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PROJECT : **CONSTRUCTION OF NANISIVIK NAVAL FACILITY, NU**			**Submittal NO.**	**SUB-ALM-DCC-560**		
OWNER : **DEFENCE CONSTRUCTION CANADA**			**Revision NO.**	0	**Date:**	2020-10-05
			Revision NO.		**Date:**	
PROJECT NO. : **NPO1301**	CONTRACT NO. : **55668 CN**	OUR FILE NO. : **148926**	**Revision NO.**		**Date:**	
			Revision NO.		**Date:**	

DISCIPLINE :

CONTRACTOR /SUB-CONTRACTOR :	
Almiq Contracting LTD 1340, Ulu Lane, PO Box 2140 Iqaluit (NU) X0A 0H0	
Person in Charge : Jean Drapeau *Phone : 418-668-3321.235* *Fax :*	
MANUFACTURER :	**SUPPLIER :**
Person in Charge : *Phone :* *Fax :*	Person in Charge : *Phone :* *Fax :*
SHOP DRAWINGS, PRODUCT DESCRIPTION OR SAMPLE SUBMITTED FOR APPROVAL:	**SPECS REFERENCE :**
Tank Farm – Emergency and Spill Response Plan - Almiq	

NOTES : Emergency and spill response plan to cover tank farm prior to transfer to DCC/DND.

We declare that we have verified the attached documents and/or sample, that they are in compliance with the contract documents and are approved for the construction of the project.

Jean Drapeau, Project Manager

Contractor's Representative

Jean Drapeau, ing.

Signature numérique de Jean Drapeau, ing.
DN : cn=Jean Drapeau, ing., o=Groupe LFL Group, ou=Gestionnaire de projets - Project Manager, email=jdrapeau@lavalfortin.com, c=CA
Date : 2020.10.05 16:09:23 -04'00'

Signature

2020-10-05

Date

NANISIVIK NAVAL FACILITY TANK FARM

EMERGENCY AND SPILL RESPONSE PLAN

CONSTRUCTION AND COMMISSIONING PHASE

Rev.00

Prepared by **Almiq Contracting Ltd.**

September 30, 2020

REVISIONS

IT: ISSUE TYPE

A – PRELIMINARY **C** – FOR INFORMATION **E** – FOR CONSTRUCTION/COMMISSIONING **G** – AS BUILT
B – FOR APPROVAL **D** – FOR QUOTATION **F** – AS PURCHASED **H** – CANCELLED

Rev.	IT	Description	By	Ckd.	Appr.	Date
00	E	Emergency and Spill Response Plan	Almiq, Progesys			2020-09-30

TABLE OF CONTENTS

1 OVERVIEW

1.1 Objective and Scope

This Emergency and Spill Response Plan (ESRP) has been prepared to provide personnel with strategies and information required when contending with emergency and spills caused by the Nanisivik Naval Facility (NNF) Tank Farm. The Tank Farm includes two (2) Naval Distillate Tanks and two (2) Diesel Fuel Tanks and the associated piping. The plan includes methods of prevention and preparedness, action plan, clean-up, reporting and training in the eventuality an emergency or a spill occurrence.

The Plan is to be implemented by the General Construction Contractor of the NNF during the construction and the commissioning of the facility. Fuel transfer above water, between a vessel and the piping manifold is **excluded** from this plan (it will be included in the ESRP for operation).

Appendix 1 contains a list of Acronyms and Abbreviations used in this plan.

1.2 ESRP Location and Review

The ESRP must be available at all time and an updated version is kept in the following locations:

- Construction Office Trailer (hard and soft copy on the computer)
- Almiq Office Project Manager Office (hard and soft copy on the project folder)
- Wharf Operation Shelter (hard and soft copy on the computer)
- DND Site Office (hard copy)

This plan is a live document which should be revisited and updated periodically as determined by the General Construction Contractor. Any changes to this plan are to be reviewed with all site personnel and stakeholders ahead of the seasonal startup.

1.3 Nanisivik Naval Facility Site Description

The NNF includes a Naval Distillate (ND) bulk liquid storage system and a diesel fuel storage system each with spill containment. Other site amenities include the control systems, fuel transfer pipelines between the wharf and fuel storage tank, pumps, power generation, distribution systems, a Suspended Span Wire Fuelling System (SSF) and fire detection and protection systems. Refer to section 2.3 for the detailed DF and ND system description (tank farm).

Support buildings available at the facility are a General Use Storage Building (GUSB), a Wharf Operator's Shelter (WOS) and the DND Site Office.

NNF is expected to be occupied between mid-June to mid-October. The facility will not be occupied or staffed during the non-navigable season, the shutdown period. Before the shutdown period, the facility is fully winterized. The winterization process consists of removing sensitive electrical components and draining all the piping system in the ND or DF storage tanks. Regular visits are planned for monitoring purposes and to ensure security and environmental protection. Figure 5 illustrates the important environmental and safety equipment in regard to emergency and spill response.

1.3.1 Site Location

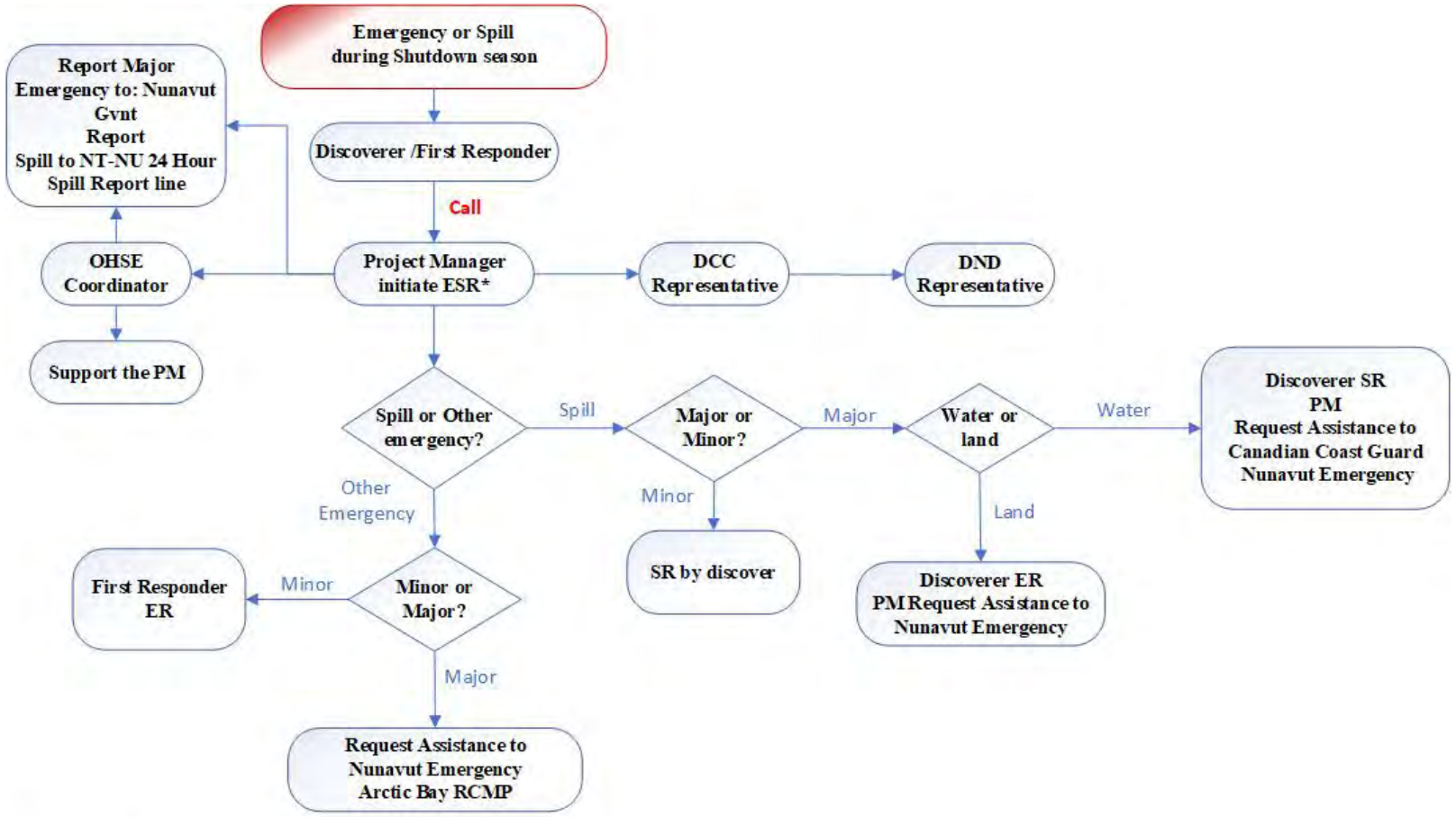
The NNF is located on the northern part of the Borden Peninsula in the Qikiqtaaluk Region of Baffin Island in Nunavut (see Figure 1 for the site location map). The NNF site is located on the southern shoreline of Strathcona Sound, fiord-like arm off Admiralty Inlet, which, in turn, is an arm off Lancaster Sound. The closest city (about 40 km) is Arctic Bay, "Ikpiarjuk" in Inuktitut (meaning the pocket). Arctic Bay's population is about a thousand people. Nyrstar is the mining company that owned the former Nanisivik lead-zinc mine from 1978 to 2002 where the NNF site is currently located.

Figure 1: NNF Location

Figure 2: NNF site view from water

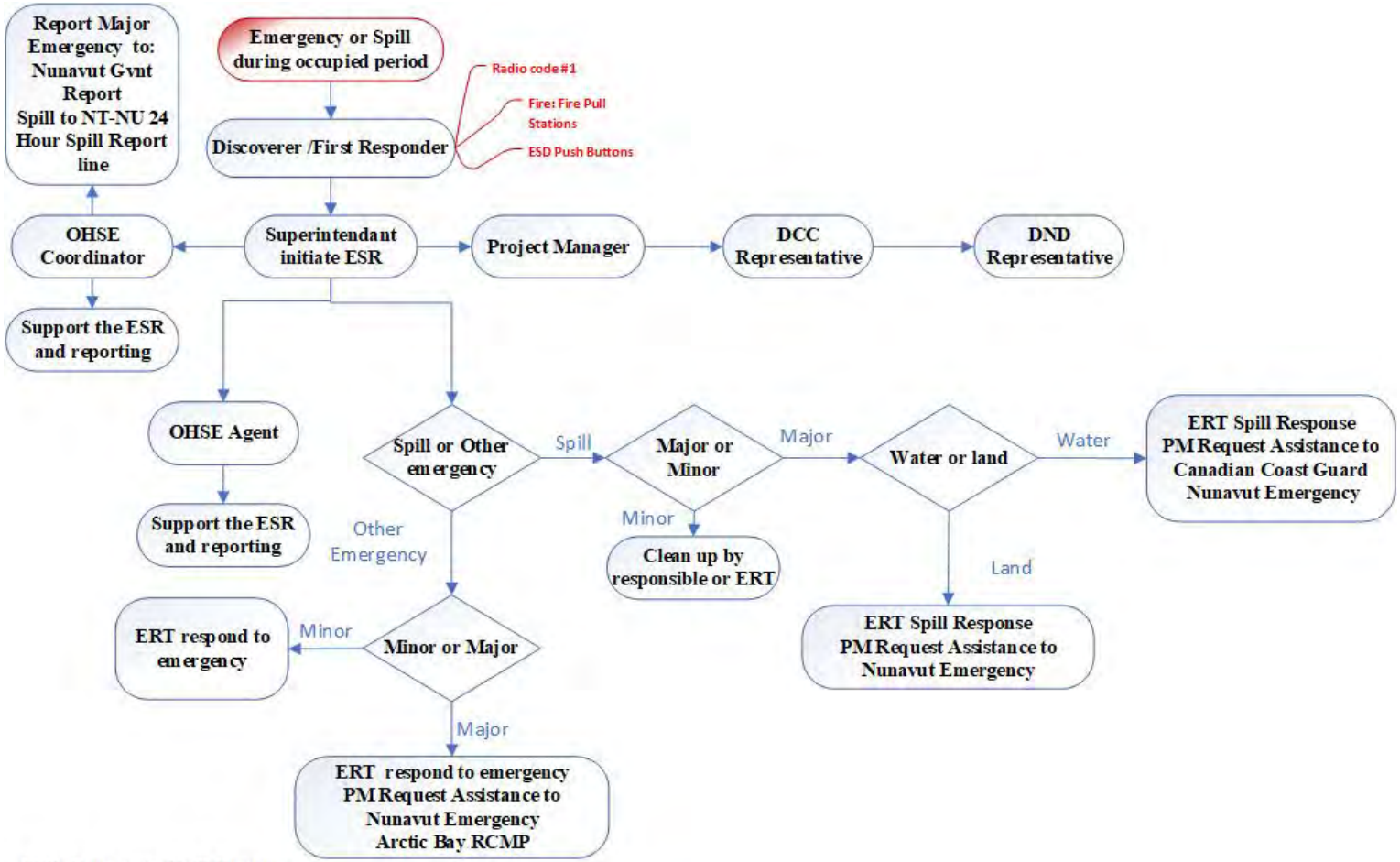
1.4 Communication

1.4.1 Emergency and Spill Communication Flow Charts



ESR: Emergency/Spill Response
ERT: Emergency Response Team (not available during shutdown period)
OHSE: Occupational, Health, Safety and Environment
PM: Project Manager
Minor Spill or Emergency: can be handle without external assistance
Major Spill or Emergency: required external assistance

Figure 3: Emergency or Spill Response Flow Chart during Shutdown Period



ESR: Emergency/Spill Response
ERT: Emergency Response Team
OHSE: Occupational, Health, Safety and Environment
PM: Project Manager
Minor Spill or Emergency: can be handle without external assistance
Major Spill or Emergency: required external assistance to be handle

Figure 4: Emergency or Spill Response Flow Chart during Occupied Period

1.4.2 Emergency Notification and Contacts

The radio code (#1) is used as an uninterrupted radio channel for direct communication with the responsible superintendent/project manager in case of an emergency.

All buildings and Site vehicles will contain the list of emergency numbers (radio code, person in charge and NNF Office).

All team leaders (foreman) and vehicles must have a two-way radio.

Important emergency contacts are listed in the tables below.

1.4.3 Owner, Person in charge or Management

In the event of an emergency or spill, the following person must be contacted as soon as possible:

Title	Name	Address	Contact
General Contractor Project Manager	**Jean Drapeau**	130, Notre-Dame Ouest Alma (Qc), G8B 2K1	During site occupancy and during the shutdown period. On site (by radio) available 24 hours jdrapeau@almiq.com Work: 418-668-0175 x235 Off site Cell: 418-720-9753 available 24 hour
Superintendent	**Richard Néron or his substitute**	130, Notre-Dame Ouest Alma (Qc), G8B 2K1	During site occupancy/construction On site (by radio) available 24 hours rneron@almiq.com Cell: 418-487-8748

1.4.4 Nanisivik Office

Title	Name	Address	Contact
Superintendant	**Richard Néron or his substitute**	NNF	581-318-2997 ext. 1001
Site Medic	**TBD**	NNF	581-318-2997 ext. 1005

1.4.5 OHSE Coordinator and agent

Title	Name	Address	Contact
OHSE Coordinator	**TBD**	130, Notre-Dame Ouest Alma (Qc), G8B 2K1	Work: 418-668-0175
OHSE Agent	**TBD**	130, Notre-Dame Ouest Alma (Qc), G8B 2K1	Work: 418-668-0175

1.4.6 Spill Report

Title	Name	Address	Contact
NT-NU – 24-Hour Spill Report line /ECCC emergencies	Regional Director, Environmental Enforcement Directorate Prairie and Northern Region	Nunavut	Phone: (867) 920-8130 Fax: 867-873-6924 spills@gov.nt.ca

1.4.7 Emergency and Spill Assistance for major emergency or spill

Organization	Assistance for	Contact
Nunavut Emergency Management 24-Hour Line	Major Fire Emergency	1-800-693-1666
Nunavut Emergency Management 24-Hour Line	Major Emergency or Spill	1-800-693-1666
Arctic Bay RCMP	Major Emergency	867-439-1111
Arctic Bay RCMP	General inquiries	867-439-0123
Canadian Coast Guard/ the Marine Communications and Traffic Services (MCTS)	Major Water spill	Spill Report 24- Hour Line: 1-800-265-0237 Iqualuit, NU (may to December) Operations: (867)979-5269 Officer-in-Charge: (867)-979-5260 Prescott, ON (January to April) Operations: (613)-925-4471 Officer-in-Charge: 613-925-0618

1.4.8 DCC and DND

Title	Name	Address	Contact
DCC Project Manager	Eric Andert		873-455-4042 eric.andert@dcc-cdc.gc.ca
DCC Environmental Coordinator	Tamara Van Dyck		613-995-9741 Cell: 613-854-0537 tamara.vandyck@dcc-cdc-gc.ca
DND Project Manager	Rodney Watson		613-761-2604 Cell: 613-761-2604 Rodney.watson@forces.gc.ca

1.4.9 Government Department

Government Department	Contact
Government of Nunavut – Department of Environment, Manager of Environmental Protection	867-975-7748
Environment Canada – Enforcement Branch	867-975-4644
Department of Fisheries and Oceans Canada	867-979-6274

1.4.10 Arctic Bay Contact

Name	Address	Phone
Arctic Bay Health Centre	Arctic Bay, NU X0A 0A0	(867) 439-8816 (24 Hours)
Qikiqtani General Hospital	503 Saputi, Iqaluit, NU X0A 0H0, Canada	(867) 975-8600 (24 Hours)
Airport	Arctic Bay	(867)-439-3000
COOP	Arctic Bay	(867)-439-9934
Hotel (Tangmaarvik Inn)	Arctic Bay	(867)-439-8005
TAXI	Arctic Bay	(867)-439-8352

1.4.11 Airline company

Name	Description	Phone
Canadian North	Offer Flight services from Arctic Bay	1-800-267-1247 charters@canadiannorth.com
Panorama Aviation	Charter Flight	418-669-5102 ext.2

1.5 Roles and Responsibilities

As shown on the communication flow charts (section 1.4.1) participants in emergency and spill management are:

- The Discoverer /First Responder
- The Project Manager
- The Superintendent
- The HSE coordinator
- The HSE Agent
- The ERT

The complete description of roles and responsibilities are listed in Appendix 2.

1.5.1 Emergency Response Team (ERT)

An Emergency Response Team (ERT) will be created from the personnel working on the site. They will be responsible for spill-related incidents or emergency response. The Team members will receive specialized training for emergency and spill response. They will lead/manage emergencies according to their capability or lead the activities of staff who do not have specialized training.

1.5.2 Facility Personnel Role and Responsibilities

All Facility personnel shall:

- have followed the site safety inductions.
- be inducted to all preventive measures in place to avoid and reduce the risk for emergency or spill incidents.
- be aware of the steps to be undertaken in the event of an emergency or spill.
- shall know how and when to communicate an incident or spill.
- be aware of the environmental and safety equipment location and their function.
- be familiar in using environmental and safety equipment and responding to emergencies or spills.

Refer to Appendix 2 for detailed roles and responsibilities.

2 GENERAL HEALTH AND SAFETY GUIDELINES

- Figure 5 shows the NNF Site Layout including environmental and safety equipment.
- Fuel transfer is prohibited when site conditions are considered unsafe by Superintendent.
- The site must have the required environment and safety equipment (refer to Figure 5, sections 4.1.2.1 and 5.2.1.2)
- The SDS (Appendix 3) shall be known and consulted by ERT to ensure all safety measures relevant to the specific material spilled are followed to protect workers and minimize the damage to the surrounding area of the spill and to ensure proper clean-up methods are being utilized.
- ALWAYS, wear the appropriate personal protective equipment (PPE) - refer to SDS (Appendix 3).
- Never take an action that will endanger yourself or others.
- Be aware of the possible spill volume and type of material found at the NNF site.
- Keep unessential people away from the emergency or spill site.
- For spill clean-up, use a spark-free shovel, work up wind, avoid low-lying areas and avoid inhalation of vapors or dust.
- Fuels and oil can be very slippery when spilled.
- Smoking on site is prohibited except in dedicated area.
- Keep cell phones and all non-intrinsically safe devices turned off.
- Follow NNF speed limit.

2.1 Required Spill and Emergency Kit for Vehicle

Table 1: Pick-up Trucks Spill and Emergency Kit (portable spill kit)

Description	Quantity	Description /Uses/Capacity
• Radio	1	
• List of emergency contacts	1	
• Nylon bag with compartments	1	
• Absorbent pads	20	
• Sorbent socks	2	
• Disposable bags	2	
• Pairs of nitrile gloves	1	
• Pairs of goggles	2	
• Fire extinguisher	1	
• First Aid Kit	1	
• Emergency rotating lights and orange flag	1	

2.2 Required Personal Protection Equipment (PPE)

Site mandatory PPE are the following:

Reflective vest 	**Oil resistant rubber gloves** 	**Safety Boots** 
Fire resistant clothing that covers the arms and legs (coveralls)* 	**CSA approved eyewear** 	**Hard hats** 

*Clothing made of 100% synthetic or nylon materials (parkas, snow suits) must be avoided due to static electricity risks and is not permitted.

Other specific work required PPE as described in the work procedures.

2.3 NNF General Site Layout with Environmental and Safety Equipment

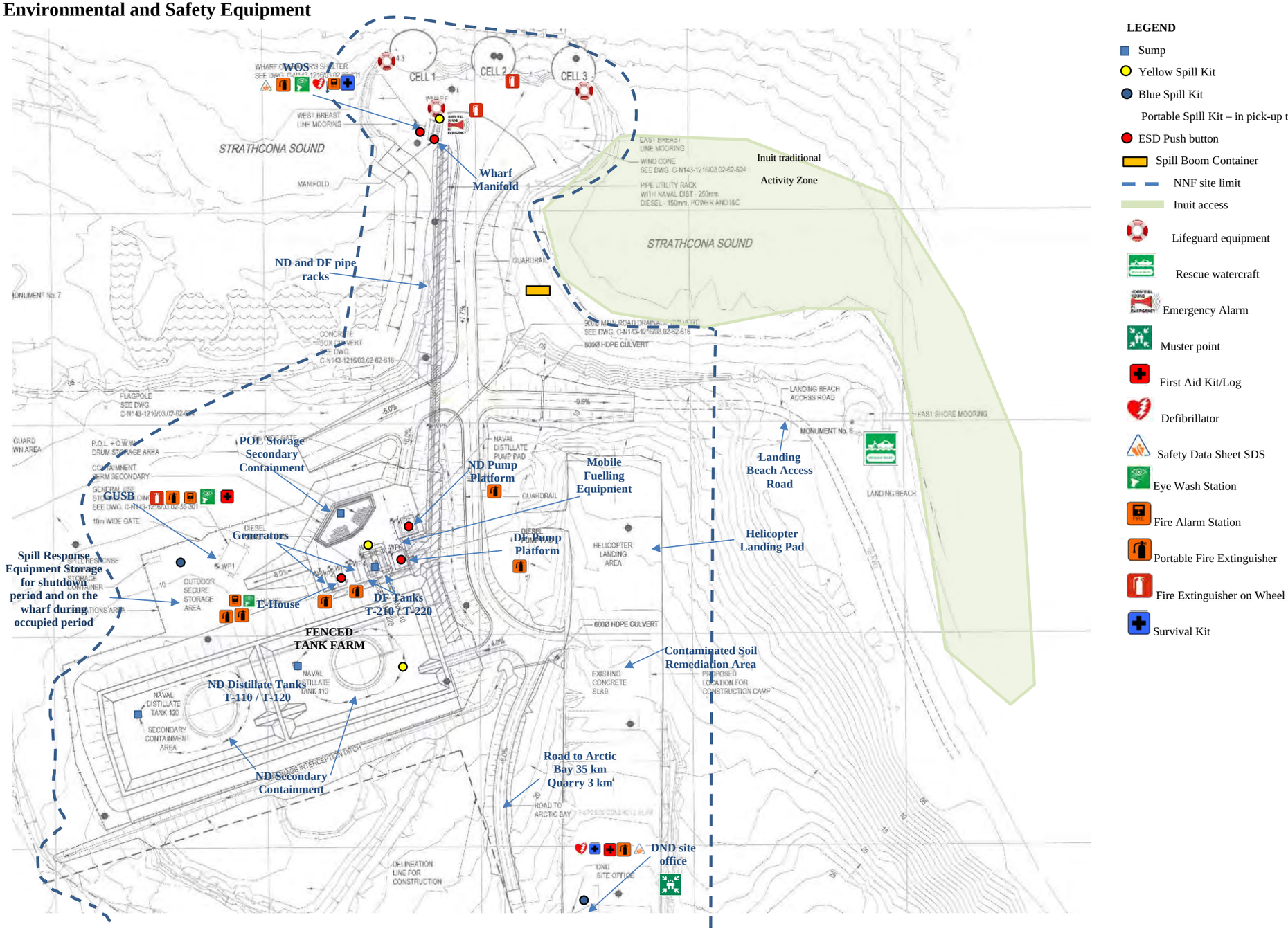


Figure 5: NNF Site Layout including environmental and safety equipment

3 TANK FARM AND EMERGENCY AND SPILL CONTROL

The following table provides the details on the NNF storage tanks, their product, and the associated environmental and safety protection.

The Maximum Total Amount of Arctic Diesel expected on the site during construction and commissioning is 700 000 L. The Diesel Safety Data Sheet (SDS) is available in Appendix 3. During commissioning tests, diesel can be transferred from one tank to another tank or used in the generator set to produce power. **Full tank capacity will not be used for the construction or commissioning phase.**

Table 2: Tank Farm Store and Used On-Site

Product	Equipment Tag	Use	Location	Maximum Tank Capacity / Design Flow rate	Spill Protection	Fire and Safety Protection
Diesel	T-210 and T-220	Generator Power and mobile equipment fuelling	Tank farm	170 056 L total 85 028 L/each tank at High High Level Design flow rate: 2 L/s	Double wall under vacuum with pressure gauge for vacuum monitoring Lined steel secondary containment 9100 L Secondary containment berm (insta-berm) placed under the wharf manifold when used Spill Kit	Structure Monokote (2 hour fire resistance) Fire Extinguisher Flame detectors ESD Push button
Diesel	T-110 and T-120	Future operation use: AOPS Fuelling with Naval Distillate Actual use: Process tests with Diesel	Tank farm	8 211 186 L total 4 105 593 L/tank at High High Level Design flow rate: 35 L/s	Containment berm Double bottom 5 inspection wells (each tank) connected to perforated pipe below the ND tank. Spill Kit 9100 L Secondary containment berm (insta-berm) placed under the wharf manifold when used	Spatial separation Fire Extinguisher Flame detectors ESD Push button

3.1 ND Tanks

Periodic visual leak detection, periodic manual dips and inventory reconciliation is required as part of in-service monitoring. As detailed in Appendix 4, the double bottom and the inspection wells will be inspected on a regular basis.

3.1.1 Containment Berm

The containment berm is the area surrounded by the banks around both ND tanks, T-110 and T-120. This area is designed specifically to contain a spill from the naval distillate tanks.

Additionally, if the wharf manifold piping must be used to transfer fuel during commissioning test, a 9100 L secondary containment berm (insta-berm) is positioned under the wharf manifold when used.

3.1.2 ND Tank Leak Detection System

The leak detection systems for the ND storage tanks are considered key spill prevention components of the ND system. The leak detection systems include a network of five (5) 100 mm diameter wiping pipes located within a lined area below each tank, which are in turn connected to inspection wells via non-wiping pipes. Each tank has five (5) inspection wells for monitoring purposes (See Figure 7).

Each ND inspection wells (10) must be inspected weekly during the operating season. When liquid is in the inspection well, it must be analyzed for the presence of oil. If the analysis confirms the presence of oil, the personal shall find the origin of the leaked product and take immediate action to prevent further leak. If the leak is coming from the tank, all the fuel is transferred to another tank and a complete tank inspection is required.

During non-operating period, when the site is accessible, weekly inspections are expected unless snow accumulation blocked access to inspection wells.

In addition, the ND tanks have a double bottom filled with sand equipped with (1) drain valve to verify if the presence of leak.

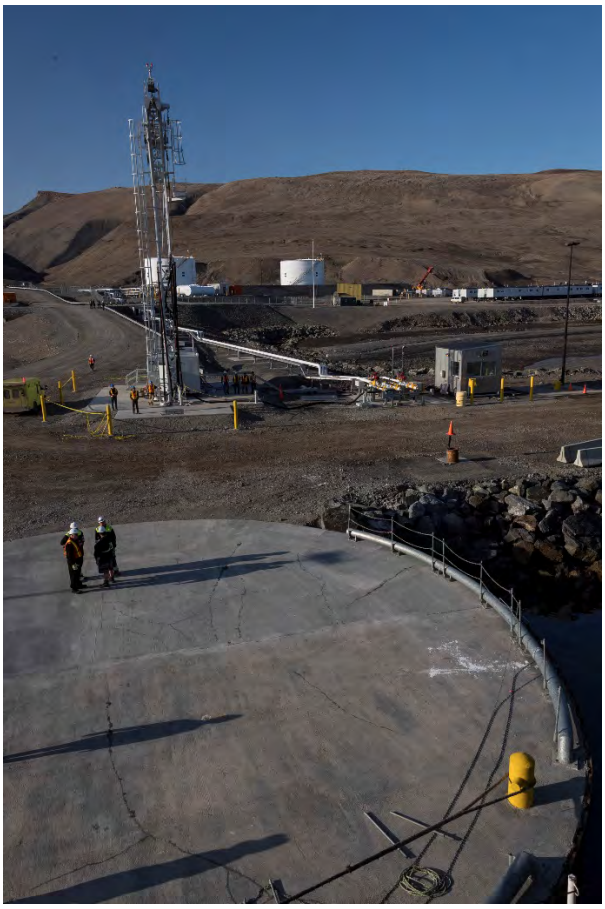


Figure 6: Tank Farm, Piping and SSF System and Wharf Cell

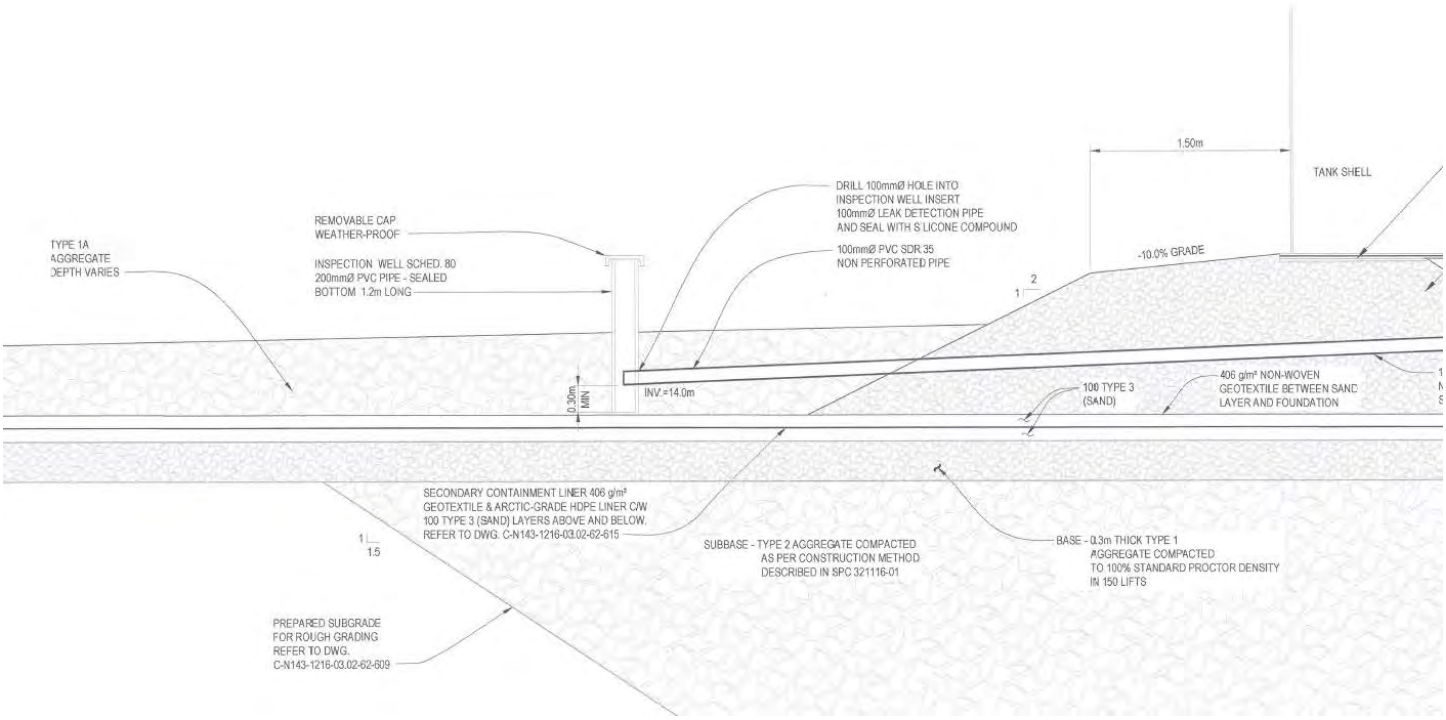


Figure 7: An inspection well around ND tanks (excerpt from drawing C-N143-121603.02-62-602)

3.2 Double Wall Tanks and Piping

Periodic visual leak detection, periodic manual dips and inventory reconciliation is required as part of in-service monitoring.

For the double wall tanks (T-210, T-220), the vacuum gauge is part of the leak detection system. If the gauge is showing a loss of vacuum pressure, it is an indication that the tank is leaking, or the leak detection system has failed. If the gauge has indicated a loss of vacuum pressure, verification is done by opening the drain valve connected to the vacuum interstice to check for the presence of fuel. Refer to section 4.3.10 for the procedure when a spill is detected in double wall tank.

During operation, double wall tanks require weekly validations of the vacuum gauge reading. During non-operating period, weekly inspections are expected unless site access is not possible.

There are 5 sections of piping with double walls. The leak/spill detection is performed as explained for the double wall tanks. Note that the piping is drained during the shutdown period. Therefore, verification is only required during the occupied period.

3.2.1 Containment Berm

The DF tanks T-210 and T-220 are located within a secondary containment. The secondary containment cell is an engineered steel containment dike system with one common cell to contain both tanks (Figure 8). The DF secondary containment area is designed to contain any accidental spills from the DF storage tanks T-210 and T-220.

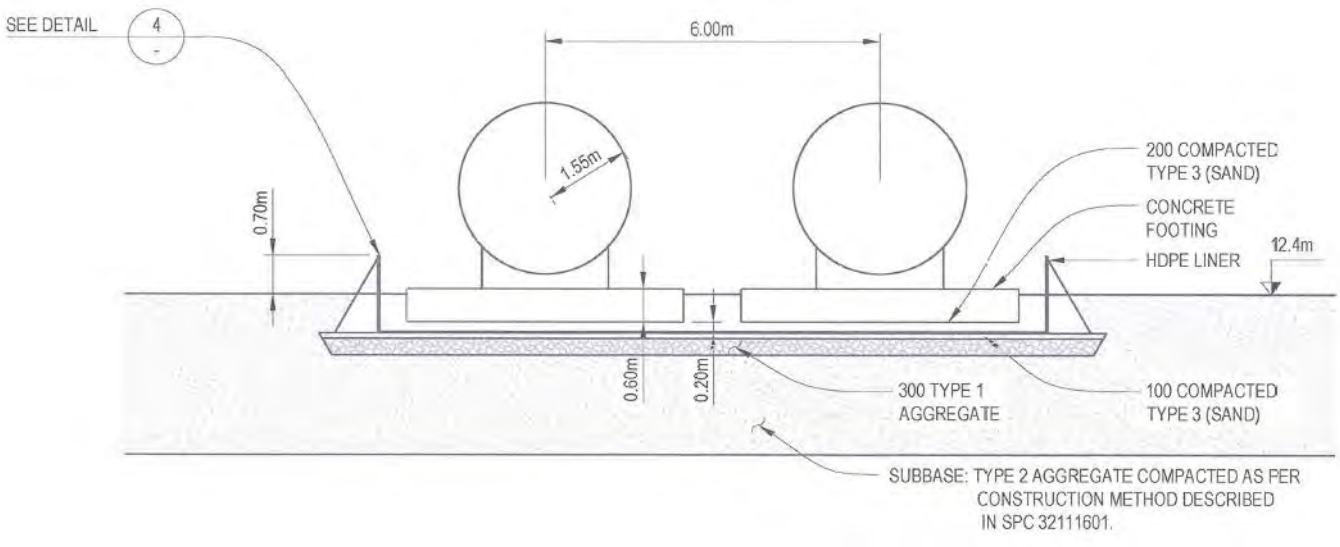


Figure 8: DF Secondary Containment Area (Drawing C-N143-121603.02-62-615)

Additionally, if the wharf manifold piping must be used to transfer fuel during commissioning test, a 9100 L secondary containment berm (insta-berm) is positioned under the wharf manifold when used.

3.3 Control System

During the commissioning, the ND and DF System is controlled via a PLC and the Human Machine Interface (HMI) Operator is located in the Wharf Operator Shelter (WOS), near the wharf manifold. The WOS operator monitor the system and is supported by Field Operators that walk down the ND and DF System during fuel transfer. Other HMIs are installed in the E-House as well as in the DND building. During commissioning the operators are commissioning specialists. Refer

to Figure 9 and Figure 10 for HMI screen shots.

ND tanks and DF tanks are all protected against overfill by level transmitters and level switches which will trigger an overfill horn when the high-level set point is exceeded.

In case of an emergency or sign of abnormal operation, the ND and DF system can be stopped using any of the installed ESD push button, located throughout the NNF. The ESD push buttons are located at the following locations:

- HXS-100 is located on the ND pump platform.
- HXS-200 is located on the DF pump platform.
- HXS-300 in the E-House.
- HXS-400 in the WOS.
- HXS-800 is located near the wharf manifold.

The location of ESD pushbutton is shown on Figure 5.

Pressing the Facility's ESD buttons will

- Stop all ND pumps (P-101, P-102, and P-103) and DF Pumps (P-201, P-202 and P-203).
- Close mainline ND valve MOV-100 at Wharf area.
- Close tank T-110 isolation valve MOV-111.
- Close tank T-120 isolation valve MOV-121.
- Close MOV-200 on DF system.
- Activate the horn and strobe at WOS (YA-800 and YI-800).

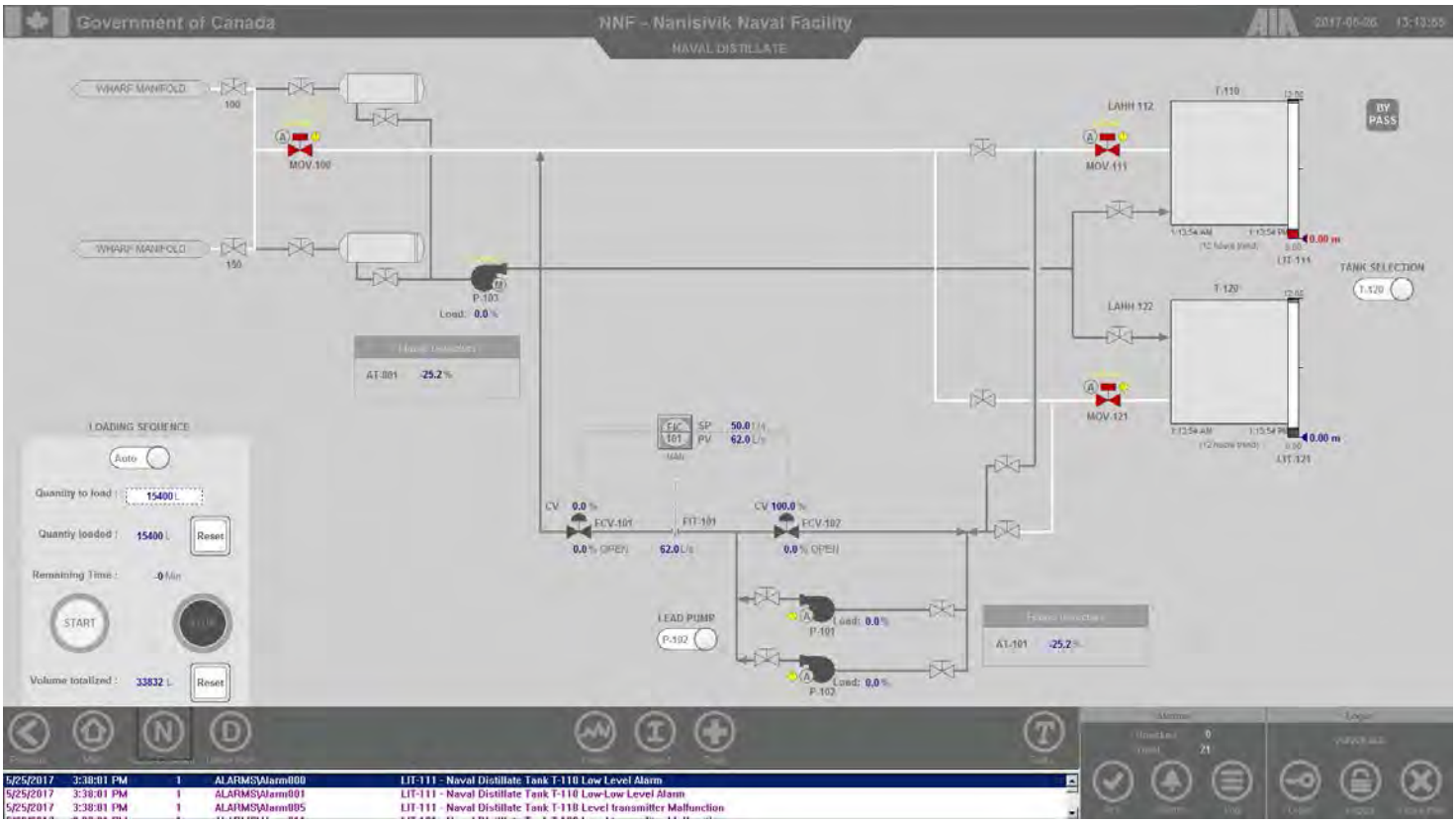


Figure 9: Naval Distillate HMI page

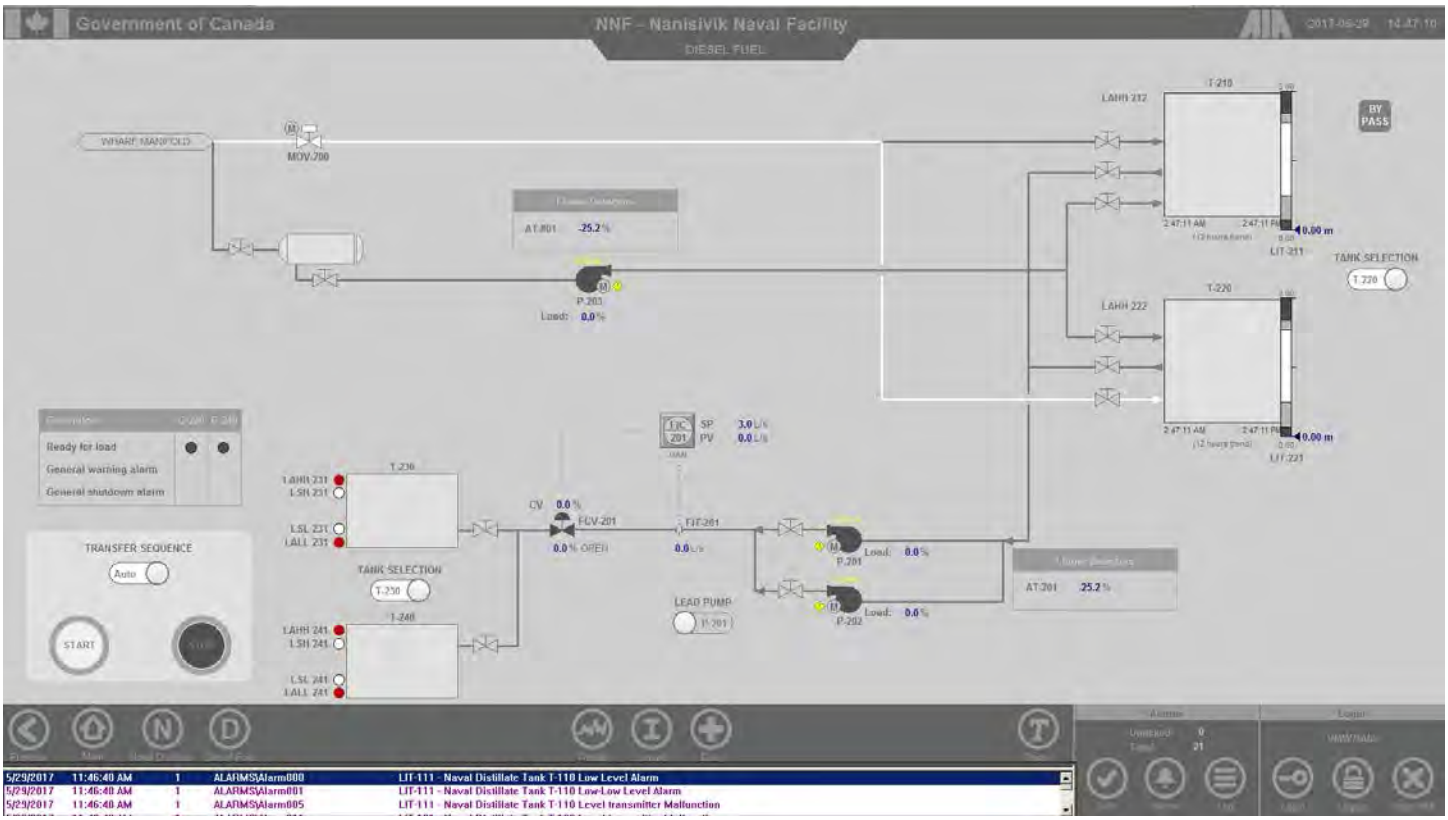


Figure 10: Diesel Fuel HMI page

4 SPILLS

Spill Response procedures provided in this plan are specific to the materials/product spill, spill location (e.g., sea, land,) and the receiving environment. The SDS of the product contained in the tanks on site is in Appendix 3.

Spills may be the result of any of the following occurrences such as:

- Spills during the transfer of fuel
- Spills resulting from accidents
- Tanks, drums or containers may develop leaks or rupture
- Failure of equipment such as valves, piping or containment structures
- Overfilling
- Vandalism
- Improper storage

4.1 Spill Prevention and Control

Spill prevention and control methods have much to do with operational procedures as much as with regular maintenance and monitoring of equipment combined with the vigilance of personnel on site. This topic is covered in the NNF Operation and Maintenance (O&M) manual. Appendix 5 of the NNF O&M manual provides the checklists of required preventive maintenance and inspections required during the occupied period as well as the shutdown period. The checklist associated with spill prevention of the NNF O&M Checklist is included in Appendix 4.

Training, review and practice of spill responses is key in spill prevention.

4.1.1 Personal Protection Equipment (PPE)

Wear appropriate PPE, such as impervious clothing, goggles, and gloves when containing the spill. If contact with the fuel is a risk, Tyvek suits and chemical master gloves from the spill kit are required.

PPE shall be easily accessible for the spill responder.

4.1.2 Spill Prevention and Control Material

4.1.2.1 Required Spill Control Equipment

An inventory of equipment currently available on and off the site, along with the quantity, location, description, intended use and capabilities is listed in this section. All required spill control equipment should be inspected at the beginning and at the end of every season. Following a spill event, the depleted material should be replaced as soon as possible. Every spill response kit shall have an inventory of required contents. This inventory should be directly attached to the container of the spill response equipment. Spill kits should be closed with a safety seal affixed to indicate if the kit has been used or tampered with.

Emergency and spill control equipment that must be kept inside vehicle is listed in section 2.1.

The following table summarizes the required spill control equipment that should be available at NNF.

Table 3: Blue Universal Spill Containment Kit (2 X)

Description	Required Quantity	Description /Uses/Capacity
• Blue Polyethylene Drum	1	55 US gallons

• Sorbent pads	100	15" x 18"
• Polypropylene cushions	10	Highly absorbent poly blend materials Ideal to absorb leaking fluids in tight spaces
• Sorbent socks	12	3" x 48"
• Sorbent socks	2	3" x 10'
• Nitrile gloves	2	XL
• Caution tape	1	3" x 300'
• Disposal Bags	4	26" x 36"

Figure 11: Blue Spill Kit (55 US gallons)(https://www.tenaquip.com/product/zenith-safety-products-spill-kit-sgd800)

Table 4: Yellow Universal Spill Containment Kit (3 X)

Description	**Required Quantity**	**Description /Uses/Capacity**
• Screw-topped drum	1	65 US gallons
• Sorbent pads	100	15" x 19"
• Disposal Bags	5	
• Pillows	7	18" x 18"
• Sorbent socks	7	3" x 48"
• Goggles	1	
• Handbook	1	
• Nitrile gloves	1	

Figure 12: Yellow Spill Kit (https://www.bradycanada.ca/spill-kits/allwik-drum-universal-spill-kit-pid-ska65)

During the unoccupied period, the Spill Containment Kits are in the outside storage area. The Wharf Containment Kit is stored in the outdoor secured area. (Refer to Figure 5 for the site Layout).

Table 5: Spill Boom Container (on Landing Beach during occupied season and storage area during shutdown period)

Description	Required Quantity	Description /Uses/Capacity
• 50-ft oil booms on a reel	25	1350 ft (410 m)
• Oil-only absorbent pads	200	(16” x 18”)
• Sorbent Pad	400	
• Sorbent Socks	4	
• Sorbent Pillow	4	
• Xsorb Granular Absorbent	3	(2 L bags)
• Nitrile Gloves	10	
• Tyvek Coveralls	6	
• Splash resistant Goggles	2	
• Disposable Bag	4	
• Drain Cover	1	
• Googles	5	
• Caution tape	1	
• PE sheet lining	1	

Table 6: Tools in the General Contractor Storage Containers

Description
• Spark free shovels
• Rakes
• Containers

• Vacuum pump and hoses
• Quatrex bags (3 units) (1.2m x 1.2m x 1.2 m)

Table 7: Other Spill Control Equipment

Description	Quantity	Description /Uses/Capacity
• Drums (45 gallons)	50	Waste fuel or OWW
• Drum labels	100	
• 9100 L capacity temporary secondary Containment (Insta berm) 	1	Under the wharf manifold when fuel passes through the wharf during fuel transfer.
• Drip pans	~10	Under the hose refueling nozzle when mobile equipment is being filled. Under specific equipment when opening the DF or ND system (drain valves, pig receiver doors, etc.)
• Sorbent Pad (in the GUSB)	Variable >25	
• Sorbent Socks (in the GUSB)	Variable >10	

4.1.2.2 Mobile Equipment available on site during occupied period

- Boats (wharf)
- Pickup trucks
- Excavator Loader
- Backhoe-loader

4.1.2.3 Locations of environmental and safety material

For the location of spill kits and emergency materials on a layout, refer to Figure 5.

To minimize the response time in case of a spill, Spill Containment Kits must be located in the following areas during the occupied period:

- DND office (blue spill kit)
- Near DF tanks (yellow spill kit)
- Near generator enclosures (blue spill kit)
- Near ND tanks (yellow spill kit)
- Near WOS (yellow spill kit)
- On landing beach (Spill boom container)

4.1.2.4 Available Equipment Off-site

A list of spill control equipment available off-site is presented in the following table:

Equipment	Delivery time	Location and Contact
Heavy equipment	1 day (occupied season)	Arqvartuuk Service Ltd. Moses Oyukuluk Box 26 439-8227 mosesoyukuluk@qiniq.com

4.2 Spill Definition and Classifications

A spill is the intentional or unintentional abandonment, deposit, discharge, dump, emission, empty, exhaust, throw, inject, leak, pour, place, release, seep, or spray of material into the environment.

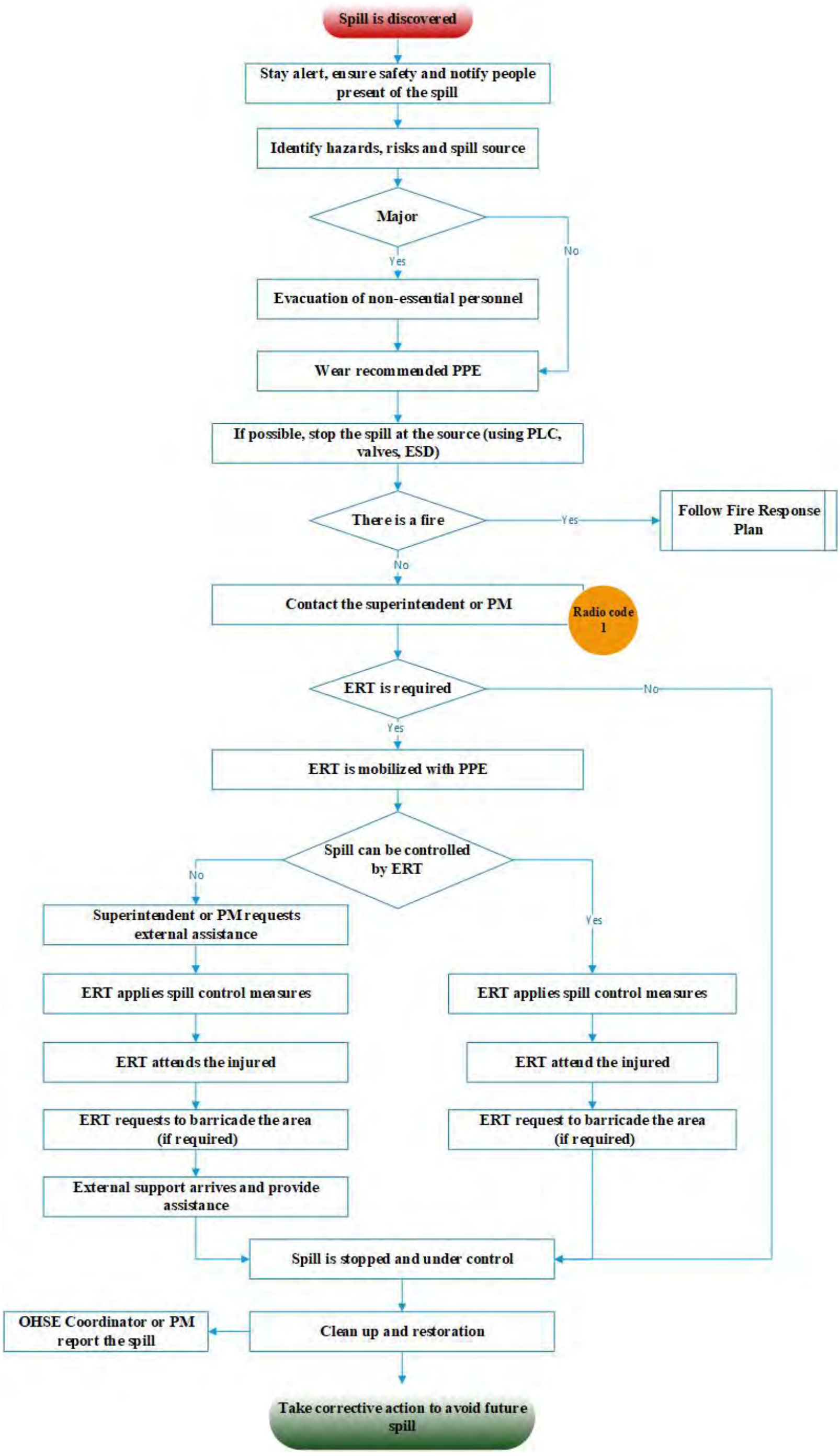
A minor spill is defined as a spill that the NNF staff can contain and clean up in its entirety without assistance. A major spill is defined as a spill that the NNF staff cannot contain and/or clean-up without assistance.

4.3 Spill Response Plan

Procedures for all spill responses will be provided in this section, including special considerations needed to address various spill locations and potential receiving environments. .

4.3.1 A General Guideline to Spill Response:

Petroleum hydrocarbons such as diesel are generally hydrophobic, and as such, do not readily dissolve in water. They typically tend to float on the water's surface. The following section describes the general guideline to spill response. The main actions are summarized in the following spill response flow diagram:


Spill is discovered
Stay alert, ensure safety and notify people present of the spill
Identify hazards, risks and spill source
Major
Yes
No
Evacuation of non-essential personnel
Wear recommended PPE
If possible, stop the spill at the source (using PLC, valves, ESD)
There is a fire
Yes
Follow Fire Response Plan
No
Contact the superintendent or PM
Radio code 1
ERT is required
No
Yes
ERT is mobilized with PPE
Spill can be controlled by ERT
No
Yes
Superintendent or PM requests external assistance
ERT applies spill control measures
ERT attends the injured
ERT requests to barricade the area (if required)
External support arrives and provide assistance
ERT applies spill control measures
ERT attend the injured
ERT request to barricade the area (if required)
Spill is stopped and under control
OHSE Coordinator or PM report the spill
Clean up and restoration
Take corrective action to avoid future spill

4.3.2 Major Spill General Guidelines

1. Be alert – ensure safety of yourself and others by notifying them of the incident;
2. Identify hazards and risks, determine the source and identify the substance that was released.
3. Evacuate nonessential personnel in the immediate area to a safe location (muster point).
4. Wear recommended PPE to prevent skin and eye contamination.
5. If it is safe to do so, stop the spill using emergency stop, PLC, manual valves or ESD push button (refer to section 4.3.6).
6. If there is fire, follow the Fire Response Plan in section 5.2.2.
7. Contact Superintendent or Project Manager (initiate Radio code 1).
8. The Superintendent will mobilize the Emergency Response Team (ERT)* if necessary.
9. ERT or spill responders put on the appropriate personal protective equipment as recommended by the SDS.
10. If the spill cannot be contained by the ERT, the Superintendent or PM request external assistance as required.
11. Confine and contain the spill and prevent run off into drains and waterways using spill control equipment available on site and containment technique.
12. Attend to the injured if applicable.
13. Barricade the area to control access to the spill zone.
14. External support is mobilized if required.
15. ERT confirm the spill has completely stopped and is under control.
16. Start the clean-up process as per section 4.4.
17. Report the spill as defined in section 4.5.
18. Take corrective actions to avoid spilling in the future.

4.3.3 Minor Spill General Guidelines

1. Be alert – ensure safety of yourself and others by notifying them of the incident.
2. Identify hazards and risks, determine the source and identify the substance that was released.
3. Wear recommended PPE to prevent skin and eye contamination.
4. f it is safe to do so, stop the spill using emergency stop, PLC, manual valves or ESD push button (refer to section 4.3.6).
5. Ensure the spill is stopped and contain
6. Start the clean-up process as per section 4.4.
7. Report the spill as defined in section 4.4;
8. Take corrective actions to avoid spilling in the future.

4.3.4 Wildlife protection

Wildlife must be protected in the event of a spill. If applicable, deterrent measures (e.g., ATVs and motorboats) will be used to prevent wildlife from entering the spill site. Fencing will be installed should the area be impacted by a spill remaining overnight or for several days. In the event of a spill affecting wildlife, the environmental authorities will be contacted. Once appropriate permission and direction are obtained, contaminated wildlife will be captured and contained; excessive handling will be avoided. Contaminated wildlife will be transported to a treatment facility. First aid will be avoided unless directed by the appropriate authorities. The site does not have a treatment facility for oiled/injured wildlife, but could accommodate with temporary installations. If a death occurs, the appropriate authorities will be contacted prior to disposal.

4.3.5 Containment and Treatment Methods

The methods for containing and controlling a spill will vary depending on the situation, media contaminated, weather, etc. The purpose of spill containment is to prevent or minimize migration and/or dispersion.

Use natural depressions or berms constructed with materials and equipment in proximity to the site to physically contain a spill on land. Deployment of booms will be necessary on water.

Spill control techniques involve the use of two types of barriers: dikes and trenches. Barriers should be placed down the gradient (downslope) from the source of the spill, and as close as possible to the source of the spill. Barriers will slow the progression of the spilled material and will also serve as containment to allow recovery of the spilled material

Warning: do not contain diesel fuel if vapours might ignite (presence of fire).

4.3.5.1 Dikes

A dike may be built with soil, booms, construction material, lumber, snow, etc. Dikes should be constructed in such a way as to accumulate a thick layer of free products in a single area (V- shaped or U-shaped). It is important to make sure the berm does not cause oil to back up and permeate the soil where it could contaminate groundwater.

Figure 13: Dikes (ref.: http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/berms-and-trenches)

4.3.5.2 Trenches

If the water table is high and the oil will not permeate the soil, shallow trenches may be dug to collect oil for removal.

Figure 14: Trench (ref.: http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/berms-and-trenches)

4.3.5.3 Absorbents and other materials

The use of large quantities of absorbent materials to recover significant volumes of spilled material should be avoided. Large volumes of free products should be recovered, as much as possible, by using vacuums and pumps, and containerized. Mixtures of water and fuel may be processed through an oil-water separator. Absorbent sheets should be used to soak up residual fuel on water, on the ground (soil and rock).

Peat moss is capable of cleaning up oil floating on water. The peat is scattered on the spill and absorbs the oil, and, because it doesn't absorb water, it can then simply be scooped out — taking the toxic oil with it.

The use of snow as a sorbent material will be limited as much as possible. It is important to scrape up the contaminated snow and ice as soon as possible because it becomes a water-contaminant mixture. Avoid use of water or fire extinguishing chemicals on nonpetroleum product spills unless it is necessary to control a fire or prevent an explosion. Since many chemicals react violently with water and chemical extinguishing agents and may release toxic fumes in the environment. In addition, chemicals may be soluble in water and dispersal will make containment and clean-up more difficult.

Do not use paper towels to absorb spill as this increases the rate of evaporation and vapour concentration in the air.

4.3.5.4 Dispersant

Dispersants are used break up an oil slick into very small droplets, which dilute throughout the water. The spilled material, can be broken down in smaller oil particles which are more easily biodegraded, and it provides a measure of protection for sensitive habitats threatened by a surface slick. Dispersants are sprayed onto spills by specially equipped boats or planes.

4.3.6 Stopping Fuel Flow using PLC System Stop and Emergency Stops

It is very important to quickly stop the fuel flow as soon as a spill is detected. This can happen automatically (when shutdown conditions are met as described in the NNF O&M) or should be done using the PLC or local emergency stops.

4.3.6.1 System Stop

Shutdown of the Naval Distillate or Diesel Fuel System can be accomplished using the PLC located at the:

- Operator workstation at the WOS building
- HMI on the PLC panel at E-House

4.3.6.2 Emergency Shutdown (ESD) Push Button

The NNF facility has 5 emergency stop buttons (refer to the Figure 5 for their location on the plan and section 3.3 for the

details on the system control).

4.3.7 Stopping Fuel Flow using hand valves

If the control system cannot stop the spill, after the identification of the source of the spill, the ERT or the discoverer can close the piping or the tank using the hand valves located on the systems.

4.3.8 Emptying main pipeline

Emptying main pipeline could, in certain situation, reduce the quantity spilled. To empty the main pipeline, run the return pump P-103 (ND system) or P-203 (DF system). This operation must be done by a qualified operator because it includes putting the control system on manual mode and opening/closing manual valves. This procedure is covered by the NNF O&M Manual.

Refer to Appendix 8 for the P&IDs.

4.3.9 Marine Spill Containment

Containment of an oil slick into the sea will require the deployment of mobile floating booms to intercept, control, contain and concentrate to increase the thickness of the floating oil. Refer to Appendix 7 for the O&M Manual of the Boom.

Prioritize containing the leaking fuel to keep the spill onshore. Measures will be taken to protect sensitive and accessible shoreline areas. The spill will be monitored to determine the direction of migration. In the absence of strong winds, the material will likely follow the water flow direction. Measures will be taken to block and concentrate the spilled material using booms where it will subsequently be recovered using the pump. Discharge recovered products will be stored in drums or tanks.

Recover larger spills on water with the pump, as required, and discharge recovered products to drums or tanks.

Refer to Appendix 7 for the O&M Manual of the Boom.

4.3.10 Spill in Double Wall Tank or Double Wall Piping

If the vacuum gauge of the double wall is not indicating the recommended vacuum levels, it is an indication that the tank is leaking or the leak detection system has failed. Should this occur, the following step must be followed:

- Determine if there is a leak by using the double wall drain valve and an appropriate container to collect fluid.
- If fuel is detected in the double wall, the fuel tank will have to be drained and inspected. Instruction from the tank O&M Manual and the NNF O&M Manual must be followed.

4.4 Spill Clean-Up

After the proper response to a spill on the site, follow the appropriate clean-up process. The spill clean-up depends on the material, location, and amount of material spilled. All personnel involved in the spill clean-up shall use the proper PPE and follow the clean-up methods as described in the SDS.

4.4.1 Land Spill Clean-up

Below is the general process for a land spill clean-up:

1. Clean up the spill according to the SDS.
2. For major spills, remove pooled spilled material and transfers into dedicated drums using a pump with a hose attached to a drum. Drums shall be marked with the proper labels.
3. For smaller spills, sorbent materials and hand tools (cans, shovels, and rakes) can be used.
4. Spill control materials should be distributed over the entire spill area, working from the outside, circling to the inside to reduce the chance of a splash or spread of the spilled material.

5. Use absorbents to absorb the material as much as possible.
6. When spilled materials are absorbed, use a brush and a scoop to place materials in an appropriate container. Use polyethylene bags for minor spills or drums with polyethylene liners for larger quantities.
7. Identifying the spilled material and affix onto the container.
8. Decontaminate the surface where the spill occurred using a mild detergent and water.
9. Soils contaminated with other spilled products shall be segregated, packaged and disposed of in the controlled area.
10. Any initial stockpiling of the contaminated matrices (i.e., soils) shall be done on an HDPE liner surrounded by a berm to ensure no migration of contaminants takes place.
11. Collect and seal in properly labelled containers or drums for disposal.
12. Spill control materials, as well as solid contaminants, shall be disposed of as per waste management procedure.

4.4.2 Heavy equipment digging

If digging operations are required, it should be performed by a professional and contaminated soil disposed as described in section 4.4.1.

4.4.3 Berm area clean-up and restoration

Berm area are protected by a membrane. The clean-up procedure described in section 4.4.1 can be followed but extreme caution must be taken. If possible, digging should be done manually with a shovel. In the case where manual digging would take too long, small motorized digging equipment could be used. The equipment operator must work under the instruction of another operator who can manually verify and communicate the maximum digging depth. If the membrane is perforated, a specialist must be contacted to repair it.

4.4.4 Marine Spill Clean-up

As a general strategy, it is important to collect environmental data such has wind speed and direction, high tide/low tide, and to ensure the spill boom has been deployed and secured properly. In case of near-shore marine spills, the clean-up response measures are as follows:

1. Clean-up the spill according to the SDS.
2. Limit the spread of fuel on water (refer to 4.3.9)
3. For small spill, use absorbent designed to work in water environment
4. Identifying the spilled material and affix onto the container.
5. Clean-up contaminated area including downstream shorelines.
6. Fuel on a beach or shore can be manually removed or refloated at high water.
7. Fuel mixed with sand on the shore must be collected and bagged for disposal (due to the instability of sand beaches, and the resultant difficulty in operating heavy equipment, oily sand removal may be limited to manual shovel activities)
8. Spill control materials, as well as solid contaminants, shall be disposed of as per NNF waste management procedure.

4.4.5 Event Monitoring

It is important to verify whether contamination of the surface soil or the nearby receiving environment has occurred as a result of an accidental release of a hazardous material or contaminated water, through monitoring of surface runoff and nearby receiving environment following remediation of any release. In the event of an accidental release, the water quality of the downstream receptor and possibly upstream of the receiving point, if any, is to be sampled (during the ice-free season)

and analyzed. When required, soil sampling is to take place at the earliest feasible time. (After thaw if the spill has happened over snow cover or ice.) Environmental consultants can be contacted to perform site assessment as soon as possible which includes soil or water analysis.

4.4.6 Management of Waste Product Generated by A Spill

Following spill containment and reporting, the released substance will be recovered and disposed of in an appropriate manner (ISO containers and stored to be shipped south). Along with the released substance, contaminated objects such as environmental media, material used for the construction of dikes or weirs, and absorbent materials will be recovered and disposed of properly. Tools and absorbent materials used in the containment of petroleum will be sealed in waste oil containers and shipped for disposal to an approved and licensed receiving facility. Tools from the spill kits will be cleaned, decontaminated and returned or returned to the spill kit. Spill kits will be resupplied as required. The clean-up will be done at permanent maintenance installations. Waste and wastewater from the clean-up will be stored into sealed, waterproof containers for disposal to an approved and licensed receiving facility.

Barrels of waste fuel (OWW) will be stored inside the designated storage area protected with a containment berm. These barrels will be transported to a specialized and licensed recycling firm for processing. The hydrocarbon contaminated soils will be treated on site or transported to an approved disposal site for treatment. The project manager shall ensure that a waste manifest accompanies the shipment of all waste oil/grease and is registered with the Government of Nunavut Department of Environment (GN-DoE). The project manager shall ensure that an export manifest and/or the appropriate transportation of dangerous goods (TDG) documentation accompanies all potential hazardous samples or materials that are transported off site. Disposal of heavily contaminated soil and vegetation shall be accomplished by storing it in sealed containers and shipping them for disposal/treatment to an approved and licensed receiving facility.

Remove and bag PPE for cleaning, inform laundry personnel of contaminant hazards, or dispose at a licensed disposal facility. Thoroughly wash with soap potential exposed skin contact locations after handling. Properly dispose of contaminated leather articles (including boots and shoes) that cannot be decontaminated.

4.4.7 Restoring Affected Areas

In consultation with Nunavut Department of Environment and DND, an appropriate reclamation plan will be determined. A site-specific study may be necessary to ensure a safe level of decontamination is attained. Remediation may include contouring, replacement of soil and revegetation.

4.4.7.1 Biopile

Lightly contaminated soil areas where restoration is feasible will be fertilized and then cultivated to a depth below the depth of contamination, then repeated as required. Bioremediation/ volatilization shall only be performed under the supervision and guidance of an environmental professional. Biopiles will be constructed on top of HDPE liners and will be surrounded by secondary containment to ensure contamination and high doses of nutrients do not migrate from the treatment site. Sampling will be performed to monitor biodegradation/volatilization progress and success.

4.5 SPILL REPORTING

The Canadian Environmental Protection Act requires that spills of an environmental contaminant be immediately reported to the 24-Hour Spill Report Line. The Spill Report Line can be contacted by telephone 24 hrs/day at (867) 920-8130. Collect calls are accepted. Any person whose health, safety, or property could be affected by the spill must also be notified.

Spill Reporting is the responsibility of the OHSE Coordinator or the Project Manager. Refer for the list of contact in section 4.5.

The NU-NT external spill report (Appendix 5) must be completed and forward to Environment Department.

4.6 ABANDONING SPILLS

Under no circumstance shall a land-borne or marine spill be abandoned unless overridden by imminent safety concerns (Eg.: uncontrollable fire, injury requiring immediate health assistance) or if the following criteria have been met:

- the spill poses no threat to any shoreline or Marine Protected Area (MPA).
- it is not possible to clean up the spill with the equipment available.
- response assistance would arrive after the spill had broken up or dispersed.

5 EMERGENCIES

This section will list the appropriate prevention and response actions to be taken in specific emergencies such as fire and evacuation. Simulations will be made randomly to familiarize personnel with the procedures in case of a real emergency.

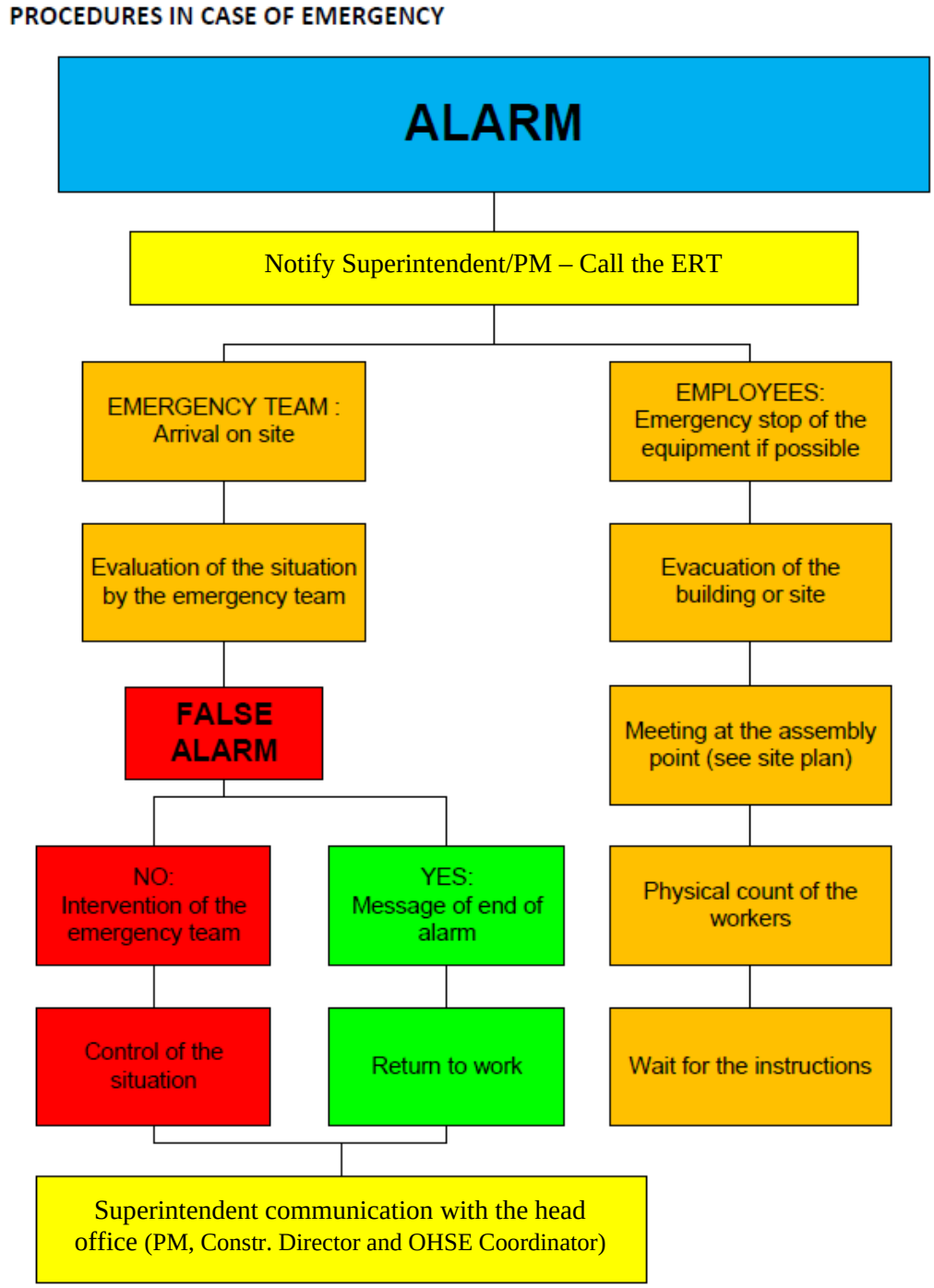


Figure 15: Emergency Flow Diagram

5.1 Emergency Evacuation

Should an emergency escalate to a level beyond the ability of personnel on site to manage, an evacuation of the area may be required. All personnel shall be trained on emergency evacuation procedures and designated assembly points. Unless specified otherwise by the Superintendent/Project Manager, the muster point is located near the DND building.

Maps showing evacuations routes and designated assembly locations shall be placed in conspicuous locations (i.e., facilities, work areas). Information regarding emergency signals, emergency contact, procedures and responsibilities for personnel, and instructions on operating notification systems shall also be included with the maps.

The evacuation process is as follow:

1. Notify Superintendent/Project Manager of the emergency and activate fire alarm pull station (in case of fire) to notify NNF personnel.
2. If time permits, return the system to the safest state .
3. If time permits, secure the area and move vehicles or objects away from the incident zone.
4. Superintendent/Project Manager request all site personnel to muster in a designated safe location away from the incident zone and await further instructions.
5. Superintendent/Project Manager will ensure that all personnel on site are safe and accounted for by performing a check of all personnel count as per the log register.
6. The Superintendent/Project Manager will inspect the site as soon as safely possible and take charge of providing the required actions.

5.2 Fire

5.2.1 Fire Protection and Detection System

The bulk fuel storage facility configuration complies with the National Fire Code of Canada and respect the fire protection standards. Large bulk fuel storage tanks are designed and constructed in compliance with American Petroleum Institute (API) Standard 650 Welded Tanks for Oil Storage. Small tanks are fabricated in compliance with ULC S601 Standard for Shop Fabricated Aboveground Tanks for Flammable and Combustible Liquids or ULC S602 Aboveground Steel Tanks.

The fire protection for the NNF is primarily based on passive fire protection principles with portable handheld extinguishers and 2 mobile wheeled fire extinguishing units provided throughout the site to extinguish or control small fires. There is no automatic fire suppression system to extinguish a fire. The bulk fuel storage layout and tank and generator spacing is designed such that automatic fire water or foam fire suppression systems are not required.

Local firefighting support is not available.

However, there are smoke, heat and flame detection devices installed at various locations throughout the site, which are integrated with the facility's fire alarm system. The fire alarm system includes visual and audible alarms, which are also located throughout the facility. The fire alarm system is also integrated with the facility's automation system to provide warning to the operator and to shutdown critical components of the facility.

Each area of the facility is equipped with portable or wheeled fire extinguishers.

Vinyl bags with a wool blanket are also located hanging near the entry door inside walls of the E-House, GUSB and WOS.

5.2.1.1 Flame Detectors

There are three (3) flame detectors (see Figure 16 to Figure 19): one (1) installed at the DF pump platform (AT-201), one (1) at the ND pump platform (AT-101) and one (1) at the wharf manifold area next to the WOS (AT-801).

Figure 16: AT-101 at the ND pump platform

Figure 17: AT-201 on the Diesel Pump Platform

Figure 18: AT-801 at the Wharf Manifold Area

Figure 19: Flame Detector

Any flame detector will

- Cause an HMI alarm,
- Stop all ND pumps P-101, P-102, and P-103 and DF Pumps P-201, P-202 and P-203,
- Close mainline ND valve MOV-100 at Wharf area,
- Close tank T-110 isolation valve MOV-111,
- Close tank T-120 isolation valve MOV-121,
- Close MOV-200 on DF system,
- Activate the fire horn and strobe at E-House (YA-301/302 and YI-301/302),
- Activate the fire horn and strobe at WOS (YA-401/402 and YI-401/402),
- Activate the fire horns and strobes at GUSB (YA-601/602 and YI-601/602),
- Activate the fire horns and strobes at DND office (YA-701 and YI-701), and
- Activate the fire horn and strobe at Spanwire (YA-901 and YI-901).

5.2.1.2 Fire Extinguisher Locations

10 lb portable dry chemical fire extinguishers:

- All vehicule: 1 per vehicule
- DND Building: 1 unit
- GUSB: 1unit
- E-House: 1unit
- Generator U-230 : 1unit
- Generator U-240 : 1 unit
- WOS : 1unit
- Spares : 4 units

AFFF Foam Wheeled Fire Extinguisher (125 litres of foam/water mixture) (3 units)

- Near wharf manifold : 1 unit
- Near apron of filling port : 1 unit (for future operation)
- Spare : 1 unit

AFFF Foam portable Fire Extinguisher (9,46 litres of Foam/water mixture) (1 unit):

- In front of E-House : 1 unit

5.2.1.3 Vehicle Emergency Response Equipment

Emergency and spill control equipment that must be kept inside vehicle is listed in section 2.1.

5.2.1.4 Site Buildings Fire Protection

The NNF buildings have been designed, as much as possible, with passive fire protection systems such as fire separations, non-combustible construction, fire walls, and spatial separation of building components. The fire protection strategy for the NNF buildings also includes fire extinguishers and fire alarm systems including pull stations, heat and smoke detectors, horns, strobes, and fire alarm control panels. Each building has its own fire detection and its own type of detector. There is no requirement for freshwater sprinkler systems and automatic fire suppression systems are not required based on the size of the buildings.

Activation of any of the building pull stations, heat and smoke detectors will

- Activate the fire horn and strobe at E-House (YA-301/302 and YI-301/302),
- Activate the fire horn and strobe at WOS (YA-401/402 and YI-401/402),
- Activate the fire horns and strobes at GUSB (YA-601/602 and YI-601/602),
- Activate the fire horns and strobes at DND office (YA-701 and YI-701), and
- Activate the fire horn and strobe at Spanwire (YA-901 and YI-901).

5.2.2 Fire Response Plan

1. The person who discovers the fire engages the fire alarm (pull station or ESD Push button) to notify personnel and ERT and follow emergency evacuation procedures.
2. The person who discovers the fire commences fire suppression measures immediately upon detection of fire provided that fire conditions allow personnel to safely proceed.
3. The person who discovers the fire immediately reports the location of fire as well as size of fire and wind direction, to the Superintendent /Project Manager.

4. The Superintendent /Project Manager inspects the fire site as soon as possible and takes charge of directing suppression measures.
5. If safe to do so, the Superintendent /Project Manager will request assistance of the ERT. All equipment and capable personnel shall be made available to control the fire. Fire control resources and capabilities may be limited depending on fire conditions, safety concerns, fitness of personnel and equipment availability.
6. The Superintendent /Project Manager ensures availability of fire suppression equipment at all times. Fire suppression measures shall continue until the fire is extinguished if personel safety is not at risk
7. Moveable material, particularly explosive or flammable materials, vehicles, etc. will be promptly moved to a safe location whenever there is a possibility of being threatened by fire.
8. The Superintendent /Project Manager will ensure that all burning embers are extinguished and will monitor the affected area for smoldering material.
9. The OHSE Coordinator will report wildfires and relevant information to the applicable authorities.

6 TRAINING

The OHSE Coordinator is responsible for training site personnel and visitors. During the occupied period, the OHSE agent provides training to all workers and visitors at the NNF. All workers and visitors at the NNF shall receive induction training and be aware of this ESRP. The following table summarize the training associated to this ESRP

Table 8: Training related ESRP

Training Modules	Audience
Workers Pre-mobilization induction	All
Workers OHS Induction	All
WHMIS (1/2 day)	All
Standard First Aid including CPR (2 days)	ERT (1 for every 25 person)
Emergency First Aid (1 day)	ERT
Handling and use of portable handheld extinguishers	All
Evacuation procedure	All
Spill notification procedure	All
Procedure in case of fire & simulations exercises	All
Waste management procedure	All
Spill and Emergency Response for ERT	ERT
Boat driving for boom deployment	ERT (2 persons)

6.1 Emergency Response Team Training

A Designated Emergency Response Team (ERT), consisting of on-site personnel, will have specific training to allow them to be prepared and ready in the event of an emergency or a spill. Each ERT member must maintain good physical fitness and the ability to wear recommended PPE. The Spill and Emergency Response Team Training includes annual mock exercises.

The ERT team must be trained on the topics including but not limited to:

- Use of various types of fire extinguishers
- Advanced First aid, including cardiopulmonary resuscitation (CPR)
- Shutdown procedures
- Evacuation procedures

- Spill Response
- Spill boom deployment
- Emergency Response
- Emergency communication protocols
- Fire suppression procedure
- Handling technique of hazardous material
- Trauma counselling

The Emergency Response Team shall be trained for all types of possible emergencies and emergency actions to be performed. They are to be informed on all types of hazards exposure during an incident, spill, fire, accident, or a medical emergency. It is important to determine when not to intervene. For example, team members must be able to determine if the fire is too large for them to handle or whether the search and rescue procedures should be performed. If the safety of the ERT is at risk, then they should request assistance and ensure their own safety.

6.2 Shutdown Period Inspector Training

The inspectors visiting the site during the shutdown period must have the same training as all NNF personnel.

6.3 Training Log

The training log must be updated by the OHSE agent and a copy must be shared with the OHSE Coordinator, Superintendent and Project Manager.

The training program name, dates and expiration are recorded in an in-house designed software.

Appendix 1. ACRONYMS AND ABBREVIATIONS

ACRONYM/ABBREVIATION	DESCRIPTION
AOPS	Arctic Offshore Patrol Ship
API	American Petroleum Institute
DCC	Defense Construction Canada
DND	Department of National Defense
DF	Diesel Fuel
ECCC	Environment Canada Climate Change
E-HOUSE	Electrical House
ESRP	Emergency and Spill Response Plan
ERT	Emergency Response Team
ESD	Emergency Shutdown
FCV	Flow Control Valve
GUSB	General Use Storage Building
HDPE	High-density polyethylene
HMI	Human Machine Interface
HSE	Health, Safety and Environmental
MOV	Motor Operated Valve
ND	Naval Distillate
NIRB	Nunavut Impact Review Board
NNF	Nanisivik Naval Facility
NU	Nunavut
NT	Northwest Territories
OHSE	Occupational, Health, Safety and Environmental
O&M	Operations and Maintenance
PLC	Programmable Logic Controller
PM	Project Manager
PPE	Personal Protective Equipment
OHSE	Occupational Health Safety and Environment
RCN	Royal Canadian Navy
RCMP	Royal Canadian Mounted Police

SDS	Safety Data Sheet
SOP	Standard Operation Procedure
SRP	Spill Response Plan
WHMIS	Workplace Hazardous Materials Information Sheet
WOS	Wharf Operator Shelter

Appendix 2. ROLES AND RESPONSIBILITIES

Emergency Response Team (ERT) (on site during occupied period)

The ERT Team will consist of the Superintendent and qualified site personel.

The Emergency Response Team is the first line of defense in emergencies and spill. Assigned personnel to these teams must assure physical capability to perform their duties. The ERT coordinates the site personnel during emergency or spill response.

Discoverer/First Responder

The person who is the primary person involved in a spill, or the first to observe a spill, is the First Responder. The responsibilities of the First Responder are as follows:

- initiate appropriate spill response as described in section 4.3.1.
- in case of a major spill or emergency, sound alarm, initiate Radio Code 1. Remain on the radio to provide guidance to the ERT.
- contact the Facility Supervisor or Project Manager.
- participate in emergency or spill response.

Superintendent (on site during occupied period)

The responsibilities of the Superintendent are as follows:

- evaluate the initial situation and assess the magnitude of the problem.
- contact the Project Manager.
- activate the initial response plan.
- gather facts regarding the spill.
- ensure appropriate PPE is worn and used properly.
- assess the requirements for people, equipment, materials, and tools to contain the spill in light of what resources are immediately available – urgency will depend on the nature of the spill.
- in consultation with the Project Manager and the OHSE agent or designate, mobilize any additional resources that may be required and arrange for the transportation of necessary personnel or materials to the spill site.
- assume complete authority over clean-up personnel and the spill area.
- assume responsibility for all mitigation efforts.
- participate in spill response as a member of the clean-up crew.
- alert and assemble key personnel in the ERT, as deemed appropriate, to handle the situation.
- in consultation with the OHSE Coordinator or Project Manager or designate, develop the overall plan of action for containment and clean-up, and direct and implement the Emergency Response Plan.
- ensure assigned responsibilities are carried out and the activities of team members are coordinated.

Project Manager/Emergency Response Team Coordinator (part-time on the site during occupied period)

The Project Manager will act as the Emergency Response Team Coordinator. He will be required to inform ERT

members of the detailed nature of the operations to be performed in the event of a facility malfunction causing a spill during the operations phase. The responsibilities of the Project Manager or designate are as follows:

- assume responsibility for the mobilization all ERT personnel.
- ensure availability of required equipment, PPE, and supplies.
- liaise with the Superintendent and OHSE Coordinator.
- liaise with National Defense personnel resources and keep them informed of clean-up activities.
- assist the Superintendent and ERT as needed, particularly in obtaining any additional personnel and resources not available on-site for spill response and clean-up.
- assist the Superintendent in obtaining any additional resources not available on-site.
- assist in developing and implementing emergency response training programs and exercises.
- ensure all spill response personnel receive adequate training to fulfil their responsibilities as part of the ERT.
- ensure that the Emergency and Spill Response Plan is exercised at least once a year.

OHSE Coordinator (off-site)

The responsibilities of the **OHSE Coordinator** or designate are as follows:

- manage the OHSE agent on site.
- train all site personnel on OHSE matters.
- implement, maintain and update the ESRP.
- liaise with the Superintendent.
- provide technical advice on the anticipated environmental impacts of spills.
- advise on the effectiveness of various containment, recoveries, and disposal options, and suggest the most appropriate approach.
- prepare and submit any formal report (see Appendix 2 for the Spill Report Form) to regulators and National Defense management detailing the occurrence of a spill or emergency.
- Report the spill to authorities.
- act as the spokesperson with regulatory and government agencies.
- if authorized by the General Manager or delegate, act as a spokesperson with the public and media, as required.
- implement a sampling protocol for the collection and analysis of samples to identify and monitor possible contaminant levels resulting from the spill.
- ensure on-site resources for spill response and clean-ups are available.
- monitor the effectiveness of the clean-up operation and recommend further work, if necessary.
- review incident occurrences and recommend preventative measures.
- ensure a proper training plan and simulation requirements for ERT have been developed and implemented.

OHSE agent (part-time on the site during occupied period)

The responsibilities of the Health and Safety Superintendent or designate in conjunction with the Training Department are as follows:

- conduct site induction, specialized site training and emergency simulation.
- maintain emergency and health and safety records.
- ensure that the environmental and safety equipment are available as described in this ESRP.
- assist in conducting emergency spill response exercises.
- track all spill emergency and health and safety training for on-site staff, including contractors and ensure valid training certification.
- notify the Project Manager when retraining is required for ERT members.
- ensure all personnel retrained in appropriate emergency response skills.

Appendix 3. SDS

SAFETY DATA SHEET

1. Identification

Product identifier	**DIESEL**
Other means of identification	
SDS number	210
Synonyms	Ultra low sulfur Diesel (ULSD) A Ultra low sulfur Diesel (ULSD) B
Recommended use	Fuel, Heating Oil
Recommended restrictions	None known.
Manufacturer/Importer/Supplier/Distributor information	
Manufacturer/Supplier	Énergie Valero Inc. 1801 McGill College, 13e étage Montreal, Quebec H3A 2N4
24-Hour Emergency	Canutec (613) 996-6666
General Information	(888) 871-4404
New Brunswick Poison Information Center	(506) 857-5555
Newfoundland Poison Control Center	(709) 722-1110
Nova Scotia / PEI Poison Control Center	1-800-565-8161
Ontario Regional Poison Information Center	1-800-267-1373 (Ottawa) 1-800-268-9017 (Toronto)
Quebec Poison Control Center	1-800-463-5060

2. Hazard(s) identification

Physical hazards	Flammable liquids	Category 3
Health hazards	Acute toxicity, oral	Category 4
	Acute toxicity, inhalation	Category 4
	Skin corrosion/irritation	Category 2
	Serious eye damage/eye irritation	Category 2
	Carcinogenicity	Category 2
	Specific target organ toxicity following single exposure	Category 1
	Specific target organ toxicity following repeated exposure	Category 2 (Bone Marrow, Liver, Thymus)
	Aspiration hazard	Category 1
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 2
	Hazardous to the aquatic environment, long-term hazard	Category 2

Label elements

Signal word Danger

Hazard statement Flammable liquid and vapour. Harmful if swallowed. May be fatal if swallowed and enters airways. Causes skin irritation. Causes serious eye irritation. Harmful if inhaled. Suspected of causing cancer. Causes damage to organs. May cause damage to organs (Bone Marrow, Liver, Thymus) through prolonged or repeated exposure. Toxic to aquatic life with long lasting effects.

Precautionary statements

Prevention Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Keep container tightly closed. Ground and bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting equipment. Use non-sparking tools. Take action to prevent static discharges. Do not breathe mist or vapour. Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection.

Response IF SWALLOWED: Immediately call a POISON CENTRE/doctor. Rinse mouth. Do NOT induce vomiting. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water. IF INHALED: Remove person to fresh air and keep comfortable for breathing. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. IF exposed or concerned: Call a POISON CENTRE/doctor. If skin irritation occurs: Get medical advice/attention. If eye irritation persists: Get medical advice/attention. Take off contaminated clothing and wash it before reuse. In case of fire: Use appropriate media to extinguish. Collect spillage.

Storage Store in a well-ventilated place. Keep cool. Store locked up.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Other hazards None known.

Supplemental information None.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Fuels, diesel	68334-30-5	0 - 100
Fuels, diesel, C9-18-alkane branched and linear	1159170-26-9	0 - 30

Additional components	CAS number	%
Nonane	111-84-2	≤ 3
Octane	111-65-9	≤ 2
Toluene	108-88-3	≤ 1
Xylene	1330-20-7	≤ 1
Ethylbenzene	100-41-4	≤ 1

Composition comments All concentrations are in percent by weight.

4. First-aid measures

Inhalation Remove victim to fresh air and keep at rest in a position comfortable for breathing. Oxygen or artificial respiration if needed. Call a POISON CENTRE or doctor/physician if you feel unwell.

Skin contact Take off immediately all contaminated clothing. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.

Eye contact Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention if irritation develops and persists.

Ingestion Call a physician or poison control centre immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.

Most important symptoms/effects, acute and delayed Aspiration may cause pulmonary oedema and pneumonitis. Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Skin irritation. May cause redness and pain. Jaundice. Prolonged exposure may cause chronic effects.

Indication of immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Thermal burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital. Keep victim warm. Keep victim under observation. Symptoms may be delayed.

General information	Take off all contaminated clothing immediately. IF exposed or concerned: Get medical advice/attention. If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before reuse.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	Vapours may form explosive mixtures with air. Vapours may travel considerable distance to a source of ignition and flash back. During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	In case of fire and/or explosion do not breathe fumes. Move containers from fire area if you can do so without risk.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	Flammable liquid and vapour.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Wear appropriate protective equipment and clothing during clean-up. Do not breathe mist or vapour. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ventilate closed spaces before entering them. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Keep combustibles (wood, paper, oil etc) away from spilled material. Take precautionary measures against static discharge. Use only non-sparking tools. Prevent entry into waterways, sewer, basements or confined areas. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Following product recovery, flush area with water. Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. Put material in suitable, covered, labeled containers. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Explosion-proof general and local exhaust ventilation. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Use non-sparking tools and explosion-proof equipment. Do not breathe mist or vapour. Do not taste or swallow. Avoid contact with eyes, skin, and clothing. Avoid prolonged exposure. When using, do not eat, drink or smoke. Should be handled in closed systems, if possible. Use only outdoors or in a well-ventilated area. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Avoid release to the environment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store locked up. Keep away from heat, sparks and open flame. Prevent electrostatic charge build-up by using common bonding and grounding techniques. Store in a cool, dry place out of direct sunlight. Store in original tightly closed container. Store in a well-ventilated place. Keep in an area equipped with sprinklers. Store away from incompatible materials (see section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
Fuels, diesel (CAS 68334-30-5)	TWA	100 mg/m3	Inhalable fraction and vapor.
Additional components	**Type**	**Value**	
Nonane (CAS 111-84-2)	TWA	200 ppm	
Octane (CAS 111-65-9)	TWA	300 ppm	
Toluene (CAS 108-88-3)	TWA	20 ppm	
Xylene (CAS 1330-20-7)	STEL	150 ppm	
	TWA	100 ppm	
Ethylbenzene (CAS 100-41-4)	TWA	20 ppm	

Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2)

Components	Type	Value
Fuels, diesel (CAS 68334-30-5)	TWA	100 mg/m3
Additional components	**Type**	**Value**
Nonane (CAS 111-84-2)	TWA	1050 mg/m3 200 ppm
Octane (CAS 111-65-9)	TWA	1400 mg/m3 300 ppm
Toluene (CAS 108-88-3)	TWA	188 mg/m3 50 ppm
Xylene (CAS 1330-20-7)	STEL	651 mg/m3 150 ppm
	TWA	434 mg/m3 100 ppm
Ethylbenzene (CAS 100-41-4)	STEL	543 mg/m3 125 ppm
	TWA	434 mg/m3 100 ppm

Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Substances, Occupational Health and Safety Regulation 296/97, as amended)

Components	Type	Value	Form
Fuels, diesel (CAS 68334-30-5)	TWA	100 mg/m3	Vapour and aerosol.
Additional components	**Type**	**Value**	
Nonane (CAS 111-84-2)	TWA	200 ppm	
Octane (CAS 111-65-9)	TWA	300 ppm	
Toluene (CAS 108-88-3)	TWA	20 ppm	
Xylene (CAS 1330-20-7)	STEL	150 ppm	
	TWA	100 ppm	
Ethylbenzene (CAS 100-41-4)	TWA	20 ppm	

Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act)

Components	Type	Value	Form
Fuels, diesel (CAS 68334-30-5)	TWA	100 mg/m3	Inhalable fraction and vapor.
Additional components	**Type**	**Value**	
Nonane (CAS 111-84-2)	TWA	200 ppm	
Octane (CAS 111-65-9)	TWA	300 ppm	
Toluene (CAS 108-88-3)	TWA	20 ppm	
Xylene (CAS 1330-20-7)	STEL	150 ppm	

Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act)

Additional components	Type	Value
	TWA	100 ppm
Ethylbenzene (CAS 100-41-4)	TWA	20 ppm

Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents)

Components	Type	Value	Form
Fuels, diesel (CAS 68334-30-5)	TWA	100 mg/m3	Inhalable fraction and vapor.

