



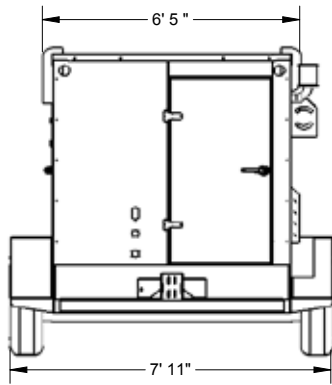
MAC 6000

MANUAL

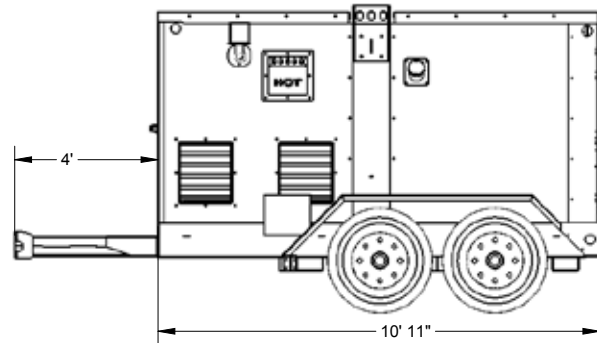


Pictures

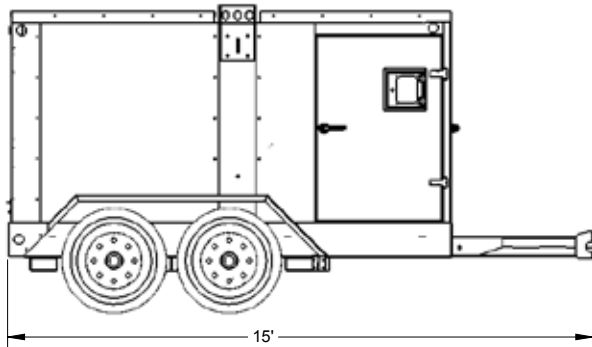
MAC 6000 Hydronic Heater



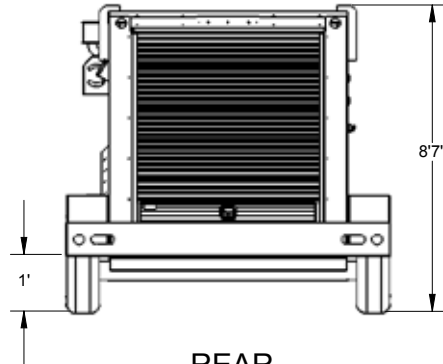
FRONT



LEFT SIDE



RIGHT SIDE



REAR



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MAC 6000 Hydronic Heater

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Specifications

MAC 6000 Hydronic Heater

MAC 6000 – SPECIFICATIONS

	<u>Imperial</u>	<u>Metric</u>
Heating Power Gross Input:	630,000 BTU/Hour	185 kW/Hour
Combustion Efficiency:	86%	86%
Engine/Genset(Isuzu):	10 hp/8 kW	7.46 kW/ 8 kW
Hose Length:	3,000 ft 6 x 500 ft	915 m 6 x 153 m
Hose Pressure:	25 - 45 psi	172 - 310 kPa
HTF Flow Rate:	1,500 GPH	5,678 LPH
Fuel Capacity:	225 US Gallons	852 Liters
Fuel Rate:	4.5 GPH + 0.65 GPH w/genset	17 LPH + 2.46 LPH w/genset
Operating Temperature:	65° - 185° F	18° - 85° C
Dimensions (L x W x H):	186 IN x 96 IN x 92 IN	4,724 mm x 2,438 mm x 2,337 mm
Weight:	7,640 lbs (dry) 10,440 lbs (wet)	3,466 kg (dry) 4,736 kg (wet)
Hitch (Trailer Mounted):	2-5/16 IN Ball hitch coupler	
Finish-Interior	Powder coat	
Finish-Exterior	Powder coat	
Construction:	Fabricated steel, fully enclosed, with forklift tubes and crane lifting points	
Run Time:	56 hrs @ 75% 78 hrs @ 50%	
Hose Rewind:	AC motor	
Fuel:	#1 Diesel (below 32° F/0° C), #2 Diesel	
Engine Controls:	PLC based operation	
Heat Transfer Fluid (HTF):	Propylene Glycol - JEFFCOOL P155	



MAC 6000 - STANDARD FEATURES

Trailer mounted-6,000 lb tandem leaf spring axles
16", 6-Lug wheels and tires
2-5/16 IN Ball hitch-4 position adjustable height
Electric trailer brakes
Stop, turn and tail lights
DOT Approved
Lift jacks
"D" Ring tie downs
Engine Block Heater
Secondary fluid containment, 110% containment
Non-toxic HTF - Propylene glycol - JEFFCOOL P155
Low operating pressures
Lockable access doors
Powder coat finish
Heavy gauge welded steel
Fork lift tubes
Crane lifting points
LED lights in rear access door

MAC 6000 - OPTIONS

Pintle hitch-4 position adjustable height-(optional trailer hitch)
Spare tire and mount
Custom paint colors
Insulated curing/thawing blankets
Emergency stop
Global Positioning System (GPS)
Work light packages

- Exterior LED work lights (flood or spot)

Hazardous Environment Options

- LEL Monitor – 75 harmful/explosive gas detection

General Information

MAC 6000 Hydronic Heater



- 1 Roll up rear access door
- 2 DOT tape and running lights
- 3 "D" ring tie down points
- 4 16", 6 lug wheels and tires
- 5 Crane lifting points
- 6 Burner compartment access door
- 7 Control panel access door
- 8 Adjustable height hitch
- 9 "Green" indicator beacon



- 1 Lift jack
- 2 Engine compartment access door
- 3 Air intake screens
- 4 Engine/Burner exhaust
- 5 Fuel fill

ONE (1) YEAR LIMITED WARRANTY

MAC, Inc. warrants to the original purchaser of the equipment, that all workmanship and materials utilized in the construction of the equipment by MAC, Inc. will be free from substantial defects in material and workmanship for a period of one (1) year from the date of purchase.

In addition to the above warranty, these components have an extended warranty period beyond one (1) year.

Isuzu Engine

12 months*, unlimited hours**

100% Parts/100% Labor

12-24 months*, 200 hours**

100% Parts/100% Labor

* Whichever occurs first.

** Coverage for all electrical, fuel system and turbocharger components is limited to 2yrs/1000 hours, whichever occurs first.

Note: In the absence of a functional hour meter, the engine will be deemed to be in use for 8 hours per calendar day commencing from the start of the warranty period.

MeccAlte generator

Two (2) years from delivery date to MAC, Inc.

Rear Overhead door

Two (2) years from shipment to customer

This warranty extends only to the original purchaser of MAC, Inc.'s equipment and is not transferable to any other parties. MAC, Inc. does not assume responsibility for any promises, warranties, or representations beyond those expressed in the written document.

MAC, Inc.'s obligations and understandings in this warranty are limited to the repair or replacement, at its option, of any defective products manufactured by MAC, Inc, and in no event shall MAC, Inc. be liable for any consequential, indirect, or incidental costs or damages, including loss of use or any other damages of any type arising out of such defective parts or products.

Some States in the U.S.A. do not allow exclusion or limitation of incidental or consequential damages or implied warranties. In addition you may have other rights which vary from state to state. Any items of this warranty which conflict with the laws of our state are deemed amended by the law of your state.

Warranty (cont.)

MAC 6000 Hydronic Heater

In the event that you believe any product manufactured by MAC, Inc. has a defect or malfunction or failure to conform to this written warranty, you should contact MAC, Inc. at its Bismarck, ND address:

MAC, Inc.
2106 East Indiana Ave.
Bismarck, ND U.S.A. 58504
+1.800.272.4604
www.macheaters.com

Follow this procedure for warranty:

1. Contact MAC, Inc. at +1.800.272.4604
2. Ask to speak to a service representative
3. Have the following information ready when you call
 - a. Original purchaser's company name
 - b. Model number of your equipment
 - c. Serial number of your equipment
 - d. Purchase date of your equipment
4. Defective product may need to be returned to MAC, Inc. with the freight prepaid. Take appropriate precautions against damage during shipping.
5. Supply the following information with the returned product
 - a. Name, address, contact person and telephone number of the original purchaser of the equipment and indicate the date of purchase.
 - b. Serial number and model number defective part is attached

MAC, Inc. will replace or repair any defective products within a reasonable period of time and return them to you. If MAC, Inc. determines there is no failure to this limited warranty, you will be notified to retrieve your product from the service facility. MAC, Inc. assumes no responsibility for merchandise not retrieved within thirty (30) days of notification to the original purchaser or owner of the product.

This warranty has been drafted to comply with Federal legislation and rules promulgated by the Federal Trade Commission.

You have additional legal rights in addition to those set forth in this written limited



General Trailering Information

MAC 6000 Hydronic Heater

- Driving a vehicle with a trailer in tow is vastly different from driving the same vehicle without a trailer in tow. It takes longer to get up to speed. You need more room to turn and pass, and more distance to stop when towing a trailer. You are responsible for keeping your vehicle and trailer in control, and for all damage that is caused if you lose control of your vehicle and trailer.
- It is critical that the trailer be securely coupled to the hitch and that the safety chains are correctly attached. Uncoupling while towing may result in death or serious injury.
- If the trailer comes loose from the hitch for any reason, we have provided safety chains so that control of the trailer can be maintained.
- Your trailer is equipped with a breakaway brake system that will apply the brakes on your trailer if your trailer comes loose from the hitch. The safety chains and breakaway brake system must be in good condition and properly rigged to be effective. The breakaway brake system must not be used as a substitute for a parking brake or wheel chocking.
- Be sure your hitch and tow vehicle are rated for the Gross Vehicle Weight Rating (GVWR) of your trailer.
- Maximum towing speed 45 mph.
- Be sure tires are inflated to pressure indicated on tire size and air pressure ID tag before towing. Improper inflation can result in a blowout and loss of control, which can lead to death or serious injury.
- Be sure lug nuts are tight before each tow.
- Be sure that the electric brakes and all of the lights on your trailer are functioning properly before each tow.
- Altering your trailer can damage essential safety items. DO NOT alter your trailer.

Safe Trailer Towing Guidelines

MAC 6000 Hydronic Heater

- Before towing, check coupling, safety chains, safety brake, tires, wheels and lights.
- Check the breakaway battery. Make sure it is fully charged.
- Check the wheel lug nuts or bolts for tightness. 85-95 ft. /lbs.
- Check coupler tightness after towing 50 miles (80km).
- Adjust the brake controller to engage the trailer brakes before the tow vehicle brakes.
- Use your mirrors to verify that you have enough room to change lanes or pull into traffic.
- Use your turn signals well in advance.
- Allow plenty of stopping distance for your trailer and tow vehicle.
- Do not drive faster than the conditions will allow.
- Allow plenty of room for passing. A rule of thumb is that passing distance with a trailer is 4 times the passing distance without a trailer.
- Use lower gears for climbing and descending grades.
- Do not ride the brakes while descending grades; this can cause overheating and potential brake failure.
- Slow down for bumps in the road. Take your foot off the brake pedal when crossing the bump.
- Slow down prior to entering a curve; maintain a constant safe speed that allows you to remain in control of your trailer. The towing vehicle will then remain in control of the trailer.
- Do not apply the tow vehicle brakes to correct extreme trailer swaying. Continued pulling of the trailer, and even slight acceleration, or carefully applying the trailer brakes (using the electronic brake controller) will provide a stabilizing force.



Make regular stops to confirm

- The coupler is secure to the hitch and is locked.
- Electrical connections are made.
- There is appropriate slack in the safety chains.
- There is appropriate slack in the breakaway switch pull-pin cable.
- The tires are inflated to proper air pressure and no damage or unusual wear to tread or sidewalls.
- The trailer and doors are secure, latched and in good condition.

Wheel chock user guidelines

- Improper use may result in product failure.
- Select wheel chock according to the equipment type and size.
- Always use in pairs and on firm surfaces.
- Chock in direction of grade.
- Chock both sides of wheel if direction of grade is undetermined.
- Use only after parking brake is applied and tested.
- Center chocks snugly and squarely against tread of each wheel.
- Always test chocks to insure they meet requirements.
- Do not drive over wheel chocks.

**For more trailering information check out:
US Department of Transportation, National Highway Traffic Safety
Administration website at:**

<http://www.nhtsa.gov/Cars/Problems/Equipment/towing/index.htm>

Warnings and Cautions

MAC 6000 Hydronic Heater

The MAC 6000 Hydronic surface heater is designed and built for sustained reliable heat production in industrial, severe operating conditions and environments. The MAC 6000 is built to withstand rough and frequent handling.

The sub-frame has forklift access at either side with crane lifting points on top for lifting and "D" ring tie-downs for transporting. The total enclosure design protects the operating components allowing all-weather storage or operations. All options incorporate integrated control and safety systems to insure reliable operations. MAC, Inc. offers training services to help you learn how to properly operate and maintain your unit. Contact MAC, Inc. at +1.800.272.4604

WARNINGS AND CAUTIONS LISTED IN THIS MANUAL MUST BE FOLLOWED!

REMEMBER

SAFETY FIRST!! OPERATOR MUST READ AND UNDERSTAND ALL OPERATING INSTRUCTIONS, WARNINGS, AND CAUTIONS BEFORE OPERATING HEATER.

WARNING!

- IMPROPER OPERATION OF THIS EQUIPMENT CAN CAUSE SERIOUS INJURY OR DEATH.
- READ OPERATION MANUAL SUPPLIED WITH THIS EQUIPMENT BEFORE OPERATING OR SERVICING.
- DO NOT OPERATE WHILE TRANSPORTING.
- MAKE SURE UNIT IS PROPERLY SECURED WITH WHEEL CHOCKS AND ON LEVEL GROUND TO PREVENT SHIFTING OR ROLLING.
- HEARING PROTECTION REQUIRED WHEN OPERATING THIS MACHINE.
- ADEQUATE AIRFLOW TO THE HEATER IS MANDATORY FOR SAFE RELIABLE OPERATION. DO NOT COVER UNIT OR RESTRICT PROPER AIR FLOW.
- KEEP AIR INTAKE FREE AND CLEAR OF DEBRIS.
- HEATER SHOULD NOT BE LEFT UNATTENDED DURING OPERATION.
- SHUT ENGINE OFF BEFORE CHECKING FLUID LEVELS.
- ALL SAFETY GUARDS MUST BE IN PLACE DURING OPERATION.
- FOLLOW LOCKOUT PROCEDURE BEFORE SERVICING.
- MOVING PARTS CAN CRUSH AND CUT.
- HOT PRESSURIZED FLUID. DO NOT OPEN DOORS WHILE MACHINE IS RUNNING.
- DOORS MUST REMAIN CLOSED DURING OPERATION.
- JACKS ARE INTENDED FOR LEVELING AND STABILIZING ONLY.
- DURING OPERATION, INTERNAL COMPONENTS CAN BECOME BURN HAZARDS. DO NOT TOUCH. ALLOW TIME TO COOL BEFORE SERVICING.
- FIRE FROM FLAMABLE FUEL CAN CAUSE SERIOUS INJURY OR DEATH.
- NO SMOKING. SPARKS OR OPEN FLAME DURING FUELING OR WASHDOWN.

The MAC6000 operates at atmospheric pressure and is not considered a pressurized boiler. Boiler regulations do not apply to this product.



Crane Lifting Requirements

- The MAC 6000 is equipped with crane lift points.
Never attempt to lift machine by any other points.
- Always use properly rated lifting equipment.
Lift points are only approved for use with a double leg sling.
- Always inspect lift points and lifting equipment for damage prior to lifting.
- Minimum sling-to-load angle is 60°.
- Select the appropriate lift point for most level lifting.
- Never attempt to lift the machine while in operation.

Crane Lifting Instructions

1. a.) To lift the machine using a double leg sling, attach one leg to each side of the machine using the appropriate equipment (e.g. shackles, hooks).
b.) Select the appropriate lift eyes for balanced and level lifting.
2. Begin lifting the machine and verify the machine is stable and level.
Adjust lift eyes as necessary.
3. Lift the machine.

INFORMATIONAL DECALS – Provide you important information about your MAC heater allowing for ease in servicing, ordering parts and/or warranty questions.



1 2 3 4

Located inside the right hand front control panel door

- 1 Serial #, Model # and VIN # ID tag
- 2 Tire size and air pressure ID tag
- 3 VIN #, Date of manufacture, GVWR, tire and rim size ID tag
- 4 MAC decal – To order parts call +1.800.272.4604 or www.macheaterparts.com



1

- 1 Model number decal – Located outside on the front right corner and the left rear corner of the heater.

Informational Decals (cont.)

MAC 6000 Hydronic Heater



- 1 Model number decal
- 2 Crane lifting points
- 3 Low or ultra-low sulfur DIESEL FUEL ONLY
NO ADDITIVES



Located on the front trailer/heater tongue

- 1 Trailer/heater front lift jack
- 2 Tire size and air pressure ID tag
- 3 VIN #, date of manufacture, GVWR, tire and rim size ID tag

INSTRUCTIONAL DECALS – Provide important information to the operator on the proper operating requirements.



- 1 Crane lifting points



- 2 “D” ring tie downs during transportation
Fork lift pockets



- 3 MAC Heaters – Engine/heater control panel



Instructional Decals (cont.)

MAC 6000 Hydronic Heater



1



2

3

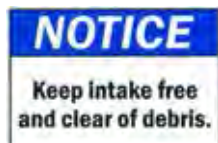
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- 1 Notice – Do NOT operate while transporting



- 2 Doors must be closed during operation

- 3 Notice – Keep air intake free and clear of debris

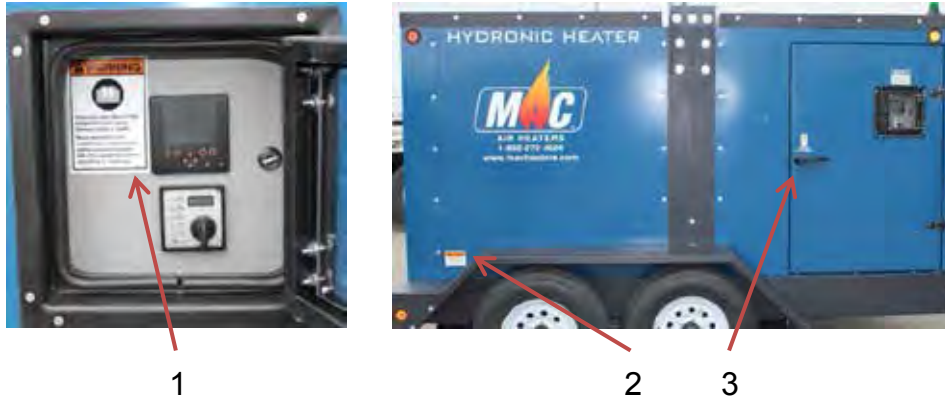


- 4 Caution: Hot Exhaust – Both engine and burner

Warning Decals

MAC 6000 Hydronic Heater

WARNING DECALS – Provide important information and warnings to ensure the safety of the operator and the machine.



- 1 **WARNING** – Improper operation of this equipment can cause serious injury or death. Read operation and maintenance manual and safety manual supplied with this equipment before operating or servicing.



- 2 **WARNING** – Wheel Lugnuts May Become Loose
Tighten wheel lugnuts to factory specifications after first 50 miles. Retighten periodically thereafter.



- 3 **WARNING** – Burn Hazard. Do NOT touch. Allow to cool before servicing. During operation, internal components are a burn hazard.



Warning Decals (cont.)

MAC 6000 Hydronic Heater



1 2 3 4 5

- 1 Doors must be closed during operation



- 2 **WARNING** – Burn Hazard. Do NOT touch. Allow to cool before servicing. During operation, internal components are a burn hazard.



- 3 Notice – Keep air intake free and clear of debris



- 4 **CAUTION: HOT EXHAUST** – Both engine and burner



- 5 **WARNING** – Fire from flammable fuel can cause serious injury or death. No smoking, sparks or open flame during fueling or wash-down.



Warning Decals (cont.)

MAC 6000 Hydronic Heater



1



1

3

1

1



2

1

- 1 WARNING – Burn Hazard. Do NOT touch. Allow to cool before servicing. During operation, internal components are a burn hazard.



- 2 DANGER – Moving parts can crush and cut. Do not operate with guard removed. Follow lock out procedure before servicing.



3. WARNING – Moving parts can crush and cut. Keep hands clear while operating machine.



For questions or more information, please contact:

MAC, Inc.

2106 East Indiana Avenue

Bismarck, ND 58504 U.S.A.

+1.800.272.4604

Pre-Start Checklist

MAC 6000 Hydronic Heater

WARNING!

- SEVERE INJURY MAY RESULT IF PRECAUTIONS ARE NOT FOLLOWED.
- DO NOT COVER THE MACHINE. MACHINE MUST BE USED IN AN OPEN AREA.
- DO NOT OPERATE MACHINE WITH ACCESS DOORS OPEN.
- MACHINE MUST BE COMPLETELY SHUT DOWN BEFORE OPENING ACCESS DOORS.
- MAKE SURE ENGINE IS SHUT OFF BEFORE CHECKING FLUID LEVELS.
- MACHINE MUST BE RUN ON LEVEL GROUND TO INSURE PROPER OPERATION.
- MACHINE MUST BE SECURED ON LEVEL GROUND TO PREVENT ROLLING OR SHIFTING AS SERIOUS INJURY MAY OCCUR.

WARNING!

Do not use any fuel other than diesel #1 or diesel #2

Do not use gasoline or ANY fuel contaminated with gasoline!

PRE-START CHECKLIST

- Check area surrounding heater for flammable materials or fire hazards.
 - Check exterior of heater for any fluid leaks. (Fuel, engine oil, engine antifreeze, glycol hose leaks)
 - Check general condition of heater.
 - Check air intake screens for any obstructions and are in proper condition.
 - Check exhaust stacks for any obstruction. (snow, ice, etc..)
 - Insure ground hose is securely fastened to outlet assembly.
 - Check to see that unit has been serviced and ready for operation.
 - Check fuel tank for proper fuel and fuel level. Only diesel fuel #1 or #2
- *ATTN: MAKE SURE DIESEL HAS NO ADDITIVES***
- Check that the unit is level and properly secure before starting.
 - Hook up ground hoses in desired configuration.

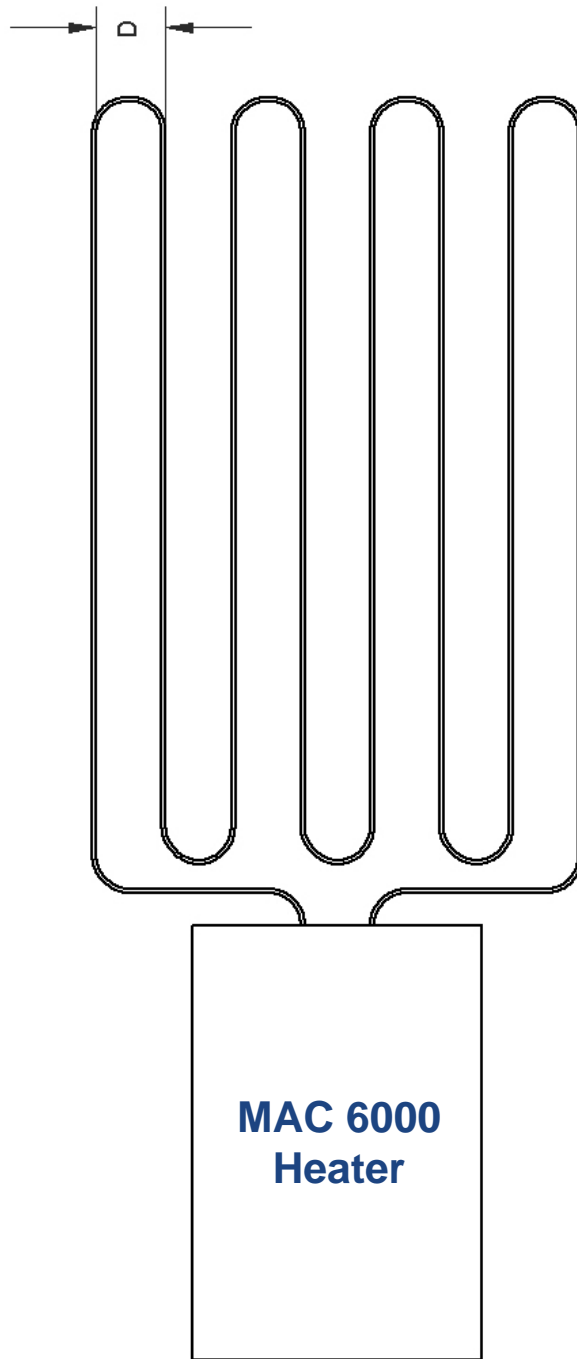
ENGINE COMPARTMENT CHECKLIST

- Check interior compartment for fluid leaks. (Fuel-engine/burner, engine oil, engine antifreeze, glycol tank/hoses/tube lines)
- Check all filters for leaks and are in proper working condition.
- Check all fluid levels prior to starting machine. (Fuel, engine oil, engine antifreeze, glycol tank)
- Check battery and battery cables are secure and in good condition.
- Check fuel lines and electrical cables and connections for damage and security.
- Check glycol lines and fittings for leaks, cracks and overall condition.
- Check engine belts and hoses for overall condition.
- Check engine control panel for security.
- Fuel supply and return valves in "Open" position.



Typical Hose Layout

MAC 6000 Hydronic Heater



DIMENSION	THAW SPACING	CURE SPACING
D	12 IN - 18 IN	18 IN - 24 IN

START/STOP PROCEDURE



3



4



6

Engine/Heater Control Panel

START PROCEDURE

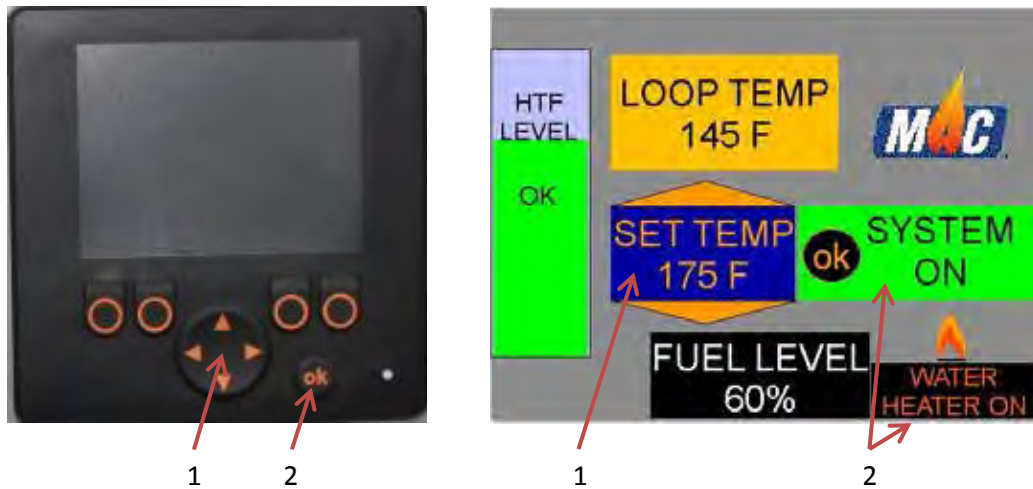
1. Perform pre-start and engine compartment checklists.
2. Hook up and layout your ground hoses in desired configuration.
3. Turn battery disconnect connect switch to “ON” position.
4. Turn ignition key to “Run” position until glow plug indicator light expires.
5. Turn ignition key to “Start” position until engine starts, then release ignition key.
6. Turn main circuit breaker to “ON” position, located on the power distribution panel.
7. Select heater performance output.
 - a. Select desired output temperature on the heater controller by using the up and down arrow keys.
 - b. Press “OK” button to engage heater.
 - c. Heater will automatically enter a “Warm Up” mode.
 - d. Once “Warm Up” mode has been completed heater will function normally.

STOP PROCEDURE

1. Press “OK” button on controller to shutdown heater.
 - a. Failure to shutdown heater before turning off generator could result in damage to the heater.
2. Turn main circuit breaker to “OFF” position.
3. Turn ignition key to “OFF” position.
4. **Caution:** Allow hot ground hoses to cool before handling and preparing for storage. Hot ground hoses can cause severe burns.

Adjusting Heater Output

MAC 6000 Hydronic Heater



Heater Main Menu

SETTING/ADJUSTING HEATER

1. Press Up and Down arrow keys for desired temperature setting.
2. Press “OK” button once you have set your desired temperature to engage heater.
3. Heater will automatically enter a “Warm Up” mode.
4. Once “Warm Up” mode has been completed heater will function normally.

