HD100i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
HD150iC	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
HD150i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
HD220i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
HD250i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
HDHH130i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a

Pump Type	Pump Speed	Compressor Speed	Back Pressure	Vacuum Pressure
	rpm	rpm	psi	kPa
HDMH130i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
HDMH150i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
MH130i	1600	1230	47	78.0
	2000	1538	58	82.0
MH150i	1500	1154	42	75.5
	1800	1385	52	81.0
MH220i	1500	1333	51	80.5
	1800	1600	60	83.0
MH300i	1300	1444	55	81.5
	1600	1778	66	82.0
SW100	2000	1250	50	83.5
	2400	1500	58	81.0
SW150	1800	1400	54	82.0
	2200	1712	66	79.5
WD100i	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
WD150iC	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a
XH80	1800	1205	45	70.0
	2500	1673	62	82.5
XH100	1500	1333	51	80.5
	1800	1600	60	83.0
XH150	1500	1333	51	80.5
	1800	1600	60	83.0
XH200	1500	1333	51	80.5
	1750	1555	59	82.5
Yakka100	2000	1250	50	83.5
	2400	1500	58	81.0
Yakka150	1800	1400	54	82.0
	2200	1712	66	79.5
YakkaHH80	2000	1556	59	81.0
	2400	1868	70	78.5

12.9 Pump Dry & Snore Running Times

Please refer to below table in regards to Sykes Pump allowable dry and snore running times.

Pump Type	Allowable Dry Running Time	Allowable "Snore" Running Time
	hours	minutes
CP80i	8	120
CP100i	8	120
CP150iC	8	120
CP150i	8	120
CP220i	8	120
CP250i	8	120
CP300i	4	30
FPB300	4	30
HH80	8	120
HH130i	8	120
HH160i	4	30
HH220i	4	30
HD100i	8	120
HD150iC	8	120
HD150i	8	120
HD220i	8	120
HD250i	8	120
HDHH130i	8	120

Pump Type	Allowable Dry Running Time	Allowable "Snore" Running Time
	hours	minutes
HDMH130i	8	120
HDMH150i	8	120
MH130i	8	120
MH150i	8	120
MH220i	4	30
MH300i	4	30
SW100	8	120
SW150	8	120
WD100i	8	120
WD150iC	8	120
XH80	4	30
XH100	4	30
XH150	4	30
XH200	4	30
Yakka100	8	120
Yakka150	8	120
YakkaHH80	8	120

Definitions

Dry Running

During initial pump start up, when there is no liquid available to the pump

Snore Running

Pump has lost its prime; the pump is still drawing in liquid and air through the suction strainer; surging of fluid mixture, containing air and other contaminants (muds, slurries, rocks etc), into the pump suction / volute waiting for full and correct submergence of suction strainer that allows the pump to return to non-snore conditions and begin actively pumping out liquid.

Special Note

Operating MH, HH and XH style of pumps in extended "snore" conditions causes oscillating pressure within the pump system and possible pump equipment damage.

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SYKES

CP150i PUMP

PARTS MANUAL

CONTRACTORS RANGE

ALLIGHTSYKES

AllightSykes
42 Munibung Rd, Cardiff, NSW 2285
Postal Address: 42 Munibung Rd, Cardiff NSW 2285
Tel 1300 ALLIGHT | +61 (2) 4954 1400 | fax +61 (2) 4954 3226
email sales@allightsykes.com | web www.allightsykes.com

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1. Introduction

Congratulations on the purchase of your new AllightSykes Pump

With AllightSykes' established quality control systems you can be assured your pump was manufactured with a high level of control and has undergone extensive testing on AllightSykes' certified test facility.

AllightSykes are pleased to offer a 12 month or 2,000hrs warranty, whichever occurs first, on your new pump. As with all warranties, AllightSykes' warranty is subject to regular maintenance. To ensure your warranty is maintained, make sure your pump is regularly serviced. AllightSykes offer maintenance and repairs on our entire range and are able to offer regular service agreements if required.

AllightSykes provide local service through a highly trained network of branches and are able to meet your service and spare parts requirements around the clock.

Turnaround on parts is rapid with AllightSykes customer service ready to meet your needs 24 hours a day with spare parts located at branches Australia wide and around the globe.

Our AllightSykes trained staff will assess your application and help to set up optimum operating settings which will help to reduce unnecessary wear and tear on the pump whilst ensuring the pump is operating at its most efficient duty point.

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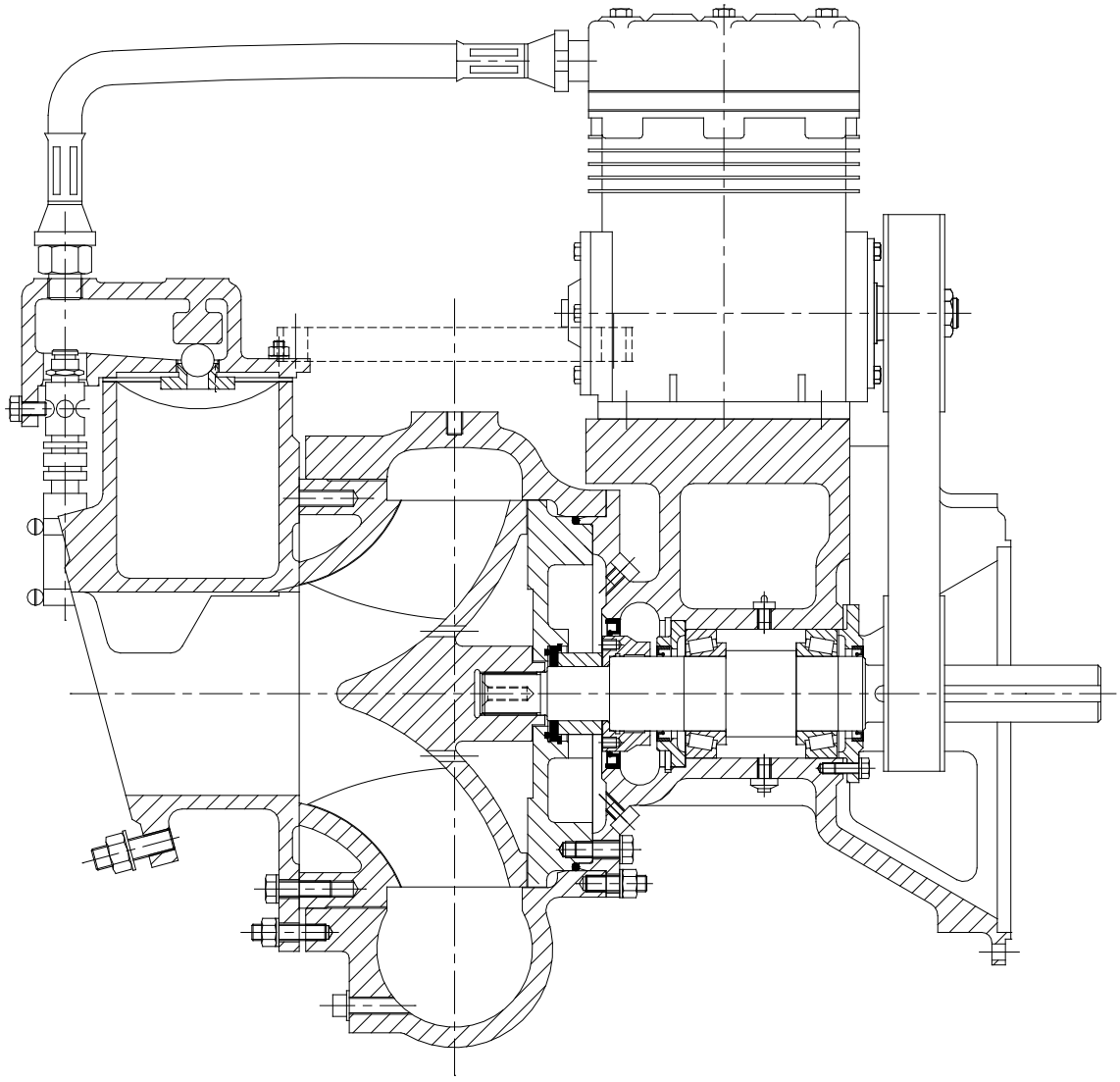
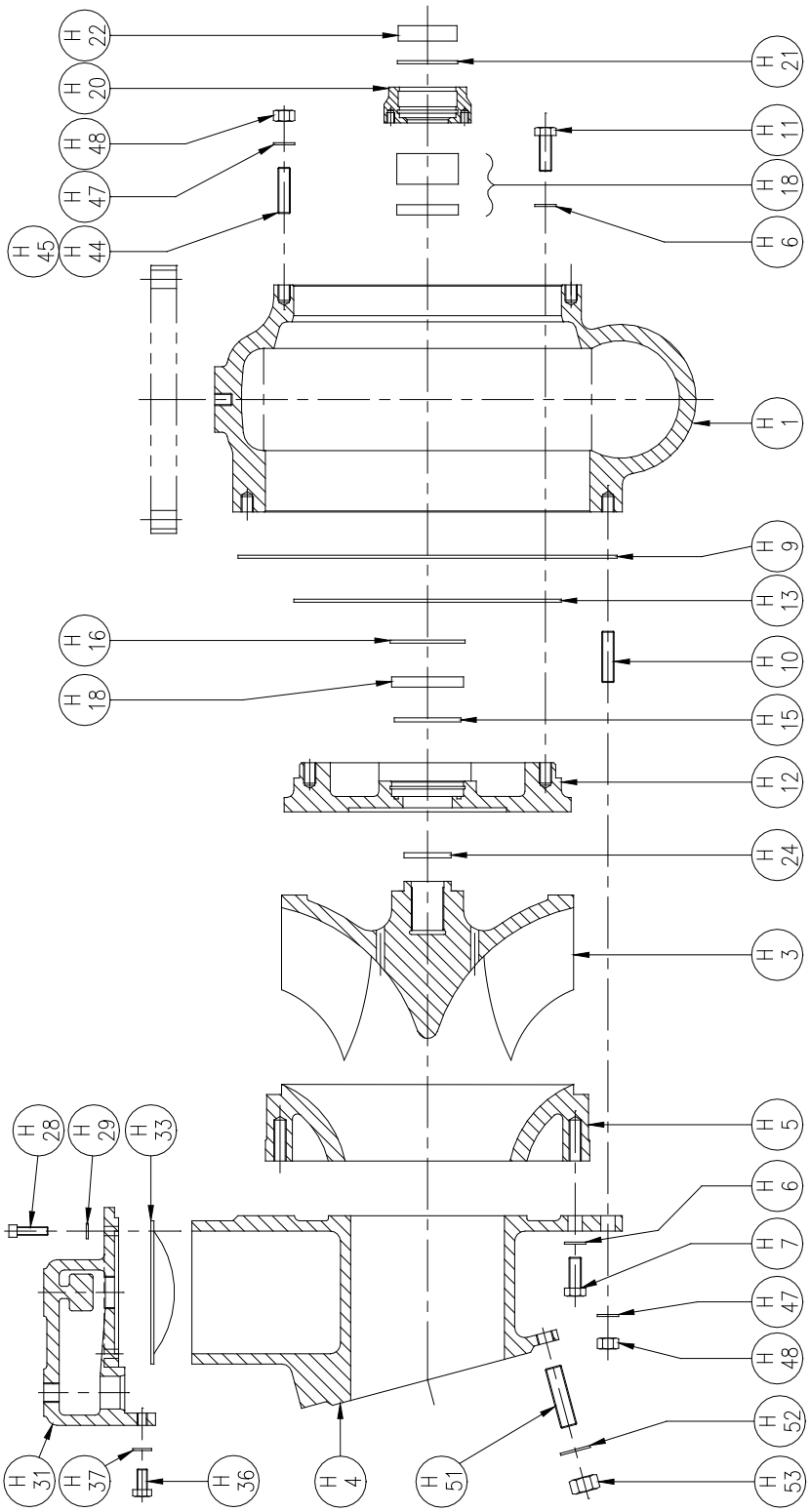
2. Parts List



CP150i General Assembly Drawing

2.1 Front Cover and Volute Parts List



FRONT COVER & VOLUTE PARTS LIST				
Illustration number	**Part Number**		**Description**	**Qty**
H1	CP150V-SGI	Standard	Volute (Pump Body)	1
	CP150V-316	Stainless		
	CP150V-SGI-R4R	R4R		
H3	CP150I-316 CP150I-316-C-255MM	Standard	Impeller	1
	CP150I-316 CP150I-316-C-255MM	Stainless		
	CP150I-CS340 CP150I-CS340-C-255MM	Chromium		
H4	11-0259-0115	Standard	Front Cover & Separation Tank	1
	11-0259-0115S	Stainless		
	11-0259-0115-R4R	R4R		
H5	CP150-FWP-316	Standard	Wearplate	1
	CP150-FWP-316	Stainless		
	CP150-FWP-CS340	Chromium		
H6	38-0785-4412		O-Ring Sealing Washer	8
	38-0787-4112V		O-Ring	8
H7	BM12X40	Standard	Setscrew	4
	BM12X40SS	Stainless		
H9a	38-1034-5413		Joint	A/R
H9b	38-1034-5423		Joint	A/R
H9c	38-1034-5443		Joint	2
H10	SM12X60	Standard	Stud	6
	SM12X60SS	Stainless		
H11	BM12X45	Standard	Setscrew	4
	BM12X45SS	Stainless		
H12	12-0284-0115	Standard	Wearplate (Rear)	1
	12-0284-0115	Stainless		
	12-0284-0115-CS	Chromium		
	12-0284-0115-R4R	R4R		
H13	38-1004-4112V		O-ring	1
H15	38-0700-4112V		O-ring	1
H16	41-0230-8712		Circlip	1
H18	38-0400-VS2S2	Standard	Mechanical Seal	1
	38-0400-VS2S2SS	Stainless		
H20	28-0255-3215		Shaft Collar	1

FRONT COVER & VOLUTE PARTS LIST				
Illustration number	**Part Number**		**Description**	**Qty**
H21	38-1036-4112V		O-ring (collar)	1
H22	41-0241-6112		Tolerance Ring	1
H24a	36-0646-8913		Impeller Shim	A/R
H24b	36-0646-8923		Impeller Shim	A/R
H24c	36-0646-8933		Impeller Shim	A/R
H28	SHCSM8X30	Standard	Socket Head Capscrew	4
	SHCSM8X30SS	Stainless		
H29	FWM8	Standard	Flat Washer	4
	FWM8SS	Stainless		
H30			N/A	0
H31	21-0230-7915	Standard	Separation Tank Cover	1
	21-0230-7915S	Stainless		
	21-0230-7915-R4R	R4R		
H33	23-0586-9923		Filter	1
H36	BM10X35	Standard	Setscrew	1
	BM10X35SS	Stainless		
H37	NM10	Standard	Nut	1
	NM10SS	Stainless		
H44	SM12X45	Standard	Stud	4
	SM12X45SS	Stainless		
H45	SM12X60	Standard	Stud	2
	SM12X60SS	Stainless		
H47	SWM12 + FWM12	Standard	Spring washer + Flat washer	10
	SWM12SS + FWM12SS	Stainless		
H48	NM12	Standard	Nut	10
	NM12SS	Stainless		
H51	SM16X65	Standard	Stud	8
	SM16X65SS	Stainless		
	SM20X80	R4R		
H52	FWM16	Standard	Flat washer	8
	FM16SS	Stainless		
H53	NM16	Standard	Nut	8
	NM16SS	Stainless		