Additional components	Type	Value
Nonane (CAS 111-84-2)	TWA	200 ppm
Octane (CAS 111-65-9)	TWA	300 ppm
Toluene (CAS 108-88-3)	TWA	20 ppm
Xylene (CAS 1330-20-7)	STEL	150 ppm
	TWA	100 ppm
Ethylbenzene (CAS 100-41-4)	TWA	20 ppm

Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety)

Additional components	Type	Value
Nonane (CAS 111-84-2)	TWA	1050 mg/m3
		200 ppm
Octane (CAS 111-65-9)	STEL	1750 mg/m3
		375 ppm
	TWA	1400 mg/m3
		300 ppm
Toluene (CAS 108-88-3)	TWA	188 mg/m3
		50 ppm
Xylene (CAS 1330-20-7)	STEL	651 mg/m3
		150 ppm
	TWA	434 mg/m3
		100 ppm
Ethylbenzene (CAS 100-41-4)	STEL	543 mg/m3
		125 ppm
	TWA	434 mg/m3
		100 ppm

Biological limit values

ACGIH Biological Exposure Indices

Additional components	Value	Determinant	Specimen	Sampling Time
Toluene (CAS 108-88-3)	0.3 mg/g	o-Cresol, with hydrolysis	Creatinine in urine	*
	0.03 mg/l	Toluene	Urine	*
	0.02 mg/l	Toluene	Blood	*
Xylene (CAS 1330-20-7)	1.5 g/g	Methylhippuric acids	Creatinine in urine	*
Ethylbenzene (CAS 100-41-4)	0.15 g/g	Sum of mandelic acid and phenylglyoxylic acid	Creatinine in urine	*

* - For sampling details, please see the source document.

Exposure guidelines

Canada - Alberta OELs: Skin designation

Toluene (CAS 108-88-3) Can be absorbed through the skin.

Canada - British Columbia OELs: Skin designation

Fuels, diesel (CAS 68334-30-5) Can be absorbed through the skin.

Canada - Manitoba OELs: Skin designation

Fuels, diesel (CAS 68334-30-5) Can be absorbed through the skin.

Canada - Ontario OELs: Skin designation

Fuels, diesel (CAS 68334-30-5)	Can be absorbed through the skin.

Canada - Quebec OELs: Skin designation

Toluene (CAS 108-88-3)	Can be absorbed through the skin.

Canada - Saskatchewan OELs: Skin designation

Fuels, diesel (CAS 68334-30-5)	Can be absorbed through the skin.
Toluene (CAS 108-88-3)	Can be absorbed through the skin.

US ACGIH Threshold Limit Values: Skin designation

Fuels, diesel (CAS 68334-30-5)	Can be absorbed through the skin.

Appropriate engineering controls Explosion-proof general and local exhaust ventilation. Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash fountain and emergency showers are recommended.

Individual protection measures, such as personal protective equipment

Eye/face protection Chemical goggles are recommended.

Skin protection

Hand protection Wear appropriate chemical resistant gloves. Viton or nitrile rubber gloves are recommended.

Other Wear appropriate chemical resistant clothing. Use of an impervious apron is recommended.

Respiratory protection Chemical respirator with organic vapour cartridge and full facepiece.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Observe any medical surveillance requirements. When using do not smoke. Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Liquid.

Form Liquid.

Colour Clear to yellow color.

Odour Not available.

Odour threshold Not available.

pH Not available.

Melting point/freezing point Not available.

Initial boiling point and boiling range 145 - 375 °C (293 - 707 °F)

Flash point >= 40.0 °C (>= 104.0 °F)

Evaporation rate 0.2 BuAc

Flammability (solid, gas) Not applicable.

Upper/lower flammability or explosive limits

Flammability limit - lower (%) 0.7 %

Flammability limit - upper (%) 5 %

Vapour pressure 0.27 kPa at 15 deg C

Vapour density Not available.

Relative density 0.78 - 0.88 g/ml

Solubility(ies)

Solubility (water) Not available.

Partition coefficient (n-octanol/water) Not available.

Auto-ignition temperature > 220 °C (> 428 °F)

Decomposition temperature	Not available.
Viscosity	1.3 - 4.1 cSt (40 °C)
Other information	
Explosive properties	Not explosive.
Oxidising properties	Not oxidising.

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Hazardous polymerisation does not occur.
Conditions to avoid	Avoid heat, sparks, open flames and other ignition sources. Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidising agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Harmful if inhaled. May cause damage to organs by inhalation. May cause damage to organs through prolonged or repeated exposure by inhalation.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye irritation.
Ingestion	Harmful if swallowed. Droplets of the product aspirated into the lungs through ingestion or vomiting may cause a serious chemical pneumonia.
Symptoms related to the physical, chemical and toxicological characteristics	Aspiration may cause pulmonary oedema and pneumonitis. Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Skin irritation. May cause redness and pain. Jaundice.

Information on toxicological effects

Acute toxicity	May be fatal if swallowed and enters airways. Harmful if inhaled.

Toxicological data

Additional components	Species	Test Results
Toluene (CAS 108-88-3)		
Acute		
Dermal		
LD50	Rabbit	12200 mg/kg
Inhalation		
Vapour		
LC50	Rat	28.1 mg/l, 4 Hours
Xylene (CAS 1330-20-7)		
Acute		
Oral		
LD50	Rat	3523 mg/kg
Ethylbenzene (CAS 100-41-4)		
Acute		
Dermal		
LD50	Rabbit	15400 mg/kg
Inhalation		
LC50	Rat	17.4 mg/l, 4 hours
Oral		
LD50	Rat	3500 - 4700 mg/kg

Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	Causes serious eye irritation.

Respiratory or skin sensitisation

Canada - Alberta OELs: Irritant

Octane (CAS 111-65-9)	Irritant

Respiratory sensitisation Not a respiratory sensitiser.

Skin sensitisation This product is not expected to cause skin sensitisation.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity Suspected of causing cancer.

ACGIH Carcinogens

Ethylbenzene (CAS 100-41-4)	A3 Confirmed animal carcinogen with unknown relevance to humans.
Fuels, diesel (CAS 68334-30-5)	A3 Confirmed animal carcinogen with unknown relevance to humans.
Toluene (CAS 108-88-3)	A4 Not classifiable as a human carcinogen.
Xylene (CAS 1330-20-7)	A4 Not classifiable as a human carcinogen.

Canada - Manitoba OELs: carcinogenicity

Ethylbenzene (CAS 100-41-4)	Confirmed animal carcinogen with unknown relevance to humans.
Fuels, diesel (CAS 68334-30-5)	Confirmed animal carcinogen with unknown relevance to humans.
Toluene (CAS 108-88-3)	Not classifiable as a human carcinogen.
Xylene (CAS 1330-20-7)	Not classifiable as a human carcinogen.

IARC Monographs. Overall Evaluation of Carcinogenicity

Ethylbenzene (CAS 100-41-4)	2B Possibly carcinogenic to humans.
Toluene (CAS 108-88-3)	3 Not classifiable as to carcinogenicity to humans.
Xylene (CAS 1330-20-7)	3 Not classifiable as to carcinogenicity to humans.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Causes damage to organs.

Specific target organ toxicity - repeated exposure May cause damage to organs (Bone Marrow, Liver, Thymus) through prolonged or repeated exposure.

Aspiration hazard May be fatal if swallowed and enters airways.

Chronic effects May cause damage to organs through prolonged or repeated exposure. Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity Toxic to aquatic life with long lasting effects.

Components		Species	Test Results
Fuels, diesel (CAS 68334-30-5)			
Aquatic			
Acute			
Crustacea	EL50	Daphnia	13 mg/l, 48 Hours
Fish	LL50	Oncorhynchus mykiss	21 mg/l, 96 Hours
Additional components		**Species**	**Test Results**
Octane (CAS 111-65-9)			
Aquatic			
Crustacea	LC50	Daphnia magna	0.38 mg/l, 48 hours
Toluene (CAS 108-88-3)			
Aquatic			
Acute			
Crustacea	EC50	Daphnia magna	11.5 mg/l, 48 hours
Fish	LC50	Oncorhynchus kisutch	5.5 mg/l, 96 hours
Chronic			
Crustacea	NOEC	Ceriodaphnia dubia	0.74 mg/l, 7 days
Fish	NOEC	Oncorhynchus kisutch	1.4 mg/l, 40 days

Additional components		Species	Test Results
Xylene (CAS 1330-20-7)			
Aquatic			
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	2.6 mg/l, 96 hours
Ethylbenzene (CAS 100-41-4)			
Aquatic			
Acute			
Crustacea	EC50	Water flea (Daphnia magna)	1.81 - 2.38 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	4.2 mg/l, 96 hours
Chronic			
Crustacea	EC50	Ceriodaphnia dubia	3.6 mg/l, 7 days

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential No data available.

Mobility in soil Expected to be mobile in soil.

Other adverse effects No data available.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

TDG

UN number UN1202

UN proper shipping name DIESEL FUEL, (MARINE POLLUTANT)

Transport hazard class(es)

Class Combustible Liquid

Subsidiary risk -

Packing group III

Environmental hazards Yes

Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

IATA

UN number UN1202

UN proper shipping name Gas oil, (Marine Pollutant)

Transport hazard class(es)

Class 3

Subsidiary risk -

Packing group III

Environmental hazards Yes

ERG Code 3L

Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number UN1202

UN proper shipping name DIESEL FUEL, (MARINE POLLUTANT)

Transport hazard class(es)

Class 3

Subsidiary risk	-
Packing group	III
Environmental hazards	
Marine pollutant	Yes
EmS	F-E, S-E
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.
General information	IMDG Regulated Marine Pollutant.

15. Regulatory information

Canadian regulations This product has been classified in accordance with the hazard criteria of the HPR and the SDS contains all the information required by the HPR.

Controlled Drugs and Substances Act

Not regulated.

Export Control List (CEPA 1999, Schedule 3)

Not listed.

Greenhouse Gases

Not listed.

Ontario. Toxic Substances. Toxic Reduction Act, 2009. Regulation 455/09 (July 1, 2011)

Ethylbenzene (CAS 100-41-4)
Toluene (CAS 108-88-3)
Xylene (CAS 1330-20-7)

Precursor Control Regulations

Toluene (CAS 108-88-3)	Class B

International regulations

Stockholm Convention

Not applicable.

Rotterdam Convention

Not applicable.

Kyoto Protocol

Not applicable.

Montreal Protocol

Not applicable.

Basel Convention

Not applicable.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	No
Canada	Domestic Substances List (DSL)	No
Canada	Non-Domestic Substances List (NDSL)	Yes
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	No
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	No

Country(s) or region	Inventory name	On inventory (yes/no)*
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information

Issue date 20-June-2017

Revision date 15-March-2018

Version No. 02

Disclaimer Énergie Valero Inc. cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

Appendix 4. NNF INSPECTION/LEAK MONITORING CHECKLIST

NNF INSPECTION/LEAK MONITORING CHECKLIST

Instructions: All the preventive maintenance must be logged in the sheet below and the checklist must be updated every year

INSPECTION/LEAK MONITORING	Leak detection/ Spill Prevention	Fire Detection and Prevention	During shutdown period	Season Start	Before Fuel Transfer	During fuel Transfer	After fuel Transfer	Season End	Specific	Daily	Weekly	Monthly	Once during operating season	When filled with fuel	Reference	Comments
BULK LIQUID FACILITY - General, ND and DF																
Environmental and Safety Equipment																
Spill kit inspection	x			x				x	After a spill						NNF O&M	
Life ring, air horn conditions and location	x			x	x										NNF O&M	
Safety Boat general inspection and trial	x			x	x						x				NNF O&M	
Spill boom general inspection	x			x											Versatech Inshore Boom Manual	
Spill Boom Reel Test	x			x											Versatech Boom Reel Operation and Maintenance Instructions	
Portable Secondary Containment Berm	x			x											Insta-Berm Operations Manual	
Secondary Containment Discharge pump lubrication change (seal and bearing)	x			x											Gorman -Rupp centrifugal pumps Manuals	
Secondary Containment Discharge pump lubrication (alignment, shaft, bearings, pipingm front and rear impeller clearance, clean air release valve plunger rod)	x			x											Gorman -Rupp centrifugal pumps Manuals	
Secondary Containment Discharge pump general conditions noise, vibration, , loose hardware, pump performance, bearing and seal lubrification check)	x				x	x									Gorman -Rupp centrifugal pumps Manuals	
Emergency shutdown button (ESD)																
Function test HXS-100 (ND pump platform)	x			x							x				NNF O&M	
Function test HXS-200 (DF pump platform)	x			x							x				NNF O&M	
Function test HXS-300 (in the E-House)	x			x							x				NNF O&M	
Function test HXS-400 (in the WOS)	x			x							x				NNF O&M	
Function test HXS-800 (near wharf manifold area)	x			x							x				NNF O&M	
Function test HXS U-201	x			x							x				NNF O&M	
Function test HXS SSFS	x			x							x				NNF O&M	
Site Wide Horns and beacons (YA-800, YI-800) (ND and DF)																
Horns and beacons general condition, gently clean exterior if required	x										x				Technical Manual for the Strobe XB11 Technical Manual for the Horn DB3	
Horns and beacons test	x			x							x				Technical Manual for the Strobe XB11 Technical Manual for the Horn DB3	
ND Tank T-110 and T-120																
Inspection of ND secondary containment (10 inspection wells) and containment berm	x		x	x							x				NNF O&M	
Verification of leaks with the valve on the perimeter of the double bottom	x			x							x				NNF O&M	
ND Tanks T-110 and T-120 exterior inspection	x		x	x							x				NNF O&M	
ND Tanks T-110 and T-120 vent, piping, cabling and label inspection	x			x								x			NNF O&M	
ND Tank T-110 and T-120 MARLANT Tank Management Plan (MTMP) - ANNEX F1 (see tab MTMP ANN F1)	x			x								x			MARLANT Tank Management Plan	
ND Tanks T-110 and T-120 lifting eyes, platform, welding, structural damage and general deterioration inspection	x			x				x				x			NNF O&M	
ND Tank T-110 and T-120 MARLANT Tank Management Plan (MTMP) - ANNEX F1 (see tab MTMP ANN G1)	x			x				x				x			MARLANT Tank Management Plan	
ND Tanks T-110 and T-120 settlement survey	x			x									x		NNF O&M	
Sump inspection (2)	x		x	x							x				NNF O&M	
External wall thickness measurement	x								5 years						API653	
Internal and external wall thickness measurement	x								10 years						API653	

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DF Tanks (T-210 and T-220)																
Inspection of vacuum for double wall tanks (Diesel Fuel Tanks T-210) (log vacuum gauge reading)	x		x	x	x						x				Industries Desjardins installation and maintenance guide	If a continuous decrease/increase in vacuum gauge reading occurs or the reading falls below 42 kPa (12 in Hg), contact the manufacturer or his agent;
Inspection of vacuum for double wall tanks (Diesel Fuel Tanks T-220) (log vacuum gauge reading)	x		x	x	x						x				Industries Desjardins installation and maintenance guide	If a continuous decrease/increase in vacuum gauge reading occurs or the reading falls below 42 kPa (12 in Hg), contact the manufacturer or his agent;
Inspection of secondary containment of T-210 and T-220	x		x													
DFTanks Inspection T-210 and T-220: - Inspect tank exterior for any damages.	x		x	x							x				Industries Desjardins installation and maintenance guide	
DF Tank T-210 and T-220 MARLANT Tank Management Plan (MTMP) - ANNEX F1 (see tab MTMP ANN 1)	x			x								x			MARLANT Tank Management Plan	
DFTanks Inspection T-210 and T-220: - check that emergency vents open and close easily and that they are unobstructed; - check that normal vent is unobstructed; - Inspect all plumbing components for signs of leakage and make necessary repairs; - Check the integrity of the structure monokote - Inspect motor/pump and electrical connections and make necessary repairs; - Inspect piping and cabling, and make necessary repairs ; and - Ensure that all labels are kept legible at all times.	x			x								x			Industries Desjardins installation and maintenance guide	
DFTanks Inspection T-210 and T-220: - Visual inspect the main tank, the lifting eyes and the platform and ramp for signs of rust, check for cracked welds, structural damage or general deterioration; - Inspect painted surfaces twice yearly; and - Inspect and tighten reservoir support nuts and bolts, if necessary.	x			x				x							Industries Desjardins installation and maintenance guide	
DF Tank T-210 and T-220 MARLANT Tank Management Plan (MTMP) - ANNEX F1 (see tab MTMP ANN G1)	x			x				x							MARLANT Tank Management Plan	
Sump inspection (1)	x		x	x							x				NNF O&M	
ND and DF Piping and pipe support																
Piping general external visual inspection (conditions, painting, coating, and associated hardware to check for signs of misalignment, vibration)	x			x	x	x						x			NNF O&M	
Piping thorough inspection, vibration, bearing temperature,	x					x									NNF O&M	
Piping leak detection (flanges, gaskets, seals, valves, etc.)	x				x	x									NNF O&M	
Piping thickness measurement	x			x											NNF O&M	
Double wall piping inspection and monitoring (pipe thourgh ND bermed area between the two ND tanks - ND-250-A1-2201) Record vacuum gauge reading	x			x	x						x				NNF O&M	
Double wall piping inspection and monitoring (pipe thourgh ND bermed area between the two ND tanks - ND-50-A1-2225) Record vacuum gauge reading	x			x	x						x				NNF O&M	
Double wall piping inspection and monitoring (pipe thourgh ND bermed area between the two ND tanks - ND-250-A1-2202) Record vacuum gauge reading	x			x	x						x				NNF O&M	
Double wall piping inspection and monitoring (pipe thourgh ND bermed area on the east side -ND-50-A1-2225) Record vacuum gauge reading	x			x	x						x				NNF O&M	
Double wall piping inspection and monitoring (pipe thourgh ND bermed area on the east side -ND-250-A1-2202) Record vacuum gauge reading	x			x	x						x				NNF O&M	
Pipe supports inspection and adjustement	x			x								x			NNF O&M	
ND Tank (T-110 and T-120) connections inspection and adjustement	x			x								x			NNF O&M	

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WHARF MANIFOLD																
Wharf manifold leak monitoring	x				x	x									NNF O&M	
Wharf manifold general external visual inspection (conditions, painting, coating and associated hardware to check for signs of misalignment, wear, vibration)	x			x	x	x						x			NNF O&M	
DRIP PANS																
Drip pans general external visual inspection (conditions, painting, and associated hardware to check for signs of misalignment, wear, vibration)	x			x	x	x						x			NNF O&M	
HOSES																
Hose general inspection/certification (pressure test and electrical continuity test)	x		x (if done off-site)	x	x										NNF O&M	Required an annual certification from Transport Canada, tag with date, test pressure, person and company performing the test
Hose visual inspection					x											
Hose and/or flanges leak detection	x				x	x									NNF O&M	
Instrument																
LIT-111 function test	x			x											NNF O&M	
LIT-121 function test	x			x											NNF O&M	
LIT-211 function test	x			x											NNF O&M	
LIT-221 function test	x			x											NNF O&M	
LSHH (LSHH-112, LSH-122, LSHH-212, LSHH-222)																
LSHH-112 function test	x			x												
LSHH-122 function test	x			x												
LSHH-212 function test	x			x												
LSHH-222 function test	x			x												

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INSPECTION/LEAK MONITORING	Leak detection/ Spill Prevention	Fire Detection and Prevention	During shutdown period	Season Start	Before Fuel Transfer	During fuel Transfer	After fuel Transfer	Season End	Specific	Daily	Weekly	Monthly	Once during operating season	When filled with fuel	Reference	Comments
Fire Protection and Detection																
Fire Alarm Control Panel and Annunciator		**x**														
Fire Alarm Control Panel Check Status (UPF-300) (AC power and trouble light)		x		x						x					Fire Alarm Control Panel NFS-320 Operations Manual	
Fire Alarm annunciator Check Status (UPA-400) (AC power and trouble light)		x		x						x						
Fire Alarm Control Panel Status (UPF-700) (AC power and trouble light)		x		x						x					Fire Alarm Control Panel NFS-320 Operations Manual	
Fire Alarm annunciator Check Status (UPA-700) (AC power and trouble light)		x		x						x						
Flame Detector																
Flame detectors test (ATS-101) cleaning											x				SharpEye Flame Detector User Guide	
Flame detectors test (ATS-201) cleaning											x				SharpEye Flame Detector User Guide	
Flame detectors test (ATS-801) cleaning											x				SharpEye Flame Detector User Guide	
Flame detectors test (ATS-101) functional test		x		x											SharpEye Flame Detector User Guide	Part of the fire protection system annual certification
Flame detectors test (ATS-201) functional test		x		x											SharpEye Flame Detector User Guide	Part of the fire protection system annual certification
Flame detectors test (ATS-801) functional test		x		x											SharpEye Flame Detector User Guide	Part of the fire protection system annual certification
Fire Horn and strobe																
Horn and strobe functional test YA/301 YI-301		x		x							x				NNF O&M	
Horn and strobe functional test YA/302 YI-302		x		x							x				NNF O&M	
Horn and strobe functional test YA/401 YI-401		x		x							x				NNF O&M	
Horn and strobe functional test YA/402 YI-402		x		x							x				NNF O&M	
Horn and strobe functional test YA/601 YI-602		x		x							x				NNF O&M	
Horn and strobe functional test YA/601 YI-602		x		x							x				NNF O&M	
Other Fire Protection Check																
Check to ensure yards, roadways and GUSB are kept clear for fire service access		x								x					NNF O&M	
Check hoods, filters, and ducts subject to the accumulation of deposits		x		x							x				NNF O&M	
Check all existing lights equipped with bulbs		x		x							x				NNF O&M	
Test fire drill		x		x								x			NNF O&M	
Inspect fire alarm batteries		x		x								x			NNF O&M	
Test fire alarm system		x		x								x			NNF O&M	
Inspect disconnected switches for mechanical air for the ventilation systems		x		x											NNF O&M	
Inspect fire dampers		x		x											NNF O&M	
Inspect and recharge extinguishers after use or as indicated by an inspection or when performing maintenance		x		x											NNF O&M	
Position all fire extinguishers and fire blankets		x		x								x			NNF O&M	
Recharge AFFF foam extinguisher (3 on wheel and 1 portable)		x		x											NNF O&M	
Empty or store in heated container AFFF foam extinguishers (3 on wheel and 1 portable)		x						x							NNF O&M	
Hand-held extinguishers inpection and maintenane by specialist		x		x					Emptied and service every 6 years			x			NNF O&M	Inspection every year (certification tag)
Fire blankets verification		x		x											NNF O&M	Hanged vinyl bags with a wool blanket are also installed near the entry door inside wall of each E-House, GUSB, WOS

Appendix 5. SPILL REPORTING FORM

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND
OTHER HAZARDOUS MATERIALS

NT-NU 24-HOUR SPILL REPORT LINE
Tel: (867) 920-8130 ● Fax: (867) 873-6924 ● Email: spills@gov.nt.ca

REPORT LINE USE ONLY

A	Report Date: MM DD YY	Report Time:	☐ Original Spill Report **OR** ☐ Update # _____ to the Original Spill Report	**Report Number:**
B	Occurrence Date: MM DD YY	Occurrence Time:		
C	Land Use Permit Number (if applicable):		Water Licence Number (if applicable):	
D	Geographic Place Name or Distance and Direction from the Named Location:		Region: ☐ NT ☐ Nunavut ☐ Adjacent Jurisdiction or Ocean	
E	Latitude: _____ Degrees _____ Minutes _____ Seconds		Longitude: _____ Degrees _____ Minutes _____ Seconds	
F	Responsible Party or Vessel Name:		Responsible Party Address or Office Location:	
G	Any Contractor Involved:		Contractor Address or Office Location:	
H	Product Spilled: ☐ Potential Spill	Quantity in Litres, Kilograms or Cubic Metres:	U.N. Number:	
I	Spill Source:	Spill Cause:	Area of Contamination in Square Metres:	
J	Factors Affecting Spill or Recovery:	Describe Any Assistance Required:	Hazards to Persons, Property or Environment:	
K	Additional Information, Comments, Actions Proposed or Taken to Contain, Recover or Dispose of Spilled Product and Contaminated Materials:			

L	Reported to Spill Line by:	Position:	Employer:	Location Calling From:	Telephone:
M	Any Alternate Contact:	Position:	Employer:	Alternate Contact Location:	Alternate Telephone:

REPORT LINE USE ONLY

N	Received at Spill Line by:	Position:	Employer:	Location Called:	Report Line Number:

Lead Agency: ☐ EC ☐ CCG/TCMSS ☐ GNWT ☐ GN ☐ ILA ☐ AANDC ☐ NEB ☐ Other: _____

Significance: ☐ Minor ☐ Major ☐ Unknown

File Status: ☐ Open ☐ Closed

Agency:	**Contact Name:**	**Contact Time:**	**Remarks:**
Lead Agency:			
First Support Agency:			
Second Support Agency:			
Third Support Agency:			

Appendix 6. SPILL LOG

Spill Log

Date of the spill (YY/MM/DD)	Spill Source (tag)	Spilled Product	Spill Cause	Description of the event	Quantity released (L)	Affected Area (m2)	Hazards to persons, property or environment	Person presents

Appendix 7. SPILL RESPONSE EQUIPMENT SPECIFICATION AND MANUAL

- Spill Boom

- Secondary Containment Berm (insta-berm)

-Pump

This Appendix includes:

- Containment boom data sheets, boom reel drawing and open side container

-Operating and Maintenance Instruction

-Inshore Boom Manual

ALMIQ CONTRACTING LTD.

SHOP DRAWING / SAMPLE / PRODUCT DATA

IDENTIFICATION FORM

T : 418-668-3321
F : 418-668-0652

1340, Ulu Lane, P.O. Box 2140, Iqaluit, NU X0A 0H0

PROJECT : **CONSTRUCTION OF NANISIVIK NAVAL FACILITY, NU**			**Submittal NO.**	**SUB-ALM-DCC-358**		
OWNER : **DEFENCE CONSTRUCTION CANADA**			**Revision NO.**	0	**Date:**	2017-03-07
			Revision NO.	01	**Date:**	2017-03-16
PROJECT NO. : **NPO1301**	CONTRACT NO. : **55668 CN**	OUR FILE NO. : **148926**	**Revision NO.**		**Date:**	
			Revision NO.		**Date:**	

DISCIPLINE :

CONTRACTOR /SUB-CONTRACTOR :
Almiq Contracting LTD
1340, Ulu Lane, PO Box 2140
Iqaluit (NU) X0A 0H0

Person in Charge : Marc Deschênes
Phone : 418-668-3321.214 *Fax :*

MANUFACTURER :

Person in Charge :
Phone : *Fax :*

SHOP DRAWINGS, PRODUCT DESCRIPTION OR SAMPLE SUBMITTED FOR APPROVAL:

Containment Booms

WORLEYPARSONS CANADA LTD.
Infrastructure & Environment
Drawing Review

REVIEWED ..... [X]
REVIEWED AS MODIFIED ..... [___]
REVISE AND RE-SUBMIT..... [___]
NOT REVIEWED ..... [___]

Reviewed only as to general conformity with the design concept. The engineer does not warrant or represent that the information contained on this drawing is either accurate or complete. Sole responsibility for correct design, details and dimensions shall remain with the party submitting the drawings.

WORLEYPARSONS CANADA LTD.
By: Graham Hirst
Date: 3 April 2017

NOTES :

We declare that we have verified the attached documents and/or sample, that they are in compliance with the contract documents and are approved for the construction of the project.

Marc Deschênes Ing., Project Manager
Contractor's Representative

Signature

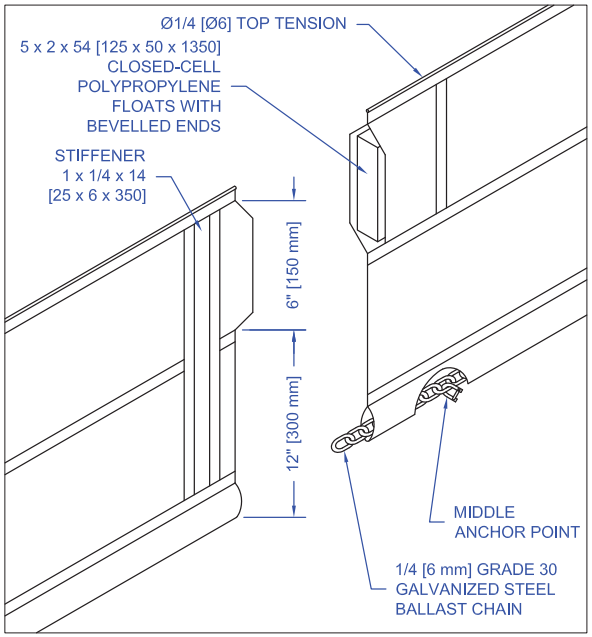
2017-03-16
Date

Pollution Control and
Spill Response Specialists
An ISO 9001:2008 Certified Company

Inshore-450 Fence Boom Product Sheet

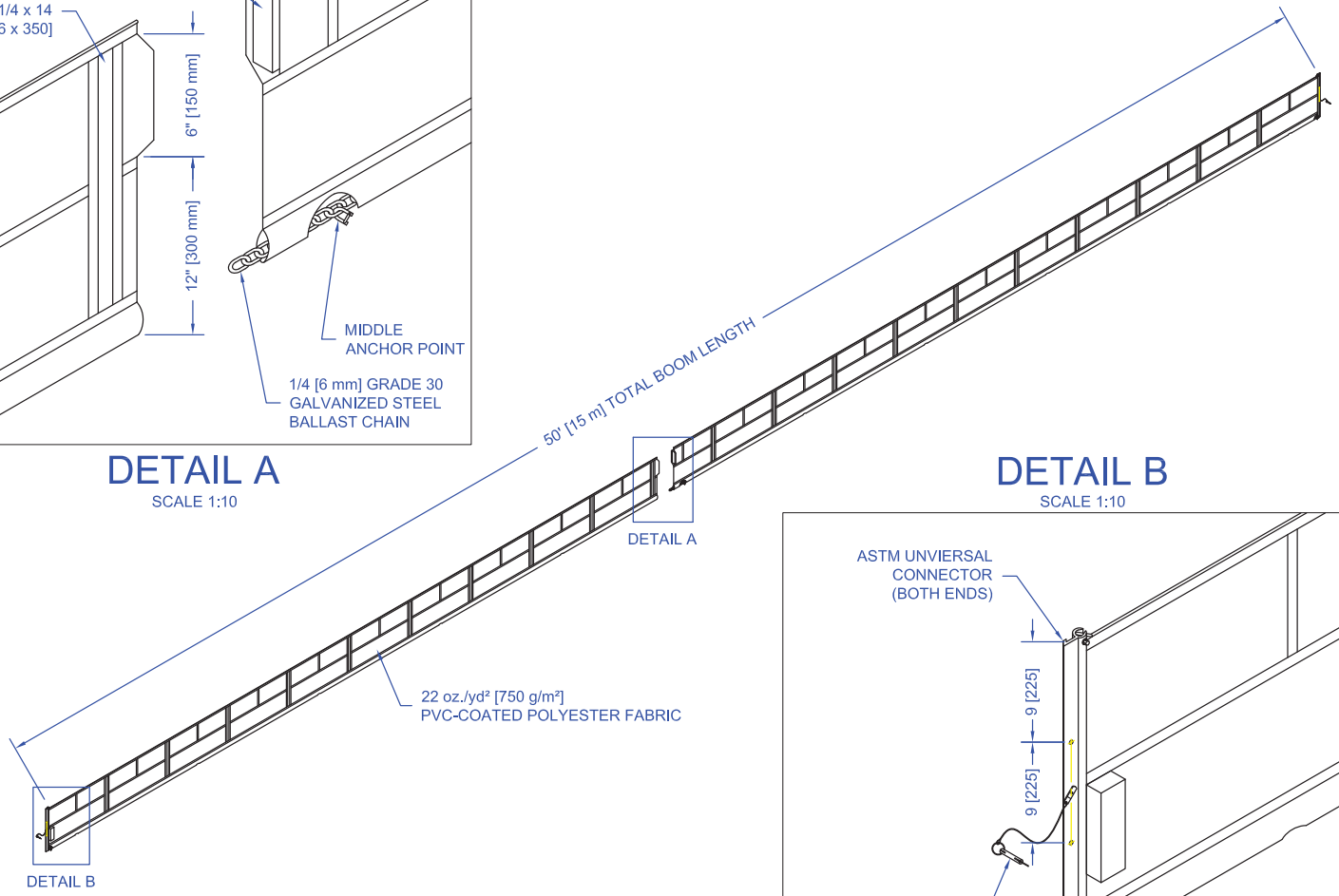
Freeboard:	6”	150 mm
Draft:	12”	300 mm
O/A height:	18”	450 mm
Fabric Material:	PVC	
Fabric Weight:	22 oz/sq. yd	750 gsm
Fabric Low Temp Cold Crack:	-40 °F	-40 °C
Section Length:	50 ft	15.25 m
Ballast (grade 30 galvanized steel):	1/4”	6.4 mm
Top Tension (7x19 SS Aircraft Cable)	¼”	6.4 mm
Floatation (closed-cell rectangular polyethylene floats)		
Float Length:	54”	45 cm
Float Width:	5”	13 cm
Float Thickness:	2”	5 cm
Fold Length:	5’	1.5 m
Number of Sections:	27 x 15 m (Stored on Reel) 1 x 10 m (Stored on Reel) 2 x 15 m (as spares)	
Fabric Colour:	International Yellow	
Construction:	Fully welded using 100% radio frequency welding	
Connectors:	ASTM F2438 Universal Connectors and S/S Toggle Pins	
Fasteners:	Grade 316 Stainless Steel	
Seams:	100% radio frequency welded	
Drainage Holes:	Every 10 ft / 3 m	
Handles	Every 10 ft / 3 m	
Silk Screen:	Versatech	
Anchor Points:	via shackles, located at the midpoint of each section	
Tow Lines:	2 x 30 m Polypropylene Tow Lines with Tow Bridles	

VERSATECH PRODUCTS INC.
MANUFACTURERS OF ENVIRONMENTAL POLLUTION CONTROL EQUIPMENT
4623 Byrne Road, Burnaby, BC, Canada V5J 3H6
Telephone: (604) 271-7500 Fax: (604) 271-7501
E-Mail: info@versatech.com Web Site: www.versatech.com



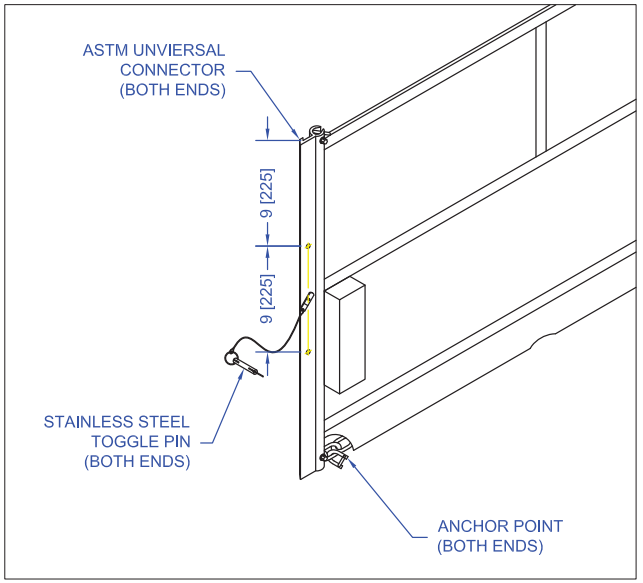
DETAIL A

SCALE 1:10



DETAIL B

SCALE 1:10



NOTES:
1. ALL DIMENSIONS GIVEN IN INCHES & [mm] UNLESS OTHERWISE SPECIFIED

Issue	Date	Description	By	Chkd.
0	02-03-2017	INITIAL-DRAFT	OJ	-

Client:
LAVAL FORTIN

Title:
INSHORE-450 BOOM GENERAL ARRANGEMENT

Scale: 1:75

Prepared by:	Checked:	Date:
JKNEESHAW	-	28-05-2012

Internal Project Number: 5686

VERSATECH PRODUCTS INC.
4573 Byrne Rd.
Burnaby, BC, Canada
V5J 3H6
Tel: 604-271-7500 • Fax: 604-271-7501
Toll Free 1-866-485-8377
ENVIRONMENTAL CONTAINMENT & SPILL RESPONSE PRODUCTS
www.versatech.com

Drawing No.: 7112-B-001-GA

Issue: 1

Pollution Control and
Spill Response Specialists
An ISO 9001:2008 Certified Company

72/116 Hydraulic Boom Reel Product Sheet

Reel Storage Capacity:	Up to 415 m of 18” Fence Boom (6” Freeboard, 12” Skirt)	
Spool Diameter:	19”	48 cm
Spool Length (Inside):	116”	295 cm
Overall Width:	72”	183 cm
Overall Length (Nominal):	156”	3496 cm
Overall Height:	80”	203 cm
Frame Material:	6061-T6 Aluminum	
Frame:	¼” T x 4” x 4” Round Corner Tubing	
Spool Material:	5052 or 5086 Aluminum Plate	
Welds	Continuous, all hollow sections of aluminum are fully sealed	
Lift Points:	Two – At Corners of A-Frame	
Forklift Pockets:	Two ¼” T x 3” x 6” (75 mm x 150 mm) forklift pockets, running through the frame – 36” / 91 cm apart centre to centre	
Pillow Block:	2” SKF	
Pillow Block Shaft:	2” 316SS Round	
Drive Type:	Direct Drive Gear Reducer	
Primary Drive:	Rossi 006A Gear Reducer	
Hydraulic Power:	Hydraulic power unit integrated into reel frame. Kubota OC95 (or equivalent) air/oil cooled Diesel Engine with a single hydraulic circuit for control of reel speed and direction. High torque hydraulic drive and gear box. Eaton Motor, Rossi direct drive planetary gear box. Hydraulic control panel with reel directional control, freewheel valve and pressure indicators	
Directional Control:	Directional joystick control valve for control of direction and speed of boom reel rotation. Valve is spring centered (returns to no flow position).	
Free Wheel:	Manual ball valve for control of free wheel to allow boom reel to rotation without hydraulic power.	
Brake:	Internal Hydraulic Brake with Freewheel Bypass	
Hydraulic Flow:	4 US gpm	15.1 lpm
Hydraulic Pressure:	1,500 psi	103 bar
Motor Gear Reduction:	Rossi 006A	
Hydraulic Reservoir:	18.5 USG	70 litre
Intermittent Output Torque:	4,670 ft*lbs	6,330 N*m
Ultimate Gearing Ratio:	25:1	
Maximum Speed:	12 rpm	
Storage:	Boom Reel stored in 20’ Open Side Container. Boom reel is bolted to container floor.	
Temperature Rating:	Boom Reel Hydraulic Power Unit is suitable for use in -25°C if diesel fuel, engine oil, and hydraulic oil rated for -25°C are used	

VERSATECH PRODUCTS INC.
MANUFACTURERS OF ENVIRONMENTAL POLLUTION CONTROL EQUIPMENT
4623 Byrne Road, Burnaby, BC, Canada V5J 3H6
Telephone: (604) 271-7500 Fax: (604) 271-7501
E-Mail: info@versatech.com Web Site: www.versatech.com

Spare Parts Included:	2 x Hydraulic Oil Filters 1 x Engine Oil Filter 1 x Engine Fuel Screen

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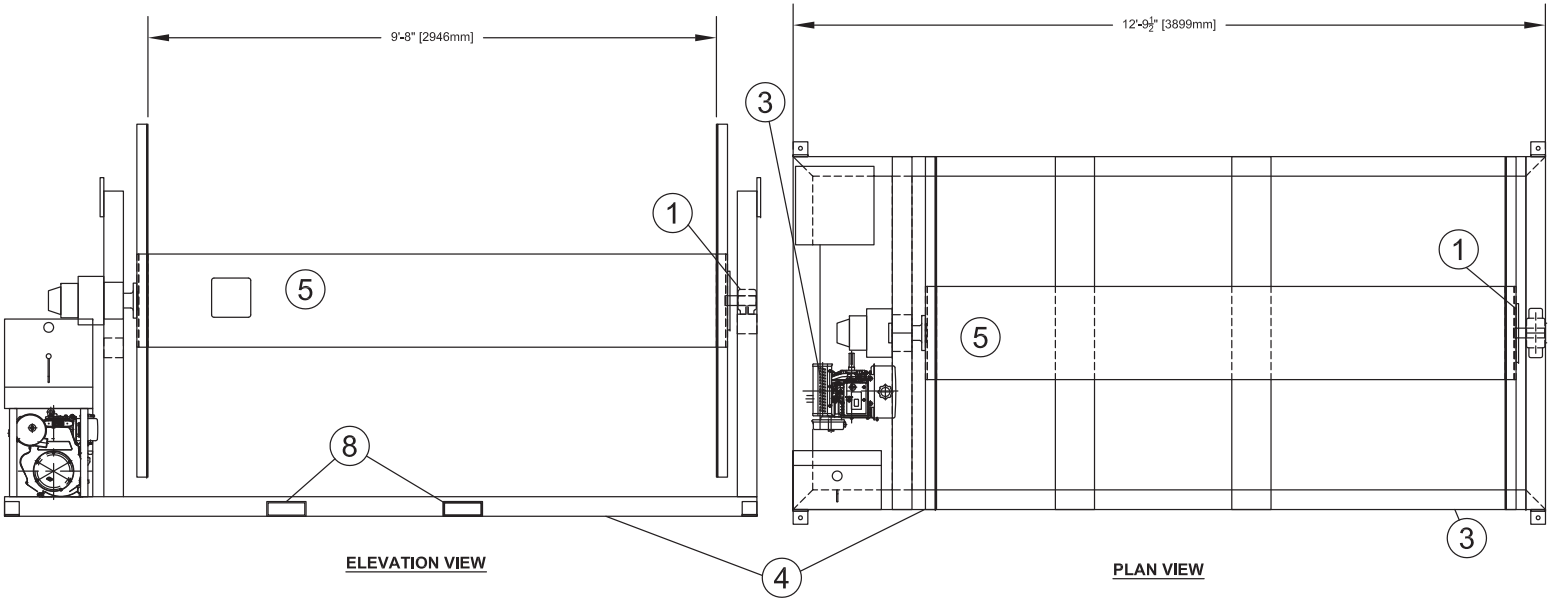
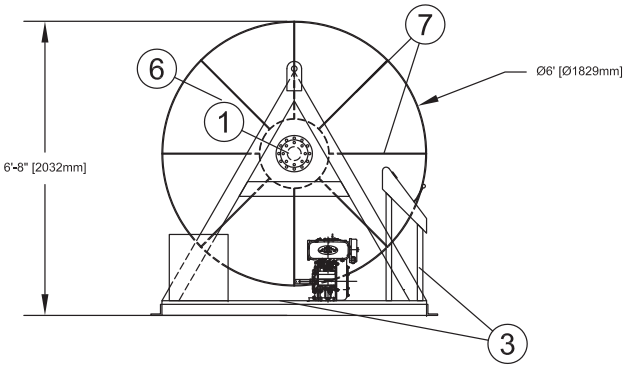


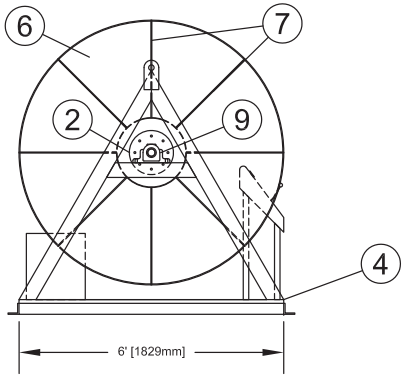
ELEVATION VIEW

PLAN VIEW

PRELIMINARY



ELEVATION VIEW
CONTAINER SIDE ENTRANCE



ELEVATION VIEW -
REEL AXIS

NOTES

1. PLEASE NOTE THAT ALL DIMENSIONS GIVEN IN INCHES AND [mm] UNLESS OTHERWISE SPECIFIED

ITEMS

ITEM NO.	QTY	DESCRIPTION	MATERIAL
1	1	ROSSI 006A PLANETARY GEAR DRIVE	COATED STEEL
2	1	PILLOW BLOCK MOUNTING FLANGE	316 STAINLESS STEEL
3	1	6,8 kW (9,1 HP) HYDRAULIC POWER PACK INCL. YANMAR L100V DIESEL ENGINE	VARIOUS
4	55' (17m)	4" x 4" x 1/4" (100mm x 100mm x 6mm) TUBING	6061 ALUMINUM
5	1	19"Ø (483mm) REEL CORE	5052 ALUMINUM
6	2	REEL SPOOL END CAPS	5086 ALUMINUM
7	90' (27m)	REEL SPOOL REINFORCING BAR	6061 ALUMINUM
8	2	3" x 8" (75mm x 200 mm) FORKLIFT POCKETS	6061 ALUMINUM
9	1	1,5" (40mm) PILLOW BLOCK	COATED STEEL

Issue	Date	Description	By	Chkd
A	03-02-2017	PRELIMINARY - FOR INFORMATION	OJ	-

QUANTITY REQUIRED:
1

Client:
LAVALFORTIN

Title:
VERSATECH
72/116 BOOM REEL
GENERAL ARRANGEMENT

Scale: N/A

Prepared by:	Checked:	Date:
OJAVADI	-	05-21-2014

VERSATECH
4023 Byrne Rd
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Tel: 604-271-7500 • Fax: 604-271-7521
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ENVIRONMENTAL CONTAINMENT & SPILL RESPONSE PRODUCTS
www.versatech.com

Drawing No.: 7112-BMR-GA-001

Open Side Containers

New Units

Open side containers offer the advantage of being able to fully open along the side, in addition to the end.

Additional features include:
- Spill Response Cabinet (2.4 m x 2.4 m x 0.6 m) complete with storage shelving
- <<SPILL RESPONSE EQUIPMENT>> labelling on storage container
- Additional ventilation to permit storage of wet containment boom

Features:

- CORTEN anti-corrosive steel construction, fully welded
- 1-1/16” hardwood flooring over steel cross members, fully undercoated
- Zinc rich and epoxy coatings for exceptionally long life
- Galvanized door hardware
- Full width side doors for easy access to cargo area
- Forklift pockets (most models) and corner castings for ease of handling
- Lockable door handles plus extra high security padlock enclosure box

Specifications:

	20’ Standard	20’ High Cube
Overall length	20’	20’
Overall width	8’	8’
Overall height	8’6”	9’6”
Door opening width	19’2”	19’2”
Door opening height	7’	8’
Interior depth	19’4”	19’4”
Interior width	7’6”	7’6”
Interior height	7’5”	8’5”
Cubic capacity	1,095 cu.ft.	1,220 cu.ft.
Empty weight	7,000 lbs.	7,170 lbs.
Gross weight	52,900 lbs.	52,900 lbs.

VERSATECH BOOM REEL

PROJECT: 7112

CUSTOMER PO: I3726-00

OPERATING AND MAINTENANCE INSTRUCTIONS

Manufactured by: Versatech Products, Inc.
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Web Site: www.versatech.com

Revision	Date	Prepared by
0	28/05/12	JKneeshaw
1	17/7/2017	OJavadi

VERSATECH PRODUCTS INC.
Boom Reel (BMR) Manual

TABLE OF CONTENTS

Versatech Products Inc.
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www.versatech.com

1 General Information

1.1 BOOM REELS

The Versatech Boom Reel provides an efficient way to store, transport, and deploy oil containment boom. A hydraulic system supplies the torque to turn the reel. The major components of the Boom Reel system include the frame, spool, engine, hydraulic fluid reservoir, hydraulic pump, and hydraulic motor with gearbox.

Figure 1: The Versatech Boom Reel

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1.2 REEL SPECIFICATIONS

	Imperial	Metric
Model:	**BMR.DH.72.120.MT**	
Spool Length (Inside):	116”	295 cm
Spool Diameter:	72”	183 cm
Overall Length:	156”	396 cm
Overall Width:	72”	183 cm
Overall Height:	80”	203 cm
Boom Storage Capacity:	415 m of Inshore-450 Fence Boom	
Forklift Pocket Dimensions:	3” x 6” – 36” Apart	75 mm x 150 mm – 900 mm apart
Drive Type:	Direct Drive via Hydraulic Gear Reduction and Diesel-Hydraulic Power Unit	
Reduction Ratio:	28:1	
Hydraulic Flow:	8 US gpm	30.3 lpm
Hydraulic Pressure:	1,500 psi	103 bar
Maximum Speed:	12 rpm	
Brake:	Internal	
Pillow Block:	2” Shaft – 316SS	
Materials of Construction:	Aluminum	

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1.3 BILL OF MATERIALS

Item No.	Qty.	Part	Manufacturer	Model	Description
1	1	Frame	Versatech		Welded aluminum construction. Provides base frame for the mounting of all other components. Forklift pockets are included for ease of mobility.
2	1	Spool	Versatech		Welded aluminum construction. 19-inch-diameter core capped at each end. Bearings support it at both ends. Holds boom.
3	1	Engine	Kubota	OC95	Air-cooled, diesel-burning, internal-combustion engine. Provides power to hydraulic pump.
4	1	Gear pump	Eaton	26003-RZC	Powered by engine, pressurizes hydraulic fluid to drive hydraulic motor.
5	1	Hydraulic motor, c/w gear drive	Rossi Gear Reducer Eaton Char-Lynn	R 2EL 006A 28Y M095M1 A30b UH SA11 B5 2000 Series 101-1035-009	2-directional geared motor. Generates torque to drive spool such that boom can be deployed or recovered.
6	1	Control panel	Versatech		Includes control valve to run hydraulic motor in both directions.
7	1	Hydraulic tank	Versatech		70-litre tank. Holds the hydraulic fluid for the system.
8	Lot	Hydraulic hose			Hoses for connecting the hydraulic pump, motor and valves.
9	1	Tank isolation valve	Green Line	1”	Ball valve. Closes tank outlet for gear pump servicing.
10	1	Control panel bypass valve	Green Line	1/2”	Ball valve. Reel may spin free while it is open.
11	1	Control Valve	Brand	SDCF755O M64LF1	Mounted to control panel. Lets operator control the reel speed.

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2 Preparation for Use

2.1 Assembly Instructions

The Versatech Boom Reel is fully assembled when it leaves the factory. These instructions are for disassembly and reassembly purposes.

2.1.1 Mounting the Gear Pump

The gear pump is mounted directly on the engine casing. To service the engine or the gear pump, remove the connecting flange bolts and consult the Eaton 26003 manual in the appendices.

Figure 2: The gear pump and engine. The pump is mounted on the engine casing.

2.1.2 Mounting the Engine

Anchor bolt holes guide where the engine sits on the frame. To service the engine, loosen the anchor bolts and consult the Kubota manual in the appendices.

Warning: The muffler and exhaust for the engine sit opposite the fuel tank and will be hot enough to cause injury after the engine has been running for 2 minutes.

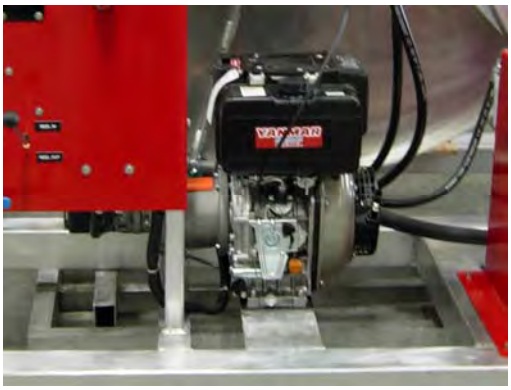

Figure 3: The engine is located next to the reel between the tank and control panel.

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2.1.3 Mounting the Hydraulic Motor and Gear Drive

Bolts connect the motor to the A-frame. To service the motor, support the spool and loosen the bolts. Then consult the Rossi manual in the appendices.

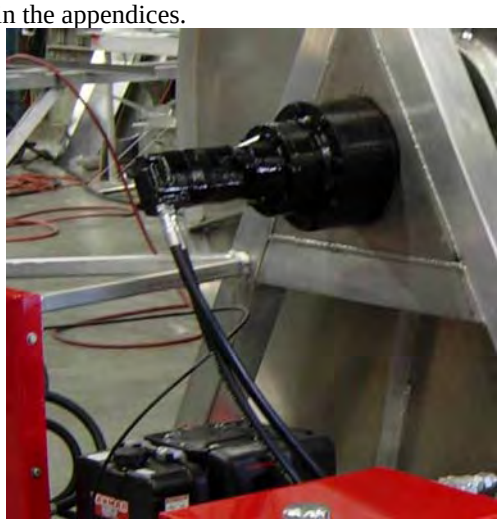

Figure 4: The hydraulic motor gets mounted on the reel.

2.1.4 Connecting the Hydraulics

Several hydraulic connections are made on the Boom Reel. They should be checked each time the Boom Reel is started up. These connections include:

- The hydraulic tank to the tank isolation valve.
- The tank isolation valve to the gear pump intake hose.
- The gear pump intake hose to the gear pump.
- The gear pump to the gear pump outlet hose.
- The gear pump outlet hose to the control panel manifold.
- The control panel manifold outlet to the motor feed hose.
- The motor feed hose to the motor.
- The motor to the motor outlet hose.
- The motor outlet hose to the hydraulic filter.
- The hydraulic filter to the hydraulic tank.

2.1.5 Securing the Control Valve

The control valve is bolted to the control panel. In the event of control valve failure, replace the control valve with an equivalent model. Catalogue information can be found in the appendices.

2.1.6 Securing the Isolation Valve

The isolation valve is located at the hydraulic tank outlet. It uses an NPT connection, and can be removed with a wrench. It should be secure and open whenever the hydraulic lines are connected.

2.1.6 Securing the Bypass Valve

The bypass valve is located at the bottom of the control panel. When opened, the reel goes into freewheel mode, where the reel can be manually rotated without the assistance of the hydraulic motor. The bypass valve should be kept closed when the reel is in normal operation.

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2.2 CONSUMABLES

2.2.1 Hydraulic Fluid

The hydraulic tank can be refilled through the refill port on top. Ensure no foreign materials enter as the tank is being refilled. Replace the cap securely. Use AW32 or AW36 Hydraulic Oil Only.

If hydraulic fluid leaks from the system, do not return it to the reservoir.

2.2.2 Fuel (If Boom Reel is supplied with Diesel Motor)

The fuel tank sits on top of the engine, opposite the muffler. Open the fuel tank and pour in diesel. Consult the Kubota OC95 for more details.

Danger: Never refill the fuel tank while the engine is running.

2.2.3 Engine Lubricant (If Boom Reel is supplied with Diesel Motor)

Follow all lubrication procedures detailed in the Kubota OC95 manual in the appendices.

2.2.4 Bearing Grease

Use low speed waterproof bearing grease (NLGI Grade 2 or similar). Fill the bearing using the grease nipple until excess grease comes out of the port.

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2.3 SECTION 2 SUMMARY: PRE-START CHECKLIST

- ☐ Gear pump mounting bolts present and secure.
- ☐ Engine anchor bolts present and secure.
- ☐ Motor flange bolts present and secure.
- ☐ Control valve secure.
- ☐ Control valve closed.
- ☐ Engine fuelled.
- ☐ Engine lubricated.
- ☐ Hydraulic reservoir filled.
- ☐ Hydraulic fluid - clean.
- ☐ Hydraulic connections secure.
- ☐ Isolation valve open.
- ☐ Bypass valve closed.
- ☐ Hydraulic fluid filter clean.

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3 Start-Up

Caution: Proceeding beyond this point without completing the pre-start checklist may result in equipment damage.

Read the manufacturer's engine manual and complete the pre-start checklist in Section 2.3 before starting engine. Prior to use of the boom reel, please familiarize yourself with the Control Panel, as described in Section 3.1.

To start the engine, close the control valve, set the engine throttle to medium, and turn the key-lock ignition on the control panel. Reduce the throttle to the desired setting. Higher throttle settings use more fuel, but allow more torque and a higher reel speed. Allow the engine and hydraulic fluid to warm up for 3 minutes before opening the control valve.

When the engine is warm, try turning the reel by opening the control valve. If the reel fails to spin, see section 6 for troubleshooting tips. If the reel does spin, the reel is ready for operation.

3.1 Control Panel

The operation of Versatech's Boom Reels is very straight forward. A photo of the control panel can be seen in Figure 5. All items on the control panel are labelled for clarity.

Figure 5: Boom Reel Control Panel

The components provide the following functions:

Pressure Gauge:	Indicates system hydraulic pressure
Ignition Start:	Engine start up
Directional Control:	Controls direction and speed of boom reel rotation
Engine Speed Control:	Controls engine speed and maximum hydraulic flow
Fuel Tank Heater Switch:	Turns the in tank fuel heater on/off (If installed)
Free Wheel Bypass Valve:	Allows the boom reel to spin without hydraulic power

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4 Operation

Boom is always wound on the top side the spool. Loading and unloading are always performed on the control panel side of the reel

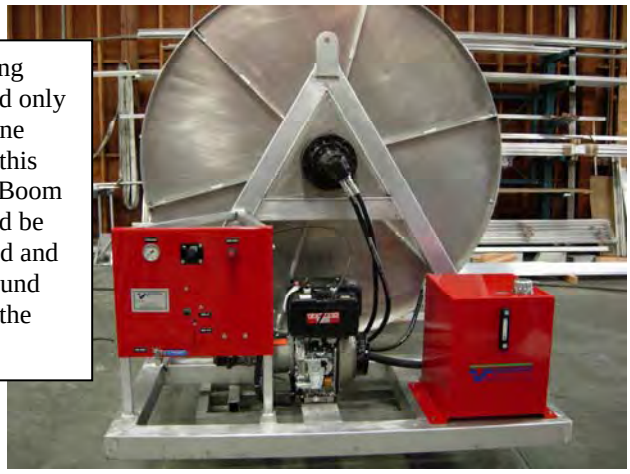

Figure 6: Only load boom from the side of the reel with the control panel.

4.1 DEPLOYING BOOM

Pull the control knob toward the base of the control panel to unwind the boom.

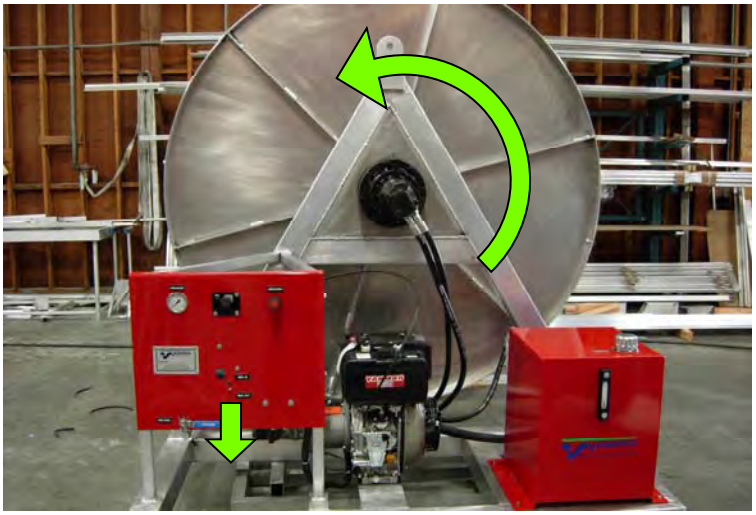

Figure 7: Boom deployment.

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4.2 RETRACTING BOOM

Pull the control knob toward the top of the control panel to retract the boom.

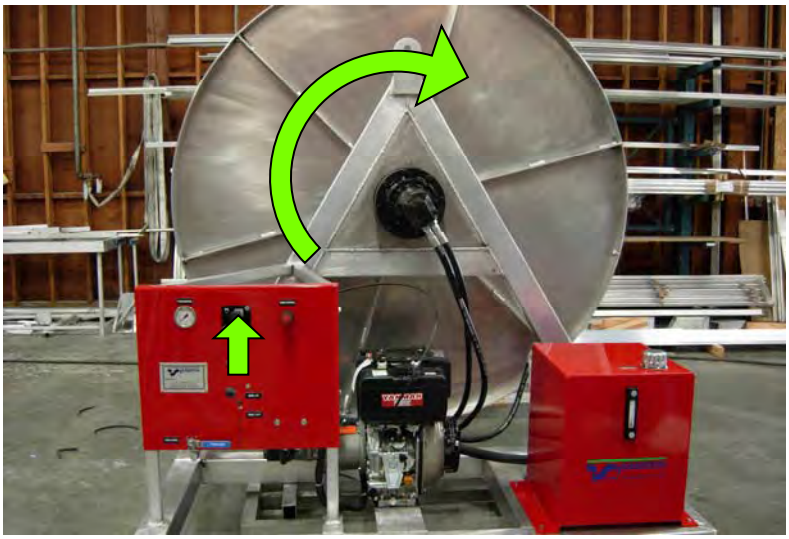

Figure 8: Boom retraction.

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5 Transportation

5.1 TRUCK/TRANSPORT LOADING

The Versatech Boom Reel has two forklift pockets at the base that allow it to be picked up and moved with an ordinary forklift. It may be loaded into a shipping container, or onto a flatbed truck.

5.2 TRUCK TRANSPORT

Boom reels have a high centre of gravity such that certain considerations regarding their transport should be taken.

On city streets, turning speeds are not to exceed 20 km/h.

If the reel is on a flatbed truck, remove the PVC cover for transport if speeds are going to exceed 40 km/h. Without the PVC cover, a flatbed truck should not exceed 90 km/h while transporting a reel.

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6 Troubleshooting Guide

ISSUE	POSSIBLE CAUSES	RECOMMENDED SOLUTION
Reel not spinning / no hydraulic pressure	Hydraulics not connected	Check hydraulic lines. Ensure secure connections.
	Reel in 'freewheel' mode	Close bypass valve.
	Equipment damage	Consult relevant manual in the appendices.
	Pump failure	Consult Eaton manual
	Isolation valve closed	Open isolation valve
	Engine not connected to pump	Check engine flange bolts
Excessive noise	Equipment damage	Check incoming and outgoing temperature of hydraulic fluid to identify problem areas. Consult section 7 for maintenance procedures.
Reel spinning slowly	Insufficient hydraulic pressure	Increase engine speed by opening engine throttle.
Reel spins too fast/difficult to control	Excessive hydraulic pressure	Reduce engine speed by closing engine throttle.

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7 Maintenance Plan

7.1 General Hydraulic Maintenance

Hydraulic systems are relatively high-maintenance. For maintenance procedures for individual components, consult the relevant manual in the appendices.

7.1.1 Hydraulic Fluid

Set up a filter maintenance schedule and follow it diligently. Change or clean the filter as required.

Take a sample of the fluid periodically and examine it, comparing it with a sample of clean new fluid. Fluid that has been running too hot will look darker, smell burned, and feel less viscous than new fluid. More contaminants will often be observed in old fluid.

When filling the reservoir, use clean containers, hoses and funnels. A filter cart is highly recommended when adding fluid.

If hydraulic fluid leaks from the system, do not return it to the reservoir.

Hydraulic fluid should be checked after the first 100 hours. Once the system is broken-in, the fluid should be changed every 1000 to 2000 hours. Use AW32 or AW36 hydraulic fluid or equivalent.

7.1.2 Heat

Hydraulic systems typically run at a relatively high temperature. 50^0C is a typical reservoir temperature. Running the system open for a few minutes will warm up the hydraulic fluid to a proper working temperature. Generally, the more work that a hydraulic system is doing, the warmer the fluid will become.

Running the system in temperatures above the fluid operating range tends to cause high wear on hydraulic components, making them more prone to failure. To determine which components are running hot and overheating the fluid, feel the inlet and outlet of each. If the fluid temperature is normal going into a component but hot coming out, promptly service that component.

Keeping the equipment clean will also help with the dissipation of heat.

During the first 100 hours of operation, and for the 100 hours after a component has been replaced, avoid allowing the system to run at the higher end of the temperature range. New parts are especially prone to seize at high temperatures.

7.2 Cleaning the System

For cleaning directions of individual components, refer to the relevant manual in the appendices.

7.2.1 Cleaning the Frame

- For simple routine cleaning, spray with fresh water or pressure-wash.
- In cases of heavy grime buildup, use detergents. Do not spray stored boom with strong detergents or other surfactants as that may compromise oil spill cleanup in subsequent uses.

7.2.2 Cleaning the Hydraulic Hoses

- Never allow any material except hydraulic fluid into the hydraulic hoses.
- Remove any debris, especially sand from the connectors on the ends of the hoses.
- Clean the outside of the hose bundle with a pressure washer.
- Use detergent if badly soiled.

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7.3 STORAGE

Follow all storage procedures in the manuals located in the appendices.
Ensure that the frame and all parts are clean. The frame, and any boom on it, should be stored in a cool, dry place, out of direct sunlight, with the supplied PVC cover in place.

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List of Major Consumables / Replacement Schedule

This is a basic list of major consumables for all of the equipment supplied. There are maintenance requirements and replacement parts that extend beyond this list, and it is recommended that the customer develop its own maintenance schedule using this list as its basis.

Component	Consumable	Replacement Schedule
Power Pack Fuel	Diesel Fuel	As Necessary
Power Pack Hydraulic Oil	AW32 or AW46 Hydraulic Oil	Annually
Boom Reel Gear Reducer Internal Lubricating Oil	PAO Synthetic Oil with ISO viscosity grade between 220 and 320 cSt at 40° C (2.5 litres)	Every 1,400 for mineral oils Every 6,300 hours for synthetic oils Or every 2 years, whichever comes first
Bearing Lubricating Grease	NLGI Grade 2 Low Speed Waterproof Bearing Grease	As necessary, inspect every 100 hours
Hydraulic Oil Filter	Donaldson P550550	Every 500 hrs
Engine Oil	SAE 10W30	Change after initial 25 hr, then every 100 hrs or 1 year, whichever comes first.
Engine Oil Strainer	OC95 Oil Strainer	Clean after initial 25 hr, then every 100 hrs or 1 year, whichever comes first. Strainer does not need replacement unless damaged.
Engine Fuel Filter	OC95 Fuel Filter	Clean every 100 hrs, replace every 500 hrs
Engine Primary Air Filter	OC95 Air Filter	Clean every 100 hrs, replace every year or after 6 cleanings.

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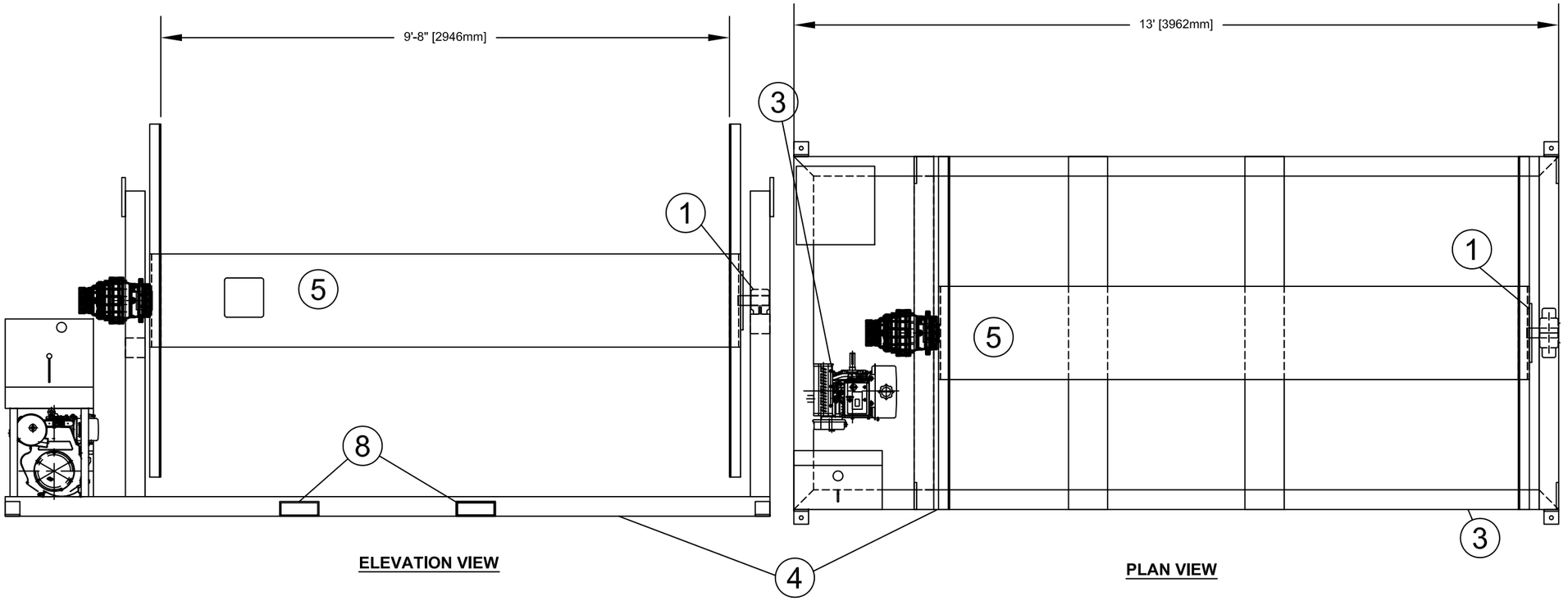
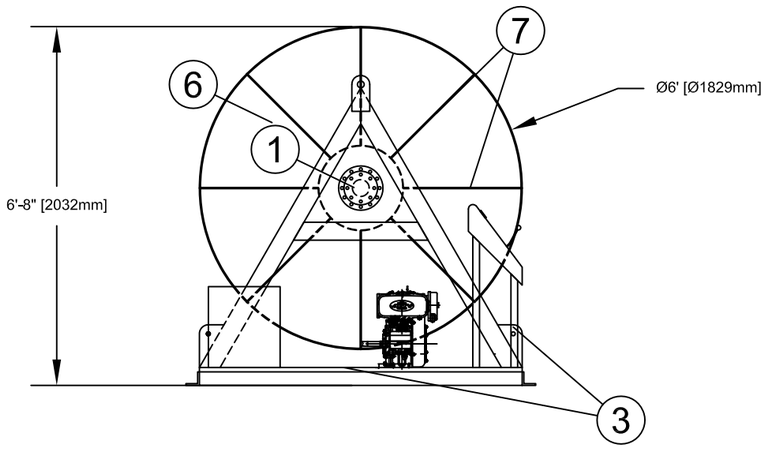
Appendix A
Versatech 72/120 Boom Reel Drawings

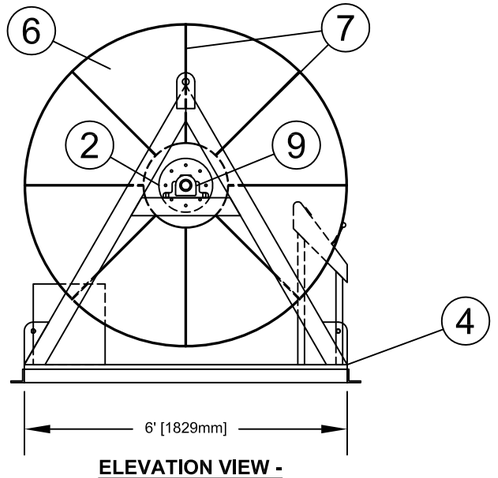


ELEVATION VIEW

PLAN VIEW



ELEVATION VIEW
CONTAINER SIDE ENTRANCE



ELEVATION VIEW -
REEL AXIS

NOTES

1. PLEASE NOTE THAT ALL DIMENSIONS GIVEN IN INCHES AND [mm] UNLESS OTHERWISE SPECIFIED

ITEMS

ITEM NO.	QTY	DESCRIPTION	MATERIAL
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5	1	19"Ø (483mm) REEL CORE	5052 ALUMINUM
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7	90' (27m)	REEL SPOOL REINFORCING BAR	6061 ALUMINUM
8	2	3" x 8" (75mm x 200 mm) FORKLIFT POCKETS	6061 ALUMINUM
9	1	2" (50 mm) PILLOW BLOCK	COATED STEEL

Issue	Date	Description	By	Chkd
0	18-07-2017	AS BUILT	OJ	-
A	03-02-2017	PRELIMINARY - FOR INFORMATION	OJ	-

QUANTITY REQUIRED:
1

Client:
LAVALFORTIN

Title:
VERSATECH
72/116 BOOM REEL
GENERAL ARRANGEMENT

Scale: N/A

Prepared by:	Checked:	Date:
OJAVADI	-	18-07-2017

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ENVIRONMENTAL CONTAINMENT & SPILL RESPONSE PRODUCTS
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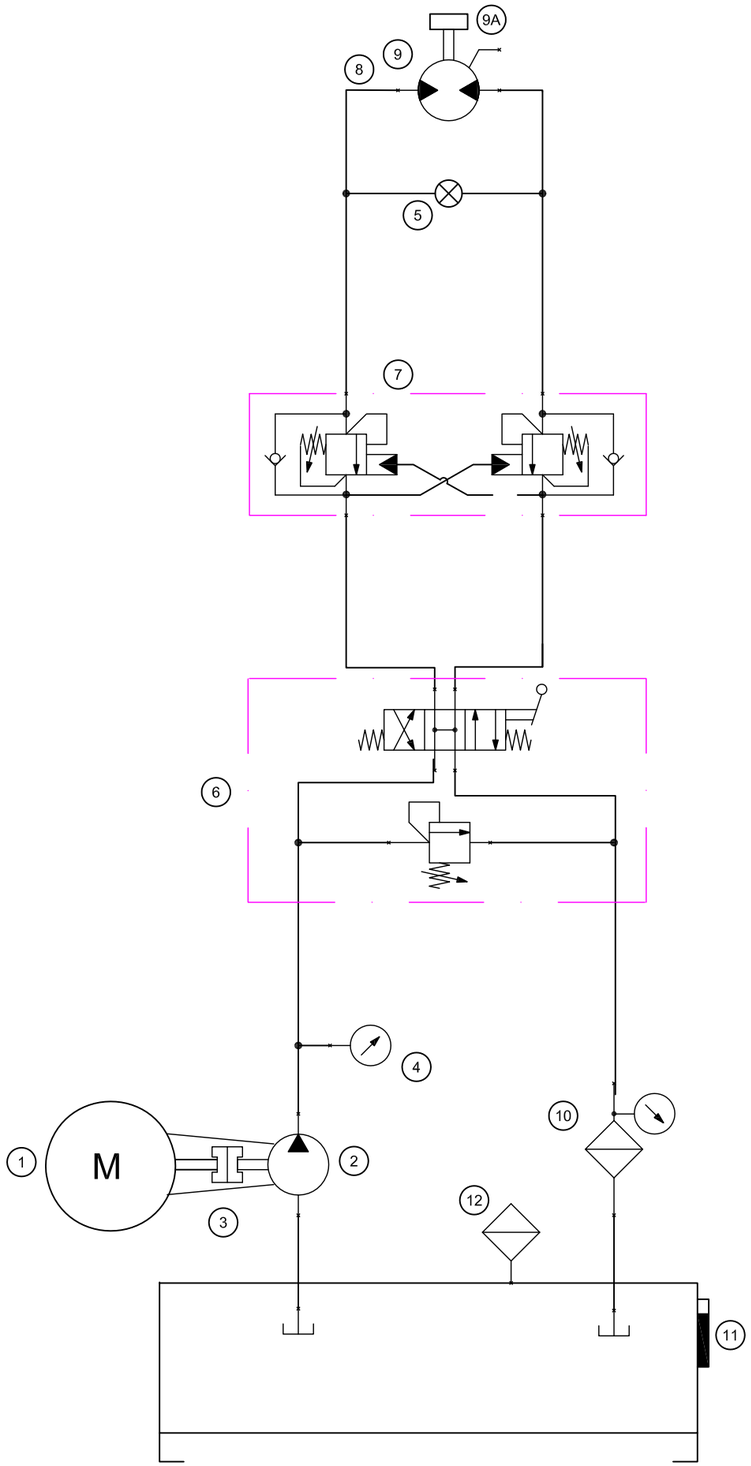
Drawing No.: 7112-BMR-GA-001

Appendix B
Hydraulic Schematic



NUM	QTY	DESC	MFG	MODEL
1	1	DIESEL MOTOR	KUBOTA	OC95
2	1	GEAR PUMP	EATON	26003-RZC
3A	1	BELLHOUSING	MAGNALOY	M182472A
3B	1	COUPLING	MAGNALOY	M100010408
3C	1	COUPLING	MAGNALOY	M10002406
3D	1	INSERT	MAGNALOY	M170H5
4	1	PRESSURE GAUGE	STAUFF	SPG-063-FF
5	2	BYPASS VALVE	STAUFF	BBVM21080001M
6	1	MANUAL VALVE W/ RELIEF	BRAND	SDCF7550M64LS
7A	4	C. BALANCE VLV CARTRIDGE	SUN	CBCA-LHN
7B	2	C. BALANCE VLV BODY	SUN	YEJ/S
8	2	GEAR REDUCER	ROSSI	R 2EL 006A 28Y M095M1 A30b UH SA11 B5
9	2	MOTOR	CIL	101-1035-009
9A	2	SUN-GEAR	HECO	16H
10A	1	RETURN FILTER HEAD	DONALDSON	P561131
10B	1	RETURN FILTER ELEMENT	DONALDSON	P551551
10C	1	RETURN FILTER GAUGE	DONALDSON	P563298
11	1	LEVEL GAUGE	STAUFF	SNA-127-B-S-T-U
12	1	BREATHER	FLO-EZY	ABG1000-3

REV.	DESCRIPTION	DWN.	APP.	DATE
A	PER PROJECT REQUIREMENTS	OJ		01/05/2017
0	INITIAL RELEASE	EM		01/07/2016

DO NOT<scale this drawing>

SEAL

DETAIL OR SECTION — DRAWING WHERE CALLED / DRAWING FOUND

TITLE: VERSATECH

PROJECT: BOOM REEL HPU

DATE: 1/05/2016

SCALE: NTS

TEMPLATE No.:

SHEET 1 OF 1

DRAWN: OJ

DESIGNED:

CHECKED: --

APPROVED:

REV.: 0

DWG. No.: 7112-BMR-HS-001

Appendix C
Rossi 006A Gear Reducer Manual

8 – Installation and maintenance

8.1 – General information

This chapter provides information about handling, installation and maintenance of the gear reducers.

All the people who work with the products presented in this catalog must carefully read all the following instructions and apply them rigorously. The products relevant to this chapter correspond to the technical level reached at the moment the catalog is printed. Rossi S.p.A. reserves the right to introduce, without notice, the necessary changes to improve efficiency and safety of its products.

Safety

The paragraphs marked with symbols shown below contain dispositions to be strictly respected in order to assure personal safety and to avoid any heavy damages to the machine or to the system.

– Live
– At temperature higher than 50 °C
– Rotating during operations

– Don't use to lift

– Lifting point

An incorrect installation, an improper use, the removing or disconnection of protection devices, the lack of inspections and maintenance, improper connections may cause severe personal injury or property damage.

Therefore, the component must be moved, installed, commissioned, handled, controlled, serviced and repaired exclusively by responsible qualified personnel (definition to IEC 364).

It is recommended to pay attention to all existing safety laws and standards concerning correct installation.

Whenever personal injury or property damage may occur, due to falling or projecting parts of gear reducer or of its parts, foresee adequate supplementary protection devices against:

– Release or breakage of fastening screws;
– Rotation or unthreading of the gear reducer from shaft end of driven machine following to accidental breakage of the reaction arrangement;
– Accidental breakage of the shaft end of driven machine.

When operating on gear reducer or on components connected to it, the machine must be at rest: disconnect motor (including auxiliary equipments) from power supply, gear reducer from load, be sure that safety systems are on against any accidental starting and, if necessary, pre-arrange mechanical locking devices (to be removed before commissioning).

Attention! During the operation the gear reducers may have hot surfaces.

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8.2 – How supplied

Name plate

Every gear reducer is provided with a name plate in anodized aluminium containing main technical information relevant to operating and constructive specifications and defining, according to contractual agreements, the application limits; the name plate must not be removed and must be kept integral and readable. All name plate data must be specified on eventual spare part orders.

Lubricant

If not differently stated, gear reducers until size 021A are supplied filled with synthetic PAO oil as foreseen in the nameplate for the specific mounting position involved.

Painting

Products are painted with dual-compound epoxy paint appropriate for resistance to normal industrial environments and suitable for the application of further coats of synthetic paint; unless otherwise specified in the order, color blue RAL 5010 DIN 1843. Internal protection in synthetic paint appropriate for resistance to mineral oils or to polyalphaolefines synthetic oils.

Protections and packing

Overhanging free shaft ends and hollow shafts are treated with protective anti-rust long life oil and protected with a plastic (polyethylene) cap (only up to D ⩽ 48 mm for overhanging shafts, D ⩽ 110 mm for hollow shafts).

All internal parts are protected with protective anti-rust oil. Unless otherwise agreed in the order, products are adequately packed: on pallet, protected with a polyethylene film, wound with adhesive tape and strap (bigger sizes); in carton pallet, wound with adhesive tape and strap (smaller sizes); in carton boxes wound with tape (for small dimensions and quantities).

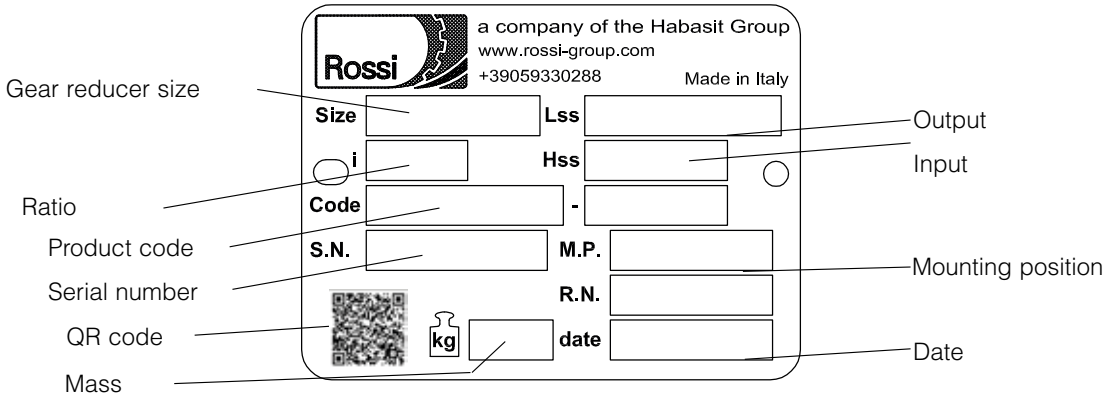
If necessary, gear reducers are conveniently separated by means of anti-shock foam cells or of filling cardboard.

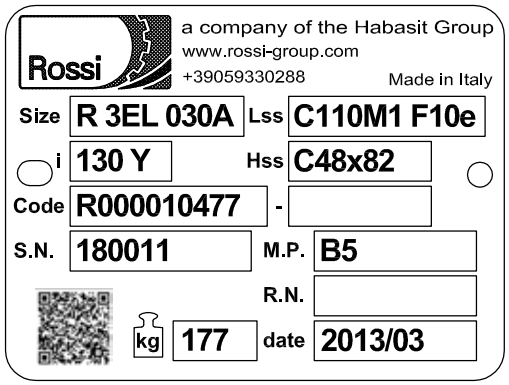
Generally the packing is suitable for the normal road/rail transport. For sea transport it is necessary to foresee a special packing, when ordering.

Before handling or transporting the gear reducers, be sure that the packing is in good conditions and suitable for the transport. Do not stock packed products on top of each other.

8.3 – Name plate

Every gear reducer is provided with a name plate in anodised aluminium containing main technical information relevant to operating and constructive specifications and defining, according to contractual agreements, the application limits; the name plate must not be removed and must be kept integral and readable. All name plate data must be specified on all spare part orders.





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8.4 – Transport, handling and storage

Receipt

At receipt verify that the unit corresponds to the one ordered and has not been damaged during the transport, in case of damages, report them immediately to the courier.

Avoid commissioning gear reducers, that are even slightly damaged.

Report any non-compliance to Rossi S.p.A.

Lifting and handling

First make sure that the lifting equipment (e.g. crane, hook, eye bolt, straps etc.) is suitable for the weight and size of the gear reducer (the weights of the product are given in the catalog). When lifting, use only the attachment point marked in the following figures.

Pay attention to avoid lifting (max 15° during handling) and, if necessary, use additional straps only to balance the load.

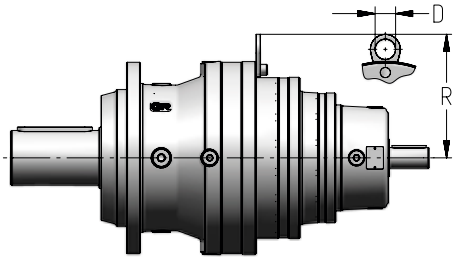
Do not use front threads at the input shaft ends to lift the gear reducers.

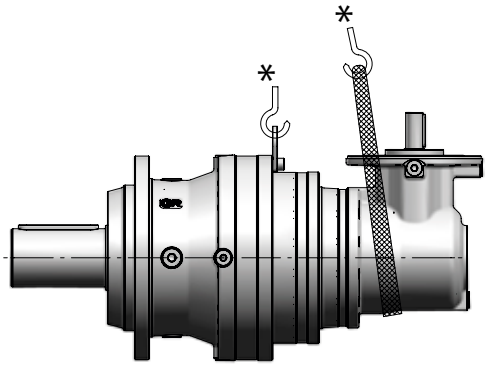
WARNING:

– suspended load can fall;
– do not stand under the load;
– improper transport may result in damage to the gear reducer.

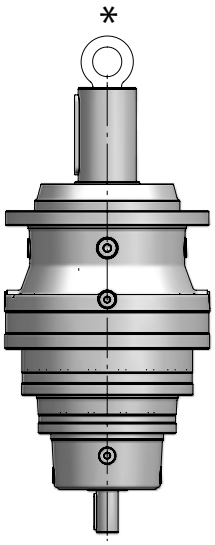
Lifting and handling

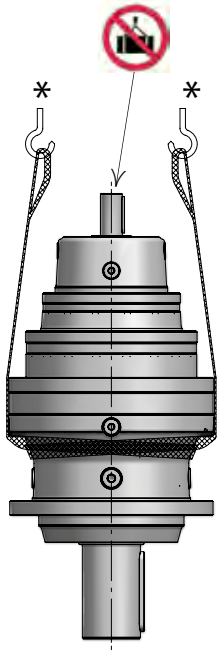
Sizes **001A ... 021A details**





Size	D ∅	R
001A, 002A	–	–
003A ... 006A	25	151
009A ... 015A	30	181
018A, 021A	35	213

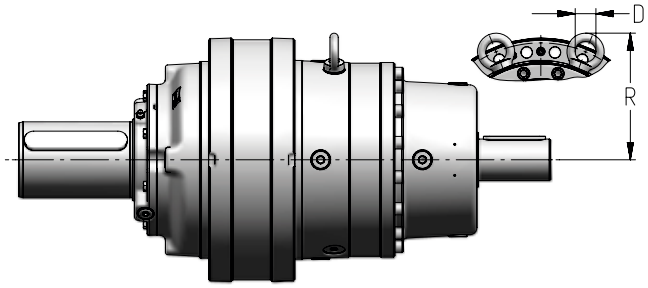


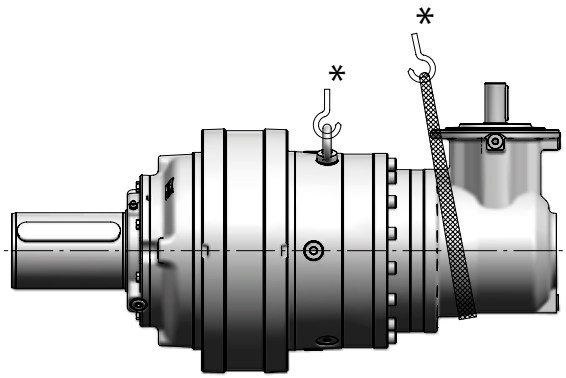


* Not included

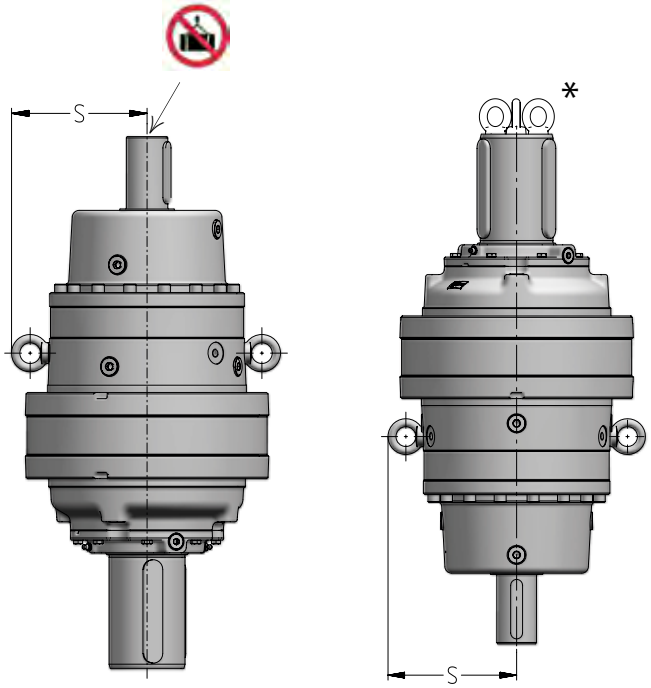
Lifting and handling

Sizes **022A ... 710A details**





Size	D ∅	R		S	
		1EL ... 4EL 3EB, 4EB	2EB	1EL ... 4EL 3EB, 4EB	2EB
022A	25	180	181	221	222
030A	30	184	204	197	231
031A	30	193	228	207	259
042A	30	193	209	207	259
043A	30	193	110	207	270
060A	30	170	243	229	277
085A	30	187	284	252	312
125A	30	225	312	280	343
180A	35	230	–	312	–
250A	40	257	–	348	–
355A	50	299	–	404	–
500A	50	324	–	439	–
710A	60	362	–	489	–



* Not included

Storage

Surroundings should be sufficiently clean, dry and free from excessive vibrations (veff ⩽ 0,2 mm/s) to avoid damage to bearings (excessive vibration should also guarded during transit, even if within wider range) and ambient storage temperature should be 0 ÷ +40 °C: peaks of 10 °C above and below are acceptable.

Every six months rotate the shafts (some revolutions are sufficient) to prevent damage to bearings and seal rings.

Assuming normal surroundings and the provision of adequate protection during transit, the unit is protected for storage up to 1 year.

For a 2 year storing period in normal surroundings it is necessary to pay attention also to the following instructions: – generously grease the sealing, the shafts and the unpainted machined surfaces, if any, and periodically control conservation state of the protective anti rust oil; – completely fill the gear reducers with lubrication oil.

For storages longer than 2 years or in aggressive surroundings or outdoors, consult Rossi S.p.A.

8.5 – Installation of gear reducer

General

Before the installation, verify that:

– There are no damages on shafts and on mating surfaces;
– Design is suitable to the environment (temperature, atmosphere,etc.);
– Be sure that the structure on which gear reducer is fitted is plane, levelled and sufficiently dimensioned in order to assure fitting stability and vibration absence (vibration speed $v_{eff} \leqslant 3,5$ mm/s for $P_N < 15$ kW and $v_{eff} \leqslant 4,5$ mm/s for $P_N > 15$ kW are acceptable), keeping in mind all transmitted forces due to the masses, to the torque, to the radial and axial loads;
– Used mounting position corresponds to the one stated on name plate;
– Carefully align the gear reducer with the motor and the driven machine (with the aid of shims if need be), interposing flexible couplings whenever possible. Attention! Bearing life and good shaft and coupling running depend on alignment precision between the shafts;
– Position the gear reducer so as to allow a free passage of air for cooling both gear reducer and motor (especially at their fan side);
– Avoid any obstruction to the air flow; heat sources near the gear reducer that might affect the temperature of cooling air and of gear reducer (for radiation); insufficient air recycle and applications hindering the steady dissipation of heat;
– Verify that the gear reducer housing is dust-free in ordering to achieve an efficient heat dissipation;
– Mating surfaces (of gear reducer and machine) must be clean and sufficiently rough to provide a good friction coefficient (indicatively *R*a 3,2 µm). Remove by a scraper or solvent the eventual paint of gear reducer on coupling surfaces and, especially in presence of external radial loads or torque required $M_2 \geqslant 0,7 \times M_{N2}$, apply **locking adhesives**;
– When external loads are present use pins or locking blocks, if necessary.
– For accessories not supplied by Rossi pay attention to their correct dimensioning; if necessary consult us.

Screws and tightening torques

According to the design and size stated on nameplate, use screws and tightening torques as shown in the following tables; at least class 10.9 is necessary but in case of heavy stresses, alternate loads and shocks use class 12.9. The screws class 12.9 must be equipped (where it is possible) with ISO 7089 washers (300 HV min.).

The suggested tightening torque value are valid for an estimated friction coefficient of µ = 0,14 and for lightly oiled steel bolts, black annealed or phosphatised and dry, cut mating threads in steel or cast iron.

Do not use lubricants altering the friction coefficient for they may overload the screw connection.

Always verify the tightening torque after the first hours of running.

Screws and tightening torque

Size	Design (e.g. **C**038M1 **F**10a) **C... F... S... F... H... A... M... A...**				**K... F... Z... F...**				**K... F... Z... F...**				**C... P... S... P...**		
	n°	**d** Ø	**l** min	**l** max	**n°**	**d** Ø	**l** min	**l** max	**n°**	**d** Ø	**l** min	**l** max	**n°**	**d** Ø	**l** min
001A, 002A	8	M10	30	40	-	-	-	-	8	M10	10	13	4	M14	40
003A	10	M12	35	35	10	M12	35	35	-	-	-	-	4	M16	45
004A, 006A	10	M12	40	50	10	M12	35	35	-	-	-	-	4	M16	45
009A, 012A	12	M14	45	55	12	M14	45	50	-	-	-	-	4	M20	55
015A	16	M14	45	55	16	M14	45	50	-	-	-	-	4	M20	55
018A, 021A	12	M16	55	75	12	M16	50	50	-	-	-	-	4	M22	60

Screw	Tightening torque [N m]		
	Class		
d Ø	**8.8** $M_2 < 70\%\ M_{n2}$	**10.9**	**12.9** Washer to be used (300 HV min.)
M10	50	70	85
M12	85	120	145
M14	135	190	230
M16	210	300	355
M20	400	560	675
M22	530	770	895

Size	Design (e.g. **C**100M1 **F**10e) **C... F... S... F... H... A... Z... F...**		
	n°	**d** Ø	**l** min
030A	24	M16	150
042A	28	M16	160
060A	24	M20	180
085A	28	M20	200
125A	28	M24	230
180A	32	M24	250
250A	28	M30	290
355A	32	M30	320
500A	28	M36	350
710A	32	M36	390

Size	Accessory ,FB **12.9**		
	n°	**d** Ø	**l** min
030A	4	M24	65
042A	4	M27	70
060A	4	M30	85
085A	4	M33	90
125A	4	M36	110
180A	4	M39	120
250A	4	M42	130
355A	4	M45	140
500A	4	M52	160
710A	4	M56	180

Screw	Tightening torque [N m]			
	Class			Class
d Ø	**8.8** $M_2 < 70\%\ M_{n2}$	**10.9**	**12.9**	**12.9** (,**FB**) Washer to be used (300 HV min.)
M16	210	300	300	355
M20	400	560	560	675
M24	690	1 000	1 000	1 165
M27	1 010	1 400	1 400	1 705
M30	1 380	1 950	1 950	2 330
M33	2 000	2 800	2 800	3 375
M36	2 500	3 550	3 550	4 220
M39	2 950	4 200	4 200	4 980
M42	4 100	5 800	5 800	6 920
M45	5 000	7 100	7 100	8 440
M52	7 600	10 700	10 700	12 800
M56	9 800	13 800	13 800	16 540

Size	Design (e.g. **C**100M1 **F**10z) **C... F... S... F...** Where present, stop pins must be used!					
	n°	**d** Ø	**l** min	**n°**	**d_1** Ø	**l_1** min
022A	12	M16	140	3	12	20
031A	15	M16	160	3	16	20
043A	24	M16	170	-	-	-

Screw	Tightening torque [N m]		
	Class		
d Ø	**8.8** $M_2 < 70\%\ M_{n2}$	**10.9**	**12.9**
M16	210	300	300

8.6 – Installation

Shaft mounting

Before mounting clean mating surface thoroughly and lubricate against seizure and fretting corrosion, except for hollow shaft mounting (See ch. «Hollow shaft with shrink disc»).

Attention! Installing and removal operations should be carried out with **pullers** and **jacking screws** using the tapped holes at the shaft butt-end (see ch. «Fitting of components to shaft end») taking care to avoid impacts and shocks which **may irremediably damage the bearings, the circlips** or other parts.

Flange and foot mounting

For splined couplings apply adequate lubricants.

To machine the driven shaft, please refer to the dimensions shown in ch. 4.

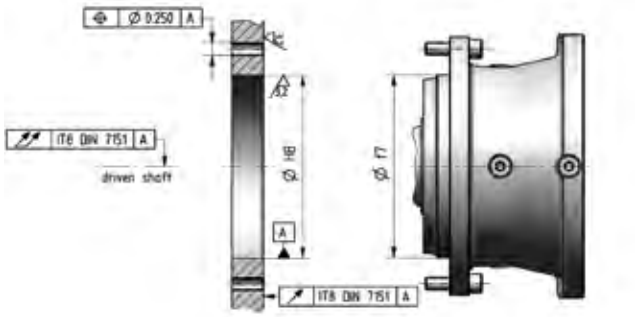
Before mounting pay attention to clean carefully mating surfaces.

In presence of external radial loads or torque required $M_2 \geqslant 0{,}7 \times M_{N2}$, apply locking adhesives.

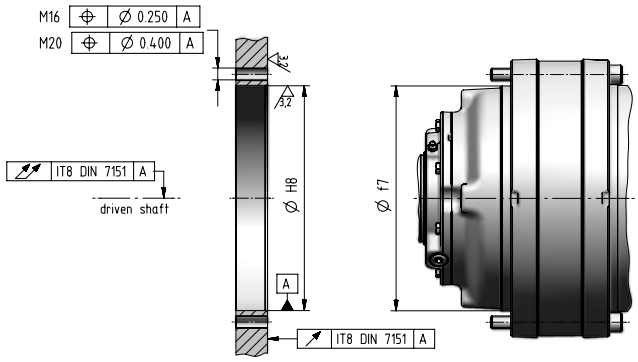
Tighten the screws according to the values given in the table on previous page.