SHUTTING DOWN HEATER

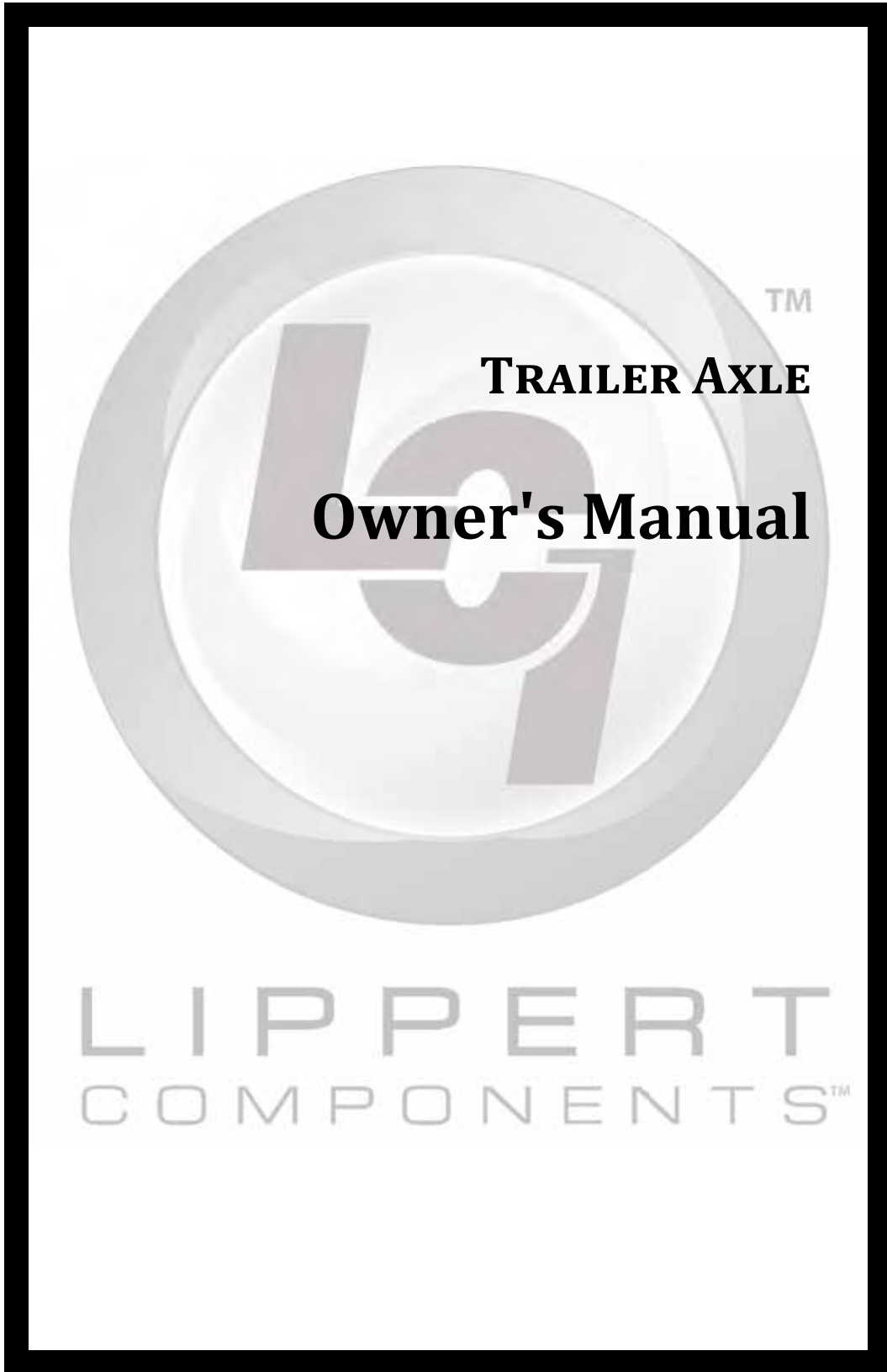
1. Press “OK” button on controller to shutdown heater.
 - a. Failure to shutdown heater before turning off generator could result in damage to the heater.
2. Turn main circuit breaker to “OFF” position.
3. Turn ignition key to “OFF” position.
4. **Caution:** Allow hot ground hoses to cool before handling and preparing for storage. Hot ground hoses can cause severe burns.

MAC 6000

REPLACEMENT PARTS AND FILTERS

<u>Description</u>	<u>MAC Part #</u>
Battery	MAC2013
Isuzu Engine Fuel Filter	3020578
Isuzu Engine Oil Filter	3020577
Isuzu Engine Air Filter	3020579
Burner Nozzle	MAC1611
Burner Fuel Filter	MAC0576

Use only Isuzu engine filters to comply with warranty



INTRODUCTION

Combining years of experience in the trailer frame and recreational vehicle industry with the newest and most innovative technology, Lippert Components, Inc. introduces its newest addition, The Axle and Running Gear Division.

The following publication is designed to give the customer an easy-to-understand operation and service manual to provide useful and important information. The quality of the Lippert name and the finest materials utilized in the production of the Axles and Running Gear provide you with hubs, brakes, drums and spindles that make trailering and braking the finest in the industry.

Quality comes threefold in Lippert Components, Inc.

1. The finest quality materials
2. The latest technology and design
3. The quality standards maintained from materials to final assembly

All three points provide the customer with the best product they can possibly buy and the satisfaction of knowing they can trust the equipment on which they have spent their hard-earned money.

Lippert Components, Inc. thanks you for purchasing our Axles and Running Gear. When you speak of Lippert Components, Inc., our quality stands beside you.



SAFETY INFORMATION

The "WARNING" symbol above is a sign that a service or maintenance procedure has a safety risk involved and may cause serious injury or death if not performed safely and within the parameters set forth in this manual.

Always wear eye protection when performing service or maintenance to the vehicle. Other safety equipment to consider would be hearing protection, gloves and possibly a full face shield, depending on the nature of the service.

This manual provides general service and maintenance procedures. Many variables can change the circumstances of the service procedure, i.e., the degree of difficulty involved in the service operation and the ability level of the individual performing the operation. This manual cannot begin to plot out procedures for every possibility, but will provide the general instructions for effectively servicing the vehicle. In the event the skill level required or the procedure to difficult, a certified technician should be consulted before performing the necessary service. Failure to correctly service the vehicle may result in voiding the warranty, inflicting injury or even death.

The owner's manual for your unit may have more procedures for service and maintenance.

Trailer Axle Manual

MAC 6000 Hydronic Heater

BREAK-IN PERIOD FOR ELECTRIC DRUM BRAKES

The break-in period is a typical phenomenon with drum brakes and especially electric drum brakes. Electric drum brakes will require a break-in period to achieve full performance. This break-in period applies for new axles and any time new brake shoes and/or magnets are installed as part of regular maintenance.

Lippert Components has found through extensive brake testing that the break-in period for our drum brakes can range from 20 to 50 brake applications.

Brakes can be seated in by applying approximately 8-10 volts to the trailer brakes at an initial speed of 40 mph and allowing the truck/trailer combination to slow down to 20 or 25 mph. For best results do not use truck brakes during this procedure. The trailer brakes will seat in faster by using them to stop both the truck and trailer. The easiest method is to apply the trailer brakes using the manual activation lever located on the in-cab brake controller. Care must be taken to not overheat the lining material, therefore brake applications conducted at one mile intervals will suffice. The driver should feel a noticeable difference in the brake performance during this period, sometimes in as few as 10 applications. After 50 applications, the brake lining material will be fully cured from the heat and develop close to 100% contact with the brake drum surface.

This break in period not only seats the shoe lining material but also seats in the brake electromagnets. During the break-in period, the linings will wear at a faster rate than they do after they are seated in.

NOTE: Brakes should be manually adjusted after the first 200 miles of operation and periodically thereafter, approx. 3,000 mile intervals.

HUBS/DRUMS/BEARINGS

HUB REMOVAL

To remove the hub assembly for inspection, maintenance or service, follow the six (6) steps below:

Lift unit by the frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing serious injury or death.

1. Lift trailer and support it per manufacturer's requirements.
2. Remove the wheel.
3. Remove the grease cap by prying the edge out of the hub. If equipped with oil lubrication, unscrew oil cap using a 2 1/2" socket, let oil drain into pan.
4. Pull the cotter pin from the castle nut and remove the outer spindle nut.
5. Remove the spindle washer.
6. Pull the hub off the spindle. Do not let the outer bearing cone fall free of the assembly. The inner bearing cone will be contained by the seal and will not fall out.

NOTE: Brakes may need to be adjusted or backed off to remove drum from spindle.

NOTE: A gear puller may be necessary to remove hub from spindle.



BRAKE DRUM INSPECTION

The brake shoes contact the drum surface and the magnet contacts the armature. These surfaces are subject to wear and should be inspected periodically.

The drum surface should be re-machined if wear is more than .030" or out of round by more than .015". The drum should be replaced if scoring or wear is greater than .090".

The inner surface of the brake drum that contacts the brake magnet is the armature surface. If the armature surface is scored or worn unevenly, it should not be machined more than .030". The magnets should be replaced whenever the armature surface is refaced and vice versa.

NOTE: Make certain that the wheel bearing cavities are clean and free of contamination before reinstalling bearing and seals. Resurfacing procedures can produce metal chips and dust that can contaminate the wheel bearings and cause failure.

Drum	Maximum Rebore Diameter
12.25"	12.340"

BEARING INSPECTION

Wash all grease and oil from the bearing cone using a suitable solvent. Dry the bearing with a clean, lint-free cloth and inspect each roller completely. If any pitting, spalling, or corrosion is present, then the bearing must be replaced. The bearing cup inside the hub must be inspected.

NOTE: Bearings must always be replaced in sets of one cone and one cup.



Always wear eye protection when servicing the axle, brakes, hubs, springs and wheels. Failure to wear eye protection may result in serious injury.

Follow the procedure below to replace the bearing cup:

1. Place hub on a flat surface with bearing cup on the bottom.
2. With brass drift punch, lightly tap around the small end of the cup to push it out.
3. Clean the hub bore. Replace the cup by tapping it back in with the brass drift punch. Cup should be seated against the retaining shoulder in the hub.

Consult Bearing Replacement Chart for proper replacement bearings.

NOTE: Replacing the bearing cup is a very precise process. The cup must be perfectly seated when replaced. If the cup is not seated correctly, damage to the assembly may not be covered by the warranty. Consult Lippert Components, Inc. prior to replacing bearing and bearing cup. The trailer should be taken to a certified service center for this work to be done.



Do not mix Lithium, calcium, sodium or barium complex greases. Chemical compatibility problems may occur. If you are changing from one chemical grease to another, be sure all old grease is removed prior to applying new grease.

BEARING LUBRICATION - OIL

If your axles are equipped with oil lubricated hubs, then your lubrication procedure is to periodically fill the hub with a high quality hypoid gear oil to the level indicated on the clear plastic oil cap. The oil can be filled through the rubber plug hole in the cap.

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BEARING LUBRICATION - GREASE

Bearing grease should be replaced every 12,000 miles or 12 months, whichever comes first. Remove all old grease from wheel hub and bearings first. Bearings should be packed by machine if possible. Packing bearings by machine is preferable; however, packing by hand is a viable alternative.

Follow these procedures to repack bearings by hand:

1. Place grease into the palm of your hand (Fig. 1).
2. Press widest end of bearing into the outer edge of the grease pile, forcing grease into the inner area of the bearing between two adjacent rollers (Fig. 2).
3. Repeat this process while turning bearing from roller to roller until all rollers are coated.
4. Apply a light coat of grease into the bearing cup surface.
5. Reassemble bearing into cup.

Fig. 1



Fig. 2



Recommended Wheel Bearing Grease Specifications	
Thickener Type	Lithium Complex
Dropping Point	230°C (446°F) Minimum
Consistency	NLGI No. 2
Additives	EP, Corrosion, & Oxidation Inhibitors
Base Oil	Solvent Refined Petroleum Oil
Base Oil Viscosity	@40°C (104°F) 150cSt (695 SUS) Minimum
Viscosity Index	80 Minimum
Pour Point	-10°C (14°F) Minimum

Approved Sources	
Mobil Oil	Mobilgrease HP
Exxon/Standard	Ronex MP
Kendall Refining Co.	Kendall L-427
Ashland Oil Co.	Valvoline Val-plex EP Grease
Pennzoil Prod. Co.	Premium Wheel Bearing Grease 707L

SEAL INSPECTION AND REPLACEMENT

Always check the seal to make sure that it is not damaged, nicked, cracked or torn and is in good working order. If there is any question of condition, replace the seal.

Procedure to replace seal:

1. Pull seal from the hub with a seal puller. Never push the seal out with the bearing. The bearing may get damaged.
2. Apply a PERMATEX sealant to the outside of the new seal.

NOTE: Do not use PERMATEX on rubber encased seals.

3. Tap the new seal into place using a clean, hard wood block (Fig. 3).

NOTE: When installing a new oil seal, be sure side marked "AIR SIDE" is away from bearing cone.

Fig. 3

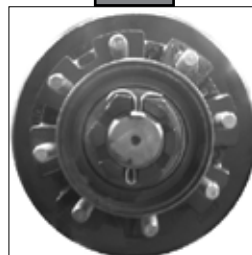


BEARING ADJUSTMENT/HUB REPLACEMENT

To adjust bearings or replace removed hub, follow procedures below:

1. Place hub, bearing, washers and castle nut back on axle spindle in the reverse order from which they were removed. Castle nut should be torqued to 50 ft.-lb. Hub will rotate during this process.
2. Loosen castle nut to back off the torque.
3. Tighten castle nut finger tight until snug.
4. Insert cotter pin. If cotter pin does not line up with hole, back castle nut up slightly until pin can be inserted (Fig. 4).
5. Bend cotter pin over to lock nut in place. Nut should be free to move with only the cotter pin keeping it in place.

Fig. 4



Trailer Axle Manual

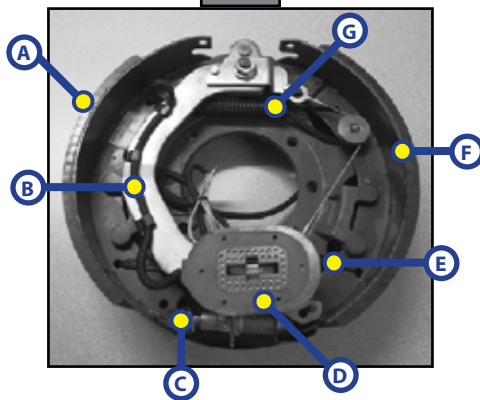
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ELECTRIC BRAKES

The basic structure of the Electric Brakes on your trailer will resemble the brakes on your car or tow vehicle, with one major difference; your trailer implements an Electric Actuation system and your tow vehicle utilizes a hydraulic system. The Electric Braking System operates in the following order of steps; refer to the Electric Braking System Diagram and the brake diagram (Fig. 5) to follow along:

1. Electric current is supplied to the trailer's braking system when the tow vehicle's brakes are applied.
2. From the tow vehicle's battery, the electricity flows to the brake's electromagnet.
3. When energized the magnets are attracted to the rotating surface of the drums.
4. This moves the actuating levers in the direction the drums are turning.
5. The actuating cam at the end of the shoe forces the primary shoe out to the drum surface.
6. The force of the primary shoe actuates the secondary shoe to contact the drum.
7. The force applied to the brake drum can be increased by elevating the current flow to the magnet.

Fig. 5



Callout	Component
A	Primary Shoe
B	Actuating Lever
C	Adjuster
D	Magnet
E	Adjusting Spring
F	Secondary Shoe
G	Retracting Spring

HOW TO USE LIPPERT ELECTRIC BRAKES PROPERLY

The Lippert Components, Inc. Electric Braking System is synchronized with the tow vehicle brakes. Never attempt to stop the combined load of the tow vehicle and the trailer by using either the tow vehicle brakes or the trailer brakes only. They are designed to work together.

Small manual adjustments may occasionally be necessary to accommodate changing loads and driving conditions. Synchronization of tow vehicle to trailer braking can only be accomplished by road testing. Locking up, excessive grab, or delayed application is quite often due to the lack of synchronization between the tow vehicle and the trailer being towed. High voltage (2V+), Low voltage (2V-) or improperly adjusted brakes are the most common causes of these problems and can be easily remedied.

Prior to any adjustments, your trailer brakes should be burnished-in by applying the brakes 20-30 times with a 20 m.p.h. decrease in speed, e.g. 40 m.p.h. to 20 m.p.h. Allow ample time for brakes to cool between application. This allows the brake shoes and magnets to begin seating to the brake drum.

Trailer Wire Gauge Chart		
Wire Gauge and Type	Number of Axles	Length of Run
16 Ga Stranded Copper	1	N/A
14 Ga Stranded Copper	2	Under 30ft. (9.1m) from hitch to center of axles
12 Ga Stranded Copper	2 or 3	Over 30ft. (9.1m) from hitch to center of axles

GENERAL MAINTENANCE - ELECTRIC BRAKES

BRAKE ADJUSTMENT



Prior to testing or adjusting brakes, be sure area is clear of any persons and vehicles. Failure to perform test in a clear area may result in serious injury or death.

Lippert Components, Inc. Electric Brakes are automatic adjust only. If manual adjusting is needed, the following 6-step procedure can be utilized. The brakes should be adjusted in the following manner:

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturer's recommendations for lifting and supporting the unit. Make sure the wheel and drum rotates freely.



Lift unit by frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing serious injury or death.

2. Remove the adjusting hole cover from the adjusting slot on the bottom of the brake backing plate.
3. With a screwdriver or standard adjusting tool, rotate the starwheel of the adjuster assembly to expand the brake shoes. Adjust the brake shoes out until the pressure of the linings against the drum makes the wheel very difficult to turn.
4. Then rotate the starwheel in the opposite direction until the wheel turns freely with a slight lining drag.

NOTE: A second screwdriver will be needed to push the auto adjusting lever away from the adjuster starwheel so that the starwheel can be rotated backwards.

5. Replace the adjusting hole cover and lower the wheel to the ground.
6. Repeat the above procedure on all brakes. For best results, the brakes should all be set at the same clearance.

LUBRICATE BRAKES

Prior to reassembling the brake drum assembly, remember to apply a light film of white grease or an anti-seize compound on the brake anchor pin, the actuating arm bushing and pin, and the areas on the backing plate that are in contact with the brake shoes and magnet lever arm. In addition apply a light film of grease on the actuating block mounted on the actuating arm.

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CLEAN AND INSPECT BRAKES

In the event the braking system encounters symptoms of improper application or failure, immediate inspection and service must be implemented. During normal use, servicing the braking system once a year is considered normal. Increased usage will require service on a regulated schedule based on 3000-6000 mile increments. As magnets and shoes become worn, they need to be changed to maintain maximum braking capability.

Be sure, when disassembling brakes for cleaning, to clean the backing plate, magnet arm, magnet and shoes. Also, make sure that any and all parts removed for cleaning are placed back into the same brake drum assembly. This is also an excellent time to check for parts that have become loose or worn.



Potential Asbestos Dust Hazard

Older brake linings have the potential to contain asbestos dust, which has been linked to serious or fatal illnesses. Certain precautions must be taken when servicing brakes:

1. Avoid creating and/or breathing any brake dust.
2. Do not machine, file, or grind the brake linings.
3. Remove with a damp brush or cloth. Dry brushing or compressed air will cause the dust particles to become airborne.

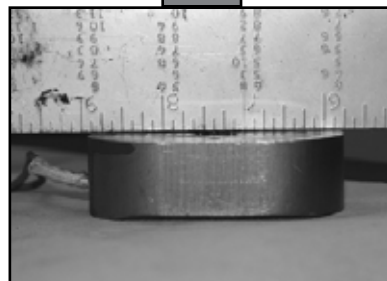
MAGNETS

This electric braking system utilizes an electromagnet to actuate the brake shoes. These high-quality magnets provide superior force and friction to safely and effectively stop the trailer. These magnets should be inspected and serviced on the same schedule as the rest of the axle system, at least once a year for normal use and more often if the trailer is used extensively. Abnormal or uneven wear is a sign that the magnet needs to be replaced. Check the surface of the magnet with a straight edge to check for uneven wear. The surface of the magnet should be completely flat.

If the magnet's coil is exposed in any way, even if normal wear is evident, the magnets should be replaced immediately. If the electromagnets are replaced, the drum armature surface should also be refaced. If a magnet is replaced on one side of an axle, it is recommended that the magnet on the opposite brake assembly also be replaced to ensure even braking capacity.

Figure 6, below, shows an Electro-Magnet with little or no wear. If there are any pronounced gaps on the surface of the Electro-Magnet, the magnet should be replaced.

Fig. 6



SHOES AND LININGS

Linings should be replaced if the material is worn to 1/16" or less. Shoes should also be replaced if they become contaminated with grease or oil or have become scored, pitted or gouged. Heat cracks are normal and rarely require attention. When replacing shoes, both shoes on the same brake and the brakes on the same axle should all be replaced at the same time, once again ensuring even braking capacity.

After replacing shoes and linings, your trailer brakes should be burnished-in by applying the brakes 20-30 times with a 20 m.p.h. decrease in speed, e.g. 40 m.p.h. to 20 m.p.h. Allow ample time for brakes to cool between application. This allows the brake shoes and magnets to begin seating to the brake drum.

AXLE AND SUSPENSION INSTALLATION

The single most important portion of axle installation is parallel alignment of the trailer axle(s) to the tow vehicle or drive axle(s). Parallel installation allows for correct and safe control, prolonged tread life and will all but eliminate dog-tracking. Proper alignment is most readily achieved by measuring from the center of the trailer king pin to the center of each end of the axles.

Lippert Components, Inc. tubular axles are made of high strength steel to prevent metal fatigue and provide the best possible welding conditions. The round tubular axles allow for even and uniform structure.



Always wear eye protection when servicing the axle, brakes, hubs, springs and wheels. Failure to wear eye protection may result in serious injury.

SUSPENSION SYSTEMS

The suspension systems incorporated into Lippert Component, Inc. axles are designed to provide the following benefits:

1. Attach the axle to the trailer.
2. Dampen the effects of road shock.
3. Provide stability to the trailer.

All Lippert suspension systems are available in single and multiple axle configurations. For specific or custom applications, please contact Lippert Components, Inc. Axle Division.

DOUBLE-EYE LEAF SPRINGS

Double-eye leaf springs have eyes at either end of the spring assembly with nylon bushings to assist in preventing wear. U-bolts hold the springs to the axle with a plate.

The articulation of this suspension occurs when the eyes rotate on the wear surfaces provided in eyes of the springs and on the equalizers. This suspension is also available in single and multiple axle configurations.

In trailers with 2 or more axles, the additional movement is maintained by an equalizer. This feature allows for even load handling from axle to axle.

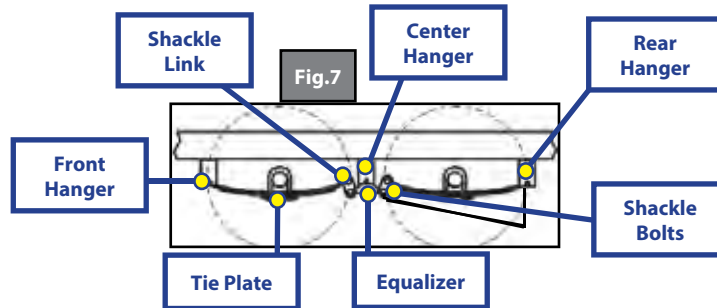
Double eye suspension systems are available on 8,000 lb. axles. Tandem and triple axle mounting kits are available for both 33" and 35" axle spacing.

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TORSION SUSPENSION SYSTEM

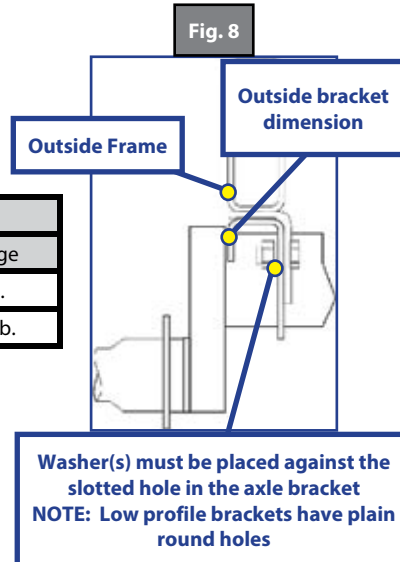
1. The Lippert Components, Inc. Torsion Suspension system is designed to offer superior qualities over leaf spring technology. The Lippert Components, Inc. Torsion Suspension system is bracketed to the trailer's frame and housed inside the trailer axle's tube.
2. The spindle is connected to a swing arm, the swing arm is connected to a square inner bar that is sheathed in rubber and as the swing arm rotates and experiences the torque and resistance of driving conditions, the characteristics of the rubber absorb and distribute the load providing benefit over leaf spring suspensions.
3. The Lippert Components, Inc. Torsion Suspension system requires very little attention in regards to maintenance. Normal inspection of the entire Lippert Components, Inc. Trailer Axle system can be applied to the Torsion Suspension system. See inspection procedures for system components in this manual.



Spring Axle Torque Specifications		
Bolt Type	Axle Capacity	Maximum Torque
U-Bolts	2K	25 ft-lb
	3.5K with 1/2"	50 ft-lb
	5.2K	65 ft-lb.
	6-8K	90 ft-lb.
	Minimum Torque	Maximum Torque
Shackle Bolts	30 ft-lb	50 ft-lb

NOTE: For Torsion installation, mount axle bracket to frame bracket (Fig. 8) and torque fasteners as specified in the chart below.

Torsion Axle Torque Specifications		
Axle Size	Bolt Size	Torque Range
#8 - #9	1/2"	70-90 ft-lb.
#10 - #13	5/8"	120-155 ft-lb.



INSPECTION

All the components of your suspension system should be visually inspected for signs of wear, damage or loose fasteners at least every 6,000 miles. When replacing or tightening loose fasteners, consult the torque specs on page 16 for correct torque values.

Worn spring eye bushings or sagging or broken springs should be replaced using the following method:

1. Support the trailer with the wheels just off the ground. Follow the trailer manufacturer's recommendations for lifting and supporting the unit.
2. After the unit is properly supported place a suitable block under the axle tube near the end to be repaired. This block is to support the weight of the axle only so that suspension components can be serviced or replaced.
3. Disassemble the U-bolts, nuts, and tie plates.
4. Remove the spring eye bolts and the spring.
5. If the spring eye bushings are to be replaced, press out the old bushing by hand or tapping out with a punch.
6. Free-floating nylon bushing needs no lubrication. Press the new bushing into the spring eye by hand or gently tapping it in with a bounceless rubber or plastic mallet.
7. Reinstall repaired or replaced components in reverse order.

NOTE: For multiple axle units, the weight of each axle must be supported as outlined in Step 2 before disassembly of any component of the suspension system.

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⚠ WARNING

Lift unit by the frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing serious injury or death.

⚠ WARNING

Always wear eye protection when servicing the axle, brakes, hubs, springs and wheels. Failure to wear eye protection may result in serious injury.

If the equalizer or equalizer bushings must be replaced, follow the instructions above for lifting and supporting the trailer unit and then proceed as follows:

1. With both axles blocked up, remove the spring eyebolt, keeper bolt, and equalizer bolt from the equalizer to be repaired or replaced.
2. Press the old nylon bushing out of the equalizer.
3. Reassemble in reverse order.

SUSPENSION REPLACEMENT

1. Make sure springs are on straight. Align spring eyes to front hanger. Insert spring eye bolts but do not torque at this point.
2. Assemble springs into equalizer.
3. After leveling equalizer to frame, torque equalizer nuts and spring eye nuts to a minimum of 55 ft.-lb. and a maximum of 70 ft.-lb.

WHEELS

WHEEL SELECTION

When specifying or replacing your trailer wheels it is important that the wheels, tires, and axle are properly matched. The following characteristics are extremely important and should be thoroughly checked when replacement wheels are considered:

1. Bolt Circle. Wheels have many bolt circle variations and some are so close that it could be possible to attach an inappropriate wheel that does not match the axle hub.
2. Capacity. Wheel load capacity should match tire and trailer max. load ratings.
3. Offset. The relationship of the center line of the tire to the hub face of the axle should match any replacement. Failure to match offset may result in reducing the carrying capacity of your axle.
4. Rim Contour. Replacement wheels should be direct replacements to match the rim contour.

⚠ WARNING

Use only rim contours suggested by manufacturer. Failure to use correct rim contour may cause dramatic separation of tire and wheel and could cause serious injury or death.

Attempting to modify or repair a wheel can cause unsafe conditions that may result in an explosion. Air pressure on a weakened or cracked rim can cause serious injury or death.



TORQUE REQUIREMENTS

It is extremely important to apply and maintain proper wheel mounting torque on your trailer axle. Torque wrenches assure the proper amount of torque is being applied to a fastener. Use no other method to torque fasteners.

▲WARNING

Proper and accurate torque must be maintained to prevent wheels from loosening, studs from cracking and/or breaking or other possible hazardous breakage resulting in serious injury or death.

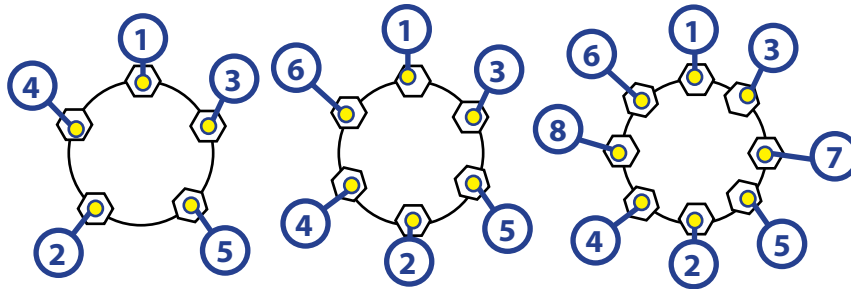
Be sure to use only the fasteners matched to the cone angle of your wheel (usually 60° or 90°.) The proper procedure for attaching your wheels is as follows:

1. Start all bolts or nuts by hand to prevent cross threading.
2. Tighten bolts or nuts in the following sequence.
3. Tightening fasteners should be done in stages. Follow the recommended sequence, tighten fasteners per wheel torque requirements diagram (Fig. 9).
4. Wheel nuts/bolts should be torqued before first road use and after each wheel removal. Check and re-torque after the 10 and 25 miles and again at 50 miles. A periodic check during regular service is recommended.

Fig. 9

Wheel Torque Requirement Chart				
Wheel Size	Stud Size	Torque Sequence		
		1st Stage	2nd Stage	3rd Stage
14"	1/2"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
15"	1/2"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
16"	1/2"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
16.5" x 6.75"	1/2"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
16"	9/16"	20-25 ft-lbs	60-70 ft-lbs	120-130 ft-lbs
16.5" x 6.75"	9/16"	20-25 ft-lbs	60-70 ft-lbs	120-130 ft-lbs
17.5" Long Nut	5/8"	50-60 ft-lbs	100-120 ft-lbs	190-210 ft-lbs
17.5" Flange Nut	5/8"	50-60 ft-lbs	150-200 ft-lbs	275-325 ft-lbs
14.5" Demount	5/8"	Tighten sequentially to 85-95 ft-lbs		

Fig. 10



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TIRES

Prior to mounting tires onto wheels, be sure the rim size and contour are approved by the Tire and Rim Association Yearbook or the tire manufacturers catalog. In addition, confirm that the tire will carry the rated load. If the load is not evenly distributed on all tires, use the tire rated for the heaviest wheel position.







The Rubber Manufacturers Association or the tire manufacturers guidelines should be consulted for mounting procedures.

Tire inflation pressure is the most important factor in tire life. Tire pressure should always be what is recommended by the manufacturer for the load. Always check pressure cold before operation. DO NOT bleed air from tires when they are hot. Check inflation pressure weekly during use to insure maximum tire and tread life.