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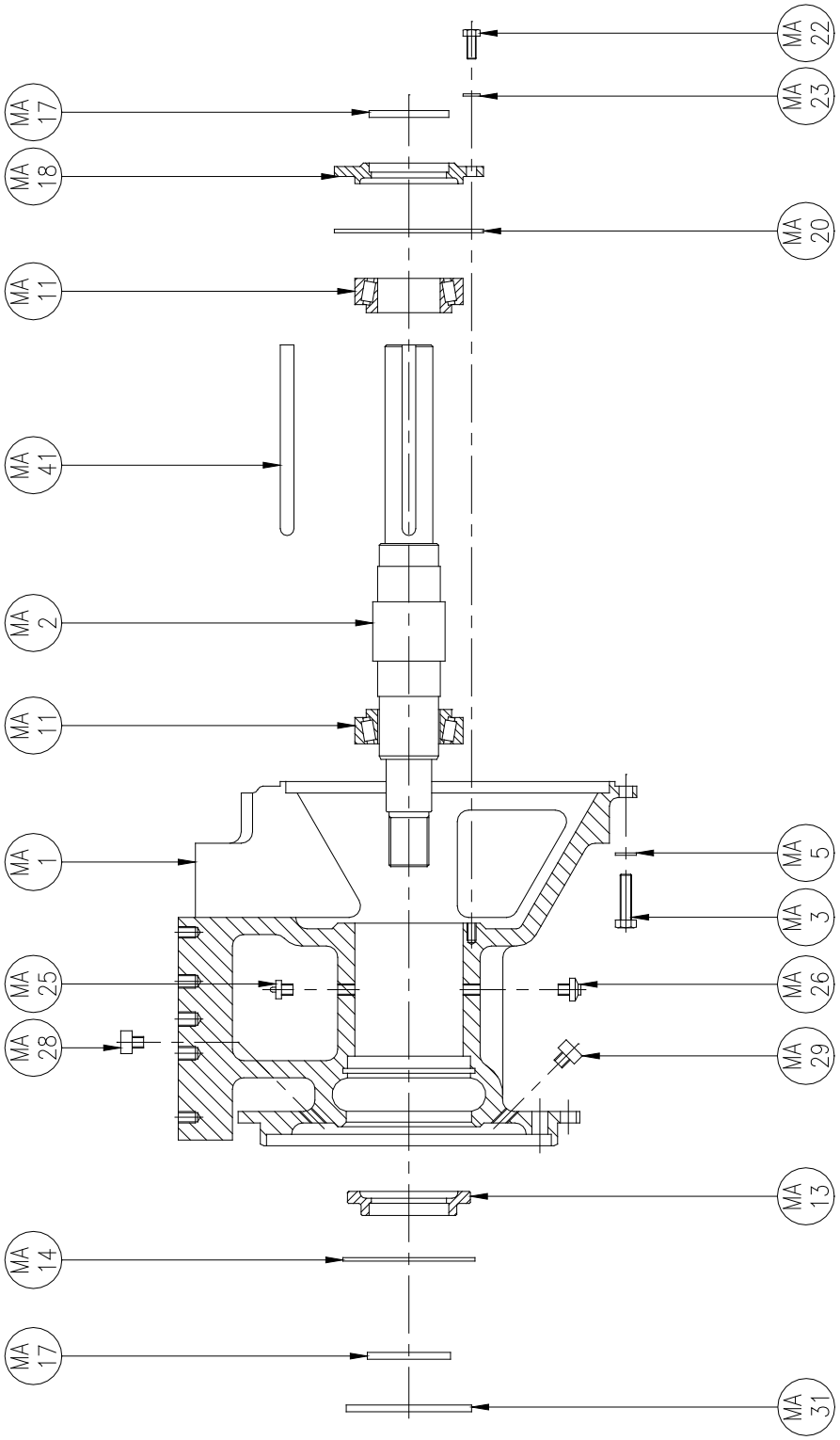
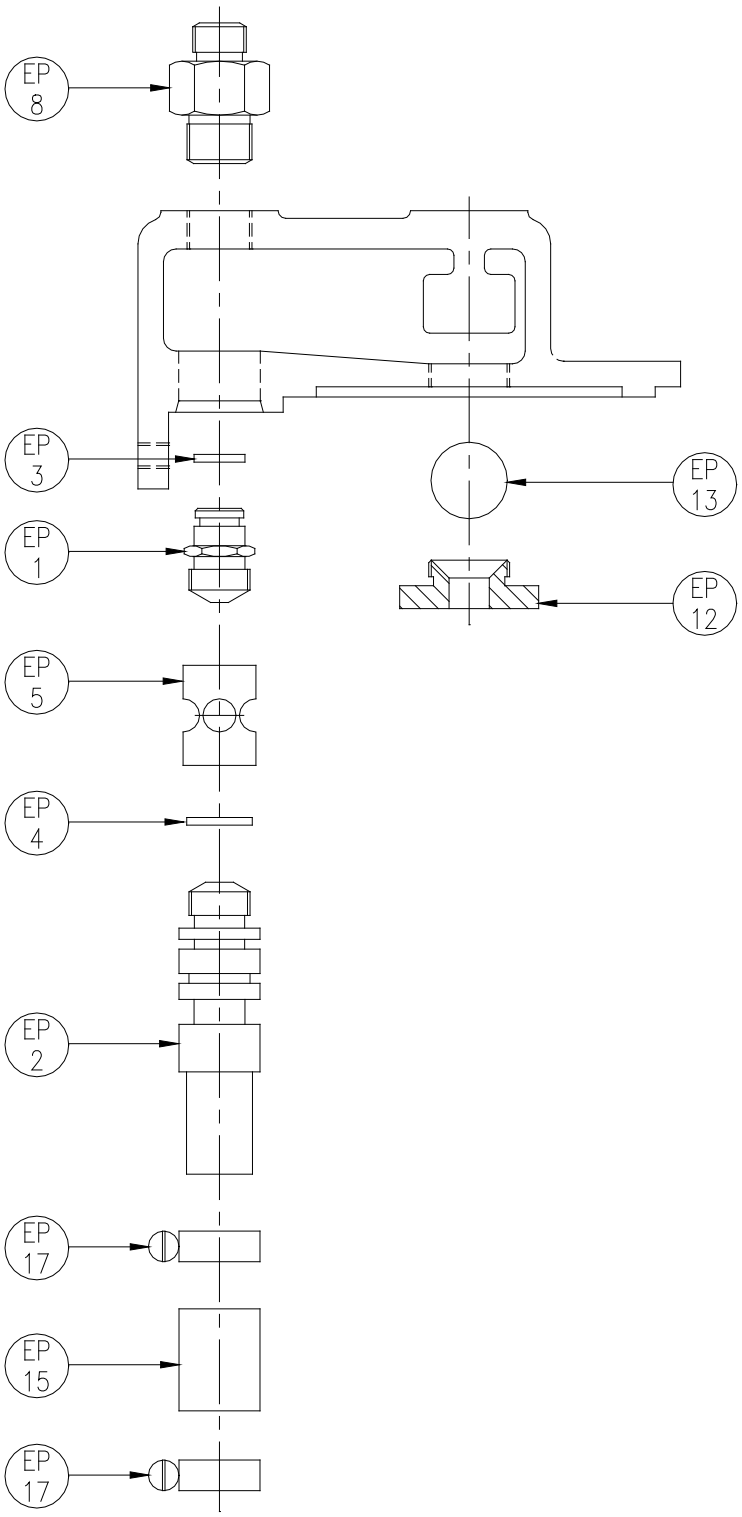
2.2 Bearing Bracket and Shaft Parts List



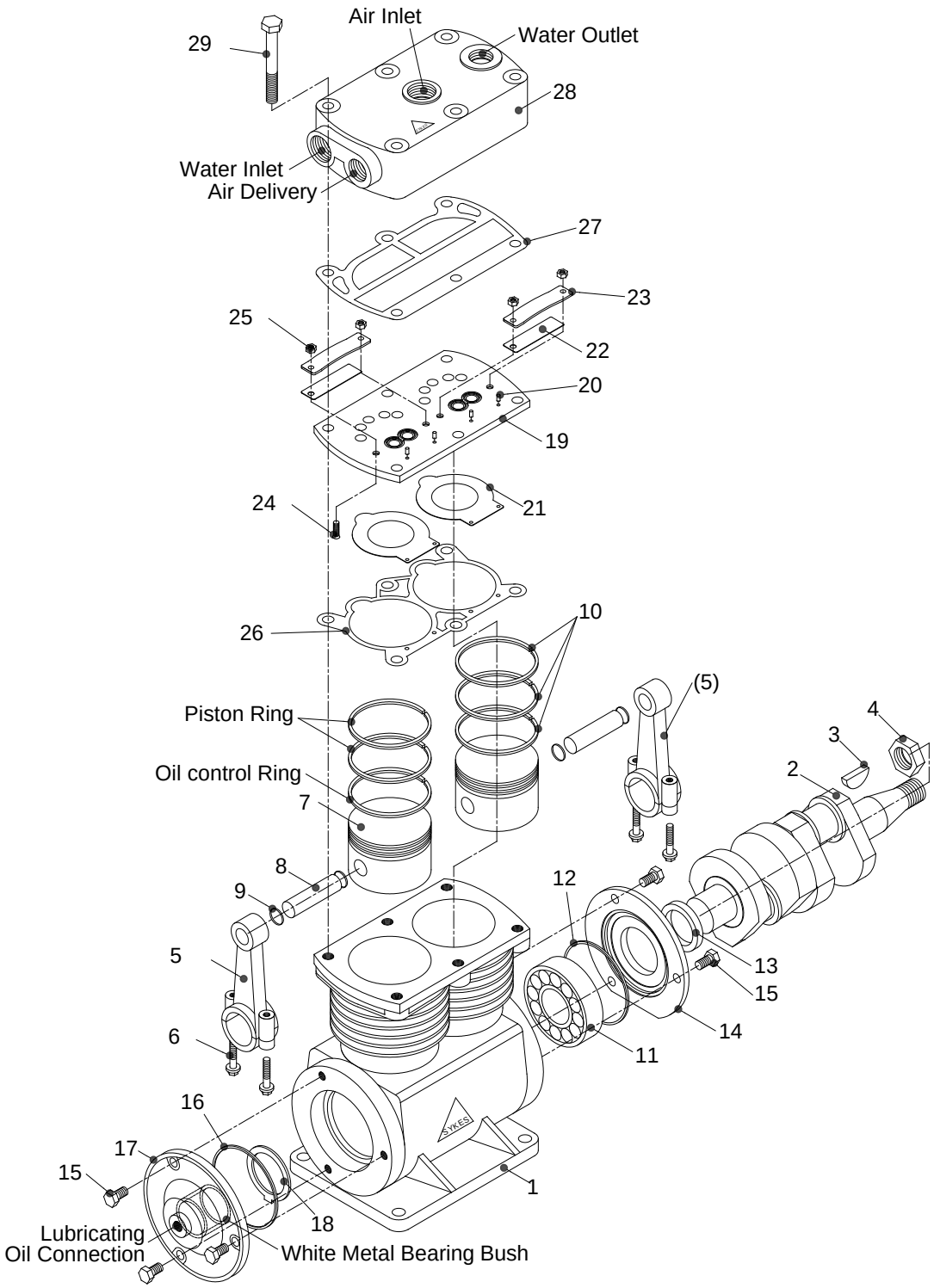
BEARING BRACKET & SHAFT PARTS LIST			
Illustration Number	**Part Number**	**Description**	**Qty**
MA1	13-0174-0215	Engine Adaptor	1
MA2	16-0400-8011-R4R	Shaft	1
MA3	BM10X30	Setscrew	9
MA5	SWM10	Spring washer	9
MA5	FWM10	Flat washer	9
MA11	39-0069-9912	Taper Roller Bearing	2
MA13	13-0172-0915	Bearing Cover (Front)	1
MA14	41-0232-8712	Circlip	1
MA17	38-0809-4112	Spiroseal	2
MA18	13-0173-0115	Bearing Cover (Rear)	1
MA20	36-0650-9903	Shim (Bearing Cover)	A/R
MA20a	36-0650-9913	Shim (Bearing Cover)	A/R
MA20b	36-0650-9923	Shim (Bearing Cover)	A/R
MA20c	36-0650-9933	Shim (Bearing Cover)	A/R
MA20d	36-0650-9943	Shim (Bearing Cover)	A/R
MA22	BM8X25	Setscrew	3
MA23	SWM8	Spring washer	3
MA23	FWM8	Flat washer	3
MA25	51-0003-8112	Grease Nipple	1
MA26	51-0010-2012	Relief Valve	1
MA28	43-1048-4515	Plug	1
MA29	43-1048-4515	Plug	1
MA31	38-1033-4112	Spiroseal	1
MA41	KS12X8X160	Key	1

2.3 Ejector Package Parts List

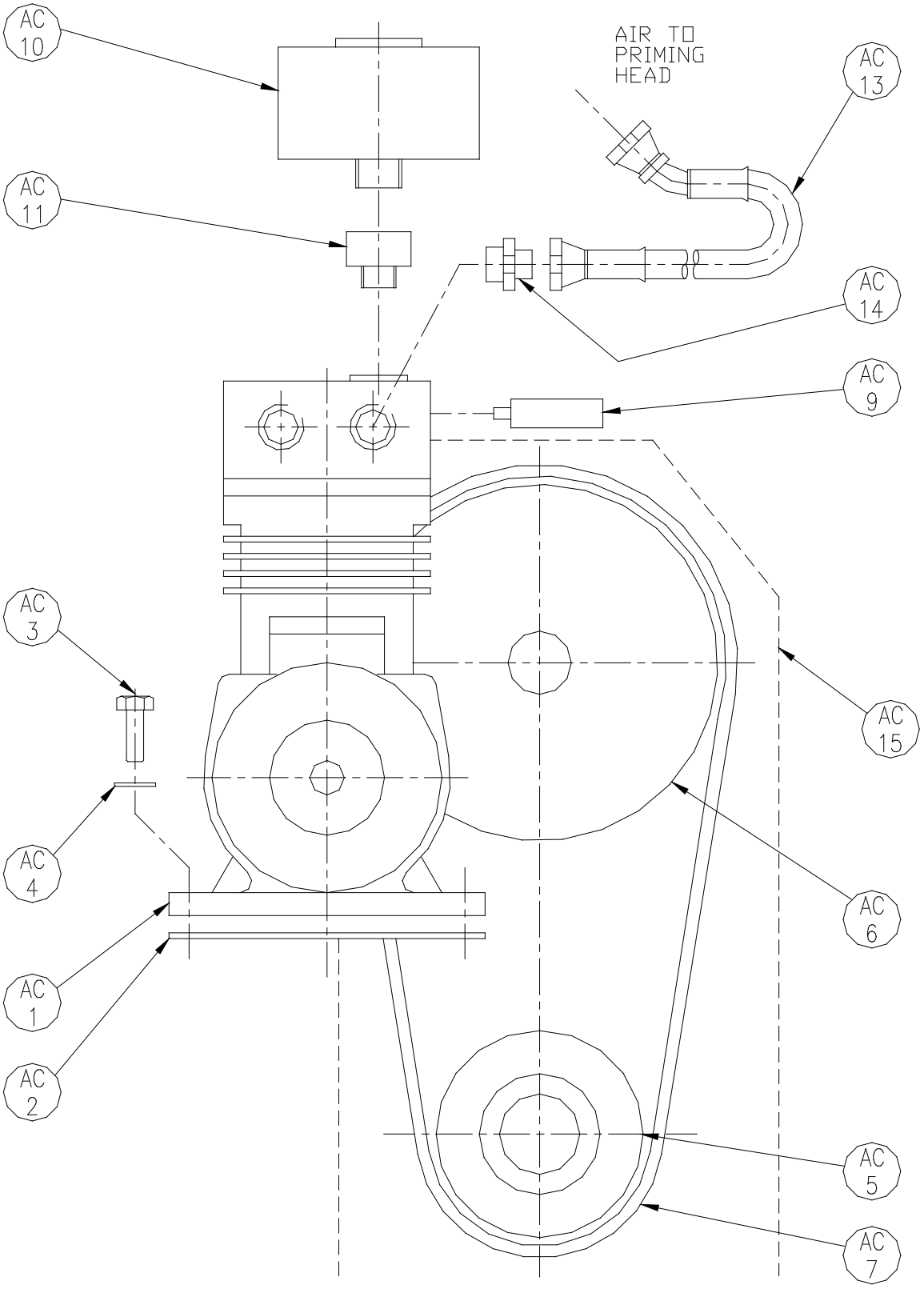


EJECTOR PACKAGE PARTS LIST				
Illustration Number	**Part Number**		**Description**	**Qty**
EP1	23-0568-2016	Standard	Ejector Jet	1
	23-0568-2016-R4R	R4R		
EP2	23-0571-2016	Standard	Ejector Nozzle	1
	23-0571-2016-R4R	R4R		
EP3	38-1013-4112	Standard	O-ring	1
	38-1013-4112V	Stainless		
EP4	38-1014-4112	Standard	O-ring	1
	38-1014-4112V	Stainless		
EP5	23-0570-2011	Standard	Ejector Collar	1
	23-0570-2011S	Stainless		
EP8	23-0567-2011	Standard	Jet Sleeve	1
	23-0567-2011S	Stainless		
EP12	23-0412-2011	Standard	Ball Seat	1
	23-0412-2011S	Stainless		
EP13	39-0641-4113	Standard	Ball	1
	39-0641-4113V	Viton		
EP15	1-319-0025		Toyo Hose	1
EP17	HC038		Hose Clamp	1
	001-0003	Standard	Vacuum Gauge	1
	001-0003S	Stainless		
EP18	NM10	Standard	Nut	
	NM10SS	Stainless		
EP19	BM10X35	Standard	Set Screw	
	BM10X35SS	Stainless		

2.4 Compressor Parts List



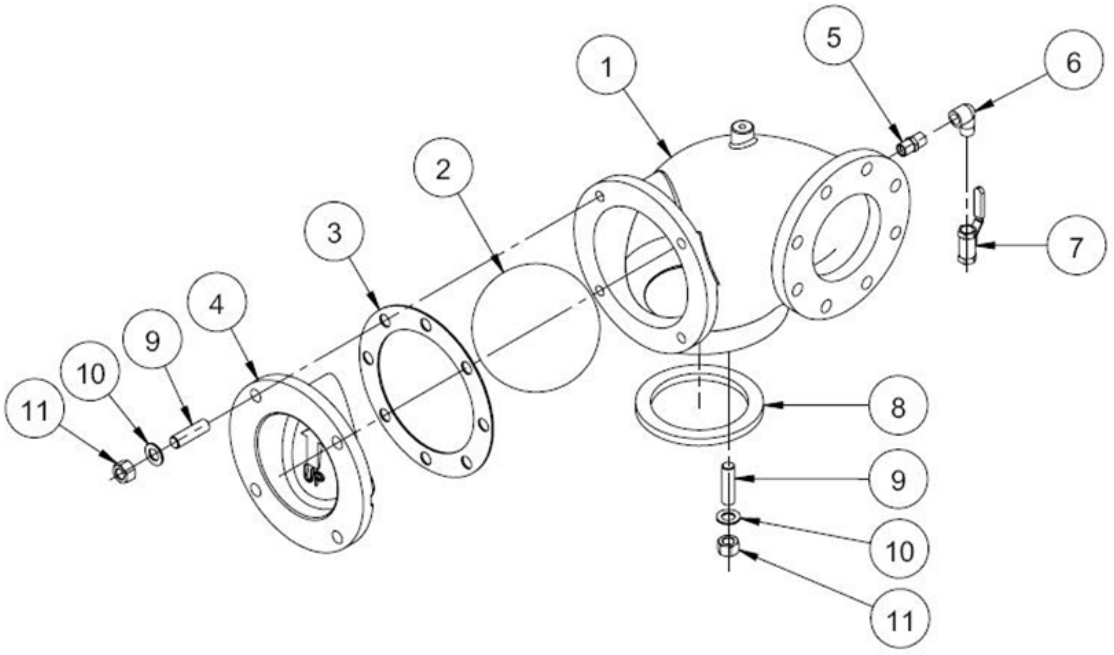
COMPRESSOR PARTS LIST				
Illustration Number	**Part Number**	**CCN Number**	**Description**	**Qty**
1	IAR 0803	71005001	Cylinder Crank Case	01
2	IAH 0804	71005002	Crank Shaft	01
3	IAF 0832	74005030	Crank Shaft Key	01
4	IAF 0830	74005028	Crank Shaft Nut	01
5	IAH 0805	71005003	Connecting Rod	02
6	IAF 0806	74005004	Allen Cap Screw	04
7	IAH 0807	71005005	Piston	02
8	IAF 0808	71005006	Piston Pin	02
9	IAF 0809	74005007	Piston Pin Lock Ring	04
10	IAF 0843	71005043	Piston Ring Set	02 SET
11	IAF 0814	74005012	Bearing	01
12	IAF 0827	75005025	O Ring	01
13	IAF 0816	75005014	Oil Seal	01
14	IAH 0815	71005013	Bearing Cover	01
15	IAF 0817	74005015	Bolt	06
16	IAF 0842	75005042	O Ring	01
17	IAH 0839	71005039	Bushing Cover	01
18	IAF 0819	74005017	Thrust Washer	01
19	IAF 0820	71005018	Spacer Plate	01
20	IAF 0826	74005024	Dowel Pin	04
21	IAF 0825	74005023	Inlet Finger Valve	02
22	IAF 0821	72005019	Discharge Valve	02
23	IAF 0822	72005020	Valve Stopper	02
24	IAF 0823	74005021	Flathead Screw	04
25	IAF 0824	74005022	Nut	04
26	IAF 0834	75005032	Gasket Spacer Plate	01
27	IAH 0835	75005033	Air Head Gasket	01
28	IAR 0833	71005031	Air Head	01
29	IAF 0828	74005026	Bolt	06