To machine the matching frame, please refer to the drawings below.

Sizes **001A ... 021A**



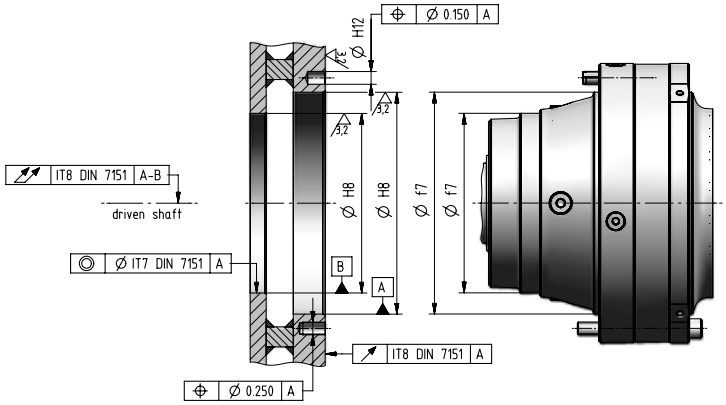
Sizes **030A ... 710A**



Sizes **022A, 031A, 043A**

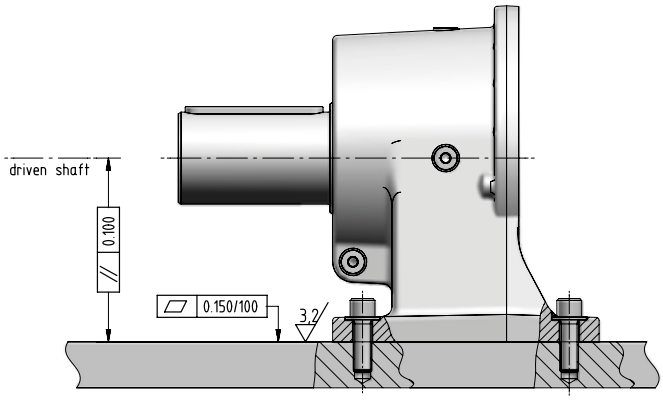
These sizes of gear reducers have two spigots. If the output shaft is not subject to radial load or if radial load is below 60% maximum allowed, only the bigger spigot may be used.

If elastic pins are present on the gear reducer flange, they must be used in the matching with a machine frame by a length equivalent to their diameter.



Flange and foot mounting

Sizes **001A ... 021A**



Shaft mounting arrangements

When shaft mounted, the gear reducer must be supported both axially and radially (also for mounting positions B5 … B53) by the shaft end of the driven machine as well as anchored against rotation only by means of a reaction having freedom of axial movement and sufficient clearance in its couplings to permit minor oscillations – always in evidence – without provoking dangerous overloads on the gear reducer. It is recommended to use the torque arm symmetrically to the gear reducer low speed shaft because, in this way, the torque reaction is equally distributed on the two constraints without loading the machine bearings. Lubricate with proper products the hinges and the parts subject to sliding. Regarding the reaction system, follow the instructions contained in the specific technical documentation.

Whenever personal injury or property damage may occur, due to falling or projecting parts of the gear reducer or of its parts, foresee adequate supplementary protection devices against:

– rotation or unthreading of the gear reducer from shaft end of driven machine following to accidental breakage of the reaction arrangement;

– accidental breakage of shaft end of driven machine.

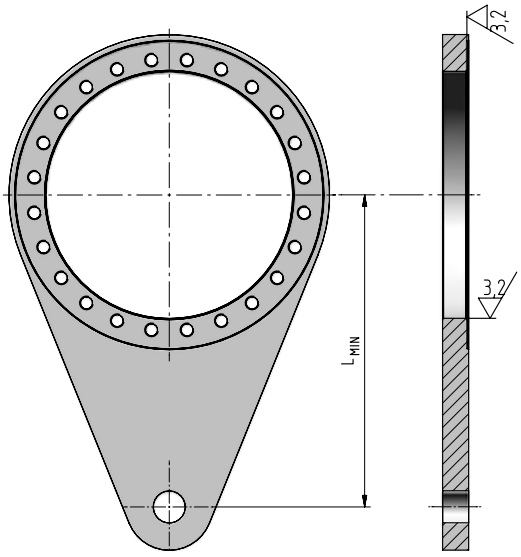
Attention! For **vertical ceiling-type** mounting and only for gear reducers equipped with locking rings or bush, gear reducer support is due only to friction, for this reason it is advisable to provide it with a fastening system.

8

Torque arm

Carefully clean the coupling surfaces, apply locking adhesives (it is recommended) and assemble the torque arm to the gear reducer. Tighten the screws by a dynamometric wrench at values shown in the table «Screws and tighening torque».

Symmetrical torque arm is provided as standard option (,TA - up to size 085A) ; if you need a one sided torque arm, it must comply with the dimensions shown below.



Size	L_{MIN}
001A	325
002A	325
003A	375
004A	375
006A	375
009A	450
012A	450
015A	450
018A	550
021A	550
030A	600
042A	700
060A	800
085A	900

Size	L_{MIN}
125A	1 000
180A	1 100
250A	1 250
355A	1 400
500A	1 550
710A	1 700

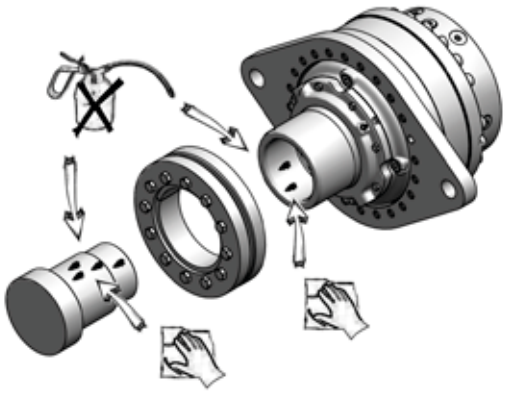
Hollow shaft mounting with shrink disc

For the shaft end detail of machines where the hollow shaft of the gear reducer is to be keyed, follow the instructions see ch 4.

Installation

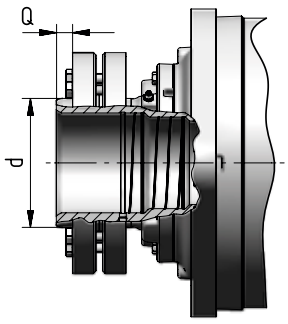
When keying the shrink disc, follow these instructions:

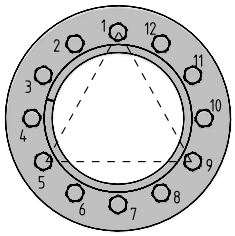
– carefully degrease the surfaces of hollow shaft and shaft end of driven machine to be fitted;



– mount the shrink disc on gear reducer hollow shaft by lubricating first only the external surface of hollow shaft; pay attention to locate axially the shrink disc at dimension «Q» shown in table below (values valid only for our shrink disc);

– slightly tighten a first group of three screws positioned at about 120° as shown for example in the figure;

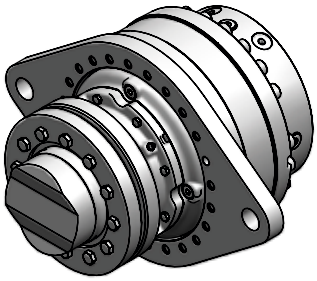


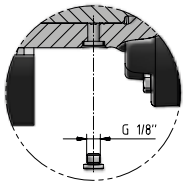


Size	d	Q
001A	55	8
002A	62	8
003A	68	10
004A	80	15
006A	90	8
009A	100	14
012A	115	13
015A	120	13
015A	125	18
018A	130	13
021A	130	13
030A	155	10
042A	165	10
060A	185	10
085A	200	10

Size	d	Q
125A	240	13,5
180A	260	13
250A	300	16
355A	340	15
500A	360	15
710A	420	15

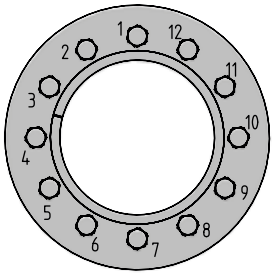
– mount the gear reducer on the machine shaft end; insert the shaft slowly to allow an air escape (from size 030A, open the plug located on the shaft, see below);





detail

– gradually and uniformly tighten, by means of dynamometric wrench, the screws of shrink disc at torque value shown in the fig. below, by a continuous sequence (not crossing) using approximately ¼ turns for several passes until ¼ turns can no longer be achieved;
– continue to apply overtorque for 1 or 2 more passes and at the end verify the bolt tightening torque;
– when having heavy duty cycles, with frequent reversals, verify the bolt tightening torque again, after some hours of running.



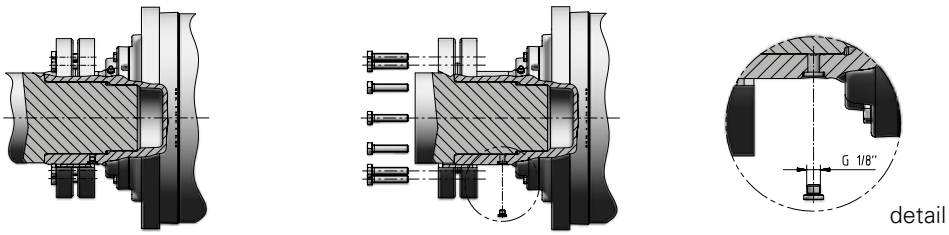
Size	screws	quantity	T... torque [N m]
001A	M6	8	12
002A	M8	6	30
003A	M8	6	30
004A	M8	8	30
006A	M8	10	30
009A	M8	12	30
012A	M10	10	59
015A	M10	12	59
018A	M12	10	100
021A	M12	10	100
030A	M12	15	100
042A	M16	10	250
060A	M16	15	250
085A	M16	15	250

Size	screws	quantity	T... torque [N m]
125A	M20	15	490
180A	M20	18	490
250A	M20	20	490
355A	M24	20	840
500A	M24	20	840
710A	M24	30	840

Removal

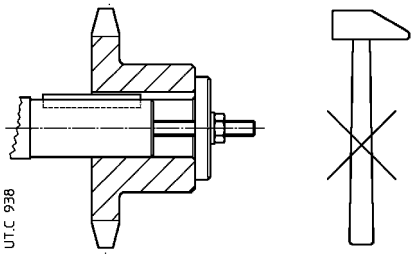
Do not completely remove fastening screws before locking rings are disengaged.
Risk of serious injury!!!
Clean off any rusty areas.

Loosen the fastening screws one after the other **only** by using approx. ½ turn at a time and by a continuous sequence (not crossing), until shrink disc can be moved on the hollow shaft.
Remove the customer shaft or the gear reducer. For sizes 030A, 042A, 060A, 085A, to make it easier is possible to inject low pressure oil through a threaded hole located on the hollow shaft (see below).



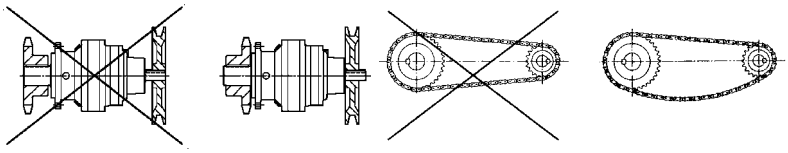
Fitting of components to shaft end

It is recommended that the bore of parts keyed to cylindrical shaft ends (spigots for splined shaft ends) is machined as indicated in ch 4. Before mounting, clean mating surfaced thoroughly and lubricate against seizure and fretting corrosion. Attention! Installing and removal operations should be carried out with pullers and jacking screws using the tapped holes at the shaft butt-end (see fig. below) taking care to avoid impacts and shocks which may irremediably damage the bearings, the circlips or other parts. For H7/m6, K7/k6 and K7/m6 fits it is advisable that the part to be keyed is preheated to a temperature of 80 ÷ 100 °C.



For splined couplings apply adequate products type MOLIKOTE, Klüber or LOCTITE. The couplings having a tip speed on external diameter up to 20 m/s must be statically balanced; for higher tip speeds they must be dynamically balanced.

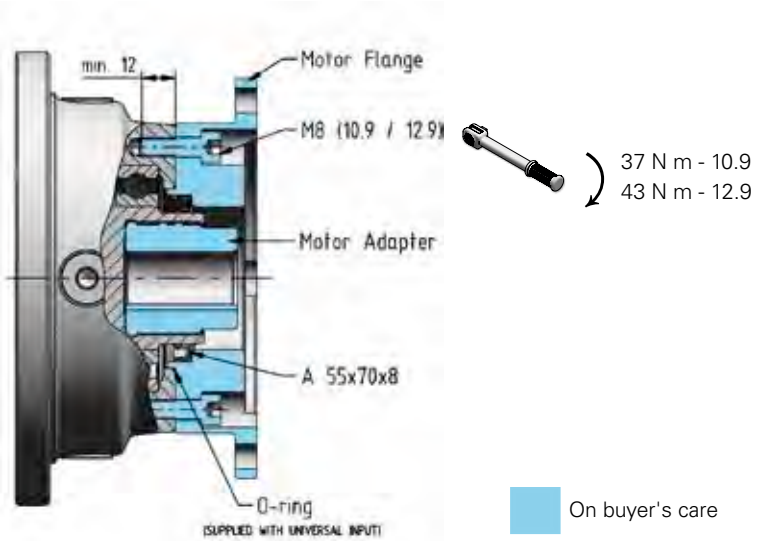
Where the transmission link between gear reducer and machine or motor generates shaft end loads, (see fig. below), ensure that the loads do not rise above the catalog values:
– transmission overhang is kept to a minimum;
– gear-type transmission must guarantee a minimum of backlash on all mating flanks;
– drive-chains should not be tensioned (if necessary – alternating loads and/or motion – foresee suitable chain tighteners);
– drive-belts should not be over-tensioned.



Incorrect Correct Incorrect Correct

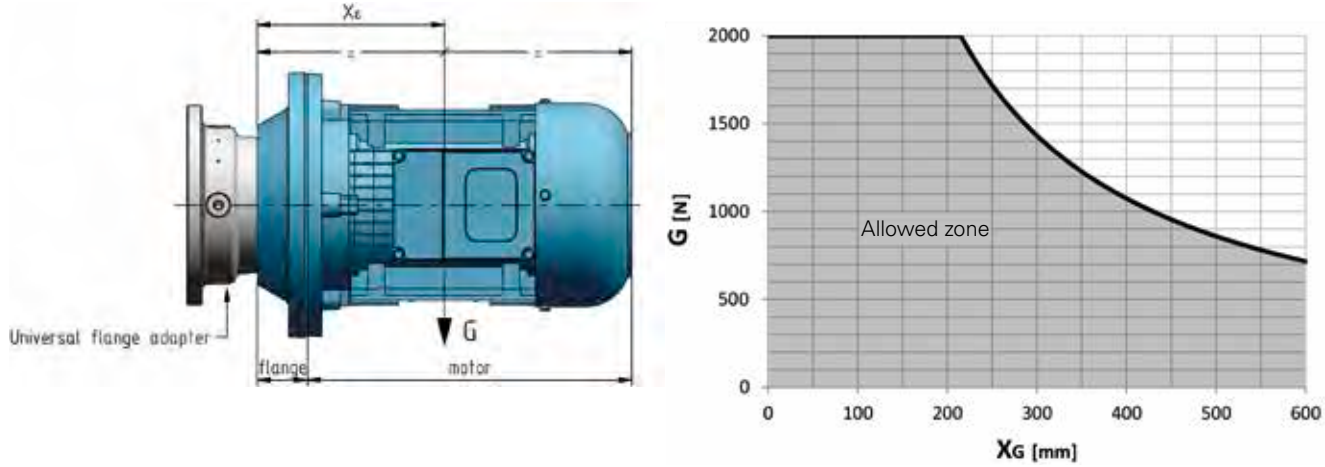
8.7 – Universal flange adapter

The universal input flange allows the customers to make their flanges and couplings suitable for the main motorization types. It's very important to observe the information shown in the drawing below to obtain a correct gear reducer oil sealing. The universal input flange can be used for motors with 1 000 Nm maximum torque and weight as per following chart.



When a universal flange adapter is used, it must be checked if the total weight of the flange+motor and the distance of their center of gravity are compliant with the following diagram.
In case of high vibrations or dynamic stress, please contact Rossi S.p.A..

Severe or fatal injury and damage to property may occur.



8.8 – Motor mounting or replacement

Electric motors

Check the mating dimensions for standards IEC 72-1 be sure that the mating surfaces are machined under accuracy rating (IEC 60072-1, UNEL 13501-69; DIN 42955) – for NEMA standards please refer to NEMA C-FACE chart;

– clean surfaces to be fitted thoroughly;
– check and, if necessary, lower the parallel key so as to leave a clearance of 0,1 ÷ 0,2 mm between its top and the bottom of the keyway of the hole. If shaft keyway is without shoulder, lock the key with a pin.
– lubricate surfaces to be fitted against fretting corrosion (Klüberpaste 46 MR 401 is recommended).
– insert the motor down to shoulder on gear reducer flange; this operation can be facilitate vertically positioning the gear reducer with motor flange mounted upwards;

Do not force the motor shaft into the gear reducer coupling. A serious damage may occur!
– check that motor centering is in the relevant gear reducer flange seat;
– check that the length of the screws is enough to have 2 × pitch over the nut;

– tighten the motor fastening screws to gear reducer flange in order to achieve the tightening torque as per following table:

Bolt **d** ∅	**Tightening torque** N m class **8.8**
M8	25
M10	56
M12	85
M14	135
M16	205

Maximum allowed bending moment

In case of assembly of motors supplied by the customer, verify that the static bending moment M_b generated by motor weight on the counter flange of gear reducer is lower than the value allowed M_{bmax}, stated in the table:

$$\boldsymbol{M}_b < \boldsymbol{M}_{bmax}$$

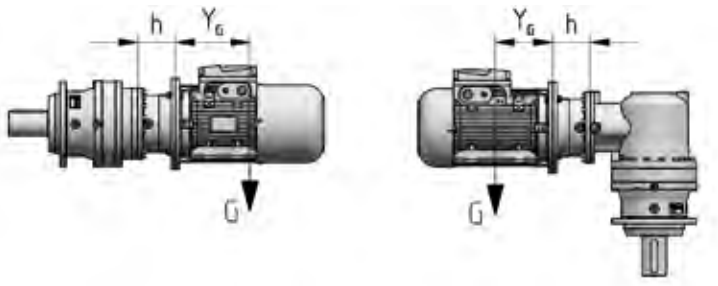
where:

$M_b = G \cdot (Y_G + h) / 1000$ [N m]

G [N] motor weight, nearly numerically equal to motor mass, expressed in kg, moltiplied by 10
Y_G [mm] distance from motor center of gravity from flange surface
h [mm] supplied in the table, according to gear reducer size and IEC motor size

Too long and thin motors, though with bending moments lower than prescribed limits, may generate anomalous vibrations during the operation. In these cases it is necessary to foresee a proper additional motor support (see motor specific documentation).

Loads higher than permissible loads may be present in dynamical applications where the gearmotor is subjected to translations, rotations or oscillations: consult us for the study of every specific case.



Bending moment M_{bmax} and dimension h

1EL	2EL	3EL	4EL	2EB	3EB	4EB	IEC	Code	h mm	M_{bmax} N m
001A, 002A	001A ... 006A	001A ... 022A	001A ... 060A	001A ... 006A	001A ... 022A	001A ... 060A	71	**I14×160**	52	900
							80	**I19×200**	72	
							90	**I24×200**	72	
							100	**I28×250**	82	
							112	**I28×250**	82	
							132	**I38×300**	102	
							160	**I42×350**	135	
							180	**I48×350**	135	
003A ... 006A	009A ... 022A	030A ... 060A	085A ... 180A	009A ... 015A 022A	030A ... 043A	085A ... 125A	100	**I28×250**	103	2800
							112	**I28×250**	103	
							132	**I38×300**	120	
							160	**I42×350**	153	
							180	**I48×350**	153	
							200	**I55×400**	153	
009A ... 015A	030A ... 043A	085A ... 125A	250A ... 355A	018A, 021A, 030A	060A, 085A	180A ... 250A	132	**I38×300**	133,5	4500
							160	**I42×350**	159	
							180	**I48×350**	159	
							200	**I55×400**	159	
							225	**I60×450**	189	
							250	**I65×550**	189	
							280	**I75×550**	189	
018A, 021A	060A	180A	500A	042A ... 060A	125A ... 180A	355A ... 500A	160	**I42×350**	159	4500
							180	**I48×350**	159	
							200	**I55×400**	159	
							225	**I60×450**	189	
							250	**I65×550**	189	
							280	**I75×550**	189	
030A ... 043A	085A ... 125A	250A ... 355A	710A	085A ... 125A	250A ... 355A	710A	160	**I42×350**	111	4500
							180	**I48×350**	111	
							200	**I55×400**	111	
							225	**I60×450**	141	
							250	**I65×550**	141	
							280	**I75×550**	141	

8

Hydraulic motors

– check the mating dimensions;
– clean surfaces to be fitted thoroughly;
– ensure that any seal provided (O-ring) with hydraulic motor is correctly fitted in its seat;
– lubricate surfaces to be fitted against fretting corrosion (Klüberpaste 46 MR 401 is recommended).
– insert the motor down to shoulder on gear reducer flange; this operation can be facilitate vertically positioning the gear reducer with motor flange mounted upwards.

Do not force the motor shaft into the gear reducer coupling. A serious damage may occur!
– check that motor centering is in the relevant gear reducer flange seat;
– tighten the motor fastening screws to gear reducer flange in order to achieve the appropriate tightening torque;
– use bolts 8.8 or higher.

8.9 – Lubrication

The gear pairs are oil-bath lubricated, the bearings are either oil bathed or splashed or lubricated «for life» with grease. For some mounting positions with continuous duty at high speed, an expansion tank is foreseen: consult us.

Sizes 001A ... 021A: gear reducers are supplied **filled with PAO synthetic oil** having ISO viscosity grade 320 cSt (at 40° C).

Important!: Verify the mounting position, keeping in mind that if gear reducer is installed in a mounting position differing from the one stated on name plate, it could need the addition of the difference between the two lubricant quantities. In any cases, always check the correct oil quantities through the transparent level plug.

Sizes 022A ... 710A: gear reducers are supplied **without oil**; before putting into service, fill to the specified level[1)] with synthetic or mineral oil (see table below).

Consider the lubrication interval stated in the table for all re-lubrication operations, emptying the gear reducers from the exhausted oil, executing a wash with clean oil of the same type to be used also for the re-filling of the gear reducer up to level[1)].

Use only lubricants of the same type stated on lubrication nameplate.

1) The lubricant quantities stated in ch. 6 are approximate and indicative for provisioning. The exact oil quantity the gear reducer is to be filled with is definitely given by the level.

Oil temperature [°C]	Oil-change interval [h]	
	synthetic oil	mineral oil
⩽ 65	**12 500**	5 600
65 ÷ 80	**10 000**	2 800
80 ÷ 95	**6 300**	1 400

Oil-change intervals assume pollution-free surroundings. When heavy overloads are present, halve the values.

Independently from running times, change the oil:

every 2 ÷ 4 years, for synthetic oil;

every 1 ÷ 2 years, for mineral oil;

The main lubricant manufacturers as well as the ISO viscosity grade to be used are stated in the following tables.

Use only lubricants with **EP** (extreme pressure) **additives**.

In case of mineral lubricant choice, follow the instructions about the service factor (ch. 2.2).

Manufacturer	**PAO synthetic oil** ISO VG 320	mineral oil ISO VG 150 ... 460
ADDINOL	Eco Gear S	Eco Gear M
AGIP	Blasia SX	Blasia
ARAL	Degol PAS	Degol BG
BP	Enersyn EPX	Energol GR XP
CASTROL	Alphasyn T	Alpha SP
KLÜBER	Klübersynth GEM4	Klüberoil GEM1
MOBIL	Mobil SHC Gear	Mobilgear 600 XP
SHELL	Omala S4 GX	Omala S2 G
TOTAL	Carter SH	Carter EP

ISO viscosity grade
Mean kinematic viscosity [cSt] at 40 °C.

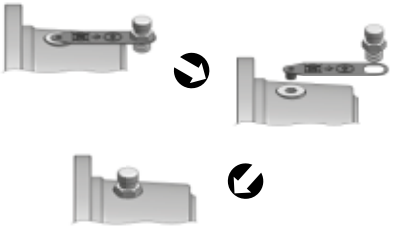
Speed n_2 min^{-1}	Ambient temperature [°C] mineral oil	
	-10 ÷ 20	10 ÷ 40
> 140	150	220
140 ÷ 2,0	220	320
< 2,0	320	460

Never mix different makes of synthetic oil; if oil-change involves switching to a type different from that used hitherto, then give the gear reducer a through clean-out. Polyglycol basis synthetic lubricants must not be used.

Bearings with independent lubrication

Usually the bearings are automatically and continuously lubricated (oil-bathed or splashed) with the same lubricant of gear reducer. However for certain gear reducer in vertical mounting positions V1, V3 and horizontal mounting positions B51, B52 the upper bearings have independent lubrication, with special grease for «long life» lubrication in absence of external pollution.

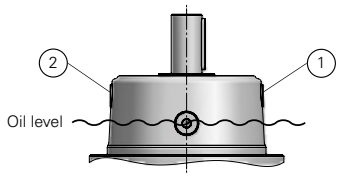
8.10 – Commissioning



Carry out an overall check, making particularly sure that the gear reducer is filled with lubricant up to level and mounted according to the mounting position stated on name plate.

The filler plug and breather is supplied disassembled, inside a bag close to its seat. Before commissioning, after positioning the gear reducer in the mounting position stated in the nameplate, replace the closed plug with the filler plug and breather (see fig. below).

Oil filling

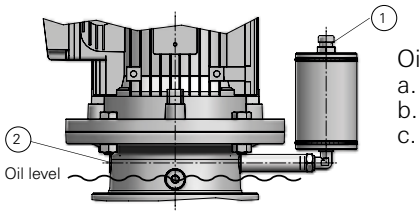


Pay attention to the correct position of the oil level plug (see ch. 6).
When the output speed n_2 is lower than 0,3 min^{-1} and the mounting position is horizontal, the gear reducer must be completely filled with oil.
For mounting positions with input side in vertical position, during the oil filling it is very important to always open the plug located up to the level of air escape in order to reach the correct level.

Oil filling:
a. Open the plugs 1 and 2.
b. Fill with oil by the plug 1 reaching the correct level
c. Close the plugs 1 and 2.

Expansion tanks

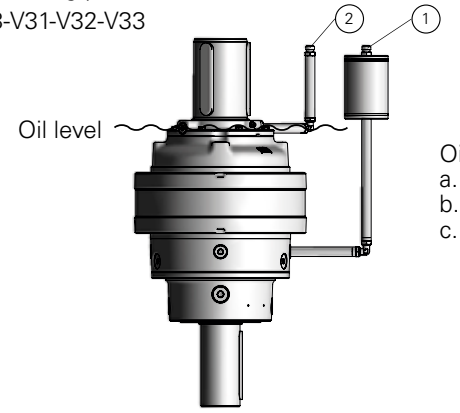
For some mounting positions, as foreseen in ch. 6, an expansion tank is needed in order to allow the correct oil level and the natural thermal expansion of lubricant.
It is very important that it must always be placed above the oil level.
For the oil filling consider the diagram below:



Oil filling:
a. Open plugs 1 and 2.
b. Fill with oil by the plug 1 up to reach the correct level
c. Close plugs 1 and 2.

For sizes from 030A with mounting positions V3-V31-V32-V33, when ordered, the expansion tank kit does not include the piping arrangement. In these cases, please refer to the diagram below:

Mounting positions
V3-V31-V32-V33



Oil filling:
a. Open plugs 1 and 2.
b. Fill with oil by the plug 1 up to reach the correct level
c. Close plugs 1 and 2.

Plugs

For the size of plugs and breather plug and the value of tightening torque see table below.

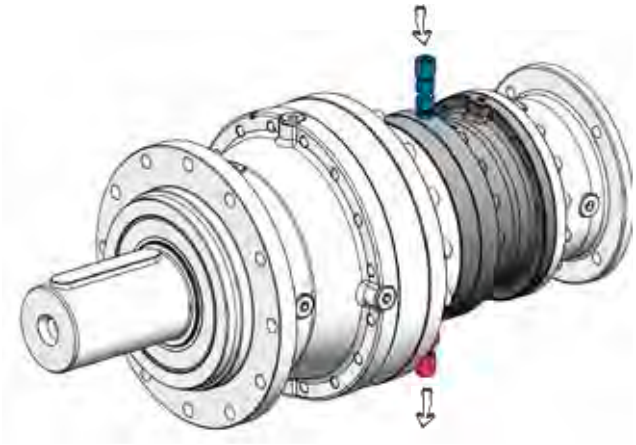
Plugs			Breather plugs		
Ø	**Ch**	Tightening torque [Nm]	**Ø**	**Ch**	Tightening torque[1] [Nm]
G 1/8 "	5	**8**	G 1/4 "	17	**12**
G 1/4"	6	**13**	G 3/8 "	20	**16**
G 3/8 "	8	**20**	G 1/2 "	24	**23**
G 1/2 "	10	**30**	G 3/4 "	32	**37**
G 3/4"	12	**45**	G 1"	40	**58**
G 1"	17	**65**	G 1" 1/4	50	**105**
G 1" 1/4	22	**100**	G 1" 1/2	55	**126**
G 1" 1/2	24	**125**			

1) Values valid with aluminium washer.

For the first commissioning, before starting with a normal running cycle, it is advisable to run the gear reducer without load in order to verify if it correctly runs.
In this circumstance, cause of the elimination of potential residual air, an oil filling up to level could be necessary.
During this first run, it is important to check :
– noise level;
– vibrations;
– sealings;
If you notice any malfunctions, please refer to ch. 8.14 and contact Rossi S.p.A..

8.11 – Cooling unit systems

Integrated water cooling unit



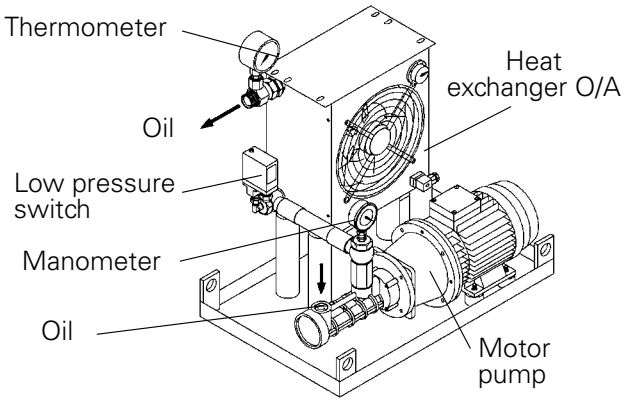
The gear reducers, according to the sizes, can be equipped with a water cooling unit.
Suggested cooling water specifications are:
– low hardness;
– max temperature 20 °C;
– minimum flow 3 dm^3/min (l/min);
– pressure 0,2 ÷ 0,4 Mpa (2 ÷ 4 bar).
For the connection you may use standard fitting according to the female coupling sizes (see pag. 7.9).
Be sure that all the connections are free of leakage.

Integrated fan cooling unit

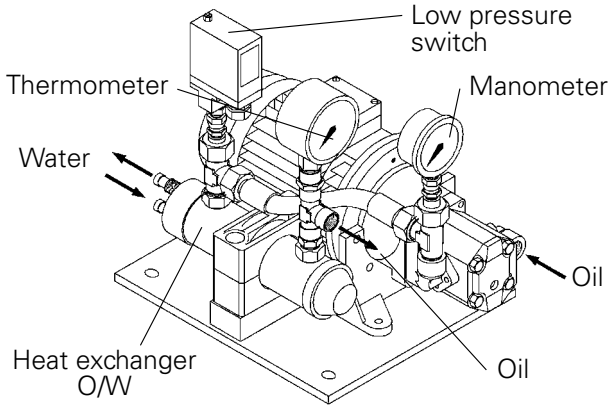
When a fan cooling unit is mounted, verify that there is sufficient space allowing for adequate circulation of cooling air also after fitting coupling protection

Independent cooling units

Independent cooling unit with oil-air heat exchanger **UR O/A ...**



Independent cooling unit with oil-water heat exchanger **UR O/W ...**



When natural cooling or integrated cooling units are not sufficient anymore (for thermal power verification see ch. 2), it is possible to install the independent cooling units described below.

Consisting of:

– **oil/air heat exchanger** (O/A; with thermostat and adjustable control knob 0 ÷ 90 °C) or **oil/water heat exchanger** (O/W),
– **motor pump**: screw or gear pump with fluoro rubber seals; 4 pole motor B3/B5 (three-phase Δ230 Y400 V 50 Hz); motor-pump connection with coupling;
– **motor fan** (O/A) (three-phase supply Δ230 Y400 V 50 Hz or single phase supply 230 V 50, 60 Hz, see table)
– **analogic manometer** (0 ÷ 16 bar) mounted between pump and exchanger;
– **analogic thermometer** (0 ÷ 120 °C) mounted at exchanger output;
– **low pressure switch** (with on-off switch) mounted between pump and exchanger;
– **supporting frame** with nameplate.

On request, several accessories are at disposal (supplied separately, assembled by Customer) in order to satisfy all functionality and safety needs.

– **oil temperature probe Pt100**;
– **2-threshold signalling device CT03** (necessary also the oil temperature probe Pt100) for the mounting on rail to DIN EN 50022;
– **3-threshold signalling device CT10** (necessary also the oil temperature probe Pt100) for the mounting on rail to DIN EN 50022;
– **bi-metal type thermostat**;
– **flow gauge**;
– **filter** (with optical-eletric blockage warning and one or two filters M60)

Connections realized by flexible pipes (type SAE 100 R1, maximum length 2 m) between gear reducer and cooling unit and the assembly of accessories and signalling devices are Buyer's responsibility.

Operational features - UR O/A ...

Unit designation	P_S kW	Exchanger	Oil motor pump motor kW	Oil motor pump capacity l/min	Motor fan motor kW	Motor fan capacity m^3/h	Oil connections suction./delivery. «F»	Exch.	Mass
UR O/A 5	**5**	AP 300E	1,5	30	0,12 mon.	900	1" (1"1/4)	2	60
UR O/A 7	**7**	AP 300/2E			0,12 mon.	1 300		3,6	65
UR O/A 10	**10**	AP 430E			0,18	2 750		3,6	70
UR O/A 13	**13**	AP 430/2E			0,23	2 700		5,5	75
UR O/A 16	**16**	AP 580 EB	2,2	56	0,23	3 500	1" 1/4 suction 1" 1/2 (1")[1] delivery	15	96
UR O/A 21	**21**	AP 680 EB			0,56	6 300		16	118
UR O/A 26	**26**	AP 730 EB	3	56	0,56	7 450		16	127
UR O/A 30	**30**		3	80					
UR O/A 40	**40**	AP 830 EB	2,2	56	0,9	9 500		20	140
UR O/A 46	**46**		3	80					

1) Connection for delivery UR O/A 16.

Operational features - UR O/W ...

Unit designation	P_S kW	Exchanger	Oil motor-pump motor kW	Oil motor-pump delivery l/min	Oil connections suction/delivery «F»	Water flow l/min	Water connection	Exch. volume dm^3	Mass ≈ kg
UR O/W 4-EP	**4**	T60CB1	0,37	3	G 1/2"	⩾ 8 (⩽ 30)	Ø 12	0,4	13
UR O/W 6-EP	**6**	T60CB2	0,37	6		⩾ 10 (⩽30)	Ø 12	0,6	15
UR O/W 9-EP	**9**	T80CB2	0,37	9		⩾ 16 (⩽30)	Ø 12	1	18
UR O/W 13-EP	**13**	MS84P2	1,1	20	G 3/4"	⩾ 25 (⩽45)	G 1/2"	1	27
UR O/W 21-EP	**21**	MS134P1	1,1	40	G 1" 1/4	⩾ 40 (⩽110)	G 1"	3,4	40
UR O/W 31	**31**	MS134P1	2,2	56		⩾ 50 (⩽110)	G 1"	3,4	55
UR O/W 50	**50**	MS134P2	3	80		⩾ 80 (⩽110)	G 1"	4,5	70

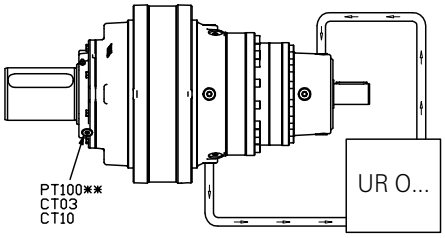
Starting mode and required accessories

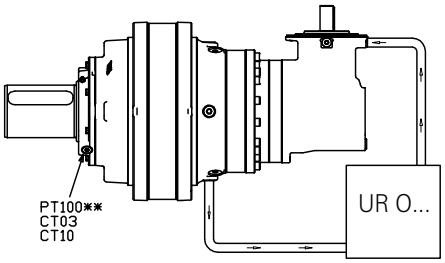
Ref.	T_{amb} °C	Required accessories	Required oil type	Description and remarks
A1	0 ÷ 25	Pt100 + CT10	Polyalphaolefine based synthetic oil or Mineral oil	**Gear reducer starting and subsequent motor-pump starting with warm oil.** The motor-pump is managed by the **three-threshold** oil temperature control system (Pt100 + CT10). Set the three-threshold device CT10 with: – operating temperature 60 °C (starting of motor-pump); – restoring temperature 40 °C; – warning temperature 90° C.
A2	> 25	–	Polyalphaolefine based synthetic oil	**Simultaneous starting of gear reducer and motor-pump** Oil filter not possible[1].

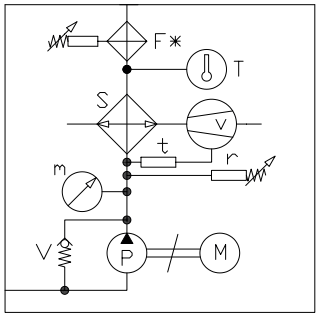
1) The oil filter requires that cooling unit is started with oil already warm: refer to case A1.

Additional description when ordering by **designation**:
independent oil-air cooling unit UR O/A ... or **independent oil-water cooling unit UR O/W ....**
For more details about reference starting mode A1 / A2, see specific literature.
For dimensions, accessories and further technical details, see specific literature.

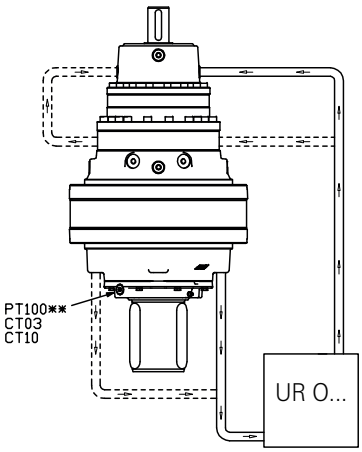
For the design of the cooling system, see the following instructions and sample diagrams.
It is recommended for suction to be in the lowest point and that suction and delivery points are adequately distant from each other.

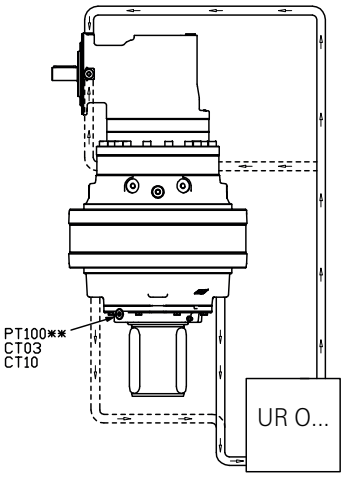


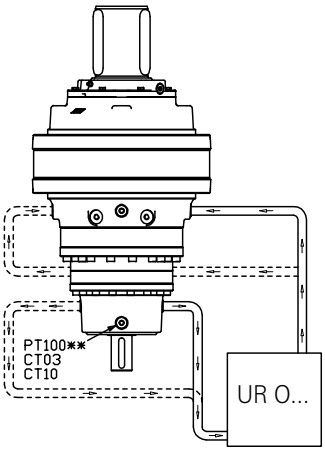


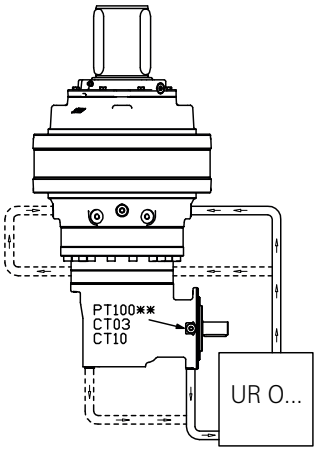


UR O ...









Legend:

Pt 100**	oil temperature probe (supplied separately)
F*[1)]	filter with electric clogging signaller (with UR O/W... it is supplied separately)
m	manometer 0 ÷ 16 bar
M	motor pump
P	pump
CT 03*, CT10*	signalling device (supplied separately)
S	oil/air or oil/water heat exchanger
v	motor fan (UR O/A ...)
t	fan thermostat 0 ÷ 90 °C (UR O/A...)
T	thermometer 0 ÷ 120 °C
V	safety valve 6 bar (screw pump)
r	low pressure switch

* On request.
** On request.

1) The filter MPS 351 M60 is always supplied apart (not mounted on cooling unit). With UR O/W the filter is always supplied apart (not mounted on cooling unit).

8

Oil flow capacity of holes

Plugs size	d [mm]	$q_{s\,(max)}$ [1)] [l/min]	$q_{d\,(max)}$ [1)] [l/min]
G 1/4"	7	3	5
G 3/8"	10	6	10
G 1/2"	12	9	15
G 3/4"	16	16	27
G 1"	22	30	51
G 1 1/4"	30	56	95

1) Stated values are valid with a kinematic oil viscosity of about 60 Cst.

For exact oil levels, plug positions and size, expansions tanks, see ch. 6.

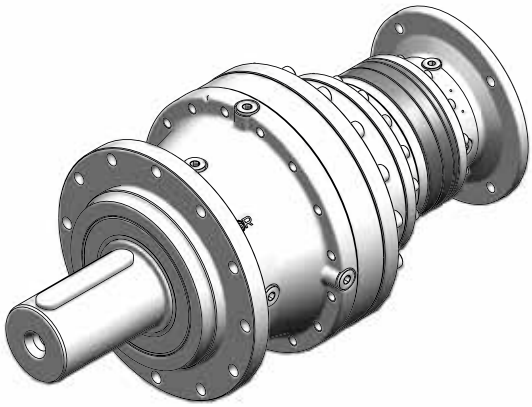
It is very important to design the hydraulic circuit according to the following indications:

$$q_s \leq Q_R$$

q_s max delivery in suction for 1 hole.
q_d max delivery sending for 1 hole.
Q_R is the gear reducer oil quantity at correct level, see ch. 6.
d internal diameter of fitting and pipes

Where the use of only one hole is not enough to dispose all the oil flow, 2 or more holes can be connected at the main pipelines (suction and delivery).
Obviously, being a closed circuit, the total oil flow in suction and delivery must be equivalent.

8.12 – Backstop



The gear reducers, according to the sizes, can be equipped with a backstop device. This system allows rotation in one specified direction only so preventing reverse rotation when the drive is disconnected. The right direction of free rotation is indicated by a name plate on the gear reducer.

Attention! Do not start the motor in the blocking direction!
Several damage can be occur!.

8.13 – Maintenance

At machine rest, verify at regular intervals (more or less frequently according to environment and use):

a) all external surfaces are clean and air passages to the gear reducer are free, in order that cooling remains fully effective. An accumulation of dust impedes efficient heat dispensal from the gear reducer housing and must be removed;

b) oil level and deterioration degree (check with cold gear reducer at rest);

c) correct fastening screws tightening.

During operation, check periodically:

– noise level;
– vibrations;
– sealings;
– etc.

Attention! After a running period, gear reducer is subject to a light internal overpressure which may cause burning liquid discharge. Therefore, before loosening whichever plug (filler plug included) wait until gear reducer has become cold and open it carefully; if not possible, take the necessary protection measures against burning due to warm oil contact. In all cases, always proceed with great care.

Maximum oil temperatures indicated on lubrication table do not represent a hindrance to the gear reducer regular running.

During oil change operation, after unscrewing also the filler plug in order to facilitate oil draining (for plug position see ch. 6):

– wash the inside part of gear reducer housing using the same oil type suitable for the running (stated on lubrication nameplate); the oil used for this wash can be applied for further washings after proper filtering by 25 µm of filtration standard;
– clean, using a compressed air stream, all magnetic plugs, taking care to assemble them again in their original position;
– fill in the gear reducer with new oil up to level, using only oil of the same type and viscosity as per lubrication nameplate.

Replace the seal rings in case of dismounting or of periodical check; in this case, the new ring must be positioned so that it does not work on the same sliding race of previous ring.

Seal rings

Duration depends on several factors such as dragging speed, temperature, ambient conditions, etc.; as a rough guide it can vary from 1 600 ÷ 12 500 h.

8.14 – Troubles: causes and corrective actions

Trouble	Possible causes	Corrective actions
Excessive temperature (in continuous duty or of bearings)	Inadequate lubrication: — excessive of insufficient oil quantity — exhaust lubricant — too tightened taper roller bearings — excessive ambient temperature	Check: — oil level (gear reducer standstill) — lubricant type Consult Rossi Increase the cooling or correct the ambient temperature
	Obstructed suction openings of fan cover	Clean the fan cover
	Bearing failure, defect or bad lubrication	Consult Rossi
	Inefficient or out of service oil cooling system: obstructed filter, insufficient oil (exchanger) or water (coil) flow rate, pump out of service, etc.	Check the pump, the pipes, the oil filter and safety devices efficiency (manostats, thermostats, etc.)
Anomalous noise	One or more teeth with — dents or spallings — excessive flanks roughness	Consult Rossi
	Bearings failure, defect or bad lubrication	
	Taper roller bearings with excessive clearance	
	Vibrations	Check the fastening
Lubricant leaking from seal rings	Seal ring with worm, bakelized, damaged or false mounted seal lip	Replace the seal ring
	Damaged rotating seating (scoring, rust, dent, etc.)	Restore the seating
	Mounting position differs from the one stated on the name plate	Correctly position the gear reducer

NOTE

When consulting Rossi state:
- all data on gear reducer or gearmotor name plate;
- failure nature and duration;
- when and under what conditions the failure happened;
- during the warrenty period, in order not to loose its validity, do not dissamble nor open the gear reducer without the approval of Rossi S.p.A..

8.15 – Technical formulae

Main formulae concerning mechanical drives, according to the Technical System and International Unit System (SI).

Size	With Technical System units	With SI units
starting or stopping **time** as a function of an acceleration or deceleration, of a starting or braking torque	$t = \frac{v}{a}$ [s]	
	$t = \frac{Gd^2 \cdot n}{375 \cdot M}$ [s]	$t = \frac{J \cdot \omega}{M}$ [s]
velocity in rotary motion	$v = \frac{\pi \cdot d \cdot n}{60} = \frac{d \cdot n}{19,1}$ [m/s]	$v = \omega \cdot r$ [m/s]
speed n and **angular velocity ω**	$n = \frac{60 \cdot v}{\pi \cdot d} = \frac{19,1 \cdot v}{d}$ [min^{-1}]	$\omega = \frac{v}{r}$ [rad/s]
acceleration or deceleration as a function of starting or stopping time	$a = \frac{v}{t}$ [m/s^2]	
	$\alpha = \frac{n}{9,55 \cdot t}$ [rad/s^2]	$\alpha = \frac{\omega}{t}$ [rad/s^2]
angular acceleration or deceleration as a function of a starting or stopping time, of a starting or braking torque	$\alpha = \frac{39,2 \cdot M}{Gd^2}$ [rad/s^2]	$\alpha = \frac{M}{J}$ [rad/s^2]
starting or stopping **distance** as a function of an acceleration or deceleration, of a final or initial velocity	$s = \frac{a \cdot t^2}{2}$ [m]	
	$s = \frac{v \cdot t}{2}$ [m]	
	$\varphi = \frac{\alpha \cdot t^2}{2}$ [rad]	
starting or stopping **angle** as a function of an angular acceleration or deceleration, of a final or initial angular velocity	$\varphi = \frac{n \cdot t}{19,1}$ [rad]	$\varphi = \frac{\omega \cdot t}{2}$ [rad]
mass	$m = \frac{G}{g}$ $[\frac{kgf\ s^2}{m}]$ G is the unit of weight (weight force) [kgf]	m è l'unità di massa [kg] m is the unit of mass [kg] $G = m \cdot g$ [N]
weight (weight force)	$F = G$ [kgf]	$F = m \cdot g$ [N]
force in vertical (lifting), horizontal, inclined motion of translation (μ = coefficient of friction; φ = angle of inclination)	$F = \mu \cdot G$ [kgf]	$F = \mu \cdot m \cdot g$ [N]
	$F = G\ (\mu \cdot \cos \varphi + \text{sen}\ \varphi)$ [kgf]	$F = m \cdot g\ (\mu \cdot \cos \varphi + \text{sen}\ \varphi)$ [N]
dynamic moment Gd^2, moment of inertia J due to a motion of translation (numerically $J = \frac{Gd^2}{4}$)	$Gd^2 = \frac{365 \cdot G \cdot v^2}{n^2}$ [kgf m^2]	$J = \frac{m \cdot v^2}{\omega^2}$ [kg m^2]
torque as a function of a force, of a dynamic moment or of a moment of inertia, of a power	$M = \frac{F \cdot d}{2}$ [kgf m]	$M = F \cdot r$ [N m]
	$M = \frac{Gd^2 \cdot n}{375 \cdot t}$ [kgf m]	$M = \frac{J \cdot \omega}{t}$ [N m]
	$M = \frac{716 \cdot P}{n}$ [kgf m]	$M = \frac{P}{\omega}$ [N m]
work, energy in motion of translation, in rotary motion	$W = \frac{G \cdot v^2}{19,6}$ [kgf m]	$W = \frac{m \cdot v^2}{2}$ [J]
	$W = \frac{Gd^2 \cdot n^2}{7160}$ [kgf m]	$W = \frac{J \cdot \omega^2}{2}$ [J]
power in motion of translation, in rotary motion	$P = \frac{F \cdot v}{75}$ [CV]	$P = F \cdot v$ [W]
	$P = \frac{M \cdot n}{716}$ [CV]	$P = M \cdot \omega$ [W]

Note. Acceleration or deceleration are understood constant; motion of translation and rotary motion are understood rectilinear and circular respectively.

Main formulae concerning mechanical drives, according to the Technical System and International Unit System (SI).

Size	With Technical System units	With SI units
power available at the shaft of a single-phase motor (cos φ = power factor)	$P = \frac{U \cdot I \cdot \eta \cdot \cos\varphi}{736}$ [CV]	$P = U \cdot I \cdot \eta \cdot \cos\varphi$ [W]
power available at the shaft of a three-phase motor	$P = \frac{U \cdot I \cdot \eta \cdot \cos\varphi}{425}$ [CV]	$P = 1{,}73 \cdot U \cdot I \cdot \eta \cdot \cos\varphi$ [W]
torque transmissible by a hydraulic motor		$M = \frac{V_g\,[cm^3/rev] \cdot \Delta p\,[bar] \cdot \eta_{mh}}{62{,}832}$ [N m]
power available at the shaft of a hydraulic motor		$P = \frac{V_g\,[cm^3/rev] \cdot \Delta p\,[bar] \cdot \eta_t \cdot n\,[min^{-1}]}{600\,000}$ [kW]
flow (hydraulic motor)		$q_v = \frac{V_g\,[cm^3/rev] \cdot n\,[min^{-1}]}{1\,000 \cdot \eta_v}$ [l/min]
speed (hydraulic motor)		$n = \frac{1\,000 \cdot \eta_v \cdot q_v\,[l/min]}{V_g\,[cm^3/rev]}$ [min^{-1}]

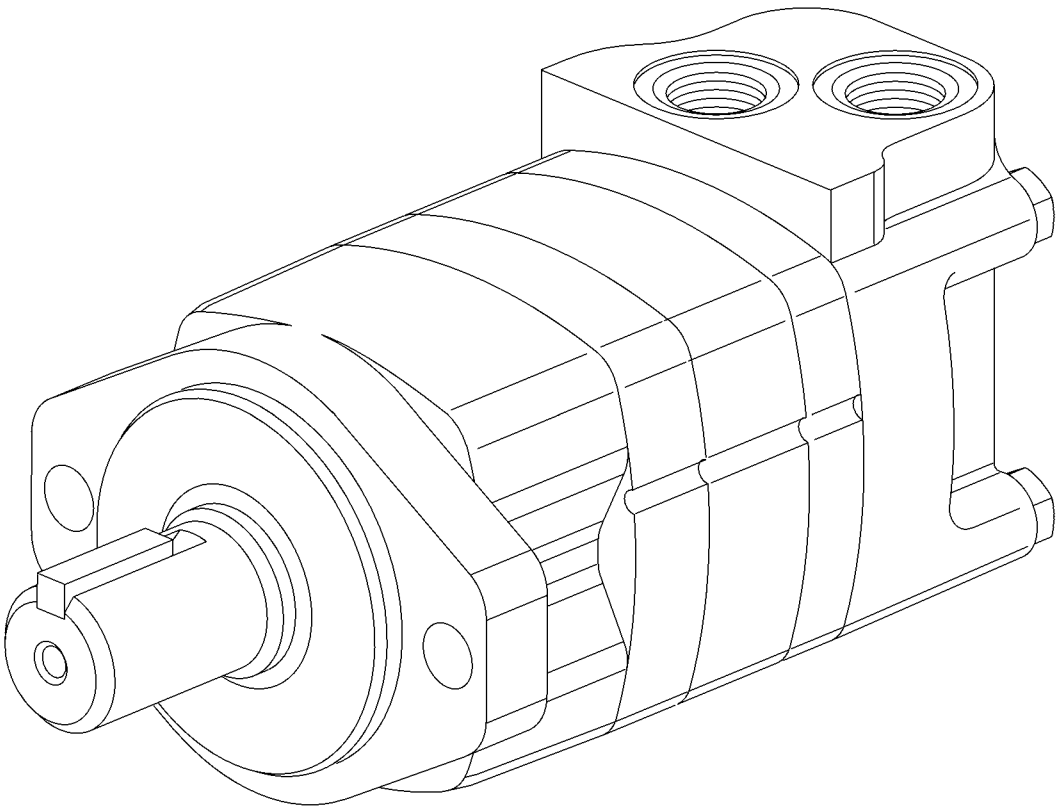
Note. Acceleration or deceleration are understood constant; motion of translation and rotary motion are understood rectilinear and circular respectively.

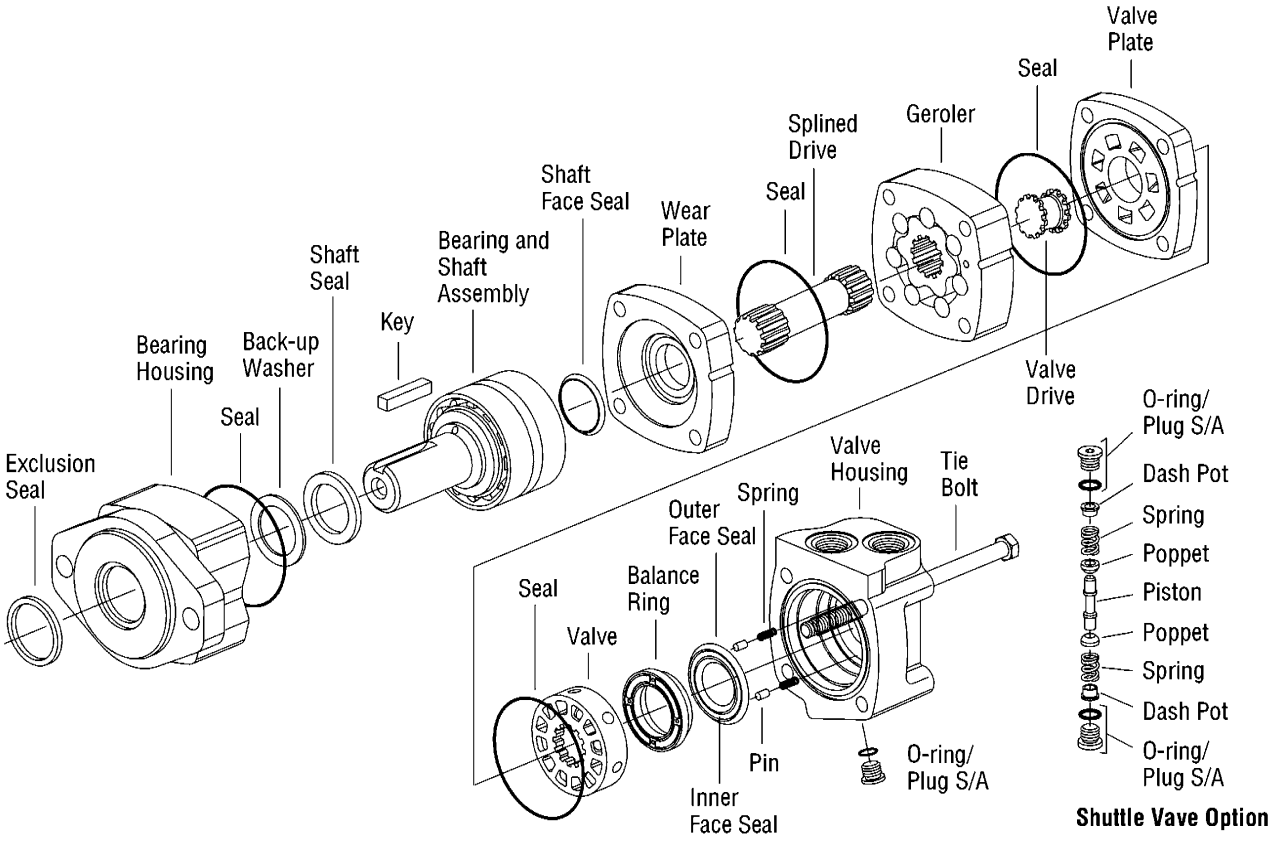
Appendix D
Eaton Char-Lynn 2000 Series Gear Motor Manual

EATON | Char-Lynn®

Hydraulic Motor

2000 Series
Disc Valve Geroler Motor **006**





Shuttle Vave Option

Tools required for disassembly and reassembly.

Torque wrench 57Nm [500 lb-in] capacity
300-450 [12-16]* breaker bar
9/16 socket
Small screwdriver 150-200 x 6,5 [6-8 x 1/4] blade
3/16 Allen wrench
Press

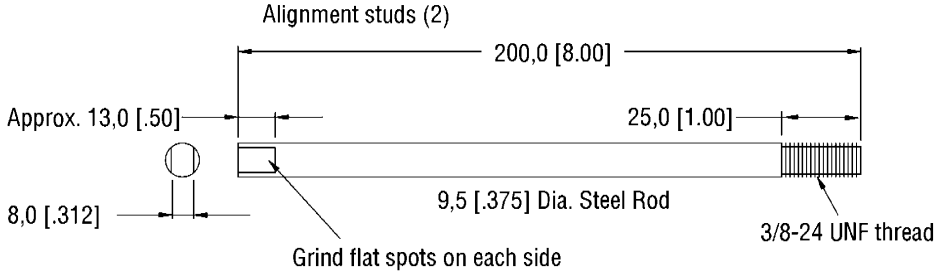
* Unless indicated otherwise, measurements are given in mm [inches]

** Shaft seal installation tool (600496)

** Bullet (600465) for 1 diameter shafts

The following tools are not necessary for disassembly and reassembly, but are extremely helpful.

Alignment studs (2)



Disassembly

Cleanliness is extremely important when repairing a hydraulic motor. Work in a clean area. Before disconnecting the lines, clean the port area of the motor thoroughly. Use a wire brush to remove foreign material and debris from around the exterior joints of the motor. Check the shaft and key slot, remove all nicks, burrs or sharp edges that might damage the bearing housing seals when installing the shaft and bearing assembly. Before starting the disassembly procedures, drain the oil from inside the motor.

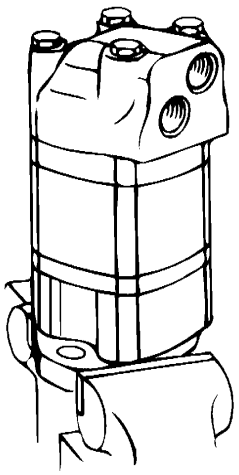


Figure 1

1 Place the motor in a vise with the output shaft down. Clamp across the mounting flange of the motor not the housing. Excessive clamping pressure will cause distortion. When clamping, use some protective device on the vise, such as special soft jaws, pieces of hard rubber or board.

Although not all drawings show the motor in a vise, we recommend that you keep the motor in the vise during disassembly and reassembly. Follow the clamping procedures explained throughout the manual.

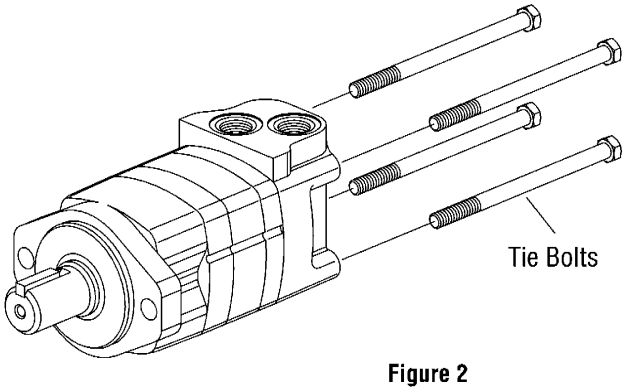


Figure 2

2 Remove 4 bolts from motor.

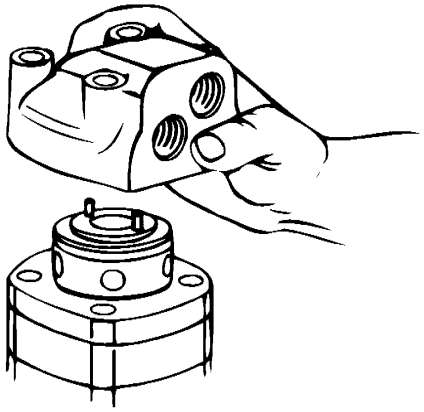


Figure 3

3 Lift valve housing straight up. If done carefully the pins, springs, balance ring assembly, and valve will remain on the valve plate.

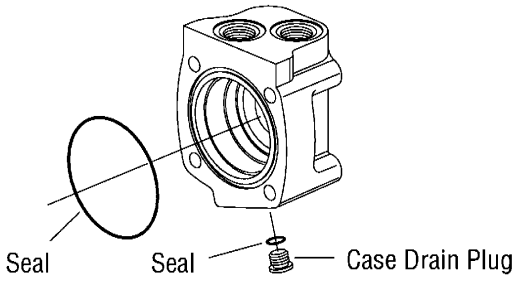


Figure 4

4 Carefully remove 76,0 [3.00] diameter seal from valve housing.

5 Remove case drain plug—with seal, from valve housing.

6 Remove 2 pins and 2 springs from balance ring assembly, see Figure 5.

Disassembly

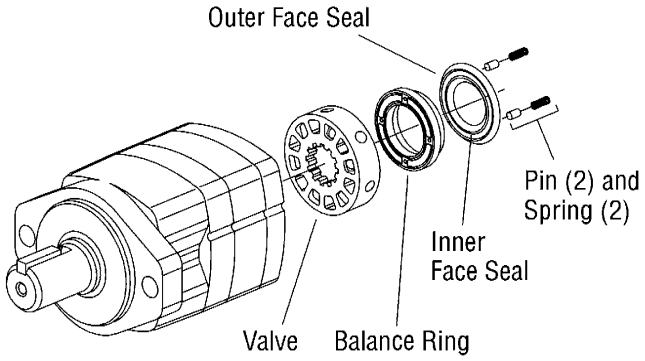


Figure 5

7 Remove balance ring assembly.

8 Remove inner and outer face seals from balance ring.

9 Remove the valve.

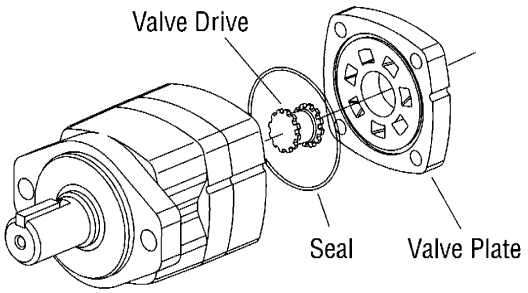


Figure 6

10 Remove the valve plate.

11 Remove the 76,0 [3.00] diameter seal from valve plate.

12 Remove the valve drive.

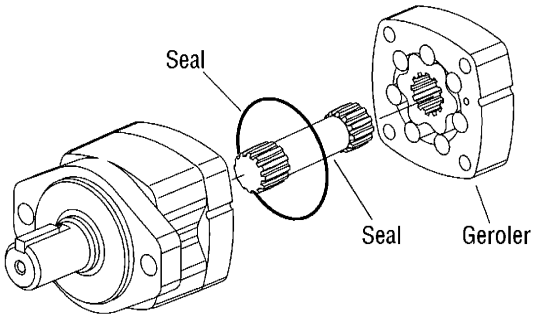


Figure 7

13 Remove the Geroler. Be sure to retain the rollers in the outer ring if they are loose.

14 Remove the drive.

15 Remove the 76,0 [3.00] diameter seal from wear plate, see Figure 7.

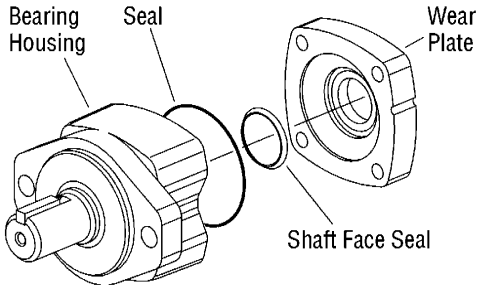


Figure 8

16 Remove the wear plate.

17 Remove the shaft face seal from the wear plate.

18 Remove the 76,0 [3.00] diameter seal from bearing housing.

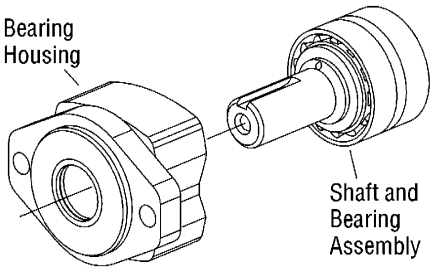


Figure 9

19 You may need a press to remove shaft and bearing assembly from bearing housing. (Key must be removed before removing shaft.)

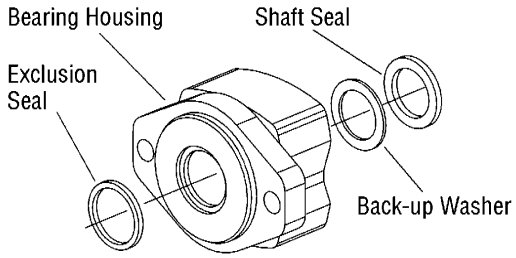


Figure 10

20 Use a small screwdriver to remove shaft seal, back-up washer and exclusion seal from bearing housing, see Figure 10. Do not damage bore of housing.

Note: Individual parts of shaft and bearing assembly are not sold separately. Replace as a unit.

Reassembly

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get in the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts. Check around the keyway and chamfered area of the shaft for burrs, nicks or sharp edges that can damage the seals when reassembling the bearing housing.

Note: Lubricate all seals (prior to installation) with petroleum jelly such as Vaseline. Use new seals when reassembling this motor. Refer to parts list (6-129) for proper seal kit number.

21 Use a press to install exclusion seal in outer bore of bearing housing. Lip of seal must face outward. See Figure 11. If a press is not available use a plastic or rubber hammer, being careful not to damage or cock seal in the bore.

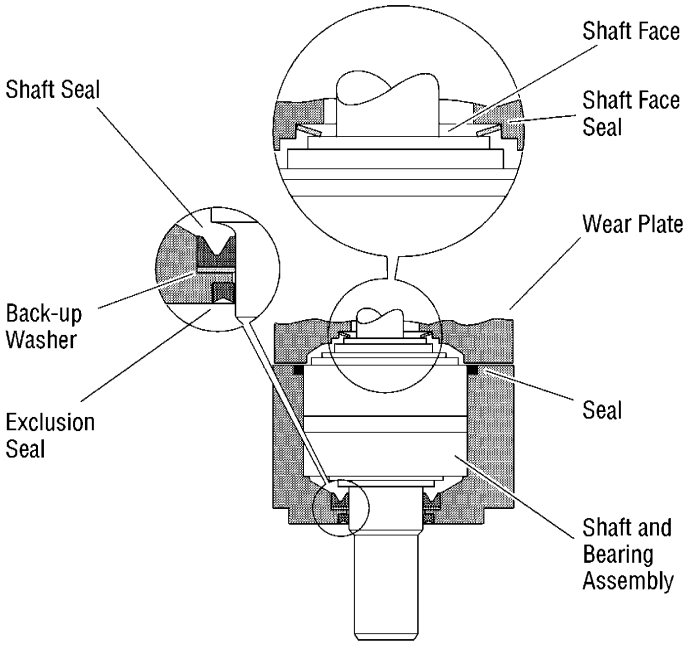


Figure 11

22 Place back-up washer into seal bore. Place shaft seal onto installation tool (600496) and press seal into seal bore of the housing.

23 Clamp housing in vise, see Figure 1.

24 Place protective bullet (see note below) over shaft. Apply petroleum jelly to inside diameter of dust and shaft seal. You may need a press to install shaft and bearing assembly. Do not distort shaft seal. Damage to this seal will cause leakage.

Note: Bullet (600465), for 1inch dia. shafts, available— by special order. Use tape over other shafts to prevent cutting the seals.

25 Apply petroleum jelly to the 76,0 [3.00] diameter seal. Install seal into the bearing housing.

26 Alignment studs can be very helpful in reassembly of the motor. See special tool listing page 2. If you use studs, install 2 studs diagonally opposed in the bearing housing.

27 Install the shaft face seal in the wear plate as shown in Figure 11. Do not distort seal.

28 Install the wear plate, see Figure 11.

29 Apply a light film of petroleum jelly to the 76,0 [3.00] diameter seal and install seal in the wear plate.

30 Install the drive into the output shaft.

31 Align the notch on the outside of the Geroler with the notch on the wear plate. Install the Geroler against the wear plate. Be sure to retain the rollers in the outer ring if they are loose.

32 Install the valve drive in the Geroler.

Note: Installation at this time involves 3 steps in the timing of the motor. Timing determines the direction of rotation of the output shaft. Timing parts include:

1. Geroler
2. Valve Drive
3. Valve Plate
4. Valve

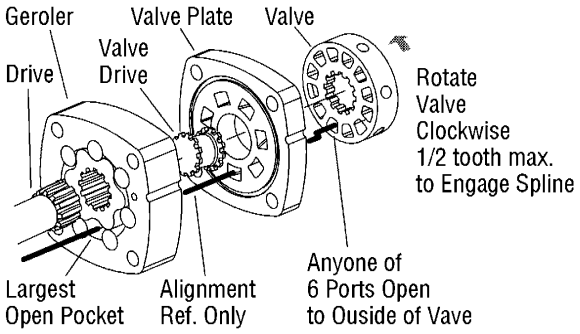


Figure 12 Timing Alignment

Timing Step # 1 — Locate the largest open pocket in the Geroler and mark it on the outside edge of the Geroler.

33 Apply a light film of petroleum jelly to the 76,0 [3.00] diameter seal. Install seal in groove of valve plate.

Reassembly

34 Align the notch on the outside of the valve plate with the notch on the Geroler as shown in Figure 12.

Timing Step # 2 — Locate the slot opening in the valve plate which is in line with the largest open pocket of the Geroler.

Timing Step # 3 — Locate any one of the side openings of the valve and align this opening with the open slot of the valve plate that is in line with the largest open pocket of the Geroler. Install the valve by rotating it clockwise until the spine teeth engage (1/2 spine tooth max.). This will provide the proper rotation when pressurized as shown in Figure 13.

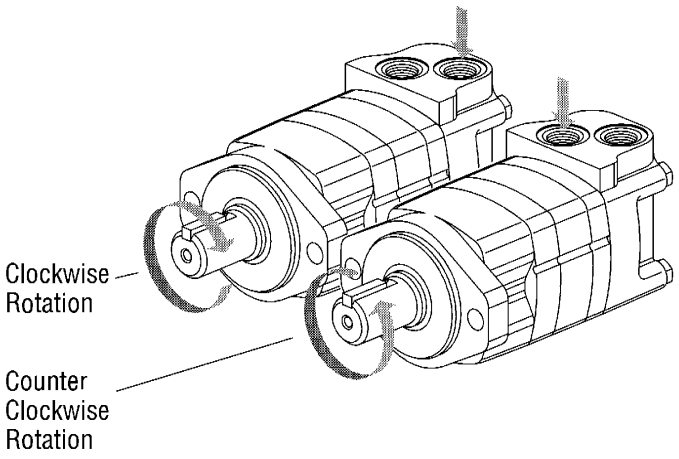


Figure 13

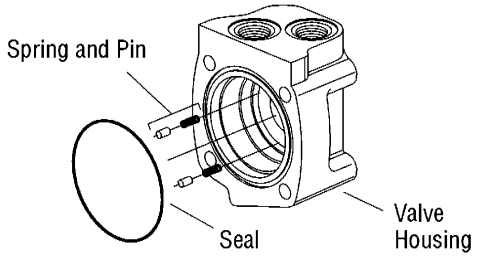


Figure 14

35 Install 2 springs and 2 pins in the holes located in the bore of the valve housing, as shown in Figure 14.

36 Apply a light film of petroleum jelly to the 76,0 [3.00] diameter seal. Install seal in the valve housing.

37 Apply petroleum jelly to inner and outer face seals. Install seals on balance ring as shown in Figure 15.

Important: Install face seals in the positions shown in Figure 15, or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.

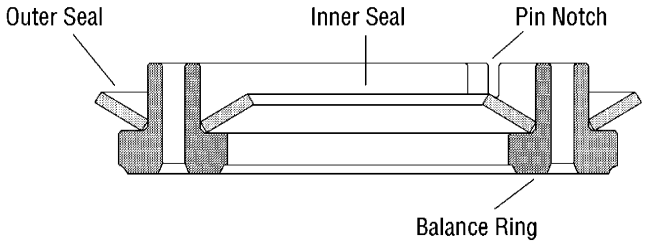


Figure 15

38 Align pin notches in balance ring with pins in bore of valve housing. Install balance ring assembly in valve housing.

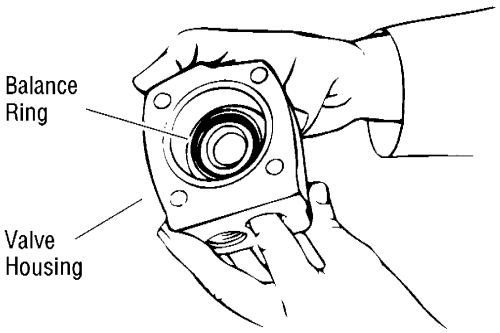


Figure 16

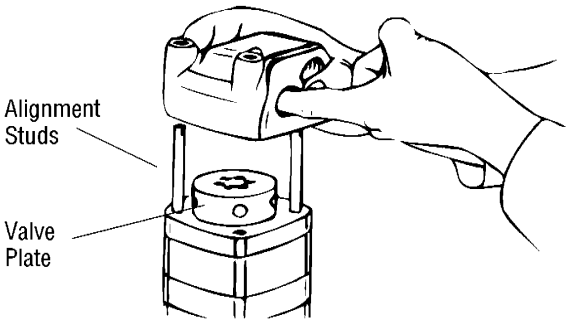


Figure 17

39 Insert your finger through port of valve housing. Apply pressure to side of balance ring as shown in Figure 16. Hold ring in position until valve housing is in place against valve plate (see Figure 17).

Note: After installing the valve housing on the valve plate check for proper placement. Push down on the valve housing. You should get a slight spring action.

Reassembly

40 Install tie bolts. If you use alignment Studs, install 2 bolts opposite the studs. Finger tighten the bolts. Remove the alignment studs and replace with the two remaining bolts. Torque all four bolts alternately to 50 Nm [450 lb-in].

41 Install seal on case drain plug then install in valve housing. Torque to 6 Nm [50 lb-in.]

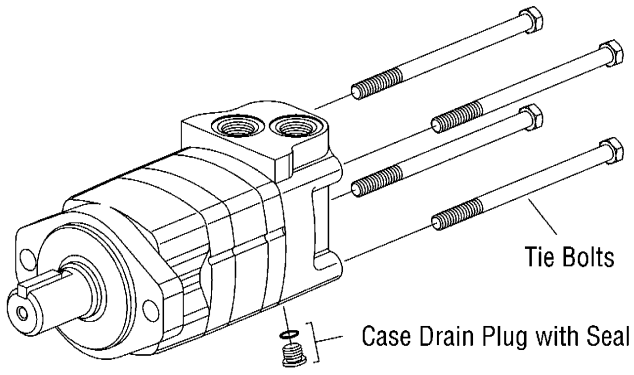


Figure 18

Wheel Motor

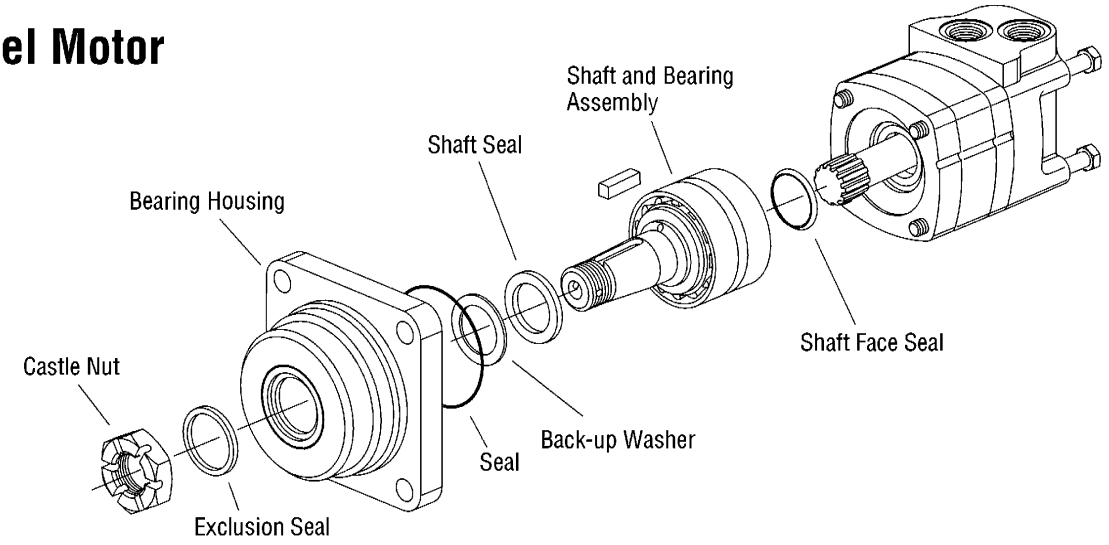
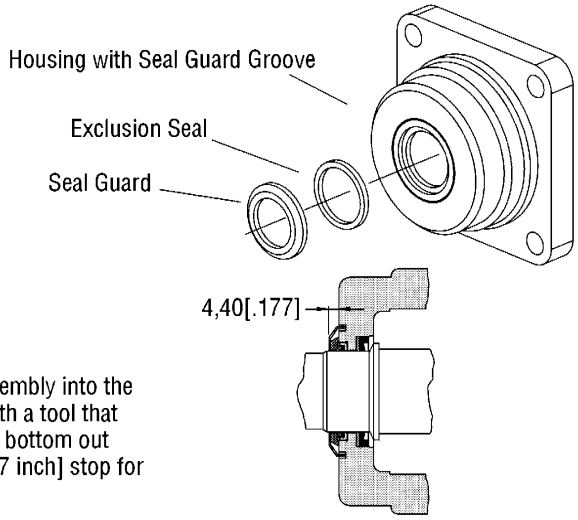


Figure 19

On wheel motors, a different bearing housing is used, see Figure 19. Other than this the parts are the same as the standard motor and the same disassembly and reassembly procedures apply.



Wheel Motor with Seal Guard

Installation of Seal Guard:

After completing assembly of the shaft and bearing assembly into the bearing housing, press the seal guard onto the shaft with a tool that will provide an even push over the seal. This tool must bottom out against the bearing housing and provide a 4,5 mm [.177 inch] stop for the seal guard.

Bearingless Motor

This motor is the same as the standard motor without the shaft/ bearing assembly, and bearing housing. The mounting flange replaces the bearing housing, see Figure 20. Follow same disassembly and reassembly procedures as rear section of standard motor.

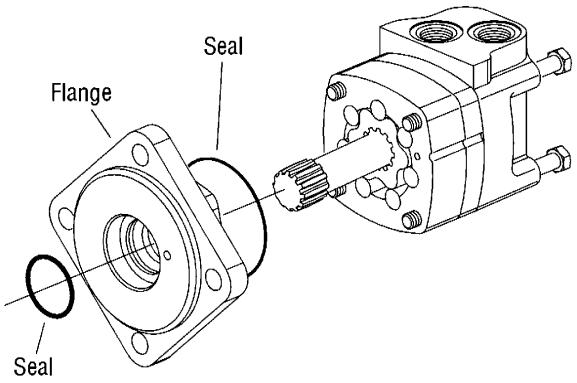
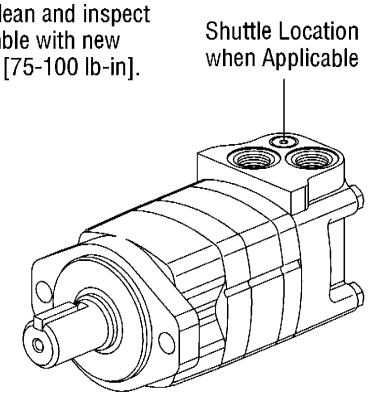


Figure 20

Disassembly Reassembly Shuttle Valve Option

Disassembly of shuttle valve option, this valve is located in the valve housing. Clean and inspect shuttle valve parts and reassemble with new seals, torque plugs to 8-11 Nm [75-100 lb-in].



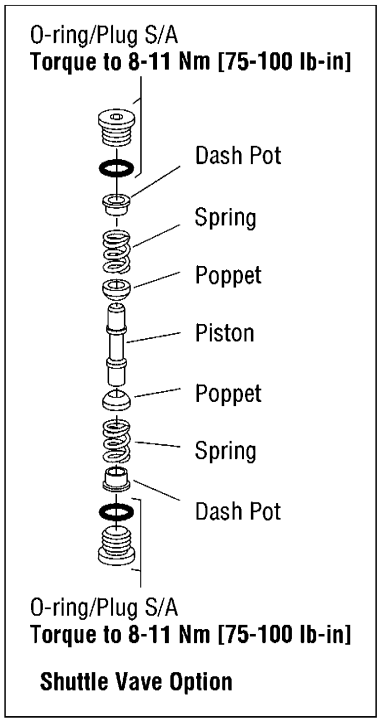


Figure 21

Reassembly — Speed Sensor

1 Rotate the motor shaft until a (gear/target) tooth is centered in the speed sensor port. If this is not done, the sensor may be damaged during the operation of the motor.

2 Make sure the lock nut and its threads are clean and dry for the proper torque. Position the lock nut against the alignment nut as shown in Figure 22.

3 Move the washer and the o-ring up against the speed sensor body threads as shown in Figure 22.

4 By hand, lightly thread the speed sensor body into the housing until the sensor touches against the motor (gear/target) tooth. **Do not force the sensor against the (gear/target) tooth, damage may occur.** Make sure the o-ring or the washer do not touch the housing — see Figure 23.

5 Turn the speed sensor body out one quarter turn (CCW) plus the additional amount (CCW) needed to make the alignment notches perpendicular to the motor shaft centerline (90° +/-5 degrees from the motor shaft centerline — Figure 24 and 25).

6 Maintain the speed sensor body alignment (Figure 25), and tighten the lock nut to 8,5-14 Nm [75-125 lb-in.] (torque values are for clean dry threads).

7 Check the speed sensor body for correct alignment (Figure 25), reinstall the sensor if it is not correct.

Speed Sensor Installation

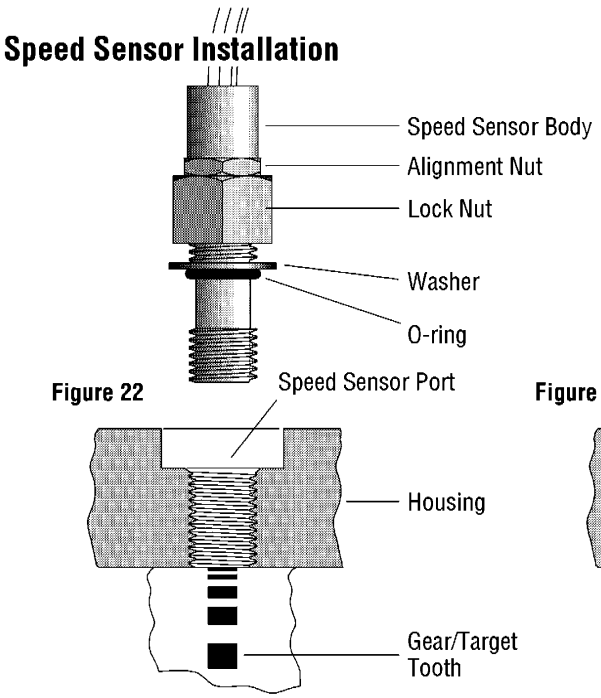


Figure 22

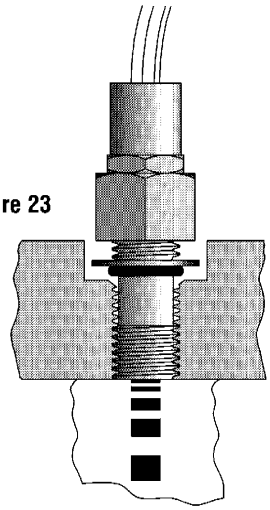


Figure 23

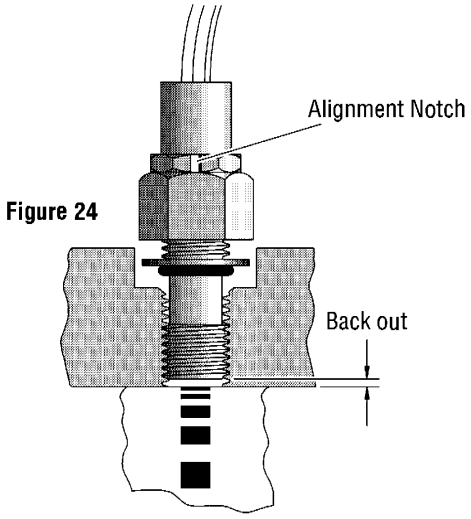


Figure 24

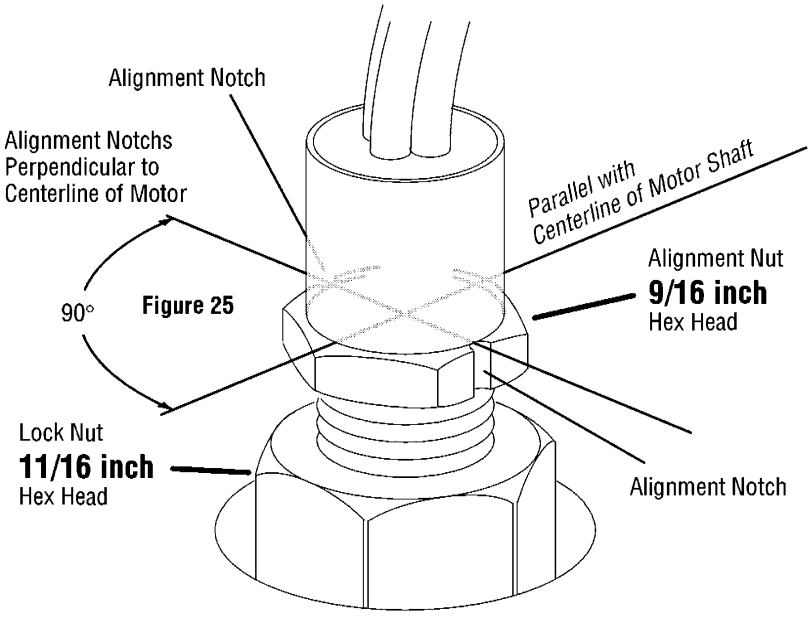


Figure 25

Product Identification

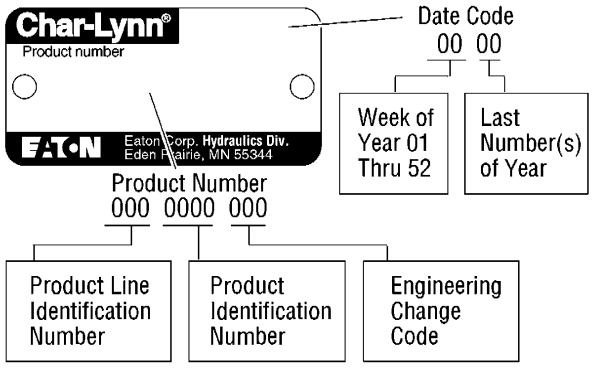
For Additional Literature Contact Eaton Corp. Hydraulics Division 15151 Highway 5 Eden Prairie, MN 55344.

- Specifications and performance data, Catalog No. 11-878
- Replacement part numbers and kit information — Parts Information No. 6-129

How to Order Replacement Parts

Each Order Must Include the Following:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts



Product Numbers—2000 Series

Use digit prefix —104-, 105-, or 106- plus four digit number from charts for complete product number—Example 106-1039.

104-1007

Mounting	Shaft	Ports	Displacement cm³/r [in³/r] and Product Number 80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
2 Bolt SAE A Flange	1 inch Straight	7/8-14 O-ring Staggered	104-1001	-1002	-1003	-1004	-1005	-1006	-1007	-1143	—
		1-1/16—12 O-ring 180° Apart	104-1037	-1038	-1039	-1040	-1041	-1042	-1043	-1044	—
	1-1/4 Inch Straight	7/8-14 O-ring Staggered	104-1022	-1023	-1024	-1025	-1026	-1027	-1028	-1228	-1420
		1-1/16—12 O-ring 180° Apart	104-1061	-1062	-1063	-1064	-1065	-1066	-1067	-1068	-1421
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	104-1029	-1030	-1031	-1032	-1033	-1034	-1035	-1229	-1422
		1-1/16—12 O-ring 180° Apart	104-1087	-1088	-1089	-1090	-1091	-1092	-1093	-1094	-1423
2 Bolt SAE B Flange	1-1/4 Inch Straight	7/8-14 O-ring Staggered	104-1200	-1201	-1202	-1203	-1204	-1205	-1206	-1207	—
	1-1/4 In. Involute SAE C Splined	7/8-14 O-ring Staggered	104-1208	-1209	-1210	-1211	-1212	-1213	-1214	-1215	—
	1 Inch SAE 6B Splined	7/8-14 O-ring Staggered	104-1193	-1194	-1195	-1196	-1197	-1198	-1199	—	—
	7/8 Inch SAE B Splined	7/8-14 O-ring Staggered	104-1216	-1217	-1218	-1219	-1220	—	—	—	—
Standard with 4 Bolt Square Flange	32 mm Straight	G 1/2 (BSP)	104-1384	-1385	-1386	-1387	-1388	-1389	-1390	-1391	—
	1-1/4 Inch 14 T Splined	G 1/2 (BSP)	104-1376	-1377	-1378	-1379	-1380	-1381	-1382	-1383	—
Wheel Motor	1-1/4 Inch Straight	7/8-14 O-ring Staggered	105- —	—	—	—	—	—	—	—	-1148
		1-1/16—12 O-ring 180° Apart	105- —	—	—	—	—	—	—	—	-1149
	32 mm Straight	G 1/2 (BSP)	105-1134	-1135	-1136	-1137	-1138	-1139	-1140	-1141	—
	1-1/4 Inch Tapered	7/8-14 O-ring Staggered	105-1001	-1002	-1003	-1004	-1005	-1006	-1007	-1060	-1152
		1-1/16—12 O-ring 180° Apart	105-1071	-1072	-1073	-1074	-1075	-1076	-1077	-1078	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	105-1029	-1030	-1031	-1032	-1033	-1034	-1035	-1096	—
		1-1/16—12 O-ring 180° Apart	105-1079	-1080	-1081	-1082	-1083	-1084	-1085	-1086	—
Bearingless		7/8-14 O-ring Staggered	106-1008	-1009	-1010	-1011	-1012	-1013	-1014	-1015	-1047
		G 1/2 (BSP)	106-1038	-1039	-1040	-1041	-1042	-1043	-1044	-1045	—

Notes:

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14615 Lone Oak Road
Eden Prairie, MN 55344
USA
Tel: 952-937-9800
Fax: 952-294-7722
www.eaton.com/hydraulics

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Powering Business Worldwide

Printed in USA
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Supersedes 07-124
December 2008

Appendix E
Kubota OC95 Engine Manual

WSM

WORKSHOP MANUAL
DIESEL ENGINE

OC60-E2,OC95-E2

Kubota

TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of OC60-E2, OC95-E2. It is divided into three parts, "General", "Mechanism" and "Servicing".

■ General

Information on the engine identification, the general precautions, maintenance check list, check and maintenance and special tools are described.

■ Mechanism

Information on the construction and function are included. This part should be understood before proceeding with troubleshooting, disassembling and servicing.

Refer to Diesel Engine Mechanism Workshop Manual (Code No. 97897-01873) for the one which has not been described to this workshop manual.

■ Servicing

Information on the troubleshooting, servicing specification lists, tightening torque, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information illustrations and specifications contained in this manual are based on the latest product information available at the time of publication.

The right is reserved to make changes in all information at any time without notice.

Due to covering many models of this manual, information or picture being used have not been specified as one model.

February 2005

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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 repair 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.**

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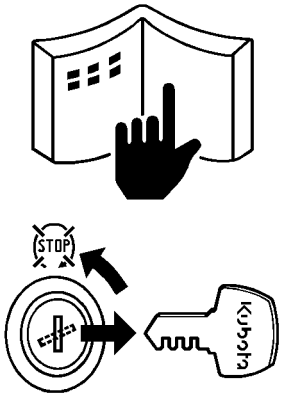

BEFORE SERVICING AND REPAIRING

- Read all instructions and safety instructions in this manual and on your engine safety decals.
- Clean the work area and engine.
- Park the machine on a firm and level ground.
- Allow the engine to cool before proceeding.
- Stop the engine, and remove the key
- Disconnect the battery negative cable

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SAFETY STARTING

- Do not start the engine by shorting across starter terminals or bypassing the safety start switch.
- Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.

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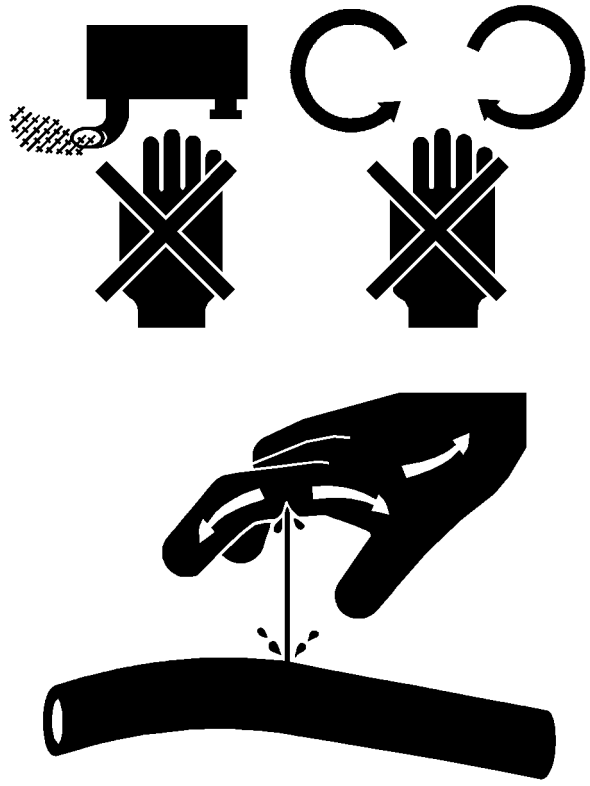

SAFETY WORKING

- Do not work on the machine while under the influence of alcohol, medication, or other substances or while fatigued.
- Wear close fitting clothing and safety equipment appropriate to the job.
- Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Do not touch the rotating or hot parts while the engine is running.
- Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Only remove radiator cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve pressure before removing completely.
- Escaping fluid (fuel or hydraulic oil) under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or fuel lines. Tighten all connections before applying pressure.
- Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

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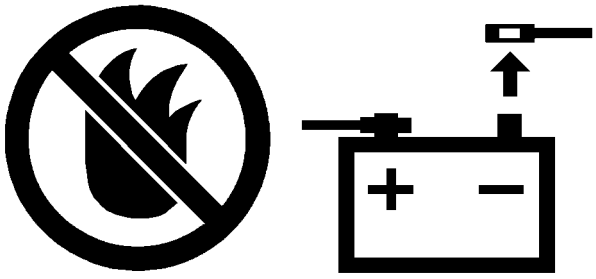

AVOID FIRES

- Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
- To avoid sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
- Make sure that no fuel has been spilled on the engine.