The following tire wear diagnostic chart will help you pinpoint the causes and solutions of tire wear problems.

NOTE: Tire wear should be checked frequently because once a wear pattern becomes firmly established in a tire it is difficult to stop, even if the underlying cause is corrected.

Fig. 10

		Probable Cause	Corrective Action
Center Wear		Over-inflation	Adjust Pressure to particular load per tire catalog
Edge Wear		Under-inflation	Adjust pressure to particular load per tire catalog.
Side Wear		Loss of camber or overloading	Make sure load doesn't exceed axle rating. Call Lippert Service & Warranty to advise.
Toe Wear		Incorrect Toe-in	Call Lippert Service & Warranty to advise.
Cupping		Out-of-Balance	Check bearing adjustment and balance tires.
Flat Spots		Wheel lockup & tire skidding	Avoid Sudden stops if possible and adjust brakes.

INTRODUCTION TO TROUBLESHOOTING

The following section is a guideline for ensuring operation of your braking system. The safety of you, those traveling with you and those sharing the road paramount and it starts with the ability to safely stop the tow vehicle and the towed vehicle.

TROUBLESHOOTING

Most brake malfunctions can be corrected by utilizing the Troubleshooting Chart on the next page. Mechanical failure is the most common form of malfunction, however, if the brake system fails and it's not mechanical, it is usually electrical. A Voltmeter and Ammeter are essential tools to diagnose these problems.

Mechanical problems are mostly self-evident; something is bent or broken. Consult the following troubleshooting chart to determine the probable cause and corrective actions for a variety of issues with the braking system.

Please remember to use only Lippert Components, Inc. replacement parts on these systems. Consult the Limited Warranty or call our Service Department for any other related issues.

MEASURING VOLTAGE

The Braking System voltage is measured at the two lead wires of the magnet on any brake. Use the pin probes inserted through the insulation of the lead wires. To ensure that the battery is indicating a full charge, the towing vehicle engine should be running with the trailer coupler connected when checking the voltage.

Voltage in the system should begin at 0 volts and, as the brake pedal of the tow vehicle is applied, voltage will gradually increase to about 12 volts. If the system does not indicate at least 12 volts, problems may occur in the wiring of the system, the battery or alternator of the tow vehicle.

When the brakes are applied, a gradual increase in voltage is preferable to a quick increase to 12 volts. A gradual increase in voltage ensures smooth and firm trailer braking. A quick increase in voltage will cause the braking system to feel like the trailer is grabbing too quickly.

Fig. 11



Taking a Voltage reading is usually done with probes inserted into the wire connector (Fig. 11).

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NO BRAKES	
Open Circuits	Find & Correct
Short Circuits	Test & Correct
Severe Underadjustment	Adjust Brakes
WEAK BRAKES	
Grease or Oil on Magnets or Linings	Clean or Replace
Corroded Connections	Clean & Correct Cause of Corrosion
Worn Linings or Magnets	Replace
Scored or Grooved Brake Drums	Machine or Replace
Improper Synchronization	Correct
Underadjustment	Adjust Brakes
Glazed Linings	Reburnish or Replace
LOCKING BRAKES	
Underadjustment	Adjust
Improper Synchronization	Correct
Loose, Bent, or Broken Brake Components	Test & Correct
Out-of-Round Brake Drums	Machine or Replace
Insufficient Wheel Load	Adjust System Resistor and Synchronize
INTERMITTENT BRAKES	
Broken Wires	Test and Correct
Loose Connections	Repair or Replace
Faulty Ground	Find and Repair
BRAKES PULL TO ONE SIDE	
Wrong Magnet Lead Wire Color	Adjust
Incorrect Adjustment	Correct
Grease or Oil on Linings or Magnets	Clean or Replace
Broken Wires	Find and Repair
Bad Connections	Find and Repair
HARSH BRAKES	
Underadjustment	Adjust
Improper Synchronization	Correct
NOISY BRAKES	
Underadjustment	Adjust
Lack of Lubrication	Lubricate
Broken	Replace Component
Incorrect Brake Components	Correct



SURGING BRAKES	
Grease or Oil on Linings or Magnet	Clean or Replace
Out of Round or Cracked Brake Drums	Machine or Replace
DRAGGING BRAKES	
Overadjustment	Readjust
Out-of-Round Brake Drums	Machine or Replace
Incorrect Brake Components	Replace
Loose, Bent, or Broken Brake Components	Replace
Faulty Breakaway Switch	Repair or Replace
Loose Wheel Bearing Adjustment	Adjust
Bent Spindle	Replace Axle

NOTE: If all trailer lights and brakes do not work, check your wiring plug connection and make sure the ball is making solid contact with the coupler (that is how a trailer is grounded). Too much grease or not using dielectric grease on the ball and coupler can cause this to happen.

MEASURING AMPERAGE

The Braking System amperage is the amount of current flowing through the system when all magnets have been energized. The amperage will change proportionately with the voltage. To ensure that the battery is indicating a full charge, the towing vehicle engine should be running with the trailer coupler connected when checking the voltage.

If a resistor is used in the brake system, it must be set at zero or bypassed completely to obtain the maximum amperage reading. Individual amperage draw can be measured by inserting the ammeter in the line at the magnet you want to check. Disconnect one of the magnet lead wire connectors and attach the ammeter between the two wires. Consult Amperage Chart on the next page for normal amp readings.

Make sure that the wires are properly reconnected and sealed after testing is completed.

Fig. 12



Fig. 13



Testing for Amperage can be done with probes (Fig. 12) or alligator clips on the leads or an amp clamp (Fig. 13).

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AMPERAGE CHART

Amps/ Magnet	Two Brakes	Four Brakes	Six Brakes
3.0	6.0	12.0	18.0

Low or no voltage are the most common problem with the Braking System. Amperage at the brakes is also a relatively common issue. Common causes of these conditions are:

1. Low quality electrical connections
2. Open circuits
3. Insufficient wire gauge
4. Broken wires
5. Blown fuses (fusing of brakes is not recommended)
6. Short circuits (indicated by high amperage)

Possible causes of shorts are:

1. Shorted magnet coils
2. Bare wires contacting a grounded object

Finding the cause of a short circuit in the system is done by isolating one section at a time. If the high amperage reading drops to zero by unplugging the trailer, then the short is in the trailer. If the amperage reading remains high with all the brake magnets disconnected, the short is in the trailer wiring.

All electrical troubleshooting procedures should start at the controller. Most complaints regarding brake harshness or malfunction are traceable to improperly adjusted or nonfunctional controllers. See your controller manufacturer's data for proper adjustment and testing procedures. For best results, all the connection points in the brake wiring should be sealed to prevent corrosion. Loose or corroded connectors will cause an increase in resistance which reduces the voltage available for the brake magnets.

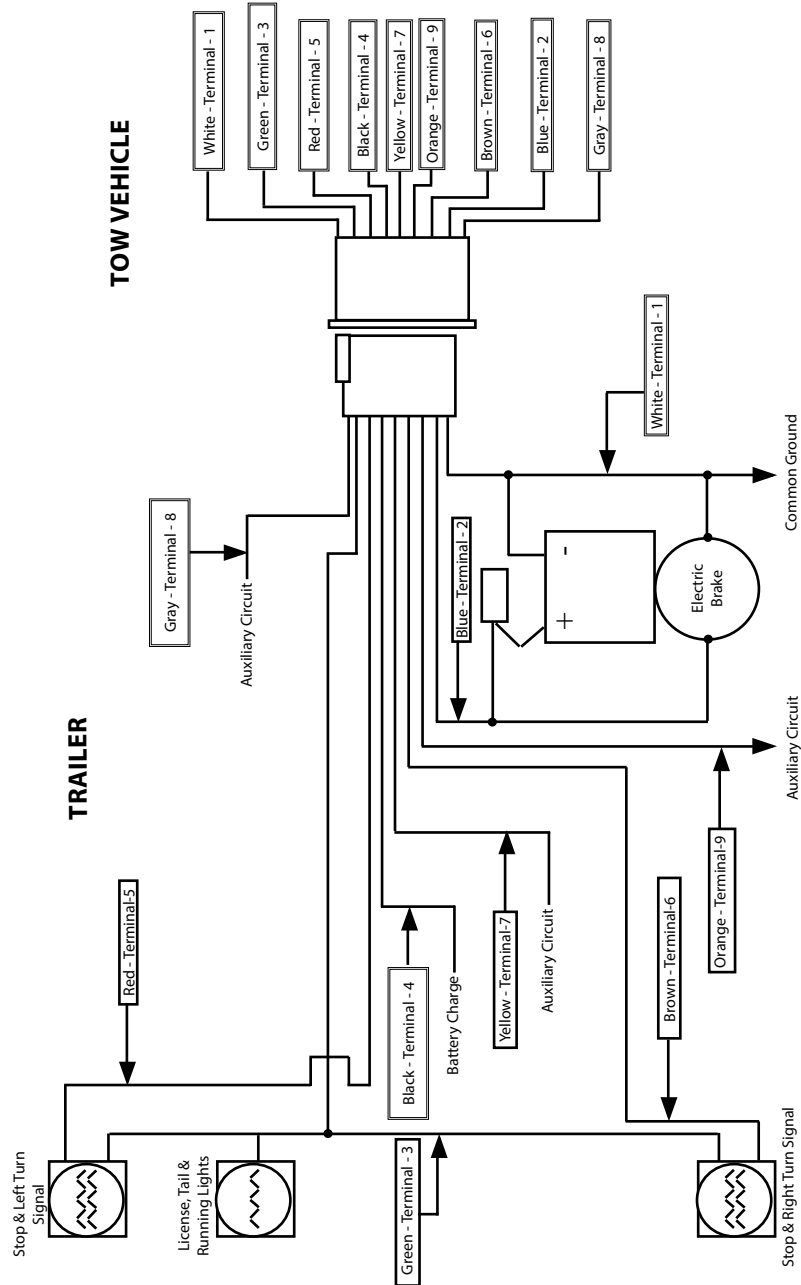


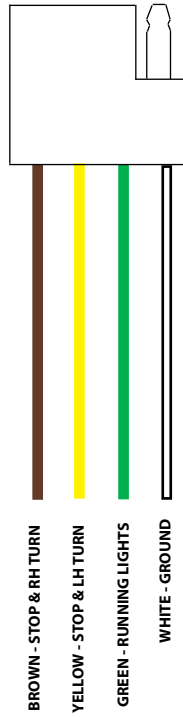
MAINTENANCE SCHEDULE

Item	Function Required	Weekly	3 Months/3000 Miles	6 Months/6000 Miles	12 Months/12000 Miles
Brakes	Test that they're operational.	At Every Use			
Breakaway System	Check battery charge and switch operation.	At Every Use			
Brake Adjustment	Adjust to proper operating clearance.		◆		
Brake Magnets	Inspect for wear and current draw.			◆	
Brake Linings	Inspect for wear or contamination.				◆
Brake Controller	Check for correct amperage and modulation.			◆	
Trailer Brake Wiring	Inspect wiring for bare spots, fray, etc.				◆
Hub/Drum	inspect for abnormal wear or scoring.				◆
Wheel Bearing	Inspect for corrosion or wear. Clean and repack.				◆
Seals	Inspect for leakage. Replace if removed.				◆
Springs	Inspect for wear, loss of arch.				◆
Suspension Parts	Inspect for bending, loose fasteners, wear.			◆	
Hangers	Inspect welds.				◆
Wheel Nuts and Bolts	Tighten to specified torque values.		◆		
Wheels	Inspect for cracks, dents, or distortion.			◆	
Tire Inflation Pressure	Inflated tires to mfg's specifications.	◆			
Tire Condition	Inspect for cuts, wear, bulging, etc.		◆		

Trailer Axle Manual

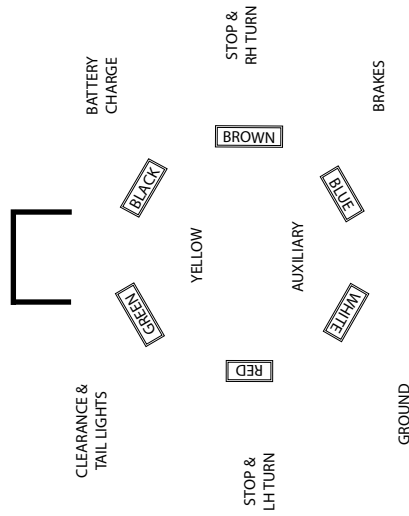
MAC 6000 Hydronic Heater



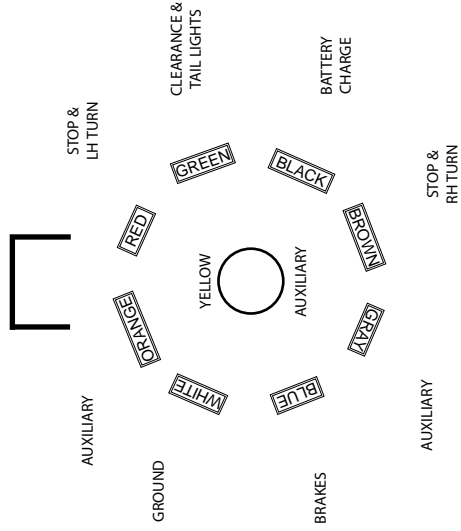


TRAILER LIGHTS PIGTAIL - DOES NOT OPERATE BRAKES

7-PIN COUPLER



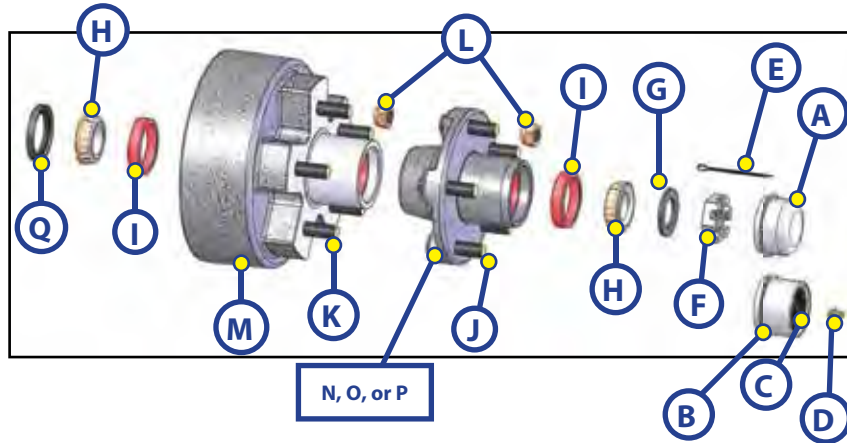
9-PIN COUPLER



TRAILER BRAKE AND LIGHT COUPLER - OPERATES BRAKES

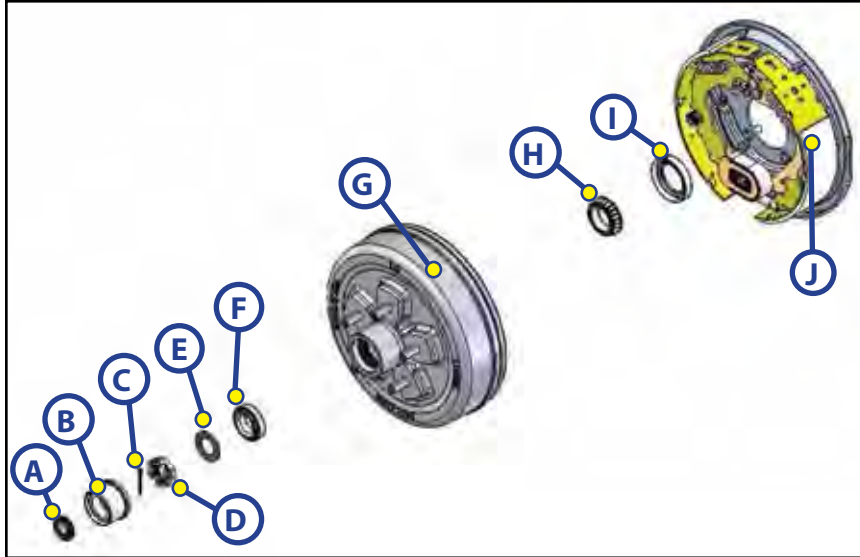
COMPONENT DIAGRAMS AND BOM LISTS

7" HUB/DRUM WHEEL END COMPONENTS



CALLOUT	DESCRIPTION	PART NO
A	Dust Cap Non Lubed	122099
B	Dust Cap Lubed	122067
C	Rubber Plug Lubed	122065
D	Grease Zerk Lubed	122255
E	Cotter Pin 0.120 x 1.75	122075
F	Spindle Nut 1" - 14	122081
G	Spindle Washer 1.06 x 1.68 OD	119214
H	Outer & Inner Bearing Cone L44649	122089
I	Outer & Inner Bearing Cup L44610	125102
J	Stud, 1/2-20, 0.617 DIA Knurl	121803
K	Stud, 1/2-20, 0.545 DIA Knurl	136109
L	Cone Wheel Nut 1/2 - 20 60°	122076
M	Brake Hub; 5 on 4.50	134206
N	Idler Hub; 5 on 4.50; 5.50" DIA Hub Flange	134332
O	Idler Hub; 5 on 4.50; 6.50" DIA Hub Flange	158529
P	Idler Hub; 4 on 4.00	134574
Q	Grease Seal 1.50" Shaft	139514

3500# WHEEL END COMPONENTS

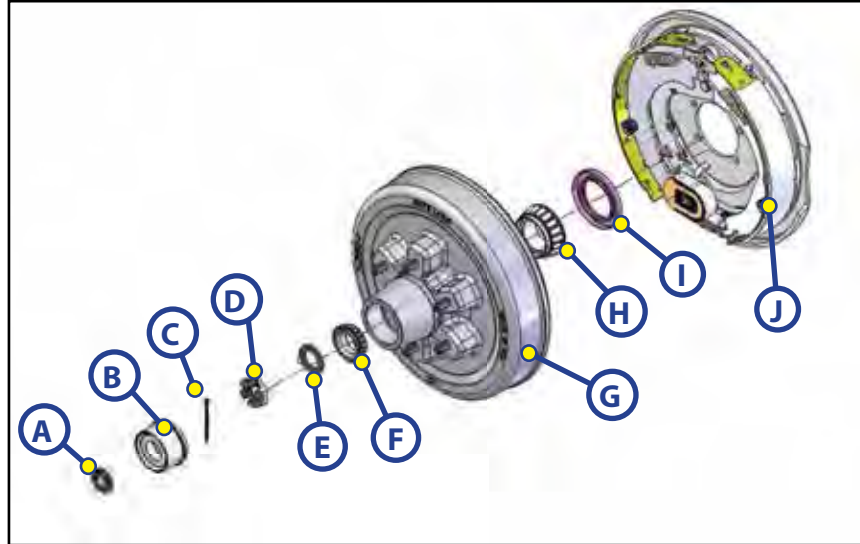


CALLOUT	DESCRIPTION	PART NO
A	Rubber plug for lubed grease caps	122065
B	Dust cap, for 2" bore, super lube	122067
	Dust cap, for 2" bore, non-lube	122099
C	Cotter pin	122075
D	Spindle Nut, 6 slot	122081
E	Spindle washer, round ID	119214
E1	Spindle Washer, for spindle with D-Flat	119215
E2	Spindle locking tang washer	119216
Use E1 and E2 in place of C and E if spindle has no hole for cotter pin and has D-flat		
F	Outer brg cone, L44649	122089
	Outer brg cup, L44610	125102
G	Hub-drum, with cups and studs, 5 on 4.50" BC	126003
H	Inner brg cone, L68149	122092
	Inner brg cup, L68111	124296
I	Grease seal, double lip, 1.72" ID x 2.565" OD	122087
J	Brake Assembly, 10" x 2.25" LH	122258
	Brake Assembly, 10" x 2.25" RH	122450
J Kits	Shoe and Lining Kit for (1) Brake	136451
	Magnet Kit for (1) brake, green wire	136454
	Spring and hardware kit for (1) Brake	136452
	Adjuster screw and spring kit for (1) brake	136453

Trailer Axle Manual

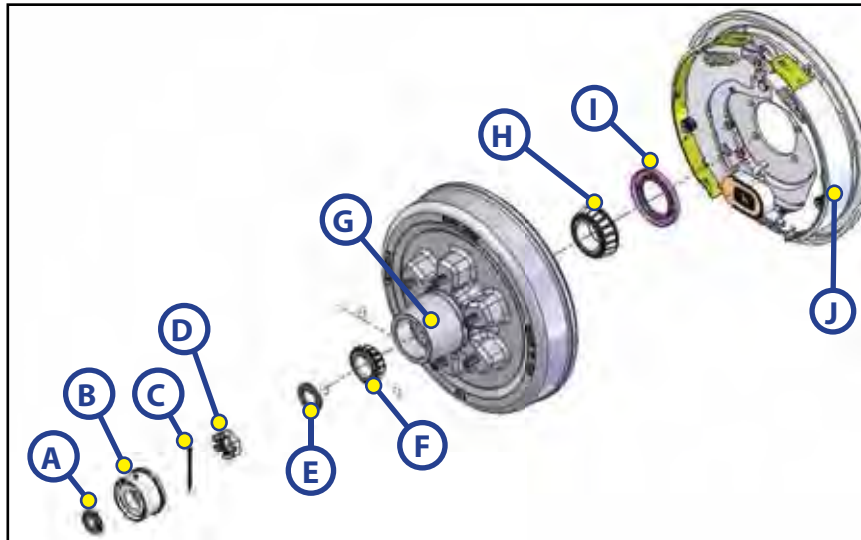
MAC 6000 Hydronic Heater

5200# WHEEL END COMPONENTS



CALLOUT	DESCRIPTION	PART NO
A	Rubber plug for lubed grease caps	122065
B	Dust cap, for 2.5" bore, super lube	122064
	Dust cap, for 2.5" bore, non-lube	122071
C	Cotter pin	122075
D	Spindle Nut, 6 slot	122081
E	Spindle washer, round ID	119214
E1	Spindle Washer, for spindle with D-Flat	119215
E2	Spindle locking tang washer	119216
Use E1 and E2 in place of C and E if spindle has no hole for cotter pin and has D-flat		
F	Outer brg cone, L44649	122090
	Outer brg cup, L44610	124292
G	Hub-drum, with cups and studs, 6 on 5.50" BC	122093
H	Inner brg cone, LM67048	122066
	Inner brg cup, LM67010	124287
I	Grease seal, double lip, 2.25" ID x 3.376" OD	122088
J	Brake Assembly, 12" x 2" LH	122259
	Brake Assembly, 12" x 2" RH	122451
J Kits	Shoe and Lining Kit for (1) Brake	136444
	Magnet Kit for (1) brake, black or white wire	136447
	Spring and hardware kit for (1) Brake	136445
	Adjuster screw and spring kit for (1) brake	136453

6000# WHEEL END COMPONENTS

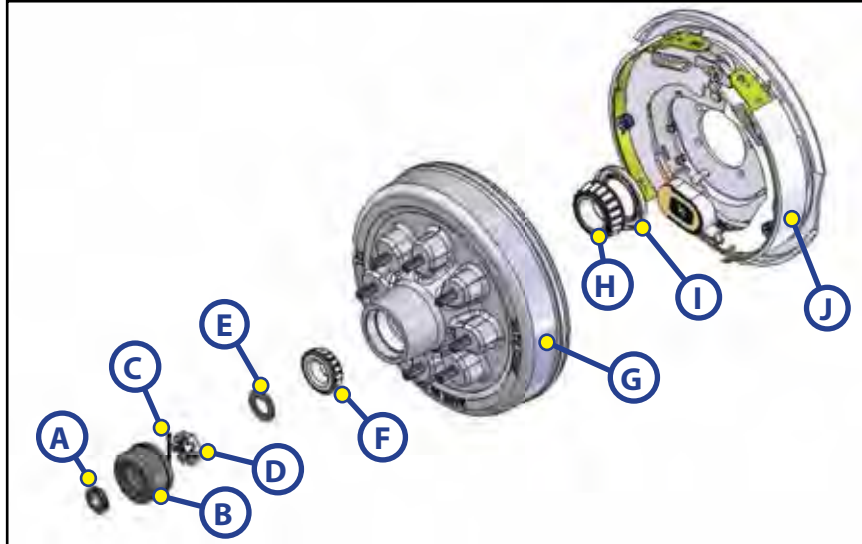


CALLOUT	DESCRIPTION	PART NO
A	Rubber plug for lubed grease caps	122065
B	Dust cap, for 2.5" bore, super lube	122064
	Dust cap, for 2.5" bore, non-lube	122071
C	Cotter pin	122075
D	Spindle Nut, 6 slot	122081
E	Spindle washer, round ID	179660
E1	Spindle Washer, for spindle with D-Flat	172888
E2	Spindle locking tang washer	119216
Use E1 and E2 in place of C and E if spindle has no hole for cotter pin and has D-flat		
F	Outer brg cone, 15123	122091
	Outer brg cup, 15245	122996
G	Hub-drum, with cups and studs, 6 on 5.50" BC	122094
H	Inner brg cone, 25580	122066
	Inner brg cup, 25520	124287
I	Grease seal, double lip, 2.25" ID x 3.376" OD	122088
J	Brake Assembly, 12" x 2" LH	122259
	Brake Assembly, 12" x 2" RH	122451
J Kits	Shoe and Lining Kit for (1) Brake	136444
	Magnet Kit for (1) brake, black or white wire	136447
	Spring and hardware kit for (1) Brake	136445
	Adjuster screw and spring kit for (1) brake	136453

Trailer Axle Manual

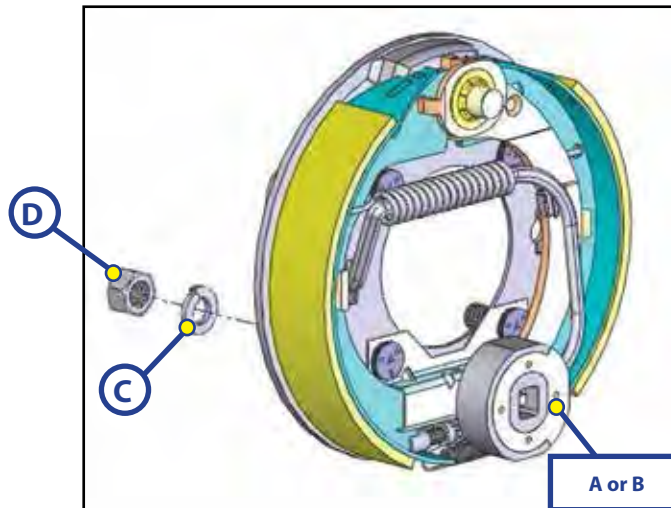
MAC 6000 Hydronic Heater

7000# WHEEL END COMPONENTS



CALLOUT	DESCRIPTION	PART NO
A	Rubber plug for lubed grease caps	122065
B	Dust cap, for 2.75" bore, super lube	127300
	Dust cap, for 2.75" bore, non-lube	127206
C	Cotter pin	122075
D	Spindle Nut, 6 slot	122081
E	Spindle washer, round ID	179660
E1	Spindle Washer, for spindle with D-Flat	172888
E2	Spindle locking tang washer	119216
Use E1 and E2 in place of C and E if spindle has no hole for cotter pin and has D-flat		
F	Outer brg cone, 14125A	127009
	Outer brg cup, 14276	127012
G	Hub-drum, with cups and ½" studs, 8 on 6.50" BC	122094
H	Inner brg cone, 25580	134543
	Inner brg cup, 25520	124287
I	Grease seal, double lip, 2.25" ID x 3.376" OD	122088
J	Brake Assembly, 12" x 2" LH	122259
	Brake Assembly, 12" x 2" RH	122451
J Kits	Shoe and Lining Kit for (1) Brake	136444
	Magnet Kit for (1) brake, black or white wire	136447
	Spring and hardware kit for (1) Brake	136445
	Adjuster screw and spring kit for (1) brake	136453

7" BRAKES AND KITS

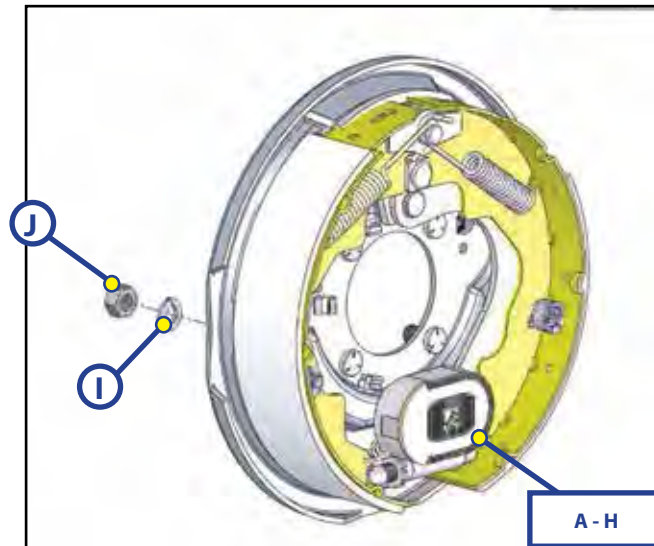


Callout	Description	Part #
A	Brake, Electric - LH x 7" x 1.25"	139700
B	Brake, Electric - RH x 7" x 1.25"	139701
C	Brake Lock Washer - 7/16	122086
D	Brake Hex Nut - 7/16 - 20	122085
Electric Brake Kits		
	7" x 1.25 Shoe & Lining Kit, 1 Brk (Includes front and rear shoe)	332900
	7" Magnet Kit (Includes magnet, spring, and clip)	332901

Trailer Axle Manual

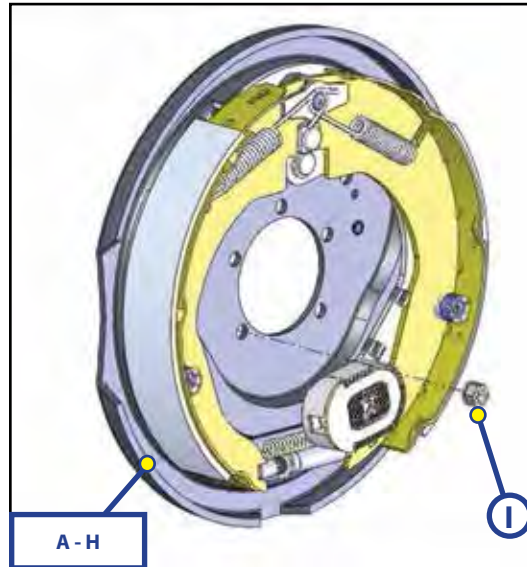
MAC 6000 Hydronic Heater

10" BRAKES AND KITS



Callout	Description	Part #
A	Brake, Electric - LH x 10" x 2.25"	122258
B	Brake, Electric - RH x 10" x 2.25"	122450
C	Brake, Electric - LH x 10" x 2.25" Self Adjust	1222583
D	Brake, Electric - RH x 10" x 2.25" Self Adjust	1224503
E	Brake, Hyd Uni-Servo - LH x 10" x 2.25"	132048
F	Brake, Hyd Uni-Servo - RH x 10" x 2.25"	132047
G	Brake, Hyd Free-Backing - LH x 10" x 2.25"	179869
H	Brake, Hyd Free-Backing RH x 10" x 2.25"	179868
I	Brake Lock Washer - 7/16	122086
J	Brake Hex Nut - 7/16 - 20	122085
Electric Brake Kits		
	10" x 2.25" Shoe & Lining Kit, 1 Brake (includes front and rear shoe)	136451
	10" Break Magnet Kit (Includes magnet, magnet spring, and clip)	136454
	10" Spring & Hardware Kit (Includes hold-down pins, hold-down springs, and retractor springs)	136452
	Adjuster Screw & Spring Kit (includes adjuster and adjuster spring)	136453

12" BRAKES AND KITS



Callout	Description	Part #
A	Brake, Electric - LH x 12" x 2"	122259
B	Brake, Electric - RH x 12" x 2"	122451
C	Brake, Electric - LH x 12" x 2" Self Adjust	1222593
D	Brake, Electric - RH x 12" x 2" Self Adjust	1224513
E	Brake, Hyd Uni-Servo - LH x 12" x 2"	138754
F	Brake, Hyd Uni-Servo - RH x 12" x 2"	138755
G	Brake, Hyd Free-Backing - LH x 12" x 2"	139419
H	Brake, Hyd Free-Backing - RH x 12" x 2"	139420
I	Brake Lock Nut $\frac{3}{8}$ " - 24	122077
Electric Brake Kits		
	12" x 2" Shoe & Lining Kit, 1 Brake (includes front and rear shoe)	136444
	12" Magnet Kit (Includes Magnet, Magnet Spring, and clip)	136447
	12" Spring & Hardware Kit (Includes hold-down pins, hold-down springs, and retractor springs)	136445
	Adjuster Screw and Spring Kit (includes Adjuster and Adjuster Spring)	136453

Trailer Axle Manual

MAC 6000 Hydronic Heater

STORAGE

STORAGE PREPARATION

If your trailer is to be stored for an extended period of time the trailer will need to be prepared prior to going into storage. Follow these guidelines to setup your trailer for storage:

1. If the trailer has an emergency breakaway battery remove it and store it inside, out of the weather. Charge the battery at least every 90 days.
2. Jack up the trailer and place jack stands under the trailer frame so that the weight will be off the tires. Follow trailer manufacturer's guidelines to lift and support the trailer.
3. Lubricate mechanical moving parts such as the hitch, and suspension parts, that are exposed to the weather.
4. In the case of boat trailer axles that are subject to repeated immersion, remove brake drums; clean, dry and re-lubricate moving brake components; inspect bearings - clean and relubricate.