AC 10
AC 11
AIR TO PRIMING HEAD
AC 13
AC 14
AC 9
AC 3
AC 15
AC 4
AC 6
AC 1
AC 2
AC 5
AC 7

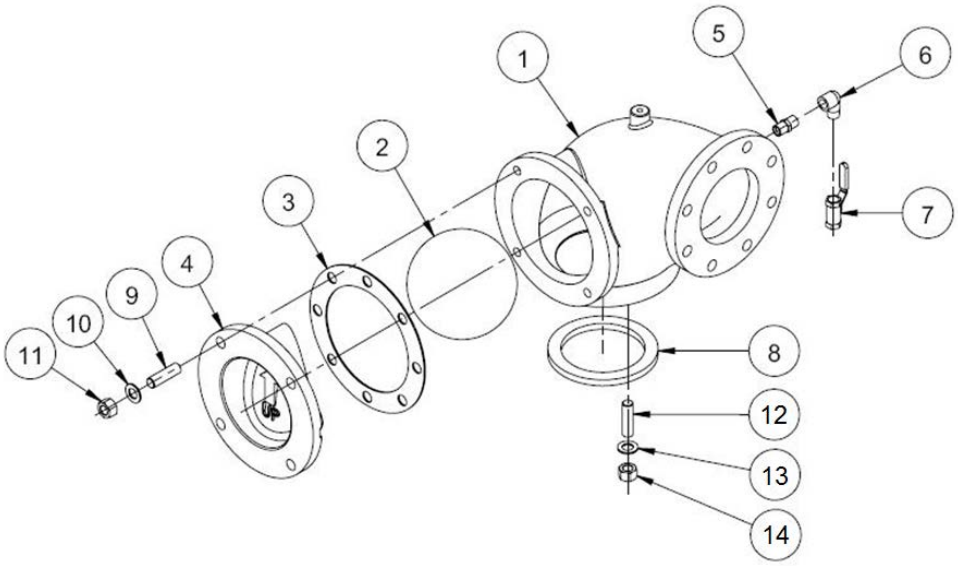
COMPRESSOR PARTS LIST			
Illustration Number	**Part Number**	**Description**	**Qty**
AC1	COMP-SYKES	Compressor - Sykes	1
AC2	KX2542/1	Gasket	1
AC3	SM10X40	Stud	4
AC4	SWM10	Springwasher	4
AC5	26-0851-9912	Pump Pulley	1
AC6	26-0724-0243	Compressor Pulley	1
AC7	26-0840-9912	Belt	1
AC8	36-0556-8111	Fan Washer	1
AC9	10-0000-0004	Relief Valve	1
AC10	54-0556-9912	Air Cleaner	1
AC11	A1212	Adaptor (Air Cleaner)	1
AC13	42-0000-0004	Compressed Air Hose	1
AC14	N1208H	Nipple	1
AC15	27-2800-1000	Pulley/Belt Guard	1

“B” SECTION LINK BELT OPTION			
Illustration Number	**Part Number**	**Description**	**Qty**
AC5	10-0000-0310	Pump Pulley	1
AC6	10-0000-0500	Compressor Pulley	1
AC7	340-4077	‘B’ Section Belt	2 mtr
	10-0000-0007	Taper Lock Bush	1
AC15	27-2800-1000	Guard to suit Water Cooled	1

2.5 Non-Return Valve Parts List

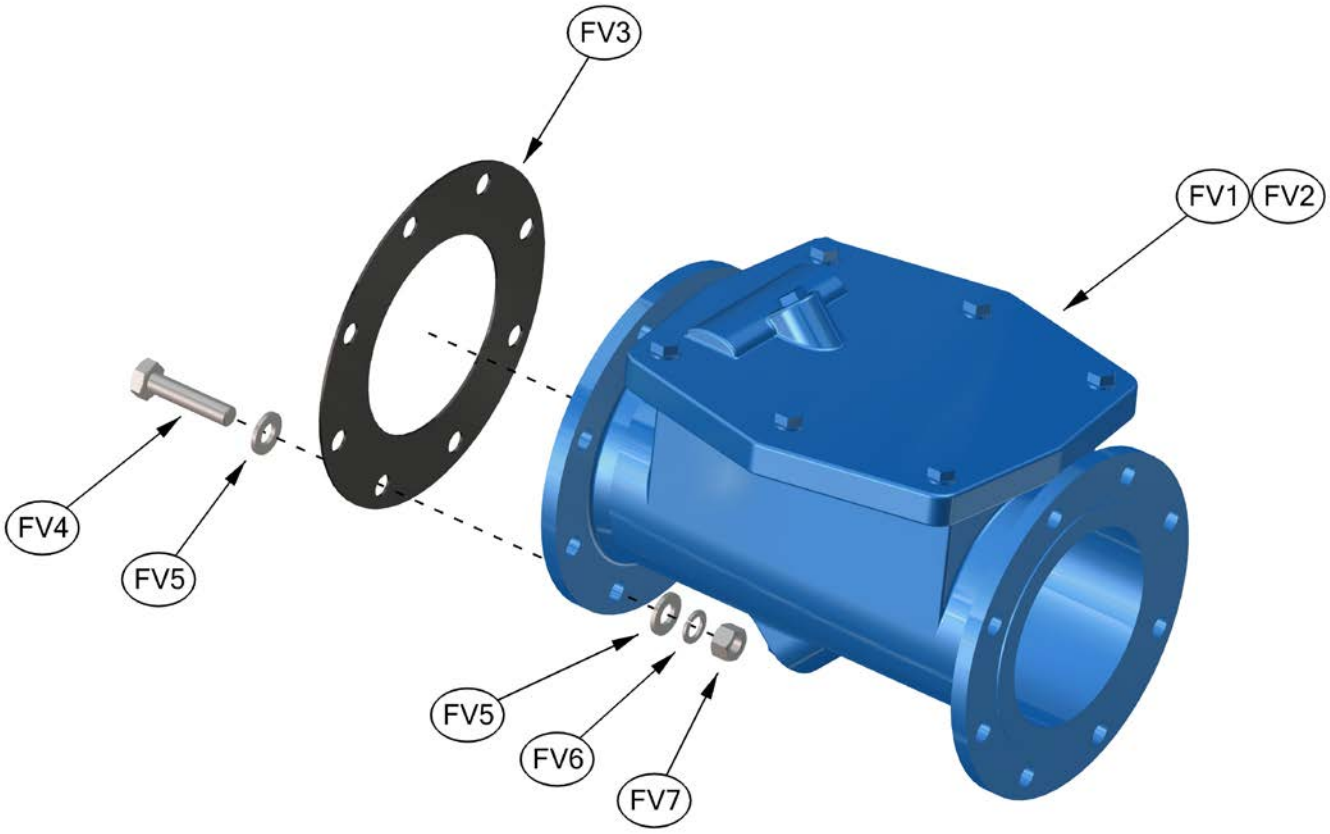


REFLUX BOX NON-RETURN VALVE PARTS LIST – Table E				
Illustration Number	**Part Number**		**Description**	**Qty**
-	726487		NRV Table E Assy	-
1	NRV150BOD-SGI-TE	Standard	Ball Style NRV	1
	NRV150BOD-316-TE	Stainless		
2	313-4169		Ball - NRV	1
3	NRV150GSK-PLA		NRV Gasket	1
4	NRV150COV-SGI	Standard	Ball Style NRV Cover	1
	NRV150COV-316	Stainless		
5	N08HSS		Nipple Hydraulic	1
6	E08BMF		Elbow	1
7	920-9242S		Mini Ball Valve	1
8	356-4063		Seat Ball	1
9	M20X70	Standard	Stud	12
		Stainless		
10	M20	Standard	Flat Washer	12
		Stainless		
11	M20	Standard	Nut	12
		Stainless		



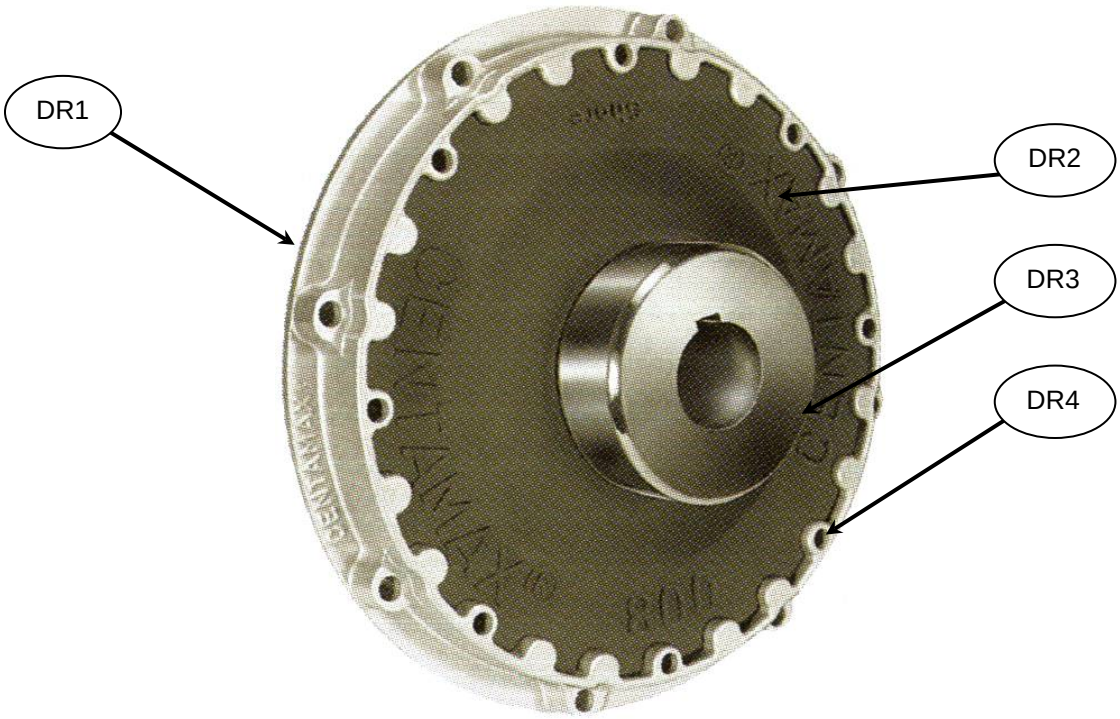
REFLUX BOX NON-RETURN VALVE PARTS LIST – Table D				
Illustration Number	**Part Number**		**Description**	**Qty**
-	726486	Standard	NRV Table D Assy	-
-	726482	Stainless		
1	NRV150BOD-SGI-TD	Standard	Ball Style NRV	1
	NRV150BOD-SAF1-TD	SAF2205		
	NRV150BOD-SAF2-TD	SAF2507		
	NRV150BOD-316-TD	Stainless		
	NRV150BOD-CD4-TD	CD4MCU		
	NRV150BOD-CS1-TD	L6		
	NRV150BOD-CS2-TD	L6C		
2	313-4169		Ball - NRV	1
3	NRV150GSK-RBR		NRV Gasket	1
4	726497	Standard	NRV Cover	1
	726496	CD4MCU		
	726495	Stainless		
5	726381	Zinc	Nipple	1
	726382	Stainless		
6	725531	Standard	Elbow	1
	725533	Stainless		
7	723920	Stainless	Mini Ball Valve	1
8	356-4063		Seat Ball	1
9	M20X70	Standard	Stud	4
		Stainless		
10	M20	Standard	Flat Washer	4
		Stainless		
11	M20	Standard	Nut	4
		Stainless		
12	M16X70	Standard	Stud	8
		Stainless		
13	M16	Standard	Flat Washer	8
		Stainless		
14	M16	Standard	Nut	8
		Stainless		

2.6 Non Return Valve Assembly - Underslung



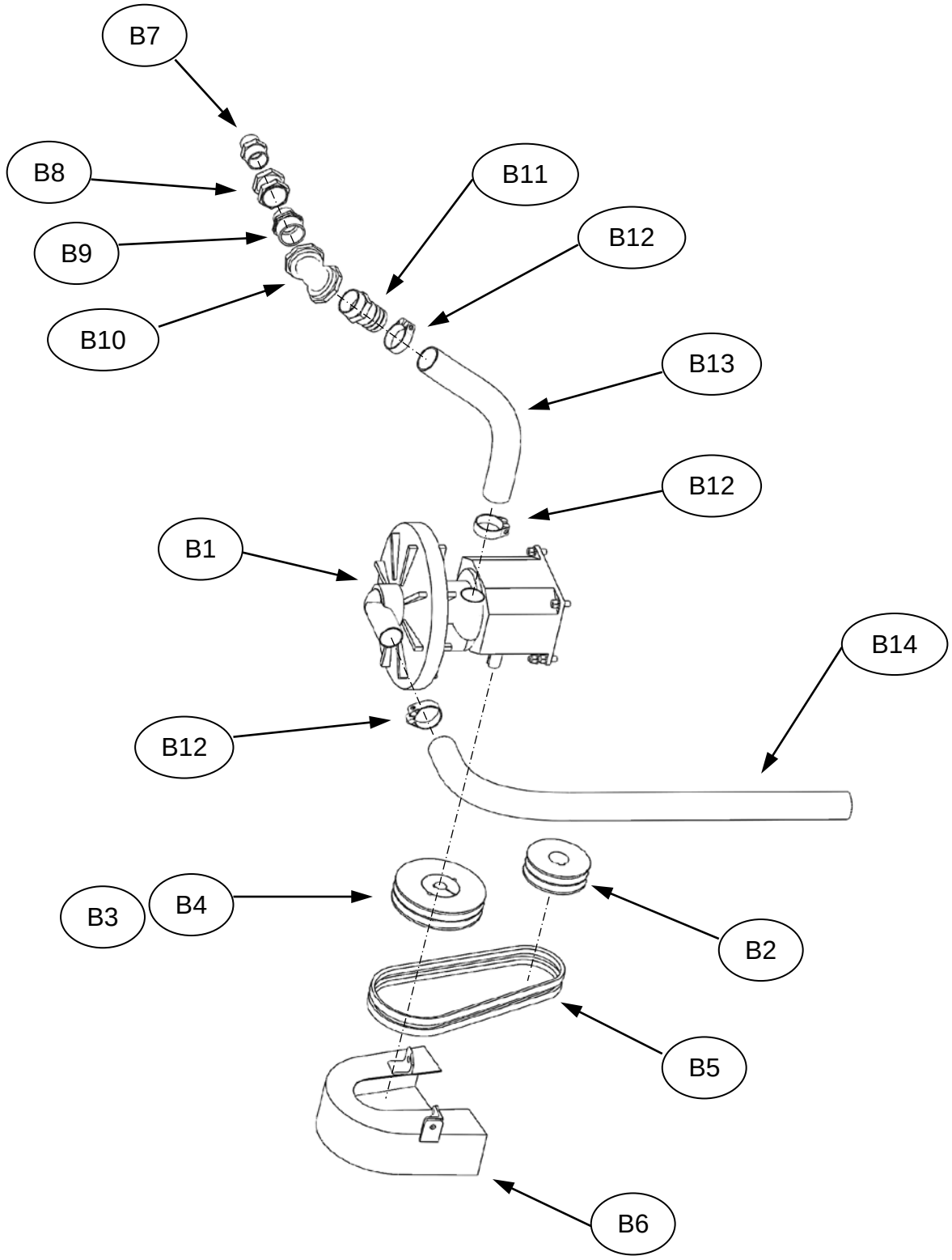
CPD150i - Parts List - Underslung Flap Type Non-Return Valve				
Item	***Part Number***		***Description***	***Qty***
FV1	506C	Standard	Flap Type Non-Return Valve - 6" - ANSI150	1
	506C.6	Stainless		
	734034		Flap Type Non-Return Valve - 6" AVK	
	721921		Flap Type Non-Return Valve - 6" Table E	
FV2	A506HP-3		Internal Flap for Non-Return Valve – Suit 6” ANSI150	
FV3	022-0960-150		Rubber Gasket – Suit 6” ANSI150	1
	500-4051		Rubber Gasket – Suit 6" AVK	
	500-4051		Rubber Gasket – Suit 6" Table E	
FV4	3/4X3.5	Standard	Set Screw	8
	3/4X3.5SS	Stainless		
FV5	3/4FLAT	Standard	Flat Washer	16
	3/4FLATSS	Stainless		
FV6	3/4LOCK	Standard	Spring Washer	8
	3/4LOCKSS	Stainless		
FV7	3/4NUT	Standard	Hexagon Nut	8
	3/4NUTSS	Stainless		

2.7 Engine / Pump Coupling Parts List



ENGINE / PUMP COUPLING PARTS LIST			
Illustration Number	**Part Number**	**Description**	**Qty**
	CM-240-50-08-42	Complete Coupling Assembly	1
	CM-240-50-10-42		
	CM-0400-50-10-42		
	CM-0800-50-10-42		
	CM-0800-50-11-42		
DR1	CM-240-FL1-8	Flywheel Flange	1
	CM-240-FL1-10		
	CM-0400-FL1-10		
	CM-0800-FL1-10		
	CM-0800-FL1-11		
DR2	CM-240-EL-50	Coupling Rubber Element	1
	CM-240-EL-50		
	CM-0400-EL-50		
	CM-0800-EL-50		
	CM-0800-EL-50		
DR3	CM-240-H-SB1-42	Hub	1
	CM-240-H-SB1-42		
	CM-0400-H-SB1-42		
	CM-0800-H-SB1-42		
	CM-0800-H-SB1-42		
DR4	CM-240-BS	Bolt Set to suit Hub	1
	CM-240-BS		
	CM-0400-BS		
	CM-0800-BS		
	CM-0800-BS		

2.8 Diaphragm Pump & Pulley Set Up Assembly



SWD150 – Parts List – Diaphragm Pump and Pulley Set Up Assembly			
Item	**Part Number**	**Description**	**Qty**
B1	732017	Diaphragm Pump	1
B2	721802	Pump Pulley c/w TLB	1
B3	721908	Diaphragm Pump Pulley	1
B4	732069	Taper Lock Bush	1
B5	340-4077	Belt	2m
B6	-	Pulley/Belt Guard	1
B7	726396	Nipple	1
B8	732953	Socket	1
B9	732903	Nipple	1
B10	732901	Elbow	1
B11	732902	Hose Tail	1
B12	-	Clamp	3
B13	-	Hose	0.45m
B14	-	Hose	2m

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Engine Manual

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Anchorage, AK 99518
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Fairbanks:
1919 Van Horn Road
Fairbanks, AK 99701
(907) 458-9049 | (888) 868-9049

Seattle:
17660 W. Valley Hwy
Tukwilla, WA 98188
(425) 251-6119

Williston:
5064 Bennett Loop
Williston, ND 58801
(701) 774-5312

Equipment Source, Inc.