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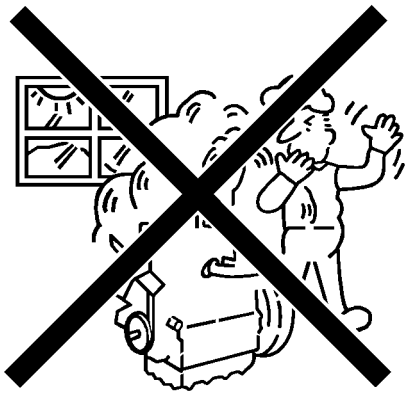

VENTILATE WORK AREA

- If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

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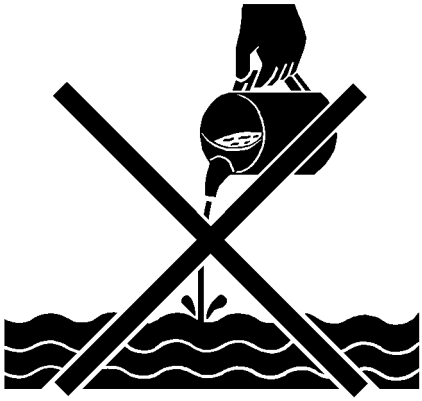

DISPOSE OF FLUIDS PROPERLY

- Do not pour fluids into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, electrolyte and other harmful waste.

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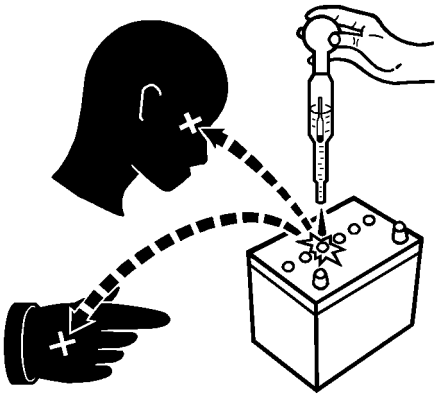

PREVENT ACID BURNS

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.

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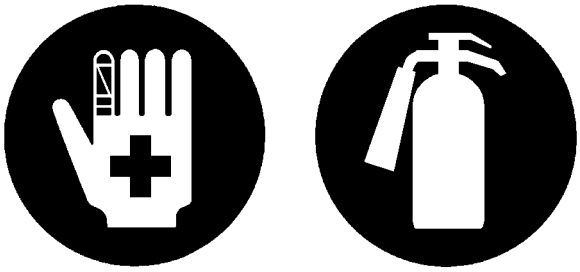

PREPARE FOR EMERGENCIES

- Keep a first aid kit and fire extinguisher handy at all times.
- Keep emergency numbers for doctors, ambulance service, hospital and fire department near your telephone.

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SPECIFICATIONS

Model	OC60-E2(-X)	OC60-E2(-X)-L	OC95-E2(-X)	OC95-E2(-X)-L
Number of Cylinders	1			
Type	Oil-cooled 4-cycle diesel engine			
Bore x Stroke mm (in.)	72 x 68 (2.83 x 2.68)		83 x 77 (3.27 x 3.03)	
Total Displacement cm^3 (cu.in.)	276 (16.8)	276 (16.8)	416 (25.4)	416 (25.4)
ISO Net Continuous kW / min^{-1} (rpm) (HP / min^{-1} (rpm))	4.2 / 3600 (5.6 / 3600)		6.3 / 3600 (8.5 / 3600)	
ISO / SAE Net Intermittent kW / min^{-1} (rpm) (HP / min^{-1} (rpm))	4.5 / 3600 (6.1 / 3600)		7.0 / 3600 (9.5 / 3600)	
Maximum Bare Speed min^{-1} (rpm)	3800			
Minimum Bare Idling Speed min^{-1} (rpm)	1300			
Combustion System	TVCS (Three-vortex combustion system)			
Fuel Injection Pump	ND type (DENSO)			
Governor	Centrifugal mechanical governor			
Direction of Rotation	Clockwise (View from flywheel side)			
Injection Nozzle	DN4PD82 (DENSO)			
Injection Timing (Static)	0.26 to 0.30 rad (15 ° to 17 °) before top dead center		0.23 to 0.26 rad (13 ° to 15 °) before top dead center	
Injection Pressure	13.7 MPa (140 kgf/cm^2, 1987 psi)			
Compression Ratio	24.5 : 1		24.0 : 1	
Lubricating System	Forced lubrication with trochoid pump			
Lubricating Filter	Oil strainer			
Cooling System	Oil cooling + Air cooling			
Starting System	Electric starting with starter			
Starting Motor	12 V 1.0 kW		12 V 1.2 kW	
Charging Alternator	12 V, 48 W	12 V, 150 W	12 V, 48 W	12 V, 150 W
Fuel	Diesel fuel No.2-D (ASTM D975)			
Fuel Tank Capacity	3.6 L (0.95 U.S.gals, 0.79 Imp.gals)		5.5 L (1.45 U.S.gals, 1.2 Imp.gals)	
Lubricating Oil	Quality better than API service CC class (SAE 10W-30)			
Lubricating Oil Capacity	1.3 L (1.37 U.S.qts, 1.14 Imp.qts)		1.7 L (1.80 U.S.qts, 1.49 Imp.qts)	
Weight (Dry) kg (lbs)	38(83.8)		55 (121.3)	

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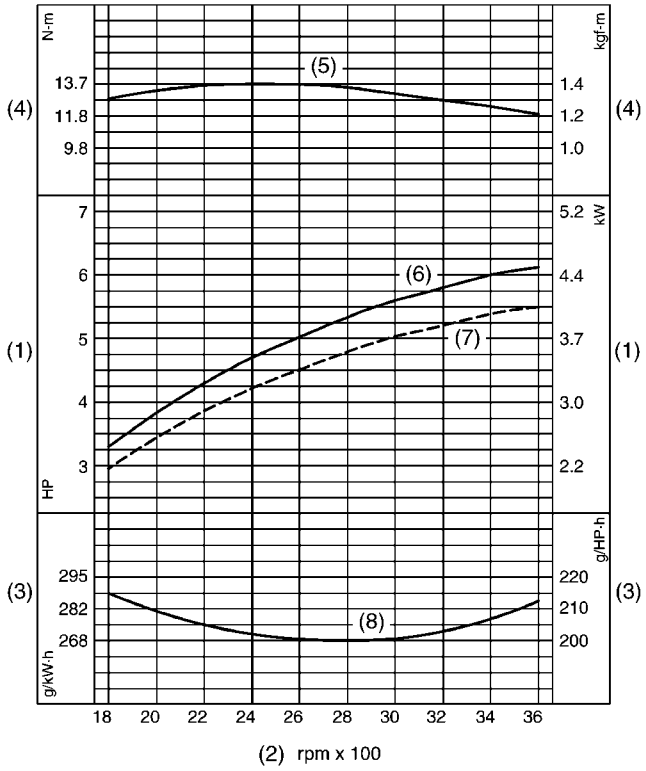
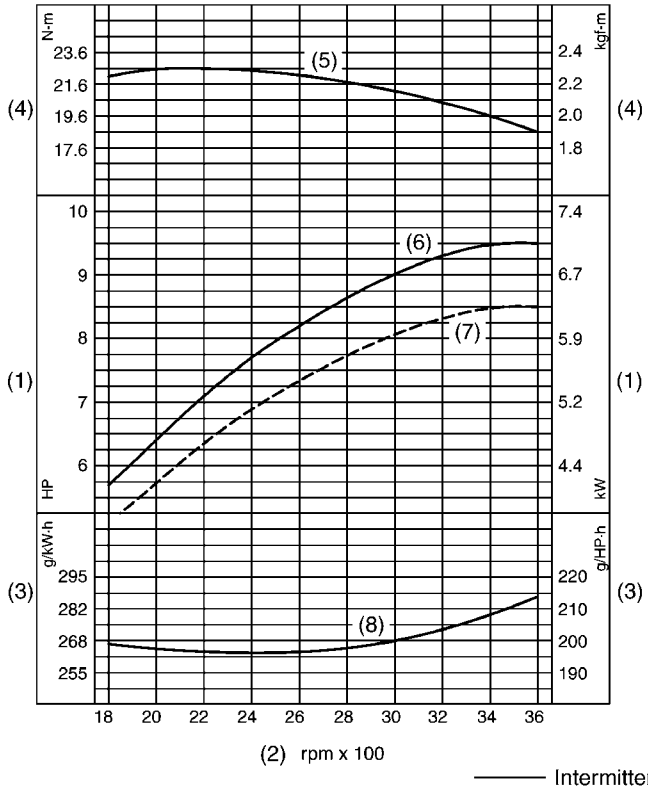
PERFORMACE CURVES

OC60-E2



OC95-E2



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(1) Brake Horsepower
(2) Engine Speed
(3) Fuel Consumption
(4) Torque
(5) Net Intermittent Torque
(6) Net Intermittent B.H.P.
(7) Net Continuous B.H.P.
(8) Net Intermittent B.S.F.C

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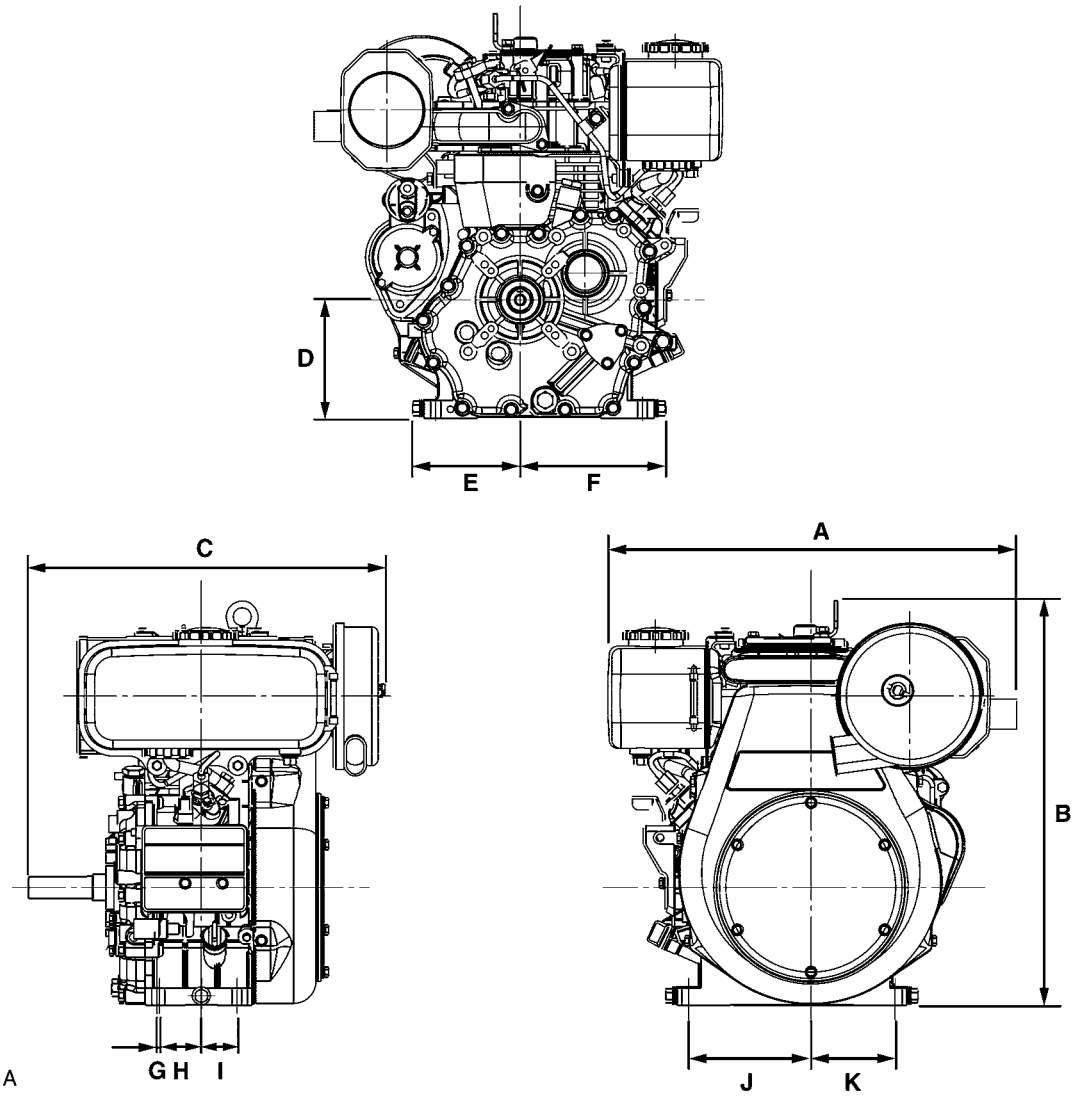
DIMENSIONS

■ STANDARD TYPE [OC60-E2]



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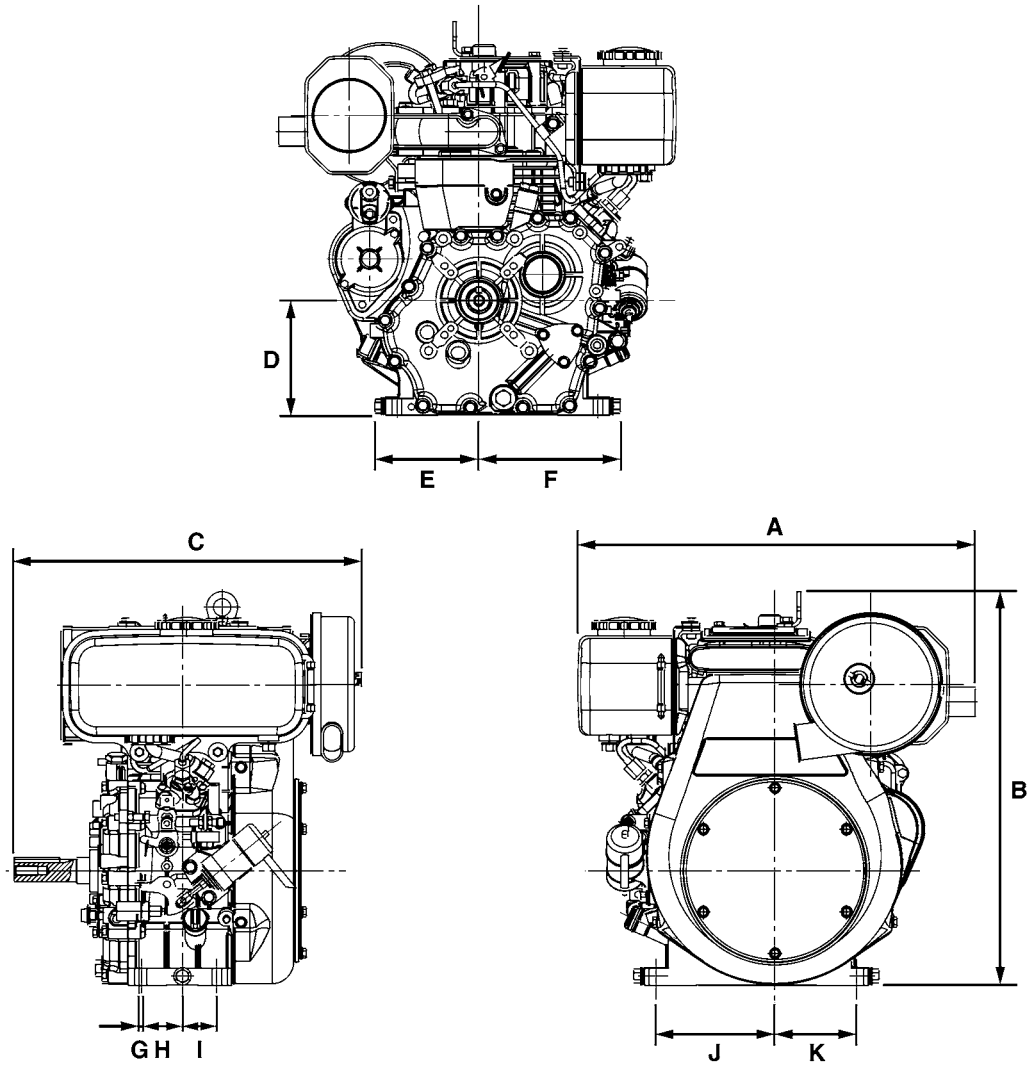
■ X TYPE (WITH STOP SOLENOID) [OC60-E2]



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	STANDARD TYPE	X TYPE
A	461 mm (18.15 in.)	461 mm (18.15 in.)
B	457.5 mm (18.02 in.)	457.5 mm (18.02 in.)
C	403 mm (15.87 in.)	403 mm (15.87 in.)
D	133.5 mm (5.26 in.)	133.5 mm (5.26 in.)
E	121 mm (4.77 in.)	121 mm (4.77 in.)
F	164 mm (6.46 in.)	164 mm (6.46 in.)
G	3 mm (0.12 in.)	3 mm (0.12 in.)
H	47 mm (1.85 in.)	47 mm (1.85 in.)
I	40 mm (1.57 in.)	40 mm (1.57 in.)
J	138 mm (5.43 in.)	138 mm (5.43 in.)
K	95 mm (3.47 in.)	95 mm (3.47 in.)

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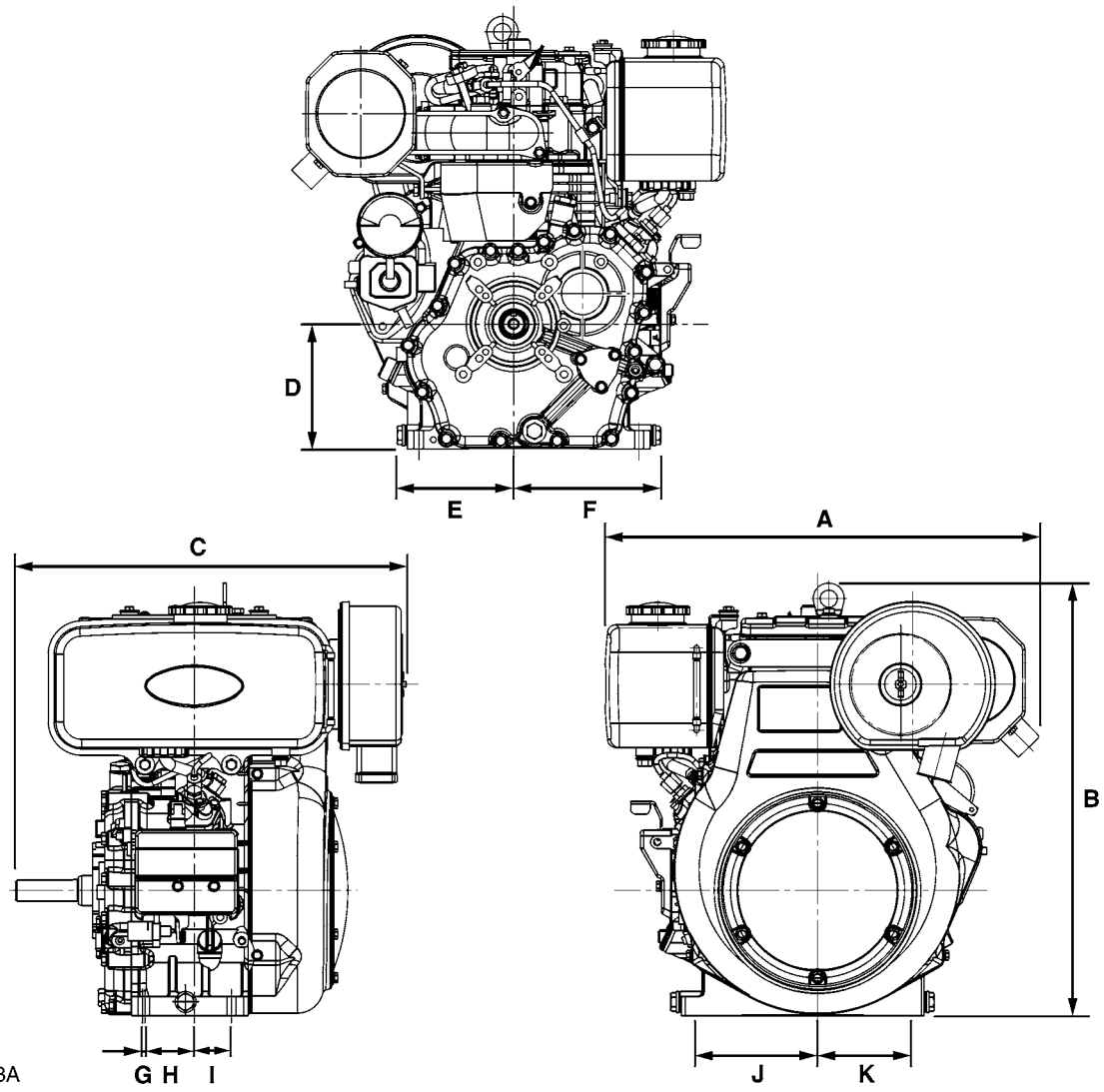
■ STANDARD TYPE [OC95-E2]



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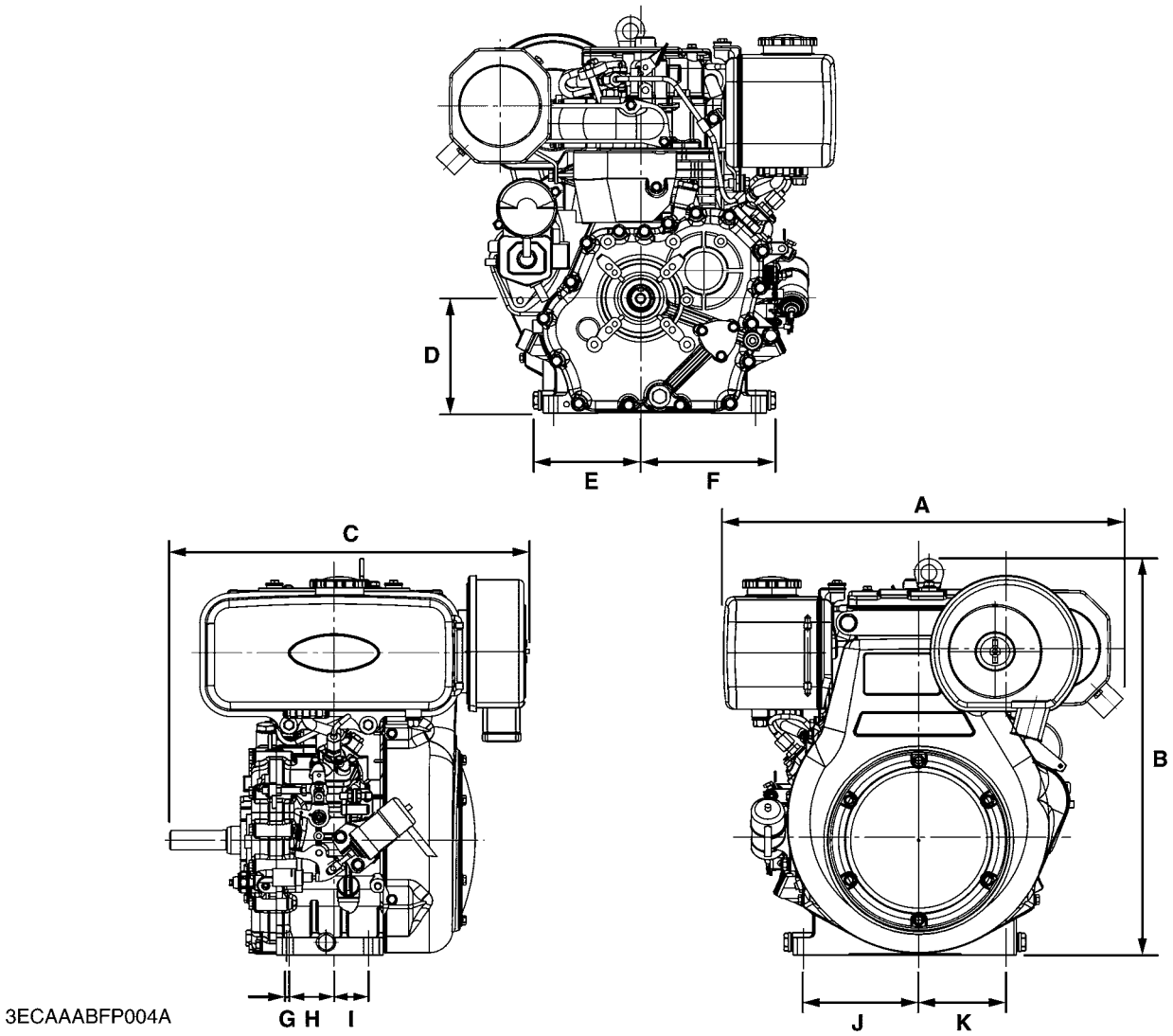
0000009665E

■ X TYPE (WITH STOP SOLENOID) [OC95-E2]

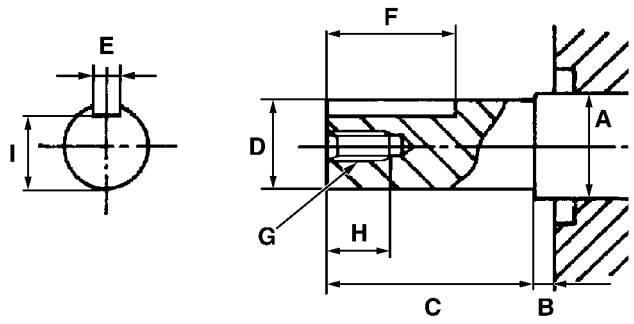


	STANDARD TYPE	X TYPE
A	503 mm (19.81 in.)	503 mm (19.81 in.)
B	501 mm (19.73 in.)	501 mm (19.73 in.)
C	452 mm (17.80 in.)	452 mm (17.80 in.)
D	145 mm (5.71 in.)	145 mm (5.71 in.)
E	135 mm (5.32 in.)	135 mm (5.32 in.)
F	170 mm (6.69 in.)	170 mm (6.69 in.)
G	3 mm (0.12 in.)	3 mm (0.12 in.)
H	57 mm (2.24 in.)	57 mm (2.24 in.)
I	43 mm (1.69 in.)	43 mm (1.69 in.)
J	145 mm (5.71 in.)	145 mm (5.71 in.)
K	110 mm (4.33 in.)	110 mm (4.33 in.)

0000009664E

PTO SHAFT DIMENSIONS

D1-D



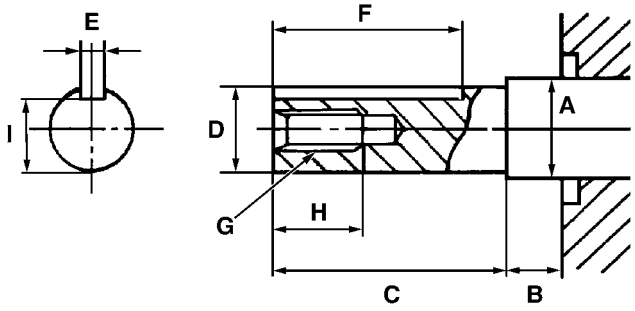
3ECAAABFP005A

■ **[OC60-E2]**

A	30 mm dia. (1.18 in. dia.)
B	2.9 mm (0.12 in.)
C	60 mm (2.36 in.)
D	24.979 to 25.000 mm dia. (0.9835 to 0.9842 in. dia.)
E	7.000 to 7.022 mm (0.2756 to 0.2764 in.)
F	38 mm (1.50 in.)
G	M 8 x 1.25 mm (M 0.31 x 0.05 in.)
H	22 mm (0.87 in.)
I	20.800 to 21.000 mm (0.8189 to 0.8267 in.)

0000009667E

D1-Q

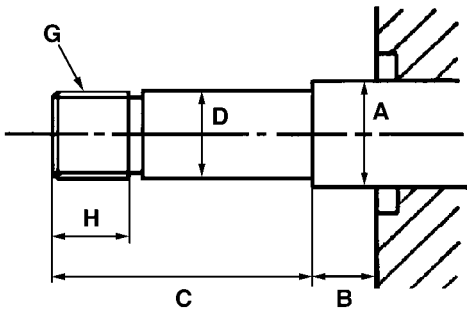


3ECAAABFP007A

A	30 mm dia. (1.18 in. dia.)
B	15.7 mm (0.62 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.000 in. dia.)
E	6.312 to 6.342 mm (0.2486 to 0.2496 in.)
F	56 mm (2.20 in.)
G	7 / 16 - 20 UNF
H	28 mm (1.10 in.)
I	21.619 to 21.819 mm (0.8512 to 0.8590 in.)

0000009668E

D1-P

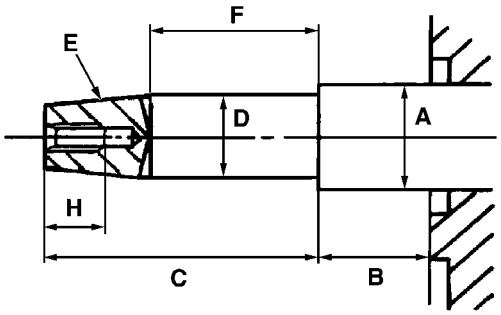


3ECAAABFP009A

A	30 mm dia. (1.18 in. dia.)
B	16.4 mm (0.65 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.000 in.dia.)
G	1 - 14 UNS
H	25 mm (0.98 in.)

0000009669E

D1-G

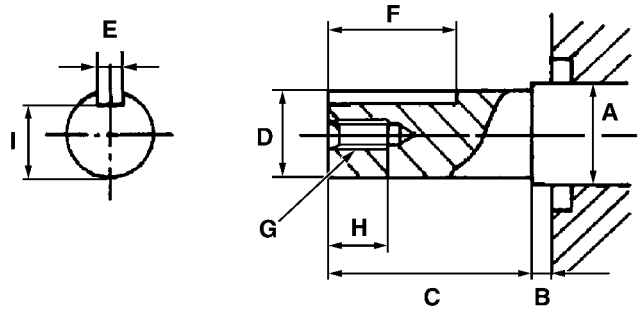


3ECAAABFP011A

A	30 mm dia. (1.18 in. dia.)
B	30.4 mm (1.20 in.)
C	75.5 mm (2.97 in.)
D	22.14 to 22.16 mm dia. (0.8717 to 0.8724 in. dia.)
E	Taper 2 - 1 / 4 per foot
F	46.5 mm (1.83 in.)
G	5 / 16 - 24 UNF
H	18 mm (0.71 in.)

0000009670E

D1-D



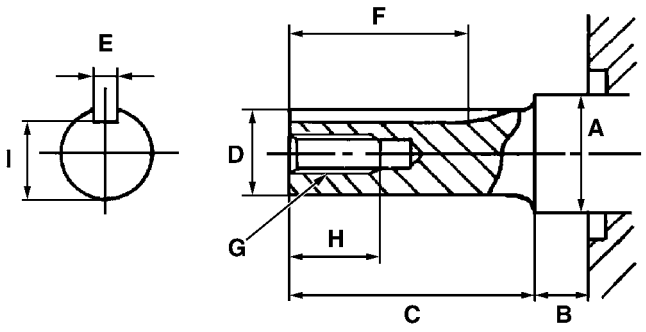
3ECAAABFP006A

■ **[OC95-E2]**

A	35 mm dia. (1.38 in. dia.)
B	2.9 mm (0.12 in.)
C	60 mm (2.36 in.)
D	24.979 to 25.000 mm (0.9835 to 0.9842 in.)
E	7.000 to 7.022 mm (0.2756 to 0.2764 in.)
F	38 mm (1.50 in.)
G	M 8 x 1.25 mm (M 0.31 x 0.05 in.)
H	22 mm (0.87 in.)
I	20.800 to 21.000 mm (0.8189 to 0.8267 in.)

0000009671E

D1-Q

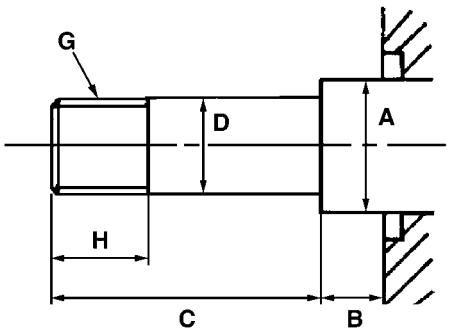


3ECAAABFP008A

A	35 mm dia. (1.38 in. dia.)
B	16.7 mm (0.66 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.0000 in. dia.)
E	6.312 to 6.342 mm (0.2486 to 0.2496 in.)
F	56 mm (2.20 in.)
G	7 / 16 - 20 UNF
H	28 mm (1.10 in.)
I	21.619 to 21.819 mm (0.8512 to 0.8590 in.)

0000009672E

D1-P

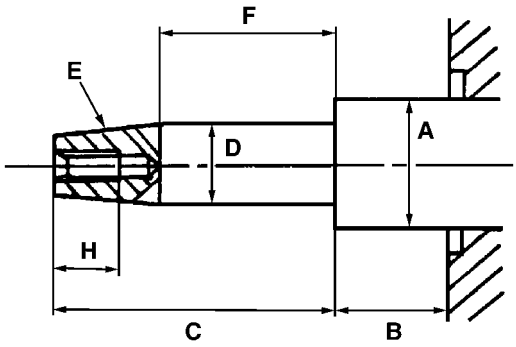


3ECAAABFP010A

A	35 mm dia. (1.38 in. dia.)
B	16.4 mm (0.65 in.)
C	72.2 mm (2.84 in.)
D	25.379 to 25.400 mm dia. (0.9992 to 1.0000 in. dia.)
G	1 - 14 UNS
H	25 mm (0.98 in.)

0000009673E

D1-G



3ECAAABFP012A

A	35 mm dia. (1.38 in. dia.)
B	30.4 mm (1.20 in.)
C	75.5 mm (2.97 in.)
D	22.14 to 22.16 mm dia. (0.8717 to 0.8724 in. dia.)
E	Taper 2 - 1 / 4 per foot
F	46.5 mm (1.83 in.)
G	5 / 16 - 24 UNF
H	18 mm (0.71 in.)

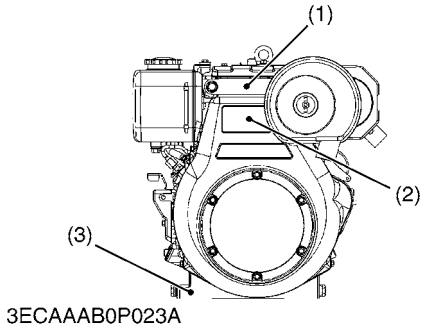
0000009674E

CONTENTS

1. ENGINE IDENTIFICATION

[1] MODEL NAME AND ENGINE SERIAL NUMBER

When contacting the manufacture, always specify your engine model name and serial number.



3ECAAAB0P023A

(1) Model Name
(2) Emission Label
(3) Serial Number

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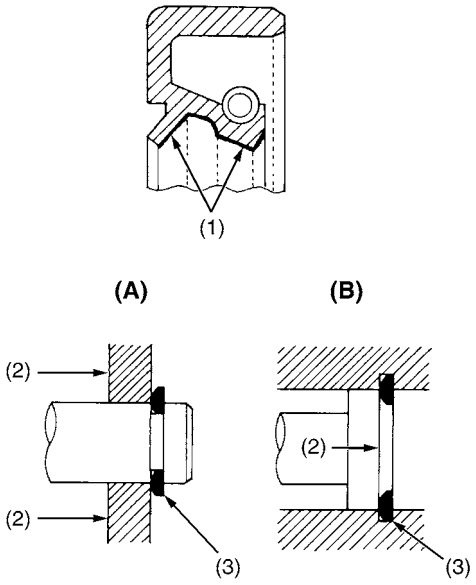
2. GENERAL PRECAUTIONS



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- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.
- When special tools are required, use KUBOTA genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only KUBOTA genuine parts for parts replacement to maintain engine performance and to ensure safety.
- Gaskets and O-rings must be replaced during reassembly. Apply grease to new O-rings or oil seals before assembling.
- When reassembling external or internal snap rings, position them so that the sharp edge faces against the direction from which force is applied.
- Be sure to perform run-in the serviced or reassembled engine. Do not attempt to give heavy load at once, or serious damage may result to the engine.

(1) Grease
(2) Force
(3) Place the Sharp Edge against the Direction of Force

(A) External Snap Ring
(B) Internal Snap Ring

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3. E2 ENGINE

The emission controls that have been put into effect in various countries to prevent air pollution will be stepped up. The time to enforce the regulations differs depending on the engine output classifications.

Kubota has been supplying the diesel engines conforming to the emission regulations in respective countries.Exhaust emissions regulations shift to the second stage. Kubota executed the improvement of the engine according to this regulation.

In order to discriminate the engines conforming to Tier 1 / Phase 1 requirements and those conforming to Tier 2 / Phase 2 requirements, we have adopted E2 as a new model name for the engines conforming Tier 2 / Phase 2 regulations.

In the after-sale services for E2 engines, only use the dedicated parts for E2 models and carry out the maintenance services accordingly.

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4. LUBRICANTS, AND FUEL

No.	Place	Capacity		Lubricants, fuel and coolant
		OC60-E2	OC95-E2	
1	Engine oil	1.3 L 1.4 U.S.qts 1.1 lmp.qts	1.7 L 1.8 U.S.qts 1.5 lmp.qts	Higher than CC class (API) Above 25 °C (77 °F) : SAE10W-30 SAE10W-40 SAE30 0 to 25 °C (32 to 77 °F) : SAE10W-30 SAE10W-40 SAE20 Below 0 °C (32 °F) : SAE10W-30 SAE10W-40 SAE10
2	Fuel	3.6 L 0.95 U.S.gals 0.79 lmp.gals	5.5 L 1.45 U.S.gals 1.21 lmp.gals	Diesel fuel No. 2-D (No. 1-D deisel fuel, if temperature is below -10 °C (14 °F).)

*KUBOTA original transmission hydraulic fluid.

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5. MAINTENANCE CHECK LIST

No	Item		Service interval								Refere-nce page
			Daily	Initial 25h	Every 100h	Every 500h	Every 800h	Every 1500h	Every 1 year	Every 2 year	
1	Engine oil	Checking	☆								G-6
		Changing		☆	☆						G-7
2	Oil strainer	Cleaning		☆	☆						G-7
3	Rubber hoses and clamp bands	Checking	☆								G-6
		Changing								☆	G-10
4	Air cleaner	Cleaning			☆						G-8
		Changing	Once year or after 6 cleanings								G-10
5	Fuel filter	Cleaning			☆						G-8
		Changing				☆					G-8
6	Valve clearance	Checking					☆				G-9
7	Nozzle injection pressure and spraying condition	Checking						☆			G-9, 10
		Cleaning						☆			G-9, 10

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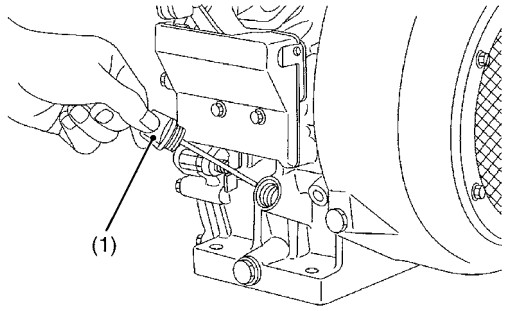
6. CHECK AND MAINTENANCE

[1] DAILY CHECK



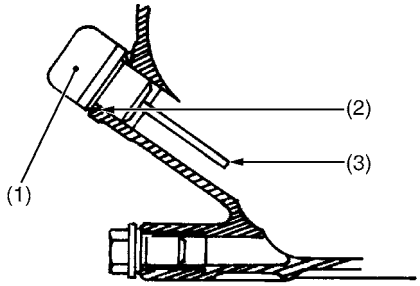
3ECAAAB0P002A

Checking Engine Oil Level

1. Put the engine on a flat surface, and check the amount and condition of the oil with an oil plug (1).
2. If the oil level is below the lower limit (2), add new oil up to the upper limit (3).
3. When using an oil of different maker or viscosity from the previous one, remove all old oil. Never mix two different types of oil.

■ **NOTE**

- **Use the proper engine oil viscosity (SAE) according to the ambient temperature.**



3ECAAAB0P003A

(1) Oil Plug
(2) Lower Limit
(3) Upper Limit

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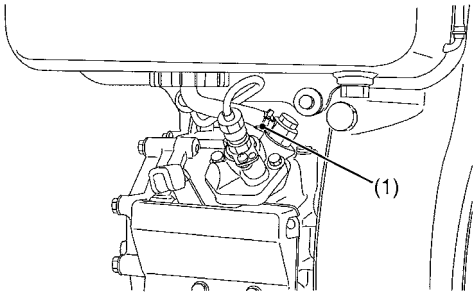

3ECAAAB0P006A

Checking Fuel Hose and Clamp Bands

1. If the clamps (1) are loose, replace with new ones.
2. The fuel and lubricating hoses are made of rubber and ages regardless of period of service. Change the fuel pipes together with the clamps every two year.
3. However, if the fuel and lubricating hose and clamp are found to be damaged or deteriorated earlier than two years, replace with new ones.

(1) Clamp

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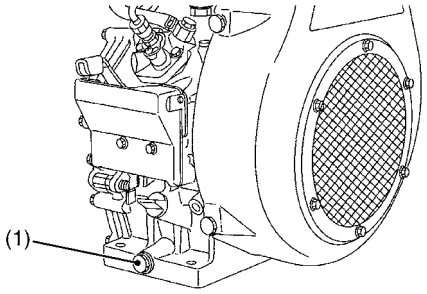
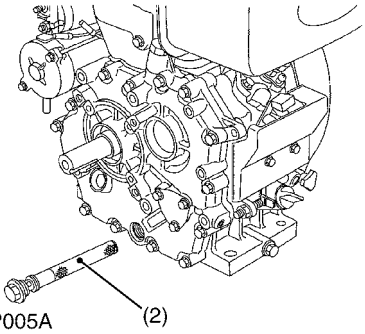
[2] CHECK POINT OF INITIAL 25 HOURS



3ECAAAB0P004A



3ECAAAB0P005A

Changing Engine Oil and Cleaning Oil Strainer

1. After warming up the engine, remove the drain plug (1) and drain the oil completely.
2. Put the drain plug and supply the specified quantity of the specified oil through the oil inlet.

■ NOTE

- **Clean the oil strainer (2) each time oil is changed.**

(When cleaning oil strainer)

1. Clean the oil strainer with fuel oil.
2. If the oil strainer is deformed or broken, replace it.

(1) Drain Plug (2) Oil Strainer

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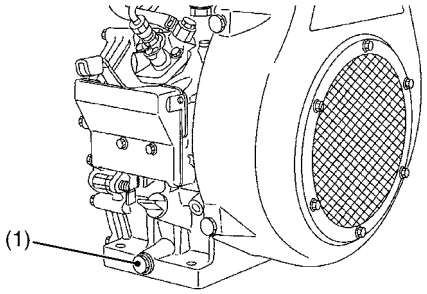
[3] CHECK POINTS OF EVERY 100 HOURS



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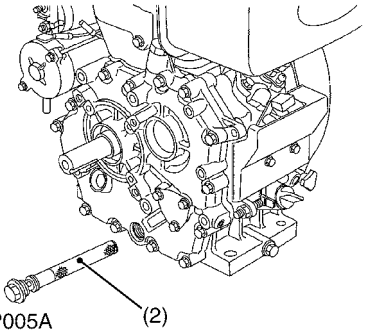

3ECAAAB0P005A

Changing Engine Oil and Cleaning Oil Strainer

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- **Clean the oil strainer (2) each time oil is changed.**

(When cleaning oil strainer)

1. Clean the oil strainer with fuel oil.
2. If the oil strainer is deformed or broken, replace it.

(1) Drain Plug (2) Oil Strainer

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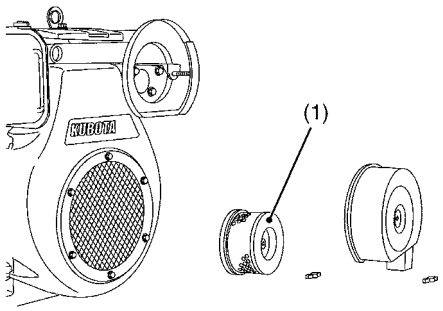


3ECAAAB0P007A

Cleaning and Changing Air Cleaner Element

■ **NOTE**

- **Change air cleaner element (1) once a year or six times of cleaning.**

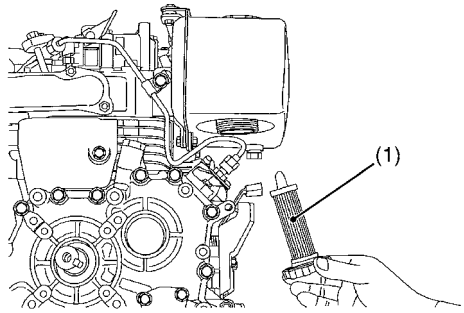
(Cleaning Air Filter Element)

- **When dry dust adheres**

1. 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/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

(1) Element

0000009368E



3ECAAAB0P008A

Cleaning Fuel Filter

1. Empty the fuel tank and disconnect the fuel pipe.
2. Loosen the ring nut and take out the filter (1).
3. Wash the filter clean off impurities with fresh fuel.
4. Take much care when handling the element because it is very fragile.

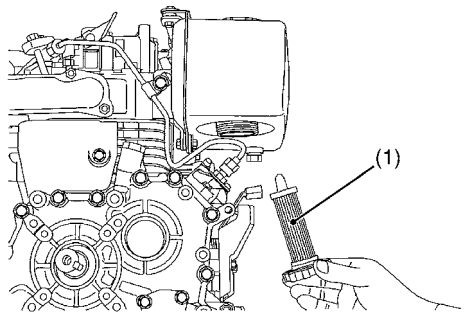
■ **NOTE**

- **If the element should have holes, replace it with a new one. A damaged element will shorten the service life of the nozzle and injection pump.**

(1) Filter

0000009677E

[4] CHECK POINT OF EVERY 500 HOURS



3ECAAAB0P008A

Changing Fuel Filter

1. Empty the fuel tank and disconnect the fuel pipe.
2. Loosen the ring nut and take out the filter (1).
3. Replace the filter (1).
4. Take much care when handling the element because it is very fragile.

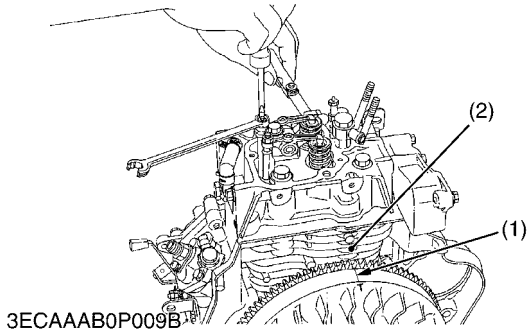
■ **NOTE**

- **A damaged element will shorten the service life of the nozzle and injection pump.**

(1) Filter

0000009370E

[5] CHECK POINT OF EVERY 800 HOURS



3ECAAAB0P009B

Checking Valve Clearance

■ IMPORTANT

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the cylinder head cover.
2. Align the "**T**" mark line (1) on the flywheel and the mark (2) on the fin at the T.D.C. in the compression stroke.
3. Check the intake and exhaust valve clearance with a thickness gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.
5. After adjusting the valve clearance, firmly tighten the lock nut on the adjusting screw.

■ NOTE

- **After rotating the flywheel clockwise twice or three times, check the valve clearance again.**

Valve clearance	Factory spec.	0.14 to 0.18 mm 0.0055 to 0.0071 in.

(1) **T** Mark Line (2) Mark

0000009371E

[6] CHECK POINTS OF EVERY 1500 HOURS

⚠ CAUTION

- **Check the nozzle injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.**
- **If the fume from the nozzle penetrate the human body, cells may be destroyed and blood poisoning may be caused.**

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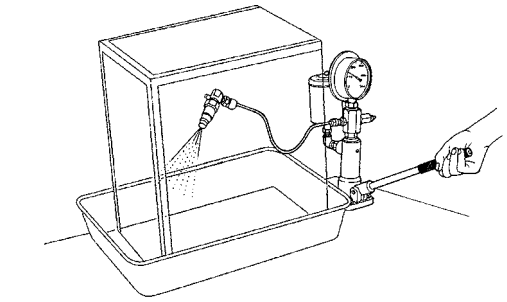
3ECAAAB1P109A

Checking Nozzle Injection Pressure

1. Set the injection nozzle to the nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, disassemble the injection nozzle, and change adjusting washer until the proper injection pressure is obtained.

Nozzle injection pressure	Factory spec.	13.9 to 14.7 MPa 142 to 150 kgf/cm^2 2019 to 2133 psi

(Reference)

- Pressure variation with 0.15 mm (0.0059 in.) difference of adjusting washer thickness 981 kPa (10 kgf/cm^2, 142 psi).

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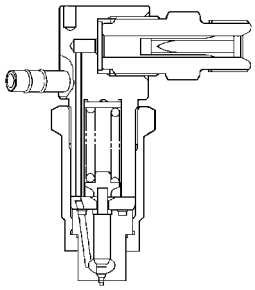
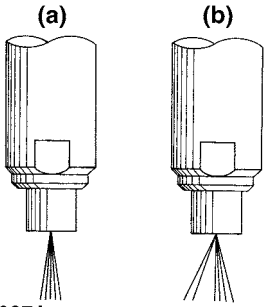


3ECAAAB0P010A

Nozzle Spraying Condition

1. Check the nozzle spray condition.
2. If the spray pattern and spraying direction are faulty, replace the nozzle piece.

(a) Good **(b) Bad**



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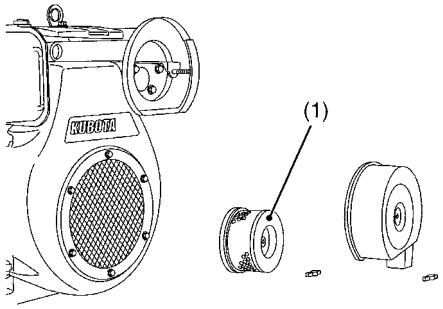
0000009212E

[7] CHECK POINT OF EVERY 1 YEAR



3ECAAAB0P007A

Cleaning and Changing Air Cleaner Element

■ NOTE

- **Change air cleaner element (1) once a year or six times of cleaning.**

(Cleaning Air Filter Element)

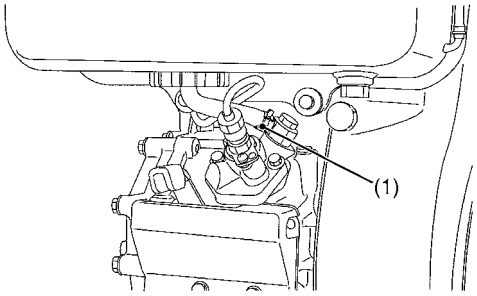
- **When dry dust adheres**

1. 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/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

(1) Element

0000009368E

[8] CHECK POINT OF EVERY 2 YEARS



3ECAAAB0P006A

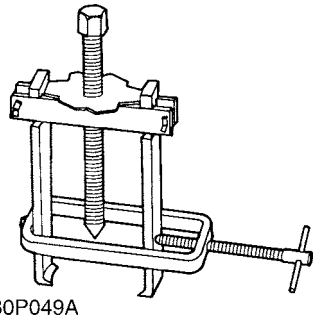
Checking Fuel Hose and Clamp Bands

1. If the clamps (1) are loose, replace with new ones.
2. The fuel and lubricating hoses are made of rubber and ages regardless of period of service. Change the fuel pipes together with the clamps every two year.
3. However, if the fuel and lubricating hose and clamp are found to be damaged or deteriorated earlier than two years, replace with new ones.

(1) Clamp

0000009344E

7. SPECIAL TOOLS



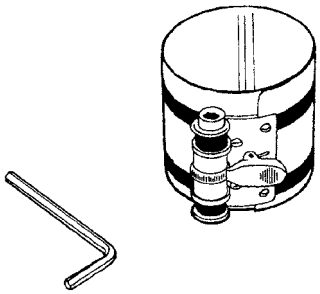
3TMABAB0P049A

Special Use Puller Set

Code No : 07916-09032

Application : Use exclusively for pulling out bearing, gears and other parts with ease.

0000000677E



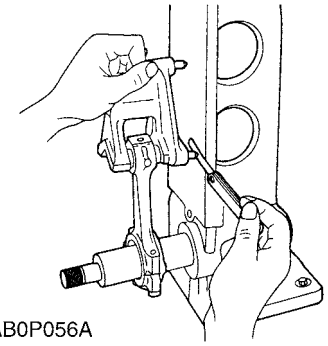
3TMABAB0P050A

Piston Ring Compressor

Code No : 07909-32111

Application : Use exclusively for pushing in the piston with piston rings into the cylinder.

0000000678E



3TMABAB0P056A

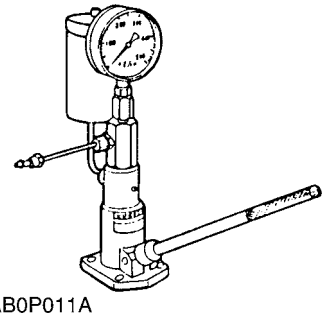
Connecting Rod Alignment Tool

Code No : 07909-31661

Application : Use to check the connecting rod alignment.

Applicable range : Connecting rod big end I.D. 30 to 75 mm (1.18 to 2.95 in.) dia. Connecting rod length 65 to 330 mm (2.56 to 12.99 in.)

0000009381E



3ECAAAB0P011A

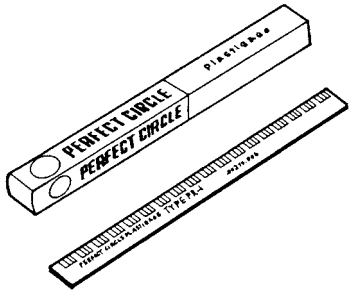
Nozzle Tester

Code No : 07909-31361

Application : Use to check the fuel injection pressure and spraying condition of nozzle.

Measuring range : 0 to 50 MPa (0 to 500 kgf/cm^2, 0 to 7000 psi)

0000009382E



3TMABAB0P058A

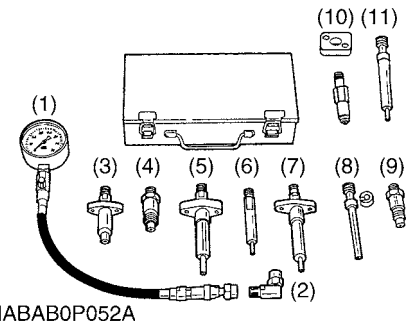
Press Gauge

Code No : 07909-30241

Application : Use to check the oil clearance between crankshaft and bearing, etc..

Measuring range : Green.....0.025 to 0.076 mm (0.01 to 0.03 in.)
Red.....0.051 to 0.152 mm (0.02 to 0.06 in.)
Blue.....0.102 to 0.229 mm (0.04 to 0.09 in.)

0000009383E



3TMABAB0P052A

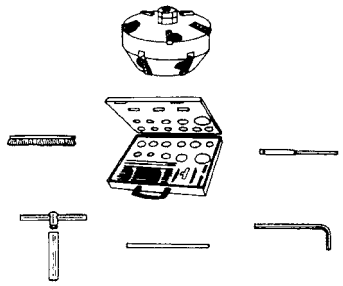
Diesel Engine Compression Tester

Code No : 07909-30208 (Assembly) 07909-31251 (G)
07909-30934 (A to F) 07909-31271 (I)
07909-31211 (E and F) 07909-31281 (J)
07909-31231 (H)

Application : Use to measure diesel engine compression and diagnostics of need for major overhaul.

(1) Gauge
(2) L Joint
(3) Adaptor **A**
(4) Adaptor **B**
(5) Adaptor **C**
(6) Adaptor **E**
(7) Adaptor **F**
(8) Adaptor **G**
(9) Adaptor **H**
(10) Adaptor **I**
(11) Adaptor **J**

0000000680E



3TMABAB0P054A

Valve Seat Cutter

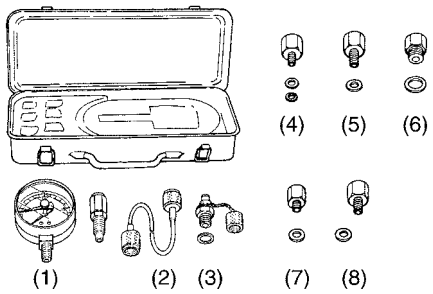
Code No : 07909-33102

Application : Use to reseat valves.

Angle : 0.785 rad (45°)
0.262 rad (15°)

Diameter : 28.6 mm (1.126 in.) 38.0 mm (1.496 in.)
31.6 mm (1.244 in.) 41.3 mm (1.626 in.)
35.0 mm (1.378 in.) 50.8 mm (2.000 in.)

0000000682E



3TMABAB0P053A

Oil Pressure Tester

Code No : 07916-32032

Application : Use to measure lubricating oil pressure.

(1) Gauge
(2) Cable
(3) Threaded Joint
(4) Adaptor **1**
(5) Adaptor **2**
(6) Adaptor **3**
(7) Adaptor **4**
(8) Adaptor **5**

0000000681E

3ECAAAB0P013A

Flywheel Puller

Code No : 07916-30161

Application : Use for removing the flywheel from crankshaft.

0000009387E

■ **NOTE**

- **The following special tools are not provided, so make them referring to the figures.**

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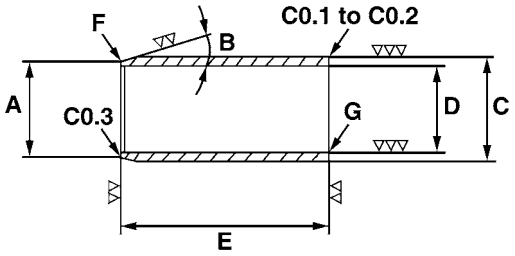


3ECAAAB0P014A

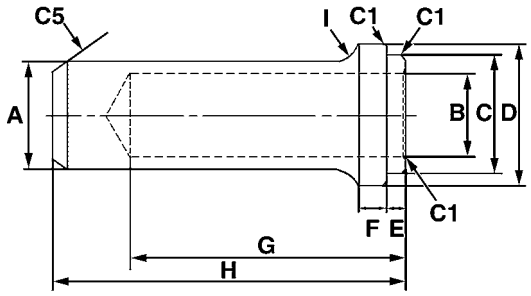
Side Cover Oil Seal Guide (OC60-E2)

Application : The oil sealing guide is helpful in fitting the side cover in position.

Material : S43C

	Q Type	G Type
A	26.9 to 27.1 mm dia. (1.060 to 1.066 in. dia.)	26.9 to 27.1 mm dia. (1.060 to 1.066 in. dia.)
B	0.2618 rad (15°)	0.2618 rad (15°)
C	29.75 to 29.85 mm dia. (1.172 to 1.175 in. dia.)	29.75 to 29.85 mm dia. (1.172 to 1.175 in. dia.)
D	25.500 to 25.533 mm dia. (1.004 to 1.005 in. dia.)	22.300 to 22.333 mm dia. (0.878 to 0.879 in. dia.)
E	70 mm (2.755 in.)	70 mm (2.755 in.)
F	R 0.5 mm (R 0.020 in.)	R 0.5 mm (R 0.020 in.)
G	R 2 mm (R 0.079 in.)	R 2 mm (R 0.079 in.)
C0.1	Chamfer 0.1 mm (0.012 in.)	Chamfer 0.1 mm (0.012 in.)
C0.2	Chamfer 0.2 mm (0.0039 in.)	Chamfer 0.2 mm (0.0039 in.)
C0.3	Chamfer 0.3 mm (0.0079 in.)	Chamfer 0.3 mm (0.0079 in.)

0000009530E



3ECAAAB0P015A

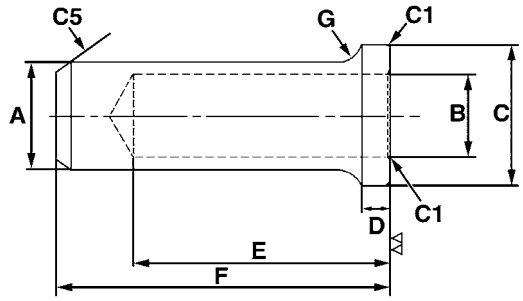
Side Cover Oil Seal Installing Tool

Application : Use to install the oil seal.

Material : S43C

	OC60-E2	OC95-E2
A	40 mm dia. (1.575 in. dia.)	46 mm dia. (1.811 in. dia.)
B	31 mm dia. (1.220 in. dia.)	36 mm dia. (1.417 in. dia.)
C	44.0 to 44.3 mm dia. (1.733 to 1.744 in. dia.)	49.0 to 49.3 mm dia. (1.930 to 1.940 in. dia.)
D	52 mm dia. (2.047 in. dia.)	58 mm dia. (2.283 in. dia.)
E	7 mm (0.276 in.)	7 mm (0.276 in.)
F	10 mm (0.394 in.)	10 mm (0.394 in.)
G	100 mm (3.937 in.)	100 mm (3.937 in.)
H	127 mm (5.000 in.)	127 mm (5.000 in.)
I	R20 mm (R0.79 in.)	R20 mm (R0.79 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)

0000009531E



3ECAAAB0P016A

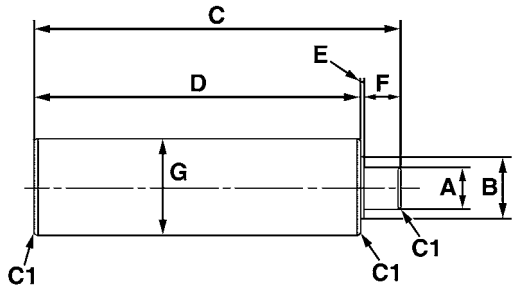
Crank Case Oil Seal Installing Tool

Application : Use to install the crank case oilseal.

Material : S43C

	OC60-E2	OC95-E2
A	40 mm dia. (1.575 in. dia.)	46 mm dia. (1.811 in. dia.)
B	31 mm dia. (1.220 in. dia.)	36 mm dia. (1.417 in. dia.)
C	52 mm dia. (2.047 in. dia.)	58 mm dia. (2.283 in. dia.)
D	10 mm (0.394 in.)	10 mm (0.394 in.)
E	100 mm (3.937 in.)	100 mm (3.937 in.)
F	120 mm (4.724 in.)	120 mm (34.724 in.)
G	R20 mm (R0.79 in.)	R20 mm (R0.79 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C5	Chamfer 5 mm (0.20 in.)	Chamfer 5 mm (0.20 in.)

0000009532E



3ECAAAB0P017A

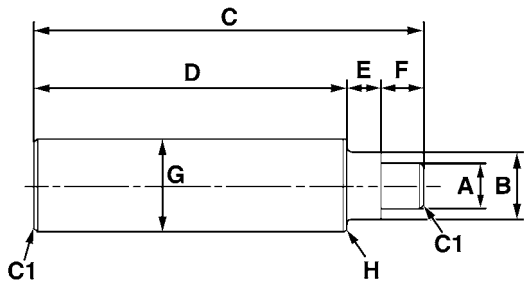
Balancer Bearing Installing Tool

Application : Use to install the balancer bearing.

Material : S43C

	OC60-E2	OC95-E2
A	13.8 to 13.9 mm dia. (0.544 to 0.547 in. dia.)	15.8 to 15.9 mm dia. (0.623 to 0.625 in. dia.)
B	19.8 to 19.9 mm dia. (0.780 to 0.783 in. dia.)	21.8 to 21.9 mm dia. (0.859 to 0.862 in. dia.)
C	112.5 mm (4.429 in.)	112.5 mm (4.429 in.)
D	100 mm (3.937 in.)	100 mm (3.937 in.)
E	0.4 to 0.6 mm (0.0158 to 0.0236 in.)	0.4 to 0.6 mm (0.0158 to 0.0236 in.)
F	12 mm (0.472 in.)	12 mm (0.472 in.)
G	30 mm dia. (1.181 in. dia.)	30 mm dia. (1.181 in. dia.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)

0000009533E



3ECAAAB0P018A

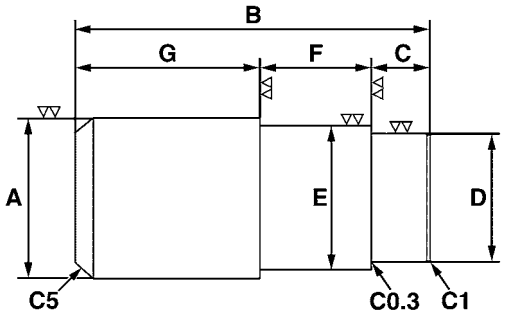
Camshaft Bearing Installing Tool (Crank Case)

Application : Use to install the camshaft bearing.

Material : S43C

	OC60-E2	OC95-E2
A	16.8 to 16.9 mm dia. (0.544 to 0.547 in. dia.)	19.8 to 19.9 mm dia. (0.780 to 0.783 in. dia.)
B	22.8 to 22.9 mm dia. (0.898 to 0.901 in. dia.)	25.8 to 25.9 mm dia. (1.016 to 1.019 in. dia.)
C	122 mm (4.803 in.)	122 mm (4.803 in.)
D	100 mm (3.937 in.)	100 mm (3.937 in.)
E	10 mm (0.394 in.)	10 mm (0.394 in.)
F	12 mm (0.472 in.)	12 mm (0.472 in.)
G	30 mm dia. (1.181 in. dia.)	30 mm dia. (1.181 in. dia.)
H	R2 mm (R0.08 in.)	R2 mm (R0.08 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)

0000009534E



3ECAAAB0P019A

Crankshaft Bearing 1 Replacing Tool (For Extracting)

Application : Use to press out and press fit the crankshaft bearing.

Material : S43C

	OC60-E2	OC95-E2
A	43.7 to 44.3 mm dia. (1.721 to 1.744 in. dia.)	48.7 to 49.3 mm dia. (1.918 to 1.940 in. dia.)
B	95 mm (3.740 in.)	96 mm (3.780 in.)
C	15 mm (0.590 in.)	16 mm (0.630in.)
D	34.6 to 34.9 mm dia. (1.363 to 1.374 in. dia.)	39.6 to 39.9 mm dia. (1.560 to 1.570 in. dia.)
E	38.7 to 38.9 mm dia. (1.524 to 1.531 in. dia.)	43.7 to 43.9 mm dia. (1.721 to 1.728 in. dia.)
F	30 mm (1.181 in.)	30 mm (1.181 in.)
G	50 mm (1.969 in.)	50 mm (1.969 in.)
C0.3	Chamfer 0.3 mm (0.012 in.)	Chamfer 0.3 mm (0.012 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C5	Chamfer 5 mm (0.20 in.)	Chamfer 5 mm (0.20 in.)

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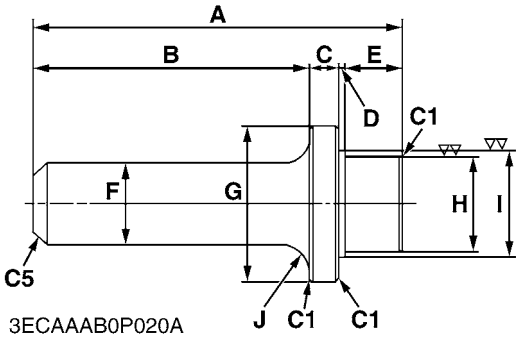

3ECAAAB0P020A

Crankshaft Bearing 1 Replacing Tool (for Installing)

Application : Use to press out and press fit the crankshaft bearing.

Material : S43C

	OC60-E2	OC95-E2
A	133.5 mm (5.256 in.)	133.5 mm (5.256 in.)
B	100 mm (3.937 in.)	100 mm (3.937 in.)
C	10 mm (0.394 in.)	10 mm (0.394 in.)
D	0.9 to 1.1 mm (0.0355 to 0.0433 in.)	0.4 to 0.6 mm (0.0158 to 0.0236 in.)
E	21 mm (0.827 in.)	23 mm (0.906 in.)
F	30 mm dia. (1.181 in. dia.)	30 mm dia. (1.181 in. dia.)
G	57 mm dia. (2.244 in. dia.)	57 mm dia. (2.244 in. dia.)
H	34.7 to 34.9 mm dia. (1.367 to 1.374 in. dia.)	39.7 to 39.9 mm dia. (1.563 to 1.570 in. dia.)
I	38.7 to 38.9 mm dia. (1.524 to 1.531 in. dia.)	43.7 to 43.9 mm dia. (1.721 to 1.728 in. dia.)
J	R10 mm (R0.39 in.)	R10 mm (R0.39 in.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C5	Chamfer 5 mm (0.20 in.)	Chamfer 5 mm (0.20 in.)

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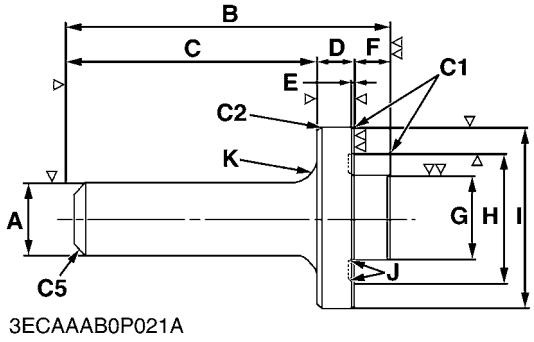

3ECAAAB0P021A

Crankshaft Bearing Installing Tool (Side Cover)

Application : Use to install the camshaft bearing.

Material : S43C

Model : OC95-E2

A	30 mm dia. (1.181 in. dia.)
B	130 mm (5.118 in.)
C	100 mm (3.937 in.)
D	15 mm (0.590 in.)
E	2 mm (0.0787 in.)
F	15 mm (0.590 in.)
G	34.7 to 34.9 mm dia. (1.367 to 1.374 in. dia.)
H	55 mm dia. (2.165 in. dia.)
I	75 mm dia. (2.953 in. dia.)
J	R2 mm (R0.079 in.)
K	R10 mm (R0.39 in.)
C1	Chamfer 1 mm (0.039 in.)
C2	Chamfer 2 mm (0.079 in.)
C5	Chamfer 5 mm (0.20 in.)

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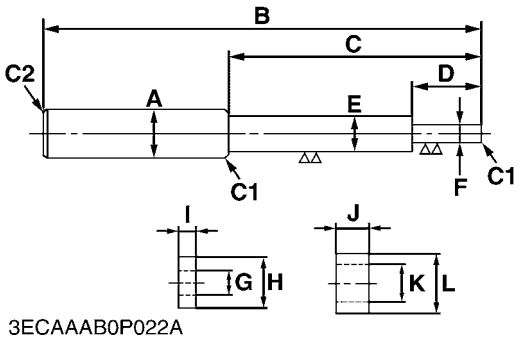


3ECAAAB0P022A

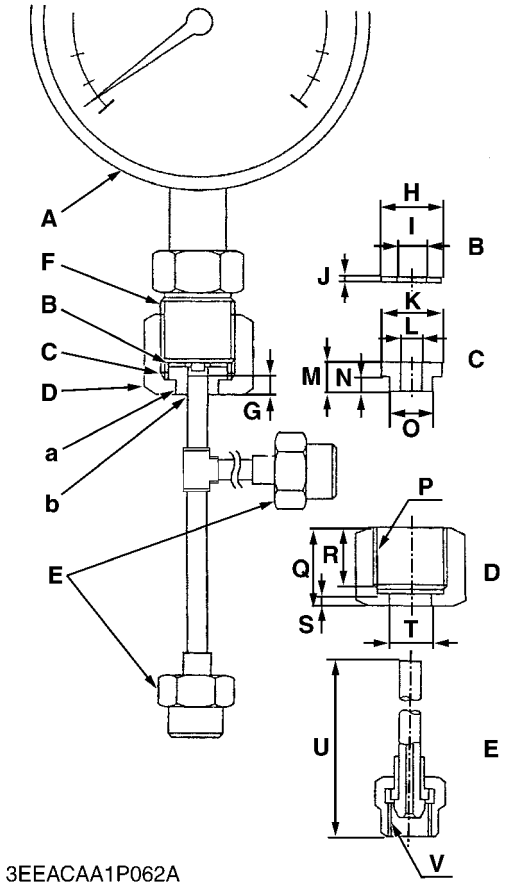
Valve Guide Replacing Tool

Application : Use to press out and press fit the valve guide.

Material : S43C

	OC60-E2	OC95-E2
A	20 mm dia. (0.787 in. dia.)	20 mm dia. (0.787 in. dia.)
B	200 mm (7.874 in.)	200 mm (7.874 in.)
C	120 mm (4.724 in.)	120 mm (4.724 in.)
D	40 mm (1.575 in.)	40 mm (1.575 in.)
E	10 mm dia. (0.394 in. dia.)	11 mm dia. (0.433 in. dia.)
F	5.7 mm dia. (0.224 in. dia.)	6.4 mm dia. (0.252 in. dia.)
G	6 mm dia. (0.236 in. dia.)	6.7 mm dia. (0.264 in. dia.)
H	15 mm dia. (0.590 in. dia.)	15 mm dia. (0.590 in. dia.)
I	5 mm (0.197 in.)	5 mm (0.197 in.)
J	8 mm (0.315 in.)	8.5 mm (0.335 in.)
K	12.1 mm dia. (0.476 in. dia.)	12.1 mm dia. (0.476 in. dia.)
L	18 mm dia. (0.709 in. dia.)	18 mm dia. (0.709 in. dia.)
C1	Chamfer 1 mm (0.039 in.)	Chamfer 1 mm (0.039 in.)
C2	Chamfer 2 mm (0.080 in.)	Chamfer 2 mm (0.080 in.)

0000009539E



3EEACAA1P062A

Injection Pump Pressure Tester

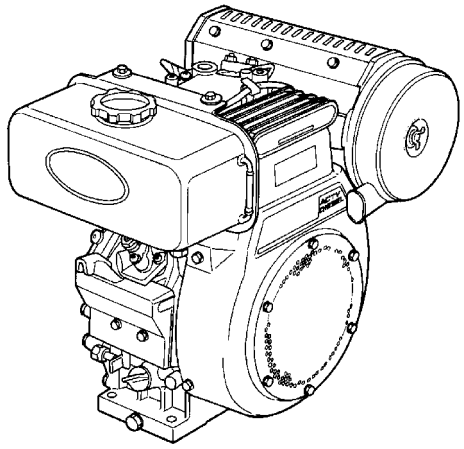
Application : Use to check fuel tightness of injection pumps.

A	Pressure gauge full scale : More than 29.4 MPa (300 kgf/cm^2, 4267 psi)
B	Copper gasket
C	Flange (Material : Steel)
D	Hex. nut 27 mm (1.06 in.) across the plat
E	Retaining nut
F	PF 1/2
G	5 mm (0.20 in.)
H	17 mm dia. (0.67 in.dia.)
I	8 mm dia. (0.31 in.dia.)
J	1.0 mm (0.039 in.)
K	17 mm dia. (0.67 in.dia.)
L	6.10 to 6.20 mm dia. (0.2402 to 0.2441 in.dia.)
M	8 mm (0.31 in.)
N	4 mm (0.16 in.)
O	11.97 to11.99 mm dia. (0.4713 to 0.4721 in.dia.)
P	PF 1/2
Q	23 mm (0.91 in.)
R	17 mm (0.67 in.)
S	4 mm (0.16 in.)
T	12.00 to 12.02 mm dia. (0.4724 to 0.4732 in.dia.)
U	100 mm (3.94 in.)
V	M12 x P1.5
a	Adhesive application
b	Fillet welding on the enter circumference

0000001341E

CONTENTS

1. FEATURE



3ECAAAB1P001A

1. Operating noise as low as that with a water-cooled engine.

The ACTV system tremendously improves noise problem that is the biggest shortcoming with air-cooled diesel engines. The noise level has now come down competitive with water-cooled diesel engines.

2. Engine body as light-weight and compact as air-cooled gasoline engine.

With a small oil cooler, the ACTV system offers a new way of cooling. This makes the engine as light-weight and compact as an air-cooled gasoline engine.

3. Good fuel economy and pollution-free exhaust.

Compared to air-cooled gasoline engines, this engine with the TVCS (Three Vortex Combustion System) saves much fuel. The TVCS is so efficient that the engine does not emit any irritating smell and smarting exhaust. Much less black exhaust and much lower exhaust concentration.

4. Balancer standard equipped for much lower vibrations.

The engine is standard equipped with a uniaxial balancer highly effective to absorb vibrations.

5. Maintenace-free coolant system and fan belt.

Both oil cooling and air cooling are introduced for the cooling system. Some servicing required for a water-cooled engine checking and adding coolant, readjusting or replacing the fan belt, and so on is not needed any longer. And there is no ignition system trouble, carburetor trouble and others that are related to gasoline engines.

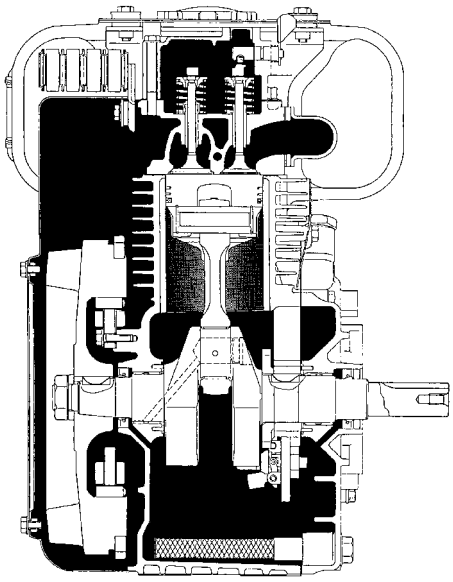
*The ACTV stands for Advanced Cooling Three Vortex, a tomorrow's combustion system based on the most advanced cooling techniques.

0000009093E

2. ENGINE BODY

The OC60-E2 and OC95-E2 are a 4-cycle diesel engine. Backed by Kubota's rich experience in engine research and development, this brand-new engine has come up with the ACTV (Advanced Cooling Three Vortex) system, introduced first in the world. The engine features low noise, light weight, compactness, good fuel economy, pollution-free exhaust and many others.

0000009114E



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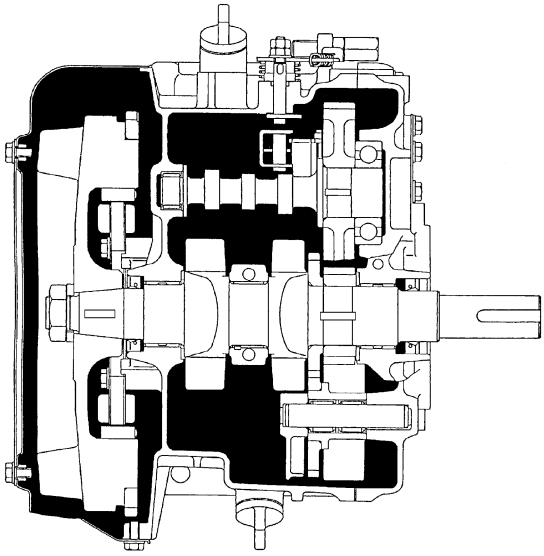
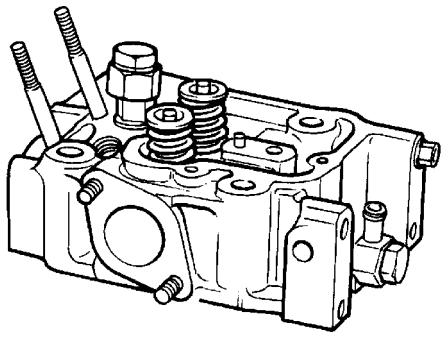


3ECAAAB1P003A

[1] CYLINDER HEAD



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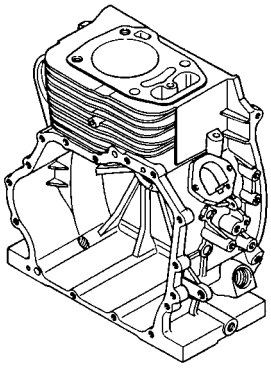
As the cylinder head is subjected to high temperature and high pressure, it is made of special cast iron.

This engine employs Kubota's exclusive TVCS (Three Vortex Combustion System) system. This system provides three swirls inside a spherical vortex chamber during the combustion stroke for effective combustion. Furthermore TVCS has been originally characterized by low noise, in comparison with direct injection type.

The combustion chamber is provided with oil passages around. This way, the injection nozzle is kept cool to prolong its service life. What's more, the explosive sound is suppressed by the oil's viscosity to keep the engine noise low.

0000009116E

[2] CRANK CASE AND CYLINDER LINER



3ECAAAB1P005A

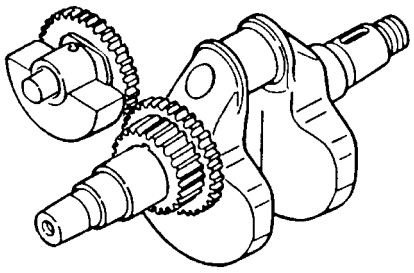
The crank case is made of aluminium die-cast.

The crank case is provided with oil galleries to lubricate the crankshaft, crank pin metal. Another oil passage is provided at the side of the cylinder liner. This passage, also, serves to keep the cylinder liner cool and to suppress the explosive sound for lower noise.

The cylinder liner made of special cast iron having excellent wear resistance, is casted into crank case.

0000009118E

[3] UNAXIAL BALANCER SYSTEM



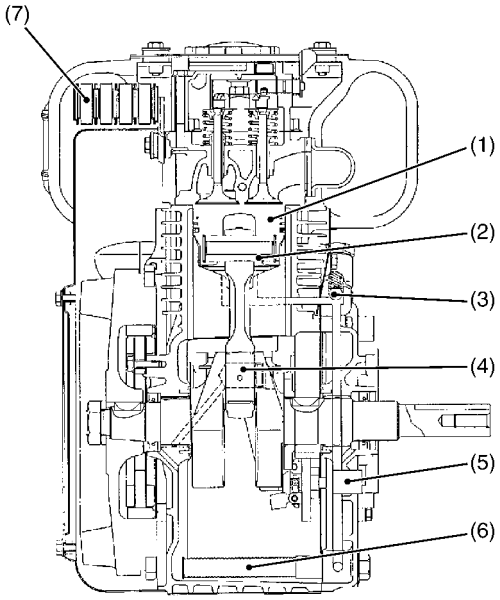
3ECAAAB1P006A

A unaxial balancer is adopted to reduce engine vibrations. There are two major vibration sources in a single-cylinder engine. One is the inertia force which is generated when the piston and the small end of the connecting rod are reciprocating. The other is the centrifugal force (kind of inertia force) generated when the large end of the connecting rod is turning. The resultant force of these two inertial forces can be directed freely by adjusting the weight, but the force itself remains unchanged. The balancer shaft is provided in order to offset these inertial forces. This shaft has a weight that turns in the direction opposite to, but at the same speed as the crankshaft.

0000009120E

3. LUBRICATING SYSTEM

[1] GENERAL



3ECAAAB1P007A

Lubrication is forced on with a trochoid pump. Lubrication oil is sucked in by the trochoid pump (5) via an oil strainer (6) mounted on the side of the gear case. The pressure of lubricating oil discharged from the trochoid pump is regulated by a relief valve (3) to 147 to 490 kPa (1.5 to 5 kgf/cm^2, 21 to 71 psi) (at the rated revolution speed of the engine) and the pressure-regulated oil then fed to the various portions through the oil gallery in the cylinder block.

Lubricating oil sent to the oil gallery in the crankshaft lubricates the crank pin portion (4).

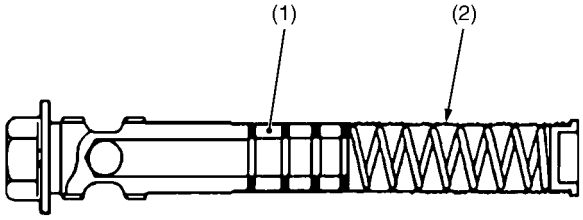
The oil passes along the cylinder liner and reaches the cylinder head to cool it down. The oil then flows into the oil cooler (7). The oil cooled there passes through the relief valve opening of the cylinder head and returns into the crankcase.

Other items such as the piston (1), piston pin (2), camshaft, tappet, bearing and rocker arm are lubricated by splash of the crankshaft, etc.

(1) Piston
(2) Piston Pin
(3) Relief Valve
(4) Crank PIn
(5) Trochoid Pump
(6) Oil Strainer
(7) Oil Cooler

0000009123E

[2] OIL STRAINER



3ECAAAB1P008A

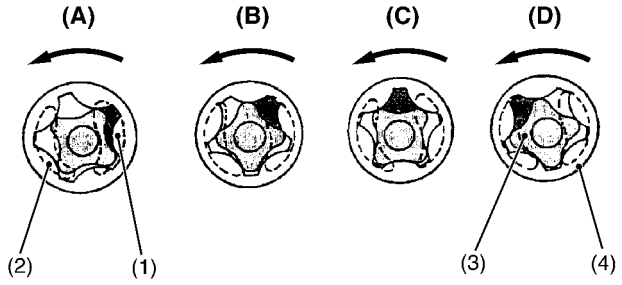
Entry of foreign material such as iron chips, dirt, etc. into the lubricating system may damage the lubricated parts. To prevent this, an oil strainer is equipped prior to the oil pump. This strainer has a double wounds stainless steel net (50 meshes) (2) at the outside, and magnets (1) are mounted inside.

This stainless steel net removes small dirt in the lubricating oil. Further, fine iron chips passing through this net are attracted by these magnets to prevent them from entering the lubricating system.

(1) Magnet
(2) Stainless Steel Net

0000009128E

[3] OIL PUMP



3ECAAAB1P111A

The oil pump in this engine is a trochoid pump.

Inside the pump body, the 4 lobe inner rotor (3) is eccentrically engaged with the 5 lobe outer rotor (4). The inner rotor (3) is driven by the governor gear shaft via gears, which in turn rotate the outer rotor (4).

When the inner rotor (3) rotates, the outer rotor (4) also rotates in the same direction.

The two rotors have differences in lobe number and center, which generates space between lobes as shown in the figure.

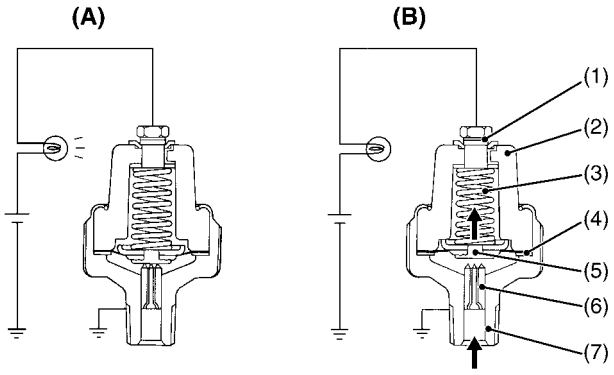
At position (**A**), there is little space between lobes in the inlet port (1). As the rotor rotates towards position (**B**), the space between the lobes becomes larger, creating a negative pressure which sucks in oil.

Outside the inlet port (1), as shown in position (**C**), the space between the lobes becomes gradually smaller, and oil pressure increases. At position (**D**), oil is discharged from the outlet port.

(1) Inlet Port
(2) Outlet Port
(3) Inner Rotor
(4) Outer Rotor

0000009139E

[4] OIL PRESSURE SWITCH



3ECAAAB1P113A

The oil pressure switch is mounted on the side cover, to warn the operator that the lubricating oil pressure is poor.

If the oil pressure falls below 49 kPa (0.5 kgf/cm^2, 7 psi), the oil warning lamp will light up, warning the operator. In this case, stop the engine immediately and check the cause of pressure drop.

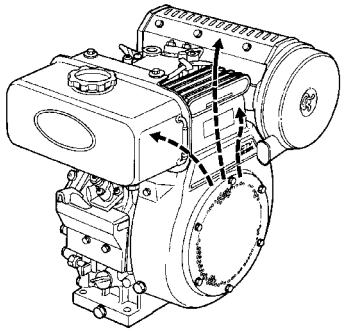
(1) Terminal
(2) Insulator
(3) Spring
(4) Diaphragm
(5) Contact Rivet
(6) Contact
(7) Oil Switch Body

[A] At Oil Pressures of 49 kPa (0.5 kgf/cm^2, 7 psi) or Less
[B] At Proper Oil Pressure

0000009142E

4. COOLING SYSTEM

[1] GENERAL

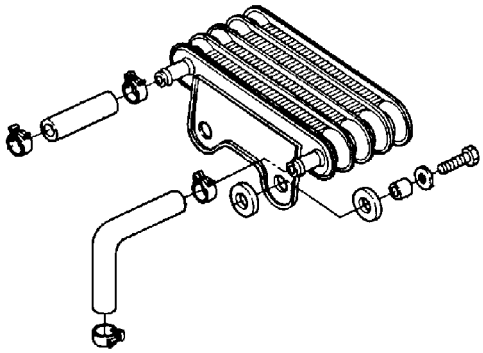


3ECAAAB1P009A

The cooling system comes in two way. The cylinder block is air-cooled, whereas the combustion area of the cylinder head is oil-cooled. Air sucked by the flywheel fan is accelerated in the spiral casing to cool down the cylinder liner as well as the oil cooler located atop the spiral casing. The lubricant cooled by the oil cooler, on the other hand, flows through the return opening of the cylinder head and back to the crankcase. The trochoid pump works to force the lubricant to the cylinder head again to cool the combustion system around. The lubricant finally comes back to the oil cooler. This series of actions is repeated while the engine is running.

0000009151E

[2] OIL COOLER



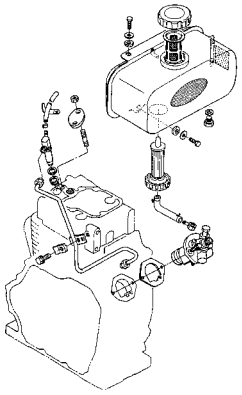
3ECAAAB1P010A

The oil cooler consist of oil carrying tubes and fins. Heat of heated oil in the tubes is radiated from the tube walls and fins. Kubota's engines are of louvered corrugated fin type, featuring light weight and better cooling/radiating effect.

0000009152E

5. FUEL SYSTEM

[1] GENERAL



3ECAAAB1P011A

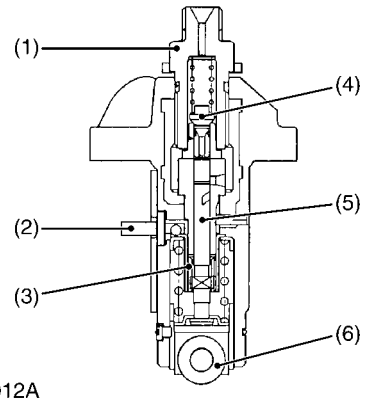
Fuel from the fuel tank passes through the fuel filter, and then enters the injection pump after impurities such as dirt, water, etc. are removed.

The fuel pressurized by the injection pump to the opening pressure (13.9 to 14.7 MPa, 142 to 150 kgf/cm^2, 2019 to 2133 psi), of the injection nozzle is injected into the combustion chamber.

Part of the fuel fed to the injection nozzle lubricates the moving parts of the plunger inside the nozzle, the returns to the fuel tank through the fuel over flow pipe from the upper part of the nozzle holder.

0000009153E

[2] INJECTION PUMP



3ECAAAB1P012A

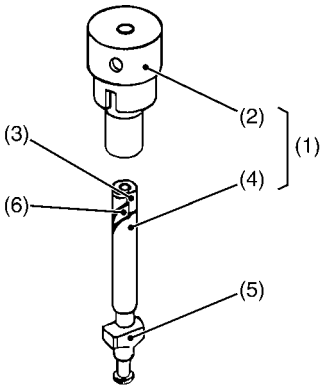
NC Type mini pump is used for the injection pump. It is small, lightweight and easy to handle.

The plunger (5) with a right-hand lead reciprocates via the tappet roller (6) by means of the camshaft fuel cam, causing the fuel to be delivered into the injection nozzle.

(1) Delivery Valve Holder
(2) Control Rack
(3) Control Sleeve
(4) Delivery Valve
(5) Plunger
(6) Tappet Roller

0000009154E

(1) Pump Element



3ECAAAB1P012A

The pump element (1) is consists of the plunger (4) and cylinder (2).

The sliding surfaces are super-precision machined to maintain injection pressure at engine low speeds. Since the driving face (5) fits in the control sleeve, the plunger (4) is rotated by the movement of the control rack to increase or decrease of fuel delivery.

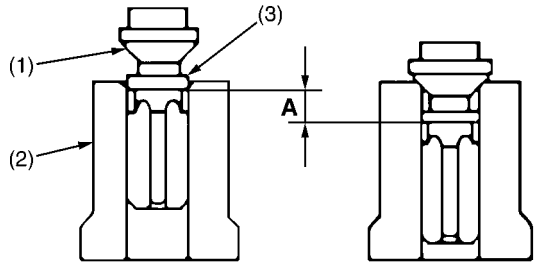
As described above, the plunger is machined to have the slot (3) and the control groove (6). The control groove has a right-hand lead.

The plunger is provided with a low speed retarder to maintain the combustion sound low under no load.

(1) Pump Element
(2) Cylinder
(3) Slot
(4) Plunger
(5) Driving Face
(6) Control Groove

0000009155E

(2) Delivery Valve



3ECAAAB1P014A

The delivery valve consists of the valve (1) and the valve seat (2).

The delivery valve prevents the fuel from flowing back into the delivery chamber through the injection pipe. It also prevents the fuel from dribbling at the injection nozzle.

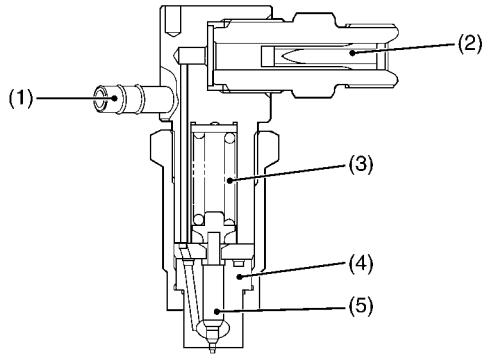
Reverse Suction Function (Dripping Prevention)

1. When the pressure-feeding of fuel ends, the delivery valve lowers and relief plunger (3) section comes into contact with the valve seat.
2. Furthermore, the valve descends until valve surface is in contact with delivery valve seat (2) but as the amount of fuel during interval **A** is sucked back from inside the injection pipe, pressure within the pipe is reduced giving improved cut-off of fuel injection by the nozzle, thereby preventing subsequent dripping of the injectors.

(1) Valve
(2) Valve Seat
(3) Relief Plunger

0000009156E

[3] INJECTION NOZZLE



3ECAAAB1P015A

Due to the use of a throttle type injection nozzle, the fuel injection quantity is small at the beginning of injection, and the fuel injection amount increases gradually for the main fuel injection. This type of injection nozzle features smooth combustion rise and quiet combustion.

The fuel is delivered into the nozzle body (4) by injection pump through the bar filter (2) where fine metallic particles, dirt and other in the fuel are removed.

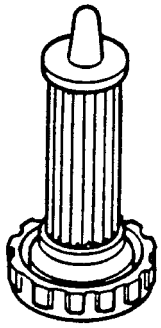
When the fuel pressure overcomes the force of the nozzle spring (3) (injection pressure: 13.92 to 14.51 MPa 142 to 150 kgf/cm^2, 2020 to 2133 psi) the needle valve (5) is pushed up and fuel is injected from the injection port. The fuel which has lubricated between the needle valve and nozzle body returns to the tank through the fuel overflow pipe (1).

Injection pressure is adjusted by changing an adjusting washer thickness.

(1) Fuel Overflow Pipe
(2) Bar Filter
(3) Nozzle Spring
(4) Nozzle Body
(5) Needle Valve

0000009157E

[4] FUEL FILTER



3ECAAAB1P016A

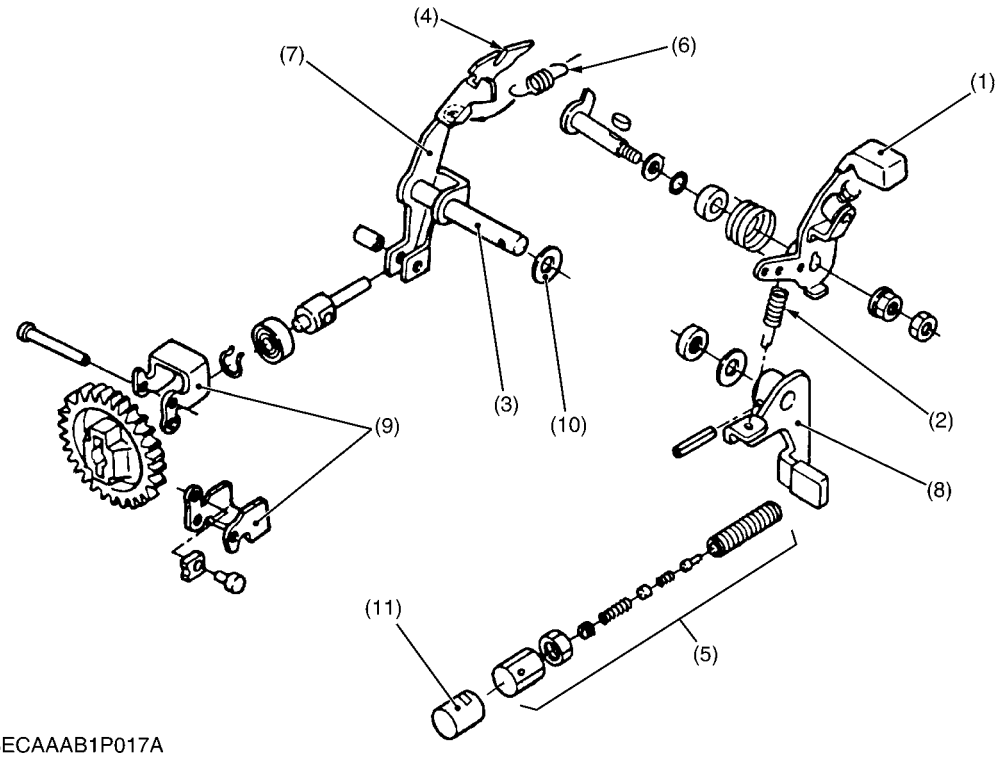
The fuel filter is fitted inside the fuel tank with a ring nut. High-quality filter paper is used to filter out fine particles as small as 30 μm.

Air may enter the filter when it is washed clean or replaced with a new one or when the tank is refueled. To cope with the trouble of discharging the air, the filter has an air vent at the end to allow automatic air removal.