Lift unit by the frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing serious injury or death.

EXTENDED STORAGE INSPECTION PROCEDURES

Trailer should remain on jack stands during this procedure:

1. Remove all wheels and hubs or brake drums. Reinstall drum to same spindle and brake from which it was removed.
2. Inspect suspension for wear.
3. Check tightness of hanger bolt, shackle bolt, and U-bolt nuts of the suspension for correct torque.
4. Check brake linings, brake drums and armature faces for excessive wear, scoring, damage or corrosion.
5. Check brake magnets with an ohmmeter. The magnets should check 3.2 ohms. If shorted or worn excessively, they must be replaced.
6. Lubricate all brake moving parts using a high temperature brake lubricant.
7. Remove any rust from braking surface and armature surface of drums with fine emery paper or crocus cloth. Be sure to protect bearings from contaminating dust.
8. Inspect oil or grease seals for wear or nicks. Replace if necessary.
9. Lubricate hub bearings.
10. Reinstall hubs and adjust bearings.
11. Mount and tighten wheels.

NOTE: Avoid getting any grease or oil on brake linings and pads or magnet surfaces.



TRIP PREPARATION CHECKLIST

The following checklist offers several guidelines to prolonging the quality of your running gear and will provide trustworthy and safe trailering for years to come.

Using the following checklist before starting a trip with your trailer is highly recommended. Allow plenty of time prior to any trip for any service or repairs that may need to be done before using the trailer.

1. Maintenance schedule should be current.
2. Inspect hitch for corrosion, lubrication and wear.
3. Inspect safety chains for rust and wear. Engage chains and breakaway switch actuating chain securely. Breakaway battery should be fully charged.
4. Electronic coupler must be secure. Run check on all lights and break engagement and synchronization.
5. Load trailer with 10% of total weight on the hitch end of trailer. Smaller trailers front end load should be increased to 15%.
6. **DO NOT OVERLOAD!** Consult your trailers i.d. plate for gross vehicle weight restrictions.
7. Tires should be inflated to manufacturer's specs. Inspect tires for any damage or wear.
8. Inspect lug nuts/bolts. All should be torqued to spec. (See Page 15 for specs).
9. Check torque of hanger bolt, shackle bolt, and U-bolt nuts on suspension.
10. Check that your trailer is towing level. Adjust hitch height if necessary to level trailer.

Trailer Axle Manual

MAC 6000 Hydronic Heater



L I P P E R T
C O M P O N E N T S™

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Ph: (574) 537-8900 Web: www.lci1.com Email: warranty@lci1.com



ISUZU DIESEL ENGINE 2CA1, 3CA1, 3CB1

INSTRUCTION MANUAL

ISUZU MOTORS LIMITED

CALIFORNIA

Proposition 65 Warning

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

FOREWORD

The ISUZU industrial diesel engines are a product of ISUZU's long years of experience, advanced technology. ISUZU takes great pride in the superior durability and operating economy of these engines.

In order to get the fullest use and benefit from your industrial engine, it is important that you operate and maintain it correctly. This Manual is designed to help you do this.

Please read this Manual carefully and follow its operating and maintenance recommendations. This will ensure many years of trouble-free and economical engine operation.

Should your engine require servicing, please contact your nearest ISUZU engine outlet. He knows your engine best and is ready to meet your satisfaction.

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

ISUZU reserves the right to make changes in this Manual at any time without prior notice.

Thank you for purchasing the ISUZU product.

[INTRODUCTION]

- This Instruction Manual describes the operation, maintenance and inspection of the 2CA1 • 3CA1 • 3CB1 diesel engines.
- Read this Instruction Manual carefully before operate the machine unit to ensure that the engine is used correctly and that it stays in the best possible condition.
- Keep this Instruction Manual in a convenient place for easy access.
- If this Instruction Manual is lost or damaged, order a new one from your dealer or Isuzu distributor.
- Make sure this manual is transferred to subsequent owners. This manual should be considered a permanent part of the engine and remain it.

- Constant efforts are made to improve the quality and performance of Isuzu products, so some details included in this Instruction Manual may differ slightly from your engine. If you have any questions about such difference, please contact your dealer or Isuzu distributor.
- The specifications and components (instrument panel, fuel tank, etc.) described in this manual may differ from ones installed in your machine unit. To obtain their information, please refer to the manual provided by the equipment manufacturers.

California

Proposition 65 Warning

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

California

Proposition 65 Warning

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.

Wash hands after handling.

The EPA (U.S. Federal) and Air Resources Board (ARB, California) Off-road Compression Ignition engines regulations

The engines for the EPA regulations will be used in the States, and the engines for the ARB regulations will only be used in the State of California.

The information on engines to comply with the EPA and ARB Regulations is released and you are kindly requested to make every effort to comply with them. Isuzu Engines of "2C" and "3C" engine models are covered with these regulations.

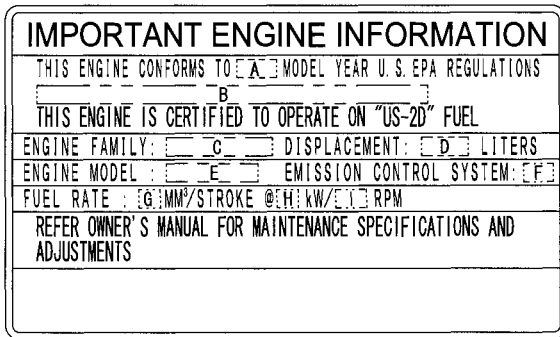
Isuzu Diesel Engine

MAC 6000 Hydronic Heater

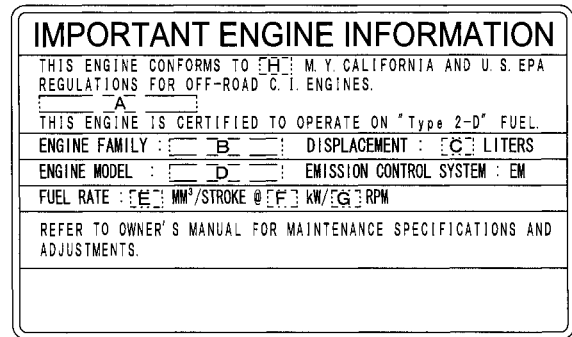
Engine identification

With the regulations on engine emission worldwide, it has become necessary to identify engines in a manner to determine which regulations they comply with, hence

- Emission control information label as shown below which will contain:

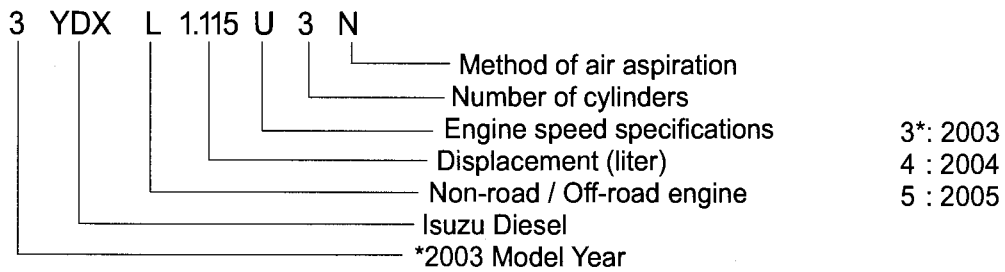


EPA Emission Control Label



EPA/ARB-OR Emission Control Label

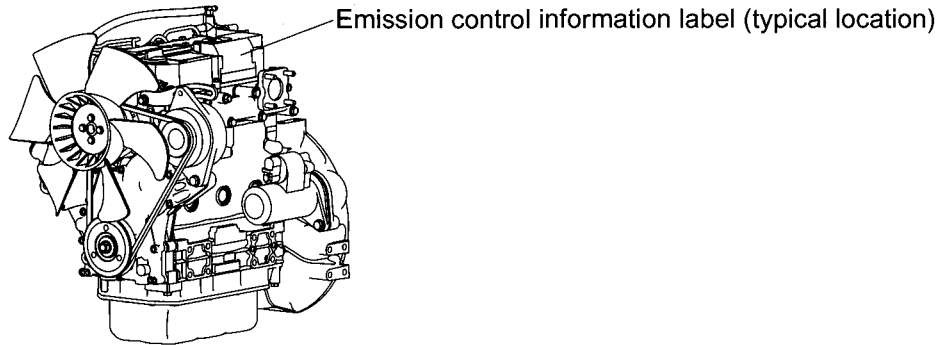
- Engine family name as assigned by EPA and ARB identifying engine family group 3YDXL1.115U3N and this identifies



- Label location:

The typical location of this label for each engine is on the "top of rocker arm cover"

A supplemental label may be used in certain applications for improved visibility.



Requirements on engine installation condition

The followings are required from the point of view of engine installation in order to comply with the EPA and ARB regulations. Unless otherwise satisfying these, engines exhaust gas emission will not be within the regulated value of the EPA and ARB Regulations.

- Maximum Exhaust Gas Restriction shall be
 11.76 kPa (1200mm H₂O) or less for 3CA1, 3CB1.
 5.88 kPa (600mm H₂O) or less for 2CA1.
- Maximum air intake restriction shall be 6.2kPa (635mm H₂O) or less and clean air cleaner element each time when air intake restriction exceeds the above mentioned value.

Emissions-related parts

The EPA and ARB regulates specific emissions-related parts to be warranted for the period in the following table. However, ultimate purchasers are obligated to use and maintain the engine correctly.

Warranty Periods

Power Range kW (Gross power)	Other than Constant-speed	Constant-speed
		Under 3000 min ⁻¹
Range < 19		1500 hours or 2 years
19 ≤ Range < 37		3000 hours or 5 years

*Actual hours or years of operation whichever occurs first is applied.

The specific emissions-related parts are

- Fuel injection nozzle
- Fuel injection pump

Isuzu Diesel Engine

MAC 6000 Hydronic Heater

Maintenance schedule

To maintain optimum engine performance and compliance with the EPA Regulations Non-road Engines, it is necessary that the maintenance schedule is adhered to. Regular scheduled maintenance is a major key to engine service life and emissions regulations compliance. It is of utmost importance that scheduled maintenance, requirements are performed on a timely basis.

EPA allows to apply Maintenance schedule for Emission related parts as follows.

—	Check Fuel Injection Nozzle and clean	Adjust, cleaning and repair of Fuel Injection Pump and Fuel Injection Nozzle
kW \leq 130	1500 hours of use and at 1500-hour intervals thereafter	3000 hours of use and at 3000-hour intervals thereafter

Maintenance schedule not related to emissions is recommended in 5.2 List of Periodic Inspection.

Emission System Warranty Statement

U.S. EPA and CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT

Isuzu Motors Limited warrants initial owner and each subsequent owner that the engine is designed, built and equipped so as to conform with applicable regulations for its warranty period.

Specific emissions-related parts and components are warranted for the period specified in "**Emissions-related parts**" whichever comes first, after the date of delivery to the initial owner. If any emissions-related part is defective during the warranty period, Isuzu will repair your engine at no cost to you including diagnosis, parts and labor.

To maintain engine performance and compliance with the regulations, the owner is responsible for the performance of the required maintenance listed in the instruction manual during the warranty period.

This emission warranty does not cover:

1. Failure caused by any of the following:
 - Abuse, neglect, improper maintenance or use of non-genuine parts.
 - Use of fuel oil and lubricating oil not recommended for the engine.
 - Improper application and installation.

2. Add-on or modification affecting engine emissions.

The use of add-on or modified parts can be grounds for disallowing a warranty claim.

Isuzu is not liable to cover failures of the emission control system parts or components caused by the use of add-on or modified parts.



The 97/68/EC Directive Certified engines

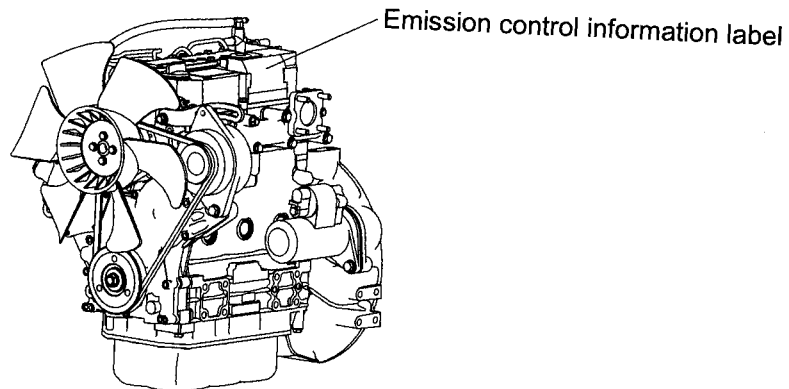
The engines in this manual have been certified by the 97/68/EC Directive.

To identify the engines, the following emission control label is affixed on the engines.

IMPORTANT ENGINE INFORMATION	
THIS ENGINE CONFORMS TO 97/68/EC DIRECTIVE	
ENGINE FAMILY :	----- A -----
ENGINE MODEL :	----- B -----
APPROVAL NUMBER :	----- C -----

EC Emission Control Label

- Label location:



1. FOR YOUR SAFETY (Please make sure to read and fully understand the description for safety)

Following the precautions described in this manual will enable you to use this engine with complete satisfaction. Failure to observe any of the rules and precautions, however, may result in injury, burns, fires, and engine damage. Read this manual carefully and be sure fully understand it before beginning operation.

1.1 Warning Symbols

These are the warning symbols which are used in this manual and on the products. Symbols and their meanings are as follows.



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.

- The failure to comply with all relevant Safety Instructions could result in bodily injury.
- The descriptions captioned by **IMPORTANT** are particularly important cautions for handling. If you ignore them, the performance of your engine and machine unit may be deteriorated leading to trouble. It may also be used to alert against unsafe practices.

Warning indications on this engine (safety labels, etc.) are also shown on your machine unit side. Make sure to also observe warnings indicated on the machine unit and instructions contained in the instruction manual supplied from the machine unit manufacturer.

Keep the warning labels affixed on the engine and machine unit from becoming dirty or torn. If a warning label is missing, damaged or cannot be read, it must be promptly replaced, ordering it in the same way as for the service parts. Also, if a warning label is affixed on a part which is replaced, a new warning label must be affixed on the replaced part.

1.2 Safety Precautions

(These instructions should be strictly followed for the safety of you and others.)

1.2.1 Precautions for operation

DANGER



Preventing burns from scalding

- Never open the radiator filler cap shortly after shutting the engine down. Steam and hot water will spurt out and seriously burn you. Allow the engine to cool down before attempt to open the filler cap.
- Securely tighten the filler cap after checking the radiator. Steam can spurt out during engine running, if tightening loose.

DANGER



Sufficient ventilation of the battery area.

- Keep the area around the battery well ventilated, paying attention to keep sparks, open flame and any other form of ignition away. During engine running or charging battery, hydrogen gas is produced from the battery and can be easily ignited.

DANGER



Preventing fire

- Be sure to use the proper diesel fuel. Filling with gasoline or the like by mistake will result in ignition.
- Be sure to stop the engine before refueling.
- If you spill fuel, wipe off such spillage completely.
- Never place oil or other flammable materials (such as straws, withered grass) close to the engine during running or shortly after shutting it down.
- Check fuel oil and engine oil for leakage from their piping lines to cause fires. Replace the rubber hoses with new ones every 2 years even if storing without use.
- Start the engine only from a starter switch without any load or in neutral position of the clutch of machine unit. Starting by means of connecting with the terminals of starter motor using a screwdriver or the like (jumping start) may cause fire due to spark at the terminals of starter motor. Also, the machine unit suddenly starts to move or generates power to cause serious personal injury.
- Keep the engine (machine unit) sufficiently away from a building and flammable materials during engine running. It may cause fires due to hot exhaust gas and engine body.
- Keep sparks, open flames or any other form of ignition (match, cigarette, etc.) away when fueling / refueling. Fire and or an explosion may result.

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WARNING



Preventing exhaust fumes inhalation

- Never block up windows, ventilation ports, or other ventilation equipment such as ventilators of the engine room. Ensure good ventilation during engine operation. Inhaling the exhaust fumes is harmful.
- Never operate the engine in a closed room, tunnel, underground room, manhole or ship's hold. It is dangerous since exhaust fumes cannot get out.

WARNING



Keep away from moving / rotating parts

- Pay sufficient attention so as not to touch moving / rotating parts, or bring your hands or part of your body or clothes close to moving / rotating parts while the engine is running.
Otherwise, you may get injured by being caught by the cooling fan, flywheel or PTO shaft. Never operate the engine without covers on the moving / rotating parts. Also, always keep kids and pets away from the engine and machine unit.
- Check before starting the engine to see that any tools or cloths used in the maintenance have been removed from the area.

CAUTION



Preventing burn from contacting with hot surface

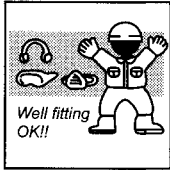
- Pay sufficient attention not to bring part of your hand and body or clothes in contact with the silencer, exhaust pipe, turbocharger and engine body during operation or shortly after stopping the engine.
The whole engine is hot and scalding / serious burns may result.
- Carry out cooling down engine running for 5 minutes without load before the engine has been stopped. Sudden shutting the engine down without any cooling down running causes the engine and around temperature to rise rapidly. Scalding / serious burns or fires may result.

WARNING

Never operate the engine while you are under the influence of alcohol

- Also, never operate the engine when you are ill or feel unwell as this results in unexpected accidents.

⚠ CAUTION



Safe work clothing

- Appropriate safety wear (gloves, special shoes / boots, eye / ear protection, head gear, harness' clothing, etc.) should be used / worn to match the task at hand. Avoid wearing jewelry, unbuttoned cuffs, ties or loose fitting clothes around moving machinery. A serious accident may occur if caught in moving / rotating machinery.
- Do not operate the engine and machine unit wearing earphone or headphone to listen to music or radio. A serious accident may occur because it is difficult to hear a warning from outside.

1.2.2 Precautions for inspection

⚠ DANGER



Do not come in contact with battery electrolyte

- Batteries contain sulfuric acid. Do not allow it to come in contact with clothing, skin and or eyes, severe burns will result. Always wear safety goggles and protective clothing when servicing the battery. If contact with the skin and or eyes should occur, flush with a large amount of water and obtain prompt medical treatment.

⚠ DANGER



- Do not intentionally make the battery spark by short-circuiting to check its remaining charge. It will cause fires. Make sure to use a gravimeter to check the remaining charge of the battery.
- If the battery electrolyte frozen, recharge the battery after warming up to thaw it. It will cause explosion.

Do not expose your skin to high pressure fuel spray

- Be careful so as not to bring your skin in contact with high pressure fuel spray from broken fuel injection pipe to penetrate your skin to cause inflamed.

If exposing to the spray should occur, obtain prompt medical treatment.

When any leakage of high pressure fuel spray is found during engine running, intercept it with a wooden plate, etc. so as not to be exposed your skin to it and shut the engine down and ask your dealer or Isuzu distributor for repair.

⚠ WARNING



Preventing electric short-circuits

- Make sure to turn off the battery switch or disconnect the negative cable (-) before inspecting the electrical system. Failure to do so could cause short-circuiting and fires.
- Check the electric lead wires for any slackened, twisted, damaged and keep the connectors and terminals of wire harness clean. They may cause fires due to electric short-circuit.

⚠ WARNING



Keep off moving / rotating parts

- Stop the engine before starting service operation. If you must inspect while the engine is operating, never bring your hand, body or clothing in contact with or close to moving / rotating parts, as you may get injured by being caught by moving / rotating parts.

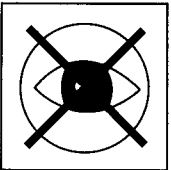
⚠ CAUTION



Preventing scald from draining hot oil and water

- If engine oil must be drained from the engine while it is still hot, take care not to let the oil splash on you to avoid scalding.
- Wait until the temperature goes down before draining the coolant. Hot water may splash to burn you.

⚠ CAUTION



Beware of dirt from air blowing

- Wear protective equipment such as goggles to protect your eyes when blowing compressed air or steam. Dust or flying debris can hurt eyes.

IMPORTANT:

Keep away from lifting up or traveling engine

- *Lifting up or traveling the engine for a repair by yourself could result in serious injury. If you need any repair, ask your dealer or Isuzu distributor.*
- *Be sure to keep away from the traveling engine or the area beneath the engine which is lifted up.*

IMPORTANT:

Modification not authorized

Never modify this product or release the limit devices (which limit engine speed, fuel injection quantity, etc.).

Such modification or release will impair the safety and performance of the product and functions and result in shorter engine life. And be sure to use Isuzu genuine part when replace the part with new one.

IMPORTANT:

Waste management

Observe the following instructions with regard to hazardous waste disposal. Negligence of these will have a serious impact on environmental pollution concerns.

- *Waste fluids such as engine oil, fuel and coolant shall be carefully put into separate sealed containers and disposed of properly.*
- *Do not dispose of waste materials irresponsively by dumping them into the sewer, overland or into natural waterways.*

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- *Waste materials such as engine oil, fuel, coolant, solvents, filter elements and batteries, must be disposed of properly according to local ordinances. Consult the local authorities or reclamation facility.*

Never permit anyone to operate the engine and or machine unit without proper instruction.

- *Explain how to operate the engine and or machine unit to make fully understand the person from you when you let someone use it. At the same time, you let the one read this manual and the instruction manual for the machine unit to further understand how to operate.*

To keep the engine in the best condition

- *Avoid the engine running in the following surrounding conditions. Otherwise, the engine may cause to damage, to be not enough engine performance or to be shorten engine life.*
 - *In extreme dusty air.*
 - *In a harmful chemical gas or fumes.*
 - *In salty win (sea side).*
 - *Flooding place when raining.*
 - *Exposing the engine in raining.*
- *When steam cleaning or water cleaning the engine, protect the air cleaner and electric components from steam or water.*
- *It is essential to run your engine at the ambient temperature +45 ~ -15°C. If the temperature is higher than the above, the engine may have overheating and get the extreme high temperature engine oil to cause engine trouble. Contrarily, If the ambient temperature is lower than the above, the engine components made of rubber are hardened to cause damage. When you run the engine at the temperature out of the above, contact your dealer or Isuzu distributor. Also when you run the engine on higher sea-level land, the engine output may not be enough and runs with poor exhaust gas due to lower atmospheric pressure and lean air intake.*



2. PRODUCT OVERVIEW

2.1 Intended Uses and Conditions

The environment friendly engine designed and controlled low exhaust gas emission, less noise and vibration has been delivered to you as a power source for civil, construction, agriculture, generator and other machine units.

- Easy starting with new developed fuel injection pump and combustion system.
- Economical running reduced fuel and engine oil consumption.
- Easy operation due to minimum maintenance and compact designed.
- Durable and reliable engine equipped with the new designed fuel injection valve and fuel injection pump.

We are sure that you will be satisfied with the above features.

Main power of this engine can be taken off from the flywheel end by means of "direct couple driving" or "belt driving". For direct couple drive engine, the flywheel housing or end plate to mount the engine to a machine unit is installed to the engine. For belt drive engine, the belt drive device equipped with a bearing is required so as not to damage the crankshaft and or main engine bearing. If you have need of the belt driving and or front power take-off device, please contact your dealer or Isuzu distributor.

The specifications of the main parts of the engine are standardized for multi-purpose application. Options (fuel tank, remote controller, instruments, alarms, etc.) are provided to meet various operating conditions. Since installation and fitting of the engine require special knowledge and skill, always consult your dealer or Isuzu distributor.

- Please consult with us for selecting optional parts. Optional parts should be selected to best match the work conditions and environments.
- To obtain the maximum engine performance with a minimum risk of machine troubles and accidents, it is very important to match the engine with the machine unit.
- Carefully establish safe exhaust piping, electric wiring, ventilation and accurate engine installation.
- Certain applications may require an inspection by the authorities.

This manual describes operation based on the standard specifications. When coupled with the machine unit, operation procedures for options and accessories may vary depending on the structure of that machine unit.

OPTION : Information for optional parts.

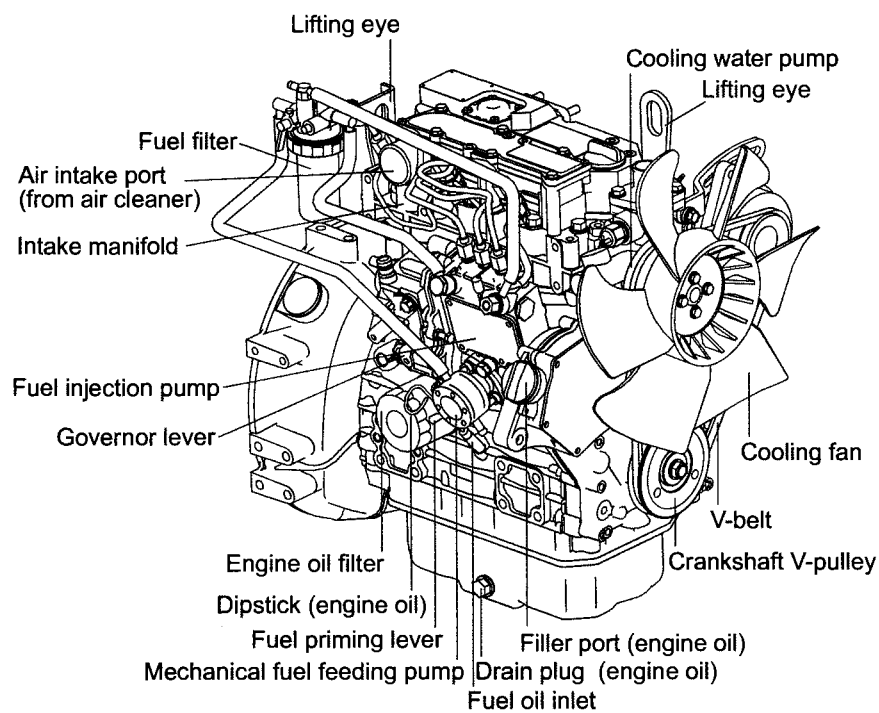
ENGINE NAME : Information for exclusive matter of the engine.

For optional parts or accessories refer to the instruction manual provided by the equipment manufacturer and observe the instructions and cautions given therein.