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California Proposition 65

⚠ WARNING ⚠

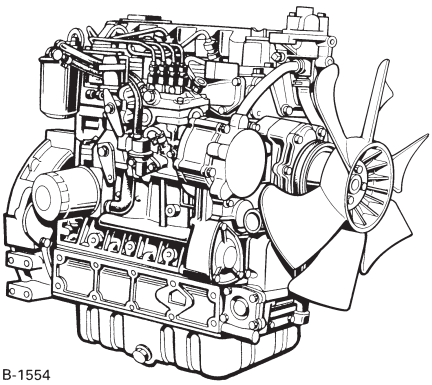
Engine exhaust, some of its constituents, certain vehicle components and fluids, contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

OPERATOR'S MANUAL

ENGLISH

KUBOTA
DIESEL ENGINE

MODELS **V3600-E3 · V3600-T-E3 · V3800-DI-T-E3 · V3300-E3BG · V3600-T-E3BG · V3800-DI-T-E3BG**



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READ AND SAVE THIS MANUAL

Kubota

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.

CONTENTS

ENGLISH

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.

1AEAAAAAP0130

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.

1AEAAAAAP0120

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.

1AAACAAAP001A

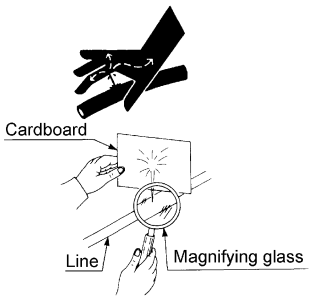
6. EXHAUST GASES & FIRE PREVENTION

- 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.

1AAACAAAP011A

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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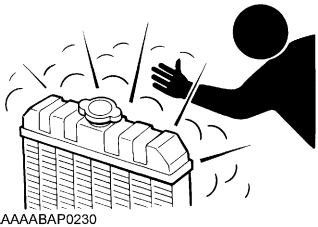

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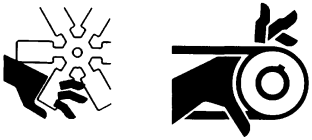
1ARAEAAAP0520

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.



1ABAAAAAP1470

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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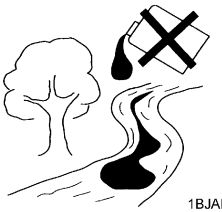
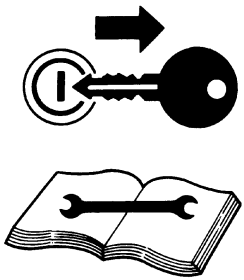


1BJABAAAP0180

11. CONDUCTING SAFETY CHECKS & MAINTENANCE

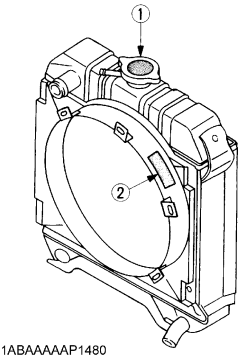
- When inspecting the engine or servicing, place the engine on a large flat surface. DO NOT work on anything that is supported ONLY by lift jacks or a hoist. Always use blocks or the correct stands to support the engine before servicing.
- Disconnect the battery from the engine before conducting service. 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.



1BJABAAAP0200

- 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)

1ABACAAAP036K

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


1AGAMAAAP2620

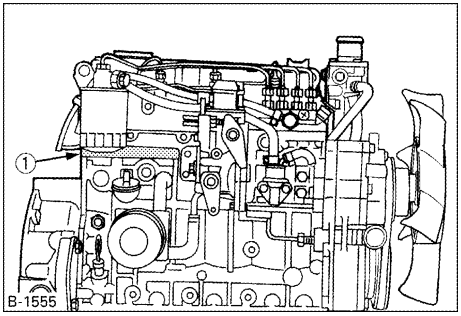
13. CARE OF WARNING AND CAUTION LABELS

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.

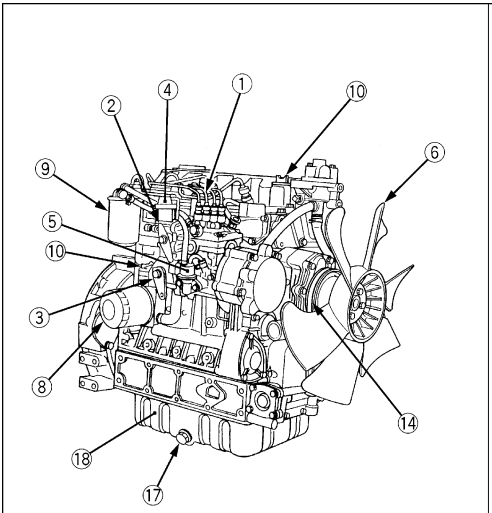
	Type	Serial No.
Engine		
Date of Purchase		
Name of Dealer		
(To be filled in by purchaser)		



(1) Engine serial number

ENGLISH

NAMES OF PARTS



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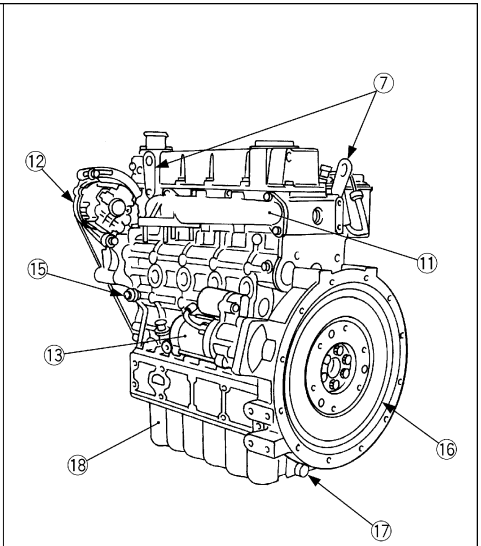


B-1543改

(1) Intake manifold
(2) Speed control lever
(3) Engine stop lever
(4) Shut off solenoid
(5) Fuel feed pump
(6) Cooling fan
(7) Engine hook
(8) Oil filter cartridge
(9) Fuel filter
(10) Oil filler plug
(11) Exhaust manifold
(12) Alternator
(13) Starter
(14) Fan belt
(15) Oil pressure switch
(16) Flywheel
(17) Oil drain plug
(18) Oil pan

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
	(3) Amount of fuel	12
	(4) Amount of coolant	18
	(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

ENGLISH

OPERATING THE ENGINE

STARTING THE ENGINE(NORMAL)

CAUTION

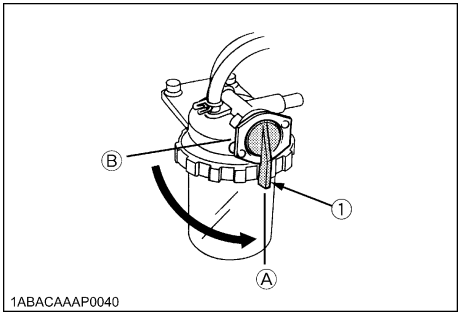
To avoid personal injury:

- **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 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.

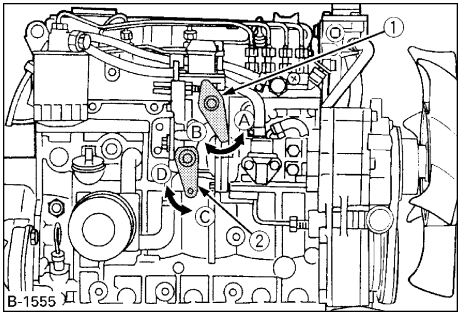


(1) Fuel lever

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

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

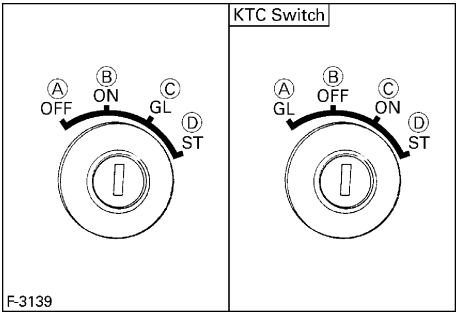
3. Place the speed control lever at more than half "OPERATION".



(1) 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.

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 "PRE-HEATING" 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	
	V3600-E3 V3600-T-E3 V3300-E3BG V3600-T-E3BG	V3800-DI-T-E3 V3800-DI-T-E3BG
Above 10°C (50°F)	NO NEED	
10°C (50°F) to -5°C (23°F)	Approx.5 seconds	Approx.15 seconds
Below -5°C (23°F)	Approx.10 seconds	Approx.30 seconds
Limit of continuous use	20 seconds	30 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.

ENGLISH

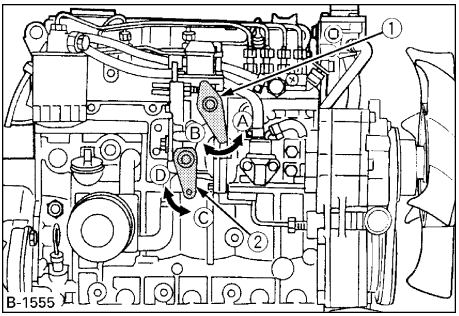
STOPPING THE ENGINE

1. **Return the speed control lever to low idle, and run the engine under idling conditions.**

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.

2. **The engine should stop with the starter switch placed at the OFF position. (In case of non-stopping, set the engine stop lever to the "STOP" position manually.)**

3. **After stopping the engine, remove the key.(Be sure to return the engine stop lever to the START position to be ready for the next starting in case of manually stopping.)**



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

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.)

■Charge lamp

The lamp lights up to warn the operator that the battery charge is low. If this should happen during operation, immediately stop the engine and check the following:

1. Cable broken
2. Poor connection at alternator terminal
3. Fan belt too loose or damaged

■**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 turn the starter switch to the "OFF" position and 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.

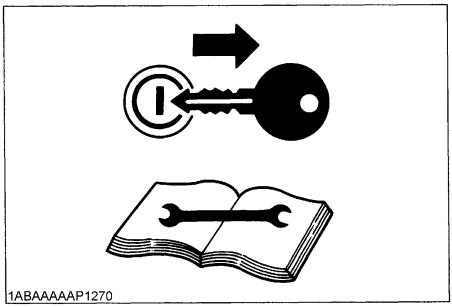
ENGLISH

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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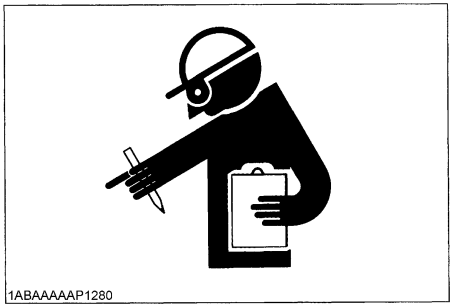

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SERVICE INTERVALS

Observe the following for service and maintenance.

Interval	Item	Ref. page		
Every 50 hours	Check of fuel pipes and clamp bands	14		@
	Draining water separator	-		
See NOTE	Change of engine oil	15 to 17	◎	
Every 250 hours	Cleaning of air cleaner element	21	*1	@
	Cleaning of fuel filter	14		
	Check of fan belt tightness	22		
	Check of radiator hoses and clamp bands	19		
	Check of intake air line	-		@
Every 500 hours	Replacement of oil filter cartridge	17	◎	
	Replacement of fuel filter cartridge	15		@
	Removal of sediment in fuel tank	-		
	Cleaning of water jacket (radiator interior)	18 to 20		
	Replacement of fan belt	22		
	Cleaning of water separator	-		
Every year	Replacement of air cleaner element	21	*2	@
Every 1000 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	@
	Check of fuel injection timer	-	*3	@
Every two years	Change of radiator coolant (L.L.C.)	19 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	@
	Replacement of fan belt (or every 500 hours)	22		

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.

- When the battery is used for less than 100 hours in a year, check its electrolyte yearly. (for refillable battery's only)
- 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	Interval
V3600-E3, V3600-T-E3, V3300-E3BG, V3600-T-E3BG	250 Hrs or 1 year whichever comes first
V3800-DI-T-E3, V3800-DI-T-E3BG	500 Hrs or 1 year whichever comes first
Initial	50 Hrs

- API service 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 × : Not recommendable

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

*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 0.05 % (500 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°C (14°F).
  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°C (77°F)	SAE30, SAE10W-30 or 15W-40
-10°C to 25°C (14°F to 77°F)	SAE10W-30 or 15W-40
Below -10°C (14°F)	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

ENGLISH

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.

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 37.8°C(100°F)	
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 °C (-4 °F) 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 0.05 % (500 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 °C (14 °F).
  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

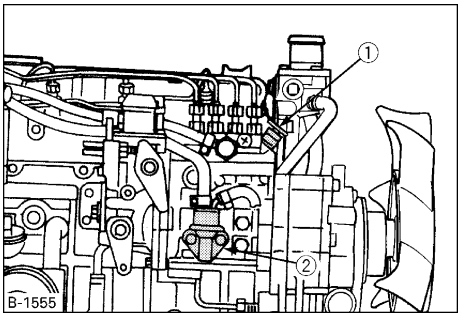
To avoid personal injury;
- **Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.**

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 joint bolt 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 Joint bolt 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]



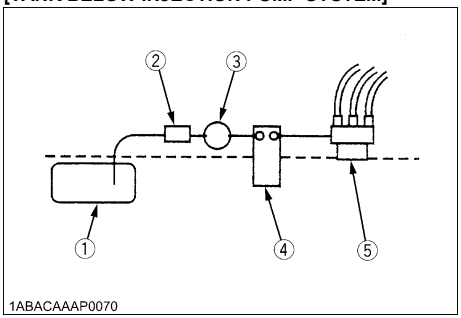
(1) Joint bolt
(2) Fuel feed pump

NOTE :
- For the engine equipped with automatic venting (optional) no manual bleeding of fuel lines is required.

[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 (4) 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

■Checking the fuel pipes

CAUTION

To avoid personal injury;

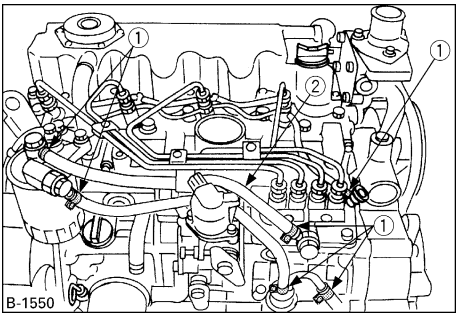
- **Check or replace the fuel pipes after stopping the engine. Broken fuel pipes can cause fires.**

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, became 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' 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.

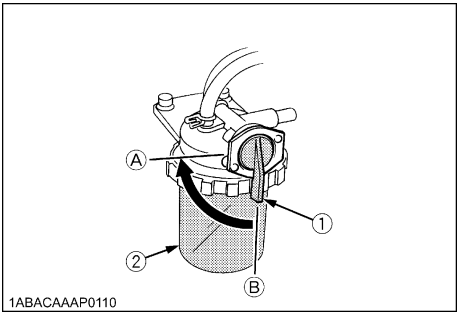


(1) Clamp band
(2) Fuel pipe

■Cleaning 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.

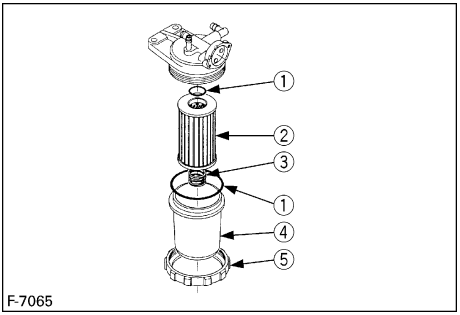


(1) Fuel filter lever
(2) Fuel filter pot
(A) "OFF"
(B) "ON"

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.



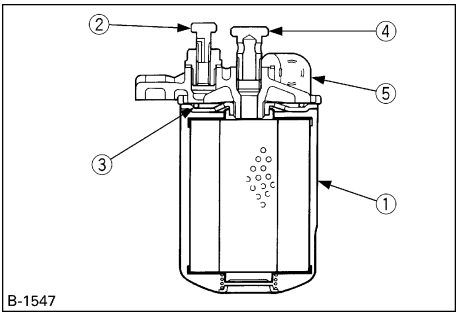
(1) O ring
(2) Filter element
(3) Spring
(4) Filter bowl
(5) Screw ring

■Fuel filter cartridge replacement

1. Replace the fuel filter cartridge with a new one every 500 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

NOTE :

- The fuel filter cartridge and water separator should be replaced more earlier according to the fuel classification in use.