0000009158E

[5] GOVERNOR MECHANISM

(1) OC60-E2



(1) Speed Control Lever
(2) Governor Spring
(3) Governor Shaft
(4) Control Rack
(5) Fuel Limiter
(6) Idle Spring
(7) Governor Lever 1
(8) Governor Lever 3
(9) Governor Weight
(10) Spacer
(11) Cap

3ECAAAB1P017A

A governor is a device which controls the fuel injection of an engine, depending on fluctuations in load, to keep the engine speed and out put power at a constant level. The governor used for this engine is of mechanical type which utilizes the balance between the centrifugal force of the governor weight and the tension of the springs. Its control covers the entire speed range from idling to max rpm. The mechanism consists of the following component part : governor weight, governor lever, governor spring, idle spring, fuel limiter with built in torque spring, speed control lever, and others.

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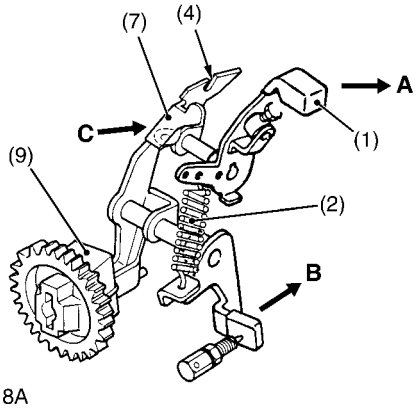

3ECAAAB1P018A

■ At Starting

When the speed control lever (1) is moved in the direction **A**, the governor lever 1 (7) is pulled in the direction **C** by the force of the governor spring (2). At this time, the governor weight (9) has no active centrifugal force, since the engine is not rotating. Thus, the control rack (4) moves to the maximum fuel injection position to facilitate starting of the engine.

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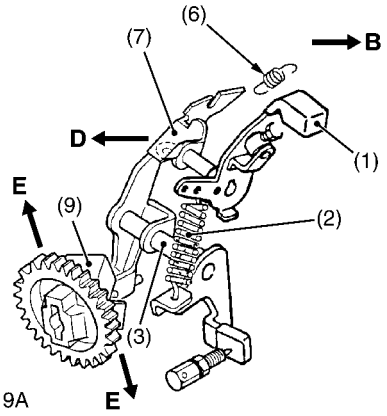

3ECAAAB1P019A

■ **At Idling**

When the speed control lever (1) is set in the idling position, the governor spring (2) is almost relaxed and the idling spring (6) of small tension alone is at work. This idling spring works in the direction **B** (to increase fuel supply). To the contrary, the governor weight (9) extends by the centrifugal force in the direction of E to push the governor shaft (3) and in turn move the governor lever 1 (7) in the direction of **D** (to decrease the fuel supply). The engine will idle in a condition in which the two forces are balanced with each other.

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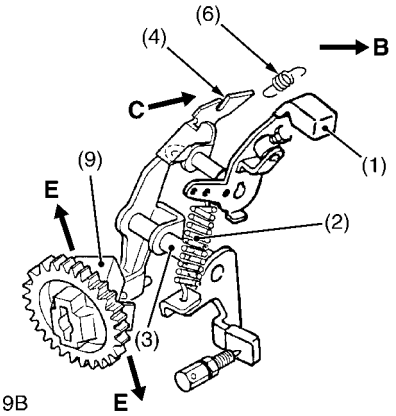
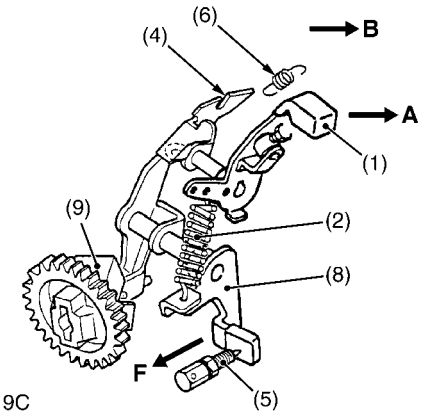


3ECAAAB1P019B

■ **At Idling to Maximum Speed**

When The engine rotates at idling to maximum speeds, engine rotates at a constant speed at the point where the governor spring tension and the governor weight's centrifugal force are well balanced. If the load is increased, the engine speeds down and the centrifugal force of the governor weight (9) becomes smaller, so that the control rack (4) is moved in the direction **C** in which fuel is increased to restore the original speed. In this way, the engine speed is automatically controlled for a constant revolution.

0000009164E

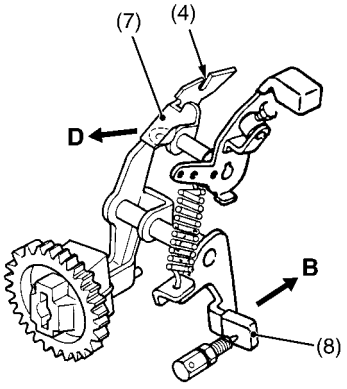


3ECAAAB1P019C

■ **At Maximum Engine Speed**

When the speed control lever (1) is moved in the direction **A**, the governor weight (9) is at the maximum centrifugal force, with the governor lever 3 (8) contacting the fuel limiter (5). As the load becomes large, the speed is reduced, decreasing the governor weight's centrifugal force. Then, the governor lever pushes the fuel limiter (the limiter contains a spring) and moves in the direction **F**. Thus, the control rack (4) is placed at the maximum fuel injection position, producing the maximum engine output power.

0000009165E



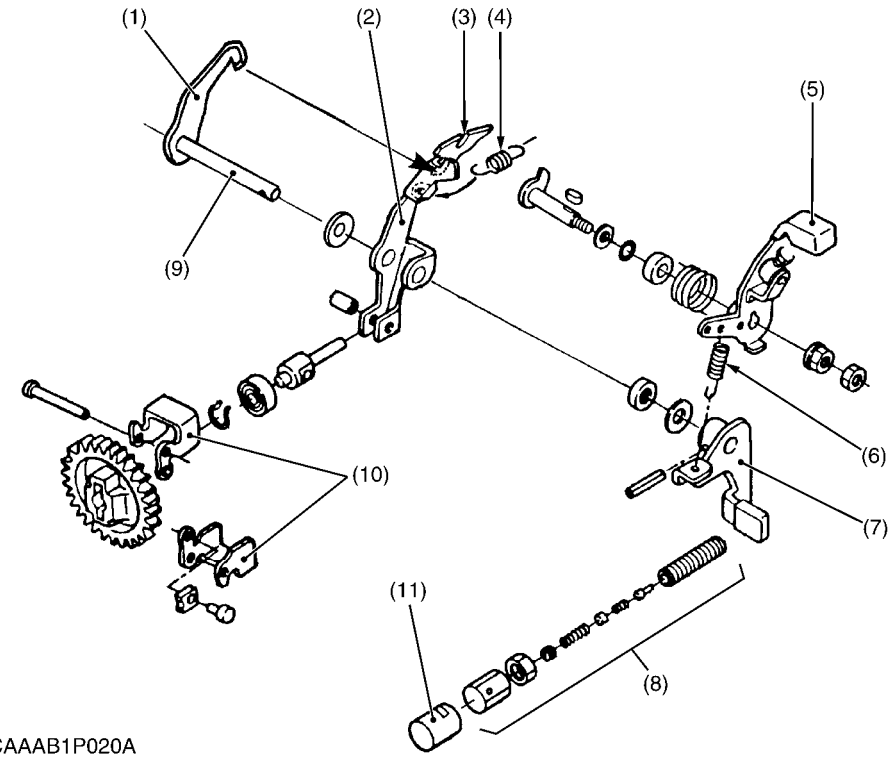
3ECAAAB1P018B

■ **At Engine Stop**

When the governor lever (8) is moved fully in the direction **B** to the stop position, the governor lever (7) moves in direction **D**, thus the control rack (4) is set to the stop position (No fuel injection) and the engine stops.

0000009166E

(2) OC95-E2



3ECAAAB1P020A

(1) Governor Lever 2
(2) Governor Lever 1
(3) Control Rack
(4) Idle Spring
(5) Speed Control Lever
(6) Governor Spring
(7) Governor Lever 3
(8) Fuel Limiter
(9) Governor Shaft
(10) Governor Weight
(11) Cap

A governor is a device which controls the fuel injection of an engine, depending on fluctuations in load, to keep the engine speed and output power at a constant level. The governor used for this engine is of mechanical type which utilizes the balance between the centrifugal force of the governor weight and the tension of the springs. Its control weight and the tension of the springs. Its control covers the entire speed range from idling to max rpm. The mechanism consists of the following component part: governor weight, governor lever, governor spring, idle spring, fuel limiter with built in torque spring, speed control lever, and others.

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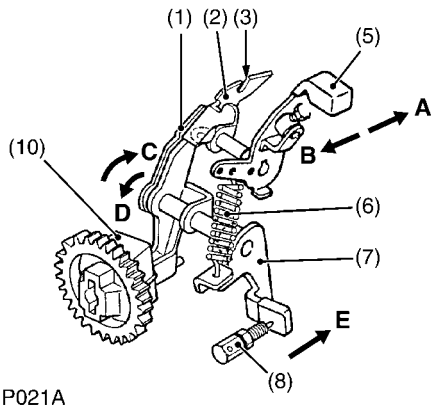

3ECAAAB1P021A

■ At Starting

When the speed control lever (5) is moved in the direction of arrow **A**, the governor lever 2 (1) is pulled by the governor spring (6) and the stop lever of the governor lever 3 (7) turns in the direction of arrow **C** until the stop lever comes into contact with the fuel injection limit pin. The governor lever 1 (2) moves together with the governor lever 2 in the same direction, but even when the governor lever 2 has stopped, the governor lever 1 remains pulled by the idling spring (4) to keep turning just by the clearance of the lever's slit in the same direction. This makes the injection pump's control rack move to the maximum fuel injection rate position, facilitating the start.

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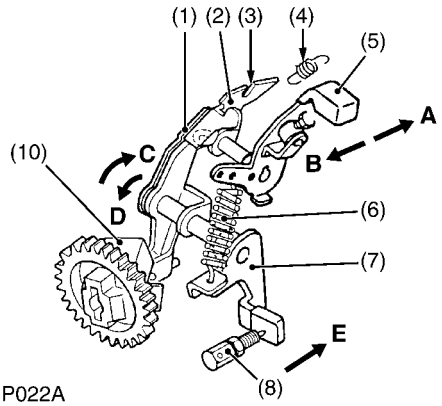

3ECAAAB1P022A

■ **At Idling**

When the speed control lever (5) is moved in the direction of arrow **B** until it hits against the idling setting bolt (idling position), the governor spring (6) becomes almost dead and the small tension idling spring (4) alone sets to work. The engine starts idling when the idling spring tension and the governor weight's (10) centrifugal force become equal. The idling rpm can be adjusted by repositioning the idling setting bolt,

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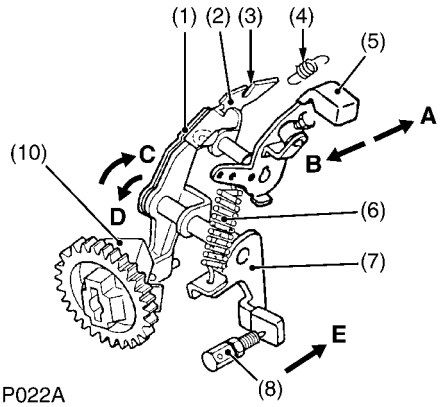

3ECAAAB1P022A

■ **At Idling to Maximum Speed**

While the load is constant, the governor lever 1 (2) is pressed in the direction of arrow **D** by the centrifugal force of the governor weight (10) and at the same time the governor lever 2 (1) is pulled in the direction of arrow **C** by the governor spring (6). The centrifugal force and the spring tension are now in balance against each other to keep the speed constant. With the speed control lever (5), the tension of the governor spring can be changed to control the engine rpm.

As the load increases, the engine rpm drops to reduce the centrifugal force of the governor weight. The governor lever 2 is therefore moved by the governor spring tension, which makes the governor lever 1 turn in the direction of arrow **C**. In so doing, the control rack (3) moves to raise the fuel injection rate and thus to increase the engine power output so that the engine rpm should go up.

As the load decreases, the reverse steps take place to drop the engine power output and thus to prevent an abrupt rise in rpm.

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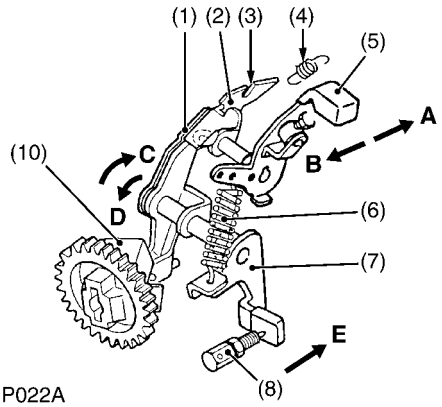

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■ **At Maximum Engine Speed**

When the speed control lever is moved in the direction of arrow **A** until it hits against the maximum rpm adjust bolt, the governor lever 3 (7) comes into contact with the fuel injection limit pin to maintain the engine rpm at maximum. If in this state the load increases and the engine rpm starts dropping, the governor lever 3 is activated to push the fuel injection limit pin. This way, the governor levers 2 (1) and 1 (2) turn in the direction of arrow **C** to raise the engine power output.

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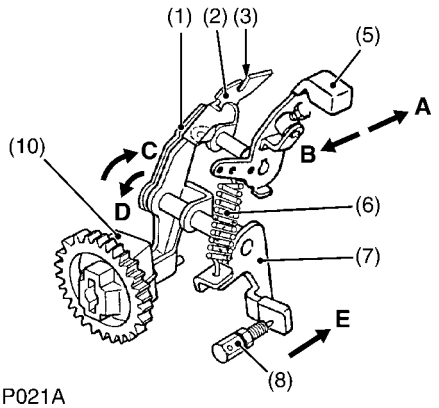


3ECAAAB1P021A

■ **At Engine Stop**

When the stop lever of the governor lever 3 (7) is moved to the stop position, the governor lever 2 (1) is activated to move the governor lever 1 (2) in the direction of arrow **D**. The control rack (3) is now moved to the stop position (no fuel injection), thereby stopping the engine.

It should be noted that the fuel injection limit pin and the maximum speed adjust bolt have been factory adjusted with a proper maximum power output in consideration. They should never be readjusted.

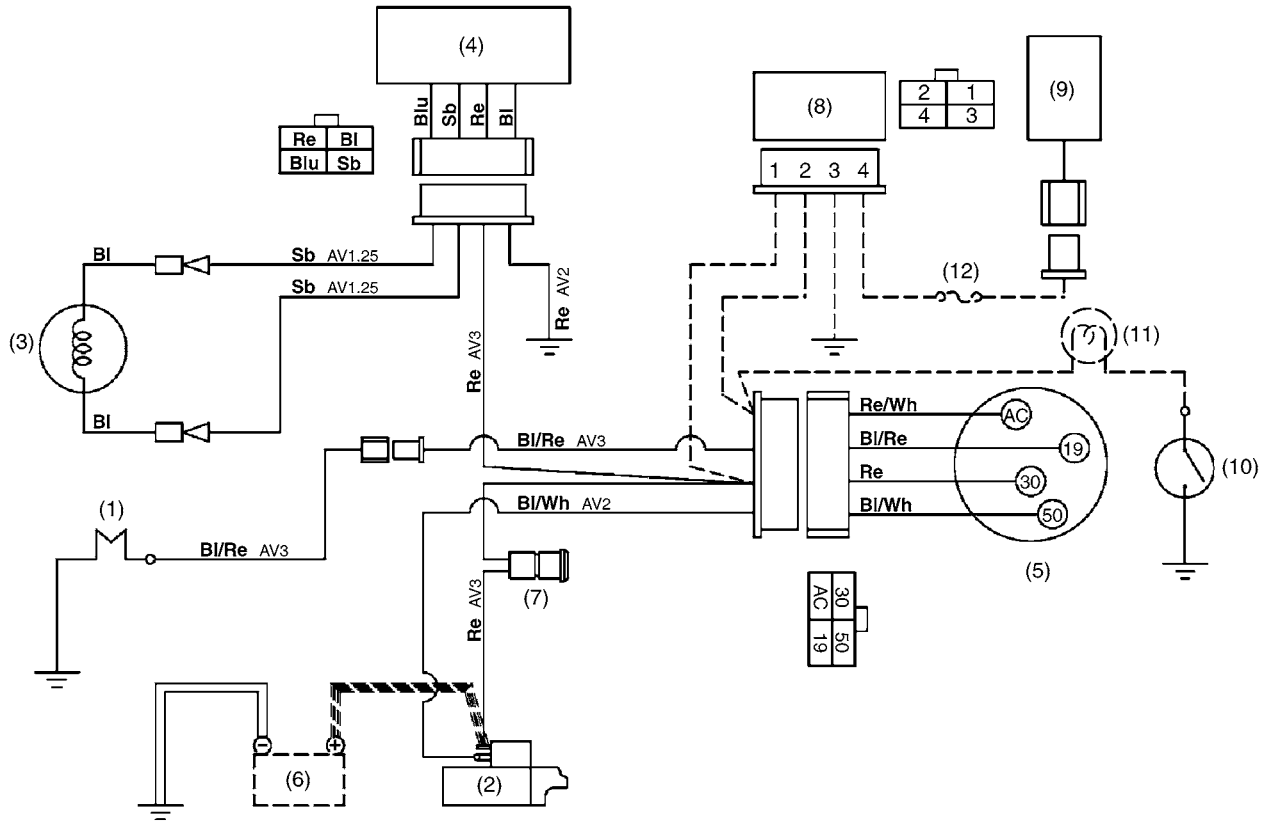
0000009172E

6. ELECTRICAL SYSTEM

[1] GENERAL

The electrical system of the engine consists of a starting system (including a starter, glow plugs, etc.), a charging system (including a alternator, regulator, etc.), and key switch.

■ **[STANDARD TYPE]**



3ECAAAB1P023A

(1)	Glow Plug	(5)	Key Switch	(9)	Stop Solenoid	**Bl:**	**Black**
(2)	Starter	(6)	Battery (12V)	(10)	Oil Pressure Switch	**Re:**	**Red**
(3)	Dynamo (48 W)	(7)	Slow Blow Fuse	(11)	Warning Lamp (Option)	**Blu:**	**Blue**
(4)	Regulator	(8)	Timer	(12)	Fuse (15A)	**Sb:**	**Sky Blue**
						Bl / Wh:	**Black / White**
						Bl / Re:	**Black / Red**
						Re / Wh:	**Red / White**

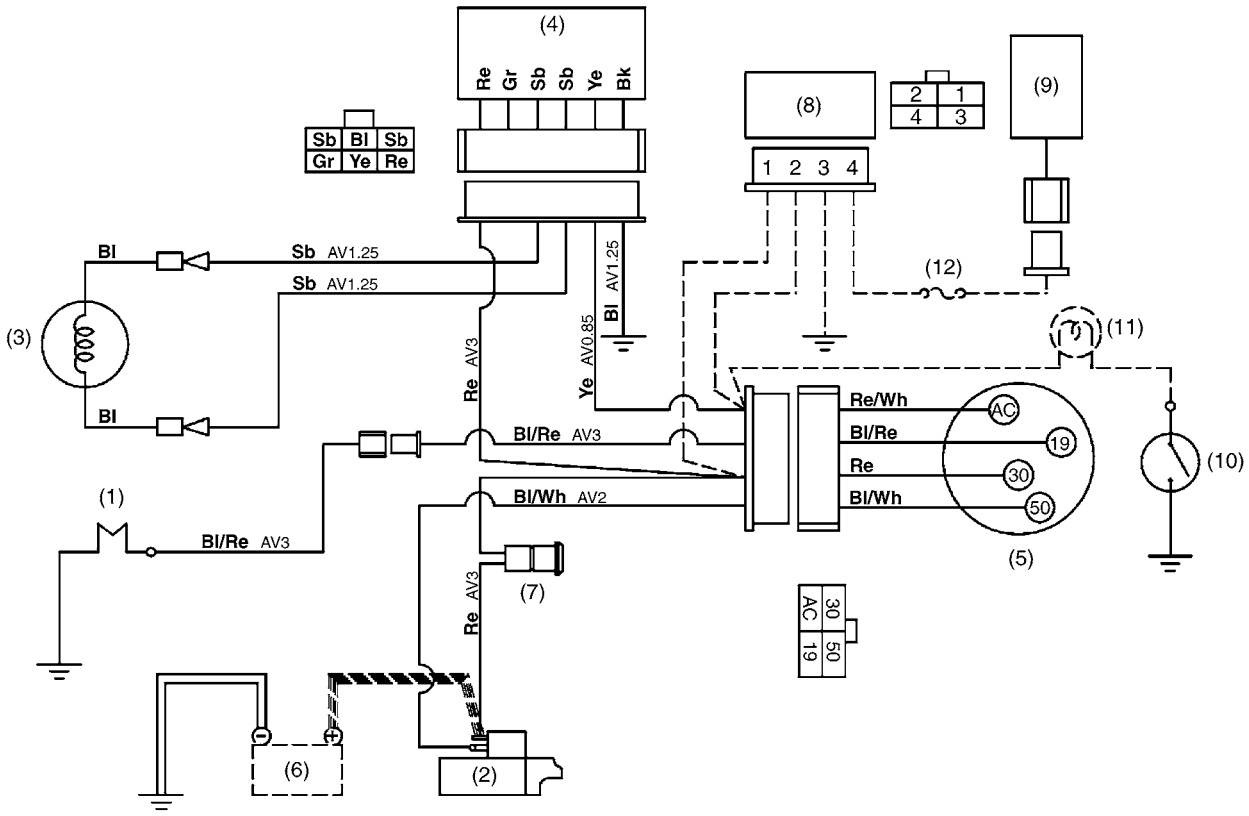
■ **NOTE**

- **The dot lines indicate option parts.**
- **The following modell is with stop solenoid.**

  OC60-E2-D1-QX
  OC60-E2-D1-GX
  OC95-E2-D1-GX

0000009173E

■ [L TYPE]



3ECAAAB1P112A

(1)	Glow Plug	(5)	Key Switch	(9)	Stop Solenoid	**Bl:**	**Black**
(2)	Starter	(6)	Battery (12V)	(10)	Oil Pressure Switch	**Re:**	**Red**
(3)	Dynamo (150 W)	(7)	Slow Blow Fuse	(11)	Warning Lamp (Option)	**Blu:**	**Blue**
(4)	Regulator	(8)	Timer	(12)	Fuse (15A)	**Sb:**	**Sky Blue**
						Gr:	**Green**
						Ye:	**Yellow**
						Bl / Wh:	**Black / White**
						Bl / Re:	**Black / Red**
						Re / Wh:	**Red / White**

■ NOTE

- **The dot lines indicate option parts.**
- **The following modell is with stop solenoid.**

  OC60-E2-D1-QX-L1

  OC95-E2-D1-QX-L1

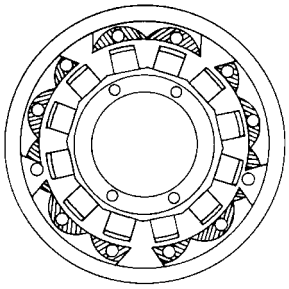
0000009662E

[2] ALTERNATOR

[A]

3ECAAAB1P024A

[B]



3ECAAAB1P025A

This alternator is 12 pole rotating magnet type generator. It is simple in construction, consisting of a stator and rotor.

A permanent magnet is attached on the inner face of the flywheel, which is connected with the engine's crankshaft. As the flywheel turns, the magnet induces electromotive force to each coil of the stator.

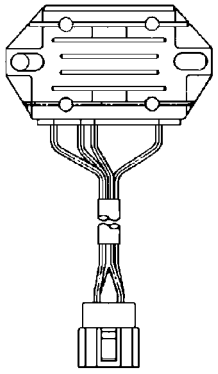
*Figure shows the flywheel, the arrangement of the stator poles, and the magnetized state of the magnet.

[A] Standard Type **[B] L Type**

0000009174E

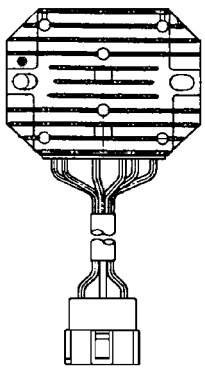
[3] REGULATOR

[A]



3ECAAAB1P114A

[B]



3ECAAAB1P116A

The regulator has a following functions.

- When the battery voltage is too low, it turns on the SCR (silicon controlled rectifier) to form a charging circuit to the battery.
- The figure shows the appearance and internal wiring.

[A] Standard Type **[B] L Type**

0000009175E

CONTENTS

1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	● No fuel	Replenish fuel	—
	● Air in the fuel system	Vent air	—
	● Water in the fuel system	Replace fuel and repair or replace fuel system	—
	● Fuel pipe clogged	Clean	—
	● Fuel filter clogged	Clean and replace	G-8
	● Excessively high viscosity of fuel or engine oil at low temperature	Use the specified fuel	G-4
	● Fuel with low cetane number	Use the specified fuel	G-4
	● Fuel leak due to loose injection pipe retaining nut	Tighten nut	—
	● Incorrect injection timing	Adjust	S-15
	● Fuel camshaft worn	Replace	S-47
	● Injection nozzle clogged	Clean	G-9, 10
	● Injection pump malfunctioning	Replace	S-26
	● Seizure of crankshaft, camshaft, piston, cylinder liner or bearing	Replace	S-44, 47
	● Compression leak from cylinder head	Replace head gasket, Tighten cylinder head bolt and nozzle holder Correct valve seat	S-12
	● Deficient compression	Check and correct valve	S-12
	● Improper valve seat alignment, valve spring broken, valve seized	Replace	S-42
	● Incorrect valve timing	Adjust	S-12
	● Piston ring and liner worn	Replace	S-44, 46
	● Excessive valve clearance	Adjust	G-9
Engine Revolution Is Not Smooth	● Fuel filter clogged or dirty	Clean	G-8
	● Air cleaner clogged	Clean or replace	G-8
	● Fuel leak due to loose injection pipe retaining nut	Tighten nut	—
	● Injection pump malfunctioning	Replace	S-26
	● Incorrect nozzle injection pressure	Repair or adjust	S-17
	● Injection nozzle stuck or clogged	Replace	—
	● Fuel overflow pipe clogged	Clean	—
	● Governor malfunctioning	Repair	M-10, 12

Symptom	Probable Cause	Solution	Reference Page
Either White or Blue Exhaust Gas Is Observed	● Excessive engine oil	Reduce to the specified level	G-6
	● Piston ring and liner worn or stuck	Replace	S-44
	● Incorrect injection timing	Adjust	S-15
	● Deficient compression	Check top clearance and correct valve recessing	S-12
Either Black or Dark Gray Exhaust Gas Is Observed	● Overload	Lessen load	—
	● Low grade fuel used	Use the specified fuel	G-4
	● Fuel filter clogged	Clean or replace	G-8
	● Air cleaner clogged	Clean or replace	G-8
Deficient Output	● Incorrect injection timing	Adjust	S-15
	● Moving parts show sign of seizing	Repair or replace	—
	● Deficient nozzle injection	Repair nozzle replace	S-17
	● Compression leak	Repair	S-12
Excessive Lubricant Oil Consumption	● Piston ring's gaps facing the same direction	Shift ring gap direction	S-32
	● Oil ring worn or stuck	Replace	S-46
	● Piston ring groove worn	Replace piston	S-46
	● Valve stem and guide worn	Replace	S-42
	● Oil leak	Repair	—
Fuel Mixed into Lubricant Oil	● Injection pump broken	Replace pump element or pump	S-26
Low Oil Pressure	● Engine oil insufficient	Replenish	G-6
	● Oil strainer clogged	Clean	G-7
	● Relief valve stuck with dirt	Clean	S-35
	● Relief valve spring weaken or broken	Replace	S-35
	● Excessive oil clearance of crankshaft bearing	Replace	S-47
	● Excessive oil clearance of crank pin bearing	Replace	S-47
	● Oil gallery clogged	Clean	—
	● Different types of oil	Use specified type of oil	G-4
	● Oil pump defective	Repair or replace	S-49, 50
High Oil Pressure	● Different types of oil	Use the specified type of oil	G-4
	● Relief valve defective	Replace	S-35

Symptom	Probable Cause	Solution	Reference Page
Engine Overheated	● Engine oil insufficient	Replenish	G-6
	● Overload running	Loosen the load	—
	● Head gasket defective	Replace	S-26
	● Incorrect injection timing	Adjust	S-15
	● Unsuitable fuel used	Use the specified fuel	G-4

0000009176E

2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Cylinder Head Surface Flatness		—	0.05 mm 0.0020 in.
Top Clearance	OC60-E2	0.60 to 0.75 mm 0.0236 to 0.0295 in.	—
	OC95-E2	0.65 to 0.80 mm 0.0256 to 0.0315 in.	—
Cylinder Head Gasket Thickness (Gromet Section)	Free (OC60-E2)	1.05 to 1.20 mm 0.0413 to 0.0472 in.	—
	Free (OC95-E2)	1.35 to 1.55 mm 0.0531 to 0.0610 in.	—
	Tightened (OC60-E2)	0.95 to 1.05 mm 0.0374 to 0.0413 in.	—
	Tightened (OC95-E2)	1.25 to 1.35 mm 0.0492 to 0.0531 in.	—
Compression Pressure		35 to 40 kgf/cm^2 3.43 to 3.92 MPa 498 to 569 psi	25.2 kgf/cm^2 2.47 MPa 358 psi
Valve Clearance (Cold)		0.14 to 0.18 mm 0.0055 to 0.0071 in.	—
Valve Seat Width		2.12 mm 0.0835 in.	—
Valve Seat Angle		45 ° 0.785 rad	—
Valve Face Angle		45.5 ° 0.794 rad	—
Valve Recessing		0.60 to 0.85 mm 0.0236 to 0.0335 in.	1.3 mm 0.0512 in.
Clearance Between Valve Stem and Valve Guide	OC60-E2	0.030 to 0.057 mm 0.0012 to 0.0022 in.	0.1 mm 0.0039 in.
	OC95-E2	0.035 to 0.065 mm 0.0014 to 0.0026 in.	0.1 mm 0.0039 in.
Valve Stem O.D.	OC60-E2	5.968 to 5.980 mm 0.2350 to 0.2354 in.	—
	OC95-E2	6.960 to 6.975 mm 0.2740 to 0.2746 in.	—
Valve Guide I.D.	OC60-E2	6.010 to 6.025 mm 0.2366 to 0.2372 in.	—
	OC95-E2	7.010 to 7.025 mm 0.2760 to 0.2766 in.	—

Item		Factory Specification	Allowable Limit
Inlet Valve	Open	0.35 rad (20 °) before T.D.C.	—
	Close	0.86 rad (49 °) after B.D.C.	—
Exhaust Valve	Open	0.94 rad (54 °) before B.D.C.	—
	Close	0.26 rad (15 °) after T.D.C.	—
Free Length	OC60-E2	31.3 to 31.8 mm 1.2323 to 1.2520 in.	31.0 mm 1.2205 in.
	OC95-E2	36.5 to 37.0 mm 1.4370 to 1.4567 in.	36.0 mm 1.4173 in.
Setting Load / Setting Length	OC60-E2	6.1 kgf / 27.3 mm 59.8 N / 27.3 mm 13.5 lbs / 1.075 in.	5.3 kgf / 27.3 mm 52 N / 27.3 mm 11.7 lbs / 1.075 in.
	OC95-E2	8.4 kgf / 31 mm 82.4 N / 31 mm 18.5 lbs / 1.220 in.	7.6 kgf / 31 mm 74.5 N / 31 mm 16.8 lbs / 1.220 in.
Tilt		—	1.2 mm 0.0472 in.
Clearance Between Rocker Arm Shaft and Shaft Hole		0.016 to 0.045 mm 0.0006 to 0.0018 in.	0.12 mm 0.0047 in.
Rocker Arm Shaft O.D.	OC60-E2	11.973 to 11.984 mm 0.4714 to 0.4718 in.	—
	OC95-E2	13.973 to 13.984 mm 0.5501 to 0.5506 in.	—
Rocker Arm Shaft Hole I.D.	OC60-E2	12.000 to 12.018 mm 0.4724 to 0.4731 in.	—
	OC95-E2	14.000 to 14.018 mm 0.5512 to 0.5519 in.	—
Clearance Between Tappet and Guide		0.018 to 0.058 mm 0.0007 to 0.0023 in.	0.1 mm 0.0039 in.
Tappet O.D.		7.972 to 7.987 mm 0.3139 to 0.3144 in.	—
Tappet Guide I.D.		8.005 to 8.030 mm 0.3152 to 0.3161 in.	—
Camshaft Side Clearance	OC60-E2	0.05 to 0.20 mm 0.0020 to 0.0079 in.	0.35 mm 0.0138 in.
	OC95-E2	0.05 to 0.25 mm 0.0020 to 0.0098 in.	0.35 mm 0.0138 in.
Cam Height (IN., EX.)	OC60-E2 (IN, EX)	27.0 mm 1.0630 in.	26.5 mm 1.0433 in.
	OC95-E2 (IN)	28.0 mm 1.1024 in.	27.5 mm 1.0827 in.
	OC95-E2 (EX)	30.0 mm 1.1811 in.	29.5 mm 1.1614 in.

Item		Factory Specification	Allowable Limit
Oil Clearance of Camshaft Journal	OC60-E2	0.016 to 0.045 mm 0.0006 to 0.0018 in.	0.08 mm 0.0031 in.
	OC95-E2	0.020 to 0.054 mm 0.0008 to 0.0021 in.	0.08 mm 0.0031 in.
Camshaft Journal O.D.	OC60-E2	16.989 to 17.000 mm 0.6689 to 0.6693 in.	—
	OC95-E2	19.987 to 20.000 mm 0.7869 to 0.7874 in.	—
Crank Gear - Cam Gear		0.033 to 0.175 mm 0.0013 to 0.0069 in.	0.3 mm 0.0118 in.
Balancer Gear 1 - Balancer Gear 2		0.033 to 0.170 mm 0.0013 to 0.0067 in.	0.3 mm 0.0118 in.
Clearance Between Balancer Gear Shaft and Balancer Gear Bearing		0.016 to 0.042 mm 0.0006 to 0.0017 in.	0.08 mm 0.0031 in.
Shaft O.D.	OC60-E2	13.992 to 14.000 mm 0.5509 to 0.5512 in.	—
	OC95-E2	15.992 to 16.000 mm 0.6296 to 0.6299 in.	—
Bearing I.D.	OC60-E2	14.016 to 14.034 mm 0.5518 to 0.5525 in.	—
	OC95-E2	16.016 to 16.034 mm 0.6306 to 0.6313 in.	—
Balancer Gear Side Clearance		0.12 to 0.37 mm 0.0047 to 0.0146 in.	0.5 mm 0.0197 in.
Piston Pin Bore	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.	20.03 mm 0.7886 in.
	OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.	23.03 mm 0.9067 in.
Clearance Between Compression Ring 2 and Ring Groove	OC60-E2	0.030 to 0.065 mm 0.0012 to 0.0026 in.	0.15 mm 0.0059 in.
	OC95-E2	0.045 to 0.080 mm 0.0018 to 0.0031 in.	0.15 mm 0.0059 in.
Piston Ring Groove 2 Width	OC60-E2	1.520 to 1.535 mm 0.0598 to 0.0604 in.	—
	OC95-E2	2.035 to 2.050 mm 0.0801 to 0.0807 in.	—
Compression Ring 2 Width	OC60-E2	1.470 to 1.490 mm 0.0579 to 0.0587 in.	—
	OC95-E2	1.970 to 1.990 mm 0.0776 to 0.0783 in.	—
Clearance Between Oil Ring and Ring Groove		0.020 to 0.055 mm 0.0008 to 0.0022 in.	0.15 mm 0.0059 in.
Piston Oil Ring Groove Width	OC60-E2	3.510 to 3.525 mm 0.1382 to 0.1388 in.	—
	OC95-E2	4.010 to 4.025 mm 0.1579 to 0.1585 in.	—

Item		Factory Specification	Allowable Limit
OIl Ring Width	OC60-E2	3.470 to 3.490 mm 0.1366 to 0.1374 in.	—
	OC95-E2	3.970 to 3.990 mm 0.1563 to 0.1571 in.	—
Ring Gap	Compression Ring 1 (OC60, 95-E2)	0.15 to 0.30 mm 0.0059 to 0.0118 in.	1.2 mm 0.0472 in.
	Compression Ring 2 (OC60-E2)	0.25 to 0.45 mm 0.0098 to 0.0177 in.	1.2 mm 0.0472 in.
	Compression Ring 2 (OC95-E2)	0.30 to 0.50 mm 0.0118 to 0.0197 in.	1.2 mm 0.0472 in.
	Oil Ring (OC60, 95-E2)	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.2 mm 0.0472 in.
Connecting Rod Alignment		—	0.05 mm 0.0020 in.
Clearance Between Piston Pin and Small End		0.012 to 0.040 mm 0.0005 to 0.0016 in.	0.15 mm 0.0059 in.
Piston Pin O.D.	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.	—
	OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.	—
Small End I.D.	OC60-E2	20.025 to 20.040 mm 0.7884 to 0.7890 in.	—
	OC95-E2	23.025 to 23.040 mm 0.9065 to 0.9071 in.	—
Crankshaft Alignment		0.02 mm 0.0008 in.	0.8mm 0.0031 in.
Oil Clearance Between Crankshaft Journal and Crankshaft Bearing		0.028 to 0.090 mm 0.0011 to 0.0035 in.	0.2 mm 0.0079 in.
Crankshaft O.D.	OC60-E2	34.934 to 34.950 mm 1.3754 to 1.3760 in.	—
	OC95-E2	39.934 to 39.950 mm 1.5722 to 1.5728 in.	—
Crankshaft Bearing I.D.	OC60-E2	34.978 to 35.024 mm 1.3771 to 1.3789 in.	—
	OC95-E2	39.978 to 40.024 mm 1.5739 to 1.5757 in.	—
Oil Clearance Between Crank Pin and Crank Pin Bearing		0.025 to 0.087 mm 0.0010 to 0.0034 in.	0.2 mm 0.0079 in.
Crankshaft O.D.	OC60-E2	35.959 to 35.975 mm 1.4157 to 1.4163 in.	—
	OC95-E2	39.959 to 39.975 mm 1.5732 to 1.5738 in.	—

Item		Factory Specification	Allowable Limit
Crankshaft Bearing I.D.	OC60-E2	36.000 to 36.046 mm 1.4173 to 1.4191 in.	—
	OC95-E2	40.000 to 40.046 mm 1.5748 to 1.5766 in.	—
Crankshaft Side Clearance		0.05 to 0.20 mm 0.0020 to 0.0079 in.	0.35 mm 0.0138 in.
Cylinder Liner I.D.	OC60-E2	72.000 to 72.019 mm 2.8346 to 2.8354 in.	72.10 mm 2.839 in.
	OC95-E2	83.018 to 83.038 mm 3.2684 to 3.2692 in.	83.10 mm 3.272 in.
Difference Between I.D.'s at The Maximum and Minimum Wear Position		—	+ 0.10 mm 0.0039 in.

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LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	49 kPa (0.5 kgf/cm^2, 7 psi) or more	—
	At Rated Speed	147 to 490 kPa (1.5 to 5.0 kgf/cm^2, 21 to 71 psi)	98 kPa (1 kgf/cm^2 14.22 psi)
Clearance Between Inner Rotor and Outer Rotor		0.15 mm 0.0059 in.	0.2 mm 0.0079 in.
Clearance Between Outer Rotor and Pump Body		0.090 to 0.171 mm 0.0035 to 0.0067 in.	0.24 mm 0.0094 in.
End Clearance Between Inner Rotor and Cover		0.02 to 0.06 mm 0.0008 to 0.0024 in.	0.25 mm 0.0098 in.

0000009180E

FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Timing (Static)	OC60-E2	0.26 to 0.30 rad (15 ° to 17 °) before T.D.C.	—
	OC95-E2	0.23 to 0.26 rad (13 ° to 15 °) before T.D.C.	—
Fuel Tightness of Pump Element		—	14.7 MPa 150 kgf/cm^2 2133 psi
Fuel Tightness of Delivery Valve		10 seconds or more 14.7 → 13.9 MPa 150 → 142 kgf/cm^2 2133 → 2019 psi	5 seconds or more 14.7 → 13.9 MPa 150 → 142 kgf/cm^2 2133 → 2019 psi
Fuel Injection Pressure		13.7 MPa 140 kgf/cm^2 1987 psi	—
Fuel Tightness of Nozzle Valve Seat		When the pressure is 12.7 MPa (130 kgf/cm^2, 1849 psi) the valve seat must be fuel tightness	—

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ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Starter	Commutator O.D. (OC60-E2)	28.0 mm 1.1024 in.	27.0 mm 1.0630 in.
	Commutator O.D. (OC95-E2)	30.0 mm 1.1811 in.	29.0 mm 1.1417 in.
	Mica Undercut (OC60-E2)	0.45 to 0.75 mm 0.0177 to 0.0295 in.	0.2 mm 0.0079 in.
	Mica Undercut (OC95-E2)	0.50 to 0.80 mm 0.0197 to 0.0315 in.	0.2 mm 0.0079 in.
	Brush Length (OC60-E2)	10.0 mm 0.3937 in.	6.0 mm 0.2362 in.
	Brush Length (OC95-E2)	15.0 mm 0.5906 in.	10.0 mm 0.3937 in.
Alternator	Changing Current (Standard type)	4 to 6 A at 3600 min^{-1}	—
	Changing Current (L type)	14 A or more at 3600 min^{-1}	—
Glow Plug	Glow Plug Resistance	1.09 to 1.29 Ω	—

0000009184E

3. TIGHTENING TORQUES

- Screws, bolts and nuts must be tightened to the specified torque with a torque wrench.
- Several screws and nuts such as those used on the cylinder head must be tightened in proper sequence and to the proper torque.

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[1] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS

Item	Size x Pitch	N·m	kgf·m	ft-lbs
**Cylinder head screws (OC60-E2)	M10 x 1.5	51.9 to 56.8	5.3 to 5.8	38.3 to 42.0
**Cylinder head screws (OC95-E2)	M12 x 1.75	68.6 to 73.6	7.0 to 7.5	50.6 to 54.2
**Connecting rod screws (OC60-E2)	M7 x 1.0	18.6 to 21.6	1.9 to 2.2	13.7 to 15.9
**Connecting rod screws (OC95-E2)	M8 x 1.25	27.5 to 30.4	2.8 to 3.1	20.3 to 22.4
*Flywheel nut (OC60-E2)	M20 x 1.5	137 to 157	14 to 16	101 to 116
*Flywheel nut (OC95-E2)	M24 x 1.5	235 to 255	24 to 26	174 to 188
Side cover screws	M8 x 1.25	23.5 to 27.4	2.4 to 2.8	17.4 to 20.3
**Rocker arm bracket mounting nut	M8 x 1.25	23.5 to 27.4	2.4 to 2.8	17.4 to 20.3
Injection pump mounting screw	M6 x 1.0	9.8 to 11.3	1.0 to 1.15	7.2 to 8.3
Injection pump eye joint bolt	M10 x 1.0	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection pipe retaining nuts	M12 x 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
Oil pipe eye joint bolt	M12 x 1.25	24.5 to 29.4	2.5 to 3.0	18.1 to 21.7
Grow plug	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle holder mounting nuts	M8 x 1.25	13.72 to 17.6	1.4 to 1.8	10.1 to 13.0
Oil switch taper screw	PT1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Exhaust manifold mounting nuts	M8 x 1.25	23.5 to 27.4	2.4 to 2.8	17.4 to 20.3

* Apply Molycoat oil to the threads of the nuts marked "*" and tighten them up.
** Apply enough engine oil to the threads and bearing surface of the bolts and nuts marked "**" and tighten them up.

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[2] TIGHTENING TORQUES FOR GENERAL USE SCREWS, BOLTS AND NUTS

When the tightening torques are not specified, tighten the screws, bolts and nuts according to the table below.

Grade / Nominal Diameter / Unit	Standard Screw and Bolt ⟨4⟩			Special Screw and Bolt ⟨7⟩		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

Punched number	Screw and bolt material grade
None or 4	Standard screw and bolt SS41, S20C
7	Special screw and bolt S43C, S48C (Refined)

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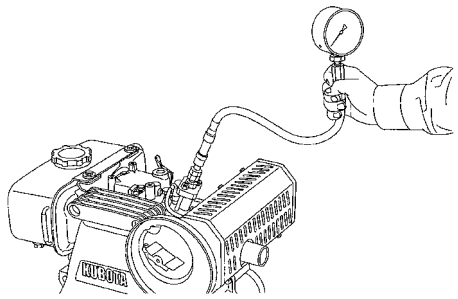
4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body



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Compression Pressure

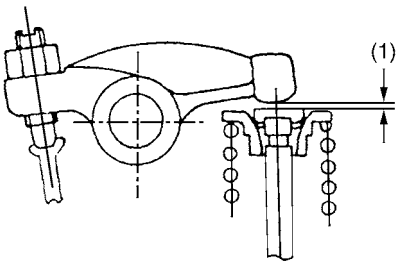
1. After warming up the engine, stop it and remove the air cleaner, and nozzle holder.
2. Install a compression tester for diesel engines to nozzle holder hole.
3. After making sure that the speed control lever is set at the stop position (Non-injection), run the engine at 3.3 to 5.0 1/s (200 to 300 rpm) with the starter.
4. Read the maximum pressure. Measure the pressure more than twice.
5. If the measurement is below the allowable limit, check the cylinder, piston ring, top clearance, valve and cylinder head.
6. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the nozzle hole and measure the compression pressure again.
7. If the compression pressure is still less than the allowable limit, check the top clearance, valve clearance and cylinder head.
8. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

■ NOTE

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for performing this test.**
- **Variances in cylinder compression values should be under 10 %.**

Compression pressure	Factory spec.	3.43 to 3.92 MPa 35 to 40 kgf/cm^2 497 to 568 psi
	Allowable limit	2.47 MPa 25.2 kgf/cm^2 358 psi

0000009191E



3TMABAB0P046C

Valve Clearance

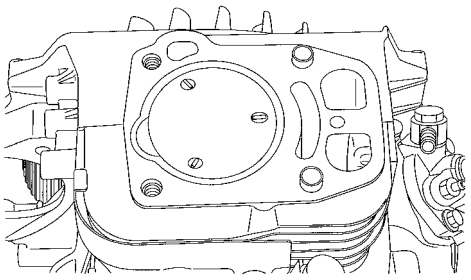
■ IMPORTANT

- **The valve clearance must be inspected and adjusted as needed when the engine is cold (equal to the atmospheric air temperature).**

Valve clearance (Cold)	Factory spec.	0.14 to 0.18 mm 0.0055 to 0.0071 in.

(1) Valve Clearance

0000009192E



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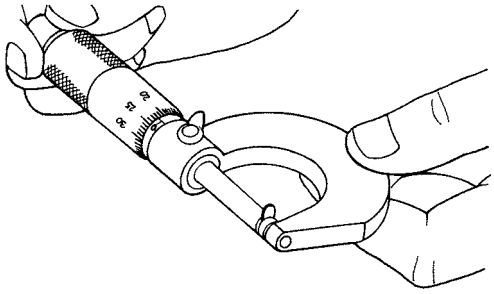


3EEABAB1P057A

Top Clearance

1. Remove the cylinder head. (Do not attempt to remove the cylinder head gasket.).
2. Move the piston up, and stick a strip of fuse [1.5 mm dia. (0.059 in. dia.), 5 to 7 mm long (0.197 to 0.276 in. long)] on the piston head at three positions with grease so as to avoid the intake and exhaust valves and the combustion chamber ports.
3. Lower the piston, and install the cylinder head and tighten the cylinder head screws to the specified torque.
4. Turn the flywheel until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure the thickness of the squeezed fuses.
6. If the measurement is not within the factory specifications, check the oil clearance between the crankpin and crankpin bearing and between the piston pin and small end bushing.

■ **NOTE**

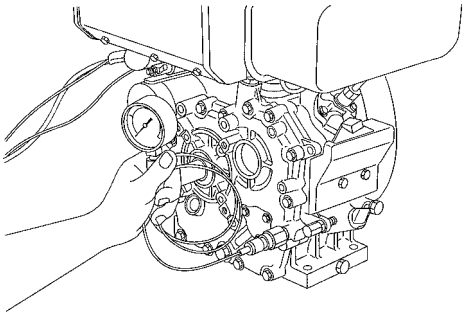
- **After checking the top clearance, be sure to assemble the cylinder head with a new cylinder head gasket.**

Top clearance	Factory spec.	OC60-E2	0.60 to 0.75 mm 0.0236 to 0.0295 in.
		OC95-E2	0.65 to 0.80 mm 0.0256 to 0.0315 in.

Tightening torque	Cylinder head mounting bolts	OC60-E2	51.9 to 56.8 N·m 5.3 to 5.8 kgf·m 38.3 to 42 ft-lbs
		OC60-E2 OC95-E2	68.6 to 73.6 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 ft-lbs

0000009193E

(2) Lubricating System



3ECAAAB1P083A

Engine Oil Pressure

1. Remove the screw plug and install an engine oil pressure tester.
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.

- Engine oil insufficient
- Oil pump defective
- Oil strainer clogged
- Excessive oil clearance of bearing
- Foreign matter in the relief valve
- Oil gallery clogged

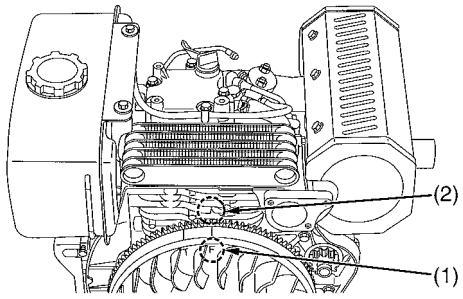
(Engine oil pressure)

At idle speed	Factory spec.	49 kPa or more 0.5 kgf/cm^2 or more 7 psi or more
At rated speed	Factory spec.	147 to 490 kPa 1.5 to 5.0 kgf/cm^2 21 to 71 psi
	Allowable limit	98 kPa 1.0 kgf/cm^2 14 psi

0000009197E

(3) Fuel System

[A]



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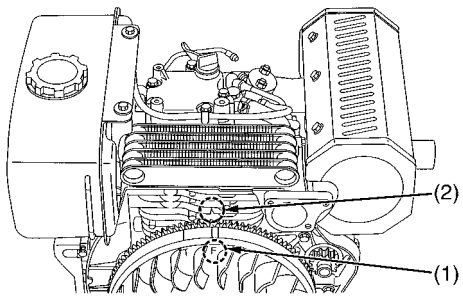
[B]



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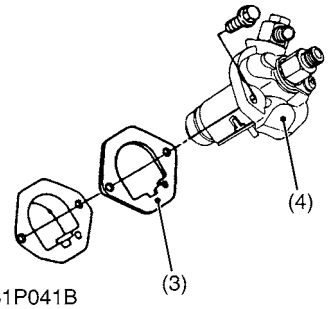

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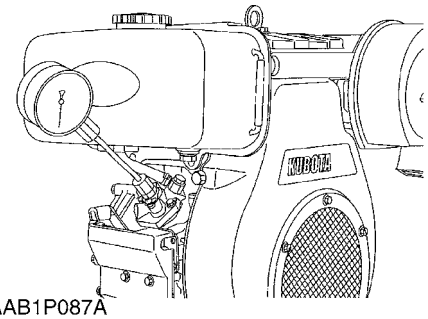


3ECAAAB1P087A

Adjusting Injection Timing

1. Connect the injection pipe to the injection pump as shown in the figure.
2. Set the speed control lever to the maximum speed position.
3. Turn the flywheel clockwise to check that fuel comes out from the tip of the injection pipe.
4. Turn the flywheel so that the **F** mark (1) on the flywheel circumference reaches near below the mark (2) on the fin slowly turn the flywheel clockwise from that position, and stop it immediately when the fuel level at the tip of the injection pipe begins rising. At this time, check if the **F** mark (1) on the flywheel circumference aligns with the fin mark.
5. If the timing is incorrect, adjust it with shims (3).

Injection timing	Factory spec.	OC60-E2	0.26 to 0.30 rad 15° to 17° before T.D.C.
		OC95-E2	0.23 to 0.26 rad 13° to 15° before T.D.C.

■ NOTE

- There are 2 **F** mark lines in **[B]**.
- Use the line near **T** mark to adjust.

(Reference)

- Adding or removing one shim (0.15 mm, 0.0059 in.) varies the crank angle by approx. 0.017 rad to 0.026 rad (1° to 1.5°)

(1) **F** Mark
(2) Mark
(3) Injection Timing Adjusting Shim
(4) Injection Pump

[A] OC60-E2
[B] OC95-E2

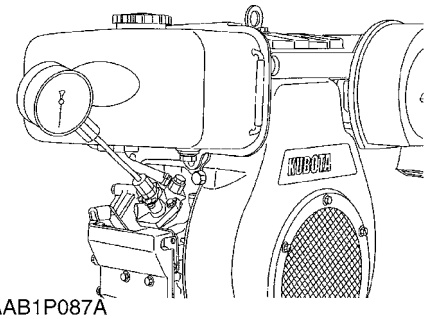
0000009202E

Fuel Tightness of Pump Element

1. Set an injection pump pressure tester to the injection pump.
2. Set the speed control lever to the maximum speed position.
3. Turn the engine ten times or more with the starter to increase the pressure.
4. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Pump element fuel tightness	Allowable limit	14.7 MPa 150 kgf/cm^2 2133 psi

0000009204E



3ECAAAB1P087A

Fuel Tightness of Delivery Valve

1. In the same way as to check the pump element fuel tightness, turn the engine ten times or more with the starter so that the pressure is increased to specified pressure.
2. Set the plunger at the bottom dead center to reduce the delivery chamber pressure to zero.
3. Measure the fall time for the pressure to drop to the reference pressure from the specified initial pressure.
4. If the measurement is less than the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

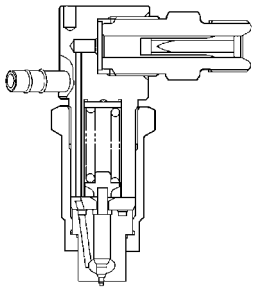
Delivery valve fuel tightness	Allowable limit	14.7 → 13.9 MPa 150 → 142 kgf/cm^2 2133 → 2019 psi	5 seconds or less

0000009207E

CAUTION

- **Be careful not to come into direct contact with the injected spray. The spray destroys any cells it touches. It may also cause blood poisoning, etc. Check the injection nozzle after confirming that nobody is standing in the direction of the spray.**

0000009211E


3ECAAAB0P010A

Nozzle Spraying Condition

1. Check the nozzle spray condition.
2. If the spray pattern and spraying direction are faulty, replace the nozzle piece.

(a) Good **(b) Bad**

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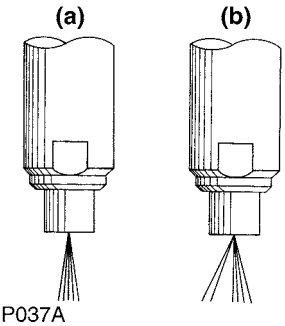

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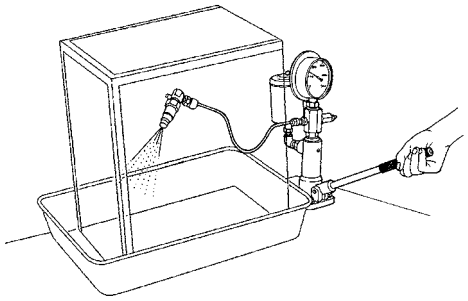


3ECAAAB1P109A

Fuel Injection Pressure

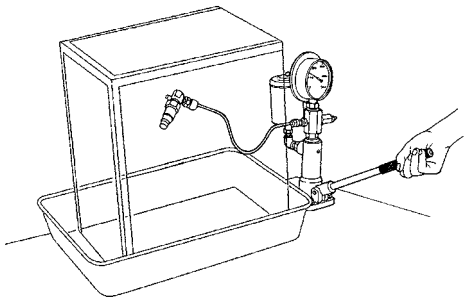
1. Set the injection nozzle to a nozzle tester.
2. Measure the injection pressure.
3. If the measurement is not within the factory specifications, adjust with the adjusting washer inside the nozzle holder.

Fuel injection pressure	Factory spec.	13.9 to 14.7 MPa 142 to 150 kgf/cm^2 2019 to 2133 psi

(Reference)

- Pressure change per 0.1 mm (0.039 in.) adjusting washer:
  Approx. 981 kPa
  10 kgf/cm^2
  142 psi

0000009213E



3ECAAAB1P110A

Valve Seat Tightness

1. Apply a pressure 12.7 to 13.9 MPa (130 to 142 kgf/cm^2, 1849 to 2019 psi) lower than the fuel injection pressure.
2. After keeping the nozzle under this pressure for 10 seconds, check to see if fuel leaks from the nozzle.
3. If any fuel leak is found, replace the nozzle piece.

0000009214E

(4) Electrical System

CAUTION

- **To avoid accidental short circuit, be sure to attach the positive cable to the positive terminal before the negative cable is attached to the negative terminal.**
- **Never remove the battery cap while the engine is running.**
- **Keep electrolyte away from eyes, hands and clothes. If you are spattered with it, wash it away completely with water immediately.**
- **Keep open sparks and flames away from the battery at all times. Hydrogen gas mixed with oxygen becomes very explosive.**

IMPORTANT

- **If the machine is to be operated for a short time without battery (using a slave battery for starting), use additional current (lights) while engine is running and insulate terminal of battery. If this advice is disregarded, damage to alternator and regulator may result.**

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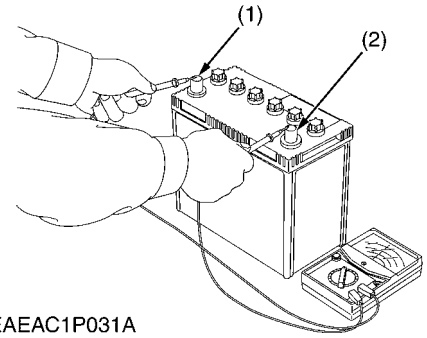


3EEAEAC1P031A

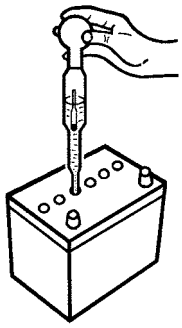
Battery Voltage

1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

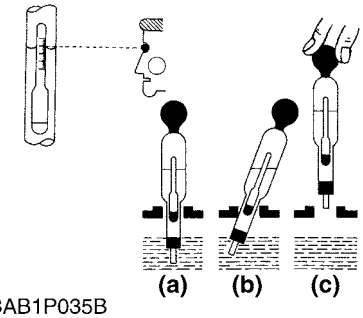
Battery Voltage	Factory spec.	More than 12V

(1) Positive Terminal (2) Negative Terminal

0000010713E



3EEABAB1P034A



3EEABAB1P035B

Battery Specific Gravity

1. Check the specific gravity of the electrolyte in each cell with a hydrometer.
2. When the electrolyte temperature differs from that at which the hydrometer was calibrated, correct the specific gravity reading following the formula mentioned in **(Reference)**.
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity differs between any two cells by more than 0.05, replace the battery.

■ NOTE

- **Hold the hydrometer tube vertical without removing it from the electrolyte.**
- **Do not suck too much electrolyte into the tube.**
- **Allow the float to move freely and hold the hydrometer at eye level.**
- **The hydrometer reading must be taken at the highest electrolyte level.**

(Reference)

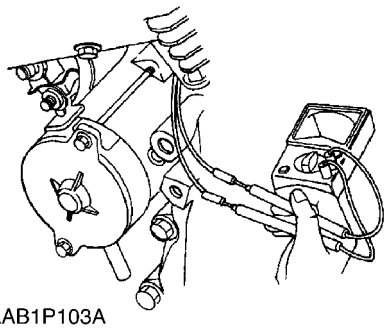
- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 ℃ (0.0004 with an increase of 1 ℉) in temperature, and increases by 0.0007 with a decreases of 1 ℃ (0.0004 with a decrease of 1 ℉).
  Therefore, using 20 ℃ (68 ℉) as a reference, the specific gravity reading must be corrected by the following formula :
  -Specific gravity at 20 ℃ = Measured value + 0.0007 x (electrolyte temperature - 20 ℃)
  -Specific gravity at 68 ℉ = Measured value + 0.0004 x (electrolyte temperature - 68 ℉)

Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 ℃ (68 ℉)

(a) Good
(b) Bad
(c) Bad

0000001142E



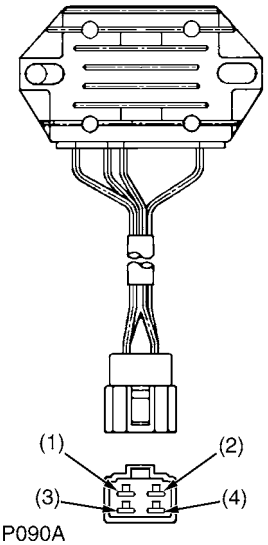
3ECAAAB1P103A

Alternator's No-load Voltage

1. Disconnect the lead wire from the alternator.
2. Start the engine and measure the voltage generated by the alternator.

No-load output	Factory spec.	Standard type	Approx. AC 38 V at 3600 min^{-1} (rpm)
		L type	Approx. AC 52 V at 3600 min^{-1} (rpm)

0000009216E



3ECAAAB1P090A

Regulator (Standard Type)

1. The engine is started.
2. Measure the output voltage of the regulator with the voltmeter.

Output Voltage	(1) - (2)	14 V to 15 V at 3600 min^{-1} (rpm)

3. When the measurement is not the above table value, measure the input voltage of the regulator with the voltmeter.

Input Voltage	(3) - (4)	Approx. AC 38 V at 3600 min^{-1} (rpm)

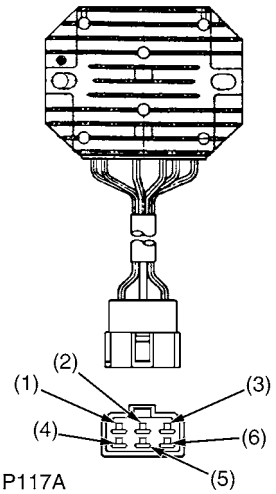
4. When the measurement is the above table value, the regulator is failure. Exchange it.

■ **NOTE**

- **When the input voltage of the regulator is out of specification, check the generator.**

(1) Terminal (Red)
(2) Terminal (Black)
(3) Terminal (Blue)
(4) Terminal (Sky Blue)
(5) Terminal (Yellow)
(6) Terminal (Green)

0000009218E



3ECAAAB1P117A

Regulator (L Type)

1. The engine is started.
2. Measure the output voltage of the regulator with the voltmeter.

Output Voltage	(6) - (2)	14 V to 15 V at 3600 min^{-1} (rpm)

3. When the measurement is not the above table value, measure the input voltage of the regulator with the voltmeter.

Input Voltage	(1) - (3)	Approx. AC 52 V at 3600 min^{-1} (rpm)

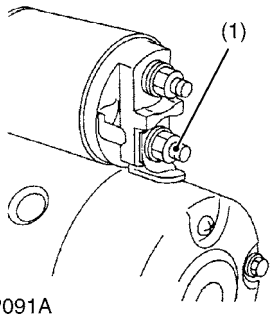
4. When the measurement is the above table value, the regulator is failure. Exchange it.

■ **NOTE**

- **When the input voltage of the regulator is out of specification, check the generator.**

(1) Terminal (Sky Blue)
(2) Terminal (Black)
(3) Terminal (Sky Blue)
(4) Terminal (Green)
(5) Terminal (Yellow)
(6) Terminal (Red)

0000009676E



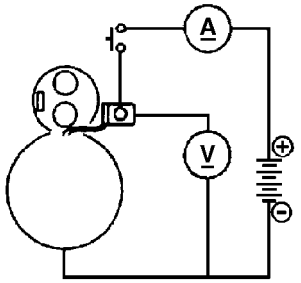
3ECAAAB1P091A

Motor Test (OC60-E2)

1. Disconnect the connecting lead to **M** terminal (1) and connect a voltmeter across the lead and the body of the starter.
2. Connect a cable between the negative terminal of the battery and the starter body.
3. Connect an ammeter and a switch in series between the positive terminal of the battery and the connecting lead, and run the starter.
4. The starter should run at the specified rate.

(1) **M** Terminal

0000009399E



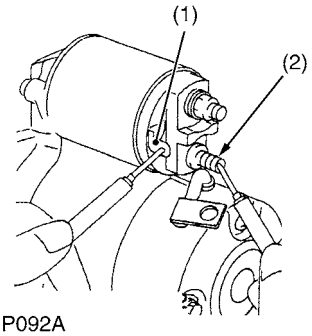
3ECAAAB1P104A

Solenoid Switch (OC60-E2)

1. Check the continuity across **S** terminal (1) and **M** terminal (2), and across **S** terminal (1) and the body with an ohmmeter.
2. If not continuous, replace.

(1) **S** Terminal (2) **M** Terminal

0000009401E



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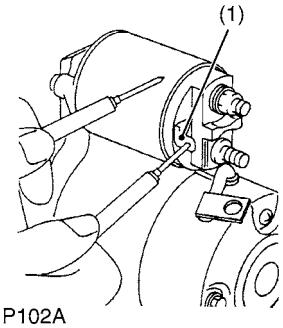


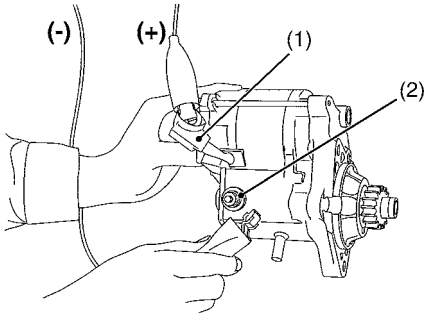
3ECAAAB1P102A

Motor Test (OC95-E2)

1. Remove the connecting lead (1) from the starter's **C** terminal (2) and connect it directly to the battery's positive terminal.
2. Then connect the battery's negative terminal to the starter body.
3. If motor rotates smoothly, it is O.K.

(1) Connecting lead (2) **C** Terminal

0000009389E



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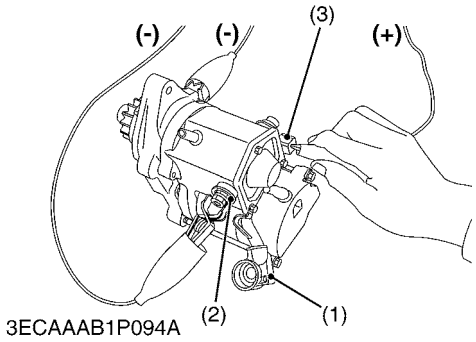

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Magnet Switch (OC95-E2)

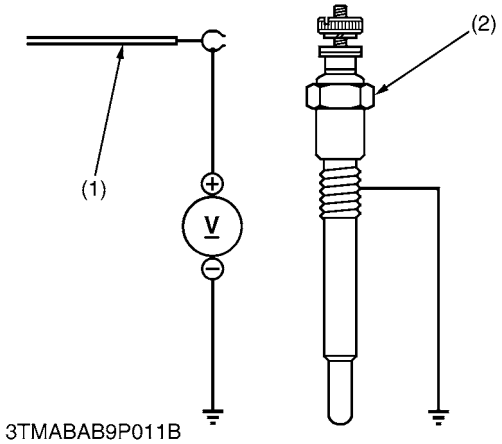
1. Disconnect the connecting lead (1) from the **C** terminal (2) of the starter.
2. Connect jumper leads from the negative terminal of 12V battery to the body and **C** terminal (2) of the magnet switch.
3. The pinion gear should pop out, when a jumper lead is connected between the positive terminal of the battery to the **S** terminal (3) of the magnet switch.
4. The pinion gear should stay out without the jumper from the negative terminal to the **C** terminal (2).

■ **NOTE**

- **Each test should be carried out for a short time, about 3 to 5 seconds.**

(1) Connecting Lead
(2) **C** Terminal
(3) **S** Terminal

0000009390E



3TMABAB9P011B

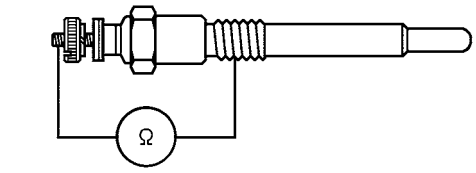
Lead Terminal Voltage

1. Disconnect the wiring lead (1) from the glow plug (2) after turning the main switch off.
2. Turn the main switch key to the **"GLOW"** position, and measure the voltage between the lead terminal and the chassis.
3. Turn the main switch key to the **"START"** position, and measure the voltage with a voltmeter between the lead terminal and the chassis.
4. If the voltage at either position differs from the battery voltage, the wiring harness or main switch is faulty.

Voltage (Lead terminal - Chassis)	Main switch key at **"GLOW"**	Approx. battery voltage
	Main switch key at **"START"**	Approx. battery voltage

(1) Wiring Lead (Positive)
(2) Glow Plug

0000009455E



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Glow Plug Continuity

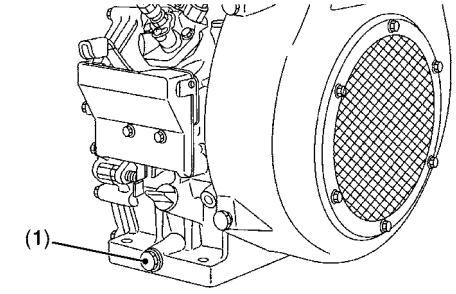
1. Disconnect the lead from the glow plugs.
2. Measure the resistance between the glow plug terminal and the chassis.
3. If 0 ohm is indicated, the screw at the tip of the glow plug and the housing are short-circuited.
4. If the factory specification is not indicated, the glow plug is faulty.

Glow plug resistance	Factory spec.	Approx. 0.9 Ω

0000005103E

[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Engine Oil and Fuel



3ECAAAB1P029A

Draining Engine Oil

1. Prepare an oil pan.
2. Remove the drain plug (1) to drain engine oil in the pan.

■ **NOTE**

- Specified engine oil.

OC60-E2	1.3 L 1.37 U.S.qts 1.14 Imp.qts
OC95-E2	1.7 L 1.80 U.S.qts 1.49 Imp.qts

(1) Drain Plug

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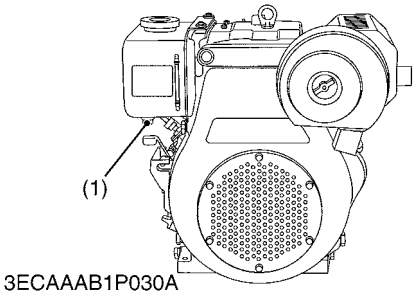

3ECAAAB1P030A

Draining Fuel

1. Prepare a clean, dry bucket.
2. Remove the drain plug (1) and let the fuel flow in the bucket.
3. Remove the fuel tank cap to completely drain the fuel.

■ **NOTE**

- **The fuel tank capacity.**

OC60-E2	3.6 L 0.95 U.S.gals 0.79 Imp.gals
OC95-E2	5.5 L 1.45 U.S.gals 1.21 Imp.gals

(1) Drain Plug

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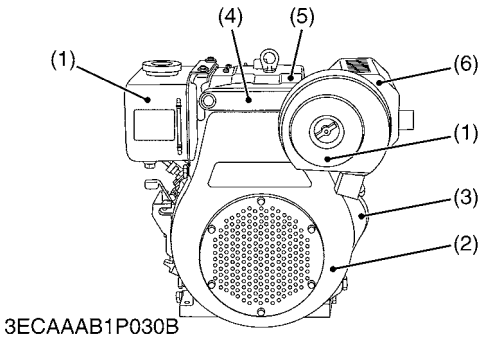
(2) External Components



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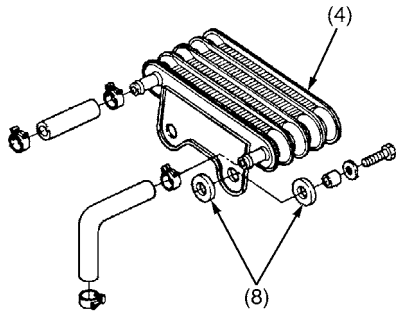

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External Components

1. Remove the following external components.

(When reassembling)

- **Oil Cooler**

■ NOTE

- **Be sure to fit the anti-vibration rubber (8) in position.**

(1) Air Cleaner
(2) Spiral Case
(3) Cell Starter
(4) Oil Cooler
(5) Intake Air Manifold
(6) Muffler
(7) Fuel Tank
(8) Anti-vibration Rubber

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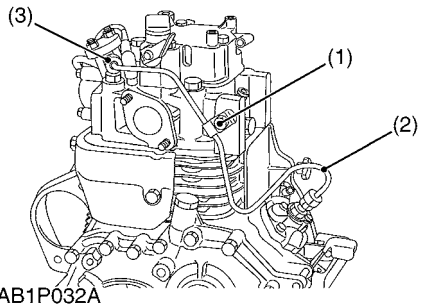
(3) Cylinder Head and Valves



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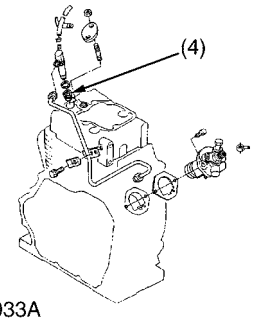

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Injection Pipe and Nozzle Holder

1. Loosen the clamp mounting screw (1).
2. Remove the injection pipe (2).
3. Remove the nozzle holder (3).

(Heat seal type)

4. Remove the nozzle heat seal.

(When reassembling)

■ NOTE

- **Tighten up the nozzle holder mounting nuts evenly.**
- When reassembling the nozzle holder, take care that no carbon or dirt gets in.
- Replace the copper gasket with a new one.

(Heat seal type)

- Replace the copper gasket and heat seal with new one.

Tightening torque	Retainer mounting nut	13.7 to 17.6 N·m 1.4 to 1.8 kgf·m 10.1 to 13.0 ft-lbs

(1) Pipe Clamp Mounting Screw
(2) Injection Pipe
(3) Nozzle Holder
(4) Heat Seal

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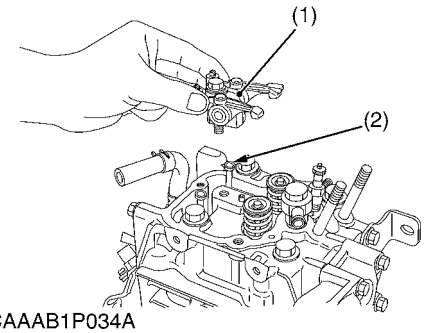

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Cylinder Head Cover and Rocker Arm Bracket

1. Remove the cylinder head cover.
2. Remove the rocker arm bracket (1) and rocker arms together.
3. Pull out the push rods (2).

(1) Rocker Arm Bracket (2) Push Rod

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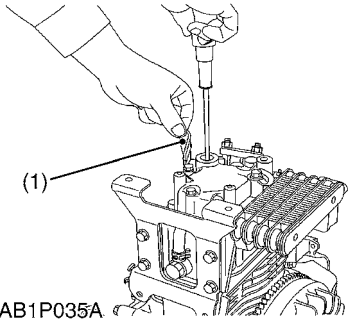
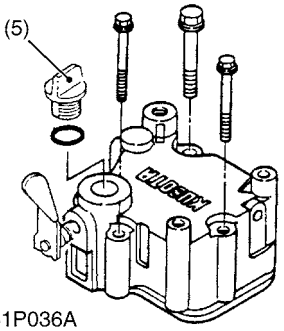


3ECAAAB1P035A

Adjusting Decompression Device

1. Align the "**T**" mark on the flywheel with the mark on the fin at the top dead center in the compression stroke.
2. Remove the head cover, and draw out the seal plug (5) from inside with due care. Place the head cover again in position and tighten up the screws to the specified torque.
3. Pull the decompression lever (1) to the operating position.
4. Loosen the lock nut (3) and screw in the decompression adjusting screw (2) until it contacts the rocker arm (4).
5. From the position where the adjusting screw contacts the rocker arm, further screw in the adjusting screw by one and a half turns.
6. Tighten the lock nut.
7. After adjustment, make sure that the piston does not push up the valve when slightly turning the flywheel with the decompression lever.
8. Apply Three-Bond 1501 or equivalent around the seal plug, and install it in place. If the plug is loose, replace it with a new one.



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(1) Decompression Lever (3) Lock Nut
(2) Decompression Adjusting Screw (4) Rocker Arm
(5) Oil Plug

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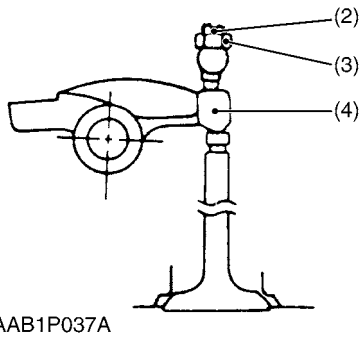

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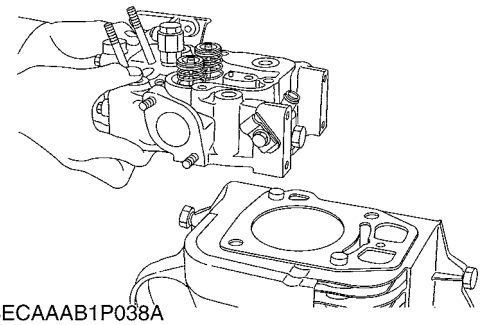
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Cylinder Head

1. Remove the glow plug first to prevent the damage of it.
2. Remove four cylinder head bolts.
3. Tap the cylinder head with plastic or wooden hammer to separate it from cylinder block.

(When reassembling)

- Replace the head gasket with a new one.
- Tighten the cylinder head bolts gradually after applying engine oil.

Tightening torque	Cylinder head mounting bolts	OC60-E2	51.9 to 56.8 N·m 5.3 to 5.8 kgf·m 38.3 to 42 ft-lbs
		OC95-E2	68.6 to 73.6 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 ft-lbs

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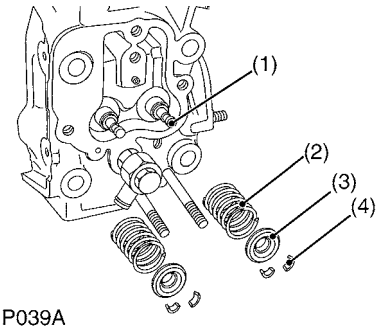

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Valves

1. Remove the valve spring collet (4) with a valve lifter.
2. Remove the valve spring retainers (3), valve spring (2) and valve (1).

(When reassembling)

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets lightly tap the stem to assure proper fit with a plastic hammer.

(1) Valve
(2) Valve Spring
(3) Valve Spring Retainer
(4) Valve Spring Collet

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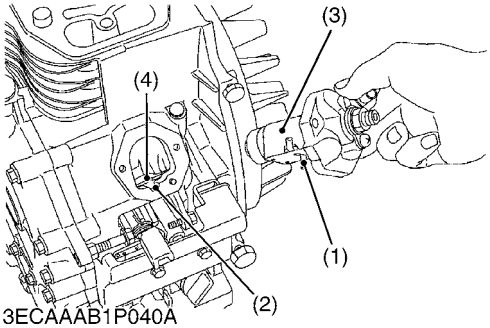
(4) Injection Pump and Injection Nozzle



3ECAAAB1P040A

Injection Pump

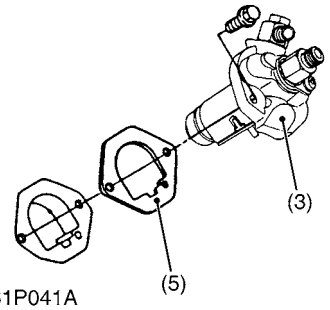
1. Remove the fuel inlet pipe.
2. Remove the injection pump mounting screw.
3. Align the control rack pin (1) with the notch (2) on the crank case, and remove the injection pump (3).
4. Remove the injection pump shims.
5. In principle, the injection pump should not be disassemble.

(When reassembling)

- When installing the injection pump, insert the control rack pin (1) firmly into the groove (4) of the fork lever.
- Addition or reduction of one shim delays or advances the injection timing by 0.018 to 0.026 rad (1° to 1.5°).

■ IMPORTANT

- **Insert the same number of shims (5) as used before between crank case and pump, and then check the injection timing.**



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(1) Control Rack Pin
(2) Notch
(3) Injection Pump
(4) Groove
(5) Shim

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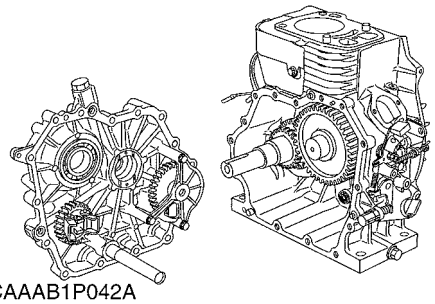
(5) Side Cover



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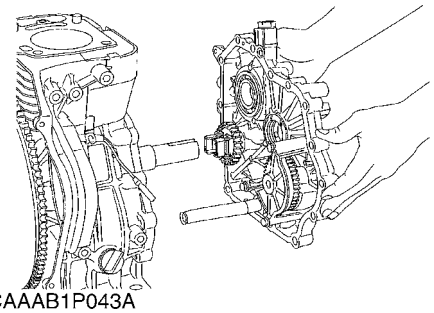

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Side Cover

1. Remove the side cover mounting screws.
2. Tap the side cover lightly with plastic or wooden hammer to separate it from cylinder block.
3. Hold the side cover with a hand and push the end of crankshaft with thumbs to remove the side cover.

■ NOTE

- **The side cover is fixed at two places by straight pins and thus cannot be removed easily. Never try to pry it open with a screwdriver, etc.**
- **Remove the cover in parallel to the PTO shaft carefully to prevent the oil seal from scraping the lip surface of the oil seal.**
- **When the side cover cannot remove due to the camshaft comes out together with side cover, lift the both tappets of intake and exhaust from injection pump installing place.**

(When reassembling)

- There is no match marks on the balancer gear. Take the following steps to install it.

1. Level the crankcase.
2. Place the piston to the top dead center.
3. Hold the side cover with both hands and make sure the balancer weight faces straight downward.
4. Install the side cover, ensuring the oil seal's lip does not come off.

■ NOTE

- **When fitting the side cover, be sure to use the oil sealing guide to prevent the oil sealing against peel-off and other damages.**

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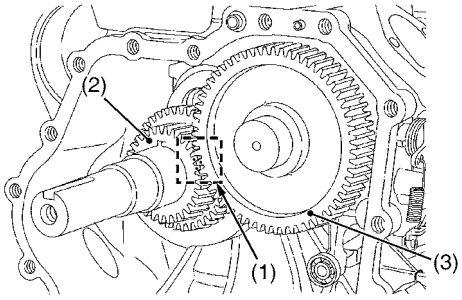

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Timing Gear

(When reassembling)

- The alignment marks (1) of the crank gear (2) and the cam gear (3) must come together when the cam gear is installed.

(1) Alignment Marks
(2) Crank Gear
(3) Cam Gear

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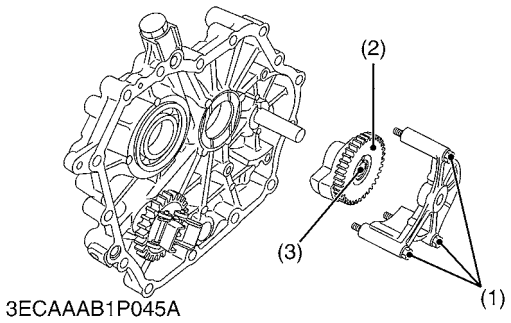

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Balancer

1. Remove the balancer case mounting screws (1).
2. Take out the balancer (2).

(When reassembling)

- Clean up the balancer needle bearing (3) and balancer shaft (at the side cover), and apply oil to them.
- Make sure the needle bearing turns smoothly. Install the balancer onto the balancer shaft from the balancer side. Finally place the balancer casing in position.

■ NOTE

- **Install the balancer with the gear facing toward the balancer casing. See the picture.**
- **Be sure that the balancer turns smoothly.**

■ IMPORTANT

- **For replacing the bearing, clean up a new bearing and the drive-in opening. Force the bearing into position with its side mark facing outward.**

Side Clearance	Factory spec.	0.12 to 0.37 mm 0.0047 to 0.0146 in.

(1) Balancer Case Mounting Screw (3) Balancer Needle Bearing
(2) Balancer

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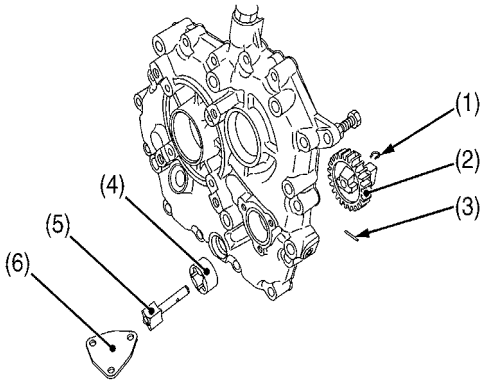

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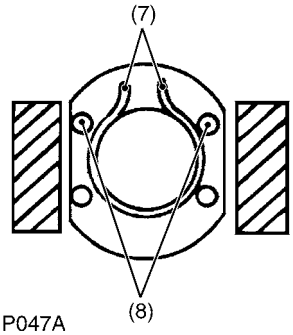

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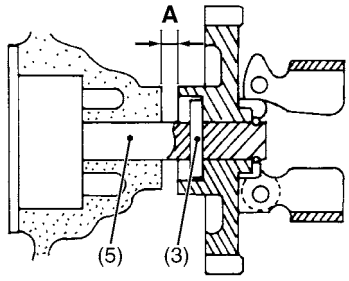

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Governor Gear and Oil Pump

1. Remove the stopper (1).
2. Pull out the gear (2).
3. Remove the spring pin (3).

- The circumference of the spring pin hole swells out when the pin has been taken out. Correct this area flat.

4. Remove the three screws retaining the oil pump cover.
5. Push out the inner rotor shaft (5) and outer rotor (4).

(When reassembling)

- Make sure the slit of the spring pin (3) faces the oil pump.
- Make sure the spring pin stretches at equal distance left and right out of the shaft.
- Place the stopper so that its knob (7) be fitted in between the two projection (8) of the gear. See the figure.
- Apply oil each section.

■ NOTE

- **Finally pull the gear to see if it is tight in position.**

Clearance between gear case and governor gear **A**	OC60-E2	1.5 mm 0.059 in.
	OC95-E2	4.5 mm 0.177 in.

(1) Stopper
(2) Governor Gear
(3) Spring Pin
(4) Outer Rotor
(5) Inner Rotor
(6) Cover
(7) Knob
(8) Projection

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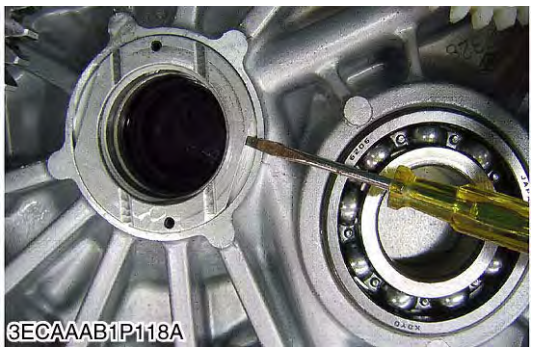

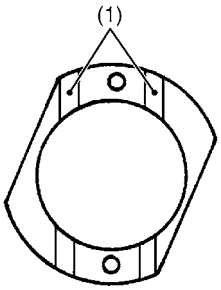

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Side Bearing

(When removing)

- Lift up the side bearing by the flat screw driver as shown in figure.

(When reassembling)

- Make sure the oil groove (1) in the side bearing comes toward the crank gear.
- Make sure the anti-fall spring pin (2) for the side bearing is not stretching out of the bearing surface.
- Keep the spring pin head **A** above the surface (not greater than the side bearing thickness as table below).

■NOTE

- **Do not confuse the above side bearing with that at the crankcase.**

Spring pin head **A**	OC60-E2	1.5 to 1.7 mm 0.059 to 0.067 in.
	OC95-E2	1.7 to 2.2 mm 0.067 to 0.087 in.

(1) Oil Groove (2) Spring Pin

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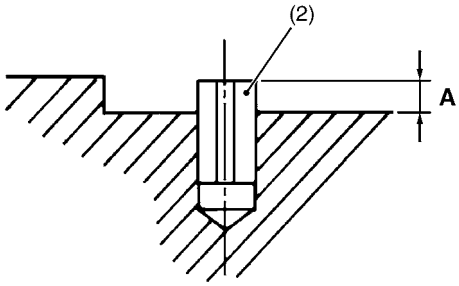

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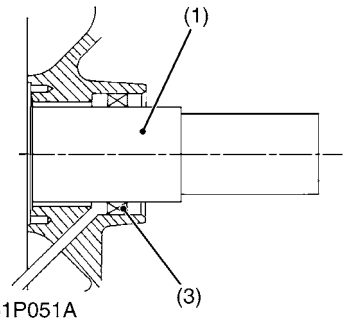
[A]



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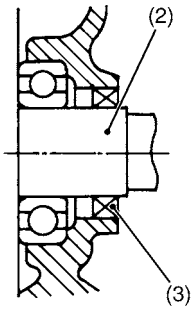

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Oil Seal

(When reassembling)

- Place the side cover on the crankcase and drive in the oil seal (3) with a special tool. (Apply oil to the inner and outer surfaces of the oil seal beforehand.)
- The oil seal mounting hole is used for the socket and spigot joint. Keep this hole 7 mm below the side cover as illustrated.

■NOTE

- **Use a special tool, because otherwise the oil hole may be covered.**

(1) Crankshaft **[A] Direct Coupling**
(2) Camshaft **[B] 1/2 Camshaft Reduction**
(3) Oil Seal

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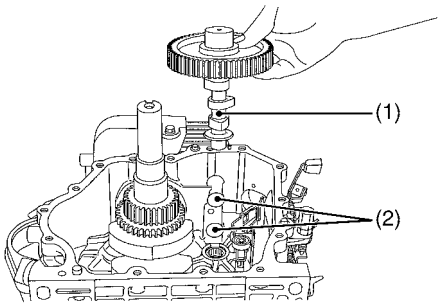
(6) Piston and Connecting Rod



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Camshaft and Tappet

1. Pull out the camshaft (1) and the cam gear as a unit.
2. Remove the tappet (2).

■ NOTE

- **Intake and exhaust tappets are of an identical shape, and need to be distinguished with a tag, etc.**

■ IMPORTANT

- **Force the bearing into position with its side mark facing outward.**

(1) Camshaft (4) Tappet

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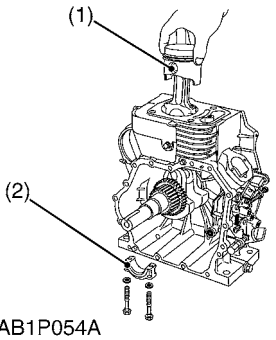

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Piston and Connecting Rod

1. Remove the cap (2) at the big end of the connecting rod.
2. Put the parting mark (↑) (4) on the piston head as shown in the figure.
3. Pull out the piston (1) from the cylinder head side.

(When reassembling)

- Insert the piston with a piston ring compressor.

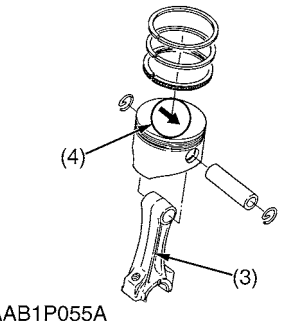
■ IMPORTANT

- **Be sure to assemble the connecting rod so that the casting mark (F) (3) of the connecting rod faces toward the flywheel.**
- **Align the mark on the side of the connecting rod and cap.**

(When reassembling piston and connecting rod)

■ IMPORTANT

- **When installing the piston pin, immerse the piston in 100 ℃ (212 ℉) oil for 10 to 15 minutes and insert the piston pin to the piston.**
- **When installing the connecting rod to the piston, align the mark (3) on the connecting rod to the parting mark (4).**



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(1) Piston (3) Casting Mark **F**
(2) Connecting Rod Cap (4) Parting Mark

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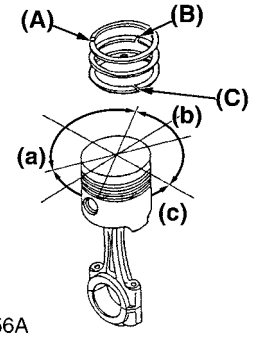

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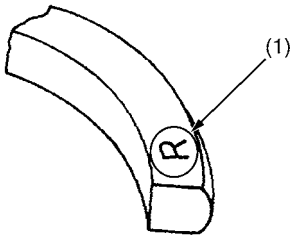

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Piston Ring

(When reassembling)

■ IMPORTANT

- **Assemble the piston ring with the manufacture's mark's (1) facing up (As shown in the figure).**
- **When inserting the piston into the cylinder, place the gap of the compression ring 1 on the opposite side of the combustion chamber and stagger the gaps of the compression ring 2 and oil ring making a right angle from the gap of the compression ring 1.**

(1) Manufacture's Mark's

(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(a) 2.09 rad (120°)
(b) 2.09 rad (120°)
(c) 2.09 rad (120°)

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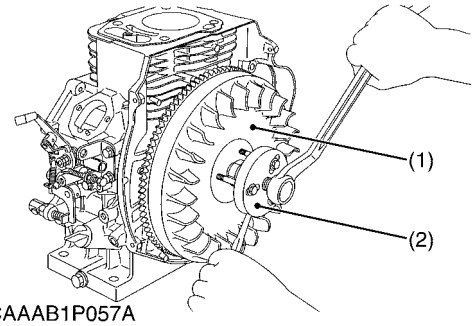
(7) Crankshaft



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Flywheel

1. Loosen the flywheel nut until it is nearly flush with the crankshaft end.
2. Set a flywheel puller (2) and remove it with the flywheel (1).

(When reassembling)

- The tapered section of the flywheel must be free of oil, etc. The rotor magnet must be free of foreign materials.

Tightening torque	Flywheel mounting nut	OC60-E2	137 to 157 N·m 14 to 16 kgf·m 101 to 116 ft-lbs
		OC95-E2	235 to 255 N·m 24 to 26 kgf·m 174 to 188 ft-lbs

(1) Flywheel (2) Flywheel Puller

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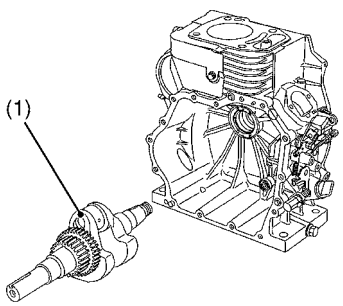

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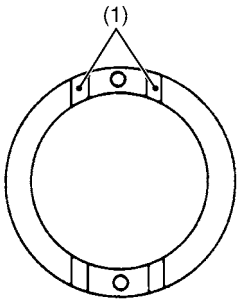
Crankshaft

1. Remove the flywheel key.
2. Pull out the crankshaft (1).

(1) Crankshaft

0000009242E



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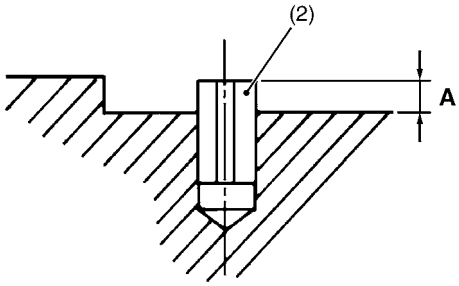

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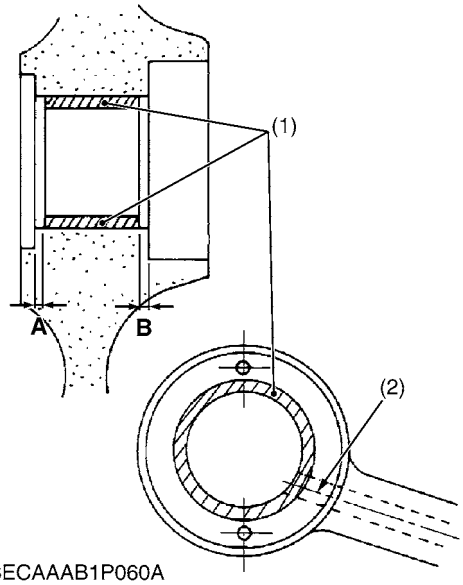

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Side Bearing (Crank Case)

(When removing)

- Lift up the side bearing by the flat screw driver as shown in figure.

(When reassembling)

- Make sure the oil groove (1) in the side bearing comes toward the crank gear.
- Make sure the anti-fall spring pin (2) for the side bearing is not stretching out of the bearing surface.
- Keep the spring pin head **A** above the surface (not greater than the side bearing thickness of 2 mm).

■NOTE

- **Do not confuse the above side bearing with that at the crankcase.**

Spring pin head **A**	OC60-E2	1.5 to 1.7 mm 0.059 to 0.067 in.
	OC95-E2	1.7 to 2.2 mm 0.067 to 0.087 in.

(1) Oil Groove (2) Spring Pin

0000009243E

Main Bearing (Crank Case and Side Cover)

1. Remove the main bearing (1) with special tool.

(When reassembling)

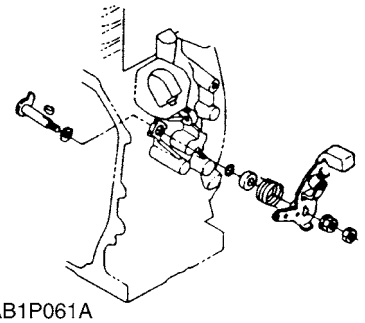
- Apply engine oil to all the fitting surface.
- As shown at left, be sure to align the oil hole (2) on the crank case and the bearing.
- Drive in the bearing **A** and **B** deep below the side bearing mounting face as shown at left.