Isuzu Diesel Engine

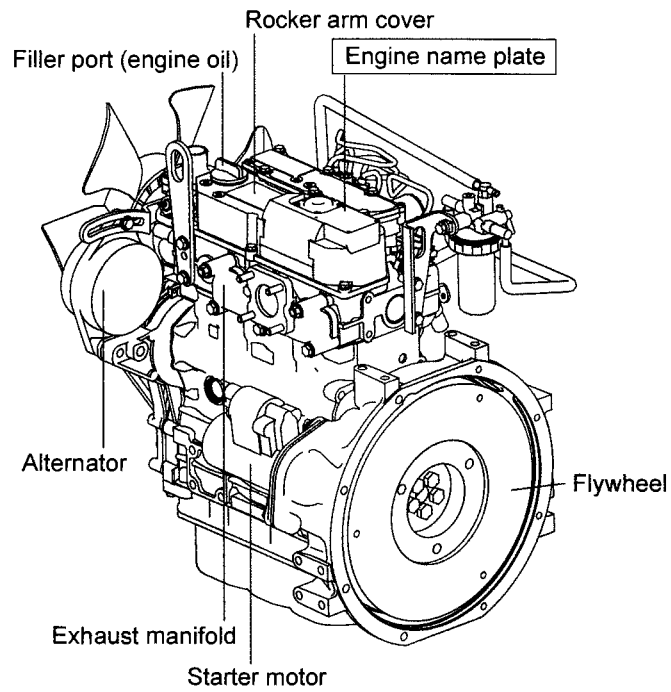
MAC 6000 Hydronic Heater

2.2 Names of parts



Isuzu Diesel Engine

MAC 6000 Hydronic Heater



Note : This illustration shows the 3CB1 engine.

2.3 Functions of Major Parts

Parts	Functions
Fuel filter	Removes dirt and water from the fuel oil. Periodic replacement of filter element is necessary before it is clogged with dirt. Replace the whole cartridge assembly for renewal.
Oil / water separator	Stand alone type (fitted on the machine unit)(engine maker supplies). Drain the dust and water periodically from the drain cock at the bottom of the separator fitted near the fuel tank of the machine unit.
Fuel priming pump	The priming pump on the top of the fuel filter mounting feeds the fuel by moving the knob of the priming pump up and down by hand to bleed the air from the fuel system. (The fuel filter mounting with priming pump is optional). The fuel priming pump position on the fuel filter mounting should be on the lower level than the fuel tank position. The electro-magnetic fuel feed pump provided as optional should be fitted on the fuel piping when installing the fuel filter mounting without fuel priming pump to bleed the air and feed fuel to the fuel injection pump.
Fuel feeding pump	Electro-magnetic fuel feeding pump (DC12V) (optional) should be fitted on the fuel piping to bleed air and feed fuel to the fuel injection pump when installing the fuel filter mounting without fuel priming pump.
Filler port (engine oil)	Filler port for engine oil.
Dipstick (engine oil)	Level gauge for engine oil in the oil pan.

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Parts	Functions
Engine oil filter	Filters fine metal fragments and carbon in the engine oil. The filter is a cartridge type and the filter element should be replaced before clogging occurs.
Air cleaner	Air intake device which drifting dust is prevented from entering the cylinder by means of the filter element, and it also serves to reduce the air intake noise. Periodic check (cleaning or replacement) of the filter element is necessary before it is clogged with dust.
[Cooling water system] •Radiator •Cooling fan and cooling water pump •Radiator cap •Sub-tank	<p>This engine is water-cooled system by means of radiator. Serves as cooling water storage tank and heat exchanger. The cooling fan is driven by the V-belt to cool the cooling water. The cooling water pump circulates the cooling water through the cylinder block and cylinder head to cool them, and returns the water into the radiator.</p> <p>The radiator cap is equipped with two pressure regulating valves: the release and vacuum valves. When the cooling water temperature rises, the radiator inner pressure gets higher and the release valve opens to release steam and overflowing thermally expanded hot water into the sub-tank through a rubber hose. (Note that the rubber hose connects the water supply port and the sub-tank.)</p> <p>Steam and hot water delivered to the sub-tank are cooled down to water again. When the load is reduced and the cooling water temperature drops, the radiator internal pressure becomes nearly negative, and vacuum valve on the radiator cap opens to suck back the water in the sub-tank to the radiator. This cycle minimizes the cooling water consumption.</p>
Starter motor	The starter motor pinion powered by battery engages with the ring gear installed on the flywheel and turn it to start the engine.
Alternator	Driven by V-belt and generates electricity and charges the battery

2.4 Control Equipment

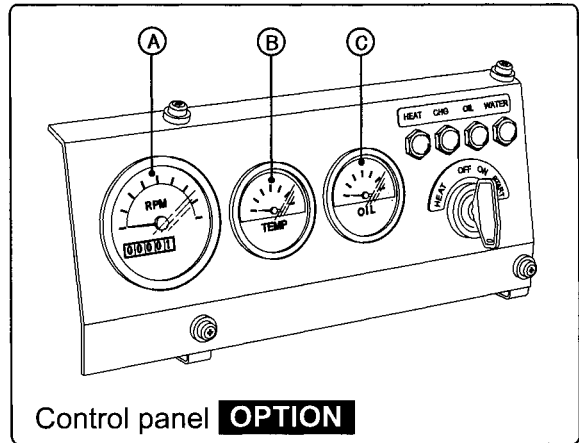
Control equipment described here includes monitoring the engine running conditions during operation, the devices for starting, adjusting the engine speed and stopping the engine.

2.4.1 Instruments and alarm devices

On the control panel for control equipment, following gauges and alarm devices could be installed.

(1) Instruments

- Ⓐ Tachometer (with integrated hour meter) **OPTION**
The needle shows the engine speed, Hour meter shows total operation hours in the window below the tachometer. Refer to the figure as a standard for periodic inspection.
- Ⓑ Cooling water temperature meter **OPTION**
The needle shows engine cooling water temperature.
- Ⓒ Engine oil pressure meter **OPTION**
The needle shows engine oil pressure.

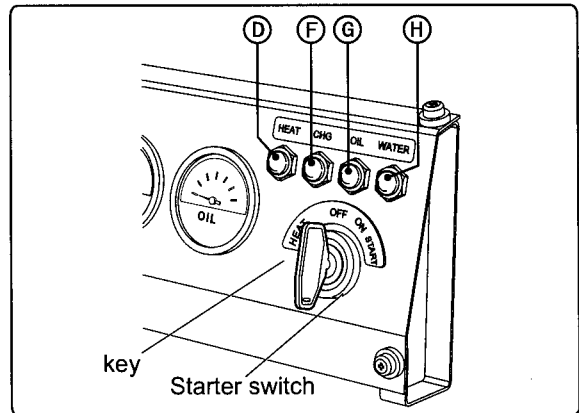


Control panel **OPTION**

(2) Lamps

OPTION

- Ⓓ Heat up indicating lamp for air glow plugs. (HEAT: Blue)
When the key is turned to the HEAT position to energize the air heater, the lamp comes on. After keeping it at the HEAT position for approx. 4 seconds, the lamp goes off to turn the key to the START position.
- Ⓕ Battery charge alarm lamp (CHG: Red)
The lamp is off while the battery is recharged. It comes on when the battery is not charged normally.
- Ⓖ Engine oil pressure alarm lamp (OIL: Red)
The lamp comes on if engine oil pressure drops below the specified.
- Ⓗ Cooling water temperature alarm lamp (WATER: Red)
The lamp comes on if the cooling water temperature exceeds the specified (110°C or more).



2.4.2 Operation Device

The devices for starting, adjusting the engine speed, and stopping the engine are as follows.

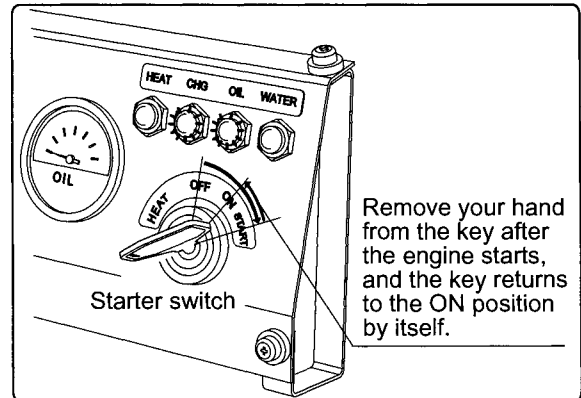
(1) Starter switch

OPTION

This is 3-stage rotary switch.

Position is changed by turning the key inserted to the slot of the starter switch.

- OFF: This is the engine stop position, and all electric current is cut off. The key can be inserted and removed at this position.
- ON: This position provides the normal operating condition. Current flows to instruments and alarm devices.
- START: This is the starting position. The starter motor rotates to crank the engine. The key returns automatically to the ON when it is released.
- HEAT: This position is used to energize the glow plugs. The key returns automatically to the OFF when it is released.

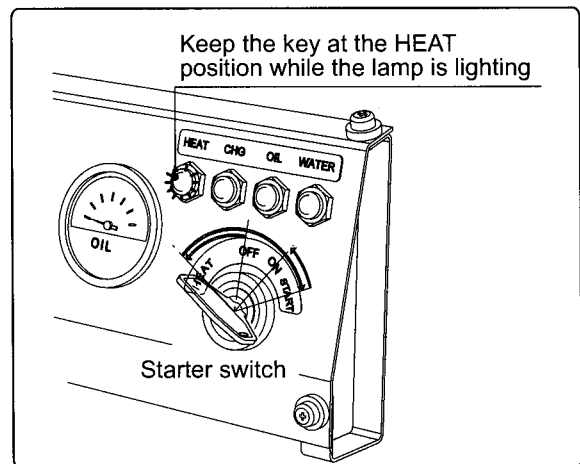


(2) Glow plugs (cold starting aid)

OPTION

Installed in the combustion chamber of the cylinder head, the glow plugs are heated up to start the engine easily under low temperature conditions.

After keeping the key at the HEAT position for approx. 4 seconds, the lamp goes off to turn the key to the START position.



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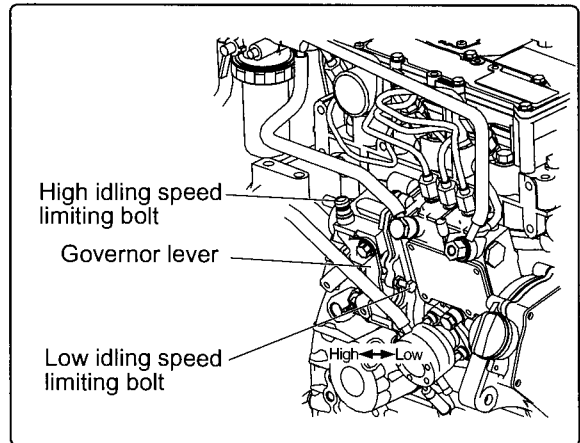
MAC 6000 Hydronic Heater

(3) Governor lever

This lever controls the engine speed via the speed control device of the machine unit.

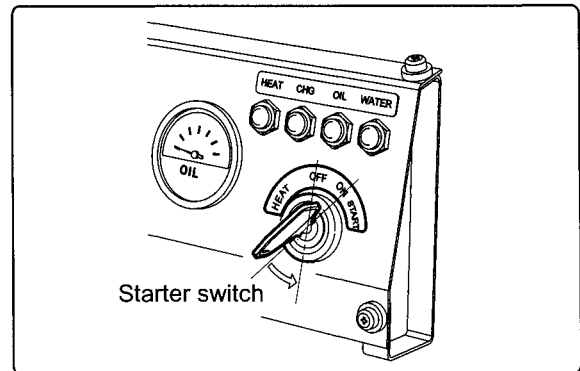
It is linked with the accelerator system on the machine unit side (accelerator handle and pedal to be procured by the equipment manufacturer) by means of an accelerator wire for remote control.

High idling and low idling speed are restricted by their limiting bolt.



(4) Engine stopping device

When the key is turned to the OFF position, the engine stop solenoid actuates the valve of fuel injection pump to stop fuel.



3. BEFORE OPERATION

Follow the procedures described in 3.1 through 3.5 before starting the engine.

The engine will be delivered without fuel oil, engine oil and coolant from ISUZU.

Read this section carefully to fully understand the requirements for fuel oil, engine oil, coolant.

3.1 Fuel Oil, Engine Oil and Coolant

3.1.1 Fuel oil

IMPORTANT:

Only use the recommended fuel to obtain the best engine performance and to keep the durability of the engine, also to comply with the emission regulations.

(1) Selection of fuel oil

Diesel fuel oil should comply with the following specifications.

- The fuel specifications need to comply with each national standard or international standards.
 - ASTM D975 No.1-D
 - No.2-D ----- for USA
 - EN590:96----- for EU
 - ISO 8217 DMX ----- International
 - BS 2869-A1 or A2 ----- for UK
 - JIS K2204 ----- for JAPAN

The following requirements also need to be fulfilled.

- Cetane number should be equal to 45 or higher.
- Sulphur content of the fuel
 - It should not exceed 0.5%by volume. (Preferably it should be below 0.05 %)
- For alternative fuel (Bio fuel such as FAME, JP-8), please contact ISUZU.
- Water and sediment in the fuel oil should not exceed 0.05% by volume.
- Ash should not exceed 0.01%by mass.
- 10% Carbon residue content of the fuel
 - It should not exceed 0.35%by volume. (Preferably it should be below 0.1 %)
- Aromatics(total) content of the fuel
 - It should not exceed 35% by volume. (Preferably it should be below 30% and aromatics(PAH*) content of the fuel preferably it should be below 10%)
 - PAH*:polycyclic aromatic hydrocarbons
- DO NOT use Biocide.
- DO NOT use Kerosene, residual fuels.
- DO NOT mix winter fuel and summer fuel.

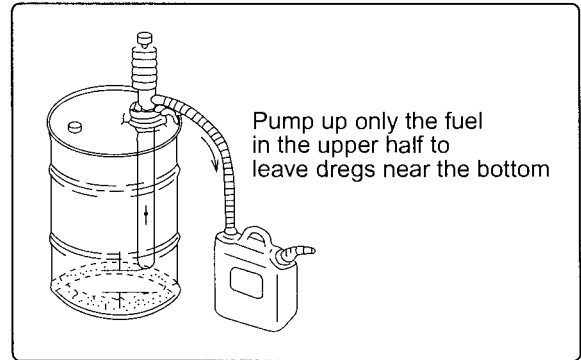
Note : Engine breakdown can be attributed to insufficient quality of fuel oil.

Isuzu Diesel Engine

MAC 6000 Hydronic Heater

(2) Fuel handling

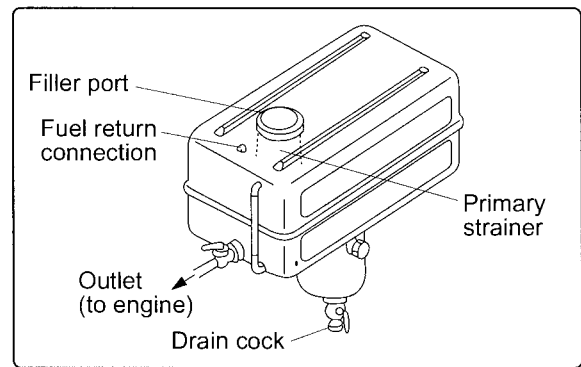
- Water and dust in the fuel oil can cause operation failure.
Use containers which are clean inside to store fuel oil. Store the containers away from rain water and dust.
- Before supplying fuel, let the fuel container rest for several hours so that water and dust in the fuel are deposited on the bottom. Pump up only the clean fuel.



(3) Fuel tank

OPTION

Fuel tank inside should be always clean enough and dry it inside for the first use.
Drain the water according to the maintenance (section 5) with a drain valve.



3.1.2 Engine oil

IMPORTANT:

Only use the recommended engine oil to keep the durability of the engine.

(1) Selection of engine lube oil

Engine oil should comply with the following specifications.

1) Classification

- API classification CD, CF, CF-4, CI-4
TBN value : =>9 (CD), =>9 (CF), =>7 (CF-4), =>7 (CI-4)
- ACEA classification E-3, E-4, E-5
TBN value : =>10 (E-3), =>0 (E-4), =>10 (E-5)
- JASO classification.....DH-1
TBN value : =>10 (DH-1)

The oil must be changed when the Total Base Number (TBN) has been reduced to 2.0.

*TBN(mgKOH/g) test method; JIS K-2501-5.2-2(HCl), ASTM D4739(HCl)

DO NOT use The following engine oils.

- API : CG-4 , CH-4
- ACEA : E-1, E-2 , B grade
- JASO : DH-2 , DL-1



Isuzu Diesel Engine

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Reason

API CG-4, CH-4

In case CG-4, CH-4 is to be used for ISUZU 2C, 3C diesel engine series, there is a possibility that excessive wears occur on the valve train system due to the content of oil.

ACEA E-1,E-2, B

These oils are developed for the different type of diesel engines.

JASO DH-2, DL-1

These oils are developed for the different type of diesel engines.

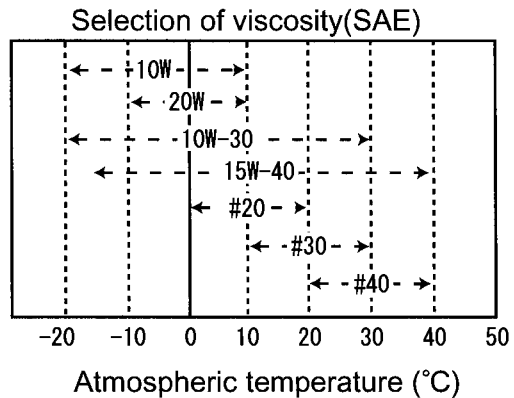
2) Viscosity

Selection of viscosity will be determined depending on the ambient temperature.

(Refer to the chart on the right.)

The following requirements are also need to be fulfilled.

- Standard engine oil service interval is 250 hrs or every 12 months.
- DO NOT add any additives to the engine oil.
- DO NOT mix the different types (brand) of engine oil.
- DO NOT use synthetic oil.



(2) Handling of engine oil

- Keep the engine oil carefully in store in order to prevent any dust or dirt entrance.
- When filling the engine oil to the engine, avoid the spillage and pay attention to be clean around the filler port.

CAUTION

Contact with engine oil may result in the roughened skin. Care should be taken so as not to contact with engine oil wearing protective gloves and clothing.

If contact, wash with soap and water thoroughly.

When handling the engine oil, make sure to use the protective gloves at any time.

In case of contact, wash your hand or body with soap and water thoroughly.

3.1.3 Coolant

Use clean soft water and always be sure to add LLC (Long Life Coolant) in order to prevent rust built up and freezing. (Do not use water only.)

The recommended LLC conform to the following specifications.

- JIS K-2234
- SAE J814C ,J1941 ,J1034 ,J2036
- ASTM D3306
- ASTM D4985

IMPORTANT:

- *Always be sure to add LLC to soft water. In particular, in cold season, to add LLC is important.*

Without LLC,

Cooling performance will decrease due to scale and rust in the cooling water system.

Cooling water may freeze to form ice; it expands approx. 9% in volume.

This causes serious damage in the cooling system.

- *Be sure to use the proper amount of coolant concentrate specified by the LLC manufacturer depending on the ambient temperature.*

LLC concentration should be 50%.

- *DO NOT mix the different types of brand of LLC, otherwise harmful sludge may yield.*
- *DO NOT use hard water.*
- *Water should be free from sludge and/or particles.*
- *Replace the coolant every once a year.*

⚠ CAUTION When handling LLC, use protective gloves to avoid skin contact.
In case you have a contact with your skin or eyes, wash out it with clean water.

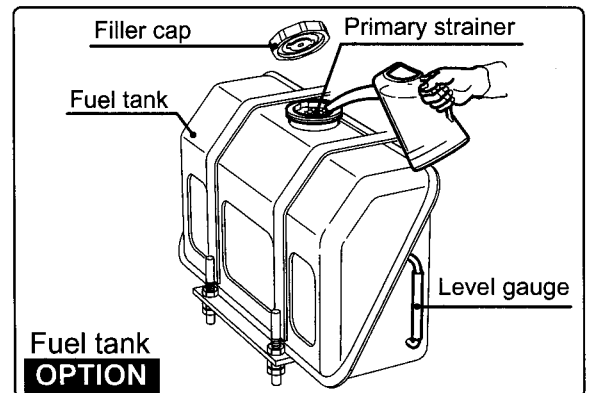
3.2 Supplying Fuel

(Refer to 3.1.1.Fuel)

- Be sure to use the correct type of fuel when fueling / refueling. Mistakenly filling with gasoline or the like will result in ignition.
- Never refuel while the engine is running. If you spill fuel, wipe off such spillage completely.
- Never place oil or other flammable material close to the engine as this could result in ignition.
- Keep sparks, open flames or any other form of ignition (match, cigarette, etc.) away when fueling / refueling. Fire and or an explosion may result.

3.2.1 Filling the fuel tank

Fill the tank with clean fuel which has not been contained with water or dust. Do not remove the primary strainer from the filler port when fill the fuel tank. If remove, trash or dust could get into the fuel tank to cause fuel pipe line clogging. Overfilling is dangerous. Do not fill the tank beyond the full mark of the fuel gauge. Be sure to fill the fuel tank at well ventilated place.



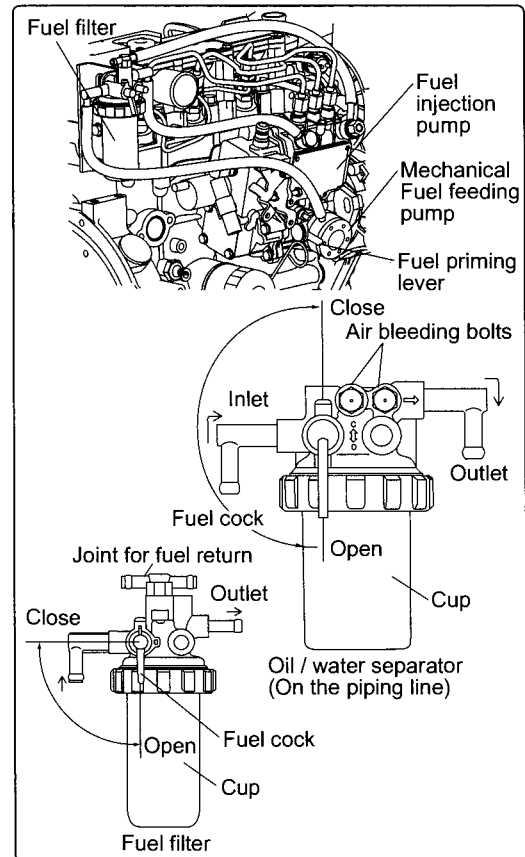
Isuzu Diesel Engine

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3.2.2 Bleeding the fuel system

Bleed the fuel system according to the following procedures. When there is air in the fuel system, the fuel injection pump will not be able to function.

- 1) Check the fuel oil level in the fuel tank. Refuel if insufficient.
- 2) Open the cock of the oil / water separator.
- 3) Loosen the air bleeding bolt on the oil /water separator by turning 2~3 times to the counter-clockwise using screw driver or spanner.
- 4) When the fuel coming out is clear and not mixed with any bubbles, tighten the air bleeding bolt.
- 5) Feed the fuel with the fuel priming lever (mechanical fuel feed pump) or electromagnetic fuel feeding pump.
 - In case of using the fuel priming lever on the mechanical fuel feed pump, move the priming lever up and down until the cup of the fuel filter is filled with fuel oil. Bleeding air for the mechanical fuel feeding pump without priming lever, refer to the manual provided by the equipment manufacturer.
 - In case of the engine using the electromagnetic fuel feeding pump. **OPTION**
Turn the starter switch to the ON position and hold it in the position for 10~15 seconds to operate the fuel feeding pump.



3.3 Supplying Engine Oil

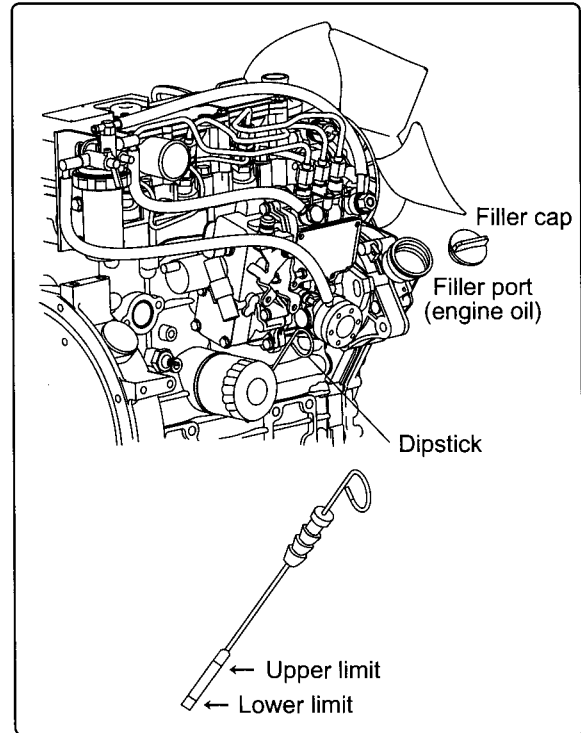
(Refer to 3.1.2 Engine oil)

Fill the oil pan with engine oil as specified level.

- 1) When checking or filling / refilling the engine oil, place the machine unit so that the engine is set on a level.
- 2) Remove the filler cap (yellow colored) on the rocker arm cover or on the side of the engine.
- 3) Fill with engine oil up to the upper limit on the dipstick. To check the oil level, insert the dipstick in fully. When checking the engine oil level with the dipstick, wait for about 3 minutes and then check the level as it takes a little while for the engine oil supplied from the filler port to fill the oil pan.
- 4) Manually tighten the filler cap. Do not use a tool such as pliers to tighten it. Excess tightening may cause to damage the filler cap.

IMPORTANT:

Do not overfill the oil pan with engine oil. Overfilling may result in white exhaust smoke, sudden over engine speed or engine internal damage, getting engine oil into the intake port. Be sure to keep the specified level between upper limit and lower limit on the dipstick.



Engine oil capacity (oil pan) (L)	
2CA1	1.7
3CA1	2.8
3CB1	3.4

NOTICE:

Engine oil capacity may differ from the above depending on the engine installed on the machine unit.

Refer to the instruction manual provided by the equipment manufacturer.

3.4 Supplying Cooling Water

⚠ DANGER



(Refer to 3.1.3. Cooling water)

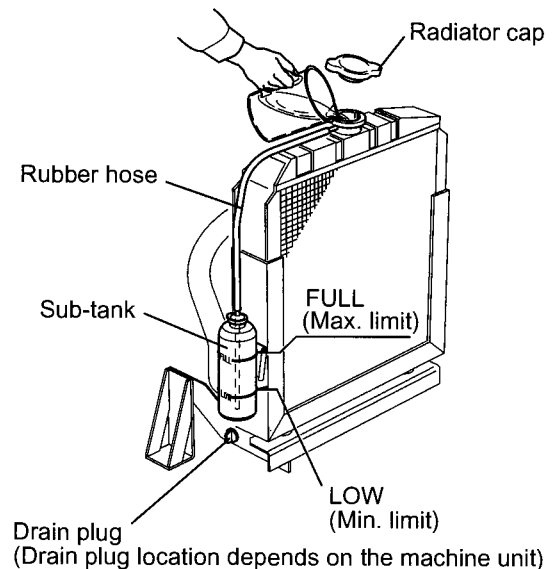
•Never open the radiator filler cap while the engine and radiator are still hot. Steam and hot water will spurt out and seriously burn you. Wait until the radiator is cooled down after the engine has stopped, wrap the filler cap with a rag piece and turn the cap slowly to gently release the pressure inside the radiator.

•Securely tighten the filler cap after checking the radiator. Steam can spurt out during operation, if the cap is tightened loosely.

Fill the radiator and sub-tank with the cooling water as following procedures.

- 1) Before filling, check to be sure the drain plug is closed.
- 2) Remove the radiator cap of the radiator by turning the radiator cap counter-clockwise about 1/3 of a turn.
- 3) Pour the cooling water slowly into the radiator up to the lip of the filler port so that air bubbles do not develop.
- 4) After supplying the cooling water, surely tighten the radiator cap. To fasten the radiator cap, align the claws on the back face of the radiator cap with the notches of the filler port and press-turn the cap clockwise approx. 1/3 of a turn until contact with each other.
- 5) Remove the cap of the sub-tank, supply the cooling water to the FULL mark and fasten the cap.
- 6) Check the rubber hose connecting the sub-tank to the radiator. Be sure the rubber is securely connected and there is no looseness or damage. When the rubber hose is not water tight, an excessive amount of cooling water will be consumed.
- 7) When filling with the cooling water for the first time or replacing, the cooling water will enclose the air into the cooling water system. So, as the air in the cooling water system is made to bleed automatically during engine operation, the cooling water level in the radiator and sub-tank will be lowered. Replenish the cooling water into the radiator and sub-tank until it reaches the FULL mark of the sub-tank.

OPTION



Cooling water capacity :

L

- Daily check of the cooling water level and refilling can be done by observing the sub-tank. **OPTION**
Refer to 4.1(4)
- The cooling water capacity of the radiator **OPTION** depends on the machine unit.
Refer to the instruction manual provided by the equipment manufacturer. And write down the cooling water capacity above right blank to remember.
- Check the cooling water level when the engine is cold. Radiator cooling water flows to the sub-tank when the radiator is still hot and makes accurate checks impossible.
- Check radiator and hoses for leakage.

3.5 Checking the Engine Oil and Cooling Water

When engine oil or cooling water is supplied for the first time or replaced, run the engine for a while and check the oil and water levels again.

The apparent levels go down because of being distributed to the engine oil passages and self-bleeding air in the cooling water system.

Refill with engine oil and cooling water until they reach the specified level.

(When checking the engine oil again after engine running, wait for about 10 minutes and then check the level as it takes a while for engine oil adhered to the engine internal parts to return to the oil pan.)

- For refilling with engine oil, refer to section 3.3.
- For refilling with cooling water, refer to section 3.4.

4. OPERATION INSTRUCTIONS

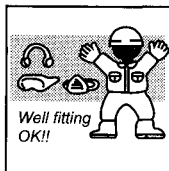
This section describes the procedures for starting, adjusting the speed and stopping the engine and the preparation before keeping the engine in storage for a long time.

⚠ WARNING

Never operate the engine while you are under the influence of alcohol

- Also, never operate the engine when you are ill or feel unwell as this results in unexpected accidents.

⚠ CAUTION



Safe work clothing

- Appropriate safety wear (gloves, special shoes / boots, eye / ear protection, head gear, harness' clothing, etc.) should be used / worn to match the task at hand. Avoid wearing jewelry, unbuttoned cuffs, ties or loose fitting clothes around moving machinery. A serious accident may occur if caught in moving / rotating machinery.
- Do not operate the engine and machine unit wearing earphone or headphone to listen to music or radio. A serious accident may occur because it is difficult to hear a warning from outside.