ENGINE OIL

⚠ CAUTION

To avoid personal injury:

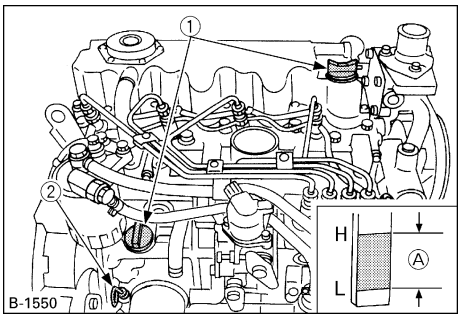
- **Be sure to stop the engine before checking and changing the engine oil and the oil filter cartridge.**
- **Do not touch muffler or exhaust pipes while they are hot; Severe burns could result. Always stop the engine and allow it to cool before conducting inspections, maintenance, or for a cleaning 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.**

IMPORTANT :

- Do not operate a diesel engine when engine oil is overfilled. This oil can drain through the air intake system, which cause engine disacceleration and oil leaks from breather pipings. It could result in a over-running or oil hammering of engine in case of the engine with suction blow-by gases breathered in.

■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.

Models	Engine oil quantity
V3600-E3, V3600-T-E3, V3800-DI-T-E3, V3300-E3BG, V3600-T-E3BG, V3800-DI-T-E3BG	13.2 L (3.49 U.S. gal.)

* API service classification: above CF grade

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 (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.

NOTE :

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

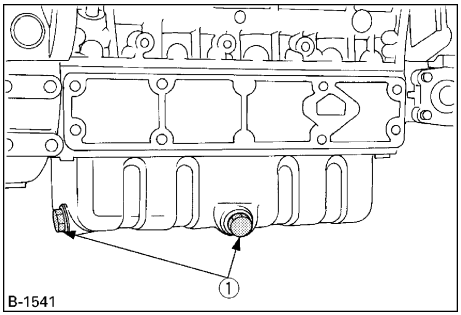
■Changing engine oil

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 500 (for DI spec), 250 (for IDI spec) hours thereafter.
   When the annual operating hours are below 500 (DI spec) or 250 (IDI spec), replace the oil every year.
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.
3. When letting out the oil, remove the filler plug too. With the filler plug still in place, it would be difficult to discharge the oil completely.
4. Add new engine oil up to the upper limit of the oil level gauge. Be careful not to add oil above the upper limit of the oil level gauge.



(1) Oil drain plug

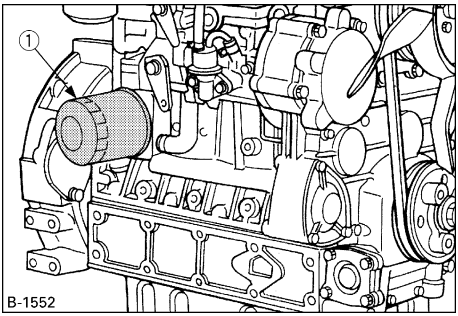
■**Replacing the oil filter cartridge**

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 after the initial 50 hours of operation and every 500 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

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.

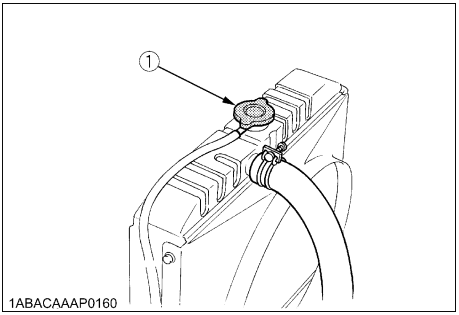
WARNING

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.

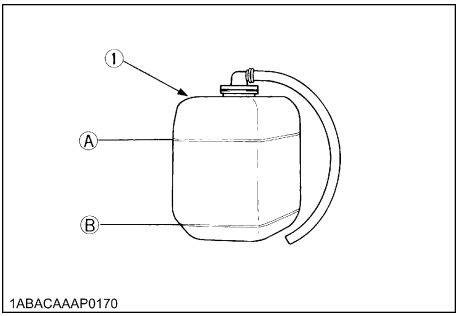
■Checking coolant level, adding coolant

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



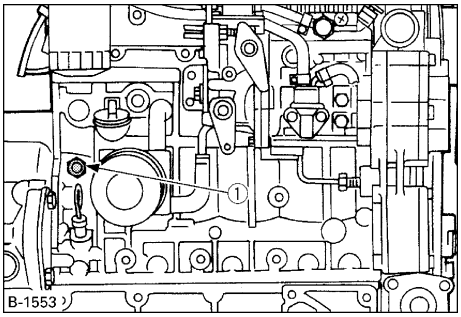
(1) Radiator pressure cap

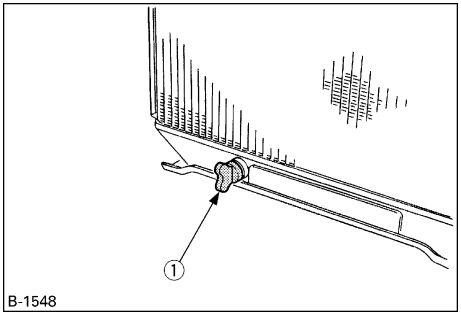
2. If the radiator is provided with a recovery tank, check the coolant level of the recovery tank. When it is between the "FULL" and "LOW " marks, the coolant will last for one day's work.



(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
V3600-E3, V3600-T-E3, V3800-DI-T-E3, V3300-E3BG, V3600-T-E3BG, V3800-DI-T-E3BG	9.0 L (2.38 U.S. gal.)

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. Check and clean the plug threads and surface and the pucking thims of the water drain plug to prevent dirt and debris from the entering the engine.
6. 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

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 250 hours of operation or 6 months, whichever comes first.

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

Replace hoses and clamp bands 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.

■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 1.013×10^5 Pa (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.

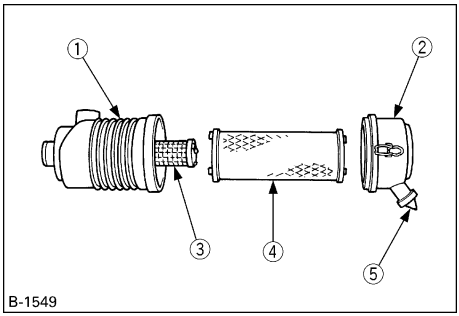
■Radiator cement

As the radiator is solidly constructed, there is little possibility of water leakage. Should this happen, however, radiator cement can easily fix it. If leakage is serious, contact your local KUBOTA dealer.

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 primary 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 primary element every year or every 6 cleanings. If the primary element is stained heavily, replace it soon. At this time, replace the secondary element too.
6. The secondary element should be removed only if it is to be replaced.
7. To protect the engine, do not remove the secondary element in servicing the primary element.



(1) Air cleaner body
(2) Cover
(3) Secondary element
(4) Primary element
(5) Evacuator valve

IMPORTANT :

- Make sure the hooking clip 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.

■Cleaning Primary Air Filter Element

To clean the element, use clean dry compressed air on the inside of the element.
Air pressure at the nozzle must not exceed 205 kPa (2.1 kgf/cm²; 30 psi).
Maintain reasonable distance between the nozzle and the filter.

■Evacuator valve

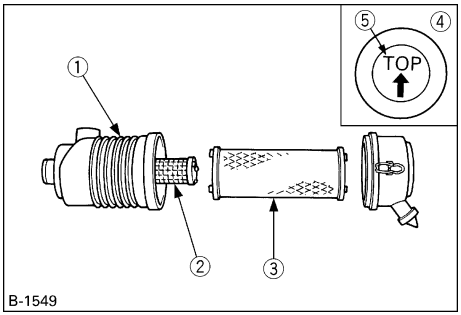
Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place - to get rid of large particles of dust and dirt.

■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 :

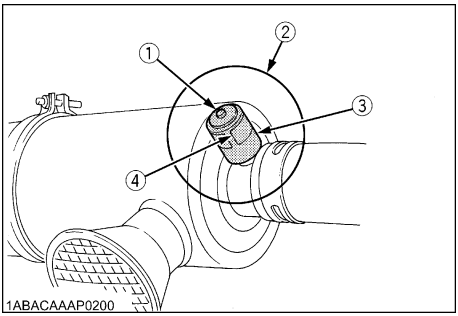
- If the dust cup is mounted incorrectly, dust or dirt does not collect in the cup, and direct attachments of the dust to the element will cause its lifetime to shorten to a great extent.



(1) Air cleaner body
(2) Secondary element
(3) Primary element
(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:

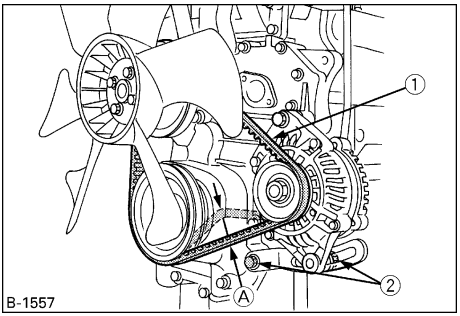
- **Be sure to stop the engine and remove the key before checking the belt tension.**
- **Be sure to reinstall the detached safety shield after maintenance or checking.**

Proper fan belt tension	A deflection of between 10 to 12 mm (0.39 to 0.47 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) 10 to 12 mm (0.39 to 0.47 in.) (under load of 6~7 kgf (13.2~15.4 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 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.

ENGLISH

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	V3600-E3	V3600-T-E3
Type	Vertical, water-cooled, 4-cycle diesel	
Number of cylinders	4	
Bore and stroke mm (in.)	98 × 120 (3.86 × 4.72)	
Total displacement L(cu.in.)	3.620 (220.9)	
Combustion type	Spherical type (E-TVCS)	
SAE NET Intermittent kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	45.8 / 2600 (61.4 / 2600)	58.8 / 2600 (78.8 / 2600)
SAE NET Continuous kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	39.8 / 2600 (29.7 / 2600)	51.1 / 2600 (68.5 / 2600)
SAE Standby kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	—	—
Maximum bare speed min^{-1}(rpm)	2800	
Maximum bare idling speed min^{-1}(rpm)	775 to 825	
Order of firing	1-3-4-2	
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch type mini pump	
Injection pressure MPa (kgf / cm^2, psi)	13.93 (142, 2020)	
Injection timing (Before T.D.C.)	0.14 rad (8°)	0.07 rad (4°)
Compression ratio	22.6	21.8
Fuel	Diesel fuel oil No.2-D	
Lubricant (API classification)	above CF grade	
Dimension mm (in.) (length × width × height)	745 × 536 × 741.5 (29.33 × 21.10 × 29.19)	745 × 538.5 × 794 (29.33 × 21.20 × 31.26)
Dry weight kg (lbs.)	264 (582)	275 (606.3)
Starting system	Cell starter (with glow plug)	
Starting motor	12V, 3.0kW	
Charging generator	12V, 1080W(KEA), 720W(EU)	
Recommended battery capacity	12V, 136AH (400 CCA or higher) 0°F (-17.8°C) SAE rating	

NOTE :

- Specifications are subject to change without notice.

Model	V3800-DI-T-E3
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	100 × 120 (3.94 × 4.72)
Total displacement L(cu.in.)	3.769 (230)
Combustion type	Direct injection type (E-CDIS)
SAE NET Intermittent kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	71.4 / 2600 (95.7 / 2600)
SAE NET Continuous kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	62.0 / 2600 (83.1 / 2600)
SAE Standby kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	—
Maximum bare speed min^{-1}(rpm)	2800
Maximum bare idling speed min^{-1}(rpm)	775 to 825
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	First opening pressure 18.63 (190, 2275) Second opening pressure 23.54 (240, 3128)
Injection timing (Before T.D.C.)	0.10 rad (6°)
Compression ratio	19.0
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	745 × 549 × 794 (29.33 × 21.61 × 31.26)
Dry weight kg (lbs.)	288 (634.9)
Starting system	Cell starter (with air heater)
Starting motor	12V, 3.0kW
Charging generator	12V, 1080W(KEA), 720W(EU)
Recommended battery capacity	12V, 136AH (400 CCA or higher) 0°F (-17.8°C) SAE rating

NOTE :

- Specifications are subject to change without notice.

Model	V3300-E3BG
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	98 × 110 (3.86 × 4.33)
Total displacement L(cu.in.)	3.318 (202.49)
Combustion type	Spherical type (E-TVCS)
SAE NET Continuous kW / min^{-1}(rpm)	30.6 / 1800 (41.0 / 1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	25.0 / 1500 (33.5 / 1500)
SAE Standby kW / min^{-1}(rpm)	33.6 / 1800 (45.0 / 1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	27.5 / 1500 (36.9 / 1500)
Maximum bare speed min^{-1}(rpm)	1890
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	13.93 (142, 2020)
Injection timing (Before T.D.C.)	0.17 rad (10°)
Compression ratio	22.6
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	769 × 536 × 770 (30.28 × 20.10 × 30.31)
Dry weight kg (lbs.)	276 (608)
Starting system	Cell starter (with air heater)
Starting motor	12V, 2.5kW
Charging generator	12V 540W
Recommended battery capacity	12V, 88AH

NOTE :

- Specifications are subject to change without notice.

NOTE (FOR E3BG or T-E3BG type):

- Flywheel type is SAE clutch No.11-1/2, SAE clutch No.10 or its equivalent.
- Flywheel housing type is SAE No.3 or its equivalent.
- Governor drop is within 5%.
- 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.

Model	V3600-T-E3BG
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	98 × 120 (3.86 × 4.72)
Total displacement L(cu.in.)	3.620 (220.9)
Combustion type	Spherical type (E-TVCS)
SAE NET Continuous kW / min^{-1}(rpm)	39.2/1800 (52.5/1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	32.1/1500 (43.0/1500)
SAE Standby kW / min^{-1}(rpm)	43.1/1800 (57.8/1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	35.3/1500 (47.3/1500)
Maximum bare speed min^{-1}(rpm)	1890
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	13.93 (142, 2020)
Injection timing (Before T.D.C.)	0.09 rad (5°)
Compression ratio	21.8
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	769 × 539 × 803 (30.28 × 21.22 × 31.61)
Dry weight kg (lbs.)	283 (624)
Starting system	Cell starter (with air heater)
Starting motor	12V, 3.0kW
Charging generator	12V 540W
Recommended battery capacity	12V, 88AH

NOTE :

- Specifications are subject to change without notice.

NOTE (FOR E3BG or T-E3BG type):

- Flywheel type is SAE clutch No.11-1/2, SAE clutch No.10 or its equivalent.
- Flywheel housing type is SAE No.3 or its equivalent.
- Governor drop is within 5%.
- 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.

Model	V3800-DI-T-E3BG
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	100 × 120 (3.94 × 4.72)
Total displacement L(cu.in.)	3.769 (230)
Combustion type	Direct injection type (E-CDIS)
SAE NET Intermittent kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	—
SAE NET Continuous kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	48.0 / 1800 (64.4 / 1800)
SAE Standby kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	52.8 / 1800 (70.8 / 1800)
Maximum bare speed min^{-1}(rpm)	1800
Maximum bare idling speed min^{-1}(rpm)	—
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	First opening pressure 18.63 (190, 2275) Second opening pressure 23.54 (240, 3128)
Injection timing (Before T.D.C.)	0.11 rad (6.5°)
Compression ratio	19.0
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	768.6 × 535.5 × 797 (30.26 × 21.08 × 31.38)
Dry weight kg (lbs.)	290 (639.3)
Starting system	Cell starter (with air heater)
Starting motor	12V, 3.0kW
Charging generator	12V, 540W
Recommended battery capacity	12V, 88AH

NOTE :

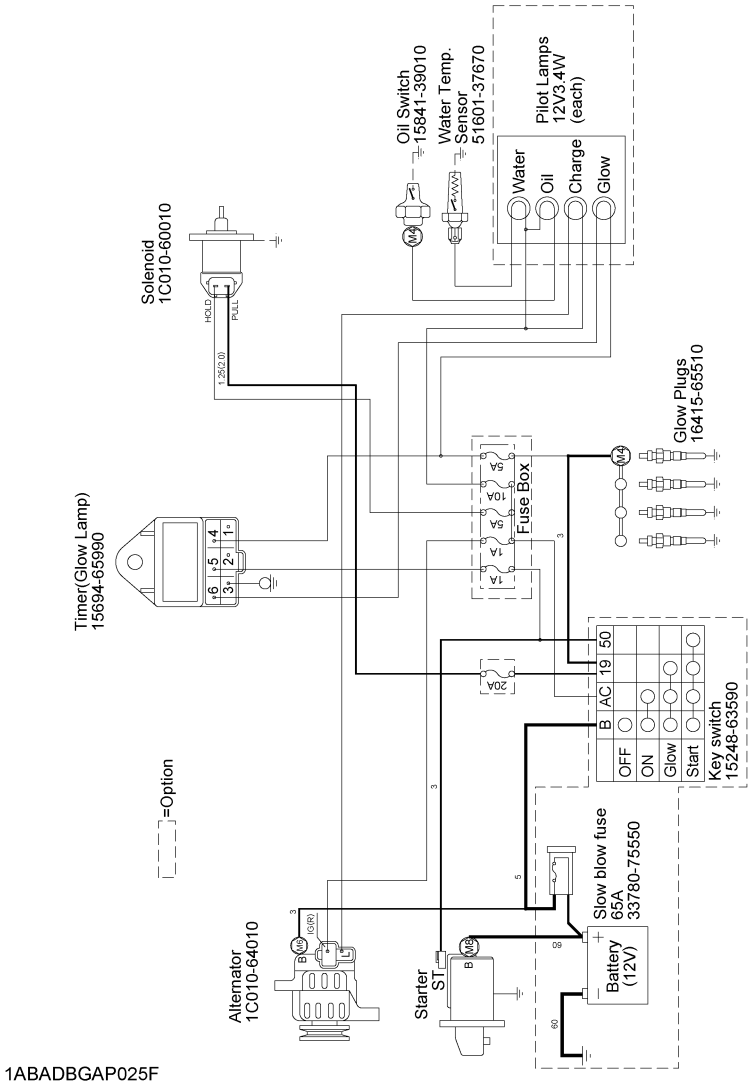
- Specifications are subject to change without notice.