Model		A	B
OC60-E2	Crank Case	1.0 mm 0.039 in.	1.0 mm 0.039 in.
	Side Cover		
OC95-E2	Crank Case	0.5 mm 0.020 in.	1.0 mm 0.039 in.
	Side Cover	0.5 mm 0.020 in.	0.5 mm 0.020 in.

(1) Main Bearing (2) Oil Hole

0000009244E

(8) Speed Control Lever and Governor Lever



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Speed Control Lever and Speed Adjust Lever Shaft

(When reassembling)

- Install the O-ring onto the crankcase, and apply oil. Place the flat washer, friction plate, key and spring in this order as shown in the figure.
- Hook the spring as illustrated.

1) Hooking to the speed control lever (1).
2) Hooking to the crankcase (2).

(1) Speed Control Lever (2) Crankcase

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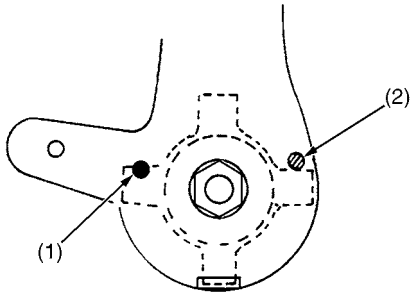

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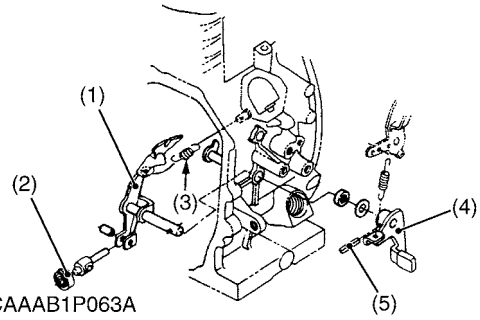
Governor Lever 1, 3 and Governor Spring (OC60-E2)

(When reassembling)

- Clean up the governor lever shaft and the shaft hole. Apply oil to them.
- Install the oil seal onto the crankcase.
- Make sure the bearing (2) of the governor lever 1 (1) moves smoothly.
- Put the governor lever into the hole.
- Hook the idle spring (3) into position.



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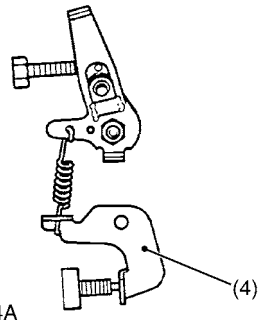
■NOTE

- **Position the stop lever of the speed control lever shaft behind the governor lever 1 (1). See the figure.**
- **Install the governor lever 3 (4) from outside the crankcase.**
- **Put the spring pin (5) and see if there is a clearance of 0.1 to 0.3 mm in the axial direction.**
- **Pull the speed control lever toward the stop position (toward the side cover), and hook the governor spring.**



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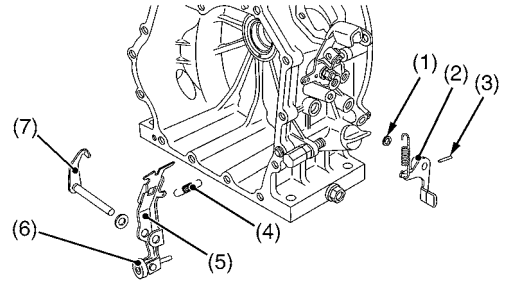
■NOTE

- **Hook the governor spring to the governor lever 3 (4) first and then into the second hole from outside in the speed lever.**

(1) Governor Lever 1 (4) Governor Lever 3
(2) Bearing (5) Spring Pin
(3) Idle Spring

0000009246E



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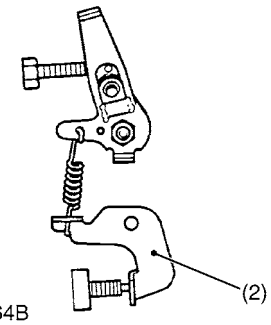

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Governor Lever 1, 3 and Governor Spring (OC95-E2)

(When reassembling)

- Clean up the governor lever 2 (7) and the shaft hole. Apply oil to them.
- Install the oil seal (1) onto the crankcase.
- Make sure the bearing (6) of the governor lever 1 (5) moves smoothly.
- Assemble the governor lever 1 (5) and 2 (7).
- Put the governor lever 2 into the crankcase hole.
- Hook the idle spring (4) into position.

■ NOTE

- **Position the stop lever of the speed control lever shaft behind the governor lever 1 (5). See the figure.**
- **Install the governor lever 3 (2) from outside the crankcase.**
- **Put the spring pin (3) and see if there is a clearance of 0.1 to 0.3 mm in the axial direction.**
- **Pull the speed control lever toward the stop position (toward the side cover), and hook the governor spring.**

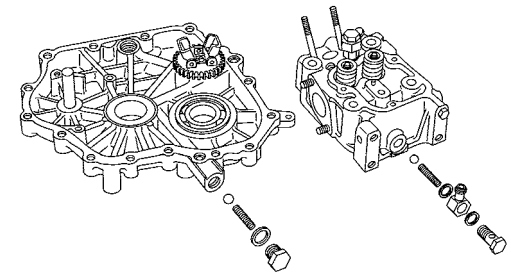
■ NOTE

- **Hook the governor spring to the governor lever 3 (2) first and then into the second hole from outside in the speed lever.**

(1) Oil Seal
(2) Governor Lever 3
(3) Spring Pin
(4) Idle Spring
(5) Governor Lever 1
(6) Bearing
(7) Governor Lever 2

0000009247E

(9) Relief Valve



3ECAAAB1P084A

Relief Valve

1. Two relief valves are installed, one is on the top of the side cover and the other one is in cylinder head.
2. Remove the eye joint bolt and take out the spring and ball.

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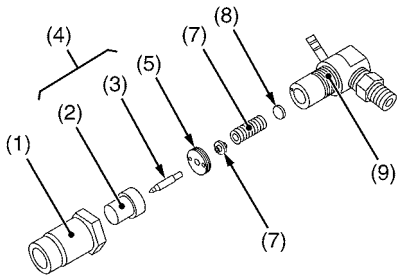
(10)Injection Nozzle



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Nozzle Holder

1. Secure the nozzle holder body (9) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod, noting its direction.

Tightening torque	Nozzle holder body and nut	97 to 116 N·m 10 to 12 kgf·m 73 to 88 ft-lbs

■ IMPORTANT

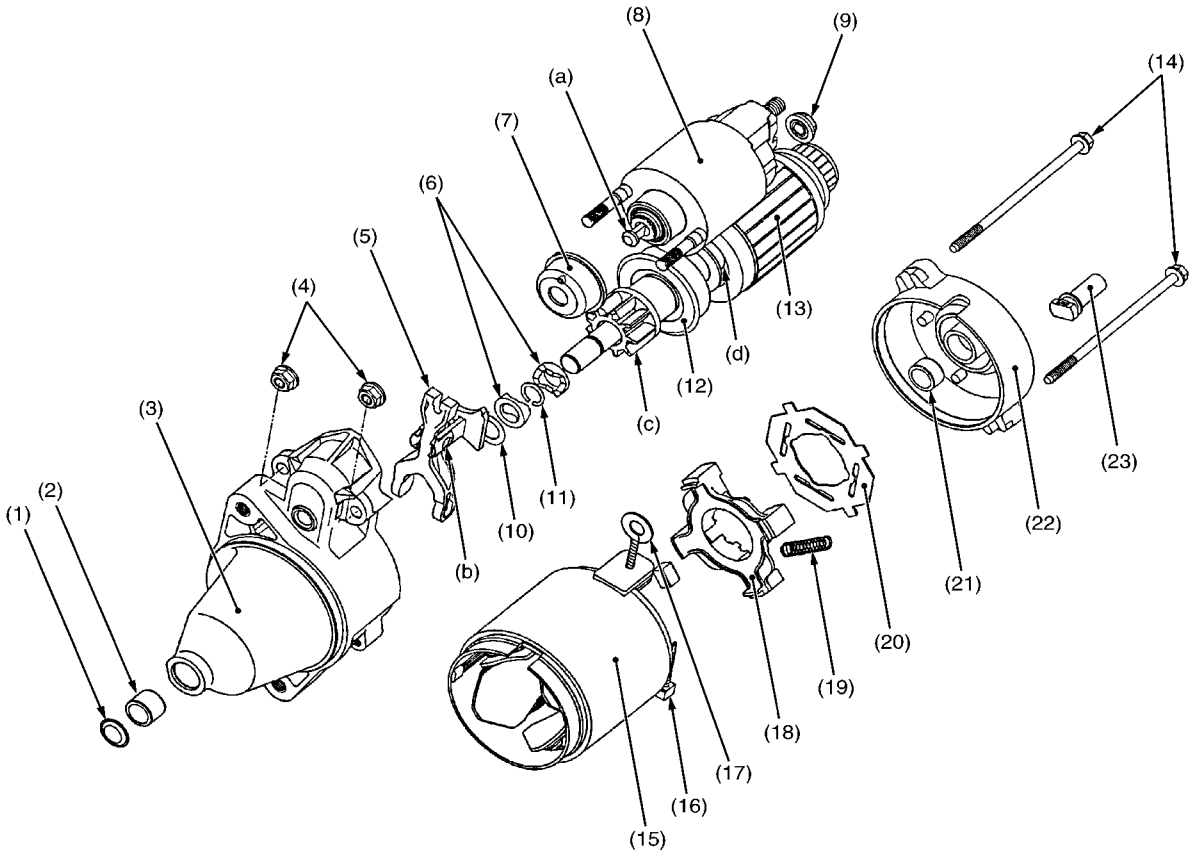
- **Since the nozzle piece is precision finished, a piece of wood must be used to remove carbon deposit. Do not use pieces of metal.**
- **After assembling the nozzle, be sure to adjust the fuel injection pressure.**

(1) Nozzle Holder
(2) Nozzle Body
(3) Needle Valve
(4) Nozzle Piece
(5) Distance Piece
(6) Push Rod
(7) Nozzle Holder
(8) Adjusting Washer
(9) Nozzle Holder Body

0000009250E

(11)Starter

Disassembling Starter (OC60-E2)



3ECAAAB1P095A

(1)	Plug	(6)	Pinion Stop Nut	(12)	Overrunning Clutch	(18)	Brush Holder
(2)	Bushing	(7)	Gasket	(13)	Armature	(19)	Brush Spring
(3)	Starter Drive Housing	(8)	Magnet Switch	(14)	Through Bolt	(20)	Insulator
(4)	Magnet Switch Mounting Nut	(9)	Nut	(15)	Yoke	(21)	Bushing
		(10)	Washer	(16)	Brush	(22)	End Frame
(5)	Drive Lever	(11)	Snap Ring	(17)	Connecting Lead	(23)	Cover

1. Unscrew the mounting nut (9), and disconnect the connecting lead (17).
2. Unscrew the magnet switch mounting nut (4).
3. Remove the magnet switch (8) by sliding it up so that it is disconnected from the drive lever (5).
4. Unscrew the two through bolts (14).
5. Remove the end frame (22).
6. Remove the insulator (20).
7. Remove the brush (16) and brush spring (19), and pull out the brush holder (18).
8. Draw out the yoke (15) from the starter drive housing (3).
9. Draw out the armature (13) with the drive lever (5).

CAUTION

- **When removing the insulator (20), from popping out like a bullet.**
- **When removing the brush (16), prevent the brush spring (19) from popping out like a bullet.**

■ **NOTE**

- **Do not damage to the brush and commutator.**

(When reassembling)

- Apply grease (Denso No.50 or equivalent) to the parts indicated in the figure.
  - **(a)** Joint of Magnet Switch
  - **(b)** Drive Lever
  - **(c)** Teeth of Pinion Gear
  - **(d)** Armature Shaft

CAUTION

- **When installing the brush springs (19), from popping out like a bullet.**

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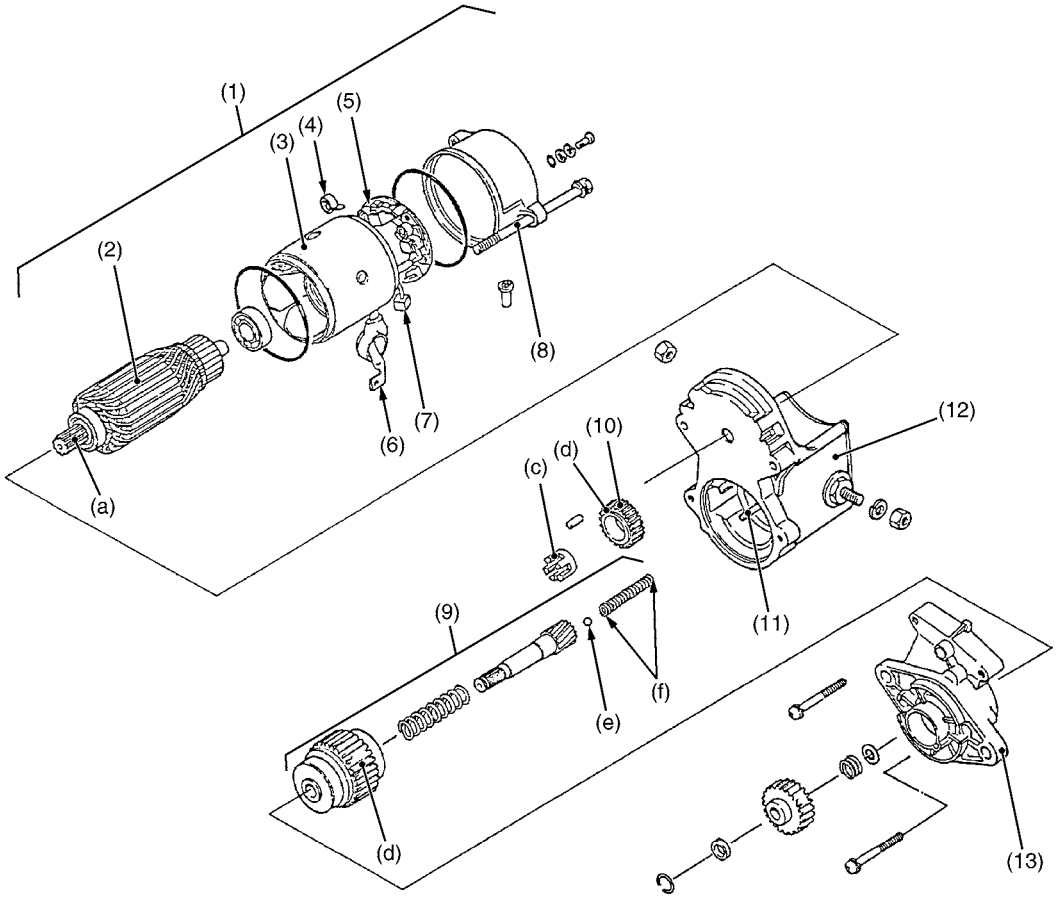
Disassembling Starter (OC95-E2)



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(1)	Motor	(5)	Brush Holder	(8)	Through Bolt	(11)	Plunger
(2)	Armature	(6)	Connecting Lead	(9)	Overrunning Clutch	(12)	Magnet Switch
(3)	Yoke	(7)	Brush	(10)	Idle Gear	(13)	Housing
(4)	Spring						

1. Disconnect the connecting lead (6).
2. Remove the two through bolts (8).
3. Detach the motor (1).
4. Draw out the brush (7) while holding the spring (4) up.
5. Remove the brush holder (5).
6. Draw out the armature (2) from the yoke (3).
7. Remove the housing (13).
8. Remove the idle gear (10) and the overrunning clutch (9).
9. Remove the end cover of magnet switch (12).
10. Remove the plunger (11).

■ **NOTE**

- **Do not damage to the brush and commutator.**

(When reassembling)

- Apply grease (Denso No.50 or equivalent) to the parts indicated in the figure.
  - **(a)** Armature Spline
  - **(b)** Teeth of idle gear
  - **(c)** Roller Retainer
  - **(d)** Clutch Gear
  - **(e)** Steel Ball
  - **(f)** End Surface of Spring

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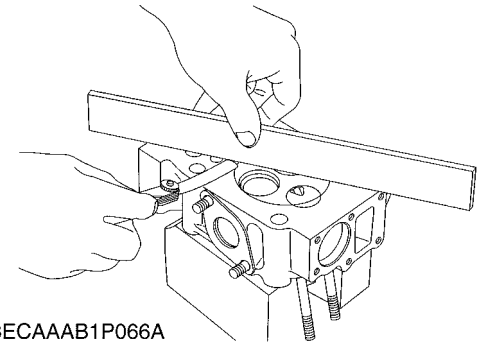
[3] SARVICING

(1) Clinder Head and Valves



3ECAAAB1P066A

Cylinder Head Surface Flatness

1. Thoroughly clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the photo.
3. Measure the clearance with a thickness gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ IMPORTANT

- **Do not place the straight edge on the combustion chamber.**

Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.

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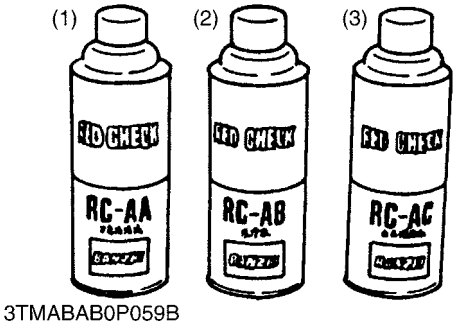

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Cylinder Head Flaw

1. Prepare an air spray red check.
2. Clean the surface of the cylinder head with the detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with the white developer (3).
6. If flawed, it can be identified as red marks.

(1) Red Permetive Liquid (3) White Developer
(2) Detergent

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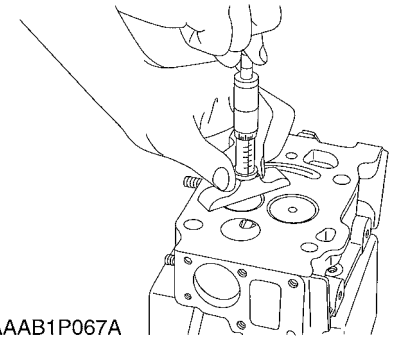

3ECAAAB1P067A

Valve Recessing

1. Clean the cylinder head, the valve face and seat.
2. Insert the valve into guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit replace the valve.
5. If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

Valve recessing	Factory spec.	0.60 to 0.85 mm 0.0236 to 0.0335 in.
	Allowable limit	1.3 mm 0.0512 in.

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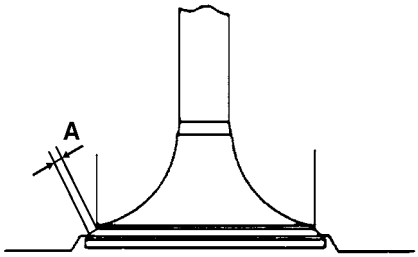

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Width of Contact between Valve and Valve Seat

1. Check the contact between the valve face and valve seat.
2. If the contact is uneven or the width of contact **A** is excessively large. Either repair or replace the valve and valve seat. Lap the valve on its seat with lapping compound.

Valve seat width **A**	Factory spec.	2.12 mm 0.0835 in.

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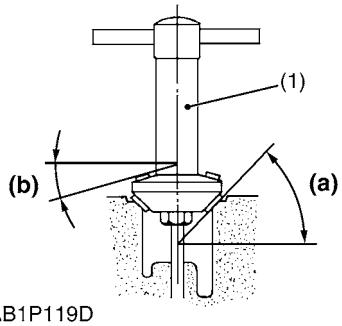

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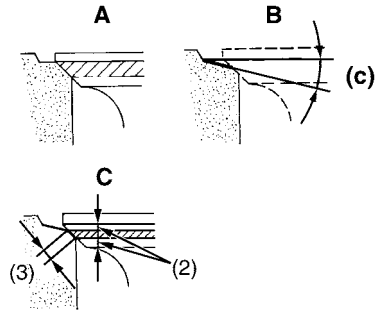

3EEABAB1P120C

Correcting Valve Seat

1. Slightly correct the seat surface with a 0.79 rad (45°) or 0.52 rad (30°) valve seat cutter (1).
2. Fitting the valve, check the contact position of the valve face and seat surface with red lead. (Visual check)
   If the valve is used for a long period of time, it deviates to the upper part of the valve face, causing the seat to contact.
3. Grind the seat surface with a 0.26 rad (15°) valve seat cutter so that the valve seat width contacts in the same dimensions from the center of the valve face width.
4. Repeatedly lap the valve and seat until the seated rate is more than 70%.

(1) Valve Seat Cutter
(2) Identical Dimensions
(3) Valve Seat Width

A : Check Contact
B : Correct Seat Width
C : Check Contact

(a) 0.79 rad (45°) or 0.52 rad (30°)
(b) 0.26 rad (15°)
(c) 0.26 rad (15°)

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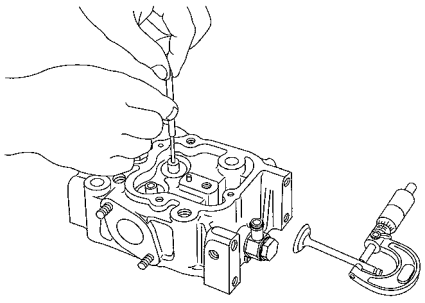

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Clearance between Valve Stem and Valve Guide

1. Measure the valve stem O.D. with an outside micrometer.
2. Measure I.D. of the cylinder head valve guide at the most worn part with a small hole gauge. and find the oil clearance.
3. If the clearance exceeds the allowable limit, replace the valve guide and valve.

Clearance between valve stem and valve guide	Factory spec.	OC60-E2	0.030 to 0.057 mm 0.0012 to 0.0022 in.
		OC95-E2	0.035 to 0.065 mm 0.0014 to 0.0026 in.
	Allowable limit	OC60-E2	0.1 mm 0.0039 in.
		OC95-E2	

Valve stem O.D.	Factory spec.	OC60-E2	5.968 to 5.980 mm 0.2350 to 0.2354 in.
		OC95-E2	6.960 to 6.975 mm 0.2740 to 0.2746 in.

Valve guide bore I.D.	Factory spec.	OC60-E2	6.010 to 6.025 mm 0.2366 to 0.2372 in.
		OC95-E2	7.010 to 7.025 mm 0.2760 to 0.2766 in.

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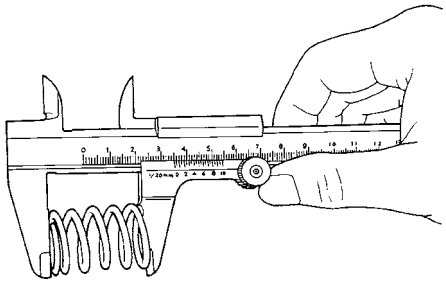

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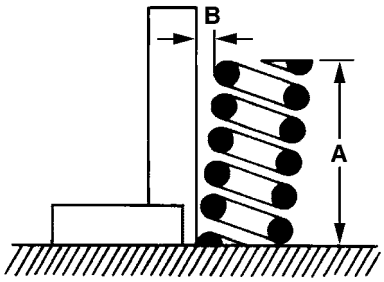
Free Length and Tilt of Valve Spring

1. Measure the valve spring with vernier calipers.
2. If the measurement is less than the allowable limit, replace it.
3. Place the spring on the surface plate and square at its side.
4. Measure the maximum distance **A** (See figure) by rotating spring.
5. If the measurement exceeds the allowable limit, replace the valve spring.

Valve spring free length **A**	Factory spec.	OC60-E2	31.3 to 31.8 mm 1.2323 to 1.2520 in.
		OC95-E2	36.5 to 37.0 mm 1.4370 to 1.4567 in.
	Allowable limit	OC60-E2	31.0 mm 1.2205 in.
		OC95-E2	36.0 mm 1.4173 in.

Tilt **B**	Allowable limit	1.2 mm 0.0472 in.



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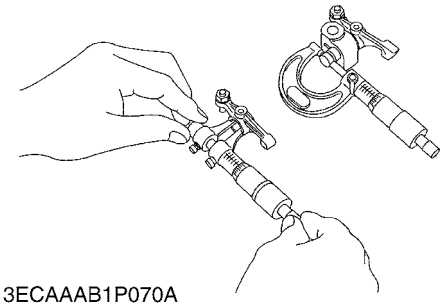

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Oil Clearance between Rocker Arm Shaft and Shaft Hole

1. Measure the rocker arm shaft O.D. with an outside micrometer.
2. Measure the rocker arm shaft hole I.D. with an inside micrometer, and calculate the oil clearance.
3. If the clearance still exceeds the allowable limit, replace the rocker arm.
4. If the clearance still exceeds the allowable limit after replacing the new rocker arm, replace the rocker arm shaft.

Oil clearance between rocker arm shaft and shaft hole	Factory spec.	0.016 to 0.045 mm 0.0006 to 0.0018 in.
	Allowable limit	0.12 mm 0.0047 in.

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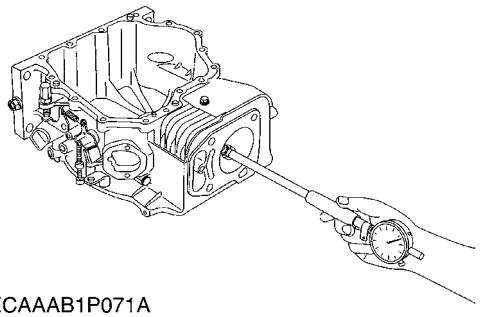

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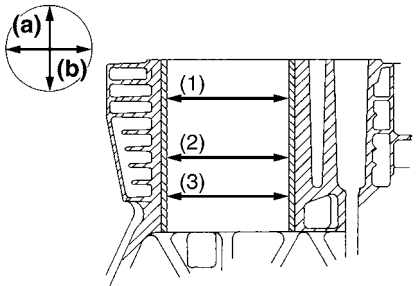
Cylinder Wear

1. Measure the I.D. of cylinder liner with a cylinder gauge at 6 points as shown in the figure to obtain the maximum wear.
2. If the measurement exceeds the allowable limit, the cylinder liner needs to be bored to an oversize, and then hone-finished.
3. When the oversize allowable limit is exceeded, replace the cylinder block.

Cylinder liner I.D.	Factory spec.	OC60-E2	72.000 to 72.019 mm 2.8346 to 2.8354 in.
		OC95-E2	83.018 to 83.038 mm 3.2684 to 3.2692 in.
	Allowable limit	OC60-E2	72.10 mm 2.839 in.
		OC95-E2	83.10 mm 3.272 in.



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[Oversize Cylinder Liner (0.25 OS)]

Oversize cylinder liner I.D.	Factory spec.	OC60-E2	72.250 to 72.269 mm 2.8445 to 2.8452 in.
		OC95-E2	83.268 to 83.288 mm 3.2783 to 3.2791 in.

- Replace the piston and piston rings with oversize ones.

Oversize	Part Name	Model	Code No.
0.25 OS	Piston	OC60-E2	11420-21913
		OC95-E2	11460-21911

Oversize	Part Name	Model	Code No.
0.25 OS	Piton ring assembly	OC60-E2	11420-21092
		OC95-E2	11460-21091

(1) Top
(2) Middle
(3) Bottom

(a) Right-angled to Piston Pin
(b) Piston Pin Direction

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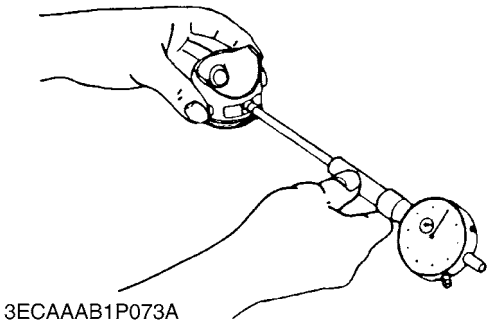
(2) Piston and Connecting Rod



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Piston Pin Bore

1. Measure the Piston boss I.D. in both the vertical and horizontal direction with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace it.

Piston boss I.D.	Factory spec.	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.
		OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.
	Allowable limit	OC60-E2	20.03 mm 0.7886 in.
		OC95-E2	23.03 mm 0.9067 in.

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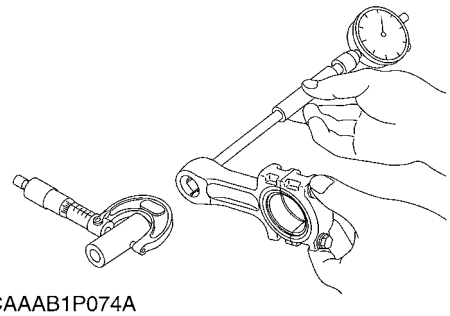

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Oil Clearance between Piston Pin and Small End Bushing

1. Measure the piston pin O.D. and small end bushing I.D. with a micrometer. Then, calculate the clearance.
2. If the oil clearance exceeds the allowable limit, replace them.

Oil clearance between piston pin and small end bushing	Factory spec.	0.012 to 0.040 mm 0.0005 to 0.0016 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory spec.	OC60-E2	20.000 to 20.013 mm 0.7874 to 0.7879 in.
		OC95-E2	23.000 to 23.013 mm 0.9055 to 0.9060 in.
Small end bushing I.D.	Factory spec.	OC60-E2	20.025 to 20.040 mm 0.7884 to 0.7890in.
		OC95-E2	23.025 to 20.040 mm 0.9065 to 0.9071 in.

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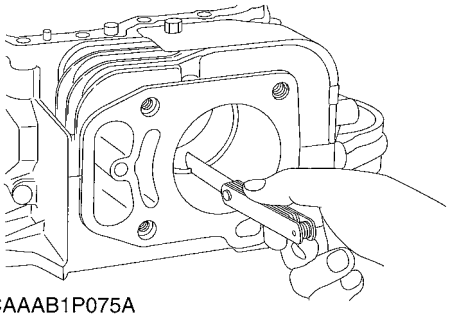

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Piston Ring Gap

1. Insert the piston ring into the cylinder and push down to the bottom, where the wear is least, with a piston head.
2. Measure the ring gap with a thickness gauge.
3. If the ring gap exceeds the allowable limit, replace the ring.

Piston ring gap	Top ring	Factory spec.	OC60-E2	0.15 to 0.30 mm 0.0059 to 0.0118 in.
			OC95-E2	
		Allowable limit	OC60-E2	1.2 mm 0.0472 in.
			OC95-E2	
	Second ring	Factory spec.	OC60-E2	0.25 to 0.45 mm 0.0098 to 0.0177 in.
			OC95-E2	0.30 to 0.50 mm 0.0118 to 0.0197 in.
		Allowable limit	OC60-E2	1.2 mm 0.0472 in.
			OC95-E2	
	Oil ring	Factory spec.	OC60-E2	0.25 to 0.40 mm 0.0098 to 0.0157 in.
		Allowable limit	OC95-E2	1.2 mm 0.0472 in.

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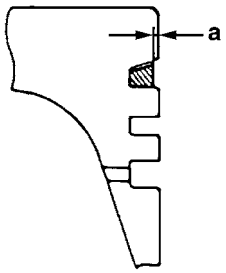
(A)



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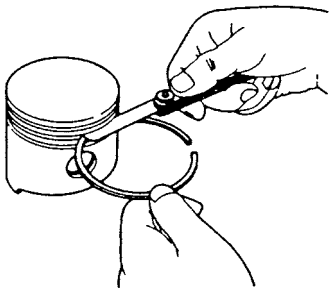

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Clearance between Piston Ring and Piston Ring Groove

1. Remove carbon from the ring grooves.
2. Measure the clearance between the ring and the groove with a thickness gauge.
3. If the clearance exceeds allowable limit, replace the ring since compression leak and oil shortage result.
4. If the clearance still exceeds the allowable limit after replacing the ring, replace the piston.

a	Factory spec.	More than 0.2 mm

Clearance between piston ring and piston ring groove	Factory spec.	Second ring	OC60-E2	0.030 to 0.065 mm 0.0013 to 0.0026 in.
			OC95-E2	0.045 to 0.080 mm 0.0018 to 0.0031 in.
		Oil ring	OC60-E2 OC95-E2	0.020 to 0.055 mm 0.0008 to 0.0022 in.
	Allowable limit	Second ring	OC60-E2 OC95-E2	0.15 mm 0.0059 in.
		Oil ring	OC60-E2 OC95-E2	0.15 mm 0.0059 in.

(A) Top Ring (Key Stone Type) **(B) Second, Oil Ring**

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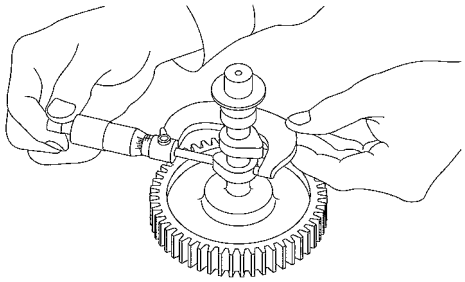
(3) Crankshaft and Camshaft



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Intake and Exhaust Cam Height

1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

Cam heights (IN)	Factory spec.	OC60-E2	27.0 mm 1.0630 in.
		OC95-E2	28.0 mm 1.1024 in.
	Allowable limit	OC60-E2	26.5 mm 1.0433 in.
		OC95-E2	27.5 mm 1.0827 in.
Cam heights (EX)	Factory spec.	OC60-E2	27.0 mm 1.0630 in.
		OC95-E2	30.0 mm 1.1911 in.
	Allowable limit	OC60-E2	26.5 mm 1.0433 in.
		OC95-E2	29.5 mm 1.1614 in.

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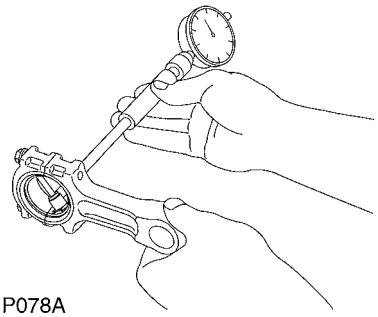

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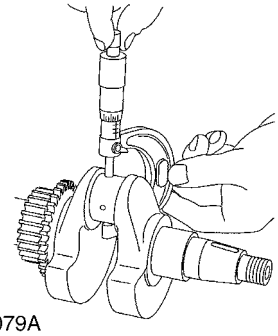
Oil Clearance between Crank Pin and Bearing

1. Measure the crank Pin O.D. and the connecting rod big end bore after tighten the connecting rod screws to the specified torque with a micrometer, and calculate the clearance.
2. If the clearance exceeds the allowable limit, replace the bearing.

(Reference)

- When the crank pin wears further over a long period of use and oil clearance exceeds the allowable limit after replacing the standard bearing, use a undersize bearing. Machine the crank pin according to the precautions.



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Clearance between crank pin and bearing	Factory spec.	0.025 to 0.087 mm 0.0010 to 0.0034 in.
	Allowable limit	0.2 mm 0.0079 in.

Crank Pin O.D.	Factory spec.	OC60-E2	35.959 to 35.975 mm 1.4157 to 1.4163 in.
		OC95-E2	39.959 to 39.975 mm 1.5732 to 1.5738 in.

Crank Pin Bearing I.D.	Factory spec.	OC60-E2	36.000 to 36.046 mm 1.4173 to 1.4191 in.
		OC95-E2	40.000 to 40.046 mm 1.5748 to 1.5766 in.

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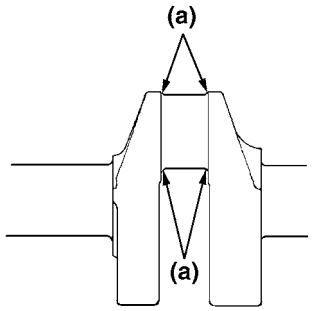

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Correcting Crank Pin

If the standard-size crank pin bearing cannot be employed due to excessive wear of the crank pin, use an undersize crank pin bearing.

For undersize crank pin bearing use, be sure to correct the crank pin.

1. Grind the corner radius (1) of the crank pin precisely.
2. The crank pin surface must be fine-finished to higher than ▽▽▽▽ (0.4-S).

[Undersize crank pin (0.25 US)]

Undersize crank pin O.D.	Factory spec.	OC60-E2	35.709 to 35.725 mm 1.4059 to 1.4065 in.
		OC95-E2	39.709 to 39.725 mm 1.5633 to 1.5640 in.

[Undersize crank pin bearing (0.25 US)]

size	Part Name	Mark	Model	Code No.
0.25 mm U.S.	Undersize crank pin bearing	U.S. 0.25	OC60-E2	11420-22961
			OC95-E2	11460-22961

Dimension **(a)**	Factory spec.	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius

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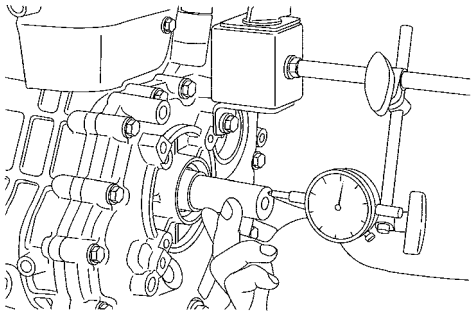
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Crankshaft Side Clearance

1. After a metal plate to the cylinder.
2. Set a dial gauge and push the shaft and measure the side clearance.
3. If the clearance exceeds the allowable limit, replace the bearing.

■ **NOTE**

- **If the clearance still exceeds the allowable limit after replacing the bearing with new one. Use an over size bearing.**

Size	Part Name	Model	Code No.
0.25 mm O.S.	Side Bearing 1	OC60-E2	11420-23951
		OC95-E2	11460-23951
	Side Bearing 2	OC60-E2	11420-23971
		OC95-E2	11460-23971

Side clearance of crankshaft	Factory spec.	0.05 to 0.20 mm 0.0020 to 0.0079 in.
	Allowable limit	0.35 mm 0.0138 in.

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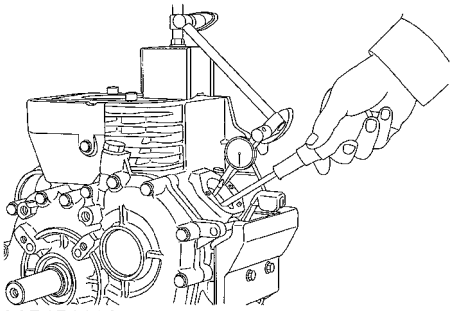
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Camshaft Side Clearance

1. Set a dial indicator (lever type) and put a screwdriver instead through the injection pump mount opening to see if there is a clearance on the right and left of the camshaft.
2. If the clearance exceeds the allowable limit, adjust the clearance with shims.

Side clearance of crankshaft	Factory spec.	OC60-E2	0.05 to 0.20 mm 0.0020 to 0.0079 in.
		OC95-E2	0.05 to 0.25 mm 0.0020 to 0.0098 in.
	Allowable limit		0.35 mm 0.0138 in.

(Reference)

- Thickness of adjusting shims: 0.2 mm (0.079 in.)

Model	Code No.
OC60-E2	11420-16261
OC95-E2	11460-16261

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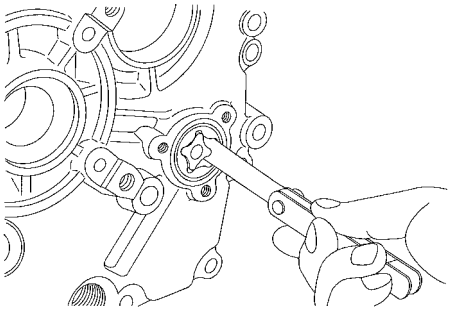
(4) Oil Pump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Rotor Lobe Clearance

1. Measure the clearance between a high point on the inner rotor and high point the outer rotor with a thickness gauge.
2. If the clearance exceeds the factory allowable limit, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory spec.	0.15 mm 0.0059 in.
	Allowable limit	0.20 mm 0.0079 in.

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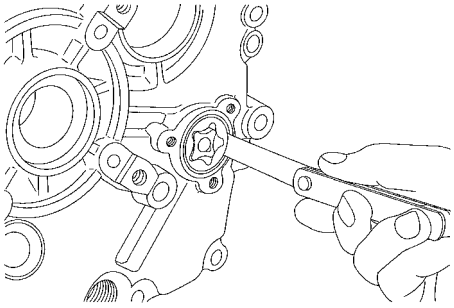
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Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a thickness gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory spec.	0.090 to 0.171 mm 0.0035 to 0.0067in.
	Allowable limit	0.24 mm 0.0079 in.

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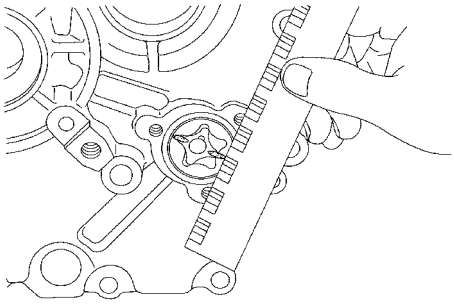

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Clearance between Rotor and Cover

1. Put a strip of press gauge onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the depression of press gauge with a sheet of gauge.
4. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

clearance between rotor and cover	Factory spec.	0.02 to 0.06 mm 0.0008 to 0.0024 in.
	Allowable limit	0.25 mm 0.0098 in.

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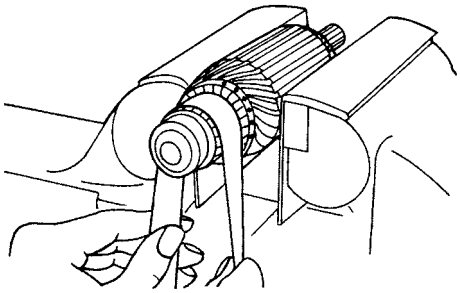
(5) Starter



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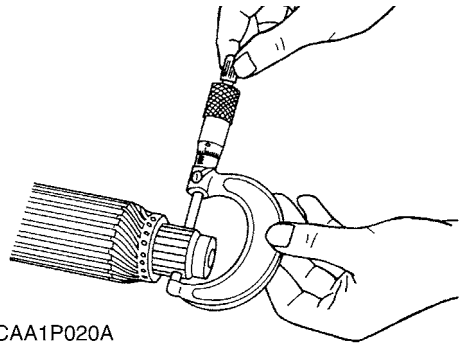

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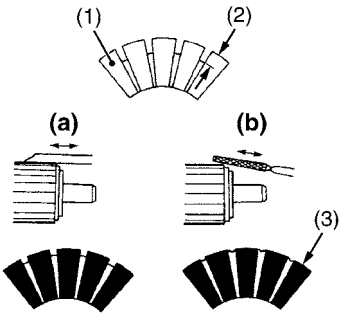

3EEABAB1P184B

Commutator and Mica

1. Check the contact face of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

Commutator O.D.	Factory spec.	OC60-E2	28.0 mm 1.10 in.
		OC95-E2	30.0 mm 1.18 in.
	Allowable limit	OC60-E2	28.0 mm 1.10 in.
		OC95-E2	29.0 mm 1.14 in.

Difference of O.D.'s	Factory spec.	Less than 0.05 mm 0.0020 in.
	Allowable limit	0.40 mm 0.0157 in.

Mica undercut	Factory spec.	OC60-E2	0.45 to 0.75 mm 0.018 to 0.030 in.
		OC95-E2	0.50 to 0.80 mm 0.020 to 0.031 in.
	Allowable limit	OC60-E2	0.20 mm 0.0079 in.
		OC95-E2	

(1) Segment
(2) Undercut
(3) Mica

(a) Correct
(b) incorrect

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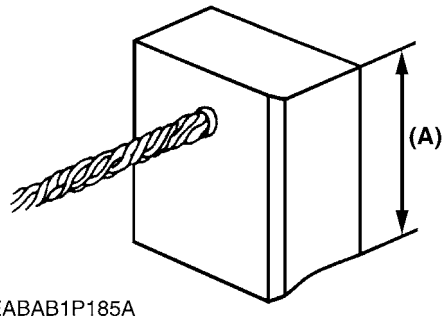

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Brush Wear

1. If the contact face of the brush is dirty or dusty, clean it with emery paper.
2. Measure the brush length **(A)** with vernier calipers.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

Brush length **(A)**	Factory spec.	OC60-E2	10.0 mm 0.3937 in.
		O95-E2	15.0 mm 0.5906in.
	Allowable limit	OC60-E2	6.0 mm 0.2362 in.
		OC95-E2	10.0 mm 0.3937 in.

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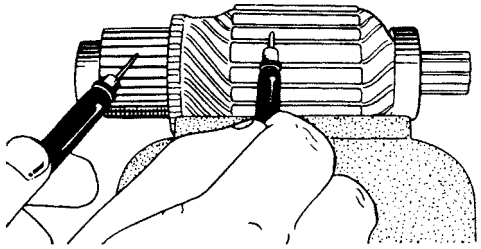

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Armature Coil

1. Check the continuity across the commutator and armature coil core with an ohmmeter.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with an ohmmeter.
4. If it does not conduct, replace the armature.

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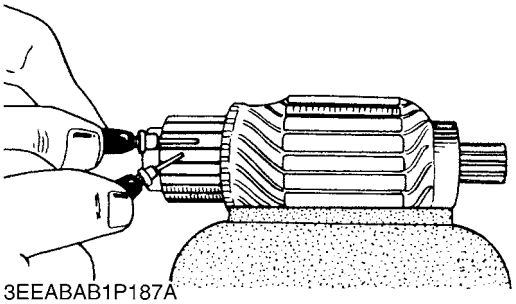

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Armature Bearing

1. Check the bearing for smooth rotation.
2. If it dose not smooth rotation, replace it.

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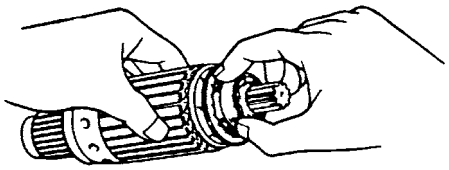

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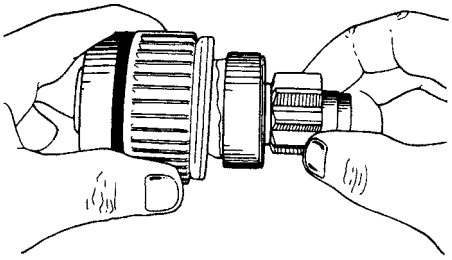

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Overrunning Clutch (OC60-E2)

1. Inspect the pinion for wear or damage.
2. If there is any defect, replace the overrunning clutch assembly.
3. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
4. If the pinion slips or does not rotate in the both directions, replace the overrunning clutch assembly.

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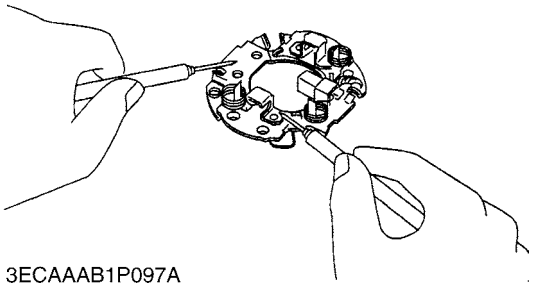

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Brush Holder (OC95-E2)

1. Check the continuity across the insulated brush holder and the brush holder support.
2. If continuous, replace the brush holder assembly.

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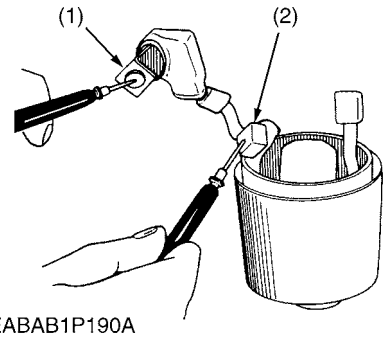

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Field Coil

1. Check the continuity across the lead (1) and brush (2) with an ohmmeter.
2. If it does not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with an ohmmeter.
4. If it conducts, replace the yoke assembly.

(1) Lead
(2) Brush
(3) Yoke

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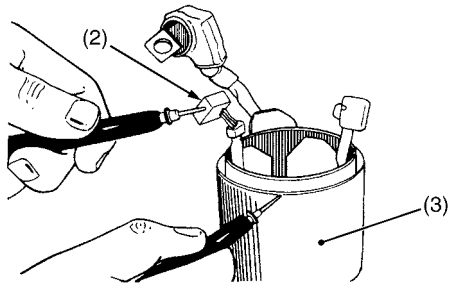

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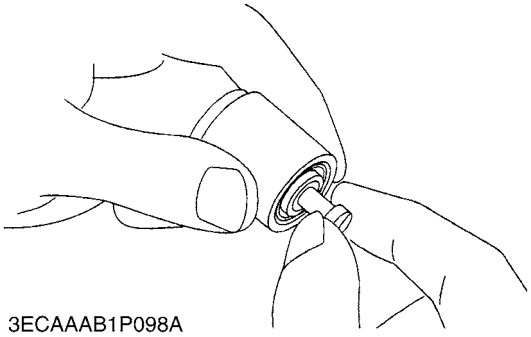

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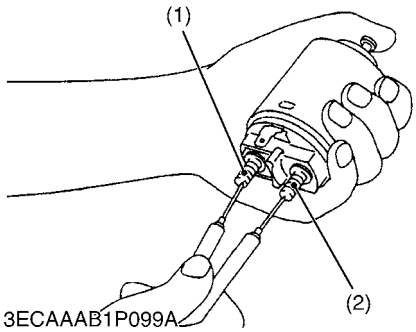

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Magnet Switch (OC60-E2)

1. Check the continuity across the **C** terminal (1) and the **B** terminal (2) with an ohmmeter, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the solenoid switch.
3. Pull the pull-rod to check the spring built in the plunger.

(1) **C** Terminal (2) **B** Terminal

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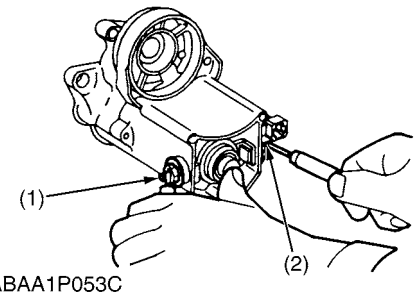

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Magnet Switch (OC95-E2)

1. Check the continuity across the **C** terminal (1) and the **B** terminal (2) with an ohmmeter, pushing in the plunger.
2. If it dose not conducts, check the contacts.

(1) **C** Terminal (2) **B** Terminal

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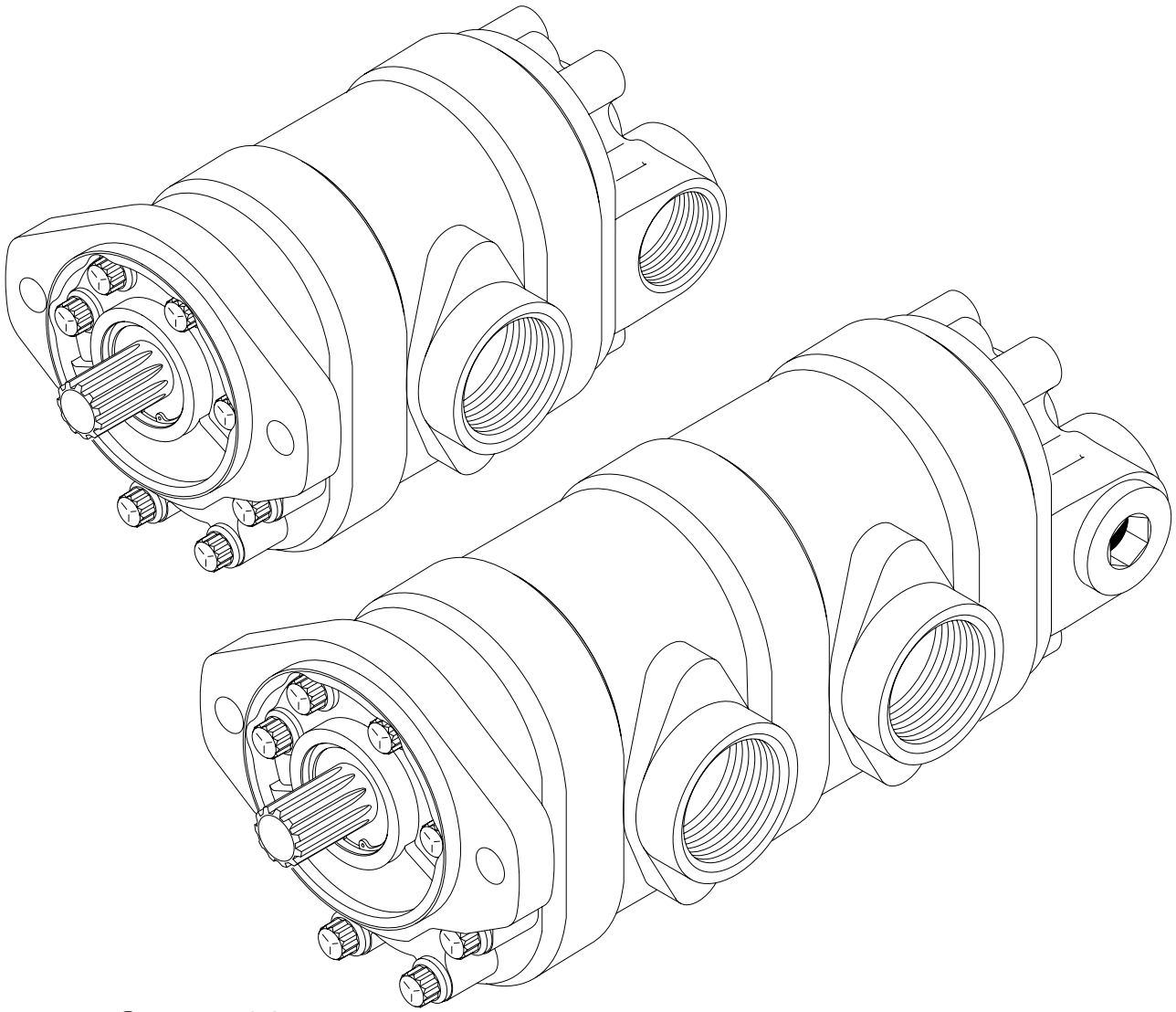
Appendix F
Eaton 26 Series Gear Pump Manual

Eaton®
Gear Pumps

December,1995

Repair Information



Series 26
Model 26000 Multiple Gear Pumps

Introduction

Table of Contents

Introduction

This manual provides service information for the Eaton model 26000 multiple gear pumps. Step by step instructions for the complete disassembly, inspection, and reassembly of the pumps are included.

The following recommendations should be followed to insure successful repairs.

- Remove the pump from the application.
- Cleanliness is extremely important.
- Clean the port areas thoroughly before disconnecting the hydraulic lines.
- Plug the pump ports and cover the open hydraulic lines immediately after they're disconnected.
- Drain the oil and clean the exterior of the pump before making repairs.
- Wash all metal parts in clean solvent.
- Use compressed air to dry the parts. Do not wipe them dry with paper towels or cloth.
- The compressed air should be filtered and moisture free.
- Always use new seals when reassembling hydraulic pumps.
- For replacement parts and ordering information refer to parts list 6-635.
- Lubricate the new rubber seals with a petroleum jelly (vaseline) before installation.
- Torque all bolts over gasket joints, then repeat the torquing sequence to makeup for gasket compression.
- Verifying the accuracy of pump repairs on an authorized test stand is essential.

Identification and Tools Required

Product Number: 26 5 01 - R Z A

Series
26 = Gear Pump
(SAE "A" Mount)

Features
0 = Standard Single Pump
1 = Standard Single W/ Relief
2 = Flow Divider Backplate
3 = Flow Divider W/ Load Sense
4 = Tandem Backplate
5 = Multiple Pumps

Displacement cm^3/r [in^3 /r]

01 = 6.6 [.40]	**08** = 22.5 [1.37]
02 = 8.2 [.50]	**09** = 24.3 [1.48]
03 = 9.5 [.58]	**10** = 25.2 [1.54]
04 = 10.8 [.66]	**11** = 27.7 [1.69]
05 = 13.8 [.84]	**12** = 29.0 [1.77]
06 = 16.7 [1.02]	**13** = 30.6 [1.87]
07 = 19.7 [1.20]	

Input Rotation
R = Right-hand (clockwise)
L = Left-hand (Counterclockwise)

Catalog / Non-Catalog
Z = Cataloged Pump
A-Y = Non-Cataloged Pump

Shafts , Porting Size and Location

Side Ports

A = 3/4 in. 11 Tooth, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
C = 3/4 in. Str. Keyed, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
E = 3/4 in. 9 Tooth, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
G = 5/8 in. Str. Keyed, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
J = 5/8 in. 9 Tooth, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
L = 5/8 in. Str. Keyed, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
N = 3/4 in. 11 Tooth, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
R = 3/4 in. Str. Keyed, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure

Rear Ports

B = 3/4 in. 11 Tooth, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
D = 3/4 in. Str. Keyed, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
F = 3/4 in. 9 Tooth, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
H = 5/8 in. Str. Keyed, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
K = 5/8 in. 9 Tooth, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
M = 5/8 in. Str. Keyed, 1 5/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
P = 3/4 in. 11 Tooth, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure
S = 3/4 in. Str. Keyed, 1 1/16-12 UN-2B Suction, 7/8-14 UNF-2B Pressure

B 95 01 31 JB Serial Number Code:

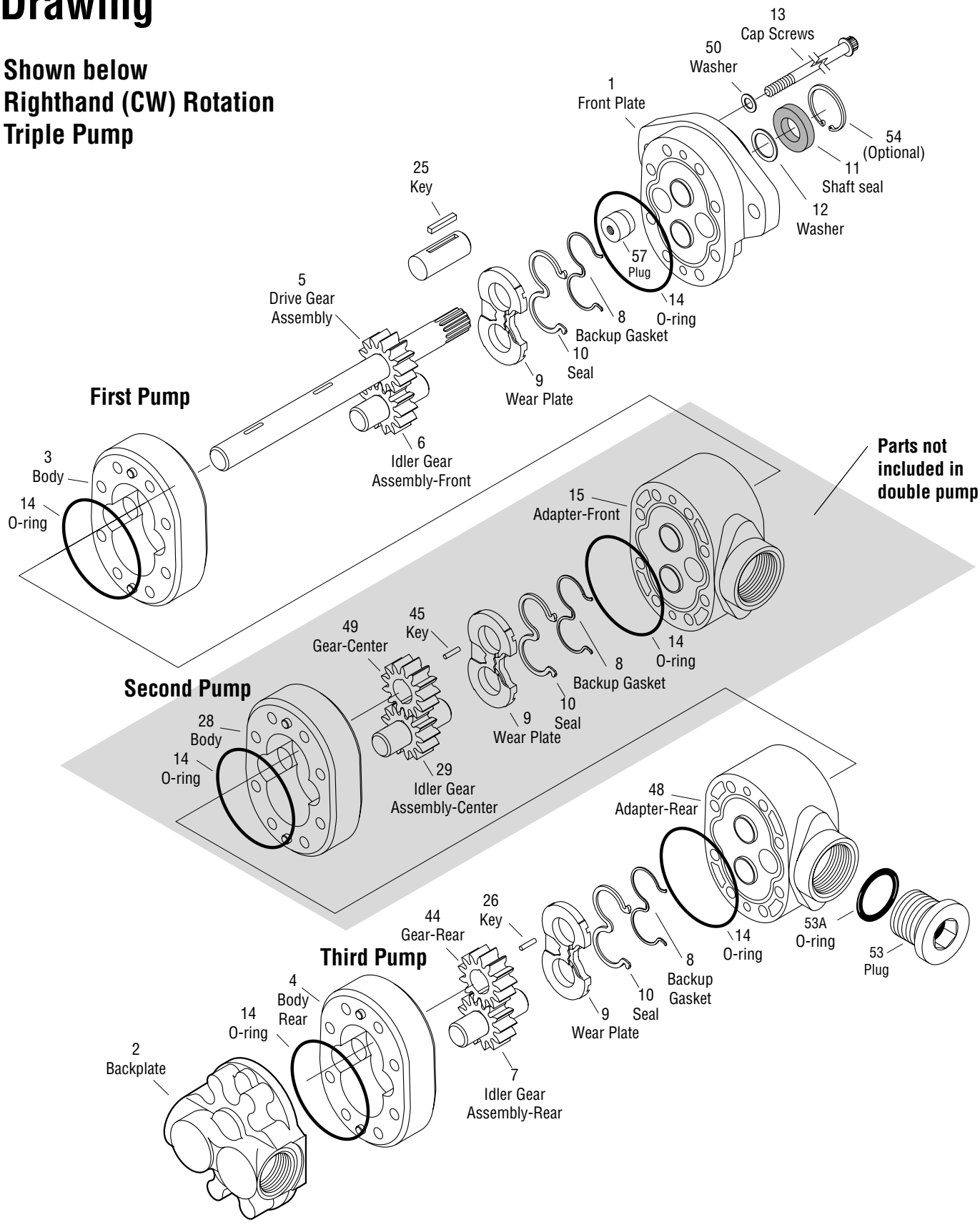
Testers Initials
Day of Month (two digits)
Month (two digits)
Last two digits of year built. (95 for 1995 etc.)
Revision level of parts list.

Tools Required

- 3/8 in. socket and ratchet wrench
- Internal Retaining Ring Pliers (straight .090 tip)
- O-ring Pick
- Thread 3/8 dia. UNC bolt/screw
- Torque Wrench (135.6 N·m [100 lbf·ft] capacity)
- Hammer (soft face)
- Light Petroleum Jelly
- Seal Driver
- Arbor Press

Parts Drawing

Shown below
Righthand (CW) Rotation
Triple Pump



Disassembly

Repair Information - Model 26000

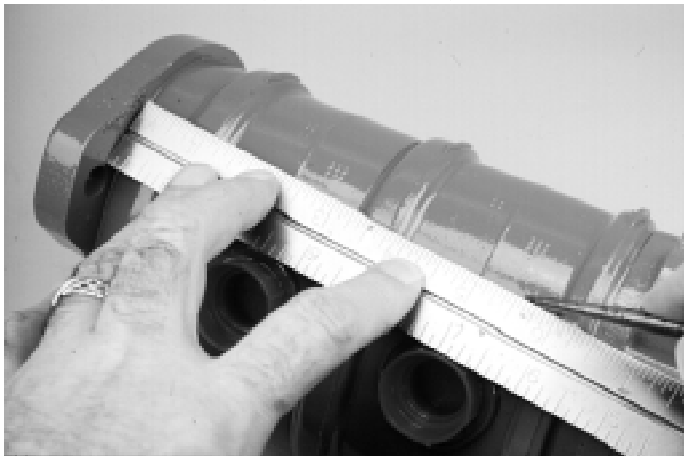
Work in a clean area; cleanliness is extremely important when repairing hydraulic pumps. Before disconnecting the lines, clean port areas of pump. Disconnect hydraulic lines, removing pump assembly from vehicle and plugging ports. Thoroughly clean the outside of the pump. After cleaning, remove port plugs and drain oil.

Disassembly of a Triple Pump

During disassembly keep all mating part in order and together.

1 Remove *key* from drive shaft if keyed drive gear assembly is used.

2 Put a *location mark* across front plate, bodies, adapters and backplate to assure proper reassembly.



3 Clamp pump in vise, shaft end up.Caution must be used as excessive clamping pressure on pump housing may distort the housing.

4 Remove *cap screws* (eight each) and washer (four each).

5 Remove pump from vise and position pump so that the shaft end is down. Now disassembly will continue from the rear of the pump.

Parts List

Item No.	Description	Qty.
1	Frontplate Assembly	1
2	Backplate	1
3	Body Assembly – Front	1
4	Body Assembly – Rear	1
5	Drive Gear Assembly	1
6	Idler Gear Assembly – Front	1
7	Idler Gear Assembly – Rear	1
~ 8	Backup Gasket	A/R
~ 9	Wear Plate	A/R
~ 10	Seal	A/R
~ 11	Shaft Seal	1
~ 12	Washer	1
13	Cap Screw	8
~ 14	O-ring	A/R
15	Adaptor Plate– Front	1
25	Key for Straight Shaft	1
26	Key – Rear Gear	1
28	Body Assembly – Center	A/R
29	Idler Gear Assembly – Center	A/R
44	Gear – Rear	1
45	Key – Center Gear	A/R
48	Adaptor Plate – Rear	1
49	Gear – Center	A/R
50	Washer	4
53	Plug Assembly	1
~ 53A	O-ring	1
~ 57	Plug	1
~	26000-902	Seal Kit for Double Pump
~	26000-903	Seal Kit for Triple Pump

A/R – As Required
~ – Parts contained in seal kits

6 Start by tapping the backplate with a soft faced hammer to remove from the third pump body. Remove *o-ring* seal from backplate.

7 To disassemble the *relief valve backplate and flow divider backplate* see page 15.

Disassembly

8 To separate the *third pump body* from adapter plate use a soft faced hammer and tap to loosen and then lift straight up.

9 Remove *idler gear assembly* from wear plate and adaptor plate.

10 Remove *drive gear* from input shaft.

11 Remove *wear plate and o-ring seal*, noting position of open or closed side of wear plate.

12 Using a pencil magnet remove the *drive gear key* from the drive shaft.

13 Using a o-ring pick or similar tool and remove the *o-ring seal* from the rear adapter plate.

14 Tap rear *adapter plate* with a soft faced hammer to loosen and remove adapter plate. After removing adapter, turn it over and remove the *second o-ring seal*.

15 Remove *second or middle pump body* from second set of gears.

16 Remove *idler gear assembly* from wear plate and *drive gear* from input shaft.

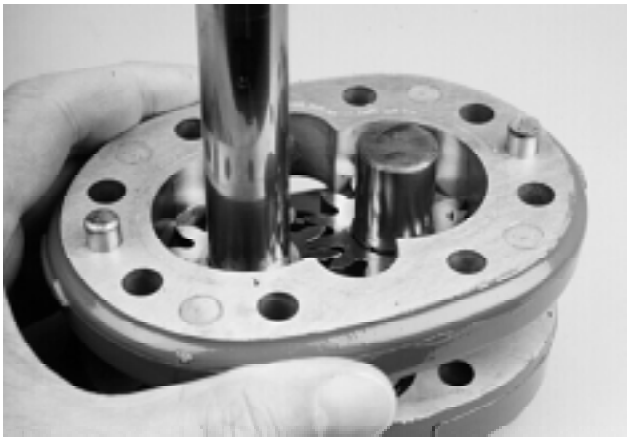
17 Remove the next (second) *wear plate assembly* from the adapter.

18 Next, use a pencil magnet to remove the *second drive key* from the pump shaft.

19 Remove the *o-ring seal* from the front adapter plate.

20 Tap *front adapter plate* with a soft faced hammer to loosen and remove adapter plate. After removing adapter, turn it over and remove the *second o-ring seal*.

21 Remove *first pump body* from front plate.



22 Remove *first pump idler gear* and *input drive gear assembly* along with *wear plate* and *o-ring seal* from front plate.

23 Remove *back-up gasket a*nd *seal* from all wear plates.

24 Using a drift punch or similar tool, remove the *shaft seal* from the front plate. Caution is needed not to damage counter bore of shaft seal area when removing seal.

25 Removing the *plug* in front plate is not necessary, unless you intend to change rotation. See Reversibility - Changing Input Rotation of Pump.

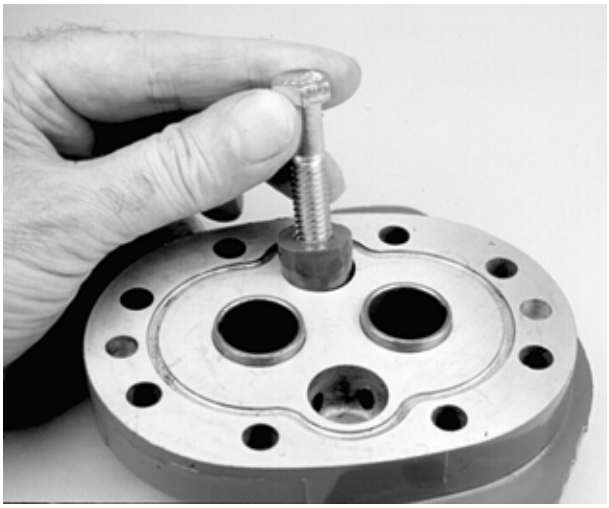
Reversibility

Changing Input Rotation of Pump

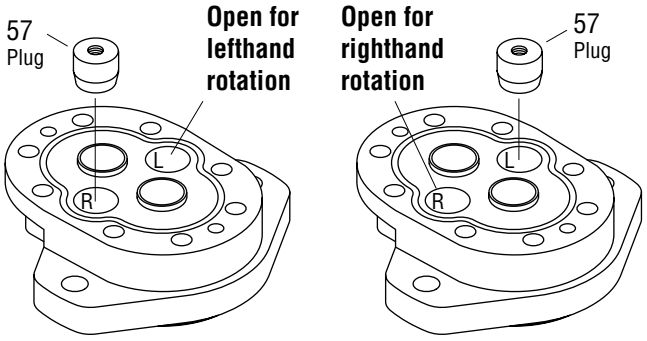
1 To change input rotation of a double or triple pump a complete disassembly is required.

2 Follow the steps below to alter the front plate assembly to the desired rotation required.

- Thread 3/8 UNC threaded bolt into *plug* cavity. Start with fingers, then place bolt head in vise and turn front plate to engage threads 2-3 turns.
- Holding bolt in vise, tap front plate with rubber hammer to disengage *plug*.
- Remove *plug* from bolt.

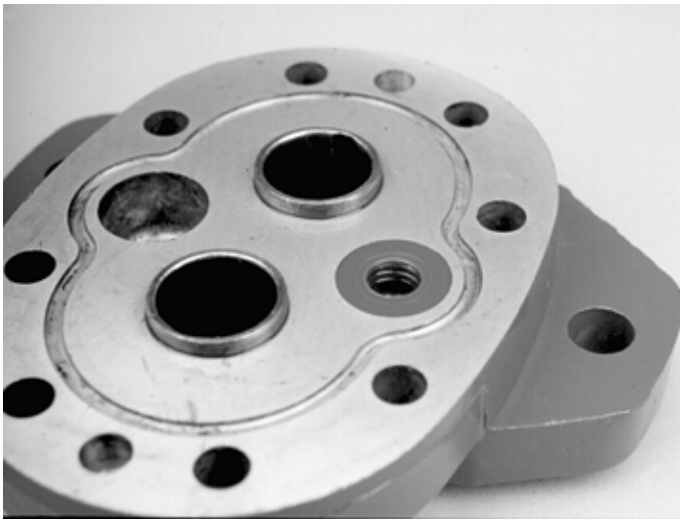


- Install plug in the other casting cavity and tap flush with rubber hammer. Note L or R at bottom of cavity.



- Ensure that bearing drain holes are free of debris.

3 After changing plug into proper cavity start the reassembly portion of this booklet.



Inspection

Inspect Parts for Wear

General

1 Clean and dry all parts.

2 Remove all nicks and burrs from all parts with emery cloth.

Gear Assembly Inspection

1 Check spline drive shaft for twisted or broken teeth or check keyed drive shaft for broken or chipped keyway.

2 Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.

3 Replace gear assembly if shaft measures less than 19 mm [.748 in] in bushing area. (One gear assembly may be replaced separately; shafts and gears are available as assemblies only.)

4 Inspect gear for scoring and excessive wear.

5 Replace gear assembly if gear width is below the following dimensions. Refer to chart on this page.

6 Assure that snap rings are in grooves on either side of drive and idler gears.

7 If edge of gear teeth are sharp, break edge with emery cloth or stone.

Front plate and Backplate Inspection

1 Oil groove in bushings in front plate should be in line with dowel pin holes and 180° apart. The oil grooves in the backplate bushings should be at approximately 37° to the pressure side.

2 Replace the backplate, adapter plate or front plate if I.D. of bushings exceed 19,2 mm [.755 in] (Bushings are not available as separate items).

3 Bushings in front plate should be at 3,20 mm [.126 in] above surface of front plate.

4 Bushings in adapter plate on the wear plate side should be at 3,20 mm [.126 in] above surface of adapter.

5 Check for scoring on face of backplate orbackplate side of adapter plate. Replace if wear exceeds ,038 mm [.0015 in.].

Body Inspection

1 Check body inside gear pockets for excessive scoring or wear.

2 Replace body if I.D. of gear pockets exceeds 43,7 mm [1.719 in].

Minimum Gear Width per Displacement

Model Number	26001	26002	26003	26004	26005	26006	26007	26008	26009	26010	26011	26012	26013
Pump Disp. cm^3/r [in^3/r]	6,6 [.40]	8,2 [.50]	9,5 [.58]	10,8 [.66]	13,8 [.84]	16,7 [1.02]	19,7 [1.20]	22,5 [1.37]	24,3 [1.48]	25,2 [1.54]	27,7 [1.69]	29,0 [1.77]	30,6 [1.87]
Gear Width mm [in]	7,85 [.309]	9,75 [.384]	11,20 [.441]	12,95 [.510]	16,15 [.636]	19,35 [.762]	22,56 [.888]	25,76 [1.014]	28,12 [1.107]	28,96 [1.140]	32,16 [1.266]	33,78 [1.330]	35,36 [1.392]

Reassembly

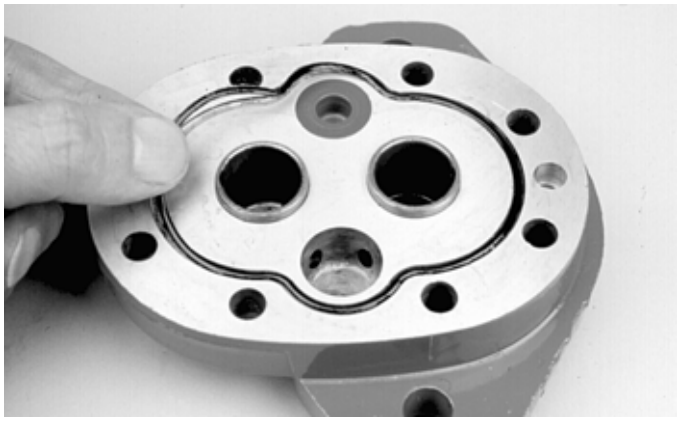
General Information

It is important that the relationship of the backplate, bodies, adapters, wear plates, and front plate is correct. You will note two half moon cavities in the body. The smaller half moon port cavity must be on the pressure side of the pump. The side of wear plate with midsection cut out must be on suction side of pump. Suction side of backplate or adapter is always side with larger port boss.

Reassembly

1 During the reassembly, replace and lubricate all of the *wear plates, seals, back-up gaskets, shaft seal and o-rings* as new parts. Lubricate all finished parts and/or assembly surfaces freely with clean hydraulic fluid during assembly.

2 Install *o-ring* in groove of front plate.



3 Apply a thin coat of petroleum jelly or hydraulic oil to both milled gear pockets of body. Slip body onto front plate with half moon port cavities in body facing away from front plate. Check and align the previously scribed line on the exterior of pump unless input rotation was changed.

Note: If rotation was changed, make sure the small half moon port cavity is on the pressure side (the plugged side of the front plate) of the pump.

4 Install new *seal* and new *backup gasket* into all wear plates. Note in the middle of the backup gasket a flat section or support. This area must face away from the wear plate inside the seal.

5 Place the first new *wear plate, seal,* and *backup gasket* into gear pocket with seal and backup gasket next to front plate. The side of the wear plate with the mid section cut-away must be on the suction side of pump.

6 Dip *gear assemblies* into oil and slip first shaft assemblies into front plate bushings and gears into body pockets.

Reassembly

7 Install new *o-ring* in groove of adapter plate (side with bushings below surface).

8 Align the scribed lines of the first body and front adapter, install adapter plate onto the drive shaft and body.

9 Lubricate and install second o-ring onto adapter.

10 Install the drive key into the key slot using some petroleum jelly to help hold it in place.

11 Aligning the previously scribed line of body and adapter, install the second pump body onto the adapter plate.

12 Lubricate and install the second wear plate assembly into the pump body. Caution is required to not dislodge the seals during installation. Remember sealing side of the wear plate is toward the adapter plate with the cut side of the wear plate facing the suction side or large cavity location of pump body.

13 Lubricate and install the second drive gear onto the shaft and into the pump body aligning key with slot in gear.

14 Lubricate and install the second idler gear assembly into body and adapter.

15 Lubricate and install the *new o-ring seal* onto the rear adapter plate.

16 Aligning the two previously scribed lines on the body and rear adapter, install *rear adapter* onto pump body. Lubricate and install the *new o-ring seal* onto the other side of rear adapter plate.

17 Install the *third drive key* into the key slot using petroleum jelly to help hold it in place.

18 Aligning the previously scribed line of body and adapter, install the *third pump body* onto the rear adapter plate.

19 Lubricate and install the third wear plate assembly into the pump body. Caution is required to not dislodge the seals during installation. Remember sealing side of the wear plate is toward the adapter plate with the cut side of the wear plate facing the suction side or large cavity location of pump body.

20 Lubricate and install the *third drive gear* onto the shaft and into the pump body aligning key with slot in gear.

21 Lubricate and install the *third idler gear assembly* into body and adapter.

22 Install the *new o-ring seal* in groove of backplate.

23 Check scribe line, make sure port orientation is correct and then slide *backplate* over gear shafts until dowel pins are engaged.

24 Secure with *cap screws* and new *washers*. Tighten cap screws evenly in a crisscross pattern 34 to 38 N•m [25 to 28 lbf•ft] torque.

25 Place washer over drive shaft into housing. Liberally oil shaft seal and install over drive shaft, carefully so that rubber sealing lips are not cut.

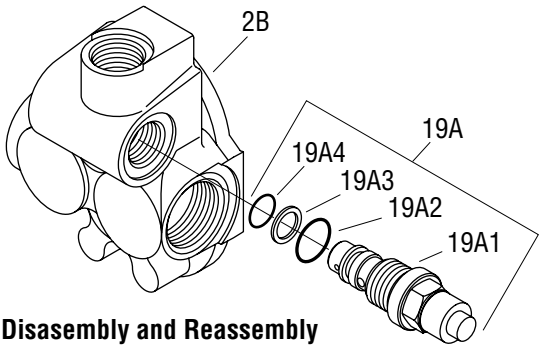
26 Place 1-5/16 in. O.D. sleeve over shaft and press in shaft seal until its below the surface of the front plate 6.1mm [.24 in].Install retaining ring if required optional feature is used.

27 Install key on keyed shaft.

Note: Refer to Start-up Procedure and Trouble Shooting Procedure.

Specific Backplate Parts List

Relief Valve Backplate



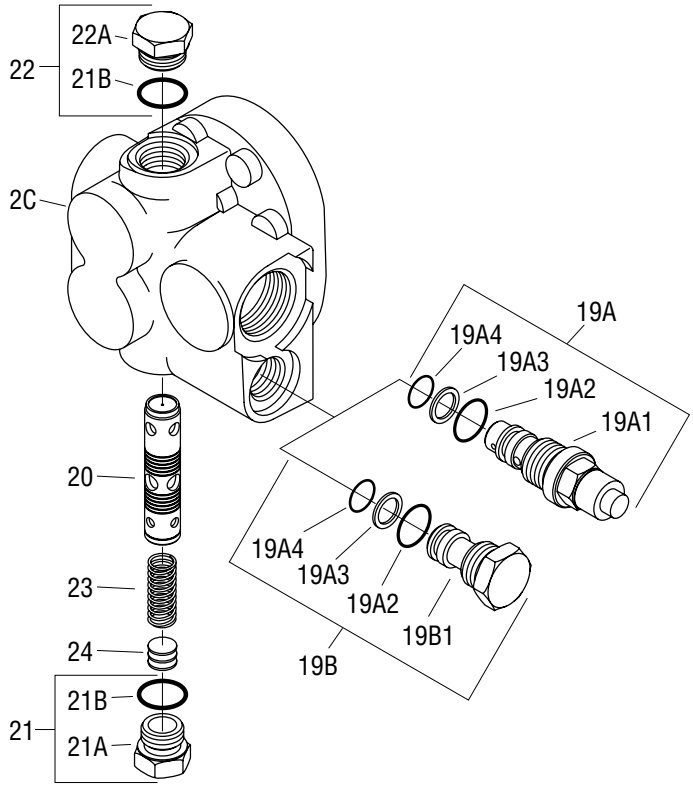
Item No.	Description	Qty.
2	Relief Valve Backplate	1
18	O-ring	3
19A	Relief Valve Assembly	1
19A1	Relief Valve	1
~ 19A2	O-ring	1
~ 19A3	Backup Ring	1
~ 19A4	O-ring	1
19B	Plug Assembly	1
19B1	Plug	1

Disasembly and Reassembly

1 After removing *relief valve*, remove and replace o-rings and backup ring with new parts.

2 Install *relief valve* and torque 41 to 46 N•m [30 to 34 lbf•ft]

Flow Divider Backplate



Item No.	Description	Qty.
2C	Flow Divider Backplate	1
19A	Relief Valve Assembly	1
19A1	Relief Valve	1
~ 19A2	O-ring	1
~ 19A3	Backup Ring	1
~ 19A4	O-ring	1
19B	Plug Assembly	1
19B1	Plug	1
20	Flow Divider Spool	1
21	Plug/O-ring Assembly	1
21A	Plug	1
~ 21B	O-ring	2
22	Plug/O-ring Assembly	1
22A	Plug	1
23	Spring	1
24	Shim (.0239 inch thick)	A/R
A/R	– As Required	

Disasembly and Reassembly

1 After removing *relief valve or plug*, remove and replace o-ring and backup ring with new parts.

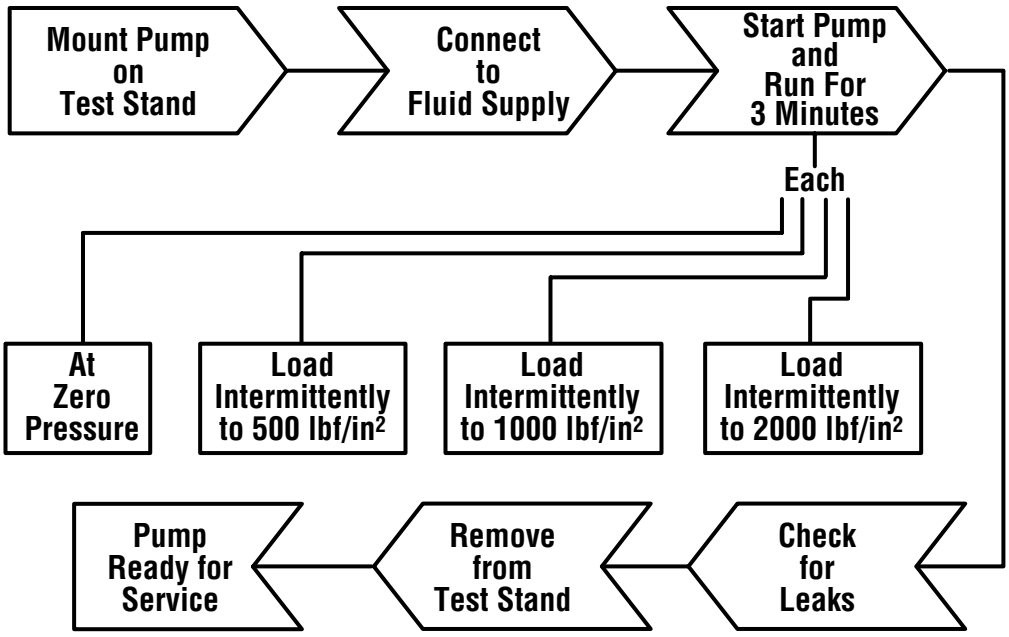
2 Install *relief valve or plug* and torque 41 to 46 N•m [30 to 34 lbf•ft]

3 Remove flow divider *plugs, shims, spring, and spool* from backplate. (Notice orientation of spool with cavity in backplate)

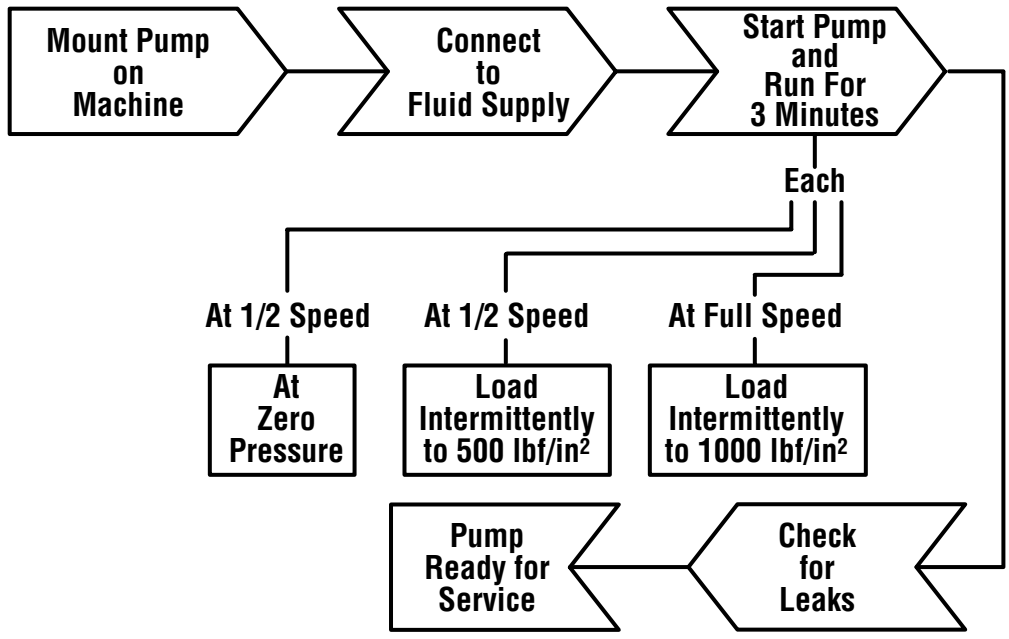
4 Install new plug *seals* on plugs. Install *spool, spring, shims, and plug assemblies* into backplate. Torque plugs 29 to 33 N•m [21 to 24 lbf•ft]

Placing Series 26 Gear Pump Back into Operation

When test stand is *available*.



When test stand is *not available*.



Trouble Shooting

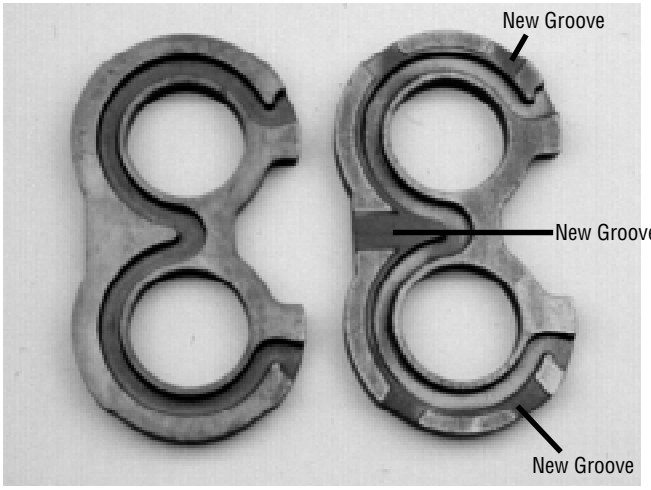
Problem	Possible Cause	Correction
Cavitation	a. Oil too heavy. b. Oil filter plugged. c. Suction line plugged or too small.	a. Change to proper viscosity b. Clean filter. c. Clean line and check size of line.
Oil heating	a. Oil supply low. b. Contaminated oil. c. Setting of relief valve too high or too low. d. Oil in system too light.	a. Fill reservoir. b. Drain reservoir and refill with clean oil. c. Set to correct pressure. d. Drain reservoir and refill with proper viscosity oil.
Shaft seal leakage	a. Worn shaft seal. b. Worn shaft in seal area. c. Debris in shaft seal suction side drain holes.	a. Replace shaft seal. b. Replace drive assembly. c. Disassemble pump and inspect.
Foaming oil	a. Low oil level b. Air leaking into suction line c. Wrong kind of oil.	a. Fill reservoir. b. Tighten fittings. c. Drain and fill reservoir with non-foaming oil.

Note

Wear Plate Identification

A product improvement has been made to the Model 26000 gear pump with a new designed wear plate. To identify the new wear plate, look for grooves placed in the seal side of the wear plate as shown below.

OLD
Wear Plate



NEW
Wear Plate

This new wear plate enables better pressure clamping with aerated oil in pumps 1.37 cubic inch or smaller. Aerated oil may occur during a cold start-up in applications with long suction lines or when the mouth of the inlet line is temporarily exposed to air.

Note

Order parts from 6-635 Parts Information booklet.
Each order must include the following information.

1. Product and/or Part Number
2. Serial Number Code
3. Part Name
4. Quantity

Eaton
Fluid Power Group
Hydraulics Business USA
14615 Lone Oak Road
Eden Prairie, MN 55344
USA
Tel: 952-937-9800
Fax: 952-294-7722
www.eaton.com/hydraulics

Eaton
Fluid Power Group
Hydraulics Business Europe
Route de la Longeraie 7
1110 Morges
Switzerland
Tel: +41 (0) 21 811 4600
Fax: +41 (0) 21 811 4601

Eaton
Fluid Power Group
Hydraulics Business Asia Pacific
11th Floor Hong Kong New World Tower
300 Huaihai Zhong Road
Shanghai 200021
China
Tel: 86-21-6387-9988
Fax: 86-21-6335-3912

Powering Business Worldwide

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December 2008

VERSATECH
PRODUCTS INC.

INSHORE BOOM MANUAL

including

Technical and Design Information
Boom Launching Instructions
Retrieval and Storage
Maintenance and Repair Instructions

Table of Contents

Terminology

Oil Spill Barrier (Boom)

The Inshore Boom is designed for deployment for short time periods in response to spills. The boom is intended to stay in the water only as long as required to contain the oil during the spill cleanup process. This boom is not designed or recommended for long term in-water deployment. Booms designed for permanent installation should be procured for this purpose.

Figure 1

Boom Section End Connectors

They are furnished installed with each fifty (50) foot section. One Versatech Inshore Boom connector (shotgun type) is supplied with each fifty (50) foot boom length. All Versatech connectors allow quick assembly/disassembly of boom without the use of any tools whatsoever.

Towing Attachments

They are available for towing boom in either a straight line configuration at high speeds, (up to 10 knots) or in a catenary configuration for sweeping at low speeds (less than ½ knot). The towing attachment also provides an additional anchor point for mooring the boom.

Storage Containers

Inshore Boom is normally shipped in intermodal containers or wrapped individually in polywrap fabric for protection during shipment. The boom can also be shipped in Versatech deployment containers, or on boom reels (manual (M), electric/hydraulic (EH), or diesel/hydraulic (DH)).

Repair Kits

They are specific to each size and type of boom. Repair kits can be ordered direct from the manufacturer (604-271-7500).

General Description

The Versatech Inshore Boom is a fast response, fence type, first line of defense oil containment barrier for use in quiet waters. It is a rugged boom which derives its buoyancy from closed cell foam flotation.

The foam flotation gives a fail-safe feature to this design. Should the flotation tube be torn during use, the foam floats will continue to maintain freeboard.

The inshore boom is available in 4 (four) standard sizes. The 12" and 18" Inshore booms are intended for use in inner harbours, and inland waterways, whereas the 24" and 36" Inshore Booms are designed for use in outer harbours, or quiet seas. Inshore Booms are not recommended for choppy wave conditions or where currents exceed about one (1) knot.

Construction (see Figure 2)

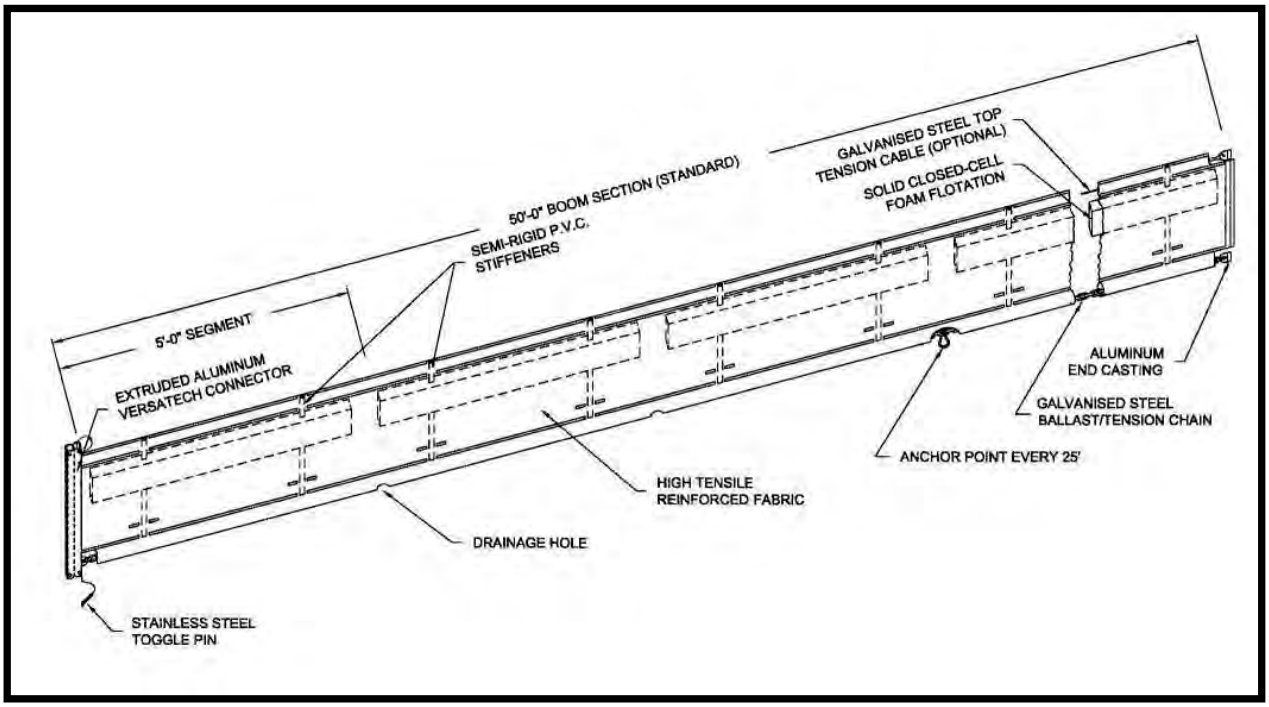


Figure 2

Individual boom sections are fifty (50) feet long. Boom membrane is manufactured by heat-sealing proper widths of PVC coated nylon or polyester fabric (see specification sheet attached).

All fabrics used on Versatech Inshore boom are of the finest material and workmanship available, and have proven field life of many years when used in accordance with the instructions contained in this manual.

All seams on the Versatech Inshore Boom are welded using radio frequency (RF) microwave welders to ensure long-lasting air-tight construction. Every boom is inspected prior to leaving the manufacturing plant.

Foam flotation segments are located in the boom flotation tube and secured longitudinally by the vertical PVC stiffeners, two of which pass through each flotation segment. These flotation segments are of the closed cell plastic type and will remain buoyant in the event of a cut or puncture.

Ballast is provided in the form of a galvanized chain. The chain also serves as a boom tension member.

The boom is fitted with Versatech Inshore Boom Connectors (Shotgun type). Any boom end can be connected to any other. Versatech uses a patented bolt-less connection system to attach boom lengths (see Figure 3).

Figure 3

Storage

The most convenient method for storing this boom is on boom reels specifically designed for this purpose. Please see the "Versatech Boom Reels" information sheet. As an alternative to reels, the boom may also be stored folded in any appropriate storage container.

Boom Launching

To ensure successful boom launching operations when responding to an oil spill, preliminary planning, including response procedures, should be initiated in advance of a spill. Some recommended steps are outlined below:

If the boom is to be pulled into the water over the sharp edge of a pier or other such area, install a roller or slide to ensure the boom does not become snagged or torn. Attach a tow bridle or floated tow bar to the end of the boom. Tie one end of a nylon tow line (100 foot minimum length) to the tow bridle and tie the other end to the towing point of the deployment boat.

Communication between the deployment boat crew and the shore crew is critical as the boom is deployed.

Boom Retrieval, Cleaning And Repacking

Retrieval

Generally, once the boom has been used in a spill, it is easiest to simply retrieve the boom quickly onto either the deck of a work boat or onto a convenient shore site where the boom can be cleaned prior to repacking.

Boom Cleaning

A pressure washer, if available, will yield best results. Washers producing a 500 - 600 psi pressure are recommended.

Repacking

Boom should be repacked only after being cleaned and dried. The boom should be returned to its storage/deployment box folded zigzag pattern from the rear to the front of the box. If the boom is to be rewound onto a reel, try to ensure that each boom is aligned close to the next across the length of the reel then back the other way on succeeding layers. Tension should be kept on the boom during re-winding so the boom will not sag or drag on the ground before storage is complete.

This Appendix includes:

- Insta-Berm Pamphlet

- Drawings

- Data Sheets

- Insta-Berm Operation Manual

ALMIQ CONTRACTING LTD.	**SHOP DRAWING / SAMPLE / PRODUCT DATA** **IDENTIFICATION FORM**	T : 418-668-3321 F : 418-668-0652 1340, Ulu Lane, P.O. Box 2140, Iqaluit, NU X0A 0H0

PROJECT : **CONSTRUCTION OF NANISIVIK NAVAL FACILITY, NU**			**Submittal NO.**	**SUB-ALM-DCC-536**		
OWNER : **DEFENCE CONSTRUCTION CANADA**			**Revision NO.**	0	**Date:**	2019-08-20
			Revision NO.		**Date:**	
PROJECT NO. : **NPO1301**	CONTRACT NO. : **55668 CN**	OUR FILE NO. : **148926**	**Revision NO.**		**Date:**	
			Revision NO.		**Date:**	

DISCIPLINE :	
CONTRACTOR /SUB-CONTRACTOR :	
Almiq Contracting LTD	
1340, Ulu Lane, PO Box 2140	
Iqaluit (NU) X0A 0H0	
Person in Charge : Jimmi Fortin Bouchard	
Phone : 418-668-3321.230 *Fax :*	
MANUFACTURER :	**SUPPLIER :**
Person in Charge :	Person in Charge :
Phone : *Fax :*	*Phone :* *Fax :*
SHOP DRAWINGS, PRODUCT DESCRIPTION OR SAMPLE SUBMITTED FOR APPROVAL:	**SPECS REFERENCE :**
PTA containment berm	
NOTES : In regards to CCN 74	

We declare that we have verified the attached documents and/or sample, that they are in compliance with the contract documents and are approved for the construction of the project.