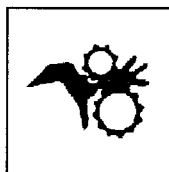
⚠ WARNING



Preventing exhaust fumes inhalation

- Never block up windows, ventilation ports, or other ventilation equipment such as ventilators of the engine room. Ensure good ventilation during engine operation. Inhaling the exhaust fumes is harmful.
- Never operate the engine in a closed room, tunnel, underground room, manhole or ship's hold. It is dangerous since exhaust fumes cannot get out.

⚠ WARNING



Keep away from moving / rotating parts

- Pay sufficient attention so as not to touch moving rotating parts, or bring your hands or part of your body or clothes close to moving / rotating parts while the engine is running. Otherwise, you may get injured by being caught by the cooling fan, flywheel or PTO shaft. Never operate the engine without covers on the moving / rotating parts. Also, always keep kids and pets away from the engine (machine unit).
- Check before starting the engine to see that any tools or cloths used in the maintenance have been removed from the area.

⚠ CAUTION



Preventing burn from contacting with hot surface

- Pay sufficient attention not to bring part of your hand and body or clothes in contact with the silencer, exhaust pipe, turbocharger and engine body during operation or shortly after stopping the engine. The whole engine is hot and scalding / serious burns may result.
- Carry out cooling down engine running for 5 minutes without load before the engine has been stopped. Sudden shutting the engine down without any cooling down running causes the engine and around temperature to rise rapidly. Scalding / serious burns or fires may result.

4.1 Check before Daily Operation

Be sure to check the following points before starting the engine every day.

(1) Visual check around engine. If any problem is found, do not use before the engine repairs have been completed.

- Oil leak from the lubrication system
- Fuel leak from the fuel system
- Cooling water leak from the cooling water system
- Damaged parts
- Loosened or lost bolts
- Fuel, radiator rubber hoses cracked, loosened clamp

(2) Checking and refueling

Check the remaining fuel oil level in the fuel tank and refuel the recommended fuel if necessary.

(3) Checking and replenishing engine oil

- 1) Check the engine oil level with the dipstick.
- 2) If the remaining engine oil level is low, replenish the specified engine oil to the specified level through the filler port. Replenish the oil to the upper limit mark while checking the level with the dipstick gauge. See 3.3

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(4) Checking and replenishing cooling water

⚠ DANGER



Burns from scalding

- Never open the radiator filler cap while the engine and radiator are still hot. Steam and hot water will spurt out and seriously burn you. Wait until the radiator is cooled down after the engine has stopped, wrap the filler cap with a rag piece and turn the cap slowly to gently release the pressure inside the radiator.
- Securely tighten the filler cap after checking the radiator. Steam can spurt out during operation, if the cap is tightened loosely.

- 1) Check the cooling water level in the sub-tank. If the water level is close to the LOW mark, open the sub-tank cap and replenish clean soft water to the FULL mark.
- 2) If the sub-tank water level is lower than the LOW mark, open the radiator cap and check the cooling water level in the radiator. Replenish the cooling water into the radiator and sub-tank if the level is low. Refer to 3.4
 - Check the cooling water level while the engine is cool. Checking when the engine is hot is dangerous. And the water volume is expanded due to the heat.
 - Daily cooling water level check and replenishing shall be done only at the sub-tank. If the cooling water is close to the LOW mark, open the sub-tank cap and replenish only clean soft water to the FULL mark. Usually do not open the radiator cap to check or replenish.

IMPORTANT:

If the cooling water runs short quickly or when the radiator runs short of water with the sub-tank level unchanged, water may be leaking or the air tightness may be lost. In such case, please contact your dealer.

Increase in the sub-tank water level during operation is not abnormal.

The increased water in the sub-tank returns to the radiator when the engine is cooled down.

(5) Checking accelerator operation

Make sure the accelerator of the machine unit can be operated smoothly before starting the engine. If it feels heavy to manipulate, lubricate the accelerator cable joints and pivots. Adjust the accelerator cable if there is a dislocation or excessive play between the accelerator and the governor lever. Refer to 5.3.3(3)

(6) Checking alarm operation

Before and after starting the engine, check to see the alarm function normally. Failure of alarm cannot warn the lack of the engine oil or the cooling water. Make it a rule to check the alarm operation before and after starting engine every day. Refer to 4.2

4.2 Checking the Control Panel and Alarm Devices

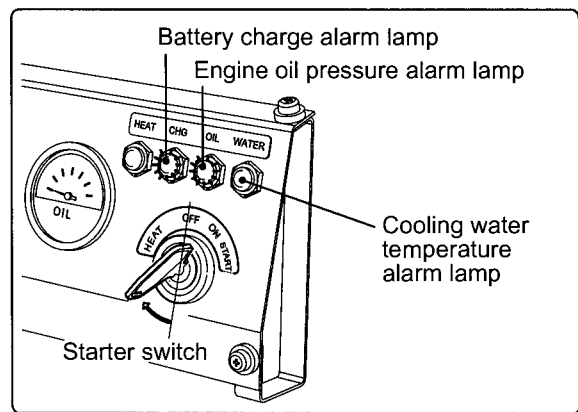
Be sure to check the alarm devices and other instruments on the panel before and after starting the engine. If the devices are not working properly, it is impossible to prevent any problems arising from insufficient oil and water in the engine. Make checking the alarm and other devices before and after starting a regular practice.

4.2.1 Checking alarm lamps

- 1) Insert the key into the starter switch.
- 2) Turning the key to the ON position, the alarm devices function as follows.
 - Battery charge alarm lamp comes on.
 - Engine oil press. alarm lamp comes on.
 - Cooling water temp. alarm lamp does not come on.

When the lamps function as above, everything is normal.
- 3) When the key is turned to the START position to start the engine and then returned to the ON position after the engine starting up. the alarm devices function as follows.

All alarm lamps go off. After the engine starts up make it the rule to check alarm devices. If they do not work normally, contact your dealer.



Function of alarm devices		
Alarm lamps	Key operation	
	OFF → ON	START → ON
Battery charge alarm lamp	ON	OFF
Engine oil pressure alarm lamp	ON	OFF
Cooling water temperature alarm lamp	OFF	OFF

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4.2.2 Checking the instruments (meters)

Before starting the engine, the needles of the meters are on the left side end. After starting the engine, the needles indicate the engine running conditions. Check the engine running conditions.

Ⓐ Tachometer

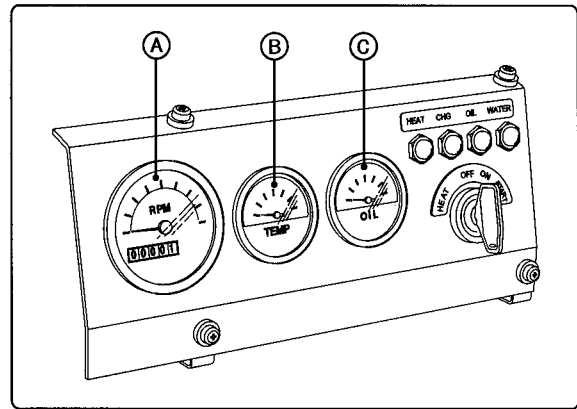
The needle indicates the engine speed in response to the running speed.

Ⓑ Cooling water temperature meter

The needle indicates the cooling water temperature.

Ⓒ Engine oil pressure meter

The needle indicates the engine oil pressure.



4.3 Starting

⚠ DANGER



Preventing fire

- Start the engine only from a starter switch without any load or in neutral position of the clutch of machine unit. Starting by means of connecting with the terminals of starter motor using a screwdriver or the like (jumping start) may cause fire due to spark at the terminals of starter motor. Also, the machine unit suddenly starts to move or generates power to cause serious personal injury.

⚠ WARNING



Keep away from moving / rotating parts

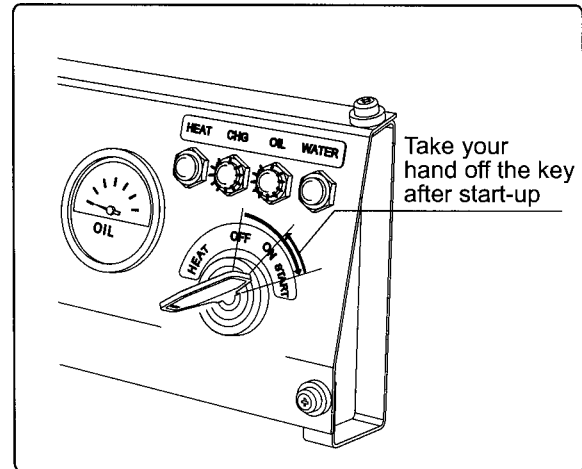
- Check before starting the engine to see that any tools or cloths used in the maintenance has been removed from the area.
- Pay sufficient attention so as not to touch moving / rotating parts, or bring your hands or part of your body or clothes close to moving / rotating parts while the engine is running.

Otherwise, you may get injured by being caught by the cooling fan, fly-wheel or PTO shaft. Never operate the engine without covers on the moving / rotating parts. Also, keep kids and pets away from the engine (machine unit).

4.3.1 Daily starting the engine procedure

Start the engine as shown below.

- 1) Place in neutral position of the clutch or turn the main switch OFF to release the load on machine unit.
- 2) Open the cocks of the oil / water separator and fuel tank.
- 3) Insert the key into the starter switch.
- 4) Turn the key from the OFF to the ON position. Check all alarms are normal. Refer to 4.2.1
- 5) Set the accelerator (Governor lever) on the middle speed position.
- 6) Turn the key to the START position to start the engine. Release the key as soon as the engine starts. The key automatically returns to the ON position. If the engine does not start, turn the key to the OFF position first before trying to start again.



IMPORTANT:

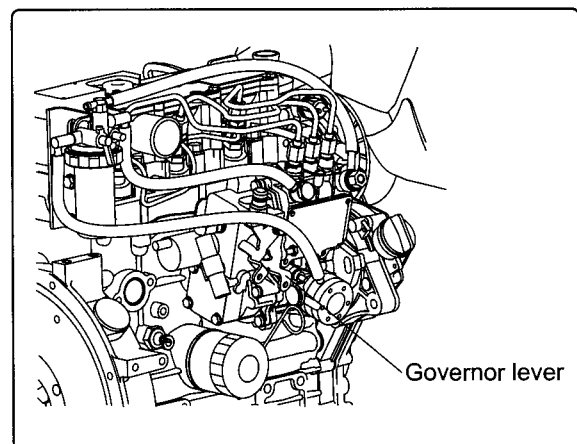
Do not hold the key at the START position for more than 15 seconds at a time. Any longer attempt will overheat the starter motor.

4.3.2 Warming up running

After the engine has started, make sure to run for 5 minutes at an even low engine speed and without any load. On load running while the engine is cold causes to emit black exhaust smoke and shortens engine life as this engine has the device automatically adjusting the fuel injection quantity and timing by detecting the cooling water temperature. While warming up running, check the engine for any abnormal sound.

IMPORTANT:

Do not race the engine while it is cold.



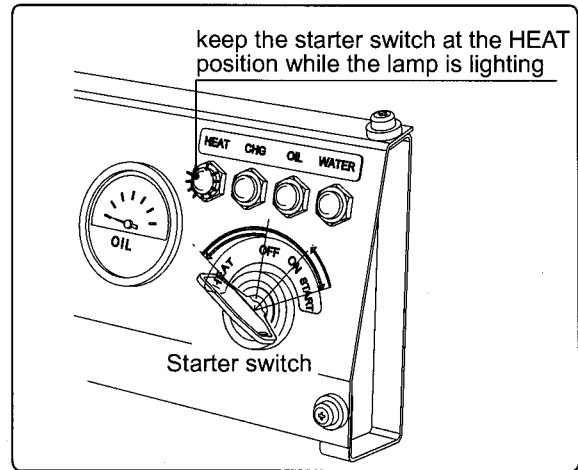
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4.3.3 Starting up the engine at low ambient temperature

If the engine is hard to start in cold weather (approx. 0°C or below), use the air heater **OPTION** for easier starting. Follow steps 1) to 4) of the previous mentioned procedure and then follow the steps below.

- 5) Set the accelerator on the maximum speed position.
- 6) Turning the key from the OFF to the HEAT position, the HEAT lamp (blue colored) **OPTION** comes on. Keep the key in the HEAT position while the lamp is lighting.
- 7) When the air heater is heated up after about 4 seconds, the lamp goes off to turn the key to the START position. Remove your hand from the key as soon as the engine starts, and the key returns to the ON position by itself.



IMPORTANT:

- Do not leave the glow plugs on for longer than 10 seconds at a time. Leaving the air heater on for longer periods of time will result in damage.
- Never use a engine start aiding liquid such as gasoline, ether. They will result in engine damage.

4.3.4 Restarting after starting failure

When attempting to restart the engine after starting failure, be sure that the engine is at a complete stop before turning the key.

IMPORTANT:

- Do not turn the key to the START position when the engine is not completely stopped or during operation. Otherwise, the starter motor pinion or ring gear will be damaged.
- Wait at least 30 seconds before the second attempt to allow for battery voltage recovery.

4.3.5 After the engine has started

After the engine has started, warm up the engine (refer to 4.3.2) and check the following points. If any abnormality, stop the engine and contact your dealer.

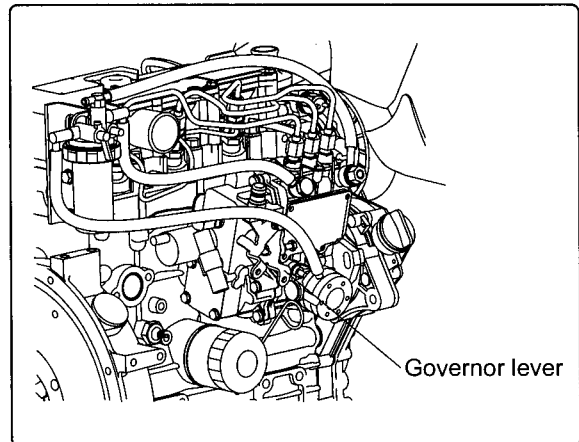
- Alarm lamps and instruments
- Water leak and oil leak from engine
- Color of exhaust gas
- Vibration or noise

4.4 Adjusting the Engine Speed

The engine speed is controlled by the governor lever. It is linked with the accelerator system on the machine unit side (accelerator handle and pedal to be procured by the equipment manufacturer) by means of an accelerator wire for remote control.

IMPORTANT:

For a new engine, be especially careful not to change engine speed abruptly or attach a heavy load for the first 50 hours of operation. Failure to do so may result in damage and shorten the life of the engine.



4.5 Check during Operation

Watch the following points to check the engine conditions.

- Exhaust gas color

Avoid engine operation if black smoke continues to come out. Black smoke is generated when the engine is overloaded. This shortens the engine life.

- Abnormal noise or vibration

Depending on the machine unit structure, resonance may arise at a certain engine speed, resulting in sudden violent vibration. Avoid engine operation near that speed.

- Alarm lamps

If an alarm lamp comes on, do not be flurried but decrease the engine speed and remove the load on the engine. Then, stop the engine, check the cause and take the necessary action.

- Water, oil or gas leakage, or loosened bolts

Occasionally check the engine and its peripheral parts for any symptom of leakage or loosened bolt.

- Low fuel level in tank

Always replenish fuel before the level drops too low during operation.

IMPORTANT:

- Allowable inclined engine operation : 25 deg. max. (both tossed and rolled side)

Excess inclined engine operation may result in white exhaust smoke, sudden over engine speed or engine internal damage, getting engine oil into the intake port. Operate the engine on a place as level as possible.

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- *Avoid low load running as much as possible. When operating at low load, operate at 1/4 load or greater. If it continues for a long time, carbon will mix in with the unburned fuel depositing the piston head, injection nozzle and exhaust pipe to cause engine trouble.*
- *Do not turn the key to the START position while engine running. Otherwise, the starter motor pinion or ring gear will be damaged.*

4.6 Stopping the Engine

⚠ CAUTION



- Pay sufficient attention not to bring part of your hand and body or clothes in contact with the silencer, exhaust pipe, turbocharger and engine body during operation or shortly after stopping the engine.
The whole engine is hot and may cause scalding / serious burns.
- Carry out the cool-down running for 5 minutes without load before the engine has been stopped. Suddenly shutting the engine down without any cool-down running causes the engine and around temperature to rise rapidly. Scalding / serious burns or fires may result.

Stop the engine in accordance with the following procedures.

- 1) Remove the load on the engine by disengaging the clutch or turning the main switch off.
- 2) Set the accelerator (governor lever) to the LOW speed position and carry out cool-down running for 5 minutes.
- 3) Turn the key to the OFF position to stop the engine. Remove the key from the starter switch and place it in a safe place.
- 4) Close the cock of the fuel tank.

IMPORTANT:

- *If the engine is stopped immediately after removing load, the temperature of engine parts will rise suddenly, and this could cause engine trouble.
Always operate the engine without load at low speed for 5 minutes.*
- *When letting the engine (machine unit) leave in open air after operating, place on the level kept away from flammable material such as straws, withered grass as this could result in ignition. And after cooling the engine (machine unit) thoroughly, cover it with airtight plastic covers to protect the air cleaner, silencer and electrical parts (alternator, starter motor, switches, etc.) from water and dust.*

4.7 Taking Care during Long-term Storage

When the engine is to be stored for a long time (3 months or more), take the following care for the next use.

4.7.1 Inspection and maintenance during long-term storage

(1) Periodic check

If the next periodic check is drawing near, carry out the inspection before storage.

(2) Cooling water

Be sure to be clean soft water added Long Life Coolant Antifreeze (LLC) in the cooling water system and do not drain the cooling water added LLC before long-term storage.

If drain the cooling water, it will cause to built up rust due to the residual water in the cooling water system.

(3) Exterior cleaning, fuel oil draining and greasing

- Clean the outside of the engine wiping off any dust or oil.
- To prevent condensation of moisture inside the fuel tank, either drain off the fuel oil or fill the tank with fuel oil.
- Grease the exposed area and joints of the accelerator system.

(4) Water - and dust - proofing

- Protect the air cleaner, silencer and electrical parts (alternator, starter motor, switches) from water and dust with airtight plastic covers.
- Store the engine at a well ventilated place not subject to high moisture or dust.

(5) To prevent the battery self-discharging

- Disconnect the negative terminal (-) of the battery during storage.
- To refill self-discharge from the battery, charge the battery at least once a month during storage.

4.7.2 Checking the engine for reuse after long storage period

When using the engine after a long period of storage, prepare for operation in the same manner as for a new engine. And warm up the engine to distribute the engine oil to all of the parts in the same manner as for daily start the engine. Refer to 3. BEFORE OPERATION, 4. OPERATION INSTRUCTIONS.

WARNING



*Never run the engine in poorly ventilated room storing it.
Inhalation of exhaust fumes may be hazardous ones health and may cause a fire hazard.*

5. MAINTENANCE

5.1 Precaution for Inspection

Be sure to perform periodic checks.

The engine deterioration and degradation proceed in proportion to its service conditions and service hours. Leaving deterioration and degradation may cause an unexpected malfunction which interferes with your work an increase in consumption of the fuel and engine oil, or an increase in exhaust gas problems or noise, and result in shortening the life of the engine. Perform routine periodic checks and maintenance to prevent accidents from occurring. Also, perform the checks at a spacious and level place and free from traffic.

Never fail to start-up inspection.

Routine periodic checks are based on start-up inspections. Make a habit of performing the start-up inspections before initial start up for the day. Refer to the section 4.1 Check before Daily Operation.

Keep a record of daily operation to perform the periodic checks.

Keep a record of daily operation and the results of maintenance work. Periodic check intervals are established every 50, 250, 500, 1000 and 2000 service hours. Be sure to perform a periodic check after each set-up interval.

Always use genuine Isuzu parts.

Always use genuine Isuzu parts when replacing consumables. The use of replacement parts which are not genuine may degrade the engine performance or shorten its life.

Have a set of maintenance tool always ready.

Have a set of maintenance tool always ready for checking the machinery.

Ask for our help with periodic checks and maintenance work.

Our professional engineers with good expertise and skills will help you with maintenance, inspection and servicing. Consult your dealer.

Tightening torque for bolts and nuts

Applying excessive tightening torque to a bolt or nut may loosen or damage a tightened part, and too small tightening torque may cause a oil leak from the mounting surface or a loose bolt, which leads to component failure. On essential parts, bolts and nuts should be tightened with an accurate tightening torque using a torque wrench in a correct way and correct order.

When removing parts is required for maintenance, consult your dealer.

The followings are the standard tightening torque for standard bolts and nuts.

IMPORTANT:

The tightening torque described below should be applied only to the bolts with "7" on their head. (JIS strength classification: 7T)

- Apply 60% tightening torque for the bolts which do not appear here.
- Apply 80% tightening torque when tightened to aluminum alloy.



Thread size × Pitch mm	M6×1.0	M8×1.25	M10×1.5	M12×1.75	M14×1.5	M16×1.5
Tightening torque N•m (kgf•m)	10.8±1.0 (1.1±0.1)	25.5±2.9 (2.6±0.3)	49.0±4.9 (5.0±0.5)	88.3±9.8 (9.0±1.0)	137±9.8 (14.0±1.5)	226±9.8 (23.0±2.0)

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5.2 List of Periodic Inspections

Daily and periodic inspections are important to keep the engine in its best condition. The following is a summary of inspection and servicing items by inspection interval. Periodic inspection intervals vary depending on the use, loads, fuels and engine oils used and handling conditions, and are hard to establish definitively. The following should be treated only as a general standard.

IMPORTANT:

Establish a periodic check plan according to the operating conditions and make sure to conduct checks at specified intervals. Otherwise, malfunctioning may occur to shorten the engine life.

As special knowledge and skill are required for items marked with ●, consult your dealer or Isuzu distributor.

○: Check ◇: Replace ●: Contact your dealer

System	Check item	Daily	Periodic inspection interval				
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 2000 hours
Fuel oil	Fuel tank oil level check and refill	○					
	Draining from fuel tank		○				
	Draining from oil / water separator		○				
	Cleaning oil / water separator				○		
	Fuel filter replacement				◇		



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System	Check item	Daily	Periodic inspection interval				
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 2000 hours
Engine oil	Engine oil level	○					
	Engine oil replacement		◇	◇			
	Engine oil filter replacement		1st time	2nd & after			
Cooling water	Check & addition cooling water	○					
	Radiator fin checking & cleaning			○			
	Cooling fan V-belt checking & adjusting		○ 1st time	○ 2nd & after			
	Cooling water replacement				◇ or every 1 yr.		
	Cooling water path flushing & maintenance						●
Rubber hoses	Fuel & cooling water pipe replacement						● or every 2 yrs.
Operating system	Governor lever & accelerator check & adjust	○		○			
Intake & exhaust	Air cleaner element cleaning & replacement			○	◇		
	Turbocharger blower washing *					●	
Electrical equipment	Alarm operation check	○					
	Battery electrolyte check & recharging		○				
Cylinder head	Adjust intake / exhaust valve clearance					●	
	Lapping intake / exhaust valve seats						●

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System	Check item	Daily	Periodic inspection interval				
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 2000 hours
Fuel valve, pump *	Check fuel injection valve pressure & adjust					●	
	Check & adjust fuel injection pump						●

*The specific emissions related parts for the EPA/ARB regulations.

EPA allows to apply Maintenance schedule for Emission related parts as follows.

—	Check Fuel Valve Nozzle and clean	Adjust, cleaning and repair of Fuel injection Pump and Fuel Valve Nozzle
kW ≤ 130	1500 hours of use and at 1500-hour intervals thereafter	3000 hours of use and at 3000-hour intervals thereafter

5.3 Periodic Inspection Items

5.3.1 Inspection after initial 50 hours operation

(1) Replacing the engine oil and engine oil filter (1st time)

⚠ CAUTION



When the engine oil is still hot, be careful with a splash of engine oil which may cause burns. Cool the engine to replace engine oil until the engine oil becomes warm. It is most effective to drain the engine oil while the engine is still warm.

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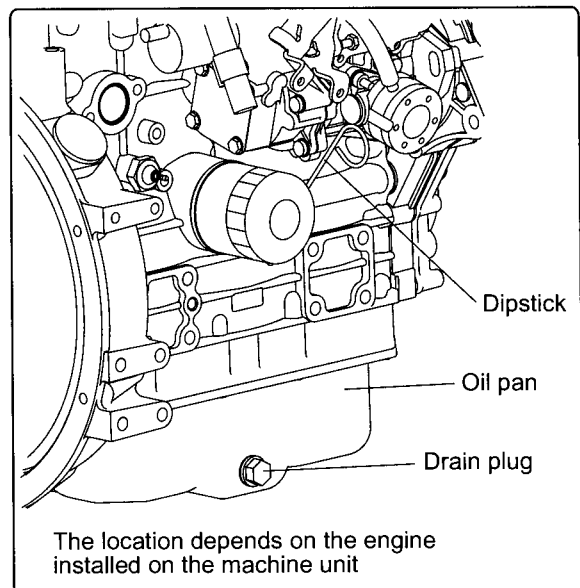
In early period of use, the engine oil gets dirty rapidly because of the initial wear of internal parts. Replace the engine oil earlier.

Engine oil filter should also be replaced when the engine oil is replaced.

Engine oil and engine oil filter replacing procedures are as follows.

Remove the oil filler cap to drain easily while draining the engine oil.

- 1) Prepare a waste oil container collecting waste oil.
 - 2) Loosen the drain plug using a wrench (customer procured) to drain the engine oil.
 - 3) Securely tighten the drain plug after draining the engine oil.
 - 4) Turn the engine oil filter counter-clockwise using a filter wrench (customer procured) to remove it.
 - 5) Clean the engine oil filter mounting face.
 - 6) Moisten the new engine oil filter gasket with the engine oil and install the new engine oil filter manually turning it clockwise until it comes into contact with the mounting surface, and tighten it further to 3/4 of a turn with the filter wrench.
- Tightening torque: 20~24N•m (2.0~2.4kgf•m)



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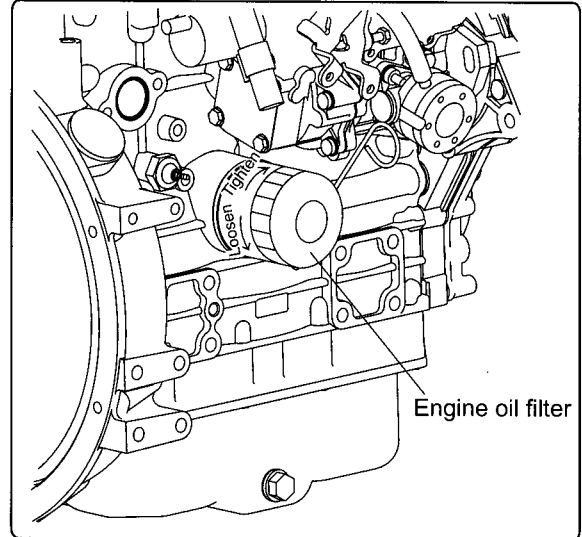
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- 7) Fill with the new engine oil until it reaches the specified level as explained in section 3.3.

IMPORTANT:

*Do not overfill the oil pan with engine oil.
Be sure to keep the specified level between upper and lower limit on the dipstick.*

- 8) Warm up the engine by running for 5 minutes while checking any oil leakage. (Refer to 4.3.2 Warming up running)
- 9) Stop the engine after warming up and leave it stopping for about 10 minute to recheck the engine oil level with dipstick and replenish the engine oil. If any oil is spilled, wipe it away with a clean cloth.



(2) Checking and adjusting cooling fan V-belt

When there is not enough tension in the V-belt, the V-belt will slip making it impossible for the alternator to generate power and cooling water pump and cooling fan will not work causing the engine to overheat.

Check and adjust the V-belt tension (deflection) in the following manner.

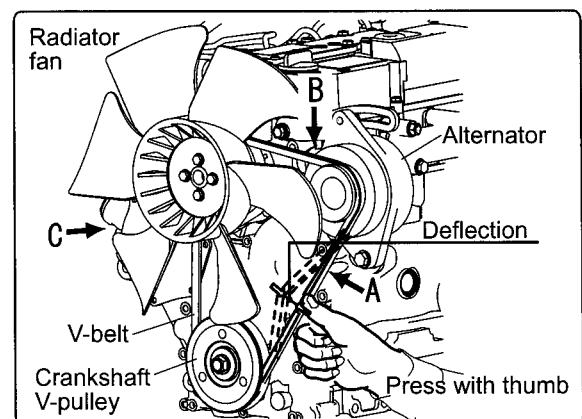
- 1) Press the V-belt down with your thumb [approx. 98N(10kgf)] at the middle of the V-belt span to check the tension (deflection).

Available positions to check and adjust the V-belt tension (deflection) are at the A, B and C showing with the arrow direction as shown illustration right.

You may choose a position whichever you can most easily carry out the check and adjustment on the machine unit.

The specified deflection to be measured at each position should be as follows.

A	B	C
10~14 mm	7~10 mm	9~13 mm



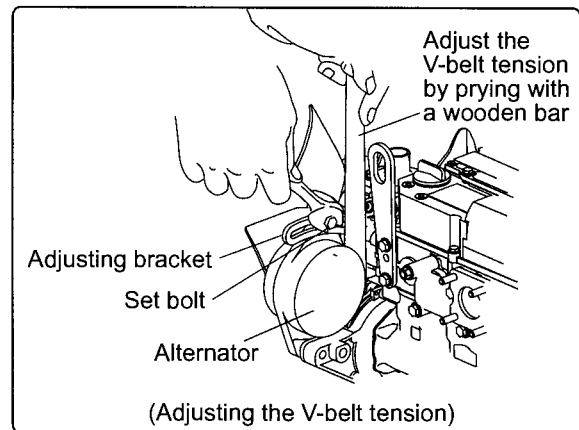
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- 2) If necessary, adjust the V-belt tension (deflection). To adjust the V-belt tension, loosen the set bolt and move the alternator to tighten the V-belt.
- 3) Visually check the V-belt for cracks, oiliness or wear. If any, replace the V-belt with new one.
 - "New V-belt" refers to a V-belt which has been used less than 5 minutes on a running engine.
 - "Used V-belt" refers to a V-belt which has been used on a running engine for 5 minutes or more.

Install the new V-belt adjusting the deflection to the value in the table below according to the above manner. After adjusting, run the engine for 5 minutes and readjust the deflection to the value in the table above.