NOTE (FOR E3BG or T-E3BG type):

- Flywheel type is SAE clutch No.11-1/2, SAE clutch No.10 or its equivalent.
- Flywheel housing type is SAE No.3 or its equivalent.
- Governor drop is within 5%.
- 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.

WIRING DIAGRAMS

■**V3600-E3, V3600-T-E3, V3300-E3BG, V3600-T-E3BG**



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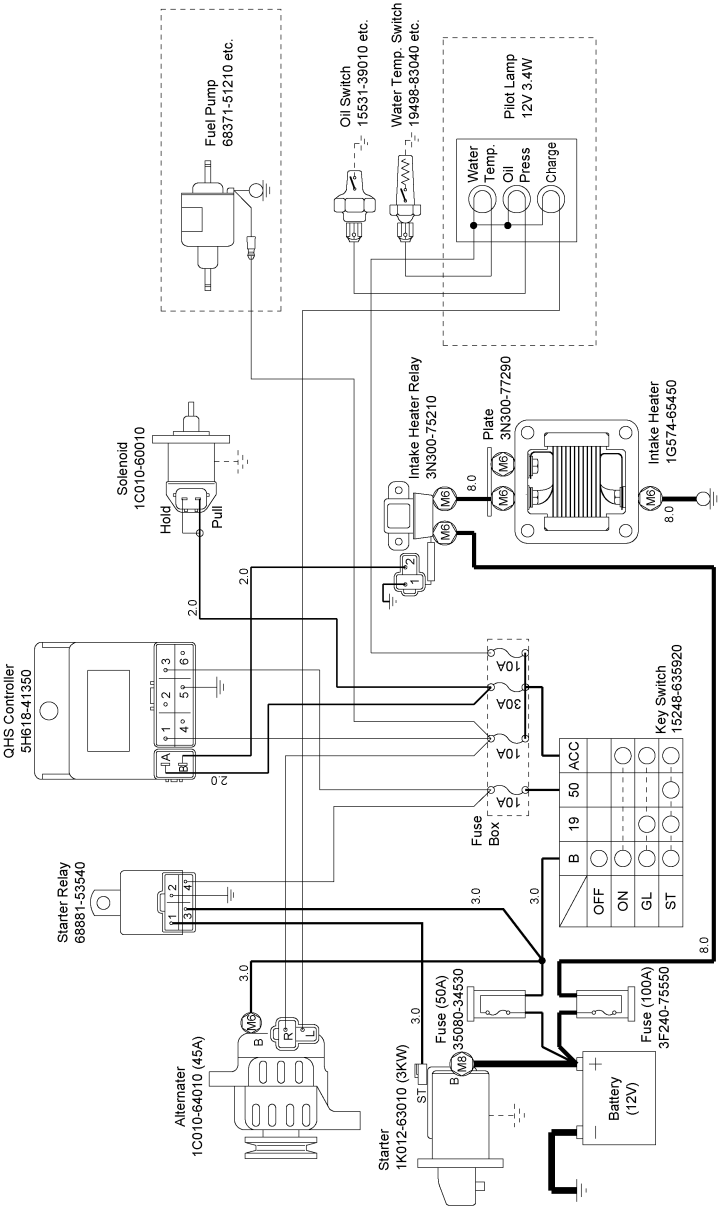
ENGLISH

■V3800-DI-T-E3



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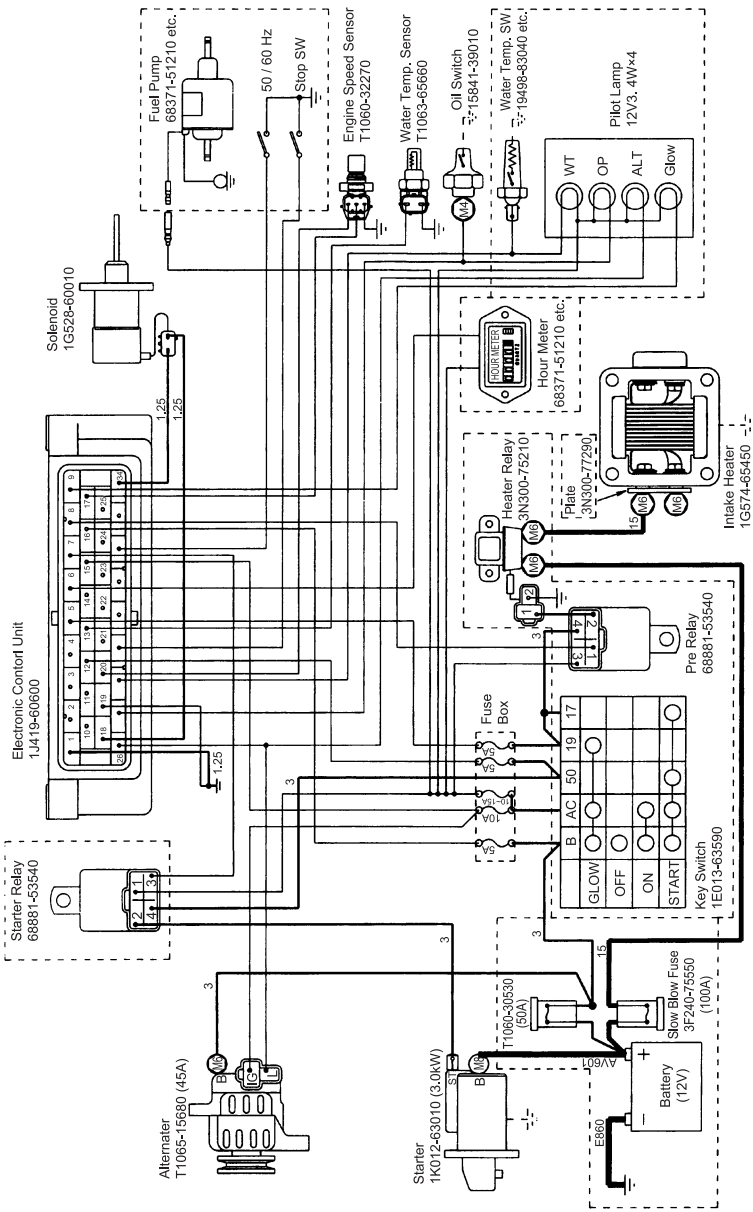
■V3800-DI-T-E3BG



※The parts boxed in [ ] are reference. NOT equipped for standard eigine spec.
※Non marked wire SQ is 0.85~1.25mm² (AWG#18~16).
※Use heatproof cables, if room temperature around wire harness become over 167°F (75°C).

KUBOTA ENGINE AMERICA CORPORATION
LIMITED WARRANTY ON INDUSTRIAL ENGINES
AND REPLACEMENT PARTS EFFECTIVE JANUARY 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.

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 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.

Engine Controls

Anchorage:
7780 Old Seward Hwy
Anchorage, AK 99518
(907) 341-2250 | (877) 341-2250

Fairbanks:
1919 Van Horn Road
Fairbanks, AK 99701
(907) 458-9049 | (888) 868-9049

Seattle:
17660 W. Valley Hwy
Tukwilla, WA 98188
(425) 251-6119

Williston:
5064 Bennett Loop
Williston, ND 58801
(701) 774-5312

Equipment Source, Inc.

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DSEGenset

DSE

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

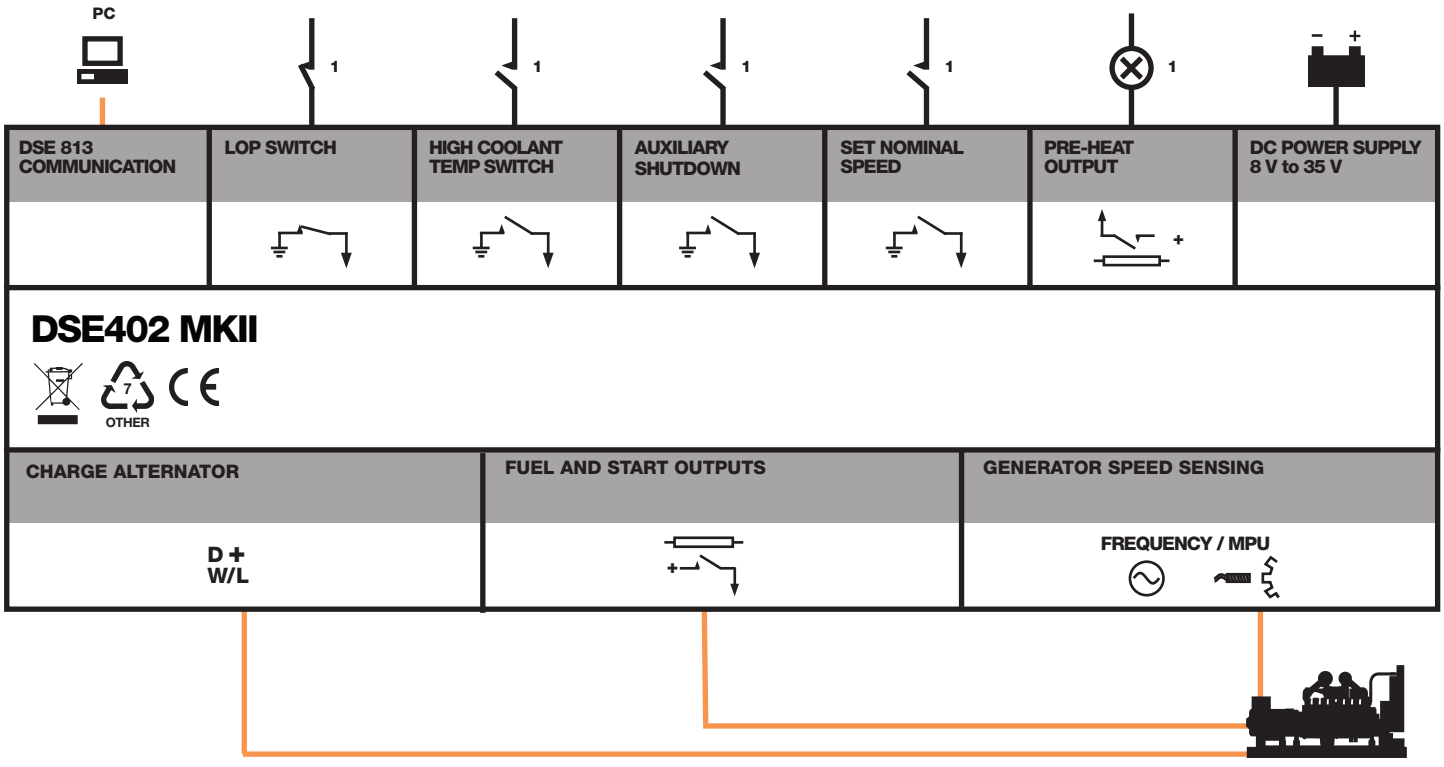
VIBRATION
BS EN 60068-2-6
Ten sweeps in each of three major axes
5Hz to 8Hz @ +/-7.5mm, 8Hz to 500Hz @ 2gn

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



IPC MEMBER
ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES®

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

DEEP SEA ELECTRONICS PLC UK
Highfield House, Hunmanby Industrial Estate, Hunmanby YO14 0PH
TELEPHONE +44 (0) 1723 890099 **FACSIMILE** +44 (0) 1723 893303
EMAIL sales@deepseaplc.com **WEBSITE** www.deepseaplc.com

DEEP SEA ELECTRONICS INC USA
3230 Williams Avenue, Rockford, IL 61101-2668 USA
TELEPHONE +1 (815) 316 8706 **FACSIMILE** +1 (815) 316 8708
EMAIL sales@deepseausa.com **WEBSITE** www.deepseausa.com

Registered in England & Wales No.01319649
VAT No.316923457

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DEEP SEA ELECTRONICS PLC
DSE402 MKII WATERPROOF KEYSTART CONTROLLER

Document number 057-137

Author : Paul Gibbons

Deep Sea Electronics Plc
Highfield House
Hunmanby
North Yorkshire
YO14 0PH
ENGLAND

Sales Tel: +44 (0) 1723 890099
Sales Fax: +44 (0) 1723 893303

E-mail: sales@deepseaplc.com
Website: www.deepseaplc.com

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.

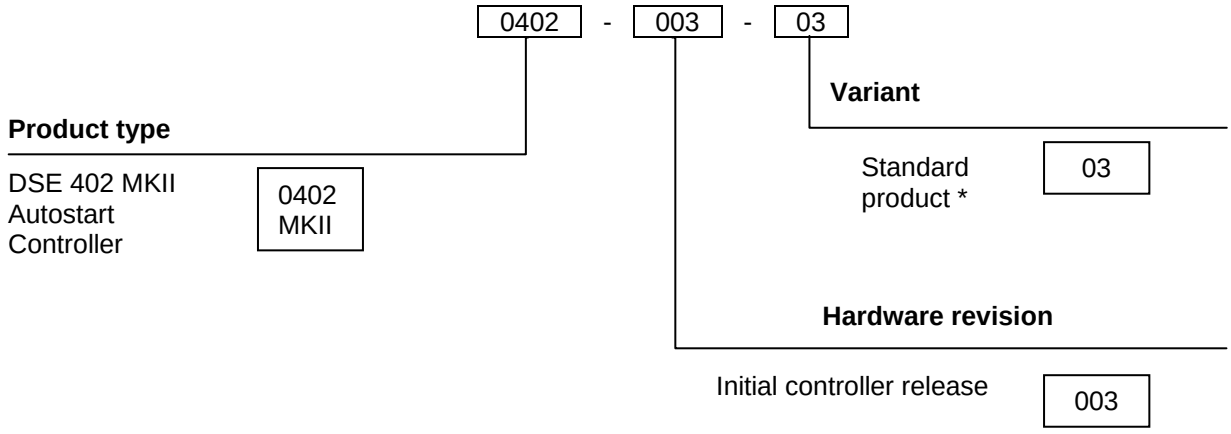
The Model 402 as described above can be configured for (AUTO), when the key position is left in RUN (I) a remote switch can be operated away from the controller to start and stop the engine.

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)

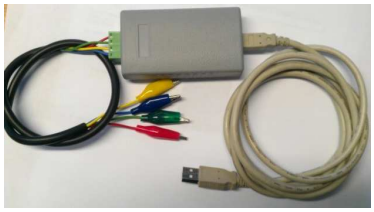
4.1.1 PC COMMUNICATION

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

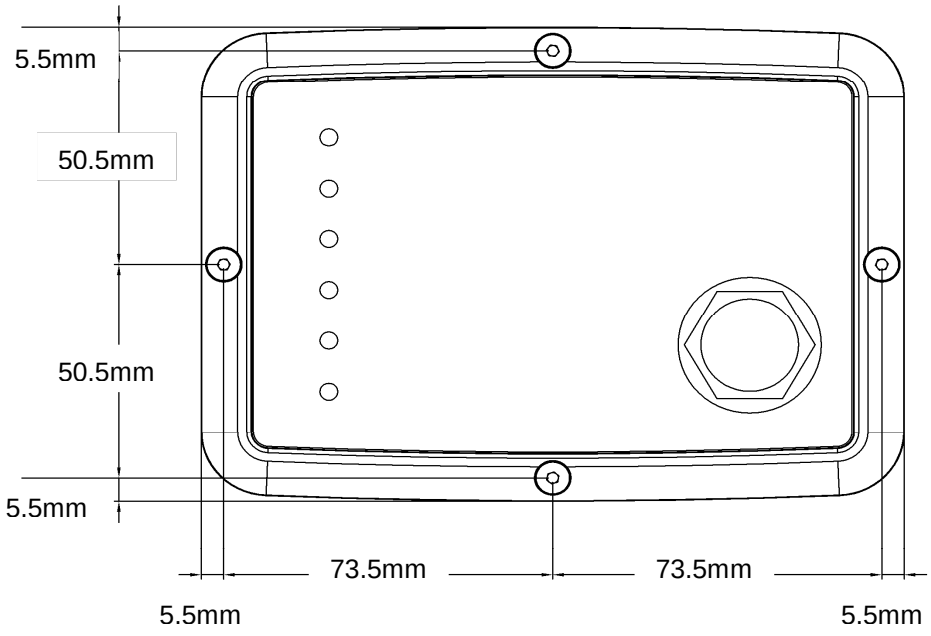
PANEL CUTOUT
132 mm x 84 mm
(5.2” x 3.3”)

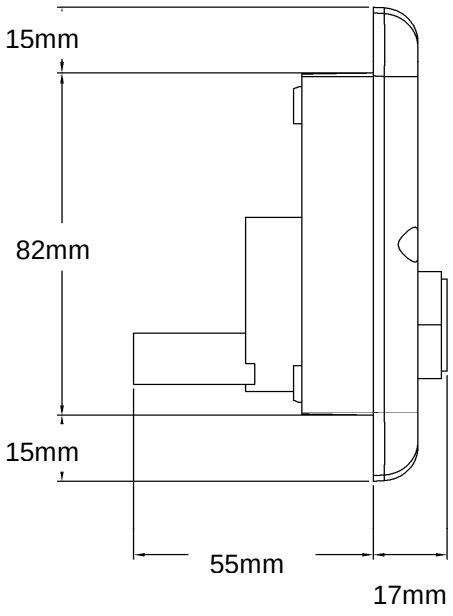
Mounting
Waterproof sealing gasket for details see elsewhere in this manual.