Jeremy Richard Signing for
Jimmi Fortin Bouchard, Project Manager
Contractor's Representative

Signature

2019-08-20
Date

INSTA-BERM™ FRAME

SECONDARY CONTAINMENT BERM WITH ALUMINUM FRAME

For larger applications that require superior environmental protection, count on the Insta-Berm (Frame) for durable and reliable secondary containment.

Recommended for use with collapsible fuel tanks and constructed from industrial-strength fabric, the Insta-Berm (Frame) is an easy-to-install environmental safeguard that allows companies to meet today's strict guidelines.

Meets EPA regulation 40CFR112.7 and Environment Canada Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (SOR/2008-197). Certified to CAN/ULC-S668-12 when built with Arctic-Shield fabric.

DESIGN FEATURES

- Rugged aluminum frame is easily assembled and quickly deployed with just one tool
- 5-ft (1.2 m) frame sections make for easy transport
- Fully collapsible for compact storage and relocation
- Wide range of standard sizes and custom sizes available
- Easily cleaned and maintained
- Includes eyelet patches for staking down the berm
- Appropriate for containment of waste water, petroleum products and various other chemicals
- Drain fitting can be opened to let out accumulated rainwater or connected to a hose to pump out spilled product

BERM OPTIONS

- RainDrain™ – removes hydrocarbons and additives from captured rainwater through gravity drainage ensuring the berm maintains spill protection
- High-wind stakes – anchors the berm to the ground

FABRIC OPTIONS

- Chem-Shield™ – Chemical-resistant fabric
- Arctic-Shield™ – Certified to CAN/ULC-S668-12, chemical and fire resistant fabric for temperatures to -50 degrees Fahrenheit /-45.6 degrees Celsius (Arctic-Shield fabric is not suitable for acids)

C ETL LISTED Intertek

CERTIFIED TO CAN/ULC-S668-12

SEI Industries Ltd. 7400 Wilson Ave, Delta, BC Canada V4G 1H3
604.946.3131 seisales@sei-ind.com www.sei-ind.com

INSTA-BERM (FRAME)™

The Insta-Berm (Frame) comes in 20 standard sizes as well as two fabric options to choose from.

The optional RainDrain filter ensures your berm has enough capacity to protect the environment in the event of a spill.

The Insta-Berm (Frame) is certified to CAN/ULC-S668-12 Class IP and Class IIP (when built with Arctic-Shield fabric) and is suitable for secondary containment of flammable liquids and combustible liquids in both above ground (exposed) and (buried) non-exposed secondary containment applications.

INSTA-BERM (FRAME) SPECIFICATIONS

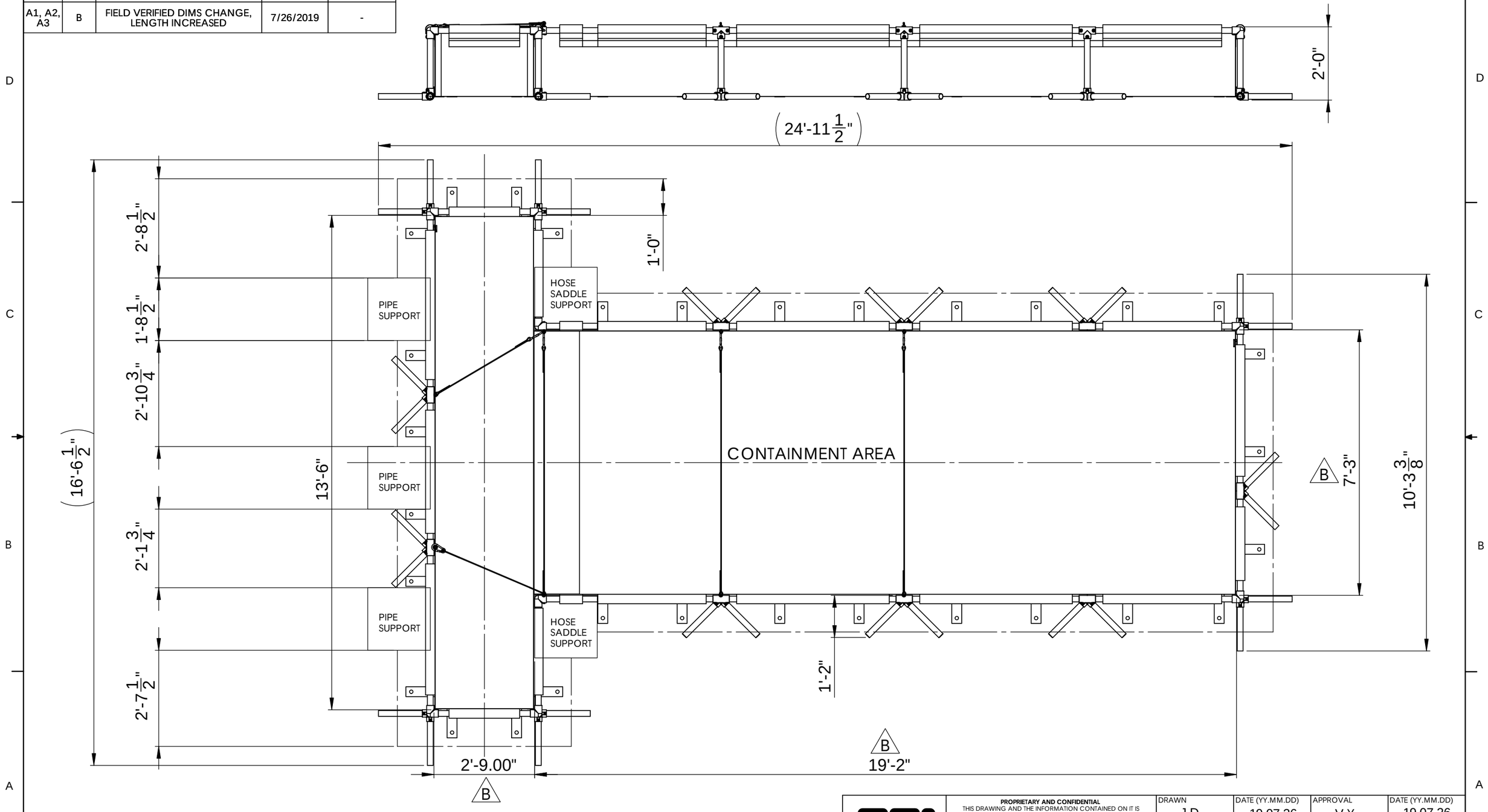
MODEL	CAPACITY		DEPLOYED DIMENSIONS (L X W X H)		SHIPPING WEIGHT	
	USG	L	IN	CM	LB	KG
IBFS101020	1060	4012	10′x 10′x 20″	305 x 305 x 50	156	71
IBFS102020	2119	8023	10′x 20′x 20″	305 x 610 x 50	242	110
IBFS202020	4239	16046	20′x 20′x 20″	610 x 610 x 50	350	159
IBFS203020	6358	24063	20′x 30′x 20″	610 x 914 x 50	458	208
IBFS204020	8478	32092	20′x 40′x 20″	610 x 1219 x 50	567	257
IBFS205020	10597	40115	20′x 50′x 20″	610 x 1524 x 50	589	306
IBFS303020	9538	36104	30′x 30′x 20″	914 x 914 x 50	589	267
IBFS304020	12717	48138	30′x 40′x 20″	914 x 1219 x 50	719	326
IBFS305020	15896	60173	30′x 50′x 20″	914 x 1524 x 50	850	386
IBFS404020	16956	64185	40′x 40′x 20″	1219 x 1219 x 50	872	396
IBFS405020	21195	80231	40′x 50′x 20″	1219 x 1524 x 50	1025	465
IBFS505020	26494	100289	50′x 50′x 20″	1524 x 1524 x 50	1200	544
IBFS101032	1808	6843	10′x 10′x 32″	305 x 305 x 80	242	110
IBFS202032	7231	27373	20′x 20′x 32″	610 x 610 x 80	515	234
IBFS203032	10847	41059	20′x 30′x 32″	610 x 914 x 80	662	300
IBFS303032	16270	61589	30′x 30′x 32″	914 x 914 x 80	832	377
IBFS304032	21694	82119	30′x 40′x 32″	914 x 1219 x 80	1003	455
IBFS404032	28925	109491	40′x 40′x 32″	1219 x 1219 x 80	1195	542
IBFS405032	36156	136864	40′x 50′x 32″	1219 x 1524 x 80	1387	629
IBFS505032	45195	171080	50′x 50′x 32″	1524 x 1524 x 80	1602	727

Shipping weight based on 30 oz. fabrics.

Printed in Canada
June 29, 2018 v02.4

SEI Industries Ltd. 7400 Wilson Ave, Delta, BC Canada V4G 1H3
604.946.3131 seisales@sei-ind.com www.sei-ind.com

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
A1, A2, A3	B	FIELD VERIFIED DIMS CHANGE, LENGTH INCREASED	7/26/2019	-



CAPACITY ESTIMATE: 9100 L

SEI INDUSTRIES
7400 WILSON AVE.
DELTA, BC
CANADA, V4G 1E5
PH: 604-946-3131
FX: 604-940-9566

UNLESS OTHERWISE SPECIFIED:
X° = ± 2° .X = ± .030
X = ± 1/16 .XX = ± .010
.XXX = ± .005

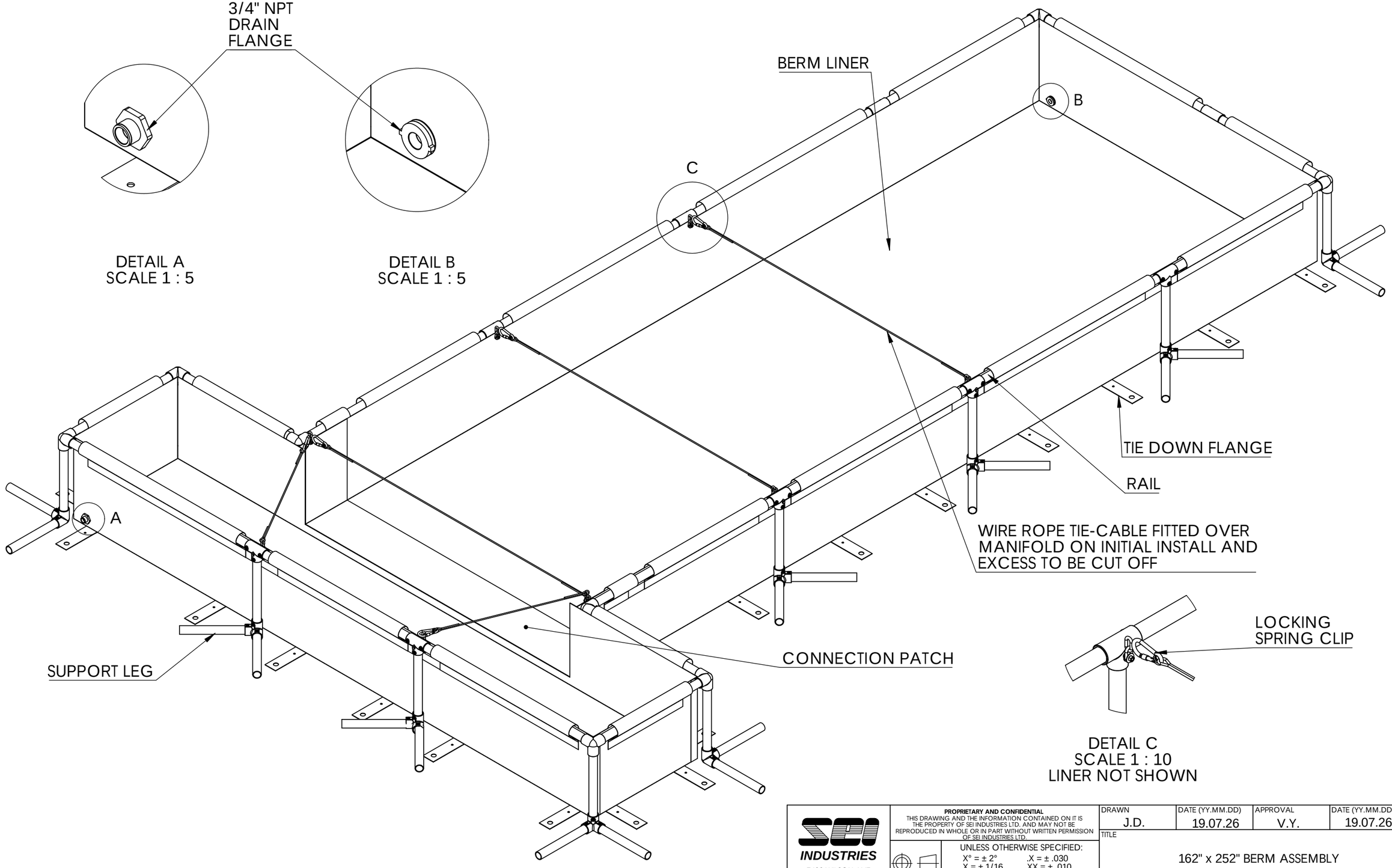
DRAWN	DATE (YY.MM.DD)	APPROVAL	DATE (YY.MM.DD)
J.D.	19.07.26	V.Y.	19.07.26

TITLE: 162" x 252" BERM ASSEMBLY

SHEET	UNITS	SCALE	SIZE	DWG. NO.	PART NO.	REV.
1 OF 2	IN	1:30	B	IBFS162x252	-	B

DETAIL A
SCALE 1 : 5

DETAIL B
SCALE 1 : 5



DETAIL C
SCALE 1 : 10
LINER NOT SHOWN

SEI
INDUSTRIES
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DELTA, BC
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PH: 604-946-3131
FX: 604-940-9566

UNLESS OTHERWISE SPECIFIED:
X° = ± 2° .X = ± .030
X = ± 1/16 .XX = ± .010
.XXX = ± .005

DRAWN	DATE (YY.MM.DD)	APPROVAL	DATE (YY.MM.DD)
J.D.	19.07.26	V.Y.	19.07.26

TITLE: 162" x 252" BERM ASSEMBLY

SHEET	UNITS	SCALE	SIZE	DWG. NO.	PART NO.	REV.
2 OF 2	IN	1:20	B	IBFS162X252	-	B

L1336DEP

1.0 BASE FABRIC

1.1	Base Fabric Weight	7.14 *oz/yd²*	243 *g/m²*	
1.2	Fiber / Style	Polyester / Woven		

2.0 COATED FABRIC

2.1	Total Weight	36 ±2 *oz/yd²*	1220 ±68 *g/m²*	
2.2	Coating Type	TPU		
2.3	Coating Distribution	50 / 50		
2.4	Sealing Properties	☒ Dielectric	☒ Thermal	

3.0 MATERIAL PROPERTIES

		Standard	Metric	ASTM TEST METHODS
3.1	Tensile Strength, Grab			
	Warp	600 *lbs*	2,670 *N*	D751-A
	Fill	500 *lbs*	2,220 *N*	
3.2	Tear Strength, Tongue			
	Warp	100 *lbs*	445 *N*	D751-B (mod)
	Fill	100 *lbs*	445 *N*	
3.3	Puncture, Screwdriver	100 *lbs*	445 *N*	D751
3.4	Puncture, Ball	600 *lbs*	2,670 *N*	D751
3.5	Hydrostatic Resistance	600 *psi*	4.1 *MPa*	D751-A
3.6	Adhesion, Tape	35 *lbs/2 in*	156 *N/ 5 cm*	D751
3.7	Adhesion RF	40 *lbs/in*	178 *N/cm*	D751
3.8	Low Temp	-65 *°F*	-54 *°C*	D2136
3.9	High Temp, Cont/Interm.	180 / 200 *°F*	82 / 93 *°C*	D1204
3.10	Abrasion Resistance (Wheel H18 / 1 kg)	10,000 *cycles*	10,000 *cycles*	D3884

COMMENTS: Cold Crack conditions – 4 hrs and 1/8" mandrel

NAV Number	006762

Notes:
1) Values presented above represent the minimum expected measurements.
2) Certificate of compliance is required for each shipment
3) Original test data for each lot may be required if requested for up to 3 years

The above specifications were approved for SEI products by

Engineer	
QC Manager	

SEI-IND #1 QC

SEI INDUSTRIES LTD., 7400 Wilson Avenue, Delta, B.C., Canada V4G 1H3
Tel: 604-946-3131, Fax: 604-940-9566, E-mail: SeiSales@SEI-Ind.com, Web: SEI-Ind.com

SEI INDUSTRIES

C ETL LISTED Intertek

INSTA-BERM (Frame) OPERATIONS MANUAL

2018 VERSION D

INSTA-BERM (FRAME) OPERATIONS MANUAL - Version D

Issue Date: September 2018

PLEASE READ BEFORE USING.

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Table of Contents

Section 1: Introduction

Overview of the Insta-Berm (Frame) System

This manual provides the necessary information and instructions for the installation, operation, maintenance, shipping and safe use of SEI Industries' Insta-Berm (Frame) – a portable secondary containment berm liner system. Additional copies of this manual are available from SEI Industries Ltd.

A fully collapsible berm, the Insta-Berm (Frame) is easy to use and meets EPA regulation 40CFR112.7. It comes in two fabric choices; Chem-Shield and Arctic-Shield fabric, which is fully certified by Intertek to meet the CAN/ULC-S668-12 Class IP and Class IIP standard and is suitable for secondary containment of flammable liquids and combustible liquids in both above ground (exposed) and (buried) non-exposed secondary containment applications.

Intertek Certified to CAN/ULC-S668-12

This standard is listed in the Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (SOR/2008-197), under the Canadian Environmental Protection Act, 1999.

Section 2: Description

Description of the Insta-Berm (Frame) System

The frame-supported Insta-Berm system is a portable secondary containment berm liner, intended to prevent the spill of liquids and hazardous materials. The liner is constructed of polymer-coated nylon or polyester fabric. Some models may be constructed of urethane-coated nylon. This type of berm system is used for larger applications that require superior environmental protection.

The prefabricated support frame is constructed of corrosion resistant aluminium pipe and galvanized malleable iron fittings.

There are two Insta-Berm frame models available (20" high and 32" high frames). The 32" model has a second set of rails to support the bottom of the liner.

20" high frame shown.

32" high frame shown.

Fabric Information

There are two types of fabric available with the frame-supported Insta-Berm systems:

- 30oz Chem-Shield fabric
- Arctic-Shield fabric is certified to ETL W/N 1746, chemical and fire-resistant fabric for temperatures to -50 degrees Fahrenheit / -46 degrees Celsius (Arctic-Shield fabric is not suitable for acids)

Chem-Shield (30 oz., black/black color)

Chem-Shield liners are constructed with interpolymer alloy coating that combines excellent durability with resistance to many chemicals. This fabric is suitable for containment of oily water, sludge, transformer mineral oil, sulphuric acid, PCB transformer oils, 30% chlorine, ammonium hydroxide, ethanol and fertilizer. This liner is designed to contain most chemicals suitable to -20 F. Call SEI to confirm usage of a specific chemical. Using optional corrosion proof fittings, phosphoric acid (10%) and sodium hydroxide (60%) is also permissible. *An alternative glue for repairs would be Loctite 495, which should be available locally.*

Arctic-Shield (tan/green color, used in Arctic berms)

Arctic-Shield liners are constructed from urethane-coated nylon that meets U.S. military specification MIL-T-52983G for fuel tanks. The following fluids are acceptable for containment: Jet A, Jet B, JP-1, JP-4, JP-8, kerosene, avgas, diesel fuels with less than 40% aromatic content and isopropyl alcohol suitable to -50 F. Arctic-Shield fabric is not suitable for use with gasoline (contact SEI for information on the Desert King). Arctic-Shield fabric meets U.S. military specification MI-T-52983G and ATPD-2266. *An alternative glue for repairs would be 3M(DP420), which should be available locally.*

Arctic-Shield fabric will provide longer service life due to a higher resistance to abrasion. It can also be used in warmer climates.

Important Note

Please contact an SEI representative for information on which fluids are acceptable for containment in a chemical resistant Insta-Berm system. The user is responsible for ensuring the berm is suitable for each application.

Chemically Resistant Insta-Berm System

Chemically resistant Insta-Berm systems are made from polymer coated polyester or nylon fabric. This fabric combines excellent durability with resistance to many chemicals.

The data shown in the chart on the following page is the result of laboratory tests and is intended to serve only as a guide. No performance warranty is intended or implied. The degree of chemical attack on any material is governed by the length of time, temperature and size of the area exposed.

When considering chemically resistant Insta-Berm system for specific applications, a fabric sample should be tested in as close to actual service conditions as possible.

Fabric Chemical Resistance

	Chem-Shield	Petro-Shield Arctic King
ACIDS		
Acetic, 5%	G	-
Formic, 20%	P	P
Hydrochloric, 10%	E	P
Sulfuric, 20%	E	F-G
ALCOHOLS		
Ethanol	E	-
Isopropanol	-	P
Methanol	E	F
ALKALI		
Sodium hydroxide 20%	E	F-P
Ammonium hydroxide10%	-	P
ORGANICS		
Acetone	P	P
ASTM Fuel A	E	G
ASTM Fuel B	E	F-G
ASTM Fuel C	G	F
ASTM Oil #1	E	E
ASTM Oil #2	E	E
ASTM Oil #3	E	E-G
Benzene	-	F-P
Brake fluid, Type A	G	F-P
Brake fluid, (H.D.)	G	-
Butane	G	G
Carbon tetrachloride	F	F
Cyclohexanone	D	D
Dimenthyl formamid	D	D
Dimethyl sulfoxide	D	D
1, 4-Dioxane	F	D
Dioctyl phthalate	G	G
Ethylene dichloride	-	P
Ethylene glycol	-	G
Ethylene glycol 50% H2O	G	G
Gasoline, 100 octane	G	G

	Chem-Shield	Petro-Shield Arctic King
ORGANICS (Continued)		
Kerosene	E	G
Methylene chloride	P	P
Methyl ethyl ketone	-	F-P
N-Methyl-2-Pyrrolidene	D	D
Oil, Texas crude	F-G	-
Oil, detergent 20W	E	-
Oil, Skydrol type B	D	-
Oil, transmission type A	E	E
Perchlorethylene	P	F
Pyridine	D	D
Tetrahydrofuran	D	D
Toluene	P	F
Trichloroethylene	P	P
Turpentine	G	G
MISCELLANEOUS		
Chlorox (5%)	E	F-P
Calcium chloride saturated solution	-	G
Freon 113	P	P
Freon 11B	P	P
Freon 12	G	G
Hydrogen disulfide (5%)	G	G
Mr. Clean	G	G
Sodium chloride saturated solution	G	G
Synthetic perspiration	G	G
Tide (1%)	G	G
Water	G	F

E-excellent, little or no change
G-good, slight loss in properties, slight swell
F-fair, swelling and some loss in properties
P-poor, significant loss of properties and significant swelling
D-dissolves
Note: Chemical resistance generally improves with increasing hardness.

Note: This table should be used as a guide only. Consult SEI Industries for specific applications.

Standard Equipment

The frame-supported Insta-Berm system comes complete with a berm liner, prefabricated support frame (20" or 32" high), pre-installed stake down tabs and bulkhead fittings for the optional RainDrain system. A crate for shipping and a repair pouch are also included. All repair instructions are found in this manual.

Optional Equipment

Also available from SEI Industries:

- RainDrain system
- High wind stakes (available only on Arctic-Shield berms)
- Groundsheet to protect the bottom of the Insta-Berm
- Track belting to protect the inside of the Insta-Berm from tires
- Carrying bag

RainDrain Description

The RainDrain system allows operators to continuously gravity-drain rain water from secondary containment berms without having to monitor the discharge. The RainDrain is designed as a go-no-go filtration system that will automatically stop the flow of discharge water when it is full or when there is a large amount of hydrocarbons present in the water being discharged.

18" Filter Assembly

36" Filter Assembly

RainDrain Performance

The RainDrain system allows rainfall and water from other sources to be discharged from the berm. The filtration unit stops all target contaminates, acting as a hydrocarbon selection unit and reducing the discharged water below 10 ppm hydrocarbon content.

When the filtration unit reaches containment capacity, it will automatically cease to discharge all fluids. When this occurs the filter cartridge will have to be replaced. Once that is completed, the system is ready for normal operation.

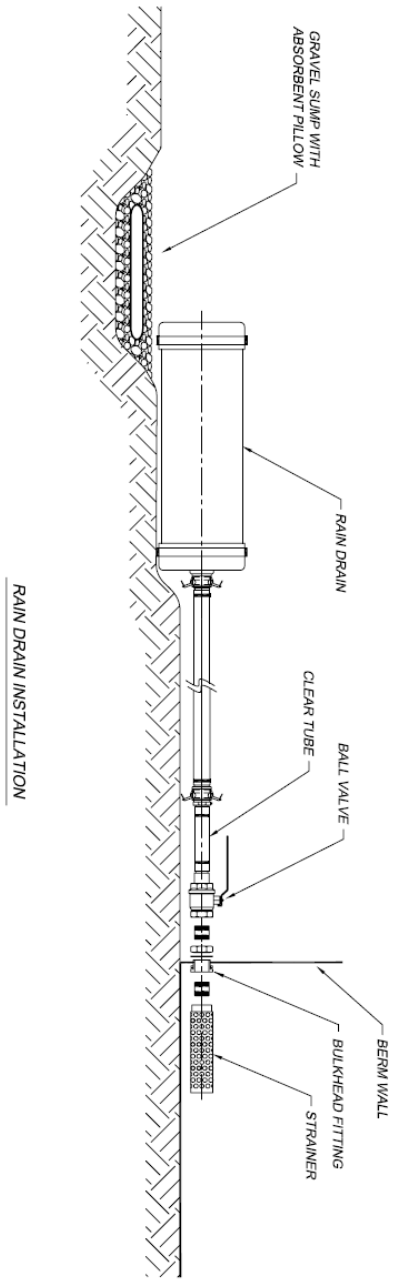
Important Note

The amount of hydrocarbons present in the secondary containment system will determine the frequency in which to replace the filter cartridge.

Warning

In the event of a catastrophic failure of a primary containment tank (that is secured within a secondary containment berm and protected by the RainDrain), the subsequent spill of a significant amount of fuel will cause the filter to shut down automatically. It is still possible that a small amount of fuel will escape through the RainDrain because of the higher fuel to water discharge ratio. This discharge can be trapped in a small discharge pit filled with hydrocarbon absorbent pads.

RainDrain Installation



RainDrain Specifications

Models

Model #	Oil Capacity	Water Flow Rate	Dimensions	Weight
IBMKF0618	.5 USG 1.9 Liters	.32 USGPM 1.2 L/Min	6” Dia. X 18” L (15 cm x 45 cm)	13 lbs. (5.89 Kg)
IBMKF0636	2 USG 7.6 Liters	.32 USGPM 1.2 L/Min	6” Dia. X 36” L (15 cm x 91 cm)	26 lbs. (11.79 Kg)

The RainDrain meets or exceeds the design requirements as well as free oil and grease water *discharge* levels for the following regulations:

- Environmental Protection Agency (EPA) 40 CFR Part 112.7
- Canadian Council of Ministers of the Environment (CCME) Code of Practice for above ground and underground storage tank systems containing petroleum and allied petroleum products. Section 3.10.3(1)(b)(i)
- British Columbia Waste Management Act, BC Regulation 168/94
- Alaska State AAC-75.075

The RainDrain is designed to produce a *discharge* of water that does not contain more then 10mg/L of free oil and grease as measured by the partition-gravimetric method. Independent testing has proven the RainDrain exceeds this performance requirement and those results are available upon request.

Based upon data available to SEI Industries Ltd. components in this product are not hazardous under the OSHA Hazard Communication (29 CFR 1910.1200).

Section 3: Safety

Safety Precautions

Handling Chemicals and Fluids

When handling chemicals and fluids, the following rules should be observed:

- Use approved skin and eye protection, as required.
- Use suggested safety procedures; contact the chemical manufacturer for the specific material safety data sheets.

Handling of Petroleum Fuels

Handling of petroleum fuels is always a potentially dangerous operation. The following rules should be observed:

- Keep the fueling site free of debris and flammable materials such as dry grass, etc.
- Observe all normal safety practices; e.g. a strict ***no smoking*** rule.
- Collect all intentional spillage in a container and discard safely.
- Keep all unnecessary personnel off site.
- Use grounding devices, where applicable.
- Have fire extinguishers manned during refuelling.
- Do not pack and ship containers with fuel residue inside.

Personnel Safety

The berm liner can become slippery when snow or water has accumulated inside. Track belting and proper footwear is recommend when walking inside the berm liner.

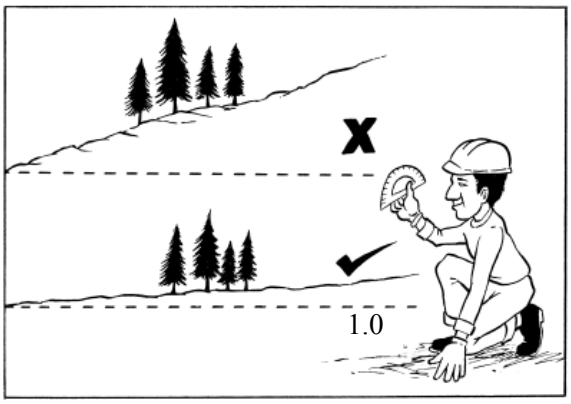
Section 4: Installation

Installation Procedures

Selecting a Site

The frame-supported Insta-Berm system may be installed on asphalt, concrete, sand or soil if the surface is well groomed and level. The site selected must be free of rocks, sticks and other debris that may damage the floor of the berm.

Select a site approximately 6' (1.8m) larger in each direction then the overall berm size (see *Section 7: Specifications and Parts* for overall dimensions). For best operating conditions, the slope of the site selected should not exceed one degree in any direction. Any slope will reduce the capacity of the berm. However, if the site has a slope in only one direction, it can result in better draining of the berm.



Select a site (maximum slope one degree).

Preparing the Site

Important Note

SEI recommends consulting a soils engineer to determine soil composition. A soils engineer can also determine if the soil is stable enough to support the weight of the berm and any objects inside the berm.

The surface of the ground should be smooth and firm. If the berm is to be installed on a paved surface, the surface should be swept clean before installation. Sharp gravel on top of a hard surface may puncture the berm.

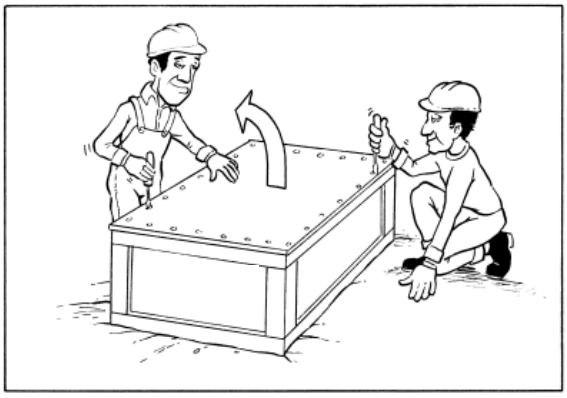
If the ground surface is too rough or irregular, it must be prepared by placing 1-2" (25-50 mm) of pea gravel covered by 1-2" (25-50 mm) of sand or soil. This also provides some drainage and helps keep water away from the liner.

The ground supporting the Insta-Berm system must be firm enough to prevent the berm from settling after filling, otherwise the berm liner may stretch and rupture. The ground must also be firm enough to prevent the frame support legs from sinking, should the berm fill with liquid.

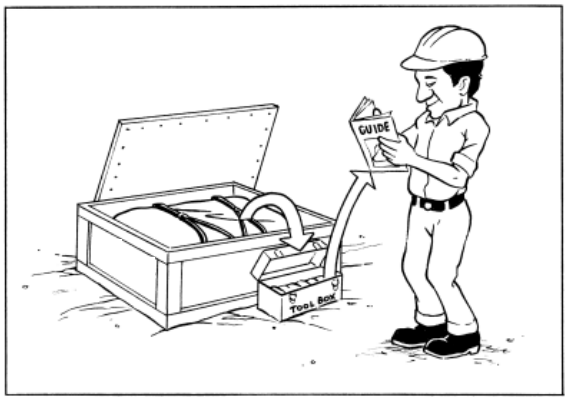
A groundsheet is recommended to protect the bottom surface of the berm from sharp objects (available from SEI Industries). An inside chafing liner is also available.

Assembling the Berm

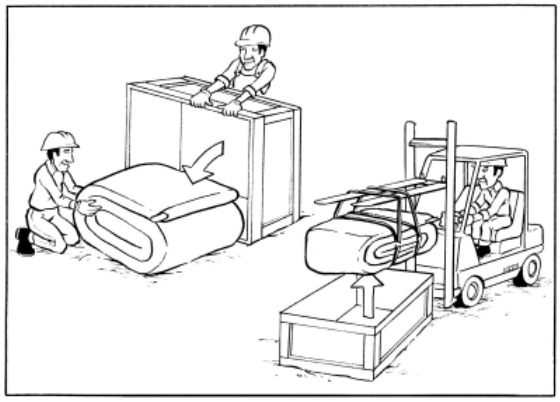
Move the crate to the assembly site and follow the procedures below:



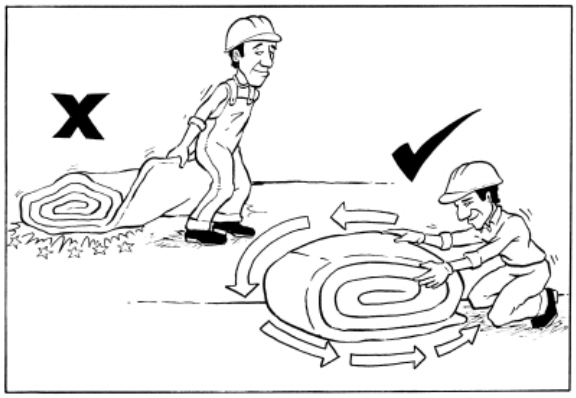
1. Open the crate.



2. Read the operator's manual.



3. Tip the crate and roll the liner and berm out OR lift the liner out with straps.



4. Roll the liner and berm to move it. Do not drag.

5. The shipping container should be retained for storage or for shipping the berm to a new location. Note how the liner is folded for easy return to the container.

6. If the berm is to be equipped with a groundsheet, spread the groundsheet out first. The groundsheet must be at least 2-3' larger then the berm itself.

Important Note

If the berm is equipped with an optional groundsheet, the groundsheet will be the smaller of the two.

7. Place the groundsheet at one corner of the site.

Groundsheet.

8. Unfold the groundsheet and centre it along one edge of the site.

9. Unroll the groundsheet across the site.

10. The groundsheet should now look like this.

11. Pull the edges of the groundsheet to remove any wrinkles. Flapping the edge to release trapped air will make it easier to pull flat.

Warning

Do not drag the berm without a barrier to protect the fabric from the ground.

Important Note

The berm liner can be moved by having personnel at opposite sides of the liner, lifting the edges. By flapping the edges, air is caught under the berm, allowing the berm to be moved without possible damage.

12. Using the crate liner fabric, carefully drag or roll the berm onto the ground-sheet.

Folded berm liner.

13. The size of your berm will determine how it should be placed on the ground-sheet. As you begin to unroll the berm, you may need to adjust its position to align the long and short sides.

14. To adjust the alignment of the berm, lift the berm by pulling on each end and move it into the correct position. For larger berms, re-roll the berm and place the crate liner material under the berm to slide it to the correct position.

15. Unfold the berm liner (ensuring the alignment is correct) as shown and pull the berm liner flat to ensure there are no wrinkles.

16. Unroll the berm liner across the site.

17. Fold back each side and end until a natural corner is formed. This creates space to assemble the frame.

Forming a natural corner.

18. Locate the four corner posts with fittings attached.

Corner posts.

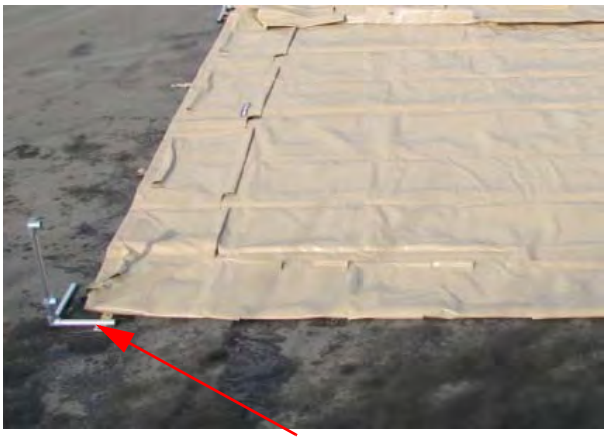
19. Attach the 16" (long) legs to the corner post.

20. Tighten the leg set screws with the supplied Allan wrench to 29 ft-lb. (39 Nm).

Tightening the leg set screws.

21. Locate the side posts and attach legs in the same manner as the corner posts.

22. Place the completed corner posts at each corner.

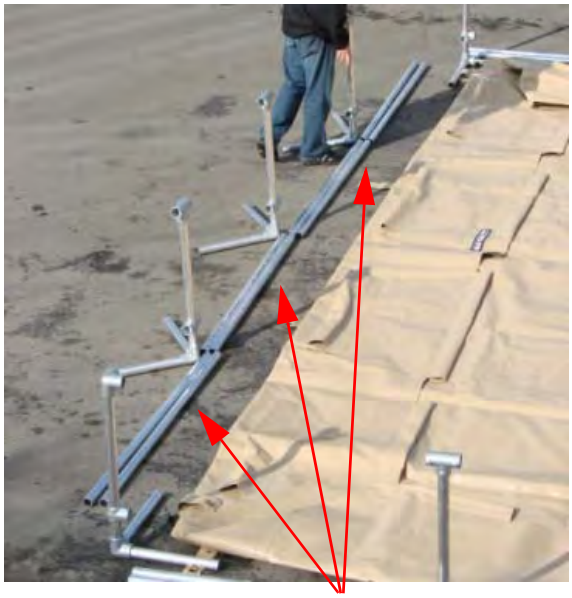


Corner post in position.

23. Place side posts approximately 5’ apart along each side.

Side posts in position.

24. Place the 5’ (1500 mm) rails in between the posts on each end and both sides. One rail for each section of 20" high berms and two rails for each section of 32" berms.



Rails laid along the side of the berm.

25. For a 20" high berm, slide the rails into each pocket around the berm.

Sliding rails on a 20" high berm.

26. For a 32" high berm, slide the rails into both the top and bottom pockets around the berm.

Slide top and bottom rails into pockets.

27. Starting with one corner, insert the lower rails. Tighten the set screw on the corner post to 29 ft-lb. (39 Nm).

Lower rails in place and tighten set screw.

28. Attach the top rails to the starting corner post and tighten the set screw to 29 ft-lb. (39 nm).

Tightening the top rail.

29. Move to the closest side post to the starting corner and attach the other end of the top rail onto the side post. Tighten the set screw.

Attaching the top rail to the side post.

30. Continue attaching the rails around the entire berm until you return to your starting point. If sufficient personnel are available, two teams can work in opposite directions from the starting corner.

31. The completed berm should now look like this.

High Wind Precautions

Warning

When using the Insta-Berm system near a helicopter or in high wind areas, it must be secured with tie-downs or sandbags to prevent the helicopter downwash or wind from lifting the liner. Helicopters can create enough downwash to lift an unsecured, empty berm liner completely off the ground. This could cause a rotor-strike.

Installing high wind stakes will lock the berm in place.

1. To secure the Insta-Berm system in high wind areas, place sandbags inside the liner near the edges. If the berm is empty, sandbags should also be placed on the corners of the liner.

2. High wind stakes should also be installed (available only on Arctic-Shield berms).

High wind stake (available on Arctic-Shield berms only).

Section 5: Maintenance

Maintenance and Repairs

Spill Clean-Up

Caution

The Insta-Berm system is for temporary secondary containment. Neutralize or transfer spills collected within the liner to permanent holding containers promptly.

Chemical resistance data is based on an exposure limit of 28 days duration at room temperature. The liner may be over-lined with disposable thin polyethylene sheeting for rapid clean up of spills.

Removing Water and Foreign Materials

Caution

SEI Industries will not be liable for any loss of stored liquids or related damage. To maximize spill retention, inspect the Insta-Berm frequently and remove rain water, snow or dirt promptly from the liner.

If the water has any chemicals floating on the surface or suspended in the water, a filter system should be used to eliminate these chemicals before allowing the water to return to the environment. SEI Industries recommends using SEI's RainDrain system for removing hydro-carbons. For non hydro-carbon chemicals, contact the local authorities to determine how to safely dispose of the chemicals.

To facilitate the pumping of water from inside the berm, each berm should be equipped with a manually operated pump. The pump should be located at the lowest point in the berm. An automatic pump should not be used as it would pump out any spillage in the berm.

If the Insta-Berm is installed on a grade, the liner can be un-hooked from the top pipe on the downhill side to allow the water to drain. Re-install the liner on the top pipe after draining the water. Do not leave the berm unattended while one side is lowered to facilitate draining. SEI Industries can automate this process with the RainDrain system. See this manual for more information.

Extending the Service Life of the Insta-Berm System

As with any equipment, the service life of the Insta-Berm system can be extended with proper care. Various factors affect portable berms:

- Ultra-violet radiation
- Folding
- Abrasion
- Moisture
- Temperature
- Type of liquid stored

An Insta-Berm system used in shady, dry, cool conditions and not moved frequently will provide longer service life.

The following suggestions will help extend berm service life:

- When moving the liner it should not be dragged or abraded. The folds should be made at different places each time the liner is moved. Be particularly careful with fork-lifts as the liner should be rolled onto the forks rather than sliding the forks under the tank.
- Spilled fluids should be removed promptly from the liner or tubes.
- The site should be arranged so the liner or tubes will not be sitting in water. A ditch around the berm will allow water to collect below the berm pad.
- Fabric berms are affected more by some liquids than by others. Contact SEI Industries for information on the liquid you intend to store.

Important Note

Check the setscrews annually for tightness. Tighten to 29 ft-lb. (39 Nm).

- If vehicles are intended to enter/exit the berm, track belting is recommended.

Track belting.

Important Note

If the berm is equipped with the optional track belting, it should now be spread out evenly inside the berm. If sharp or abrasive equipment is to be placed inside the berm, plywood panels can be laid down to protect the fabric.

Repairs

Using Glue

Tools and Materials Required

- Roller
- Scissors
- Patch material
- Glue
- Solvent (isopropyl rubbing alcohol is recommended)
- Abrasive pad

Important Note

Try a test repair before attempting to repair the item. It is much harder to fix a repair once a failed attempt has been made as the hardened glue is difficult to remove.

Before commencing repairs using glue, the following should be noted:

- The weather should be warm (above 60 deg. F or 15 deg. C) and dry.
- If the glue and patch are not properly placed, air bubbles will be created between the glue and patch.
- The patch should be weighted down for 8-12 hours.
- The repaired item should not be used before the glue has set.

Important Note

Dura-Seal glue has been designed specifically for the SEI family of fabrics. The shelf life of this adhesive is about one year. Fresh adhesive can be obtained directly from SEI Industries Ltd.

Warning

Glue vapours are highly explosive. Explosive vapours may occur causing fire and/or injury. Keep away from all sparks, flame, lighters or cigarettes.

Solvent and glue are both extremely hazardous. Use solvent and glue under well ventilated conditions only.

When using a warm air fan, either use one which is rated EXPLOSION PROOF or make sure that there is a steady flow of air past the work area to remove fumes as they are generated.

Repairing in High Humidity

In conditions of high humidity, a proper technique is essential for securing the bond strength desired as the presence of surface moisture can destroy the effectiveness of the cemented bond.

The evaporation of solvent from the adhesive may reduce the surface temperature below the dew point resulting in condensation of water vapour on the surface of the adhesive. This is often visible as fogging or a milky white appearance on the surface.

The use of a solvent to clean the surface prior to cementing can also reduce temperatures below the dew point.

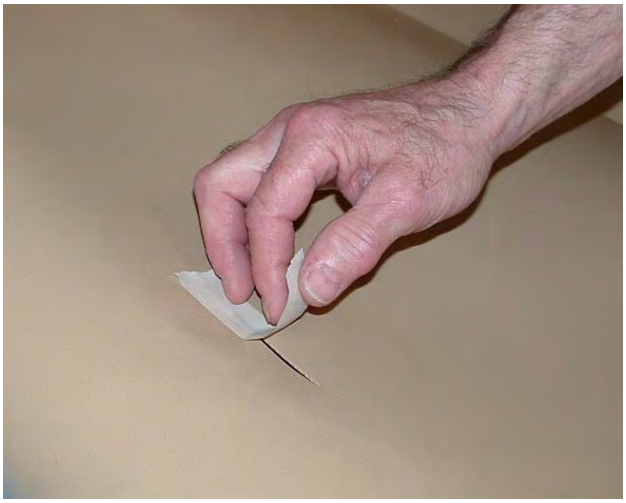
To overcome the high humidity problem, raise the temperature of the patch area. This can be accomplished with a warm air fan.

Applying the Glue

Small scrapes, damaged fabric coating or pinholes, which are not leaking, can be repaired with glue only. They do not require a patch. (A small scrape is defined as damage to the outer fabric coating only. A pinhole is defined as a small puncture that is not leaking.) However, damage to the base fabric must be repaired with a patch.

1. Fill the weight bag with water prior to beginning repairs.

2. Clean the area to be repaired with an abrasive pad dampened with solvent. Remove all traces of masking tape, if previously used. If possible, place a piece of masking tape on the back side of the item being repaired.



Apply masking tape on the backside of tear.

3. Paint the damaged area with glue. Use a thick coat of glue, overlapping the edges of the repair by 1" (25 mm). Be sure that the edges are well coated. A damaged coating should be given two coats of glue. Apply the second coat within four hours of the first coat.

Squeeze glue around tear and spread with fingers.

Important Note

Allow repair to harden for 24 hours at room temperature before using the item.

Gluing with Patches

If liquid is escaping or there is dampness around the damaged area, the item must be drained. If the damaged area is still dry, it will be possible to obtain a good bond without draining the item.

Any loose coating should be cut back with scissors. Trim to a point where there is a solid bond between the reinforcing fabric or scrim and the coating.

1. Support the damaged area on a flat, solid platform. If the item is drained, the damaged area should be supported above the rest of the item. This allows residual liquid to drain away from the damaged area. This platform should be strong enough to support the fabric (flat) and allow the patch to be rolled once it is in place.

2. Scrub the damaged area with an abrasive pad dampened with solvent (isopropyl rubbing alcohol is recommended). Scrub vigorously to remove the cured surface. The area should be clean and dry with a dull matte finish.

Caution

Solvent will damage the fabric if too much is used or if the fabric is left exposed to solvent residue.

3. Wipe with a rag, dampened with solvent, to remove any residue from cleaning. Check to see if the area is totally clean and all coated surfaces and edges are dull. If not, repeat the cleaning. This is critical for a good glue bond.

Cutting the Patch

1. Cut a patch. The patch should be at least 2" (50 mm) larger in every direction from the damaged area. A round patch is recommended but, if a rectangular patch covers the damage better, then round all corners.

The color of patch will vary, depending on the product repair kit.

2. Clean the patch by scrubbing with a pad dampened with solvent. Rub vigorously to remove the gloss from the fabric. Clean both sides of the patch, as it is easy to get the patch turned over during installation. The patch should also be cleaned on the outside since it will be painted with glue later.

Applying the Patch

1. Apply the Dura-Seal glue to the patch and damaged area. Wait 30 minutes (at 75 deg. F or 22 deg. C) for some of the solvent to evaporate from the glue. The glue should become thicker but still be quite wet. If it has been allowed to dry too long, give both sides another thin coat. If the glue has dried too long, it will be difficult to avoid entrapping air bubbles in the bonded joint.

2. Place the patch and roll it down with the roller. Place the centre of the patch down first, then roll it out towards the edges with the roller. This expels trapped air. Once the patch is rolled down, do not let it lift up. This will prevent air from getting under the patch which causes a weak bond.

3. If the item is sloped during the repair, tape the patch in place while holding it down. This stops the patch from sliding away from the damaged area.

4. Weight the patch down. Place a plastic cover sheet over the patch followed by a weight bag for 12 hours at room temperature. The item can then be moved but should not be filled until the glue has cured for 24 hours. The weight should hold the patch tight against the item while the glue sets. The plastic cover sheet will prevent the glue from sticking to the weight bag.

5. If the patch will be subjected to abrasion after 24 hours, paint over the patch with glue. Painting the patch also provides protection from ultra violet light and weather. Allow the bond to harden for 24 hours at room temperature before using the item.

Using Other Glues

If you do not have any Dura-Seal available, there are two other glues that can be used and are typically easy to purchase locally.

1. Loctite 495 can be used on Chem-Shield fabric to provide a quick patch repair but it will make a long term repair difficult at a later date as all 495 glue must be removed before applying Dura-Seal.

Warning

Loctite 495 carries the following warning: Irritating by inhalation. Eye irritant. Combustible liquid. Contains cyanoacrilate ester which may cause allergic skin reactions. Skin contact through clothing may cause burns. Use adequate ventilation in case of eye or body contact. Flush with water. Get medical attention for eye or internal contact.

2. The other glue option is 3M's 420 glue which has the advantage of creating a more permanent repair. If using this glue, follow the same instructions in this manual as for Dura-Seal adhesive.

Section 6: Packing and Storage

Repacking, Shipping and Storage

Repacking the Insta-Berm System

The following procedure is recommend for folding a liner:

1. Empty all liquids from the liner.

2. Clean the berm liner with a pressure washer using a mild soap and water solution through the RainDrain system. Allow the berm liner to dry completely.

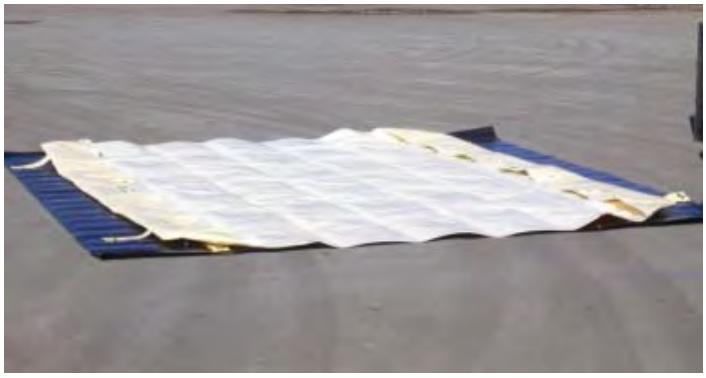
3. Remove all rails from the posts and the liner pockets.

Removing rails from posts.

4. Collapse the sides towards the centre. Remove all rails and posts from the area.

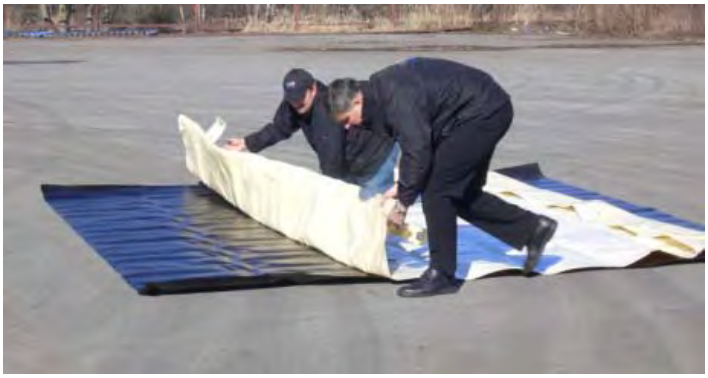
Sides collapsed towards the centre.

5. Ensure the berm liner is completely flat.



Berm liner laid flat.

6. Begin folding the berm liner as shown.



Folding the berm liner.

7. Continue folding the berm liner as shown.

8. Finished folding procedure.

Shipping Instructions

Warning

Do not pack and ship containers with fuel residue inside.

Important Note

If hazardous chemicals were stored, there may be restrictions on the method in which the berm can be transported. Please contact your local carriers to determine how to transport your liner safely.

To minimize the risk of damage, the Insta-Berm system should be shipped in its original crate or in an equivalent sturdy, well padded crate.

Storing the Insta-Berm System

For the best storage life, the system should be stored inside the carrying bag or shipping crate in a cool, dry location that is out of direct sunlight.

Section 7: Specifications and Parts

Specifications

CHEM-SHIELD						
MODEL	CAPACITY		INSIDE DIMENSIONS (L x W x H)		SHIP WT.	
	USG	LITERS	FT. / IN.	METERS	LBS.	KG.
20" Frames						
IBFS101020	1060	4012	10' x 10' x 20"	3.05 x 3.05 x 0.5	156	71
IBFS102020	2119	8023	10' x 20' x 20"	3.05 x 6.10 x 0.5	242	110
IBFS202020	4239	16046	20' x 20' x 20"	6.10 x 6.10 x 0.5	350	159
IBFS203020	6358	24069	20' x 30' x 20"	6.10 x 9.14 x 0.5	458	208
IBFS204020	8478	32092	20' x 40' x 20"	6.10 x 12.19 x 0.5	567	257
IBFS205020	10597	40115	20' x 50' x 20"	6.10 x 15.24 x 0.5	675	306
IBFS303020	9538	36104	30' x 30' x 20"	9.14 x 9.14 x 0.5	589	267
IBFS304020	12717	48138	30' x 40' x 20"	9.14 x 12.19 x 0.5	719	326
IBFS305020	15896	60173	30' x 50' x 20"	9.14 x 15.24 x 0.5	850	386
IBFS404020	16956	64185	40' x 40' x 20"	12.19 x 12.19 x 0.5	872	396
IBFS405020	21195	80231	40' x 50' x 20"	12.19 x 15.24 x 0.5	1025	465
IBFS505020	26494	100289	50' x 50' x 20"	15.24 x 15.24 x 0.5	1200	544
32" Frames						
IBFS101032	1808	6843	10' x 10' x 32"	3.05 x 3.05 x 0.8	242	110
IBFS202032	7231	27373	20' x 20' x 32"	6.10 x 6.10 x 0.8	515	234
IBFS203032	10847	41059	20' x 30' x 32"	6.10 x 9.14 x 0.8	662	300
IBFS303032	16270	61589	30' x 30' x 32"	9.14 x 9.14 x 0.8	832	377
IBFS304032	21694	82119	30' x 40' x 32"	9.14 x 12.19 x 0.8	1003	455
IBFS404032	28925	109491	40' x 40' x 32"	12.19 x 12.19 x 0.8	1195	542
IBFS405032	36156	136864	40' x 50' x 32"	12.19 x 15.24 x 0.8	1387	629
IBFS505032	45195	171080	50' x 50' x 32"	15.24 x 15.24 x 0.8	1602	727
Shipping Weight Based On 30oz. Fabric						

ARCTIC-SHIELD						
MODEL	CAPACITY		INSIDE DIMENSIONS (L x W x H)		SHIP WT.	
	USG	LITERS	FT. / IN.	METERS	LBS.	KG.
20" Frames						
IBFS101020A	1060	4012	10' x 10' x 20"	3.05 x 3.05 x 0.5	160	73
IBFS102020A	2119	8023	10' x 20' x 20"	3.05 x 6.10 x 0.5	247	112
IBFS202020A	4239	16046	20' x 20' x 20"	6.10 x 6.10 x 0.5	358	162
IBFS203020A	6358	24069	20' x 30' x 20"	6.10 x 9.14 x 0.5	469	213
IBFS204020A	8478	32092	20' x 40' x 20"	6.10 x 12.19 x 0.5	581	264
IBFS205020A	10597	40115	20' x 50' x 20"	6.10 x 15.24 x 0.5	693	314
IBFS303020A	9538	36104	30' x 30' x 20"	9.14 x 9.14 x 0.5	604	274
IBFS304020A	12717	48138	30' x 40' x 20"	9.14 x 12.19 x 0.5	740	336
IBFS305020A	15896	60173	30' x 50' x 20"	9.14 x 15.24 x 0.5	875	397
IBFS404020A	16956	64185	40' x 40' x 20"	12.19 x 12.19 x 0.5	900	408
IBFS405020A	21195	80231	40' x 50' x 20"	12.19 x 15.24 x 0.5	1058	480
IBFS505020A	26494	100289	50' x 50' x 20"	15.24 x 15.24 x 0.5	1240	562
32" Frames						
IBFS101032A	1808	6843	10' x 10' x 32"	3.05 x 3.05 x 0.8	247	112
IBFS202032A	7231	27373	20' x 20' x 32"	6.10 x 6.10 x 0.8	525	238
IBFS203032A	10847	41059	20' x 30' x 32"	6.10 x 9.14 x 0.8	675	306
IBFS303032A	16270	61589	30' x 30' x 32"	9.14 x 9.14 x 0.8	850	386
IBFS304032A	21694	82119	30' x 40' x 32"	9.14 x 12.19 x 0.8	1027	466
IBFS404032A	28925	109491	40' x 40' x 32"	12.19 x 12.19 x 0.8	1225	556
IBFS405032A	36156	136864	40' x 50' x 32"	12.19 x 15.24 x 0.8	1424	646
IBFS505032A	45195	171080	50' x 50' x 32"	15.24 x 15.24 x 0.8	1646	747
Shipping Weight Based On 32oz. Fabric						

Terra Tank to Frame Insta-Berm Cross Reference Chart

	FRAME BERM	
TANK CAPACITY	**20"**	**32"**
1000 USG	IBFS202020	
1200 USG	IBFS202020	
1500 USG	IBFS202020	
1800 USG	IBFS202020	
2000 USG	IBFS202020	
2400 USG	IBFS202020	
2500 USG	IBFS202020	
3000 USG	IBFS202020	
3600 USG	IBFS202020	IBFS202032
4000 USG	IBFS203020	IBFS202032
4800 USG	IBFS203020	IBFS203032
5000 USG	IBFS203020	IBFS203032
6000 USG	IBFS303020	IBFS203032
7500 USG	IBFS303020	IBFS303032
9000 USG	IBFS304020	IBFS303032
10000 USG	IBFS304020	IBFS303032
12000 USG	IBFS404020	IBFS303032
15000 USG	IBFS404020	IBFS304032
18000 USG	IBFS405020	IBFS304032
20000 USG	IBFS505020	IBFS404032
24000 USG	IBFS505020	IBFS404032
25000 USG	IBFS606020	IBFS404032
30000 USG	IBFS606020	IBFS405032
48000 USG		
50000 USG		

Repair Kits

Mini Repair Pocket Kit REPKM002

Mini Repair Pocket Kit REPKM002NG (no glue)

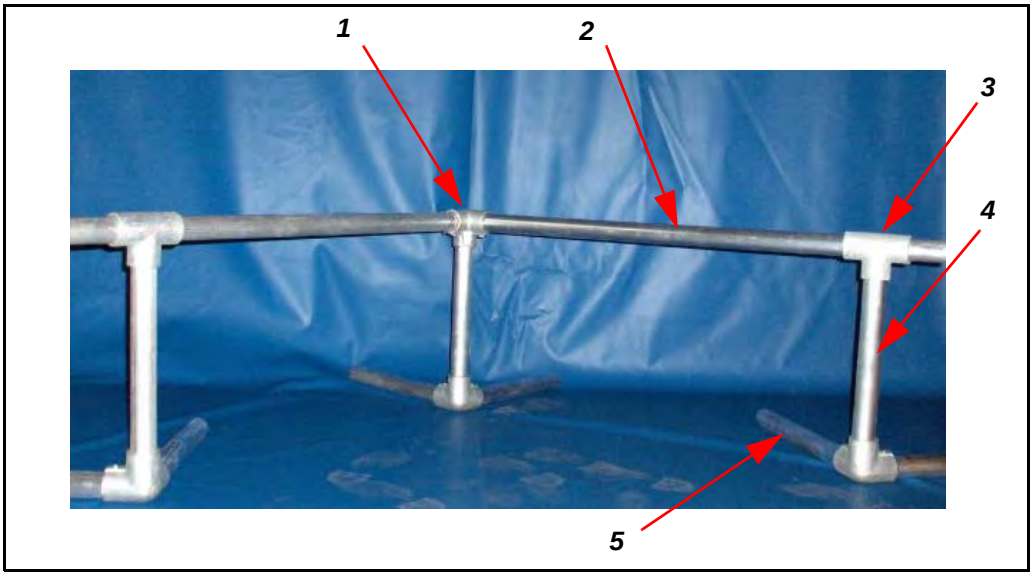
Important Note

It is the responsibility of the dealer and end user to ensure that the importation of glue is allowed in the country of use.

PART #	DESCRIPTION	QTY.
REPM102	FABRIC REPAIR FLYER	1
REPP001	POUCH FOR REPAIR POCKET	1
PP504	ABRASIVE PAD	2
PP525	ADHESIVE, DURA-SEAL 1 oz. (see note above)	1
PP513	SCISSORS	1
REPP140	REPAIR PATCH FOR CHEM GUARD 24 OZ	3
REPP120	REPAIR PATCH FOR CHEM GUARD 30 OZ	3
REPP142	REPAIR PATCH FOR PETROSHIELD	3
REPP150	REPAIR PATCH FOR TEMPSHEILD	3

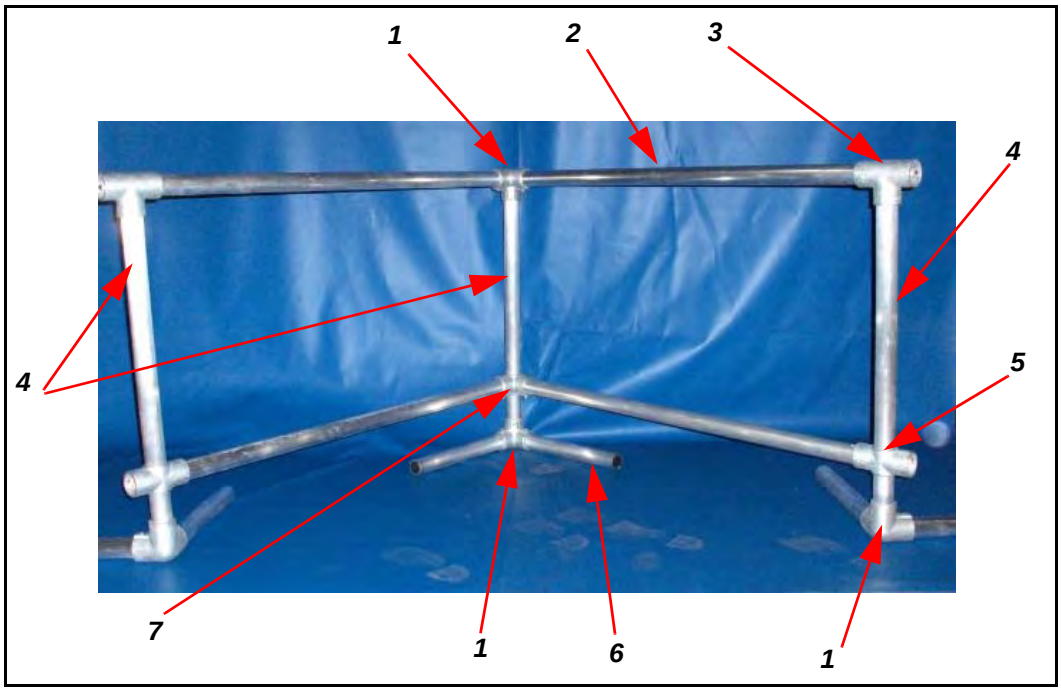
Parts List

20" High Berms



ITEM	PART #	DESCRIPTION	QTY.
1	IBMF001	Fitting elbow 3 way 90 degrees Galv. 1 ½”	1
2	IBMF044	Rail section 1 ½” x 58” Alum.	1
3	IBMF002	Fitting long tee Galv. 1 ½”	1
4	IBMF033	Corner or side post 1 ½” x 18 ¾” Alum.	1
5	IBMF032	Foot tube 1 ½” X 15 7/8”	1

32" High Berms



ITEM	PART #	DESCRIPTION	QTY
1	IBMF001	Fitting elbow 3 way 90 degrees Galv.1 ½"	1
2	IBMF044	Rail section 1 ½" X 58" Alum.	1
3	IBMF002	Fitting long tee Galv. 1 ½"	1
4	IBMF040	Corner or side post 1 ½" X 33 ½" Alum	1
5	IBMF011	Fitting cross straight 4 way Galv. 1 ½	1
6	IBMF032	Foot tube 1 ½" x 15 7/8" Alum	1
7	IBMF010	Fitting side outlet 90 degrees 4 way Galv 1 ½"	1

Section 8: Warranty

a) Warranty is limited to repairing or replacing, at the company's sole discretion, any product approved to be defective.

b) The company's products are not guaranteed for any specific length of time or measure of service, but are warranted only to be free from defects in workmanship and material for a period of one year to the original purchaser.

c) To the extent allowable under applicable law, the company's liability for consequential, incidental and environmental damages is expressly disclaimed. **The company's liability in all events is limited to and shall not exceed, the purchase price paid.**

d) This warranty is granted to the original purchaser and does not extend to a subsequent purchaser or assignee.

e) The company must receive notification in writing of any claims of warranty from the original purchaser which must give details of the claimed defect in the product.

f) Where the original purchaser is claiming under warranty, the product must be returned to the company for inspection with all transportation and duty charges prepaid.

g) The warranty does not extend to any product that has been accidentally damaged, abraded, altered, punctured, abused, misused or used for a purpose which has not been approved by the company.

h) This warranty does not apply to any accessories used with the product such as pumps, filters, hoses, etc., that are not supplied by the company, and any warranty on such accessories must be requested from the manufacturer or dealer of the accessories.

i) In the event the original purchaser does not give notice of a warranty claim within one year of the original purchase of the product, it is understood that the purchaser has waived the claim for warranty and the purchaser and/or any subsequent purchaser must accept the condition of the product as it may be, without warranty.

j) Any technical information supplied by the company regarding the product is not a condition of warranty but rather is information provided by the company to the best of its knowledge.

k) There are no implied warranties nor is there any warranty that can be assumed from any representation of any person, except the company itself.

Exclusions

This warranty is void if the product is not assembled, used and/or maintained in accordance with the operator's manual supplied by SEI.

This Appendix includes:

- Self-Priming Centrifugal Pumps - Installation and Operation Part 1 of 3

- Self-Priming Centrifugal Pumps - Part list Part 2 of 3

- Self-Priming Centrifugal Pumps - Maintenance and Repair Part 3 of 3

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GORMAN-RUPP PUMPS

SELF-PRIMING CENTRIFUGAL PUMPS

MANUAL PART 1 of 3

INSTALLATION AND OPERATION

THE GORMAN-RUPP COMPANY ● MANSFIELD, OHIO
GORMAN-RUPP OF CANADA LIMITED ● ST. THOMAS, ONTARIO, CANADA Printed in U.S.A.

INTRODUCTION

Thank You for purchasing a Gorman-Rupp Self-Priming Centrifugal Pump. **Read this manual** carefully to learn how to safely install and operate your pump. Failure to do so could result in personal injury or damage to the pump.

A set of three manuals accompanies your pump. Each set consists of three parts; the Installation/ Operation Manual contains essential information on installing and operating the pumps. However, since pump installations are seldom identical, some of the information only summarizes general recommendations and practices required to inspect, position, and arrange the pump and piping.

The Parts List Manual provides performance curve(s), a pump model cross-section drawing, and parts list for your pump.

The Maintenance and Repair Manual provides troubleshooting and maintenance instructions required to properly diagnose operational problems, and to service the pump components.

Because pump installations are seldom identical, this manual cannot possibly provide detailed instructions and precautions for every aspect of each specific application. Therefore, it is the responsibility of the owner/installer of the pump to ensure that applications not addressed in this manual are performed **only** after establishing that neither operator safety nor pump integrity are compromised by the installation. Pumps and related equipment **must** be installed and operated according to all national, local and industry standards.

If there are any questions regarding the pump which are not covered in this manual or in other literature accompanying the unit, please contact your Gorman-Rupp distributor or the Gorman-Rupp Company:

The Gorman-Rupp Company
P.O. Box 1217
Mansfield, Ohio 44901 – 1217
or:
Gorman-Rupp of Canada Limited
70 Burwell Road
St. Thomas, Ontario N5P 3R7

CONTENTS

RECORDING MODEL AND SERIAL NUMBERS

Please record the pump model and serial number in the spaces provided below. Your Gorman-Rupp distributor needs this information when you require parts or service.

Pump Model: _____

Serial Number: _____

WARRANTY INFORMATION

The warranty provided with your pump is part of Gorman-Rupp's support program for customers who operate and maintain their equipment as described in this and the other accompanying literature. Please note that should the equipment be abused or modified to change its performance beyond the original factory specifications, the warranty will become void and any claim will be denied.

The following are used to alert personnel to procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel:

DANGER!

Immediate hazards which WILL result in severe personal injury or death. These instructions describe the procedure required and the injury which will result from failure to follow the procedure.

WARNING!

Hazards or unsafe practices which COULD result in severe personal injury or death. These instructions describe the procedure required and the injury which could result from failure to follow the procedure.

CAUTION

Hazards or unsafe practices which COULD result in minor personal injury or product or property damage. These instructions describe the requirements and the possible damage which could result from failure to follow the procedure.

NOTE

Instructions to aid in installation, operation, and maintenance or which clarify a procedure.

SAFETY - SECTION A

This information applies to G-R Self-Priming Centrifugal pumps. These pumps are available as basic, pedestal-mounted models or as close-coupled models driven by either an electric motor, gasoline or diesel engine. Refer to the manual accompanying the power source before attempting to begin operation.

This manual will alert personnel to known procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel. However, this manual cannot possibly anticipate and provide detailed instructions and precautions for every situation that might occur during maintenance of the unit. Therefore, it is the responsibility of the owner/maintenance personnel to ensure that only safe, established maintenance procedures are used, and that any procedures not addressed in this manual are performed only after establishing that neither personal safety nor pump integrity are compromised by such practices.

In addition to this manual, see the separate literature covering maintenance and repair, pump parts, and any optional equipment shipped with the pump.

Before attempting to open or service the pump:

1. **Familiarize yourself with this manual.**
2. **Disconnect or shut down the power source and take necessary precautions to ensure that the pump will remain inoperative.**
3. **Allow the pump to completely cool if overheated.**
4. **Check the temperature before opening any covers, plates, or plugs.**
5. **Close the suction and discharge valves.**
6. **Vent the pump slowly and cautiously.**
7. **Drain the pump.**

Do not attempt to pump any liquids the pump has not been designed for, and which may damage the pump or endanger personnel as a result of pump failure. Consult the factory to determine compatibility between the pump and liquid.

Use lifting and moving equipment in good repair and with adequate capacity to prevent injuries to personnel or damage to equipment. Suction and discharge hoses and piping must be removed from the pump before lifting.

After the pump has been positioned, make certain that the pump and all piping or hose connections are tight, properly supported and secure before operation.

Do not operate the pump against a closed discharge valve for long periods of time. If operated against a closed discharge valve, pump components will deteriorate, and the liquid could come

to a boil, build pressure, and cause the pump casing to rupture or explode.

WARNING!

Do not remove plates, covers, gauges, pipe plugs, or fittings from an overheated pump. Vapor pressure within the pump can cause parts being disengaged to be ejected with great force. Allow the pump to cool before servicing.

WARNING!

These pumps may be used to handle products which if overheated could produce dangerous fumes. Use extreme caution when venting the pump, or when removing covers, plates, plugs, or fittings.

WARNING!

Never run this pump backwards. Be certain that rotation is correct before fully engaging the pump.

WARNING!

If the pump is used to pump materials which could cause serious illness or injury through direct exposure or emitted fumes, wear protective clothing, such as rubber gloves, face mask, and rubber apron, as necessary before disassembling the pump or piping.

WARNING!

Do not operate the pump without shields and/or guards in place over the drive shafts, belts, and/or couplings, or other rotating parts. Exposed rotating parts can catch clothing, fingers, or tools, causing severe injury to personnel.

WARNING!

If the pump is powered by an electric motor, do not operate a non-explosion proof motor in an explosive atmosphere. An explosion, which may cause severe personal injury or death, could result. Install, connect and operate the motor in accordance with the National Electric Code and all local codes. If there is a conflict between the instructions in the manual accompanying the unit and the National Electric Code or applicable local code, the National or Local code shall take precedence. All electrical equipment supplied with the pump conforms to applicable federal regulations and national codes in effect on the date of manufacture.

WARNING!

If the pump is electric motor driven, the electrical power used to operate this pump is high enough to cause injury or death. Obtain the services of a qualified electrician to troubleshoot, test and/or service the electrical components of this pump.

DANGER!

If the pump is powered by an internal combustion engine, do not operate in an explosive atmosphere. When operating internal combustion engines in an enclosed area, make certain that exhaust fumes are piped to the outside. These fumes contain carbon monoxide, a deadly gas that is colorless, tasteless, and odorless.

Fuel used by internal combustion engines presents an extreme explosion and fire hazard. Make certain that all fuel lines are securely connected and free of leaks. Never refuel a hot or running engine. Avoid overfilling the fuel tank. Always use the correct type of fuel.

Never tamper with the engine governor to gain more power. The governor establishes safe operating limits that should not be exceeded. The maximum continuous operating speed for the pump is shown on the performance curve (see the Parts List Manual).

If the pump is powered by an engine, the engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

Pumps and related equipment must be installed and operated according to all national, local and industry standards.

INSTALLATION – SECTION B

Review all SAFETY information in Section A.

Since pump installations are seldom identical, this section offers only general recommendations and practices required to inspect, position, and arrange the pump and piping.

Most of the information pertains to a standard **static lift** application where the pump is positioned above the free level of liquid to be pumped.

If installed in a **flooded suction application** where the liquid is supplied to the pump under pressure, some of the information such as mounting, line configuration, and priming must be tailored to the specific application. Since the pressure supplied to the pump is critical to performance and safety, **be sure** to limit the incoming pressure to 50% of the maximum permissible operating pressure as shown on the pump performance curve (see Parts List Manual). **If the pump is fitted with a Gorman-Rupp double grease lubricated seal, the maximum incoming pressure must be reduced to 10 p.s.i.**

For further assistance, contact your Gorman-Rupp distributor or the Gorman-Rupp Company.

PREINSTALLATION INSPECTION

The pump assembly was inspected and tested before shipment from the factory. Before installation, inspect the pump for damage which may have occurred during shipment. Check as follows:

a. Inspect the pump and power source (if so equipped) for cracks, dents, damaged threads, and other obvious damage.

b. Check for and tighten loose attaching hardware. Since gaskets tend to shrink after drying, check for loose hardware at mating surfaces.

c. Carefully read all tags, decals, and markings on the pump assembly, and perform all duties indicated. Note that the pump shaft rotates in the required direction.

d. Check levels and lubricate as necessary. Refer to **LUBRICATION** in the **MAINTENANCE AND REPAIR** section of this manual and any other literature accompanying the unit and perform duties as instructed.

e. If the pump and power source have been stored for more than 12 months, some of the components or lubricants may have exceeded their maximum shelf life. These **must be inspected or replaced** to ensure maximum pump service.

If the maximum shelf life has been exceeded, or if anything appears to be abnormal, contact your Gorman-Rupp distributor or the factory to determine the repair or updating policy. **Do not** put the pump into service until appropriate action has been taken.

Battery Installation

If the pump is engine driven, the engine battery is **not** included with the unit unless otherwise specified on the pump order. See the battery tag included with the battery box assembly for battery specifications. Refer to information accompanying the battery and/or electrolyte solution for activation and charging instructions.

Before installing the battery, clean the positive and negative cable connectors, and the battery terminals. Secure the battery by tightening the hold-down brackets. The terminals and clamps may be coated with petroleum jelly to retard corrosion. Connect and tighten the positive cable first, then the negative cable.

POSITIONING PUMP

Lifting

Use lifting equipment with a capacity of at least **5 times** the weight of the pump, not including the weight of accessories, wheel kit or optional equipment. Customer installed equipment such as suction and discharge piping **must** be removed before attempting to lift.

CAUTION

The pump assembly can be seriously damaged if the chains or cables used to lift and move the unit are improperly wrapped around the pump.

Mounting

Locate the pump in an accessible place as close as practical to the liquid being pumped. Level mounting is essential for proper operation.

The pump may have to be supported or shimmed to provide for level operation or to eliminate vibration.

If the pump has been mounted on a moveable base, make certain the base is stationary by setting the brake and blocking the wheels before attempting to operate the pump.

If the pump is engine driven, **do not** position the pump and engine more than 15° off horizontal for continuous operation in order to ensure sufficient lubrication and fuel supply to the engine. The pump and engine may be positioned up to 30° off horizontal for **intermittent operation only**; however, the engine manufacturer should be consulted for continuous operation at angles greater than 15°.

Clearance

When positioning the pump, allow clearance in front of the back cover to permit removal of the cover and easy access to the pump interior. Consult the factory or the Specification Data sheet for recommended clearance.

SUCTION AND DISCHARGE PIPING

Pump performance is adversely effected by increased suction lift, discharge elevation, and friction losses. See the performance curve in the Parts List manual to be sure your overall application allows the pump to operate within the safe operation range.

Materials

Either pipe or hose maybe used for suction and discharge lines; however, the materials must be compatible with the liquid being pumped. If hose is used in suction lines, it must be the rigid-wall, reinforced type to prevent collapse under suction. Using piping couplings in suction lines is not recommended.

Line Configuration

Keep suction and discharge lines as straight as possible to minimize friction losses. Make minimum use of elbows and fittings, which substantially increase friction loss. If elbows are necessary, use the long-radius type to minimize friction loss.

Connections to Pump

Before tightening a connecting flange, align it exactly with the pump port. Never pull a pipe line into place by tightening the flange bolts and/or couplings.

Lines near the pump must be independently supported to avoid strain on the pump which could cause excessive vibration, decreased bearing life, and increased shaft and seal wear. If hose-type lines are used, they should have adequate support to secure them when filled with liquid and under pressure.

Gauges

Most pumps are drilled and tapped for installing discharge pressure and vacuum suction gauges. If these gauges are desired for pumps that are not tapped, drill and tap the suction and discharge lines not less than 18 inches (457,2 mm) from the suction and discharge ports and install the lines. Installation closer to the pump may result in erratic readings.

SUCTION LINES

To avoid air pockets which could affect pump priming, the suction line must be as short and direct as possible. When operation involves a suction lift, the line must always slope upward to the pump from the source of the liquid being pumped; if the line

slopes down to the pump at any point along the suction run, air pockets will be created.

Fittings

Suction lines should be the same size as the pump inlet. If reducers are used in suction lines, they should be the eccentric type, and should be installed with the flat part of the reducers uppermost to avoid creating air pockets. Valves are not normally used in suction lines, but if a valve is used, install it with the stem horizontal to avoid air pockets.

Strainers

If a strainer is furnished with the pump, be certain to use it; any spherical solids which pass through a strainer furnished with the pump will also pass through the pump itself.

If a strainer is not furnished with the pump, but is installed by the pump user, make certain that the total area of the openings in the strainer is at least three or four times the cross section of the suction line, and that the openings will not permit passage of solids larger than the solids handling capability of the pump.

Refer to the Specification Data sheet for the spherical solids handling capability of your specific pump model.

Sealing

Since even a slight leak will affect priming, head, and capacity, especially when operating with a high suction lift, all connections in the suction line should be sealed with pipe dope to ensure an airtight seal. Follow the sealant manufacturer's recommendations when selecting and applying the pipe dope. The pipe dope should be compatible with the liquid being pumped.

Suction Lines In Sumps

If a single suction line is installed in a sump, it should be positioned away from the wall of the sump at a distance equal to 1-1/2 times the diameter of the suction line.

If there is a liquid flow from an open pipe into the sump, the flow should be kept away from the suction inlet because the inflow will carry air down into the sump, and air entering the suction line will reduce pump efficiency.

If it is necessary to position inflow close to the suction inlet, install a baffle between the inflow and the suction inlet at a distance 1-1/2 times the diameter of the suction pipe. The baffle will allow entrained air to escape from the liquid before it is drawn into the suction inlet.

If two suction lines are installed in a single sump, the flow paths may interact, reducing the efficiency of one or both pumps. To avoid this, position the suction inlets so that they are separated by a distance equal to at least 3 times the diameter of the suction pipe.

Suction Line Positioning

The depth of submergence of the suction line is critical to efficient pump operation. Figure 1 shows recommended minimum submergence vs. velocity.

NOTE

The pipe submergence required may be reduced by installing a standard pipe increaser fitting at the end of the suction line. The larger opening size will reduce the inlet velocity. Calculate the required submergence using the following formula based on the increased opening size (area or diameter).

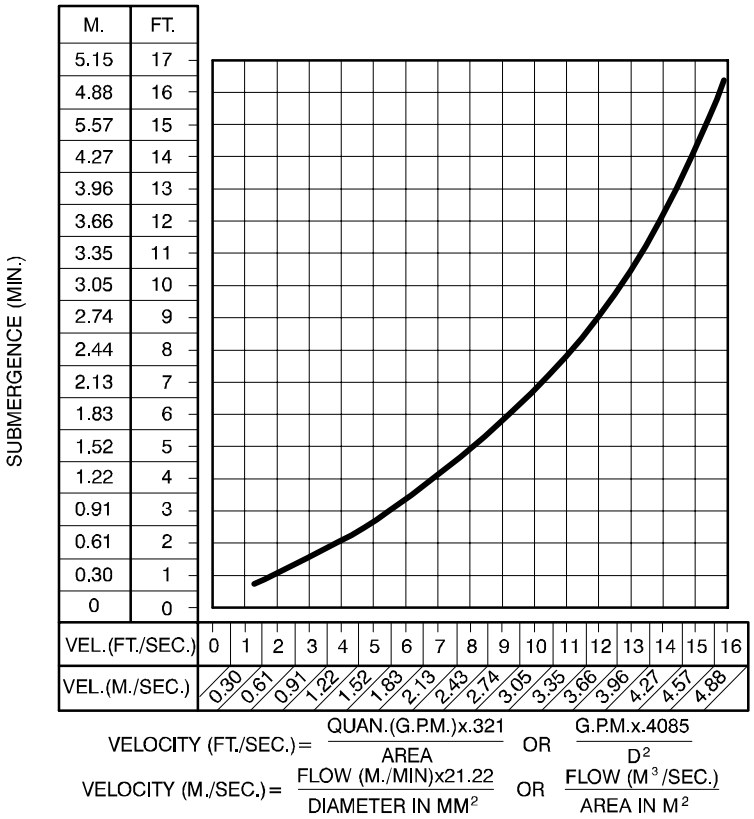


Figure 1. Recommended Minimum Suction Line Submergence vs. Velocity

DISCHARGE LINES

Siphoning

Do not terminate the discharge line at a level lower than that of the liquid being pumped unless a siphon breaker is used in the line. Otherwise, a siphoning action causing damage to the pump could result.

Valves

If a throttling valve is desired in the discharge line, use a valve as large as the largest pipe to minimize friction losses. Never install a throttling valve in a suction line.

A check valve in the discharge line is normally recommended, but it is not necessary in low discharge head applications.

With high discharge heads, it is recommended that a throttling valve and a system check valve be installed in the discharge line to protect the pump from excessive shock pressure and reverse rotation when it is stopped.

CAUTION

If the application involves a high discharge head, gradually close the discharge throttling valve before stopping the pump.

Bypass Lines

Self-priming pumps are not air compressors. During the priming cycle, air from the suction line must be vented to atmosphere on the discharge side. If the discharge line is open, this air will be vented through the discharge. However, if a check valve has been installed in the discharge line, the discharge side of the pump must be opened to atmospheric pressure through a bypass line installed between the pump discharge and the check valve. A self-priming centrifugal pump **will not prime** if there is sufficient static liquid head to hold the discharge check valve closed.

NOTE

The bypass line should be sized so that it does not affect pump discharge capacity; however, the bypass line should be at least 1 inch in diameter to

minimize the chance of plugging.

In **low discharge head applications** (less than 30 feet or 9 meters), it is recommended that the bypass line be run back to the wet well, and located 6 inches below the water level or cut-off point of the low level pump. In some installations, this bypass line may be terminated with a six-to-eight foot length of 1 1/4 inch I.D. **smooth-bore** hose; air and liquid vented during the priming process will then agitate the hose and break up any solids, grease, or other substances likely to cause clogging.

CAUTION

A bypass line that is returned to a wet well must be secured against being drawn into the pump suction inlet.

It is also recommended that pipe unions be installed at each 90° elbow in a bypass line to ease disassembly and maintenance.

In **high discharge head applications** (more than 30 feet), an excessive amount of liquid may be bypassed and forced back to the wet well under the full working pressure of the pump; this will reduce overall pumping efficiency. **Therefore, it is recommended that a Gorman-Rupp Automatic Air Release Valve be installed in the bypass line.**

Gorman-Rupp Automatic Air Release Valves are reliable, and require minimum maintenance. See **AUTOMATIC AIR RELEASE VALVE** in this section for installation and theory of operation of the Automatic Air Release Valve. Consult your Gorman-Rupp distributor, or contact the Gorman-Rupp Company for selection of an Automatic Air Release Valve to fit your application.

If the installation involves a flooded suction such as a below-ground lift station, a pipe union and manual shut-off valve may be installed in the bleed line to allow service of the valve without shutting down the station, and to eliminate the possibility of flooding. If a manual shut-off valve is installed **anywhere** in the air release piping, it **must** be a full-opening **ball type** valve to prevent plugging by solids.

WARNING!

If a manual shut-off valve is installed in a bypass line, it must not be left closed during operation. A closed manual shut-off valve may cause a pump which has lost prime to continue to operate without reaching prime, causing dangerous overheating and possible explosive rupture of the pump casing. Personnel could be severely injured.

Allow an over-heated pump to cool before servicing. Do not remove plates, covers, gauges, or fittings from an overheated pump. Liquid within the pump can reach boiling temperatures, and vapor pressure within the pump can cause parts being disengaged to be ejected with great force. After the pump cools, drain the liquid from the pump by removing the casing drain plug. Use caution when removing the plug to prevent injury to personnel from hot liquid.

AUTOMATIC AIR RELEASE VALVE

When properly installed and correctly adjusted to the specific hydraulic operating conditions of the application, the Gorman-Rupp Automatic Air Release Valve will permit air to escape through the bypass line, and then close automatically when the pump is fully primed and pumping at full capacity.

Theory of Operation

Figures 2 and 3 show a cross-sectional view of the Automatic Air Release Valve, and a corresponding description of operation.

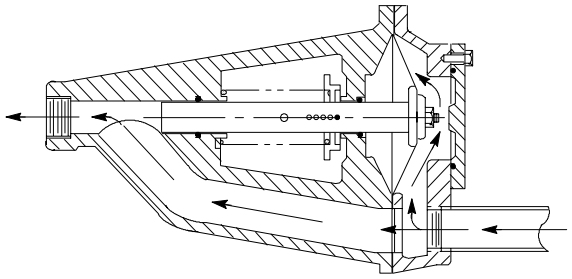


Figure 2. Valve in Open Position

During the priming cycle, air from the pump casing flows through the bypass line, and passes through the Air Release Valve to the wet well (Figure 2).

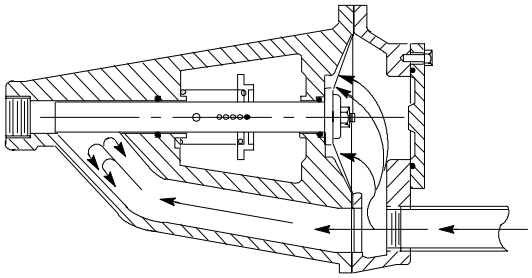


Figure 3. Valve in Closed Position

When the pump is fully primed, pressure resulting from flow against the valve diaphragm compresses the spring and closes the valve (Figure 3). The valve will remain closed, reducing the bypass of liquid to 1 to 5 gallons (3.8 to 19 liters) per minute, until the pump loses its prime or stops.

WARNING!

Some leakage (1 to 5 gallons or 3.8 to 19 liters per minute) will occur when the valve is fully closed. Be sure the bypass line is directed back to the wet well or tank to prevent hazardous spills.

When the pump shuts down, the spring returns the diaphragm to its original position. Any solids that may have accumulated in the diaphragm chamber settle to the bottom and are flushed out during the next priming cycle.

NOTE

The valve will remain open if the pump does not reach its designed capacity or head. Valve closing pressure is dependent upon the discharge head of the pump at full capacity. The range of the valve closing pressure is established by the tension rate of the spring as ordered from the factory. Valve closing pressure can be further adjusted to the exact system requirements by moving the spring retaining pin up or down the plunger rod to increase or decrease tension on the spring. Contact your Gorman-Rupp distributor or the Gorman-Rupp Company for information about an Automatic Air Release Valve for your specific application.

Air Release Valve Installation

The Automatic Air Release Valve must be independently mounted in a horizontal position and connected to the discharge line of the self-priming centrifugal pump (see Figure 4).

NOTE

*If the Air Release Valve is to be installed on a **staged** pump application, contact the factory for specific installation instructions.*

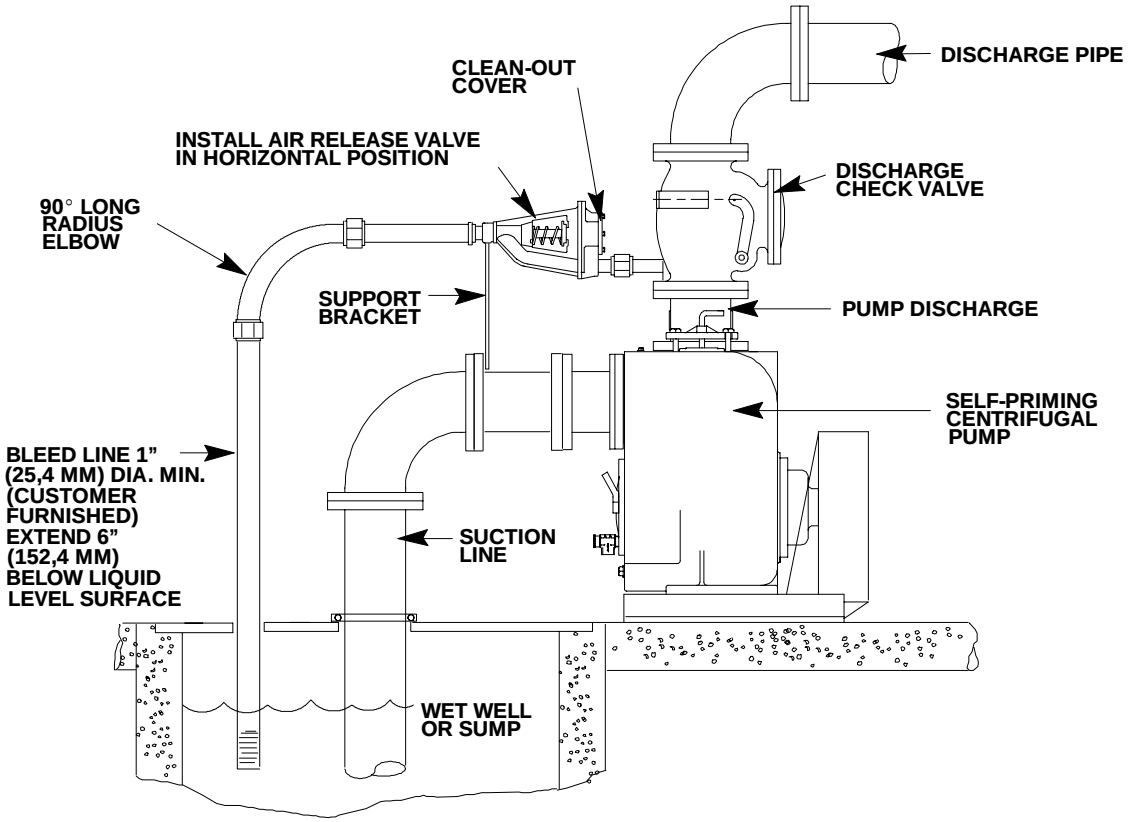


Figure 4. Typical Automatic Air Release Valve Installation

The valve inlet line must be installed between the pump discharge port and the non-pressurized side of the discharge check valve. The valve inlet is at the large end of the valve body, and is provided with standard 1-inch NPT pipe threads.

The valve outlet is located at the opposite end of the valve, and is also equipped with standard 1-inch NPT pipe threads. The outlet should be connected to a bleed line which slopes back to the wet well or sump. The bleed line must be the same size as the inlet piping, or larger. If **piping** is used for the bleed line, avoid the use of elbows whenever possible.

NOTE

*It is recommended that each Air Release Valve be fitted with an independent bleeder line directed back to the wet well. If multiple Air Release Valves are installed in a system, they **must** be fitted with independent bleeder lines; **never** use a common manifold pipe. Contact your Gorman-Rupp distributor or the Gorman-Rupp Company for information about installation of an Automatic Air Release Valve for your specific application.*

ALIGNMENT

The alignment of the pump and its power source is critical for trouble-free mechanical operation. In either a flexible coupling or V-belt driven system, the driver and pump must be mounted so that their shafts are aligned with and parallel to each other. It is imperative that alignment be checked after the pump and piping are installed, and before operation.

NOTE

Check **Rotation***, Section C, before final alignment of the pump.*

When mounted at the Gorman-Rupp factory, driver and pump are aligned before shipment. Misalignment will occur in transit and handling. Pumps **must** be checked and realigned before operation. Before checking alignment, tighten the foundation bolts. The pump casing feet and/or pedestal feet, and the driver mounting bolts should also be tightly secured.

WARNING!

When checking alignment, disconnect the power source to ensure that the pump will remain inoperative.

CAUTION

Adjusting the alignment in one direction may alter the alignment in another direction. check each procedure after altering alignment.

Coupled Drives

When using couplings, the axis of the power source must be aligned to the axis of the pump shaft in both the horizontal and vertical planes. Most couplings require a specific gap or clearance between the driving and the driven shafts. Refer to the coupling manufacturer's service literature.

Align spider insert type couplings by using calipers to measure the dimensions on the circumference of the outer ends of the coupling hub every 90 degrees. The coupling is in alignment when the hub ends are the same distance apart at all points (see Figure 5).

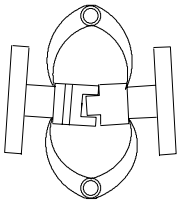


Figure 5. Aligning Spider-Type Couplings

Align non-spider type couplings by using a feeler gauge or taper gauge between the coupling halves every 90 degrees. The coupling is in alignment when the hubs are the same distance apart at all points (see Figure 6).

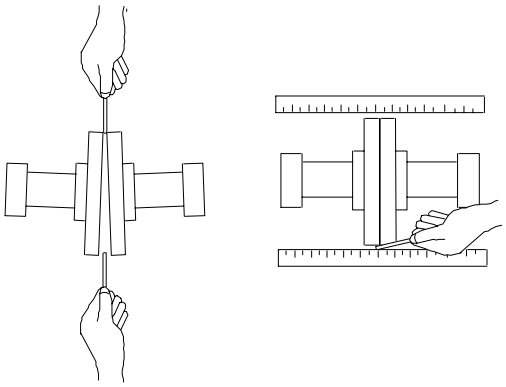
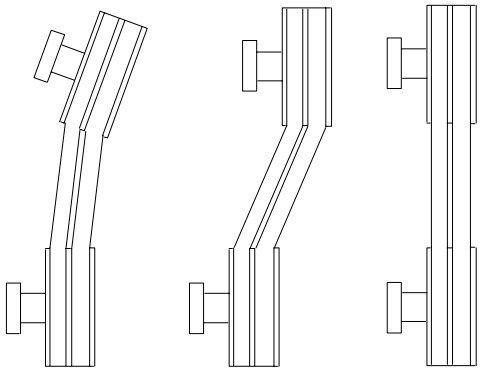


Figure 6. Aligning Non-Spider Type Couplings

Check parallel adjustment by laying a straightedge across both coupling rims at the top, bottom, and side. When the straightedge rests evenly on both halves of the coupling, the coupling is in horizontal parallel alignment. If the coupling is misaligned, use a feeler gauge between the coupling and the straightedge to measure the amount of misalignment.

V-Belt Drives

When using V-belt drives, the power source and the pump must be parallel. Use a straightedge along the sides of the pulleys to ensure that the pulleys are properly aligned (see Figure 7). In drive systems using two or more belts, make certain that the belts are a matched set; unmatched sets will cause accelerated belt wear.



MISALIGNED: SHAFTS NOT PARALLEL | **MISALIGNED: SHAFTS NOT IN LINE** | **ALIGNED: SHAFTS PARALLEL AND SHEAVES IN LINE**

Figure 7. Alignment of V-Belt Driven Pumps

Tighten the belts in accordance with the belt manufacturer's instructions. If the belts are too loose, they will slip; if the belts are too tight, there will be excessive power loss and possible bearing failure.

Select pulleys that will match the proper speed ratio; overspeeding the pump may damage both pump and power source.

Do not operate the pump without the guard in place over the rotating parts. exposed rotating parts can catch clothing, fingers, or tools, causing severe injury to personnel.

ELECTRICAL CONNECTIONS

If the pump is driven by an electric motor, check that the electrical service available matches the motor requirements stamped on the motor nameplate before connecting a motor to the incoming power. Check that the motor speed meets pump specifications.

If rotation is incorrect on a three-phase motor, have a qualified electrician interchange any two of the three phase wires to change direction. If rotation is incorrect on a single-phase motor, consult the literature supplied with the motor for specific instructions.

The electrical power used to operate the pump is high enough to cause injury or death. Obtain the services of a qualified electrician to make all electrical connections.