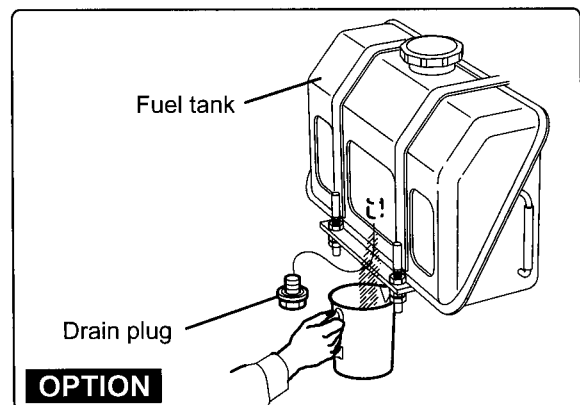
A	B	C
8~12 mm	5~8 mm	7~11 mm



5.3.2 Inspection every 50 hours operation

(1) Draining of the fuel tank

- 1) Prepare a waste oil container.
- 2) Loosen the drain plug of the fuel tank to drain (water, dust, etc.) from the fuel tank bottom.
- 3) Drain until fuel with no water and dust flow out. Then tighten the drain plug firmly.



(2) Draining of the oil/water separator

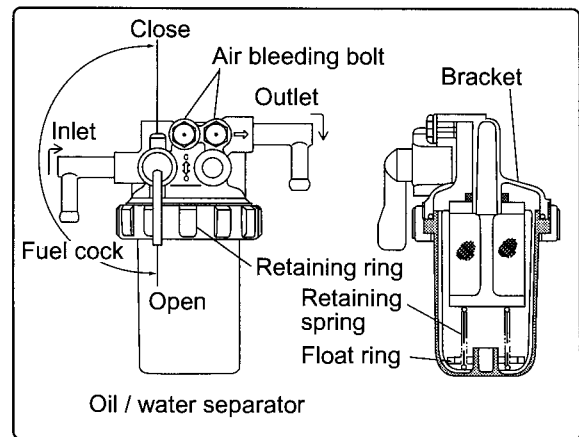
Drain off the oil/water separator whenever there is a lot of drain collected in the oil/water separator at the bottom of the cup even if not the time for periodic inspection hour. The cup of the oil/water separator is made from semi-transparency material and in the cup, the red colored float ring which rises on the surface of the drain is installed to visualize the amount of drain.

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Drain off the oil/water separator in the following manner.

- 1) Prepare a waste oil container.
- 2) Close the fuel cock.
- 3) Turn the retaining ring counter-clockwise and remove the cup and put the drain into a waste oil container to dispose properly. Keep the retaining spring and float ring at hand. (When removing the cup, hold the bottom of the cup with a piece of rag to prevent the fuel oil from dropping. If you spill fuel, wipe off the spillage completely.)
- 4) Wash the cup inside with clean fuel oil.
- 5) Put the retaining spring and float ring in the cup and then install it to the bracket by tightening the retaining ring clockwise.
Tightening torque: 13~16N·m (1.3~1.6kgf·m)
- 6) Be sure to bleed air in the fuel system.
Refer to 3.2.2



(3) Inspection of battery



WARNING

Fire due to electric short-circuit

- Make sure to turn off the battery switch or disconnect the negative cable (-) before inspecting the electrical system. Failure to do so could cause short-circuiting and fires.
- Always disconnect the (-) Negative battery cable first before disconnecting the battery cables from battery. An accidental "Short circuit" may cause damage, fire and or personnel injury.
And remember to connect the (-) Negative battery cable (back onto the battery) LAST.



Proper ventilation of the battery area

Keep the area around the battery well ventilated, paying attention to keep away any fire source. During operation or charging, hydrogen gas is generated from the battery and can be easily ignited.



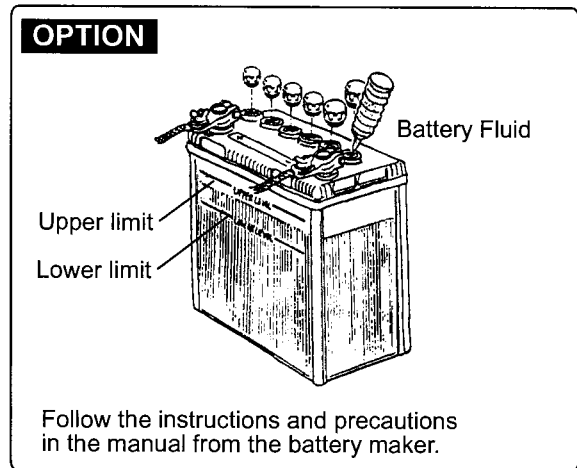
Do not come in contact with battery electrolyte

Pay sufficient attention to avoid your eyes or skin from being in contact with the fluid. The battery electrolyte is dilute sulfuric acid and causes burns. Wash it off immediately with a large amount of fresh water if you get any on you.

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- Check the level of fluid in the battery.
When the amount of fluid nears the lower limit, fill with battery fluid (available in the market) to the upper limit. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode.
- Battery fluid tends to evaporate more quickly in the summer, and the fluid level should be checked earlier than the specified times.
- If the engine cranking speed is so slow that the engine does not start up, recharge the battery.
- If the engine still will not start after charging, replace the battery.
- Remove the battery from the battery mounting of the machine unit after daily use if letting the machine unit leave in the place that the ambient temperature could drop at -15°C or less. And store the battery in a warm place until the next use the unit to start the engine easily at low ambient temperature.



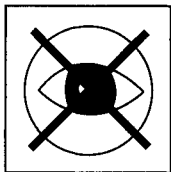
5.3.3 Inspection every 250 hours operation

(1) Replacing the engine oil and engine oil filter (2nd time and after)

Replace the engine oil every 250 hours operation from 2nd time and on. Replace the engine oil filter at the same time. Refer to 5.3.1(1).

(2) Checking and cleaning radiator fins.

CAUTION



Beware of dirt from air blowing

Wear protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can hurt eyes.

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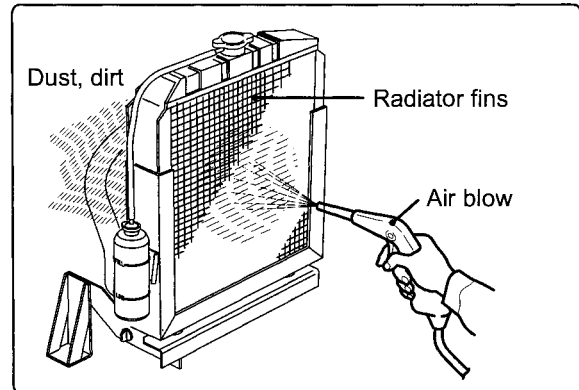
MAC 6000 Hydronic Heater

Dirt and dust adhering on the radiator fins reduce the cooling performance, causing overheating. Make it a rule to check the radiator fins daily and clean as needed.

- Blow off dirt and dust from fins and periphery with compressed air [0.19MPa (2kgf/cm²) or less] not to damage the fins with compressed air.
- If contaminated heavily, apply detergent, thoroughly clean and rinse with tap water shower.

IMPORTANT:

Never use high pressure water or air from close by fins or never attempt to clean using a wire brush. Radiator fins can be damaged.



(3) Checking and adjusting the governor lever and accelerating device

The governor lever and accelerating devices (accelerating lever, pedal, etc.) of the machine unit are connected by an accelerating wire or rod. If the wire becomes stretched or the connections loosen, the deviation in the position may result and make operation unsafe. Check the wire periodically and adjust if necessary. Consult your dealer for the adjustment.

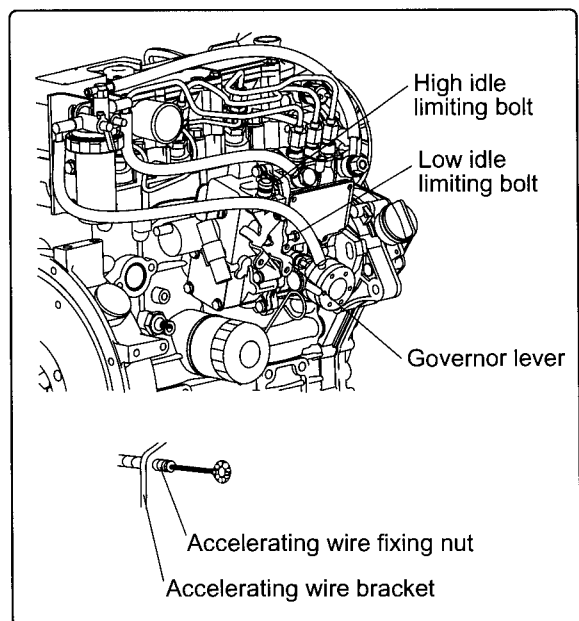
Do not strongly move the accelerating wire or accelerating pedal. It may deform the governor lever or stretch the wire to cause irregular engine speed control.

Checking and adjusting procedures are as follows.

- 1) Check that the governor lever of the engine makes uniform contact with the high idling and low idling limiting bolt when the accelerating devices is in the high idling speed or low idling speed position.
- 2) If either the high or the low idling speed side does not make contact with the limiting bolt, adjust the accelerating wire.
Loosen the accelerating wire fixing nut and adjust the wire to contact with the limiting bolt.

IMPORTANT:

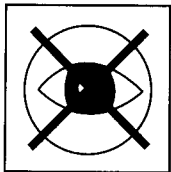
Never release the limiting bolts. It will impair the safety and performance of the product and functions and result in shorter engine life.



(4) Air cleaner element cleaning

⚠ CAUTION

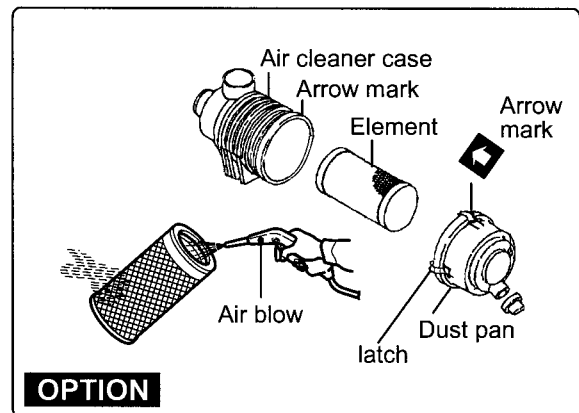
Beware of dirt from air blowing



Wear protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can hurt eyes.

The engine performance is adversely affected when the air cleaner element is clogged by dust. So periodical cleaning after disassembly is needed.

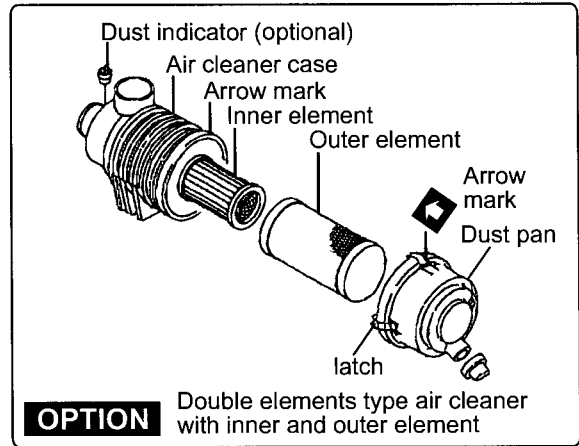
- 1) Undo the latches on the dust pan and remove the dust pan.
- 2) And then pull out the element.



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- 3) Blow air [0.29~0.49MPa (3.0~5.0kgf/cm²)] from inside the element to blow dust off as shown the illustration right. Apply the air blowing pressure as low as possible so as not to damage the element. If having the air cleaner with double elements, never remove and clean the inner element. The aim of installing the inner element is for back up protecting from intaking dust during engine running when leaving the outer element to reinstall after removing to clean it or when damaging the outer element unexpectedly during engine running.
- 4) Replace the element with new one if the element is damaged, excessively dirty or oily.
- 5) Clean inside of the dust pan.
- 6) Reinstall the element inserting into the air cleaner case. And install the dust pan to the air cleaner case matching the arrow marks on the dust pan and air cleaner case, then fasten the dust pan with the latches.



IMPORTANT:

- When the engine is operated in dusty conditions, clean the element more frequently.
- Do not run the engine with removed air cleaner or element, as this may cause foreign material to enter and damage the engine.

(5) Checking and adjusting cooling fan V-belt (2nd time and after)

Check and adjust the cooling fan V-belt tension every 250 hours operation from 2nd time and on. Refer 5.3.1(2)

5.3.4 Inspection every 500 hours operation

(1) Replacing the air cleaner element

Replace the air cleaner element periodically even if it is not damaged or dirty.

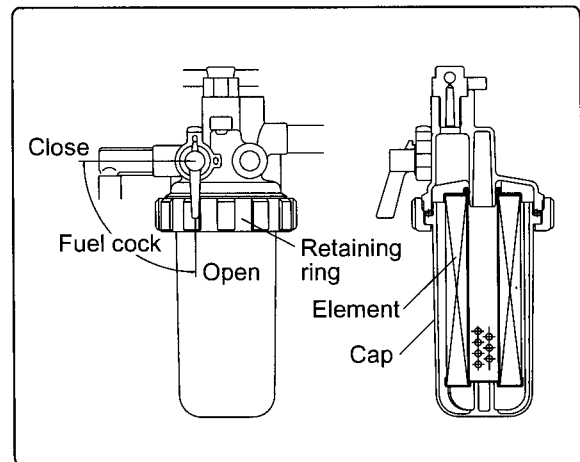
When replacing the element, clean the inside air cleaner case at the time.

If having the air cleaner with double elements, do not remove the inner element. If the engine output is still not recover (or the dust indicator still actuates if having the air cleaner with a dust indicator) even though the outer element has replaced with new one, replace the inner element with new one.

(2) Replacing fuel filter element

Replace the fuel filter element at specified intervals before, it is clogged with dust to adversely affect the fuel flow. Also, replace the fuel filter element after the engine has fully been cooled.

- 1) Prepare a waste oil container.
- 2) Close the fuel cock of the fuel filter.
- 3) Turn the retaining ring counter-clockwise and remove the cup. And put the drain in the cup into a waste container to dispose properly. (When removing the cup, hold the bottom of the cup with a piece of rag to prevent the fuel oil from dropping. If you spill fuel, wipe off the spillage completely.)
- 4) Remove the element (pull out downward) and replace with new one. And wash the cup inside with clean fuel oil.
- 5) Insert the new element to the bracket and install the cup to the bracket by tightening the retaining ring clockwise.
Tightening torque: 13~16N•m (1.3~1.6kgf•m)
- 6) Open the fuel cock and feed the fuel oil. Refer to 3.2.2,5



IMPORTANT:

Be sure to use genuine Isuzu part (super fine mesh filter). Otherwise, it results in engine damage, uneven engine performance and shorten engine life.

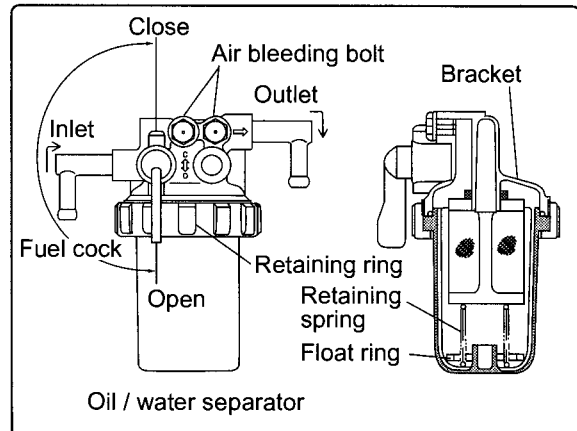
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(3) Cleaning oil/water separator

Periodically wash the oil/water separator element and inside cup with clean fuel oil.

- 1) Prepare a waste oil container.
- 2) Close the fuel cock.
- 3) Turn the retaining ring counter-clockwise and remove the cup. And put the drain in the cup into a waste oil container to dispose properly. Keep retaining spring and float ring at hand. (When removing the cup, hold the bottom of the cup with a piece of rag to prevent the fuel oil from dropping. If you spill fuel, wipe off the spillage completely.)
- 4) Remove the element (pull out downward). Wash the element and inside cup with clean fuel oil. Replace the element with new one if any damaged.
- 5) Insert the element to the bracket. Put the retaining spring and float ring in the cup and install in to the bracket by tightening the retaining ring clockwise. Tightening torque: $13\sim 16\text{N}\cdot\text{m}$ ($1.3\sim 1.6\text{kgf}\cdot\text{m}$)
- 6) Bleed the fuel system. Refer to 3.2.2

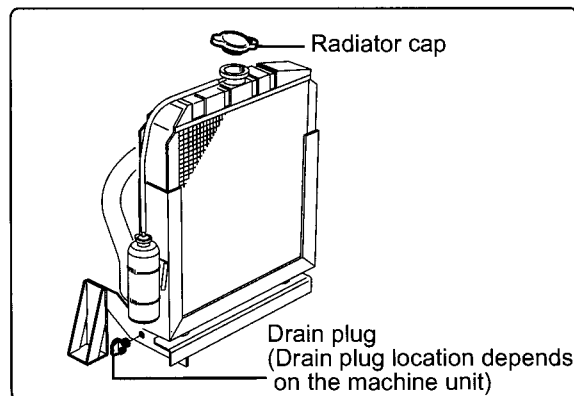


5.3.5 Inspection every 1000 hours operation

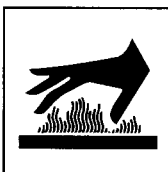
(1) Replacing cooling water

Cooling water contaminated with rust or water scale reduces the cooling effect. Even when antifreeze agent (LLC) is mixed, the cooling water gets contaminated due to deteriorated ingredients. Replace the cooling water at least once a year.

- 1) Remove the radiator cap.
- 2) Loosen the drain plug at the lower portion of the radiator and drain the cooling water.
- 3) After draining the cooling water, tighten the drain plug.
- 4) Fill radiator and engine with cooling water. Refer to 3.4



⚠ CAUTION



Beware of scalding by hot water

Wait until the temperature goes down before draining the cooling water. Otherwise, hot water may splash to cause scalding.

(2) Checking and adjusting the fuel injection valve

As the adjustment requires specialized knowledge and skill, consult your dealer. This adjustment is needed to obtain the optimum injection pattern for full engine performance.

(3) Adjusting intake / exhaust valve clearance

As this adjustment requires specialized knowledge and skill, consult your dealer. The adjustment is necessary to maintain the correct timing for the opening and closing of valves. Neglecting the adjustment will cause the engine to run noisily and result in poor engine performance and other damage.

5.3.6 Inspection every 2000 hours operation

(1) Flushing the cooling system and checking the cooling system parts

As this maintenance requires specialized knowledge and skill, consult your dealer. Rust and water scale will accumulate in the cooling system through many hours of operation. This lowers the engine cooling effect. Cooling system parts: radiator, cooling water pump, thermostat, cylinder block, cylinder head.

(2) Checking and replacing fuel hoses and cooling water hoses

As this maintenance requires specialized knowledge and skill, consult your dealer. Regularly check the rubber hoses of the fuel system and cooling water system. If cracked or degraded, replace them with new one. Replace the rubber hoses at least every 2 years.

(3) Lapping the intake and exhaust valves

As this maintenance requires specialized knowledge and skill, consult your dealer. The adjustment is necessary to maintain proper contact of the valves and seats.

(4) Checking and adjusting the fuel injection timing

As this maintenance requires specialized knowledge and skill, consult your dealer.

5.3.7 Checking and adjusting the EPA emission related parts

The inspection and servicing require specialized knowledge and techniques. Consult your dealer or Isuzu distributor.

EPA allows to apply maintenance schedule for emission related parts as follows.

—	Check Fuel Valve Nozzle and clean	Adjust, cleaning and repair of Fuel injection Pump and Fuel Valve Nozzle
kW ≤ 130	1500 hours of use and at 1500-hour intervals thereafter	3000 hours of use and at 3000-hour intervals thereafter

6. TROUBLESHOOTING

In case of an abnormality, stop the engine immediately and locate a problem by referring to the following table.

SYMPTOM	PROBABLE CAUSE	ACTION	Ref. Section
Alarm lamps lighting during operation	IMPORTANT: When a alarm lamp lights, immediately stop the engine and check and remove the cause.		
• Engine oil pressure alarm lamp	Insufficient level of engine oil. Clogged engine oil filter	Replenish engine oil. Replace the filter element.	3.3 5.3.1(1)
• Cooling water Temp. alarm lamp	Low radiator cooling water level Contaminated radiator fins Leak of cooling water V-belt is loose or damaged Contaminated cooling water system Faulty cooling water pump	Replenish cooling water Clean the radiator fins Ask for repair Adjust V-belt or replace Ask for service Ask for repair	4.1(4) 5.3.3(2) — 5.3.1(2) — —
• Charge lamp	V-belt is loose or damage Battery failure Faulty alternator	Adjust V-belt or replace Check electrolyte recharge Ask for repair	5.3.1(2) 5.3.2(3) —
Faulty alarm lamp	IMPORTANT: If a alarm lamp is faulty, do not continue operation. Otherwise, faults will not be noticed, developing a serious accident.		
• Charge lamp, engine oil pressure lamp not coming on when starter switch is turned ON (OFF → ON)	Faulty electrical wiring or faulty lamp	Ask for repair	—

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SYMPTOM	PROBABLE CAUSE	ACTION	Ref. Section
• Charge lamp, engine oil pressure lamp not going off when starter switch is turned from START to ON (START → ON)	Faulty alternator or faulty engine oil pressure	Ask for repair	—
Failure to start			
• Starter motor works but engine does not start	No fuel	Replenish fuel, bleed	3.2
	Air in fuel system	Bleed	3.2.2
	Improper fuel	Replace with recommended fuel	3.1.1
	Clogged fuel filter	Replace fuel filter	5.3.4(2)
• Starter motor does not turn or turns too slowly (engine can be turned manually)	Poor fuel injection	Ask for repair	—
	Compressed air leakage from intake / exhaust valves	Ask for repair	—
	In sufficient battery charge	Check electrolyte, recharge	5.3.2(3)
• Cannot be turned manually	Faulty cable connection at battery terminals	Clean terminals, retighten	—
	Faulty starter switch	Ask for repair	—
	Faulty starter motor	Ask for repair	—
• Cannot be turned manually	Inner parts seized or damaged	Ask for repair	—
Poor exhaust gas color			
• Black smoke	Overloaded	Reduce load	—
	Clogged air cleaner element	Clean element or replace	5.3.3(4)
	Improper fuel	Replace with recommended fuel	5.3.4(1)
	Faulty spraying of fuel injection	Ask for repair	3.1.1
Excessive intake / exhaust valve clearance	Ask for repair	—	—
	Ask for repair	—	—

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SYMPTOM	PROBABLE CAUSE	ACTION	Ref. Section
• White smoke	Improper fuel	Replace with recommended fuel	3.1.1
	Faulty spraying of fuel injection	Ask for repair	—
	Fuel injection timing delay	Ask for repair	—
	Engine oil burning	Ask for repair	—

TROUBLESHOOTING INFORMATION

If your engine is not working normally, check it referring to the troubleshooting section.

You can of course consult your dealer.

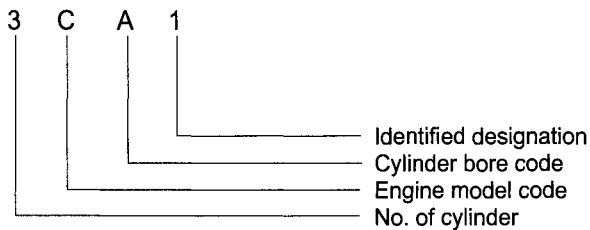
When asking the service, please give the following information to your dealer:

- Model name and serial number of your engine
- The machine unit type, manufacturers name, model and serial number.
- Operating conditions. Which speed or work has brought a problem.
- How long have you used your engine? (Approximate area worked or hours of operation)
- Situation when a trouble is developed
Engine revolution, color of exhaust gas, fuel in use, engine oil type, engine sound, etc.
- History of troubles
- Any other information when a trouble has occurred.

7. ENGINE SPECIFICATIONS

7.1 General

- Description of model name



- Engine speed specifications

Notation	Available engine speed min^{-1}	Intended uses
VM	3200 ~ 3600	Lawn mower, constructive, industrial machine
CL	2000 or 3000	Agricultural, constructive, industrial machines, etc.
CH	3000 or 3600	2-pole generator sets, irrigation pumps
CL	1500 or 1800	4-pole generator sets, irrigation pumps, etc.

VM: Variable, Medium speed, VH: Variable High speed

CL: Constant Low speed, CH: Constant High speed

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• Engine general specifications

Type	Vertical inline water cooled 4-cycle diesel engine
Combustion system	Swirl chamber (ball type)
Starting system	Electric starting
Cooling system	Radiator
Lubricating system	Forced lubrication with trochoid pump
P.T.O position	Flywheel end
Direction of rotation	Counter-clockwise (viewed from flywheel side)

NOTE:

- 1) *The information described in the principal engine specifications (the next page and after) is for "standard" engine. To obtain the information for the engine installed in your machine unit, please refer to the manual provided by the equipment manufacturer.*
- 2) *Engine rating conditions are as follows (SAE J1349, ISO 3046/1)*
 - *Atmospheric condition: Room temperature 25°C, Atmospheric pressure 100 kPa (750mm Hg), Relative humidity 30%*
 - *Fuel temperature: 25°C (Fuel injection pump inlet)*
 - *With cooling fan, air cleaner, exhaust silencer (Isuzu standard)*
 - *After running-in hours. Output allowable deviation: ±3%*
 - *1PS = 0.7355 kW*

7.2 Principal Engine Specifications

• 2CA1

Engine model	—	2CA1										
Version	—	CL				CH			VH			
Type	—	Vertical inline water cooled diesel engine										
Combustion system	—	Swirl chamber (ball type)										
Aspiration	—	Natural										
No. of cylinder	—	2										
Bore × Stroke	mm	70×74										
Displacement	L	0.570										
Continuous rated output / Engine speed	kW/min ⁻¹ (PS)	—						8.16/3000 (11.1)	9.76/3600 (13.3)	—		
Max. rated output(net) / Engine speed	kW/min ⁻¹ (PS)	5.96/2000 (8.10)	6.62/2200 (9.00)	7.28/2400 (9.90)	7.87/2600 (10.7)	8.53/2800 (11.6)	9.12/3000 (12.4)	9.97/3000 (12.2)	10.7/3600 (14.6)	9.34/3200 (12.7)	9.78/3400 (13.3)	10.3/3600 (14.0)
High idling	min ⁻¹	2160±25	2355±25	2570±25	2780±25	2995±25	3210±25	3165±25	3800±25	3390±25	3605±25	3815±25
Engine mass(dry)** with flywheel housing	kg	66										
P.T.O position	—	Flywheel side										
Direction of rotation	—	Counter-clockwise (viewed from flywheel side)										
Cooling system	—	Water cooled (radiator)										
Lubricating system	—	Forced lubrication with trochoid pump										
Starting system	—	Electric starting (Starter motor: DC12V1.0kW, Alternator: DC12V18A) (Recommended battery capacity:12V36Ah (5h rating) for 12V1.0kW S.motor)										
Dimensions (L×W×H)**	mm	416×427×484						504×427×536			416×427×484	
Engine oil capacity (Oil pan)	L	1.6/0.8 (Dipstick upper limit / lower limit)						2.3/1.3 (←)			1.6/0.8 (←)	

Engine model	—	2CA1	
Cooling water capacity(engine)	L	0.6	
Cooling fan(std.)	—	290mm O/D	
		5 blades pusher type	

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• 3CA1

Engine model	—	3CA1													
Version	—	CL	VM						CH	VH					
Type	—	Vertical inline water cooled diesel engine													
Combustion system	—	Swirl chamber (ball type)													
Aspiration	—	Natural													
No. of cylinder	—	3													
Bore × Stroke	mm	70×74													
Displacement	L	0.854													
Continuous rated output / Engine speed	kW/min ⁻¹ (PS)	6.09/1500 (8.27)	7.29/1800 (9.91)	—						8.16/3000 (16.5)	9.76/3600 (19.7)	—			
Max. rated output(net) / Engine speed	kW/min ⁻¹ (PS)	6.69/1500 (9.1)	8.02/1800 (10.9)	8.97/2000 (12.2)	9.93/2200 (13.5)	11.0/2400 (14.9)	11.8/2600 (16.1)	12.8/2800 (17.4)	13.7/3000 (18.6)	13.3/3000 (18.1)	16.0/3600 (21.7)	14.0/3200 (19.0)	14.7/3400 (20.0)	15.4/3600 (21.0)	
High idling	min ⁻¹	1585±25	1880±25	2160±25	2355±25	2570±25	2780±25	2995±25	3210±25	3165±25	3760±25	3390±25	3605±25	3815±25	
Engine mass(dry)** with flywheel housing	kg	83													
P.T.O position	—	Flywheel side													
Direction of rotation	—	Counter-clockwise (viewed from flywheel side)													
Cooling system	—	Water cooled (radiator)													
Lubricating system	—	Forced lubrication with trochoid pump													
Starting system	—	Electric starting (Starter motor: DC12V1.0kW, Alternator: DC12V18A) (Recommended battery capacity:12V36Ah (5h rating) for 12V1.0kW S.motor)													
Dimensions (L×W×H)**	mm	504×427×506						504×427×536			504×427×506				
Engine oil capacity (Oil pan)	L	2.8/1.5 (Dipstick upper limit / lower limit)						3.5/2.0 (←)			2.8/1.5 (←)				
Cooling water capacity(engine)	L	0.9													

Engine model	—	3CA1												
Cooling fan(std.)	—	310mm O/D												
		5 blades pusher type												

**Engine mass and dimensions without radiator

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• 3CB1

Engine model	—	3CB1					
Version	—	VM					
Type	—	Vertical inline water cooled diesel engine					
Combustion system	—	swirl chamber (ball type)					
Aspiration	—	Natural					
No. of cylinder	—	3					
Bore × Stroke	mm	76×82					
Displacement	L	1.115					
Max. rated output(net) / Engine speed	kW/min ⁻¹ (PS)	11.8/2000 (16.1)	13.2/2200 (16.1)	14.3/2400 (19.5)	15.5/2600 (21.1)	16.7/2800 (22.7)	17.9/3000 (24.3)
High idling	min ⁻¹	2160±25	2355±25	2570±25	2780±25	2995±25	3210±25
Engine mass(dry)** with flywheel housing	kg	110					
P.T.O position	—	Flywheel side					
Direction of rotation	—	Counter-clockwise (viewed from flywheel side)					
Cooling system	—	Water cooled (radiator)					
Lubricating system	—	Forced lubrication with trochoid pump					
Starting system	—	Electric starting (Starter motor: DC12V1.1kW, Alternator: DC12V18A) (Recommended battery capacity:12V52Ah (5h rating) for 12V1.1kW S.motor)					
Dimensions (L×W×H)**	mm	485×436×535					
Engine oil capacity (Oil pan)	L	3.4/1.8 (Dipstick upper limit / lower limit)					
Cooling water capacity(engine)	L	0.9					
Cooling fan(std.)	—	335mm O/D, 6 blades pusher type					

** Engine mass and dimensions without radiator

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 at any time without notice.