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

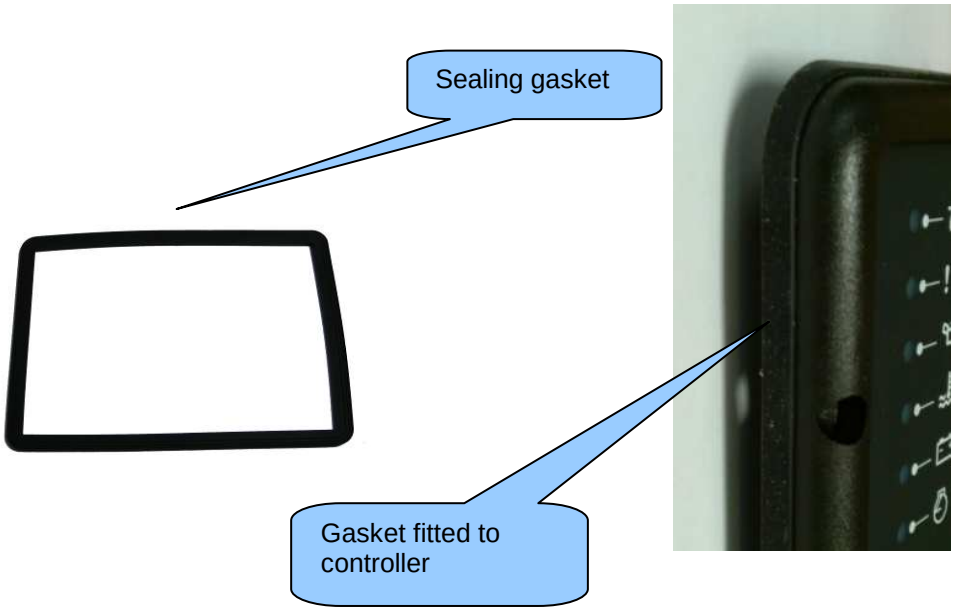
WEIGHT
0.3 Kg (0.661 lb)





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

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

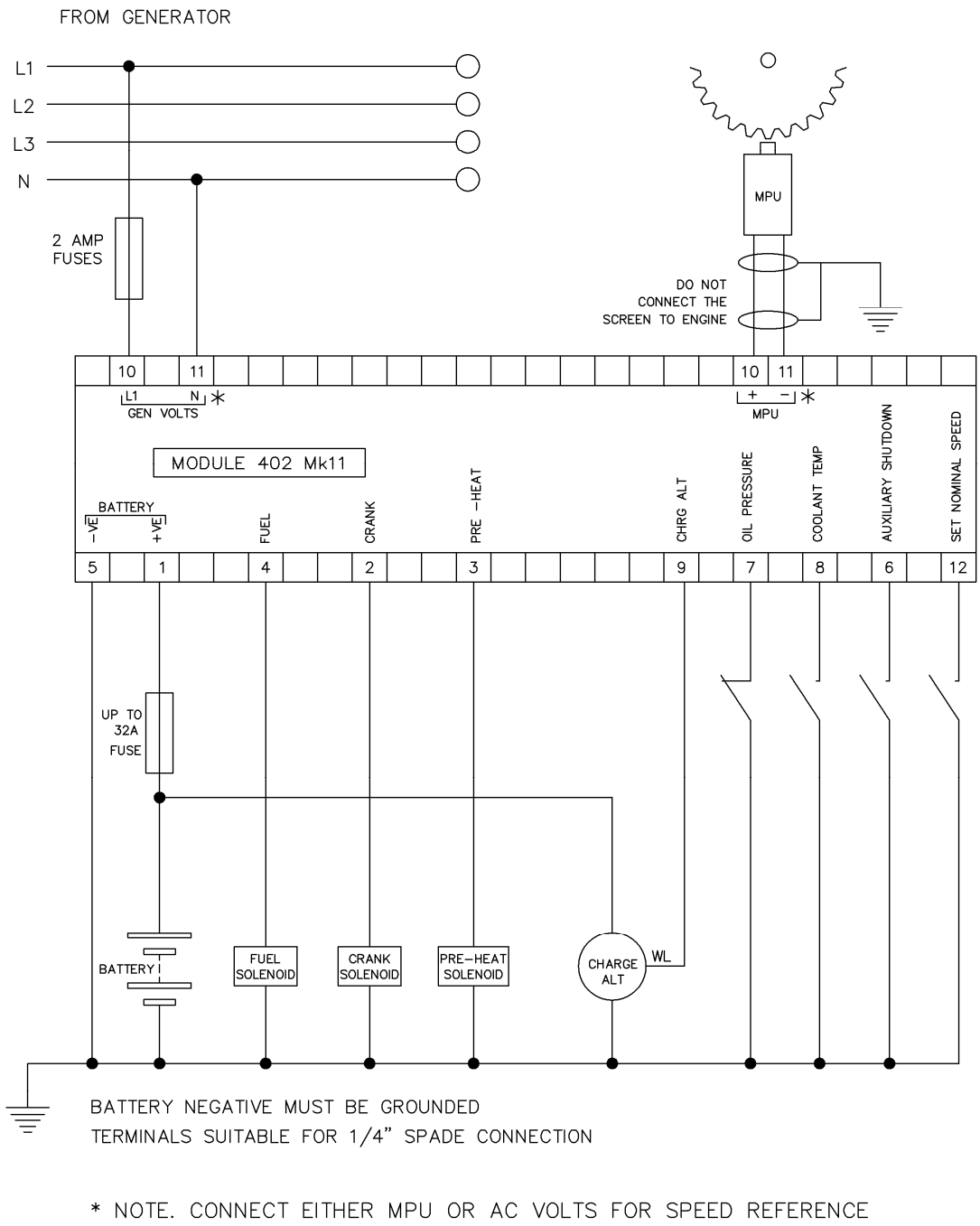
NOTE: - If you use PTFE insulating tape on the Oil pressure or Temperature switch thread when using earth return switches, ensure you do not insulate the entire thread, as this will prevent the switch body from being earthed via the engine block.

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

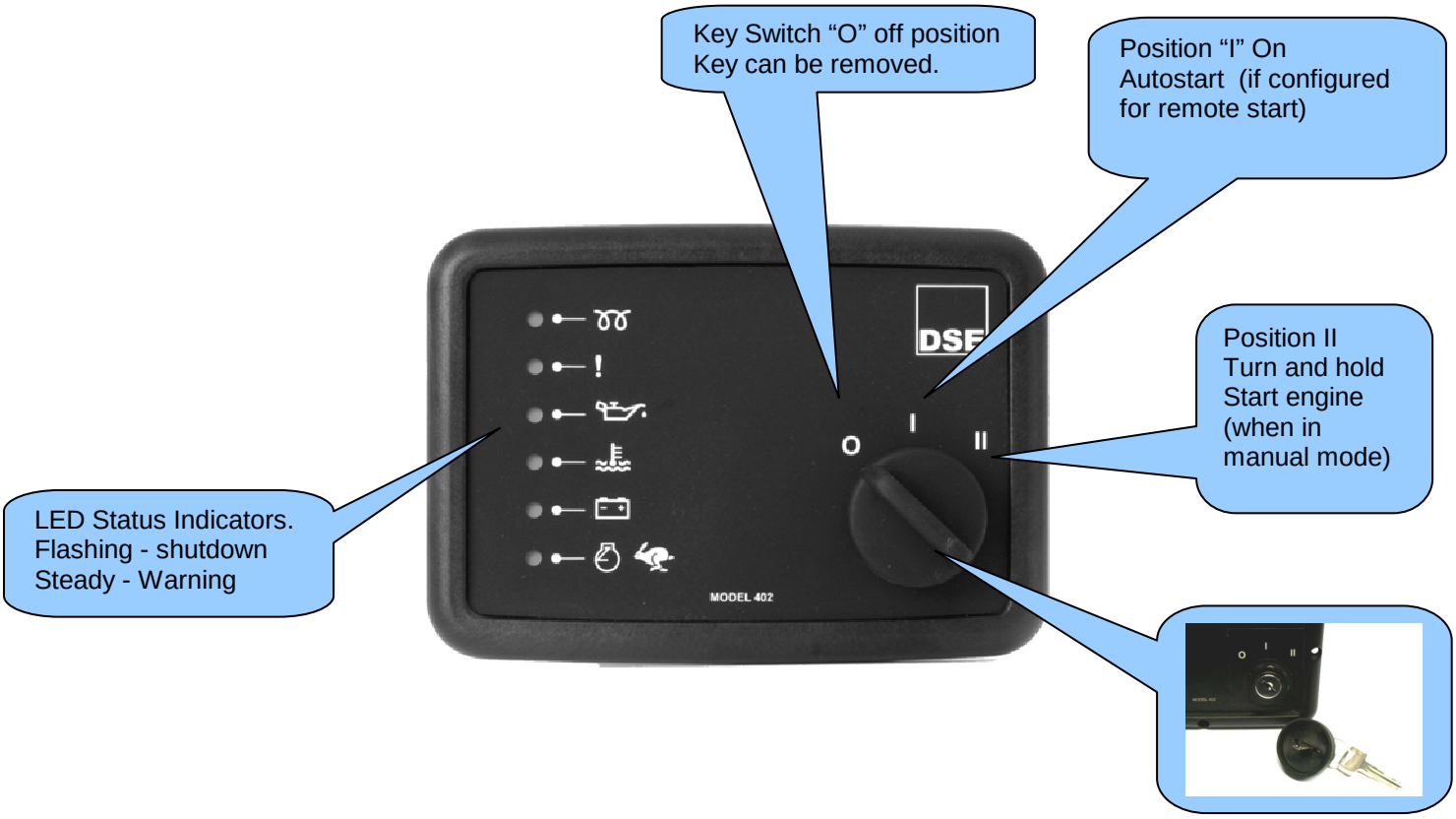
Where neither the battery positive nor battery negative terminals are connected to earth the following points must to be followed

- 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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Hourmeters

ETM-97030B
Revised 11-01
Catalog Section 20
(00-02-0259)

CE*

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.

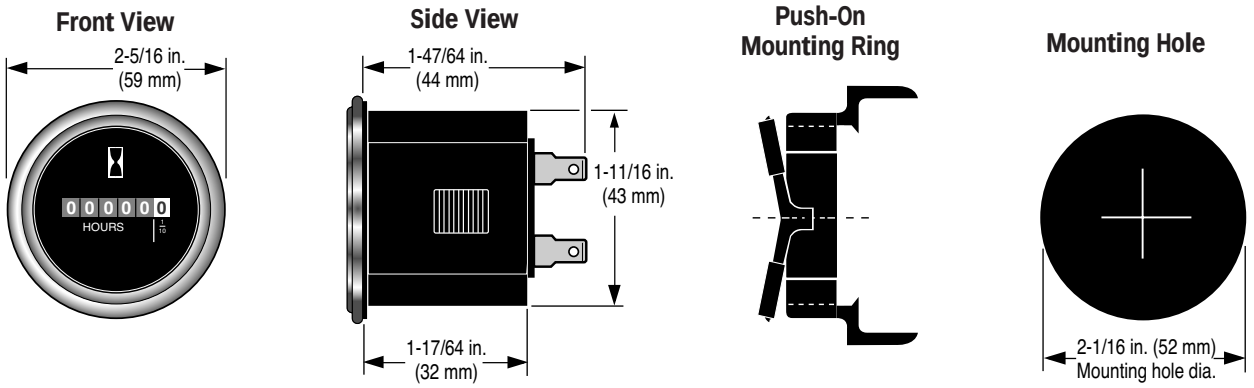
Warranty

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

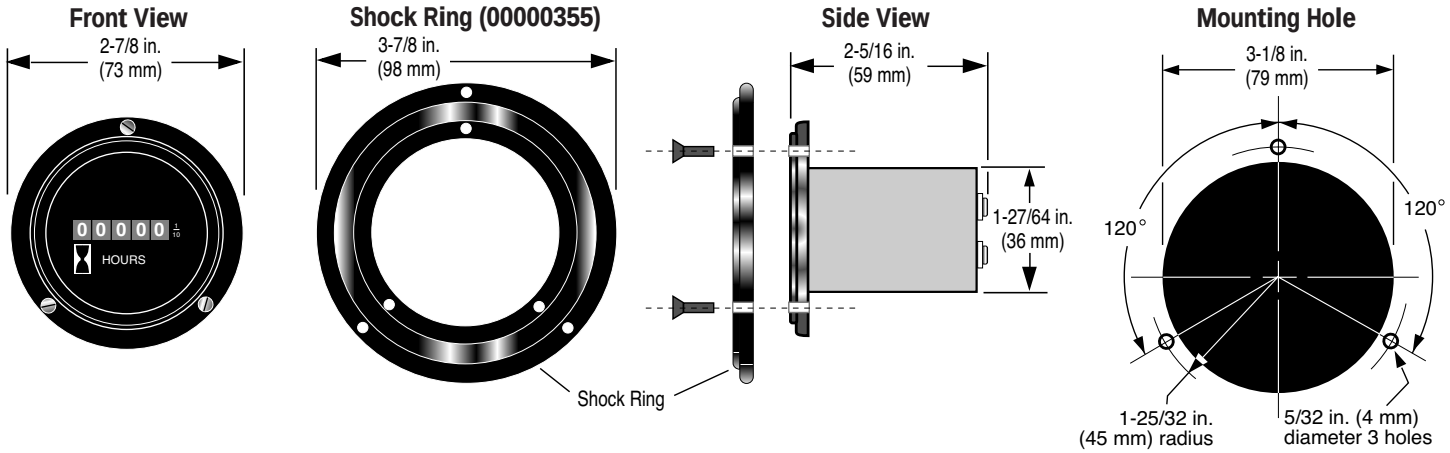
* Products covered by this bulletin comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted. The CE mark does not apply to the TM612 and TM624 models.

MURPHY®

TM4592–TM4595 Models

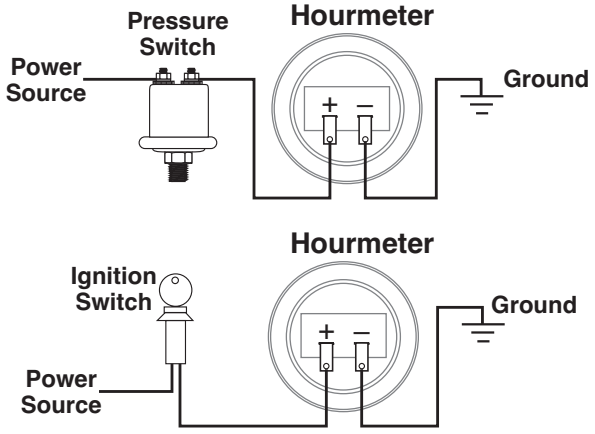


TM612/624 Model with Shock Ring



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

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).

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.

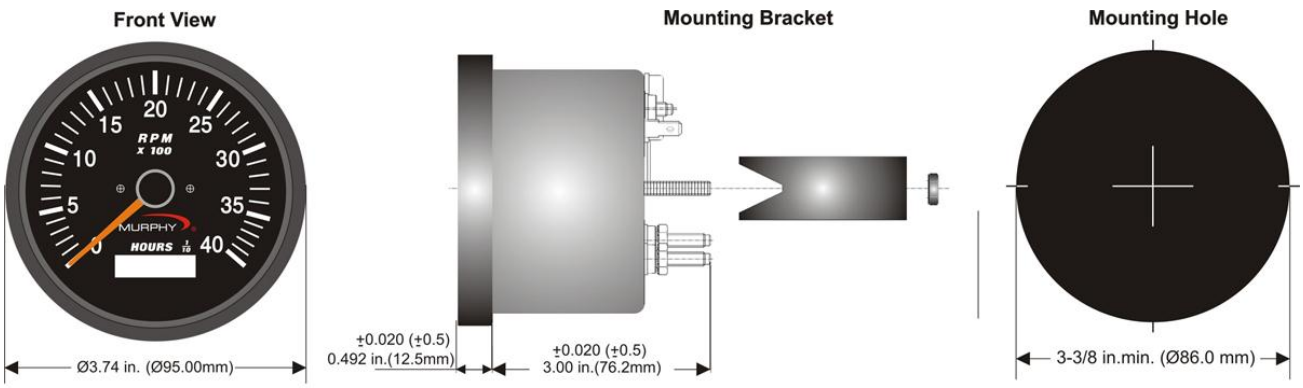


Figure 1

Mounting Requirements

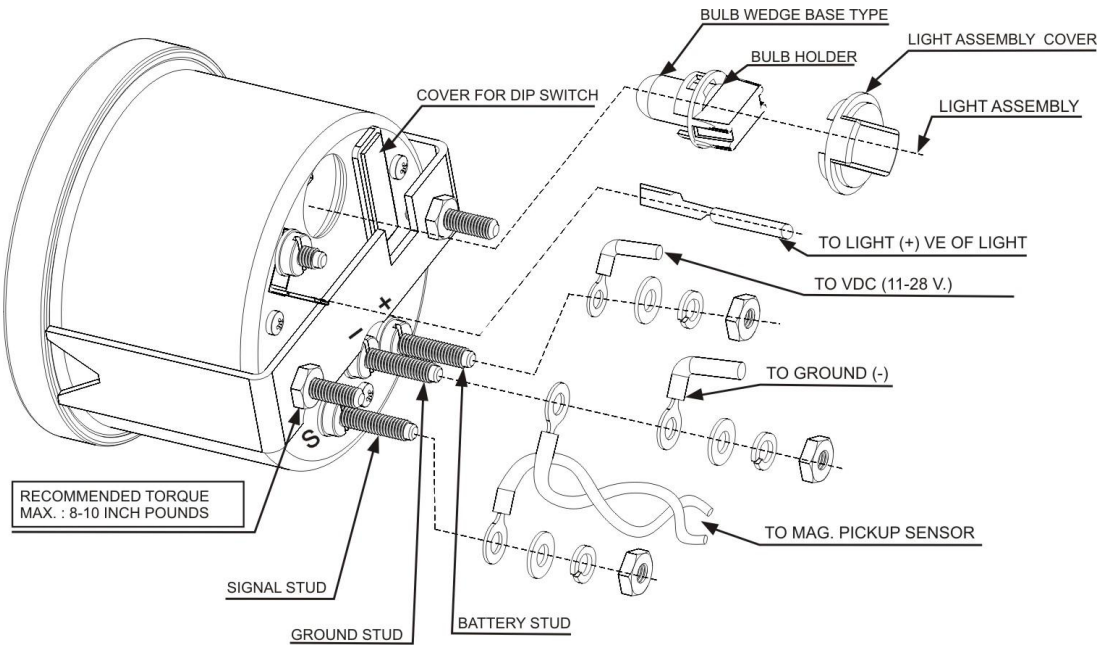


Figure 2 - Back of AT TACH

Tools and Supplies Required for Installation

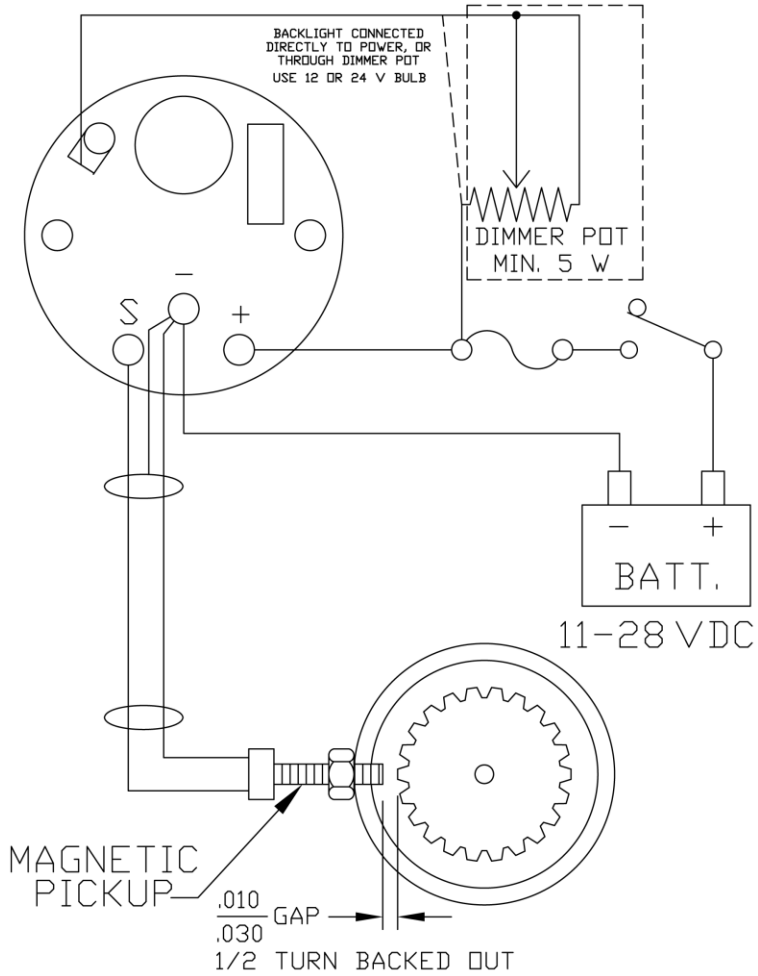
1.	11/32” and 3/8” Nut Drivers
2.	Wire Cutting & Stripping Tool
3.	Wire terminal Crimping Tool
4.	#10 crimp on ring terminals, and Faston™ or slip-on crimp terminals (for backlight)