If the pump is powered by an electric motor, do not operate a non-explosion proof motor in an explosive atmosphere. An explosion, which may cause severe personal injury or death, could result. Install, connect and operate the motor in accordance with the National Electric Code and all local codes. If there is a conflict between the instructions in the manual accompanying the unit and the National Electric Code or applicable local code, the National or Local code shall take precedence. All electrical equipment supplied with the pump conforms to applicable federal regulations and national codes in effect on the date of manufacture.

OPERATION – SECTION C

Review all SAFETY information in Section A.

Follow the instructions on all tags, labels and decals attached to the pump.

WARNING!

Do not attempt to pump any liquids the pump has not been designed for, and which may damage the pump or endanger personnel as a result of pump failure.

CAUTION

Pump speed and operating conditions must be within the performance range shown on the curve in Parts Lists manual.

Refer to the pump Specification Data Sheet or the accompanying Parts List Manual for the specific performance for your pump.

PRIMING

Install the pump and piping as described in **INSTALLATION**. Make sure that the piping connections are tight, and that the pump is securely mounted. Check that the pump is properly lubricated (see **LUBRICATION** in the **MAINTENANCE AND REPAIR** manual).

The pump is self-priming, but it should never be operated unless there is liquid in the pump casing.

CAUTION

Never operate the pump unless there is liquid in the pump casing. The pump will not prime when dry. Extended operation of a dry pump will destroy the seal assembly.

Add liquid to the pump casing when:

1. The pump is being put into service for the first time.
2. The pump has not been used for a considerable length of time.
3. The liquid in the pump casing has evaporated.

Once the pump casing has been filled, the pump will prime and reprime as necessary.

WARNING!

After filling the pump casing, reinstall and tighten the fill plug. Do not attempt to operate the pump unless all connecting piping is securely installed. Otherwise, liquid in the pump forced out under pressure could cause injury to personnel.

To fill the pump, remove the pump casing fill cover or fill plug in the top of the casing, and add clean liquid until the casing is filled. Replace the fill cover or fill plug before operating the pump.

STARTING

Starting procedures will vary slightly depending on the pump application, type of priming device, and type of drive. Consult the operations manual furnished with the power source.

Rotation

The correct direction of pump rotation is indicated by an arrow on the pump body or accompanying decals. If the pump is operated in the wrong direction, the impeller could become loosened from the shaft and seriously damage the pump.

CAUTION

The pump must operate in the direction indicated by the arrow on the pump, or ac-

companying decals. Reverse rotation could loosen the impeller and seriously damage the pump.

If the pump is driven by an electric motor, consult the operating manual furnished with the motor before attempting to start the motor.

If rotation is incorrect on a three-phase motor, have a qualified electrician interchange any two of the three phase wires to change direction. If rotation is incorrect on a single-phase motor, consult the literature supplied with the motor for specific instructions.

OPERATION

CAUTION

Pump speed and operating points must be within the continuous performance range shown on the pump curve. (See the Parts List Manual accompanying the pump.)

Lines With a Bypass

Close the discharge throttling valve (if so equipped) so that the pump will not have to prime against the weight of the liquid in the discharge line. Air from the suction line will be discharged through the bypass line back to the wet well during the priming cycle. When the pump is fully primed and liquid is flowing steadily from the bypass line, open the discharge throttling valve. Liquid will then continue to circulate through the bypass line while the pump is in operation.

Lines Without a Bypass

Open all valves in the discharge line and start the power source. Priming is indicated by a positive reading on the discharge pressure gauge or by a quieter operation. The pump may not prime immediately because the suction line must first fill with liquid. If the pump fails to prime within five minutes, stop it and check the suction line for leaks.

After the pump has been primed, partially close the discharge line throttling valve in order to fill the line slowly and guard against excessive shock pressure which could damage pipe ends, gaskets, sprinkler heads, and any other fixtures connected to the line. When the discharge line is completely filled, adjust the throttling valve to the required flow rate.

WARNING!

Do not operate the pump against a closed discharge throttling valve for long periods of time. If operated against a closed discharge throttling valve, pump components will deteriorate, and the liquid could come to a boil, build pressure, and cause the pump casing to rupture or explode.

Leakage

No leakage should be visible at pump mating surfaces, or at pump connections or fittings. Keep all line connections and fittings tight to maintain maximum pump efficiency.

Liquid Temperature And Overheating

Refer to the Specification Data sheet for the **maximum** liquid temperature for your specific pump. Do not apply the pump at a higher operating temperature.

Overheating can occur if operated with the valves in the suction or discharge lines closed. Operating against closed valves could bring the liquid to a boil, build pressure, and cause the pump to rupture or explode. If overheating occurs, stop the pump and allow it to cool before servicing it. Refill the pump casing with cool liquid.

DANGER!

Allow an over-heated pump to completely cool before servicing. Do not remove plates, covers, gauges, or fittings from an over-heated pump. Liquid within the pump can reach boiling temperatures, and vapor pressure within the pump can cause parts being disengaged to be ejected with great force. Af-

ter the pump cools, drain the liquid from the pump by removing the casing drain plug. Use caution when removing the plug to prevent injury to personnel from hot liquid.

If overheating does occur, stop the pump immediately and allow it to cool before servicing it. **Approach any overheated pump cautiously**.

As a safeguard against rupture or explosion due to heat, some pumps are equipped with a pressure relief valve which will open if vapor pressure within the pump casing reaches a critical point. It is recommended that the pressure relief valve assembly be replaced at each overhaul, or any time the pump casing overheats and activates the valve. **Never** replace this valve with a substitute which has not been specified or provided by the Gorman-Rupp Company.

Strainer Check

If a suction strainer has been shipped with the pump or installed by the user, check the strainer regularly, and clean it as necessary. The strainer should also be checked if pump flow rate begins to drop. If a vacuum suction gauge has been installed, monitor and record the readings regularly to detect strainer blockage.

Never introduce air or steam pressure into the pump casing or piping to remove a blockage. This could result in personal injury or damage to the equipment. If backflushing is absolutely necessary, liquid pressure **must** be limited to 50% of the maximum permissible operating pressure shown on the pump performance curve. **If the pump is fitted with a Gorman-Rupp double grease lubricated seal, the maximum incoming pressure must be reduced to 10 p.s.i.**

Pump Vacuum Check

With the pump inoperative, install a vacuum gauge in the system, using pipe dope on the threads. Block the suction line and start the pump. At operating speed the pump should pull a vacuum of 20 inches (508 mm) or more of mercury. If it does not, check for air leaks in the seal, gasket, or discharge valve.

Open the suction line, and read the vacuum gauge with the pump primed and at operation speed. Shut off the pump. The vacuum gauge reading will immediately drop proportionate to static suction lift, and should then stabilize. If the vacuum reading falls off rapidly after stabilization, an air leak exists. Before checking for the source of the leak, check the point of installation of the vacuum gauge.

Operational Checks

Check the pump for proper operation when it is first started and periodically thereafter to identify minor problems.

Check the pump for unusual noises or excessive vibration while it is operating. If noise or vibration is excessive, stop the pump and refer to **Troubleshooting** in the Maintenance And Repair Manual for possible causes.

To avoid serious damage to the pump, check for unusual noises or excessive vibration while the pump is running. If noise or vibration is excessive, stop operation and refer to the troubleshooting chart in the Maintenance and Repair manual.

STOPPING

Never halt the flow of liquid suddenly. If the liquid being pumped is stopped abruptly, damaging shock waves can be transmitted to the pump and piping system. Close all connecting valves slowly.

On engine driven pumps, reduce the throttle speed slowly and allow the engine to idle briefly before stopping.

If the application involves a high discharge head, gradually close the discharge throttling valve before stopping the pump.

After stopping the pump, lock out or disconnect the power source to ensure that the pump will remain inoperative.

Cold Weather Preservation

In below freezing conditions, drain the pump to prevent damage from freezing. Also, clean out any solids by flushing with a hose. Operate the pump for approximately one minute; this will remove any remaining liquid that could freeze the pump rotating parts. If the pump will be idle for more than a few hours, or if it has been pumping liquids containing a large amount of solids, drain the pump, and flush it thoroughly with clean water. To prevent large solids from clogging the drain port and preventing the pump from completely draining, insert a rod or stiff wire in the drain port, and agitate the liquid during the draining process. Clean out any remaining solids by flushing with a hose.

BEARING TEMPERATURE CHECK

Bearings normally run at higher than ambient temperatures because of heat generated by friction. Temperatures up to 160°F (71° C) are considered normal for bearings, and they can operate safely to at least 180°F (82° C).

Checking bearing temperatures by hand is inaccurate. Bearing temperatures can be measured accurately by placing a contact-type thermometer against the housing. Record this temperature for future reference.

A sudden increase in bearing temperature is a warning that the bearings are at the point of failing to operate properly. Make certain that the bearing lubricant is of the proper viscosity and at the correct level (see **LUBRICATION** in the **Maintenance And Repair** manual). Bearing overheating can also be caused by shaft misalignment and/or excessive vibration.

When pumps are first started, the bearings may seem to run at temperatures above normal. Continued operation should bring the temperatures down to normal levels.

LUBRICATION

WARNING!

Do not remove plates, covers, gauges, pipe plugs or fittings from an overheated pump. Vapor pressure within the pump can cause parts being disengaged to be ejected with great force. Allow the pump to completely cool before servicing.

On a new pump, check the oil level in the seal and bearing cavities before initial startup, after the first two weeks of operation, and every month thereafter.

Before installing or removing the lubrication plug, always clean the area around the plug to prevent contamination.

Self Lubricated Seal Assembly

The self lubricated seal assembly is lubricated by the medium being pumped, or by a flow of fresh liquid from an external source. Flushing liquid may be taken from the pump discharge and supplied through auxiliary piping.

When handling abrasive or tacky liquids, supply fresh lubricating liquid from an external source. Be sure the liquid supplied to the seal is compatible with the liquid being pumped, and that its flow is controlled to prevent dilution. Consult the factory if flushing is required.

Oil Lubricated Seal Assembly

Before starting the pump, remove the vented plug and fill the seal cavity with SAE No. 30 non-detergent oil. Clean and reinstall the vented plug. Refer to the **Maintenance And Repair** Manual for the seal cavity oil capacity.

Grease Lubricated Seal Assembly

Fill the automatic grease cup through the grease fitting with No. 2 lithium base grease until grease escapes from the relief hole. Turn the grease cup arm counterclockwise until it is at the top of the

stem; this will release the spring to apply grease to the seal.

Oil Lubricated Bearings

Bearing housings are fully lubricated when shipped from the factory. Check the oil level regularly and maintain it at the desired level. When lubrication is required, add SAE No. 30 non-detergent oil. **Do not** over-lubricate. Over-lubrication can cause the bearings to over-heat, resulting in premature bearing failure.

Under normal conditions, drain the bearing housing once each year and refill with clean oil. Change the oil more frequently if the pump is operated continuously or installed in an environment with rapid temperature change.

Monitor the condition of the bearing lubricant regularly for evidence of rust or moisture condensation. This is especially important in areas where variable hot and cold temperatures are common.

For cold weather operation, consult the factory or a lubricant supplier for the recommended grade of oil.

Grease Lubricated Bearings

Bearing housings are fully lubricated when shipped from the factory. Under normal conditions, add No. 0 lithium base grease from a grease gun through the grease fitting after each 250 hours of operation or once each month, whichever comes first. **Do not** over-lubricate. Over-lubrication can cause the bearings to over-heat, resulting in premature bearing failure.

If there is no provision in the bearing cavity to drain or flush the lubricant, the pump and bearing housing must be disassembled to completely clean and maintain this cavity.

Under normal conditions, change the grease after each 5000 hours of operation, or at 12 month intervals, whichever comes first. Change the grease more frequently if the pump is operated continuously or installed in an environment where variable hot and cold temperatures are common.

Refer to the **Maintenance And Repair Manual** for grease capacity of the bearing housing for the pump.

For cold weather operation, consult the factory or a lubricant supplier for the recommended grade of lubricant.

Power Source

Consult the literature supplied with the power source, or contact your local power source representative.

For U.S. and International Warranty Information,
Please Visit www.grpumps.com/warranty
or call:
U.S.: 419—755—1280
International: +1—419—755—1352

For Canadian Warranty Information,
Please Visit www.grcanada.com/warranty
or call:
519—631—2870

THE GORMAN-RUPP COMPANY ● MANSFIELD, OHIO
GORMAN-RUPP OF CANADA LIMITED ● ST. THOMAS, ONTARIO, CANADA

Use With: OM–04760
MR–04959

PUBLICATION NUMBER PL–05375–01
June 25, 2002
Rev. A 08-04-11

GORMAN-RUPP PUMPS

10 SERIES
PUMP MODEL
14D1–CH23 S/G

MANUAL
PART 2 of 3

PARTS LIST
WITH
PERFORMANCE CURVE

THE GORMAN-RUPP COMPANY • MANSFIELD, OHIO
GORMAN-RUPP OF CANADA LIMITED • ST. THOMAS, ONTARIO, CANADA Printed in U.S.A.
www.grpumps.com

Register your new
Gorman-Rupp pump online at
www.grpumps.com

Valid serial number and e-mail address required.

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

RECORD YOUR PUMP MODEL AND SERIAL NUMBER

Please record your pump model and serial number in the spaces provided below. Your Gorman-Rupp distributor needs this information when you require parts or service.

Pump Model: _____

Serial Number: _____

PERFORMANCE CURVE – SECTION A

RECORDING MODEL AND SERIAL NUMBERS

Please record the pump model and serial number in the spaces provided below and in the separate Installation/Operation Manual accompanying your pump. Your Gorman-Rupp distributor needs this information when you require parts or service.

Pump Model: _____

Serial Number: _____

WARRANTY INFORMATION

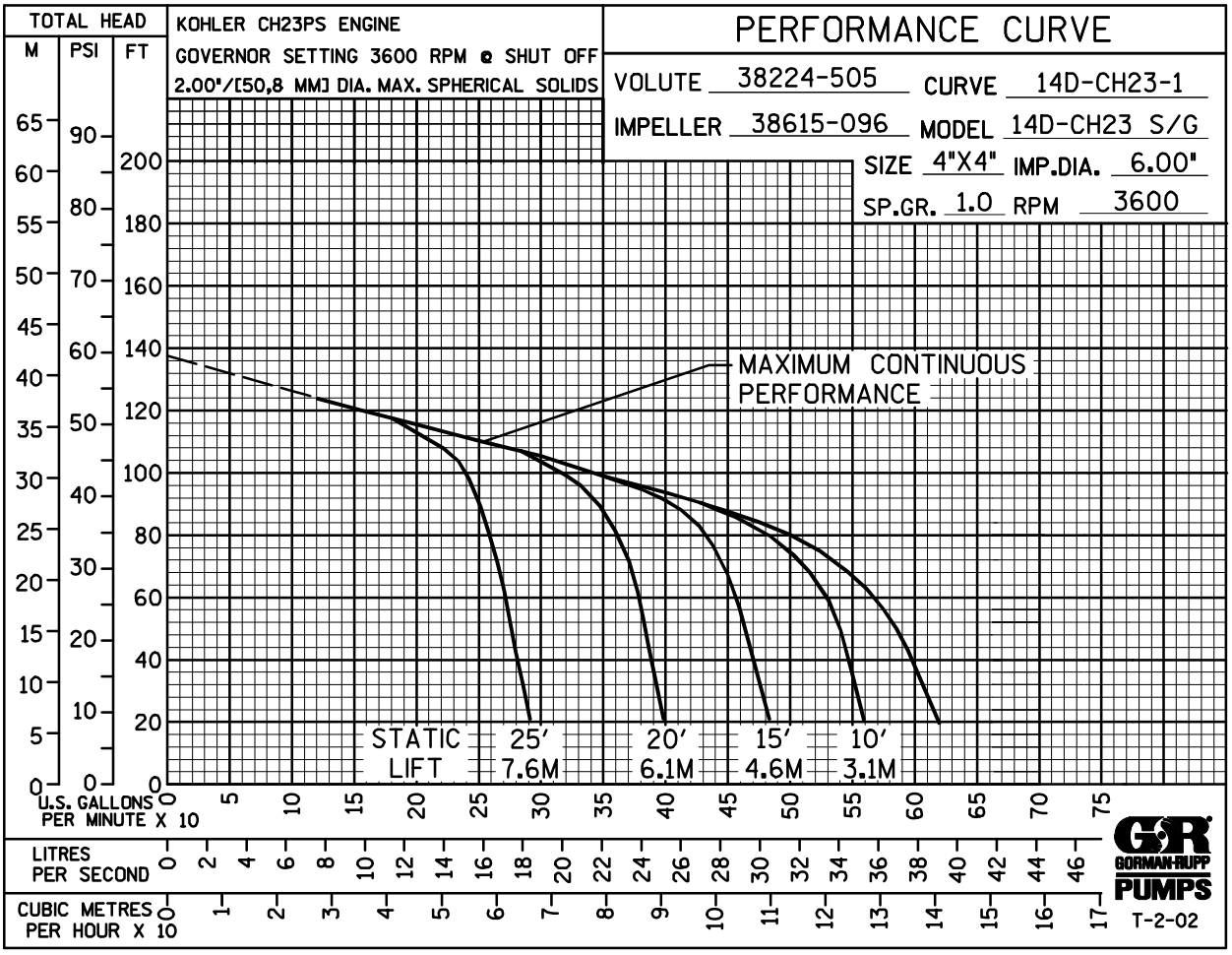
The pump warranty is provided as part of Gorman-Rupp's support program for customers who operate and maintain their equipment as described in this manual and other accompanying literature. Please note that should the equipment be abused or modified to change its performance beyond the original factory specifications, the warranty will become void and any claim will be denied.

PERFORMANCE CURVE

The performance curve on the following page is based on 70° F (21° C) clear water at sea level with minimum suction lift. Since pump installations are seldom identical, your performance may be different due to such factors as viscosity, specific gravity, elevation, temperature, and impeller trim.

If your pump serial number is followed by an "N", your pump is **NOT** a standard production model. Contact the Gorman-Rupp Company to verify performance or part numbers.

Pump speed and operating condition points must be within the continuous performance range shown on the curve.



Performance Curve — Model 14D1–CH23 S/G

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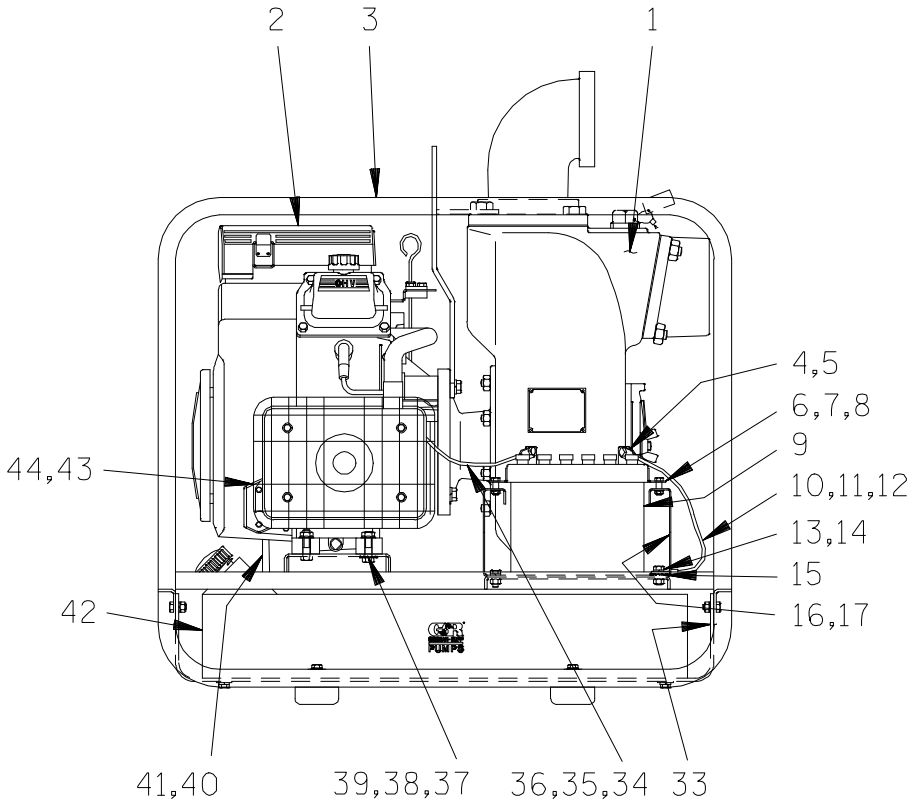
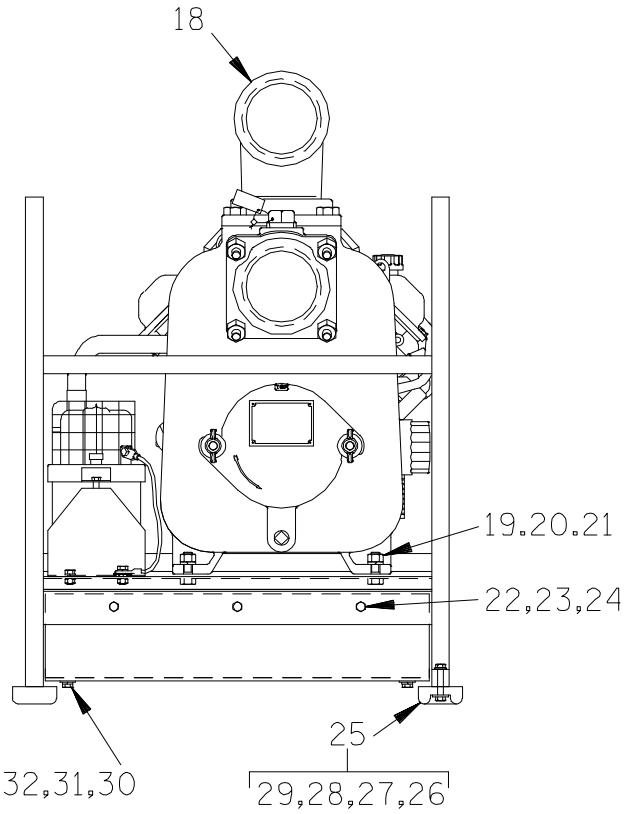
14D1—CH23 S/G
14D1—(CH23)

S/N 1246475 Up
PUMP ISSUE 1





14D1—CH23 S/G
14D1—(CH23)

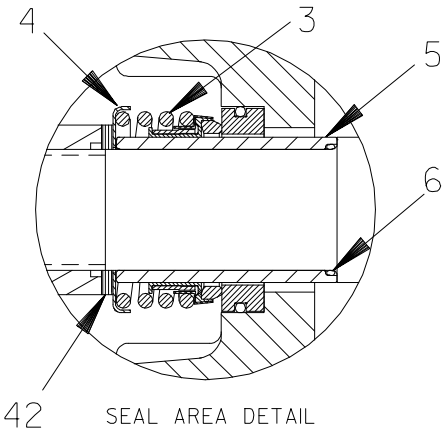
S/N 1246475 Up
PUMP ISSUE 1

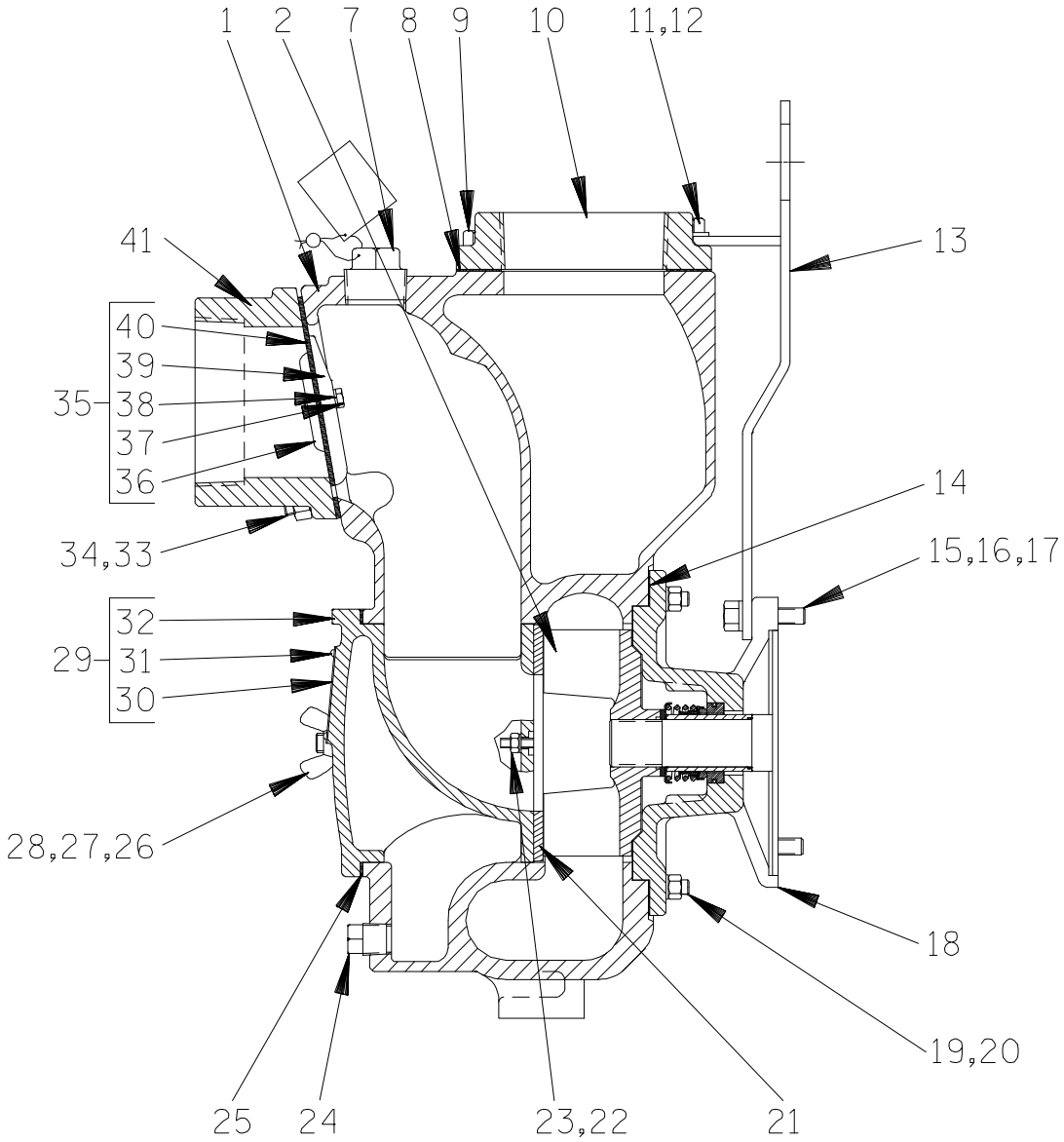
If your pump serial number is followed by an "N", your pump is **NOT** a standard production model. Contact the Gorman-Rupp Company to verify part numbers.

ITEM NO.	PART NAME	PART NUMBER	MAT'L CODE	QTY
1	PUMP END ASSEMBLY	14D1—(CH23)		1
2	KOHLER CH23PS ENGINE	29127—303	———	1
3	ROLLOVER BASE	41583—345	24150	1
4	HEX HD CAPSCREW	B0503	15991	1
5	FLANGED HEX NUT	21765—312	———	1
6	BATTERY BOX COVER	11870	24000	1
7	HEX HD CAPSCREW	B0504	15991	2
8	FLANGED HEX NUT	21765—312	———	2
9 ✳	BATTERY	SEE OPTIONS		1
10	START CABLE SUB	47311—542	———	1
11	HEX HD CAPSCREW	B0503	15991	1
12	FLANGED HEX NUT	21765—312	———	1
13	HEX HD CAPSCREW	B0503	15991	4
14	LOCK WASHER	J05	15991	4
15	T TYPE LOCK WASHER	BL05	15991	1
16	BATTERY BOX	34383—017	15120	1
17	BATTERY TAG	38818—680	———	1
18	STREET ELBOW	RS64	11990	1
19	HEX HD CAPSCREW	B0807	15991	2
20	HEX NUT	D08	15991	2
21	LOCK WASHER	J08	15991	2
22	HEX HD CAPSCREW	B0504	15991	6
23	HEX NUT	D05	15991	6
24	LOCK WASHER	J05	15991	6
25 ‡	RUBBER FOOT MTG KIT	48152—603	———	1
26	—RUBBER BUMPER	S1224	———	4
27	—FLAT WASHER	K05	15991	4
28	—HEX HD CAPSCREW	B0504	15991	4
29	—FLANGED HEX NUT	21765—312	———	4
30	HEX HD CAPSCREW	B0503	15991	4
31	FLAT WASHER	K05	15991	4
32	LOCKWASHER	J05	15991	4
33	FUEL TANK GUARD	34318—025	15120	1
34	START CABLE	47311—504	———	1
35	HEX HD CAPSCREW	B0503	15991	1
36	FLANGED HEX NUT	21765—312	———	1
37	HEX HD CAPSCREW	B0606	15991	4
38	FLANGED HEX NUT	21765—314	———	4
39	T TYPE LOCK WASHER	BL06	15991	1
40	HOSE	18513—052	———	1.25'
41	HOSE CLAMP	26518—641	———	2
42	FUEL TANK	46711—089	19220	1
43	MUFFLER KIT	29187—107	———	1
44	MUFFLER GUARD KIT	29187—112	———	1
NOT SHOWN:				
	WARNING DECAL	2613FE	———	1
	HAND CARRY DECAL	2613FT	———	2
	PRIMING STICKER	6588AH	———	1
OPTIONAL:				
✳	12V BATTERY	S1680	———	1
	WHEEL KIT	GRP30—58	———	1

✳ INDICATES PARTS RECOMMENDED FOR STOCK

‡ ITEM SHIPPED LOOSE





PARTS LIST
14D1—(CH23)

ITEM NO.		PART NAME	PART NUMBER	MAT'L CODE	QTY
1		PUMP CASING	38224—505	13040	1
2	✳	IMPELLER	38615—096	11010	1
3	✳	SEAL ASSEMBLY	25285—856	———	1
4		SPRING RETAINER	31161—042	17000	1
5	✳	SHAFT SLEEVE	11876A	16000	1
6		SHAFT SLEEVE O-RING	25154—022	———	1
7		FILL PLUG ASSY	48271—065	———	1
8	✳	DISCH FLANGE GSKT	38687—009	20000	1
9		HEX HD CAPSCREW	B1005	15991	2
10		DISCHARGE FLANGE	38644—506	13000	1
11		HEX HD CAPSCREW	B1007	15991	2
12		FLAT WASHER	21161—442	———	2
13		HOISTING BAIL ASSY	44711—024	24150	1
14	✳	CASING GASKET SET	48211—022	———	1
15		HEX HD CAPSCREW	B0706	15991	4
16		LOCK WASHER	J07	15991	4
17		HEX NUT	D07	15991	4
18		INTERMEDIATE	38264—332	13000	1
19		STUD	C0606	15991	8
20		HEX NUT	D06	15991	8
21		WEAR PLATE ASSY	46451—302	24150	1
22		LOCK WASHER	J04	15991	2
23		HEX NUT	D04	15991	2
24		CASING DRAIN PLUG	P08	15079	1
25	✳	COVER PLATE GSKT	38682—015	20000	1
26		STUD	C0808	15991	2
27		FLAT WASHER	K08	15991	2
28		WING NUT	BB08	15991	2
29		COVER PLATE ASSY	42111—937	———	1
30		—WARNING PLATE	2613EV	13990	1
31		—DRIVE SCREW	BM#04—03	17000	4
32		—BACK COVER PLATE	NOT AVAILABLE		1
33		STUD	C0808	15991	4
34		HEX NUT	D08	15991	4
35		CHECK VALVE ASSY	46413—029	———	1
36	✳	—VALVE WEIGHT	19	10010	1
37		—HEX HD CAPSCREW	B0403—1/2	17000	2
38		—LOCKWASHER	J04	17000	2
39	✳	—VALVE WEIGHT	4718	10010	1
40	✳	—CHECK VALVE	38671—626	19070	1
41		SUCTION FLANGE	38645—506	13000	1
42		IMP ADJUST SHIM SET	37J	17090	1
NOT SHOWN:					
		NAME PLATE	38818—021	13990	1
		DRIVE SCREW	BM#04—03	17000	4
		STRAINER	2690	24000	1
		SUCTION STICKER	6588AG	———	1
		DISCHARGE STICKER	6588BJ	———	1
		PRIMING STICKER	6588AH	———	1

✳ INDICATES PARTS RECOMMENDED FOR STOCK

For U.S. and International Warranty Information,
Please Visit www.grpumps.com/warranty
or call:
U.S.: 419—755—1280
International: +1—419—755—1352

For Canadian Warranty Information,
Please Visit www.grcanada.com/warranty
or call:
519—631—2870

THE GORMAN-RUPP COMPANY ● MANSFIELD, OHIO
GORMAN-RUPP OF CANADA LIMITED ● ST. THOMAS, ONTARIO, CANADA

Use With: OM--04760

PUBLICATION NUMBER MR--04959
January 19, 1999

GORMAN-RUPP PUMPS

10 SERIES PUMPS

13D, 14A, 14C, 14D And 16D Closed Coupled Electric Motor Or Engine Driven Pumps

with Self Lubricated Seal or Grease Seal

MANUAL PART 3 of 3

MAINTENANCE AND REPAIR WITH TROUBLESHOOTING

THE GORMAN-RUPP COMPANY ● MANSFIELD, OHIO

GORMAN-RUPP OF CANADA LIMITED ● ST. THOMAS, ONTARIO, CANADA Printed in U.S.A.

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

INTRODUCTION

Thank You for purchasing a Gorman-Rupp 10 Series Pump. **Read this manual** carefully to learn how to safely maintain and service your pump. Failure to do so could result in personal injury or damage to the pump.

A set of three manuals accompanies your pump. The Installation/Operation Manual contains essential information on installing and operating the pump. The Parts List Manual provides a performance curve, a pump model cross-section drawing, and parts list for your pump.

This Maintenance and Repair Manual provides troubleshooting and maintenance instructions required to properly diagnose operational problems, and to service the pump components.

As described on the following page, this manual will alert personnel to known procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel. However, this manual cannot possibly anticipate and provide detailed precautions for every situation that might occur during maintenance of the pump. Therefore, it is the responsibility of the owner/maintenance personnel to ensure that **only** safe, established maintenance procedures are used, and that any procedures not addressed in this manual are performed **only** after establishing that neither personal safety nor pump integrity are compromised by such practices. Pumps and related equipment **must** be installed and operated according to all national, local and industry standards.

If there are any questions regarding the pump which are not covered in this manual or in other literature accompanying the unit, please contact your Gorman-Rupp distributor or the Gorman-Rupp Company:

The Gorman-Rupp Company
P.O. Box 1217
Mansfield, Ohio 44901–1217
or:
Gorman-Rupp of Canada Limited
70 Burwell Road
St. Thomas, Ontario N5P 3R7

CONTENTS

RECORDING MODEL AND SERIAL NUMBERS

Please record the pump model, serial number, voltage, and phase in the spaces provided below. Your Gorman-Rupp distributor needs this information when you require parts or service.

Pump Model: _____

Serial Number: _____

Motor:

Voltage: _____

Phase: _____

Engine:

Model: _____

Serial Number: _____

WARRANTY INFORMATION

The warranty provided with your pump is part of Gorman-Rupp's support program for customers who operate and maintain their equipment as described in this and the other accompanying literature. Please note that should the equipment be abused or modified to change its performance beyond the original factory specifications, the warranty will become void and any claim will be denied.

The following are used to alert personnel to procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel:

Immediate hazards which WILL result in severe personal injury or death. These instructions describe the procedure required and the injury which will result from failure to follow the procedure.

Hazards or unsafe practices which COULD result in severe personal injury or death. These instructions describe the procedure required and the injury which could result from failure to follow the procedure.

Hazards or unsafe practices which COULD result in minor personal injury or product or property damage. These instructions describe the requirements and the possible damage which could result from failure to follow the procedure.

NOTE

Instructions to aid in installation, operation, and maintenance or which clarify a procedure.

SAFETY - SECTION A

This information applies to 10 Series electric motor or engine driven pumps. Refer to the manual accompanying the power source before attempting to begin operation.

This manual will alert personnel to known procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel. However, this manual cannot possibly anticipate and provide detailed instructions and precautions for every situation that might occur during maintenance of the unit. Therefore, it is the responsibility of the owner/maintenance personnel to ensure that only safe, established maintenance procedures are used, and that any procedures not addressed in this manual are performed only after establishing that neither personal safety nor pump integrity are compromised by such practices.

This manual contains essential information on troubleshooting and maintaining the pump. In addition to this manual, see the separate literature covering installation and operation, pump parts, and any optional equipment shipped with the pump.

WARNING!

Before attempting to open or service the pump:

1. **Familiarize yourself with this manual.**
2. **Disconnect or shut down the power source and take the necessary precautions to ensure that the pump will remain inoperative.**
3. **Allow the pump to completely cool if overheated.**
4. **Check the temperature before opening any covers, plates, or plugs.**
5. **Close the suction and discharge valves.**
6. **Vent the pump slowly and cautiously.**
7. **Drain the pump.**

WARNING!

Do not attempt to pump any liquids the pump has not been designed for, and which may damage the pump or endanger personnel as a result of pump failure. Consult the factory to determine compatibility between the pump and liquid.

WARNING!

Use lifting and moving equipment in good repair and with adequate capacity to prevent injuries to personnel or damage to equipment. Suction and discharge hoses and piping must be removed from the pump before lifting.

WARNING!

After the pump has been positioned, make certain that the pump and all piping or hose connections are tight, properly supported and secure before operation.

WARNING!

Do not operate the pump against a closed discharge valve for long periods of time. If operated against a closed discharge valve, pump components will

deteriorate, and the liquid could come to a boil, build pressure, and cause the pump casing to rupture or explode.

WARNING!

Do not remove plates, covers, gauges, pipe plugs, or fittings from an overheated pump. Vapor pressure within the pump can cause parts being disengaged to be ejected with great force. Allow the pump to cool before servicing.

WARNING!

These pumps may be used to handle products which if overheated could produce dangerous fumes. Use extreme caution when venting the pump, or when removing covers, plates, plugs, or fittings.

WARNING!

Never run this pump backwards. Be certain that rotation is correct before fully engaging the pump.

WARNING!

If the pump is used to pump materials which could cause serious illness or injury through direct exposure or emitted fumes, wear protective clothing, such as rubber gloves, face mask, and rubber apron, as necessary before disassembling the pump or piping.

WARNING!

Do not operate the pump without shields and/or guards in place over the drive shafts, belts, and/or couplings, or other rotating parts. Exposed rotating parts can catch clothing, fingers, or tools, causing severe injury to personnel.

WARNING!

If the pump is powered by an electric motor, do not operate a non-explosion proof motor in an explosive atmosphere. An explosion, which may cause severe personal injury or death, could result. Install, connect and operate the motor in accordance with the National Electric Code and all local codes. If there is a conflict between the instructions in the manual accompanying the unit and the National Electric Code or applicable local code, the National or Local code shall take precedence. All electrical equipment supplied with the pump conforms to applicable federal regulations and national codes in effect on the date of manufacture.

WARNING!

If the pump is electric motor driven, the electrical power used to operate this pump is high enough to cause injury or death. Obtain the services of a qualified electrician to troubleshoot, test and/or service the electrical components of this pump.

DANGER!

If the pump is powered by an internal combustion engine, do not operate in an explosive atmosphere. When operating internal combustion engines in an enclosed area, make certain that exhaust fumes are piped to the outside. These fumes contain carbon monoxide, a deadly gas that is colorless, tasteless, and odorless.

Fuel used by internal combustion engines presents an extreme explosion and fire hazard. Make certain that all fuel lines are securely connected and free of leaks. Never refuel a hot or running engine. Avoid overfilling the fuel tank. Always use the correct type of fuel.

Never tamper with the engine governor to gain more power. The governor establishes safe operating limits that should not be exceeded. The maximum continuous operating speed for the pump is shown on the performance curve (see the Parts List Manual).

Pumps and related equipment must be installed and operated according to all national, local and industry standards.

TROUBLESHOOTING -- SECTION B

Review all SAFETY information in Section A.

WARNING!

Before attempting to open or service the pump:

1. **Familiarize yourself with this manual.**
2. **Disconnect or shut down the power source and take the necessary precautions to ensure that the pump will remain inoperative.**
3. **Allow the pump to completely cool if overheated.**
4. **Check the temperature before opening any covers, plates, or plugs.**
5. **Close the suction and discharge valves.**
6. **Vent the pump slowly and cautiously.**
7. **Drain the pump.**

Table B-1 Troubleshooting Chart

TROUBLE	POSSIBLE CAUSE	PROBABLE REMEDY
PUMP FAILS TO PRIME	Not enough liquid in casing.	Add liquid to casing. See **PRIMING**.
	Suction check valve contaminated or damaged.	Clean or replace check valve.
	Air leak in suction line.	Correct leak.
	Lining of suction hose collapsed.	Replace suction hose.
	Leaking or worn seal or pump gasket.	Check pump vacuum. Replace leaking or worn seal or gasket.
	Suction lift or discharge head too high.	Check piping installation and install bypass line if needed. See **INSTALLATION**.
	Strainer clogged.	Check strainer and clean if necessary.
PUMP STOPS OR FAILS TO DELIVER RATED FLOW OR PRESSURE	Air leak in suction line.	Correct leak.
	Lining of suction hose collapsed.	Replace suction hose.
	Suction intake not submerged at proper level or sump too small.	Check installation and correct submergence as needed.

Table B-1 Troubleshooting Chart (continued)

TROUBLE	POSSIBLE CAUSE	PROBABLE REMEDY
PUMP STOPS OR FAILS TO DELIVER RATED FLOW OR PRESSURE (cont.)	Impeller or other wearing parts worn or damaged.	Replace worn or damaged parts. Check that impeller is properly centered and rotates freely.
	Leaking or worn seal or pump gasket.	Check pump vacuum. Replace leaking or worn seal or gasket.
	Impeller clogged.	Free impeller of debris.
	Pump speed too slow.	Check driver output (engine driven models).
	Pump running backwards (electric motor driven models).	Check direction of rotation. Correct 3-phase wiring by interchanging any two motor leads at control box. (See **Pump Rotation** in the Installation and Operations Manual.)
	Suction lift or discharge head too high.	Check piping installation and install bypass line if needed. See **INSTALLATION** in the Installation and Operations manual.
PUMP REQUIRES TOO MUCH POWER	Pump speed too high.	Check governor setting (engine driven models).
	Discharge head too low.	Adjust discharge valve.
	Liquid solution too thick.	Dilute if possible.
PUMP CLOGS FREQUENTLY	Discharge flow too slow.	Open discharge valve filly to increase flow rate, and run power source at maximum governed speed.
	Suction check valve or foot valve clogged or binding.	Clean valve.
EXCESSIVE NOISE	Cavitation in pump.	Reduce suction lift and/or friction losses in suction line. Record vacuum and pressure gauge readings and consult local representative or factory.
	Pumping entrained air.	Locate and eliminate source of air bubble.
	Pump or drive not securely mounted.	Secure mounting hardware.
	Impeller clogged or damaged.	Clean out debris; replace damaged parts.

PREVENTIVE MAINTENANCE

Since pump applications are seldom identical, and pump wear is directly affected by such things as the abrasive qualities, pressure and temperature of the liquid being pumped, this section is intended only to provide general recommendations and practices for preventive maintenance. Regardless of the application however, following a routine preventive maintenance schedule will help assure trouble-free performance and long life from your Gorman-Rupp pump. For specific questions concerning your application, contact your Gorman-Rupp distributor or the Gorman-Rupp Company.

Record keeping is an essential component of a good preventive maintenance program. Changes in suction and discharge gauge readings (if so equipped) between regularly scheduled inspections can indicate problems that can be corrected before system damage or catastrophic failure occurs. The appearance of wearing parts should also be documented at each inspection for comparison as well. Also, if records indicate that a certain part (such as the seal) fails at approximately the same duty cycle, the part can be checked and replaced before failure occurs, reducing unscheduled down time.

For new applications, a first inspection of wearing parts at 250 hours will give insight into the wear rate for your particular application. Subsequent inspections should be performed at the intervals shown on the chart below. Critical applications should be inspected more frequently.

Preventive Maintenance Schedule

Item	Service Interval*				
	Daily	Weekly	Monthly	Semi-Annually	Annually
General Condition (Temperature, Unusual Noises or Vibrations, Cracks, Leaks, Loose Hardware, Etc.)	I				
Pump Performance (Gauges, Speed, Flow)	I				
Bearing Lubrication		I			R
Seal Lubrication (And Packing Adjustment, If So Equipped)		I			R
V-Belts (If So Equipped)			I		
Air Release Valve Plunger Rod (If So Equipped)			I	C	
Front Impeller Clearance (Wear Plate)				I	
Rear Impeller Clearance (Seal Plate)				I	
Check Valve					I
Pressure Relief Valve (If So Equipped)					C
Pump and Driver Alignment					I
Shaft Deflection					I
Bearings					I
Bearing Housing					I
Piping					I
Driver Lubrication -- See Mfgr's Literature					

Legend:
I = Inspect, Clean, Adjust, Repair or Replace as Necessary
C = Clean
R = Replace

* Service interval based on an intermittant duty cycle equal to approximately 4000 hours annually. Adjust schedule as required for lower or higher duty cycles or extreme operating conditions.

PUMP MAINTENANCE AND REPAIR – SECTION C

GENERAL INFORMATION

Review all SAFETY information in Section A.

Follow the instructions on all tags, label and decals attached to the pump.

WARNING!

Before attempting to install, operate, or service this pump, familiarize yourself with this manual, and with all other literature shipped with the pump. Unfamiliarity with all aspects of operation or maintenance could lead to destruction of equipment, injury or death to personnel.

WARNING!

Use lifting and moving equipment in good repair and with adequate capacity to prevent injuries to personnel or damage to equipment. If slings or chains are used to move the pump or components, make sure that the load is balanced; otherwise serious personal injury or death could result. Suction and discharge hoses and piping must be removed from the pump before lifting.

The maintenance and repair instructions in this manual are keyed to the sectional views (Figure C–1 or C–2), and the corresponding parts identification list. Refer to the separate Parts List Manual for replacement parts.

Select a suitable location, preferably indoors, to perform required maintenance.

This Maintenance and Repair Manual provides troubleshooting and maintenance instructions required to properly diagnose operational problems, and to service the pump components. Maintenance instructions within this manual are limited to the pump hydraulic, priming and drive components only.

Check **TROUBLESHOOTING**, Section B to determine causes and remedies of pump problems. Disassemble the pump only as far as required.

As described in the **SAFETY** Section, this manual will alert personnel to known procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel. However, this manual cannot possibly anticipate and provide detailed precautions for every situation that might occur during maintenance of the unit. Therefore, it is the responsibility of the owner/maintenance personnel to ensure that **only** safe, established shop procedures are used, and that any procedures not addressed in this manual are performed **only** after establishing that neither personal safety nor pump integrity are compromised by such practices.

Lifting

Use lifting equipment with a capacity of **at least five times the weight of the pump**, including the weight of any options or customer-installed accessories. Discharge hose or piping **must** be removed before attempting to lift the pump.

For the approximate weight of your pump, refer to the pump specification data sheet or contact your Gorman-Rupp distributor or the Gorman-Rupp Company.

SECTION DRAWING

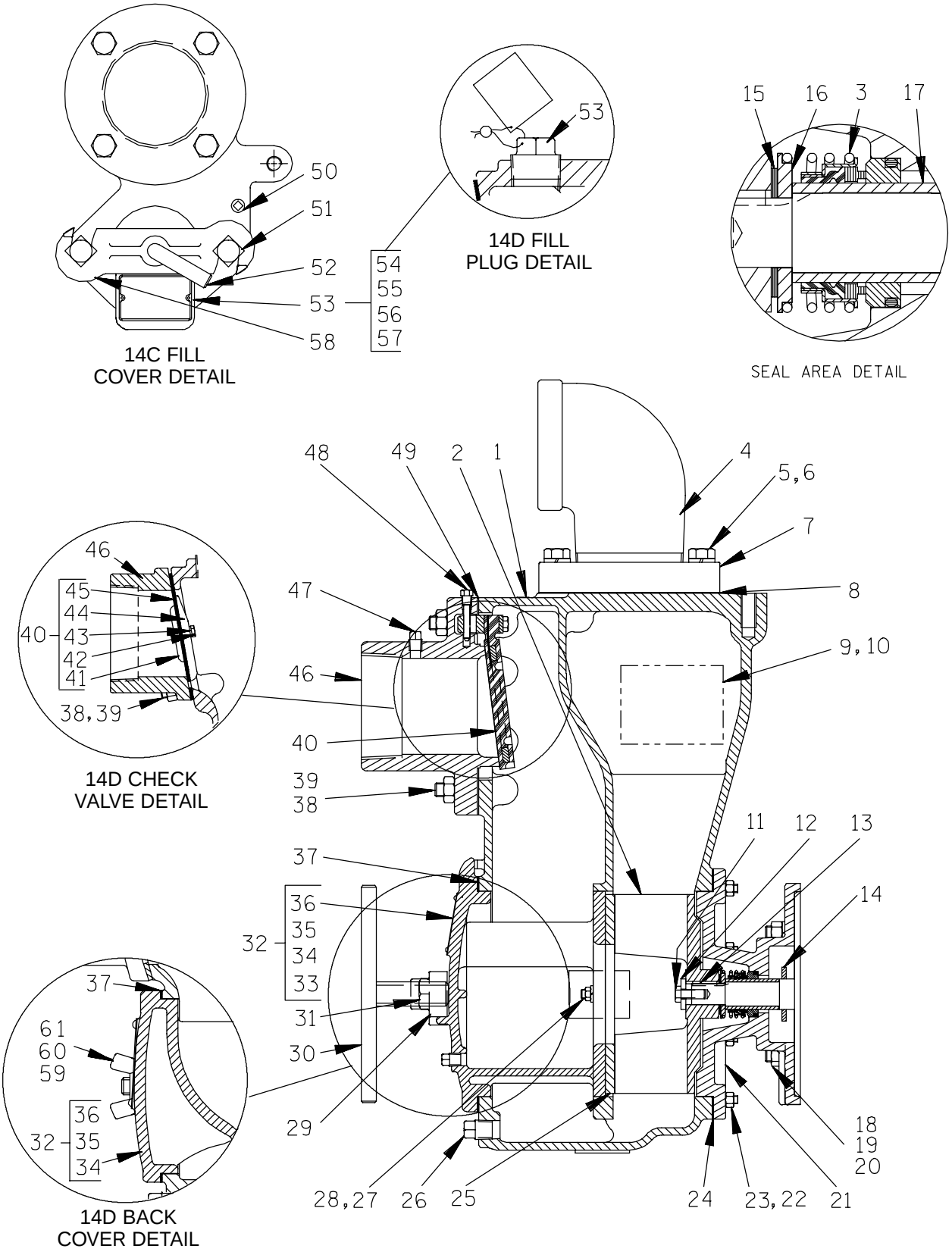


Figure C–1. Typical 14C And 14D Pump End Assembly w/Self Lubricated Mechanical Seal

Typical 14C And 14D Pump End Assembly w/Self Lubricated Mechanical Seal Parts Identification List

Refer to the separate Parts List Manual for serviceable parts, part numbers and quantities.

ITEM NO.	PART NAME
1	PUMP CASING
2	IMPELLER
3	SEAL ASSEMBLY
4	STREET ELBOW (IF REQUIRED)
5	HEX HEAD CAPSCREW
6	LOCKWASHER OR FLAT WASHER (IF REQUIRED)
7	DISCHARGE FLANGE
8	DISCHARGE FLANGE GASKET
9	NAME PLATE
10	DRIVE SCREW
11	HEX HD CAPSCREW (IF REQUIRED)
12	IMPELLER WASHER (IF REQUIRED)
13	IMP SHAFT KEY (IF REQUIRED)
14	SLINGER RING (IF REQUIRED)
15	IMPELLER SHIM SET
16	SPRING CNTR WASHER (IF REQ.)
17	SHAFT SLEEVE
18	STUD
19	LOCKWASHER OR FLAT WASHER
20	HEX NUT
21	INTERMEDIATE
22	STUD OR LOCKWASHER
23	HEX NUT OR HEX HD CAPSCREW
24	CASING GSKT SET OR O-RING
25	WEAR PLATE ASSEMBLY
26	CASING DRAIN PLUG
27	LOCKWASHER
28	HEX NUT
29	CLAMP BAR (IF REQUIRED)
30	CLAMP BAR SCREW (IF REQUIRED)
31	MACHINE BOLT (IF REQUIRED)
32	BACK COVER PLATE ASSEMBLY
33	–PIPE PLUG (IF REQUIRED)
34	–BACK COVER
35	–WARNING PLATE
36	–DRIVE SCREW
37	BACK COVER GASKET
38	STUD
39	HEX NUT
40	CHECK VALVE ASSEMBLY
41	–SMALL VALVE WEIGHT
42	–HEX HEAD CAPSCREW
43	–LOCKWASHER
44	–LARGE VALVE WEIGHT
45	–CHECK VALVE GASKET
46	SUCTION FLANGE
47	PIPE PLUG (IF REQUIRED)
48	CHECK VALVE PIN (IF REQUIRED)
49	SUCT FLANGE GSKT (IF REQUIRED)
50	PIPE PLUG
51	MACHINE BOLT
52	CLAMP BAR SCREW
53	FILL PLUG ASSEMBLY OR FILL COVER PLATE ASSY
54	–COVER PLATE
55	–WARNING PLATE
56	–DRIVE SCREW
57	–COVER PLATE GASKET
58	CLAMP BAR
59	STUD
60	FLAT WASHER
61	WING NUT

SECTION DRAWING

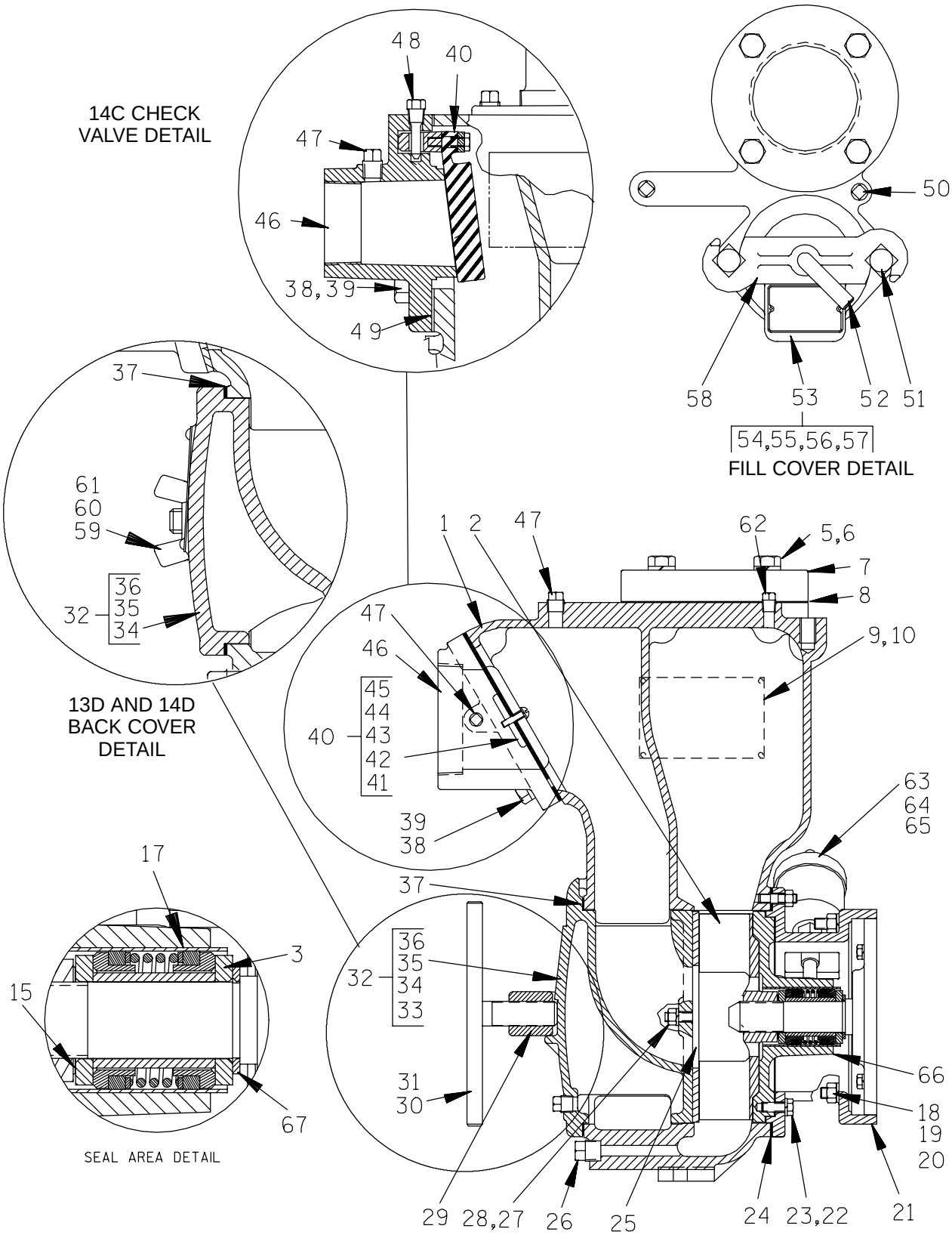


Figure C–2. Typical 13D, 14A, 14C, 14D And 16D Pump End Assembly w/Grease Seal

Typical 13D, 14A, 14C,14D and 16D Pump End Assembly w/Grease Seal Parts Identification List

Refer to the separate Parts List Manual for serviceable parts, part numbers and quantities.

ITEM NO.	PART NAME
1	PUMP CASING
2	IMPELLER
3	SEAL ASSEMBLY
4	STREET ELBOW (IF REQUIRED)
5	HEX HEAD CAPSCREW
6	LOCKWASHER OR FLAT WASHER (IF REQUIRED)
7	DISCHARGE FLANGE
8	DISCHARGE FLANGE GASKET
9	NAME PLATE
10	DRIVE SCREW
11	HEX HD CAPSCREW (NOT REQ.)
12	IMPELLER WASHER (NOT REQ.)
13	IMP SHAFT KEY (NOT REQ.)
14	SLINGER RING (NOT REQ.)
15	IMPELLER SHIM SET
16	SHAFT SLEEVE (IF REQUIRED)
17	SEAL LINER
18	STUD
19	LOCKWASHER OR FLAT WASHER
20	HEX NUT
21	INTERMEDIATE
22	STUD OR LOCKWASHER
23	HEX NUT OR HEX HD CAPSCREW
24	CASING GSKT SET OR O-RING
25	WEAR PLATE ASSEMBLY
26	CASING DRAIN PLUG
27	LOCKWASHER
28	HEX NUT
29	CLAMP BAR (IF REQUIRED)
30	CLAMP BAR SCREW (IF REQUIRED)
31	MACHINE BOLT (IF REQUIRED)
32	BACK COVER PLATE ASSEMBLY
33	–PIPE PLUG (IF REQUIRED)
34	–BACK COVER
35	–WARNING PLATE
36	–DRIVE SCREW
37	BACK COVER GASKET
38	STUD
39	HEX NUT
40	CHECK VALVE ASSEMBLY
41	–SMALL VALVE WEIGHT
42	–HEX HEAD CAPSCREW
43	–LOCKWASHER
44	–LARGE VALVE WEIGHT
45	–CHECK VALVE GASKET
46	SUCTION FLANGE
47	PIPE PLUG (IF REQUIRED)
48	CHECK VALVE PIN (IF REQUIRED)
49	SUCT FLANGE GSKT (IF REQUIRED)
50	PIPE PLUG
51	MACHINE BOLT
52	CLAMP BAR SCREW
53	FILL PLUG ASSEMBLY OR FILL COVER PLATE ASSY
54	–COVER PLATE
55	–WARNING PLATE
56	–DRIVE SCREW
57	–COVER PLATE GASKET
58	CLAMP BAR
59	STUD
60	FLAT WASHER
61	WING NUT
62	PIPE PLUG (IF REQUIRED)
63	GREASE CUP
64	PIPE NIPPLE
65	PIPE COUPLING
66	SEAL PLATE
67	SEAL WASHER (IF REQUIRED)

PUMP AND SEAL DISASSEMBLY AND REASSEMBLY

Review all SAFETY information in Section A.

Follow the instructions on all tags, label and decals attached to the pump.

This pump requires little service due to its rugged, minimum-maintenance design. However, if it becomes necessary to inspect or replace the wearing parts, follow these instructions which are keyed to the sectional views (see Figure C–1 or C–2) and the accompanying parts list. Unless otherwise specified, the instructions apply to either Figure C–1 or Figure C–2.

Before attempting to service the pump, disconnect or lock out the power source and take the necessary precautions to ensure that the pump will remain inoperative. Close all valves in the suction and discharge lines.

For power source disassembly and repair, consult the literature supplied with the power source, or contact your local source representative.

WARNING!

This manual will alert personnel to known procedures which require special attention, to those which could damage equipment, and to those which could be dangerous to personnel. However, this manual cannot possibly anticipate and provide detailed instructions and precautions for every situation that might occur during maintenance of the unit. Therefore, it is the responsibility of the owner/maintenance personnel to ensure that only safe, established maintenance procedures are used, and that any procedures not addressed in this manual are performed only after establishing that neither personal safety nor pump integrity are compromised by such practices.

WARNING!

Before attempting to open or service the pump:

1. **Familiarize yourself with this manual.**
2. **Disconnect or shut down the power source and take the necessary precautions to ensure that the pump will remain inoperative.**
3. **Allow the pump to completely cool if overheated.**
4. **Check the temperature before opening any covers, plates, or plugs.**
5. **Close the suction and discharge valves.**
6. **Vent the pump slowly and cautiously.**
7. **Drain the pump.**

WARNING!

If the pump is designed to pump materials which could cause serious illness or injury through direct exposure or emitted fumes, wear protective clothing, such as rubber gloves, face mask, and rubber apron, as necessary before disassembling the pump or piping.

Suction Check Valve Removal and Disassembly

(Figure C–1 or Figure C–2)

Before attempting to service the pump, remove the pump casing drain plug (26) and drain the pump. Clean and reinstall the drain plug.

(Models 13D, 14A, 14D And 16D)

To service the suction check valve assembly (40), remove the suction piping. Remove the hardware (38 and 39) securing the suction flange (46) and check valve assembly to the pump casing (1). Separate the check valve assembly from the suction flange.

Inspect the check valve parts for wear or damage. If replacement is required, remove the hardware

(42 and 43), and separate the check valve gasket (45) and weights (41 and 44), or remove the check valve pin (48) and pull the complete assembly from the suction flange. Remove the suction flange gasket (49).

(Model 14C)

If the check valve assembly (40) is to be serviced, reach through the back cover opening (32) and hold the assembly in place while removing the check valve pin (48). Slide the assembly from the suction flange (46) and remove it from the pump.

NOTE

Further disassembly of the check valve is not required since it must be replaced as a complete unit. Individual parts are not sold separately.

The check valve assembly may also be serviced by removing the suction flange. To remove the flange, disengage the nuts (39) and pull the flange and assembled check valve from the suction port. Remove the check valve pin, and pull the check valve assembly out of the seat.

If no further disassembly is required, see **Suction Check Valve Installation**.

Back Cover Removal

(Models 14A, 14C And 16D)

The wear plate assembly (25) is easily accessible and may be serviced by removing the back cover (32). Loosen the clamp bar screw (30) and remove the clamp bar (29). Pull the back cover and wear plate from the pump casing. Remove the back cover gasket (37). Clean the mating surfaces of the back cover plate and pump casing.

Inspect the wear plate and replace it if badly scored or worn. To remove the wear plate, disengage the hardware (27 and 28) securing it to the back cover.

(Models 13D And 14D)

Remove the wing nuts and washers (60 and 61) securing the back cover to the casing. Pull the back cover and wear plate from the pump casing (1).

Inspect the wear plate for excessive wear or scoring. If replacement is required, remove the hardware (27 and 28) securing it to the back cover.

Remove the cover plate gasket (37) and clean the mating surfaces.

If no further disassembly is required, see **Back Cover Installation**.

Pump Casing Removal

To service the impeller or seal assembly, disconnect the discharge piping. Remove the hardware securing the pump casing to the base. Tie and tag any leveling shims used under the pump mounting feet to ease reassembly.

If so equipped, disengage the hardware securing the pump casing to the hoisting bail. Support the pump casing using a suitable hoist and sling, and remove the hardware (22 and 23) securing the pump casing to the intermediate (21). Separate the pump casing and gasket set (24) from the intermediate by pulling the casing straight away. Clean the mating surfaces of the intermediate and pump casing. Tie and tag the gaskets, or measure and record their thickness for ease of reassembly.

(Model 13D)

Support the pump casing (1) using a suitable hoist and sling and remove the hardware (19 and 20) securing the pump casing to the intermediate. Separate the parts by pulling the casing straight away from the intermediate. Remove the intermediate O-ring (24) and clean the mating surfaces.

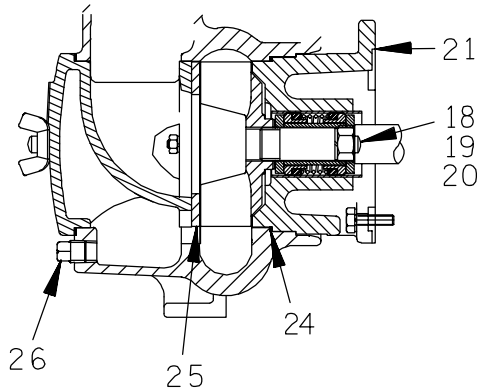


Figure C–3. Pump Model 13D

Impeller Removal

If the pump is equipped with a grease seal, turn the cross arm on the automatic lubricating grease cup (63, Figure C–2) clockwise until it rests against the cover (see Figure C–7) before attempting to remove the impeller (2). This will prevent the grease

in the cup from escaping when the impeller is removed.

NOTE

For close-coupled electric motor driven models, use a screwdriver or other suitable tool to immobilize the motor shaft before attempting to remove the impeller.

(Models 13D, 14A, 14D And 16D)

To loosen the impeller (2), tap the vanes of the impeller in a counterclockwise direction (when facing the impeller) with a block of wood or a soft-faced mallet. Unscrew the impeller using caution; tension on the seal spring will be released as the impeller is unscrewed.

Inspect the impeller and replace it if cracked or badly worn. Slide the impeller adjusting shims (15) off the impeller shaft. Tie and tag the shims or measure and record their thickness for ease of reassembly.

(Model 14C and 14D)

Remove the impeller hardware (11 and 12) and use a suitable puller to remove the impeller from the shaft. Save the impeller shaft key (13).

Inspect the impeller and replace it if cracked or badly worn. Slide the impeller adjusting shims (15) off the impeller shaft. Tie and tag the shims or measure and record their thickness for ease of reassembly.

Self Lubricated Seal Removal And Disassembly

(Figures C--1 and C--4)

Remove the spring centering washer (16) and seal spring. Slide the shaft sleeve (17) and rotating portion of the seal off the shaft as a single unit. Apply oil to the sleeve and work it up under the bellows. Slide the rotating portion of the seal off the shaft. Use a pair of stiff wires with hooked ends to remove the stationary seat and O-rings from the intermediate (21).

NOTE

An alternate method of removing the seal assembly is to remove the hardware securing the intermediate to the power source and slide the intermediate and seal assembly off the shaft as a single unit. Place the intermediate on a flat surface with the impeller side down. Use a suitable sized dowel to press the seal components from the intermediate.

Remove the slinger ring (14, if so equipped). If required, remove the intermediate as described above.

If no further disassembly is required, see **Self Lubricated Seal Installation.**

Grease Seal Removal and Disassembly

(Figures C--2 and C--5)

To remove the seal assembly (3), remove the grease cup and piping (63, 64 and 65) from the intermediate (21) or the seal plate (66).

Carefully remove the outer stationary and rotating seal elements, packing ring, stationary washer, seal spring, and spacer sleeve from the intermediate. Using two stiff wires with hooked ends, remove the inboard stationary washer, packing ring and stationary and rotating seal elements.

NOTE

The seal assembly may also be removed by disengaging the hardware securing the intermediate to the power source and sliding the intermediate and seal assembly off the shaft as a single unit. Use a dowel of suitable size to press the seal components from the intermediate.

Inspect the seal liner for wear or grooves which could cause leakage or damage to the seal packing rings. The seal liner is a press fit in the intermediate or seal plate and does not normally require replacement. If replacement is necessary, separate the intermediate from the power source as described above. Remove the seal washer (67).

If the seal liner needs replaced, see **Grease Seal Reassembly and Installation**.

If no further disassembly is required, see **Grease Seal Reassembly and Installation**.

Seal Installation

(Figures C-1 C--4 and C--5)

Clean the seal cavity and shaft with a cloth soaked in fresh cleaning solvent.

WARNING!

Most cleaning solvents are toxic and flammable. Use them only in a well ventilated area free from excessive heat, sparks, and flame. Read and follow all precautions printed on solvent containers.

Inspect the shaft for damage. Small scratches or nicks may be removed with a fine file or emery cloth. If excessive wear exists, the shaft will have to be replaced. (Refer to the power source service manual).

The seal is not normally reused because wear patterns on the finished faces cannot be realigned during reassembly. This could result in premature failure. If necessary to reuse an old seal in an emergency, **carefully** wash all metallic parts in **fresh** cleaning solvent and allow to dry thoroughly.

Handle the seal parts with extreme care to prevent damage. Be careful not to contaminate precision finished faces; even fingerprints on the faces can shorten seal life. If necessary, clean the faces with a non-oil based solvent and a clean, lint-free tissue. Wipe **lightly** in a concentric pattern to avoid scratching the faces.

Inspect the seal components for wear, scoring, grooves, and other damage that might cause leakage. If any components are worn, replace the complete seal; **never mix old and new seal parts**.

Self Lubricated Seal Reassembly And Installation

(Figures C--1 and C--4)

Clean and polish the shaft sleeve (17), or replace it if there are nicks or cuts on either end. If a replacement seal is being used, remove it from the container and inspect the precision finished faces to ensure that they are free of any foreign matter.

To ease installation of the seal, lubricate the O-rings and shaft sleeve with water or a very **small** amount of oil, and apply a drop of light lubricating oil on the finished faces. Assemble the seal as follows, (see Figure C--4).

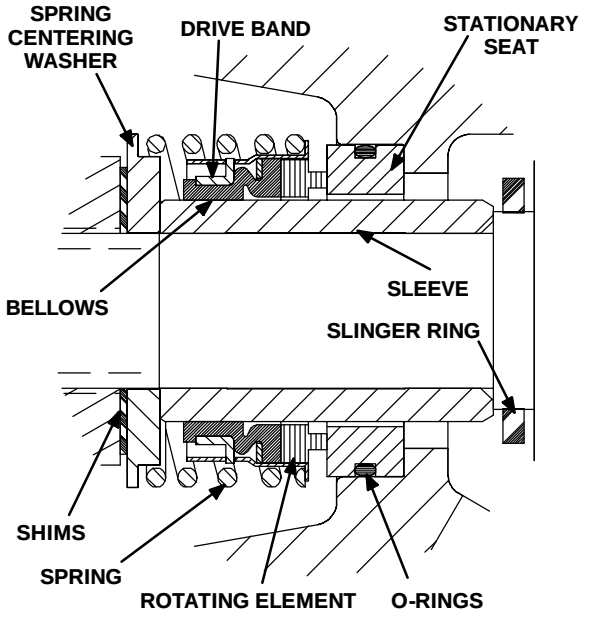


Figure C--4. Self Lubricated Seal Assembly

CAUTION

This seal is not designed for operation at temperatures above 160°F (71°C). Do not use at higher operating temperatures.

If the intermediate (21) was removed, position the intermediate over the shaft and secure it to the power source with the previously removed hardware.

If used, install the slinger ring (14) on the shaft.

Press the stationary subassembly (consisting of the stationary seat and O-ring) into the intermediate until the stationary seat bottoms against the intermediate bore. A push tube cut from a length of plastic pipe would aid this installation. The I.D. of the pipe should be approximately the same diameter as the I.D. of the seal spring.

Slide the rotating subassembly (consisting of the rotating element, retainer and bellows) onto the lubricated shaft sleeve until the rotating element is **just flush** with the end of the sleeve with the chamfered I.D. Slide the sleeve and rotating subassembly onto the shaft until the seal faces contact. Con-

tinue to push the sleeve through the seal until it bottoms against the shaft shoulder.

Install the seal spring and spring centering washer (16).

Grease Seal Reassembly And Installation

(Figures C--2 and C--5)

Before installing the seal, inspect the bore of the seal liner (17) for wear or grooves which might cause leakage or damage to the seal packing rings. If the seal liner must be replaced, position the intermediate or seal plate (21) on the bed of an arbor (or hydraulic) press. Use a new sleeve to force the old one out. After the new liner is properly installed, drill a 1/4-inch diameter hole through the liner to permit the flow of lubricant to the seal assembly. **Be careful** to center the drill in the threaded grease piping hole and not damage the threads. Deburr the hole from the inside of the seal liner after drilling.

To ease installation of the seal, lubricate the packing rings and seal liner with water or a very **small** amount of oil, and apply a drop of light lubricating oil on the finished faces. Assemble the seal as follows, (see Figure C--5).

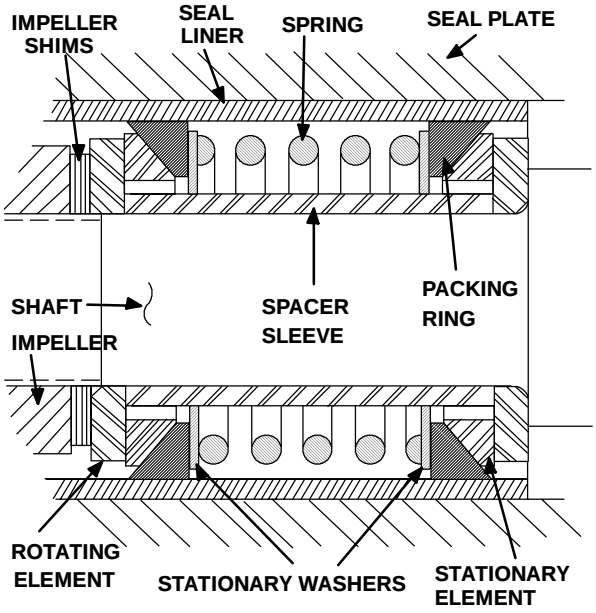


Figure C--5. Grease Seal Assembly

CAUTION

This seal is not designed for operation at temperatures above 110°F (43°C). Do not use at higher operating temperatures.

If so equipped, install the seal plate (66) on the intermediate. Install the seal washer (67, if required).

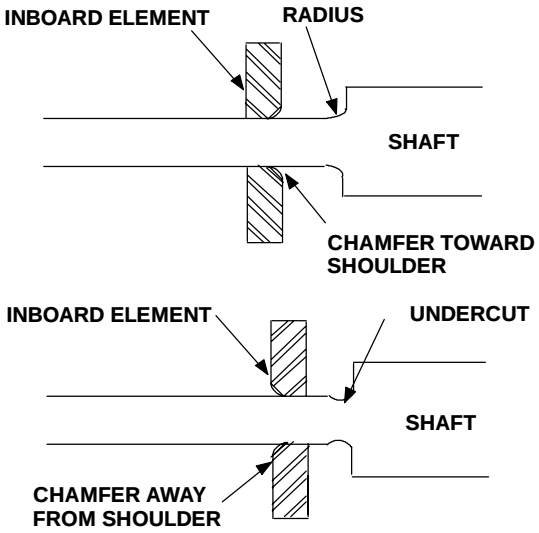


Figure C--6. Positioning of Inboard Element

The position for the inboard rotating element is determined by the machining of the impeller shaft at the shoulder where the element seats. See Figure C--6, if there is a radius on the shaft, position the inboard element with the I.D. chamfer **toward** the shaft shoulder. If the shaft is undercut at the shoulder, position the inboard element with the I.D. chamfer **away** from the shoulder.

Subassemble the inboard stationary element, packing ring and seal washer. Press this unit into the lubricated seal liner until the seal faces contact. A push tube cut from a length of plastic pipe would aid this installation. The I.D. of the tube should be approximately the same as the the I.D. of the seal spring.

Install the spacer sleeve and seal spring.

Subassemble the outboard stationary element, packing ring and seal washer. Press this unit into the lubricated seal liner.

Install the outboard rotating element with the chamfered side **toward the impeller end of the shaf**t.

Install the grease cup and the piping (63, 64 and 65) in the intermediate.

After the impeller has been installed, lubricate the seal as indicated in **LUBRICATION** at the end of this section.

NOTE

Some smoking and leakage may occur after installing a new seal assembly. This should stop after the pump has run a while and the lapped seal faces have seated in.

Impeller Installation And Adjustment

Inspect the impeller, and replace it if cracked or badly worn. Install the same thickness of impeller adjusting shims (15) as previously removed, and screw the impeller onto the shaft until tight.

For maximum pump efficiency, a specific clearance is required between the impeller and the intermediate or seal plate (see Table C–1). This back clearance can be achieved by adding or removing impeller shims.

NOTE

Be sure the intermediate or seal plate is secured while measuring this clearance.

Table C–1. Impeller Clearances

Pump Model	Clearance	
	Back Clearance	Front Clearance
13D	– – – – – –	.008 to .015
14A	.020 to .040	.008 to .015
14C	.020 to .040	.010 to .020
14D	.020 to .040	.008 to .015
16D	.020 to .040	.008 to .015

Pump Casing Installation

(Model 13D)

See Figure C–3 and lubricate the intermediate O-ring (24) with light oil and install it on the intermediate. Slide the pump casing over the intermediate until the casing bottoms against the locating shoulder on the intermediate. **Be careful** not to damage the O-ring when installing the pump casing. Secure the casing to the intermediate with the previously removed hardware (19 and 20).

(Models 14A, 14C, 14D And 16D)

Install the same thickness of pump casing gaskets (24) as previously removed, and secure the pump casing (1) to the intermediate (21) with the nuts (23). **Do not** fully tighten the nuts at this time.

NOTE

The back cover assembly must be in place to adjust the impeller face clearance.

For maximum pump efficiency, a specific clearance is required between the wear plate (25) and the impeller (see Table C–1). Install the back cover assembly (32) and set the front clearance by adding or removing gaskets in the pump casing gasket set (24).

NOTE

An alternate method of adjusting this clearance is to reach through the discharge port with a feeler gauge and measure the gap. Add or subtract pump casing gaskets accordingly.

After the face clearance has been set, tighten the nuts (23) securing the pump casing to the intermediate.

Back Cover Installation

(Figure C–1 or C–2)

If the wear plate (25) was removed for replacement, center the wear plate against the cover plate (34) and secure it using the attaching hardware (27 and 28). The wear plate **must** be concentric to prevent binding when the back cover is installed.

NOTE

To ease future disassembly, apply a film of grease or 'Never-Seez' on the back cover shoulder, or any surface that contacts the pump casing. This action will reduce rust and scale build-up.

Clean any scale or debris from the contacting surfaces on the pump casing that might prevent a good seal with the back cover. Replace the back cover gasket (37) and slide the back cover assembly (32) into the pump casing. Be sure the wear plate does not bind against the impeller.

(Models 14A, 14C And 16D)

Secure the back cover assembly by installing the clamp bar (29) and tightening the clamp bar screw (30). **Do not** over-tighten the clamp bar screw; it

should be just tight enough to ensure a good seal at the back cover shoulder.

(Models 13D And 14D)

Secure the back cover assembly with the hardware (60 and 61). **Do not** over tighten the wing nuts; they should be just tight enough to ensure a good seal at the back cover shoulder.

Suction Check Valve Installation

(Figure C--1 or C--2)

Inspect the check valve components and replace as required. Subassemble the check valve weights (41 and 44) and check valve gasket (45) using the attaching hardware (42 and 43).

Position the check valve assembly (40) in the suction port with the large weight toward the inside of the pump casing. Install the suction flange (46) and secure with the hardware (38 and 39). Check the operation of the check valve to ensure proper seating and free movement.

(Model 14C)

NOTE

The check valve assembly (40) for Model 14C must be replaced as a complete unit. Individual parts are not sold separately.

Position the check valve adaptor in the mounting slot of the suction flange (46). Align the adaptor with the flange hole, and secure the assembly with the check valve pin (48). Install the suction flange and suction flange gasket (49), and secure with the hardware (38 and 39). Check the operation of the check valve to ensure proper seating and free movement.

Final Pump Assembly

Secure the pump to the base with the previously removed hardware. Be sure to reinstall any leveling shims used under the pump mounting feet.

Be sure the pump and power source are securely mounted to the base.

Install the suction and discharge lines. Make certain that all piping connections are tight, properly supported and secure. Open all the valves in the suction and discharge lines.

Be sure the pump and power source have been properly lubricated, see **LUBRICATION**.

Remove the fill plug assembly/fill cover plate assembly (53) and fill the pump casing with clean liquid. Reinstall the fill plug and tighten it.

Refer to **OPERATION** in the Installation And Operation manual before putting the pump back into service.

LUBRICATION

Self Lubricated Seal Assembly

(Figure C--1)

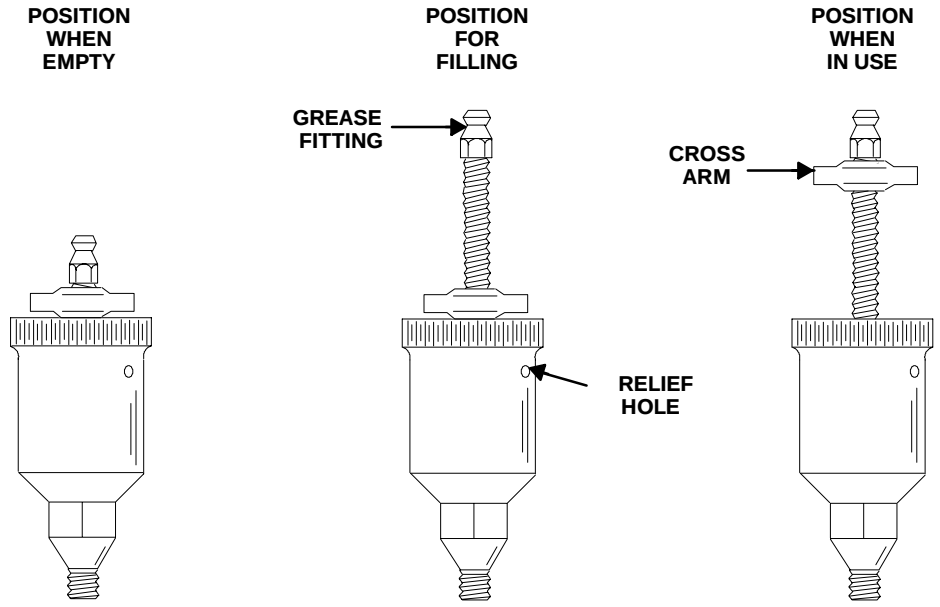
The seal assembly is lubricated by the medium being pumped, or by a flow of fresh liquid from an external source. Flushing liquid may be taken from the pump discharge and supplied through auxiliary piping.

When handling abrasive or tacky liquids, supply fresh lubricating liquid from an external source. Be sure the liquid supplied to the seal is compatible with the liquid being pumped, and that its flow is controlled to prevent dilution. If flushing is required, contact the factory.

Grease Lubricated Seal Assembly

(Figure C--2)

Fill the grease cup (63) through the grease fitting with No. 2 lithium base grease until grease escapes from the relief hole. Turn the grease cup arm counterclockwise until it is at the top of the stem; this will release the spring to apply grease to the seal (see Figure C--7).



NOTE:
When installing a new grease cup, lubricate the cup as indicated on the installation tag furnished with the grease cup.

Figure C--7. Automatic Lubricating Grease Cup

NOTE

Some smoking and leakage may occur after installing a new seal assembly. This should stop after the pump has run a while and the lapped seal faces have seated in.

Power Source

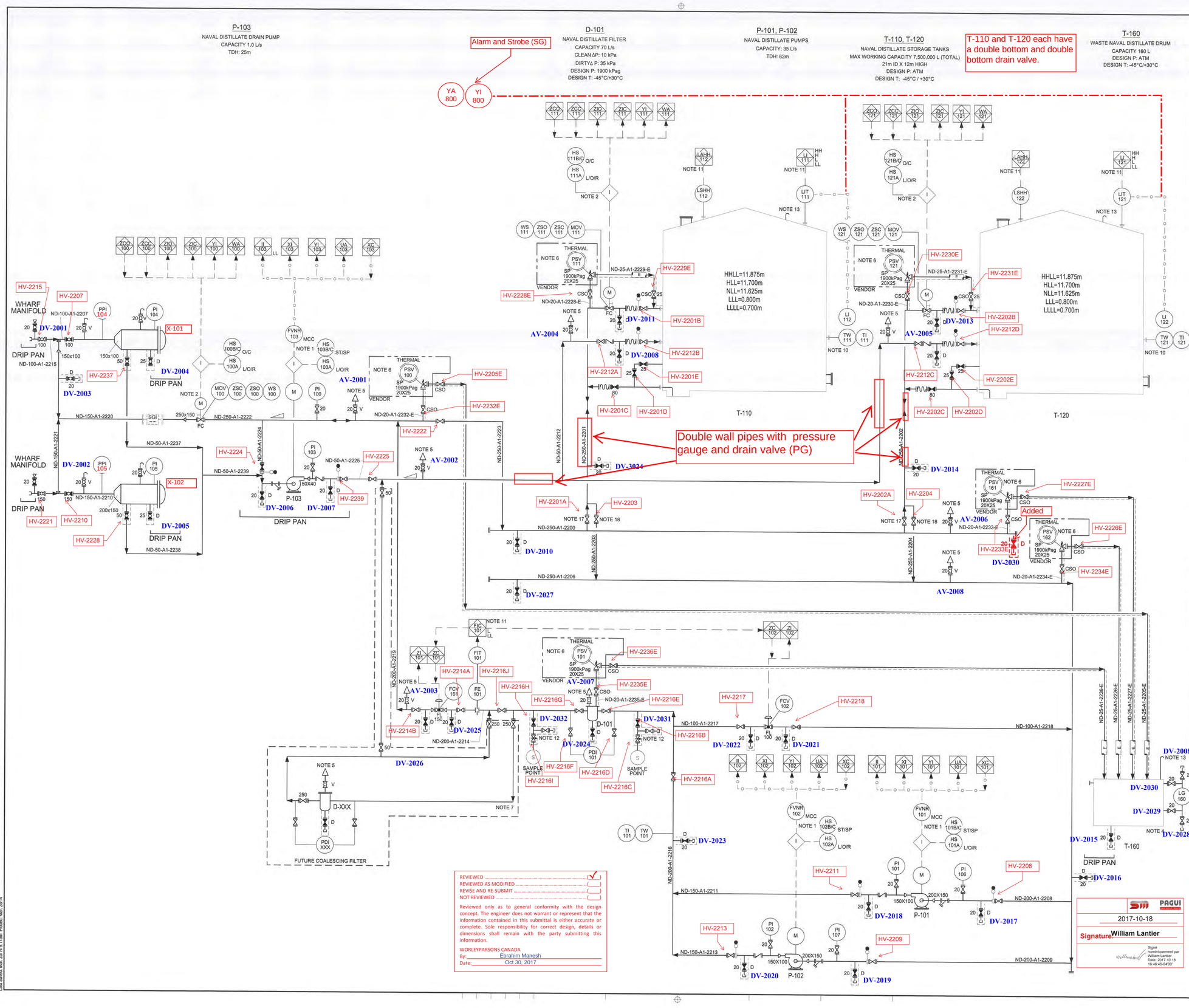
Consult the literature supplied with the power source, or contact your local power source representative.

For U.S. and International Warranty Information,
Please Visit www.grpumps.com/warranty
or call:
U.S.: 419—755—1280
International: +1—419—755—1352

For Canadian Warranty Information,
Please Visit www.grcanada.com/warranty
or call:
519—631—2870

THE GORMAN-RUPP COMPANY ● MANSFIELD, OHIO
GORMAN-RUPP OF CANADA LIMITED ● ST. THOMAS, ONTARIO, CANADA

Appendix 8. ND AND DF SYSTEM P&ID



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LEVEL OF SECURITY | NIVEAU DE SÉCURITÉ

CONSULTANT

WorleyParsons resources & energy

307071-00833

NOTES:

1. FOR FVNR MOTOR CONTROL SCHEMATIC DIAGRAM, SEE DWG C-N143-1218/03.02-41-521.
2. FOR MOV MOTOR CONTROL SCHEMATIC DIAGRAM, SEE DWG. C-N143-1218/03.02-41-520.
3. FOR SCHEMATIC SYMBOLOGY, SEE DWG. C-N143-1216/03.02-21-401.
4. THREADED CAP AND FUNNEL TO BE PROVIDED FOR LOCAL WASTE FROM MINOR SPILLS AND MAINTENANCE.
5. AUTOMATIC AIR VENT WITH A BALL VALVE.
6. THE THERMAL RELIEF VALVES SIZE TO BE VERIFIED BY VENDOR BASED ON DESIGN CONDITIONS PROVIDED TO THE CONTRACTOR.
7. TIE-INS FOR A FUTURE COALESCING FILTER.
8. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE PROJECT NMS SPECIFICATIONS.
9. LOW POINTS AND/OR DRAINS TO BE INSULATED AND ELECTRICALLY TRACED.
10. TWO MANWAYS.
11. FOR DETAILS OF ALARMS AND TRIPS, REFER TO OPERATING MANUAL AND CAUSE AND EFFECT DIAGRAM.
12. DRAIN TO A BUCKET OR BOTTLE WITH A RUBBER HOSE.
13. GOOSE NECK AND ALL VENTS ON ALL TANKS TO BE SIZED BY VENDOR.
14. FOR NOZZLE DETAILS SEE DWG C-N143-1216/03.02-22-402.
15. VALVES INSTALLED ON PIGGABLE LINE SHALL BE FULL BORE ROUND PORT.
16. PUMP MOTORS TO BE SIZED BY VENDOR.
17. TANK FILLING OPERATION: MANUAL VALVES ON LINES ND-250-A1-2201 AND ND-250-A1-2202 NORMALLY OPEN DURING TANK FILLING, OTHERWISE NORMALLY CLOSED.
18. TANK EMPTYING / AOPS SHIP FUELLING OPERATION: MANUAL VALVES ON LINES ND-250-A1-2203 AND ND-250-A1-2204 NORMALLY OPEN, OTHERWISE CLOSED.
19. ALL VALVE SIZES ARE THE SAME SIZE AS THEIR CORRESPONDING LINE SIZES, UNLESS STATED OTHERWISE.
20. SYSTEM OPERATES DURING SUMMER SEASON ONLY.

PERMIT TO PRACTICE
WORLEYPARSONS CANADA SERVICES LTD.
Signature
Date March 26, 2014
PERMIT NUMBER: P 029
NWT/NU Association of Professional Engineers and Geoscientists

NO.	DATE	REVISION	APPR.
1	2014/03/24	RE-ISSUED FOR TENDER	T.M.
0	2013/12/06	ISSUED FOR TENDER	T.M.
G	2013/10/03	ISSUED FOR CUSTOMER REVIEW	M.C.
F	2013/09/13	ISSUED FOR HAZOP-KDCN2	M.C.
E	2013/08/16	ISSUED FOR INFORMATION	M.C.
D	2013/07/09	ISSUED FOR INTERNAL REVIEW	M.C.
C	2013/06/14	RE - ISSUED FOR DISCIPLINE REVIEW	M.C.
B	2012/08/31	ISSUED FOR CUSTOMER REVIEW	P.W.
A	2012/08/01	ISSUED FOR INTERNAL REVIEW	P.W.

SCALE | ÉCHELLE: NOT TO SCALE

LOCATION | EMPLACEMENT: NANISIVIK NUNAVUT

PROJECT | PROJET: NANISIVIK NAVAL FACILITY (NNF)

TRADE | MÉTIER: BULK LIQUIDS (4)

DATE: 2012/06/02

SUBJECT | SUJET: BULK LIQUIDS FACILITIES NAVAL DISTILLATE SCHEMATIC

PRODUCTION	REVIEWED | REVU	
DESIGNED | ÉTUDIÉ: R.R.	T.M.	DES O | AGENT CONC: N/A
DRAWN | DESSINÉ: J.D.	J.L.R.	PROJ MGR | GEST PROJ: N.M.W.
CHECKED | VÉRIFIÉ: N/A		DES MGR | GEST CONC: N/A
COORDINATION: T.B.		FIRE | INCENDIE: N/A
PF NUMBER | No DP: -	DWG. NO. | No. DESSIN: C-N143-1216/03.02- 22-401	

Canada

Filename: U:\YVR\307701\00833_DCC_Phase 3B\11_Drawings\06_Piping\02_Piping Layouts\C-N143-1216-03.02-22-401.dwg -Layout1
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Layout1
jennifer.coppendale
2014/Mar/25, 9:17am

Sheet 1 of 1

U-230, U-240
DIESEL GENERATOR
SET PACKAGES
250 kVA, 600V
PRIME GENERATOR

P-203
DIESEL DRAIN PUMP
CAPACITY: 1.0L/s
TDH: 17m

U-201
DIESEL MOBILE
EQUIPMENT FUEL
DISPENSER
(WITH A DAY TANK)

T-210, T-220
DIESEL STORAGE TANKS
MAX WORKING CAPACITY 160 000L (TOTAL)
3m x 12.2m
DESIGN P: ATM
DESIGN T: -45°C/+30°C

DF tank have double wall tank with pressure gauge and a drain valves (SG)

P-201, P-202
DIESEL PUMPS
CAPACITY: 2 L/s
TDH: 21m

T-240
WASTE DIESEL DRUM
CAPACITY 160 L
DESIGN P: ATM
DESIGN T: -45°C / +30°C

Alarm and Strobe (SG)

T-210

T-220

HHLL=~~2.519m~~ 2.7 m
HLL=~~2.320m~~ 2.61 m
NLL=~~1.525m~~ 2.5 m
LLL=0.730m
LLLL=0.200m

WHARF MANIFOLD
DRIP PAN
DRIP PAN
DRIP PAN
U-230
U-240
VENDOR
MOBILE FUELLING EQUIPMENT
CONTAINMENT AREA
P-203
P-201
P-202
T-240

normally closed (SG)

WORLEYPARSONS CANADA LTD.
Infrastructure & Environment
Drawing Review

REVIEWED ..... [ ]
REVIEWED AS MODIFIED ..... [X]
REVISE AND RE-SUBMIT ..... [ ]
NOT REVIEWED ..... [ ]

Reviewed only as to general conformity with the design concept. The engineer does not warrant or represent that the information contained on this drawing is either accurate or complete. Sole responsibility for correct design, details and dimensions shall remain with the party submitting the drawings.

WORLEYPARSONS CANADA LTD.
Ozer Ozdemir/Sanjay Khera
By:
Date: 8 Nov 2017

AS BUILT
PAGUI
DATE: 2017-10-18
BY : William Lantier
Signature: Signé numériquement par William Lantier Date: 2017.10.18 16:47:22-04'00'

Government of Canada / Gouvernement du Canada

LEVEL OF SECURITY | NIVEAU DE SÉCURITÉ

CONSULTANT
WorleyParsons
resources & energy
307071-00833

NOTES:

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2. FOR MOV MOTOR CONTROL SCHEMATIC DIAGRAM, SEE DWG. C-N143-1216/03.02-41-520.
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6. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE PROJECT NMS SPECIFICATIONS.
7. LOW POINTS AND/OR DRAINS TO BE INSULATED AND ELECTRICALLY TRACED.
8. FOR DETAILS OF ALARMS AND TRIPS, REFER TO OPERATING MANUAL AND CAUSE AND EFFECT DIAGRAM.
9. GOOSE NECK AND ALL VENTS ON ALL TANKS TO BE SIZED BY VENDOR.
10. FOR NOZZLE DETAILS, SEE DWG. C-N143-1216/03.02-23-403.
11. FILL PORT.
12. VALVES INSTALLED ON PIGGABLE LINE SHALL BE FULL BORE ROUND PORT.
13. AUTOMATIC AIR VENT WITH BALL VALVE.
14. PUMP MOTORS TO BE SIZED BY VENDOR.
15. ALL VALVE SIZES ARE THE SAME SIZE AS THEIR CORRESPONDING LINE SIZE, UNLESS STATED OTHERWISE.
16. SYSTEM OPERATES DURING SUMMER SEASON ONLY.

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WORLEYPARSONS CANADA SERVICES LTD.
Signature
Date March 26, 2014
PERMIT NUMBER: P 029
NWT/NU Association of Professional Engineers and Geoscientists

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		ISSUED FOR INTERNAL REVIEW	.
			.
			.
A	2017/07/24	ISSUED FOR INTERNAL REVIEW	P.W.

SCALE | ÉCHELLE
NOT TO SCALE

LOCATION | EMPLACEMENT
NANISIVIK
NUNAVUT

PROJECT | PROJET
NANISIVIK NAVAL FACILITY (NNF)

TRADE | MÉTIER
BULK LIQUIDS (4)

DATE
2018/07/24

SUBJECT | SUJET
BULK LIQUIDS FACILITIES
DIESEL FUEL
SCHEMATIC

PRODUCTION	REVIEWED	REVU
DESIGNED | ÉTUDIÉ R.R.	T.M.	DES O | AGENT CONC N/A
DRAWN | DESSINÉ J.D.	J.L.R.	PROJ MGR / GEST PROJ N.M.W.
CHECKED | VÉRIFIÉ N/A		DES MGR | GEST CONC N/A
COORDINATION T.B.		FIRE | INCENDIE N/A
PF NUMBER | No DP -	DWG. NO. | No. DESSIN C-N143-1216/03.02- 23-401	

Canada