Connection Instructions

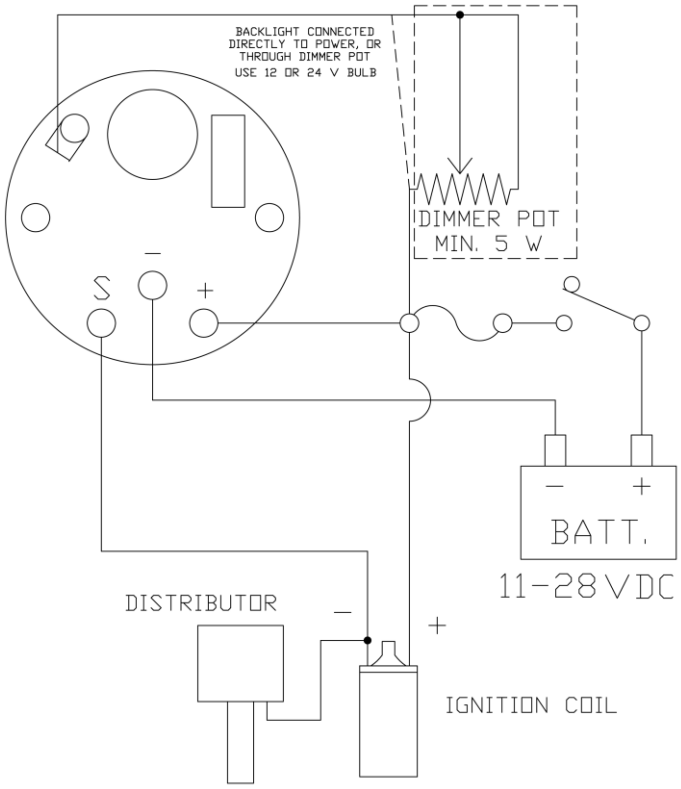
CAUTION: For safety of both personnel and equipment, disconnect the battery/power source before beginning installation.

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.

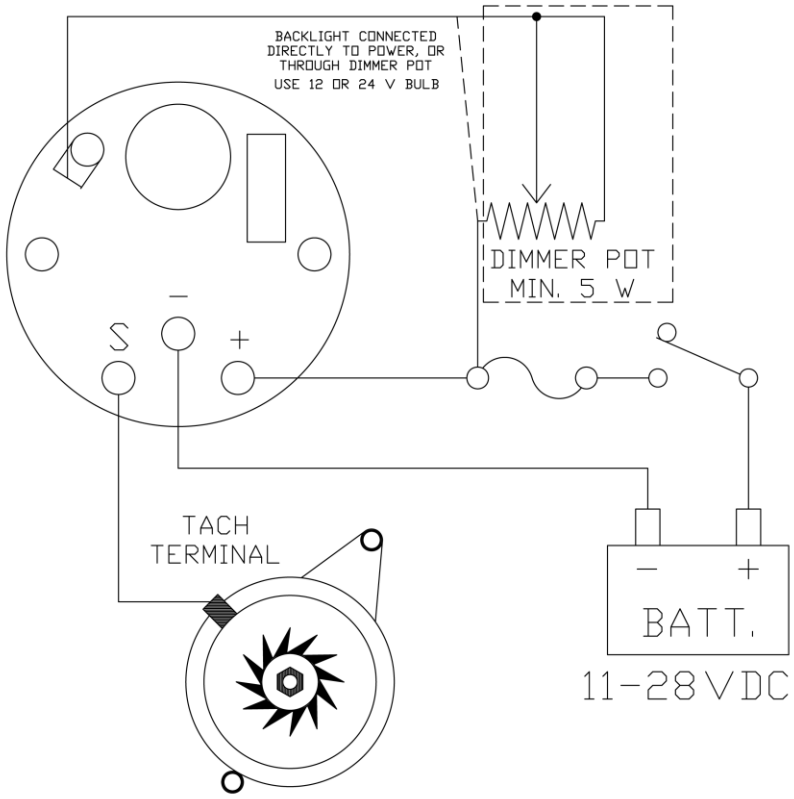
Typical Wiring Diagrams – Hookup for Magnetic Pickup



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.

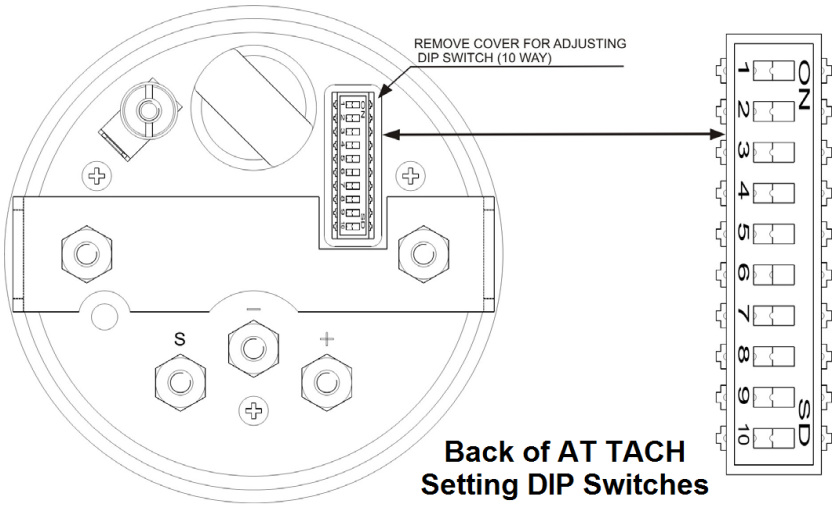


FIGURE 3

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:

$$\frac{\text{NUMBER OF POLES}}{2} \times \text{PULLEY RATIO} = \text{PULSES PER ENGINE REVOLUTION}$$

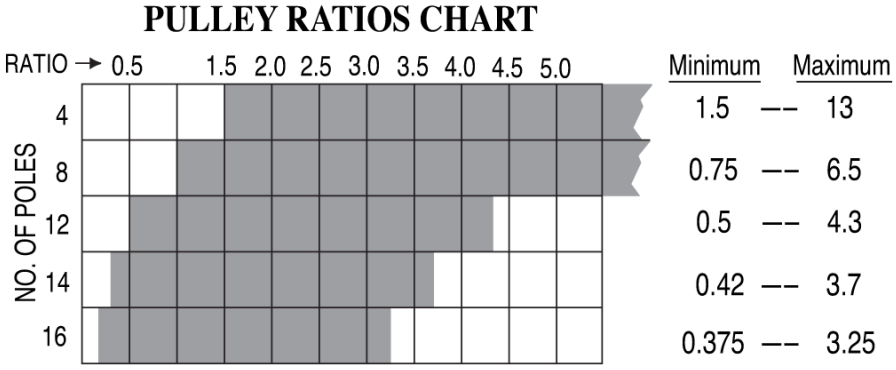
5. If the Pulses per engine revolution is determined, then set the calibration "through selector/dip switches" (See Fig. 3 in the section: Calibration Instructions, Magnetic Sensor Driven Models).

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 not 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

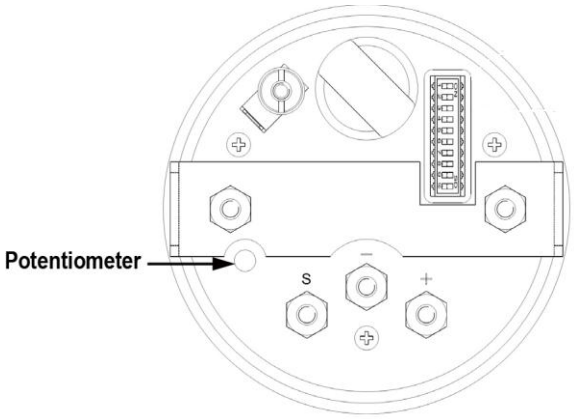
4-Cycle Engines	No. of Pulses per Engine Revolution	Decimal Equivalent	Binary of Decimal Equivalent Dip Switch Position		
			D1	D2	D3
2 cylinder	1	1	1	0	0
4 cylinder	2	2	0	1	0
6 cylinder	3	3	1	1	0
8 cylinder	4	4	0	0	1
10 cylinder	5	5	1	0	1

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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FW MURPHY
5311 South 122nd East Avenue
Tulsa, Oklahoma 74146 USA
Phone: +1 918 317 4100 Fax: +1 918 317 4266
E-mail: sales@fwmurphy.com
Website: www.fwmurphy.com

ECONTROLS, INC.
5757 Farinon Drive
San Antonio, Texas 78249 USA
Phone: +1 210 495 9772 Fax: +1 210 495 9791
E-mail: info@econtrols.com
Website: www.econtrols.com

FWM INDUSTRIAL PANEL DIVISION
5311 South 122nd East Avenue
Tulsa, Oklahoma 74146 USA
Phone: +1 918 317 4100 Fax: +1 918 317 4124
E-mail: ipdsales@fwmurphy.com
Website: www.fwmurphy.com

USA-ISO 9001:2008 FM 28221
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Registered Facilities

FRANK W. MURPHY, LTD.
Church Road, Laverstock
Salisbury, SP1 1QZ, UK
Phone: +44 1722 410055 Fax: +44 1722 410088
E-mail: sales@fwmurphy.co.uk
Website: www.fwmurphy.co.uk

FW MURPHY INSTRUMENTS (HANGZHOU) CO., LTD.
77 23rd Street
Hangzhou Economic & Technological Development Area
Hangzhou, Zhejiang, 310018, China
Phone: +86 571 8788 6060 Fax: +86 571 8684 8878
E-mail: apsales@fwmurphy.com
Website: www.fwmurphy.com/company_ch

FW MURPHY (LATIN AMERICA & CARIBBEAN)
Apdo. Postal 2-06, Admon "Lomas"
Cord. Arakán 606-16, Lomas 4ª Secc.
78211 San Luis Potosí, S.L.P. – México
Phone: +1 918 317 2500
E-mail: lasales@fwmurphy.com
Website: www.fwmurphy.com

FW MURPHY (INDIA)
230, Regus, Connaught Place Centre
Bund Garden Road, Pune 411001
Maharashtra State, India
Phone: +91 915 813 7633
E-mail: indiasales@fwmurphy.com
Website: www.fwmurphy.com

COMPUTRONIC CONTROLS
41 - 46 Railway Terrace
Nechells, Birmingham, B7 5NG, UK
Phone: +44 1722 410055
Fax: +44 1722 410088
E-mail: sales@computroniccontrols.com
Web site: www.computroniccontrols.com

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Accessories

Anchorage:
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Anchorage, AK 99518
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Fairbanks:
1919 Van Horn Road
Fairbanks, AK 99701
(907) 458-9049 | (888) 868-9049

Seattle:
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Williston:
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Williston, ND 58801
(701) 774-5312

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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

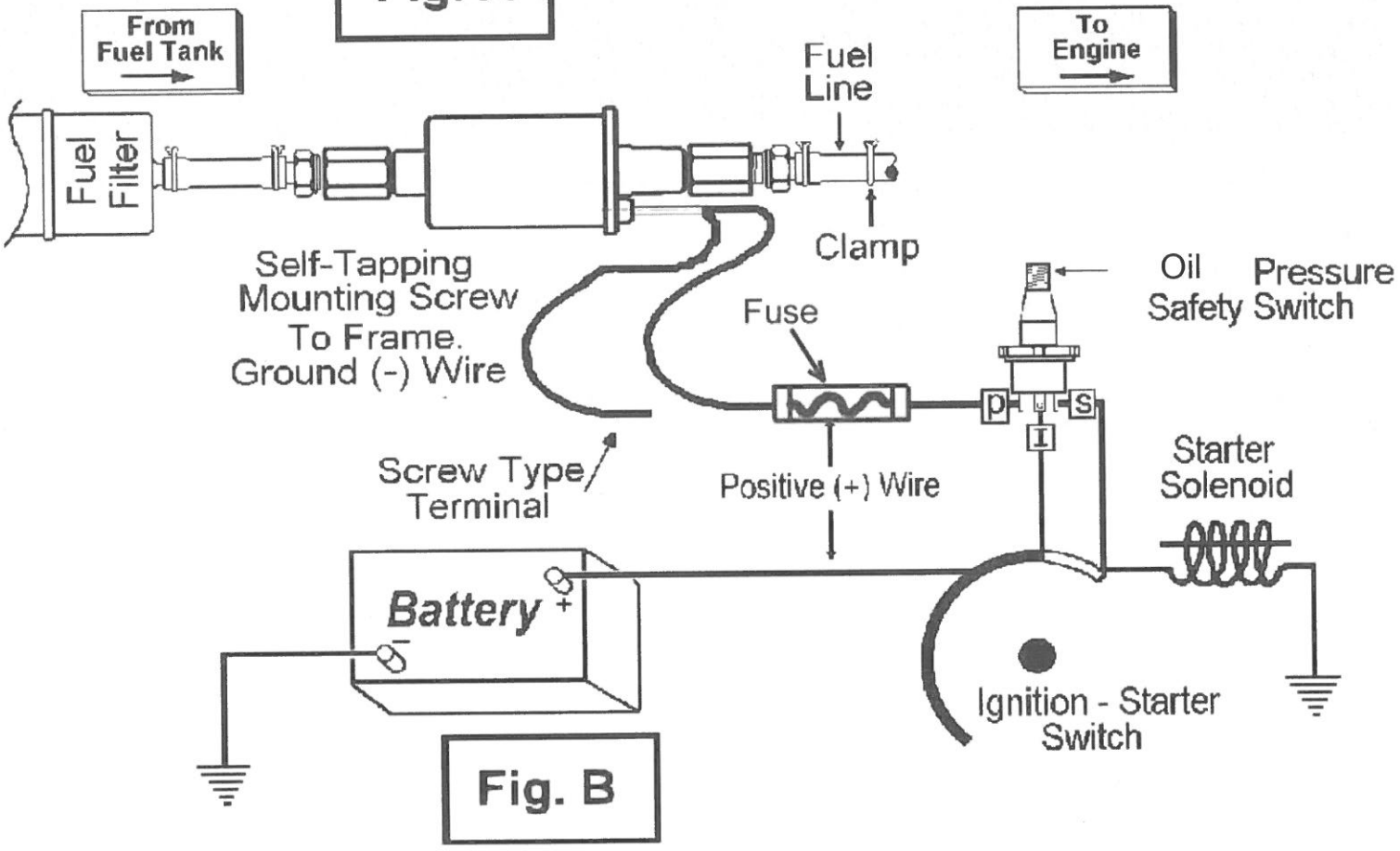
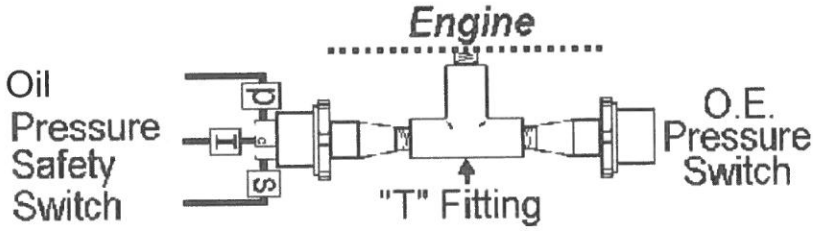

From Fuel Tank
To Engine
Fuel Line
Fuel Filter
Clamp
Self-Tapping Mounting Screw To Frame. Ground (-) Wire
Fuse
Oil Pressure Safety Switch
p
s
I
Screw Type Terminal
Positive (+) Wire
Starter Solenoid
Battery
+
-
Ignition - Starter Switch

Fig. B


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

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Notes