INSTRUCTION MANUAL (INDUSTRIAL)

2CA1, 3CA1, 3CB1

IDE-6144

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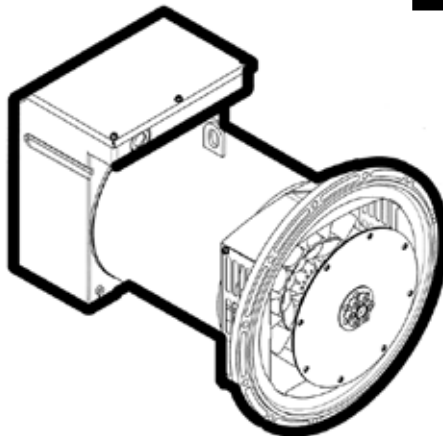
Generator

MAC 6000 Hydronic Heater



GB SELF-REGULATING ALTERNATORS SERIES ECP3 OPERATING AND MAINTENANCE INSTRUCTIONS

ECP3

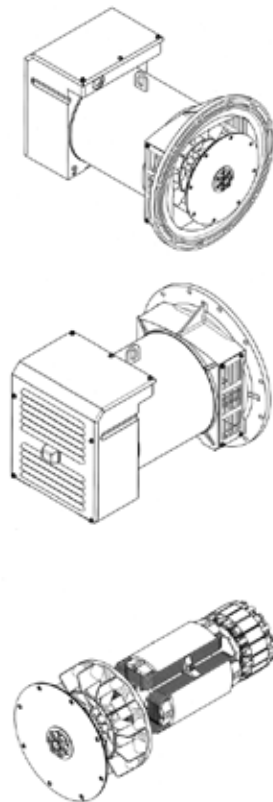


Generator

MAC 6000 Hydronic Heater

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MACHINE DESCRIPTION



ECP3 2 and 4 pole alternators are brushless, self regulating and incorporate a rotating inductor with damper cage (2 pole generators) and a fixed stator with skewed slots. The stator windings have a shortened pitch to reduce the harmonic content of the output waveform. The alternators are made in compliance with the 2006/42, 2006/95, 2004/108 directives and their amendments, and the CEI 2-3, EN60034-1, IEC34-1, VDE0530, BS 4999-5000 regulations.

Tests to verify the electromagnetic compatibility have been carried out in the foreseen conditions by the standards with the neutral connected to the earth.

On customer's request alternators can be manufactured according to different specifications.

The robust mechanical construction gives good access to the generator output connections, and allows the user to inspect the various components with ease. The casing is made of steel, the shields of cast iron, and the shaft of C45 steel and it has a keyed fan.

The mechanical protection level meets standard IP23 (upon request higher levels of protection can be supplied).

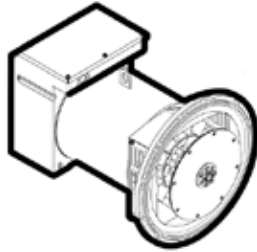
Insulation materials meet class H requirements, and all rotating components are epoxy resins impregnated, higher voltage parts, such as the stators, are vacuum-treated (special treatments are available on request). Radio interference suppression meets the requirements of EN61000-6-3, EN61000-6-1 regulations.

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INTRODUCTION



The ECP3 alternators comply with the EEC directives 2006/42, 2009/95, 2004/108 and their amendments; therefore they pose no danger to the operator if they are installed, used and maintained according to the instructions given by Mecc Alte and provided the safety devices are kept in perfect working conditions.

Therefore a strict observance of these instructions is required.

Any reproduction of this manual is forbidden.

MACHINE IDENTIFICATION

ID N°	TYPE	PHASE	DUTY
SP/2	SP/2	PH/OL	SP
RYA	D N	A	PH
RYA	A	PH	PH
CONNECTION	EX. A	PH	PH
RYA	C D	A	PH
RYA	A	PH	PH
SP	A/B	A	PH
REMARKS			

Always indicate the generator type and code when contacting Mecc Alte or the authorized after-sales service centres.

INSPECTION ON DELIVERY

When the alternator is delivered, check that unit conforms with the delivery note and ensure that there are no damaged or defective parts; should there be any, please inform the forwarding agent, the insurance company, the seller or Mecc Alte immediately.

SAFETY REQUIREMENTS



Before any cleaning, lubrication or maintenance operation, ensure that the generator is stationary and disconnected from the power supply.

When stopping the generator, ensure the compliance with the procedures for stopping the prime mover.

The generator, in fact, has no Emergency Stop, but is controlled by the device arranged by the installer.

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Generator

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SAFETY REQUIREMENTS

Symbols having specific meanings have been used throughout this instruction and maintenance manual.

CONVENTIONAL SYMBOLS AND SYMBOL DESCRIPTION

IMPORTANT

This symbol warns the personnel concerned that the described operation may cause damages to the machine if it is not carried out according to the safety standards.

IMPORTANTE
IMPORTANT
WICHTIG



CAUTION

This symbol warns the personnel concerned that the described operation may cause damages to the machine and/or injures to the personnel if it is not carried out according to the safety standards.



WARNING

This symbol warns the personnel concerned that the described operation may cause serious injuries or death to the personnel if it is not carried out according to the safety standards.



DANGER

This symbol warns the personnel concerned that the described operation may immediately cause serious injuries or death to the personnel if it is not carried out according to the safety standards.

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SAFETY REQUIREMENTS



HANDLER

This symbol identifies the type of operator in charge of the operation described. This qualification requires a complete knowledge and understanding of the information contained in the manufacturer's instruction manual as well as specific skills about the hoisting means, slinging methods and features and safe handling procedures.



MECHANICAL SERVICE MAN

This symbol identifies the type of operator in charge of the operation described. This qualification requires a complete knowledge and understanding of the information contained in the manufacturer's instruction manual as well as specific skills necessary to perform installation, adjustment, maintenance, cleaning and/or repair operations.



ELECTRICAL SERVICE MAN

This symbol identifies the type of operator in charge of the operation described. This qualification requires a complete knowledge and understanding of the information contained in the manufacturer's instruction manual as well as specific skills necessary to perform electrical operations such as connections, adjustment, maintenance and/or repair. **The electrical service man must be able to work even in case electrical cabinets and panels are live.**

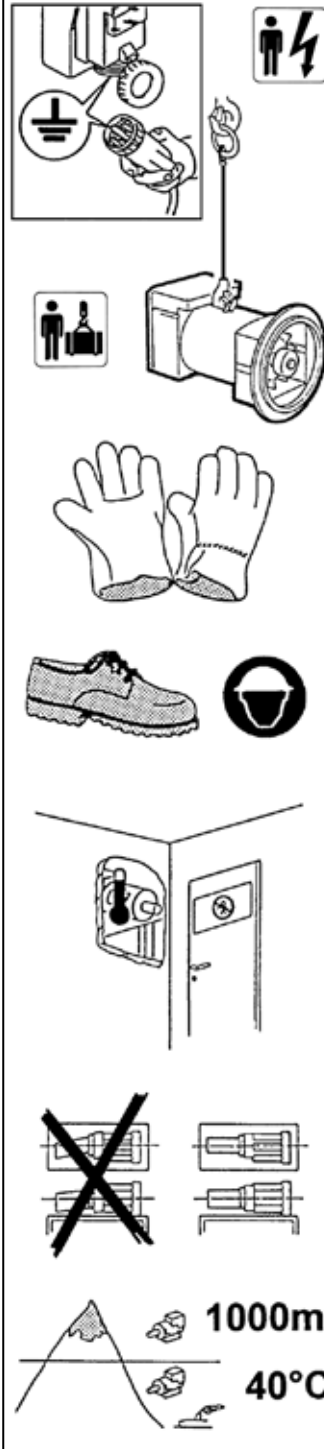
In case of exceptional operations and upon written request of servicing operations please apply to Mecc Alte authorized centers.

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Generator

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SAFETY REQUIREMENTS



Before installing the generator, arrangements must be made to earth the machine in compliance with any relevant electrical regulations. This is the reason why you must make sure that the grounding system is in good conditions and in compliance with the regulations of the country where the generator will be installed.

CAUTION
THE FINAL INSTALLER IS RESPONSIBLE FOR THE INSTALLATION OF ALL THE PROTECTIONS (SECTIONING DEVICES, PROTECTIONS AGAINST DIRECT AND INDIRECT CONTACTS, OVERCURRENT AND OVERVOLTAGE PROTECTIONS, EMERGENCY STOP, ETC.) NECESSARY FOR THE MACHINE TO COMPLY WITH THE EXISTING INTERNATIONAL/EUROPEAN SAFETY REGULATIONS.

For handling the unpacked generators, always use the special eyebolts only; use ropes having a suitable carrying capacity and do not lift the generator too much from the floor (max 30 cm.).

When the machine is worn out, contact the companies in charge of the disposal of ferrous material and do not throw away its parts into the environment.

The operators in charge of the installation, operation and maintenance of the generators must be skilled technicians who know the characteristics of the generators.

The people in charge of the handling must always wear work gloves and safety shoes. In case the generator or the whole plant must be lifted from the floor, the operators must wear a safety helmet.

The generator must be installed in an airy room. If there is not enough air, a malfunction or an overheating may occur. All entry doors into generator room should be clearly marked "Authorized persons only".

Take sure that gen-set foundations and baseframe are suitable to bear the combined weight of the alternators and prime mover.

The installer is responsible for the correct coupling of the generator to the engine and for the performance of all precautions necessary to guarantee the correct operation of the generator and avoid abnormal stress, which could damage the generator (such as vibrations, misalignment, strange noises or vibrations, etc.)

The machine was designed to guarantee the nominal power in environments with a maximum temperature of 40° C, at altitudes lower than 1000 m asl (EN60034-1), unless otherwise specified; for different operating conditions, see the commercial catalogue (brochure).

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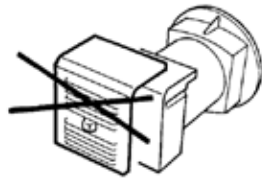
Generator

MAC 6000 Hydronic Heater

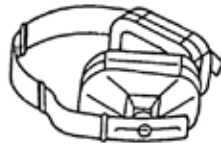
SAFETY REQUIREMENTS



No person must wear fluttering clothes (such as scarves, etc.) near the machine and any garment must be fastened with elastic bands at its ends.



The generators must never and for no reason run with the following guards removed:
- terminals cover
- fan guards.



If required, the generator can be equipped with a regulator with led display, as follows:
Green - regular operation
Yellow - overload protection activated
Red - low speed protection activated



The generators are noisy; even if the sound level is certainly lower than that of the prime motor, they must be installed in soundproof rooms (room, engine room, etc.) where it is necessary to wear antinoise ear protectors.

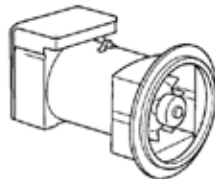
The generators produce heat proportional to the output.
Therefore, do not touch the generator if you do not wear antiscorch gloves and, after switching it off, do not touch it until it has cooled down.



Even if all the machine components are protected, keep away from the machine.

Do not lean or sit on the generator for whatever reason.

Do not remove the labels for whatever reason; on the contrary, if necessary, replace them.



DANGER OF SHORT CIRCUIT

The degree of protection of the generator is IP23; short circuits may occur if liquids are spilled onto areas containing electrical parts.

In case of replacement of spare parts, use original spare parts only.



For the replacement of worn parts, carefully follow the maintenance instruction; these operations must be carried out by skilled technicians.

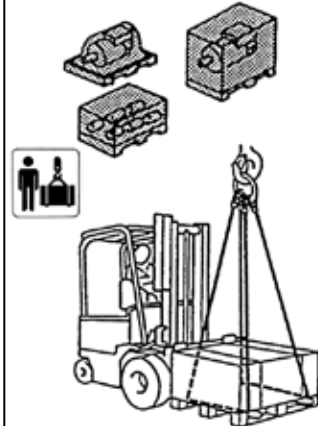
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Generator

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TRANSPORT AND STORAGE



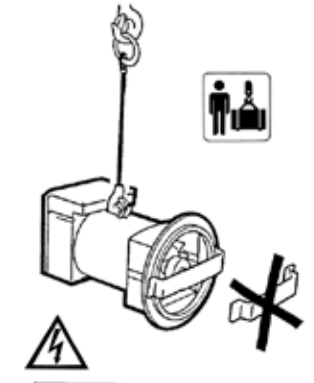
Alternators will be packed for shipment in a manner suitable to their mode of transport and final destination.

Prior to handling goods, please ensure that lifting equipment is of sufficient capacity. Under lifting conditions machinery should be elevated to a minimal distance from the ground.

When lifting or moving goods by forklift apparatus, care should be taken to ensure that forks are correctly positioned to prevent slipping or falling of pallet or crate.

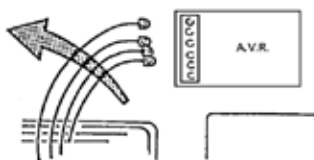


Both packed and unpacked alternators shall be stored in a cool and dry room, and shall never be exposed to the inclemency of the weather.



With regard to single bearing alternators (form MD35) please ensure that the rotor securing device is in place. Failure to do so may lead to slippage or assembly.

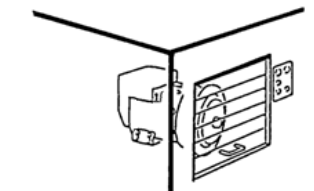
When installing the alternators, always lift them by using their eyebolts.



PLEASE NOTE :

AFTER PROLONGER STORAGE OR IF THE MACHINES SHOW SIGNS OF CONDENSATION, ALL WINDINGS SHOULD BE SUBJECTED TO INSULATION TESTS PRIOR TO OPERATING.

THE INSULATION TEST SHALL BE MADE BY SKILLED PERSONNEL.


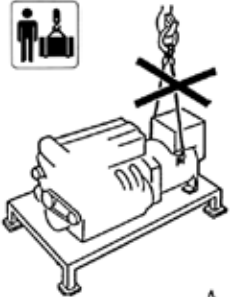




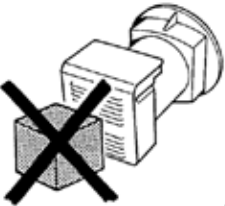

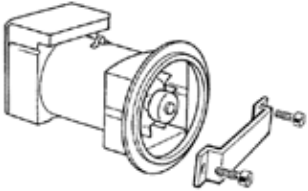


BEFORE CARRYING OUT THE TEST, THE VOLTAGE REGULATOR MUST BE DISCONNECTED; IF THE TEST RESULTS ARE TOO LOW (LOWER THAN 1 MΩ)(EN60204-1) THE ALTERNATOR MUST BE DRIED IN AN OVEN AT 50-60°C.

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Generator

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  	<h3>TRANSPORT AND STORAGE</h3> <p>Once the generator is coupled with an engine, mounted on a baseframe, or installed on a complete generating set, it cannot be lifted by its lifting bolts. The relevant instructions for lifting complete generating set should be followed.</p> <p>Any packing materials should be disposed of via correct waste disposal methods. Do not discard waste materials into the environment.</p>
   <div data-bbox="537 1224 737 1289" style="border: 1px solid black; padding: 5px; text-align: center;"> <p>IMPORTANTE IMPORTANT WICHTIG</p> </div>   	<h3>MECHANICAL COUPLING</h3> <p>The mechanical coupling is under the sole responsibility of the final user, and has to be done at his discretion.</p> <p>Warnings:</p> <p>BEFORE STARTING THE ALTERNATOR, CHECK THAT THE AIR INLETS AND OUTLETS ARE FREE OF ANY OBSTRUCTIONS.</p> <p>THE AIR INLETS SHOULD NOT BE NEAR ANY HEATING SOURCES. IN ANY CASE, IF NOT SPECIFICALLY REQUESTED, THE COOLING AIR TEMPERATURE MUST BE EQUAL TO THE ENVIRONMENT TEMPERATURE AND NEVER HIGHER THAN 40°C.</p> <div data-bbox="805 1577 1130 1772" style="border: 1px solid black; padding: 5px;"> <p>BEFORE MECHANICAL COUPLING OF SINGLE BEARING ALTERNATORS REMOVE THE ROTOR SECURING DEVICE PLACED THERE TO PREVENT ROTOR FROM SLIPPING.</p> </div>

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MECHANICAL COUPLING

When coupling with an ECP3 series generator having a B3/B9 form, follow the instructions below:

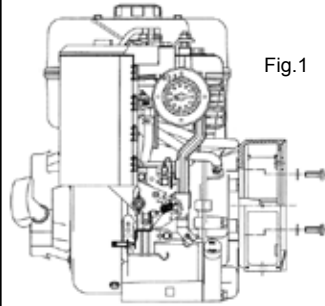


Fig.1

-) mount the front cover on the motor, fixing it with the appropriate screws and applying a tightening torque of $48 \pm 7\%$ Nm if using M10 screws or $21 \pm 7\%$ Nm for M8 screws (figure 1)

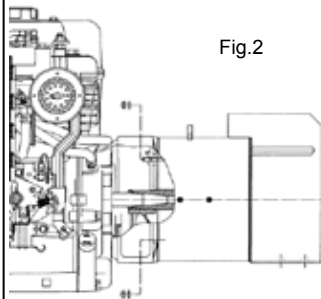


Fig.2

-) lock the alternator into the cover by fixing the four M8 nuts onto the bolts, applying a tightening torque of $16 \pm 7\%$ Nm (figure 2)

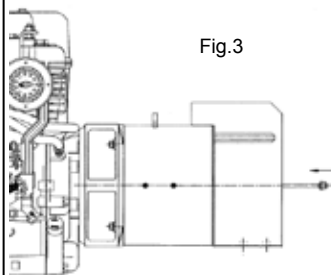


Fig.3

-) insert the central bolt into its housing and screw the nut (figure 3)

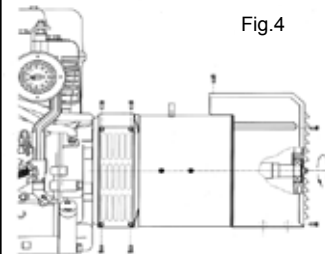
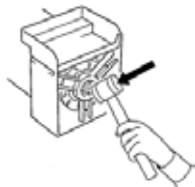


Fig.4

-) block the central stay rod, applying a tightening torque of $21 \pm 7\%$ Nm if you are using stay rods of M8, while if you are using M14 stay rods, apply a tightening torque of $120 \pm 7\%$ Nm; reassemble the lateral protective nets and the rear closing grid by applying a tightening torque of $3,5 \pm 7\%$ Nm to the M5 screws (figure 4)



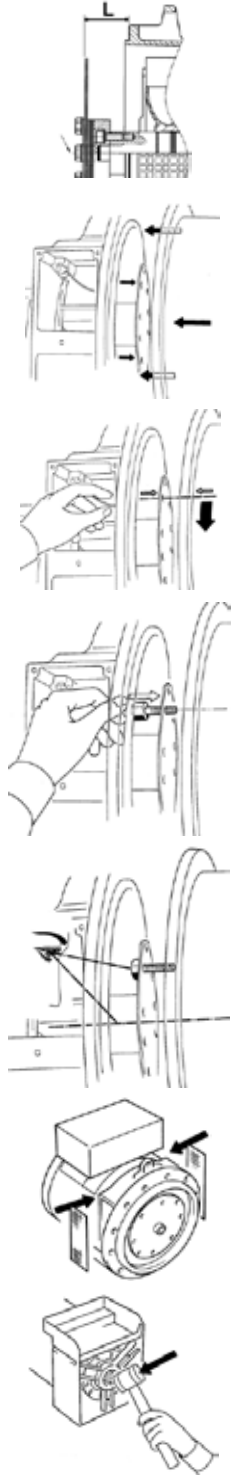
-) Eliminate possible axial loads in the bearing by tapping with a rubber hammer on the seat of the bearing.

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MECHANICAL COUPLING



A bad alignment may cause vibrations and bearing damages. It is advisable to verify the compatibility of the generator torsional characteristics and the engine (by the customer). The necessary data for this verification are available on the concerning documentation.

When coupling with an ECP3 series generator having a MD35 form, follow the instructions below:

-) according to the type of the coupling, verify the correct placement of the discs (dimension "L") (table 2 pag. 38); if necessary restore the "L" dimension moving gently and axially the rotor. In the right position the clearance of rear bearing should be from 0.5 to 2 mm.

-) move the generator close to the coupling engine

-) align one of the flywheel disk fastening holes with the holes of the previously positioned disks

-) Insert and partially tighten the screws that lock the disks to the flywheel. Turn the flywheel until another two holes are in the same position and partially tighten the screw. Repeat this operation for all the other holes

-) after inspecting the correct centring of the disks on the engine flywheel, the screws must be completely tightened

-) fix the two lateral protection grids supplied with the generator.

-) Eliminate possible axial loads in the bearing by tapping with a rubber hammer on the seat of the bearing.

Only after a correct mechanical coupling, proceed with the electrical connections.

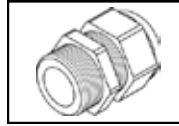
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Generator

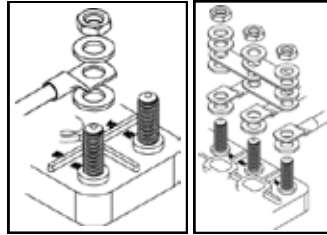
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ELECTRICAL CONNECTIONS



All electrical output connections are the responsibility of, and are at the discretion of, the end user. When making terminal box connections, all cable and terminal lugs should meet the relevant standards of the country of final destination.

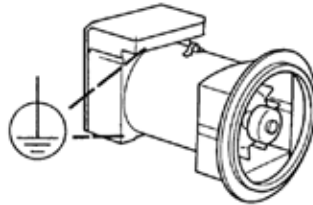


Windings connection

(table 3 pag. 39)
All alternators feature both star with neutral (Y) and delta (Δ) connections. To reconnect from a star to delta connection (for ex. from 400V to 230V), modify the linking arrangements on the output terminal board (see diagram on table 3 page 39). It is not necessary to adjust the voltage regulator.

Standard alternators are equipped with 12 cables to offer different voltages (for example 115 / 200 / 230 / 400).

The alternator must always be earthed by sufficiently rated cable, using one of the inside or outside terminals. After completing output connections, ensure that the terminal box cover is securely in place.

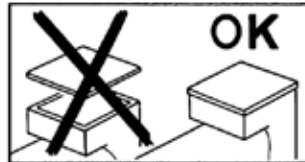


NOTE : frequency variations.

A standard production machine wound for 50 Hz can also function at 60 Hz (and vice versa) by resetting the A.V.R. voltage potentiometer to the new nominal voltage value.

When changing from 50 to 60 Hz the alternator power, and nominal voltage will increase by 20%, but the current does not change from 50 Hz value. Should voltage stay at 50 Hz nominal value, then the output power may be increased by 5% due to improved ventilation.

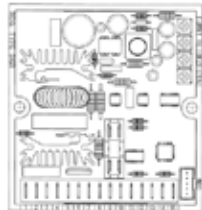
For machines wound for 60 Hz, changing to 50 Hz, the voltage and power values have to decrease by 20% of 60 Hz values.



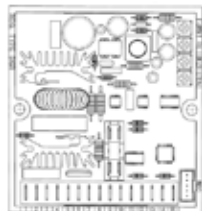
VOLTAGE REGULATOR

(table 4 page 39)

Self-regulation by means of an DSR electronic regulator guarantees precise voltages of $\pm 1\%$ in static conditions with any power factor and with a variation in speed of between -10% and +20%.



← VOLT



↑↑ 10 -11

PLEASE NOTE :

The generator output voltage must be checked under no-load conditions, with the correct setting of frequency.

The voltage may be adjusted by $\pm 14\%$ of the nominal, by acting upon the voltage potentiometer on the electronic regulators.

By connecting a 10 K Ω potentiometer across the relevant terminals (10-11), it is possible to have a remote voltage regulation of $\pm 14\%$ of nominal voltage.

For further details on regulators, please see the specific manual.

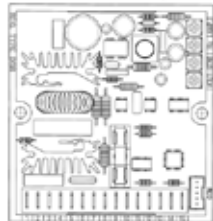
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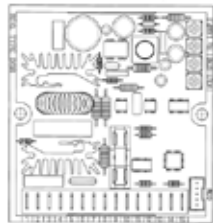
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ELECTRICAL CONNECTIONS



←
Hz



←
AMP

PROTECTIONS

The DSR electronic regulator is equipped with a low speed safety device as well as an overload safety device to prevent irregular and dangerous operation of the alternator.

Low speed safety device:

It is activated immediately to reduce the machine voltage when the frequency decreases to less than 10% of the rated value. The activation level can be regulated using the "Hz" potentiometer.

Overload safety device:

A special circuit is used to compare the partial excitation voltage. If, for a period longer than 20 seconds, this voltage is higher than the pre-set value (which corresponds to a charging current equal to 1,1 times the current indicated on the alternator data plate), the regulator is activated and lowers the machine voltage, thereby limiting the current to a safe amount. The time delay is specifically set to give the motors time to pickup, as they usually require about 5-10 seconds to start. This activation level can be regulated using the "AMP" potentiometer.

INTERVENTION OF PROTECTION DEVICES CAUSES.

Underspeed protection instantaneous intervention :

1 - speed reduced by 10% of nominal RPM

Delayed intervention of overload protection :

- 2 - overload by 10% of nominal rating.
- 3 - power factor ($\cos \phi$) lower than the nominal-one.
- 4 - ambient temperature above 50°C.

Intervention of both protections :

5 - combination of factor 1 with factors 2, 3, 4.

In case of intervention the output voltage will drop down to a value which will depend on the fault.

The voltage will return automatically to its nominal value as soon as the fault is removed.

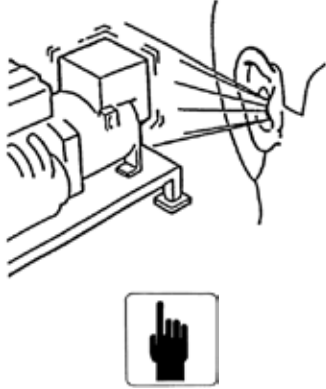
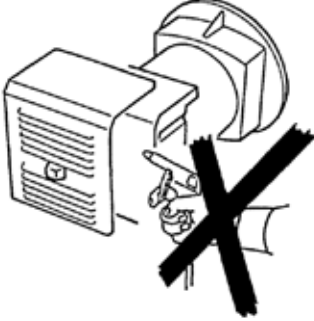
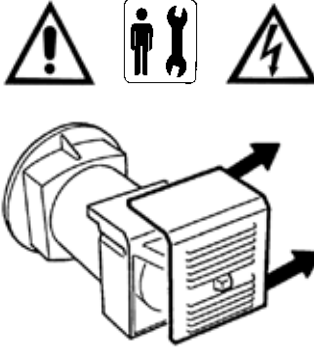



After all the electric connections have been made and **only after all the protections have been put in place**, can the system be started.

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STARTING AND STOPPING OPERATIONS	
	<p>All the instrumentation for starting, running and stopping the system shall be provided by the installer.</p> <p>THE STARTING, RUNNING AND STOPPING OPERATIONS MUST BE CARRIED OUT BY SKILLED PERSONNEL WHO HAVE READ AND UNDERSTOOD THE SAFETY INSTRUCTIONS AT THE BEGINNING OF THIS MANUAL.</p> <p>PLEASE NOTE : When the system is set to work for the first time, which has to be done at a reduced speed, the operator shall check that no anomalous noises can be detected. If an anomalous noise is detected, stop the system immediately and improve the mechanical coupling.</p>
CLEANING AND LUBRICATION	
	<p>Prior to approaching or touching the alternator, ensure that it is not live and it is at room temperature; at this stage it is possible to clean it on the outside using compressed air.</p> <p>NEVER USE LIQUIDS OR WATER.</p> <p>DO NOT CLEAN THE INSIDE ELECTRIC COMPONENTS WITH COMPRESSED AIR, BECAUSE THIS MAY CAUSE SHORT-CIRCUITS OR OTHER ANOMALIES.</p> <p>For the alternator Series ECP3 it is not necessary the lubrication for all the period of functioning (30.000 h).</p>
MANUTENTION	
	<div data-bbox="857 1470 938 1554" style="display: inline-block; border: 1px solid black; padding: 2px;">  </div> <div data-bbox="954 1470 1149 1554" style="display: inline-block; border: 1px solid black; padding: 5px; text-align: center;"> <p>GEFAHR PELIGRO</p> </div> <p>In order to disassemble the alternator series ECP3, follow the following instructions:</p> <p>Remove the rear panel.</p>

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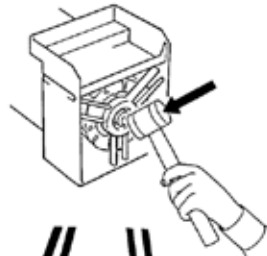
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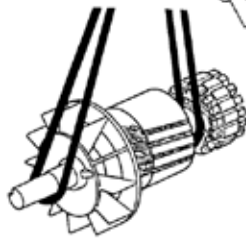
MAINTENANCE



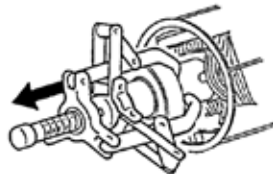
To remove the front shield, unscrew the four fixing nut.



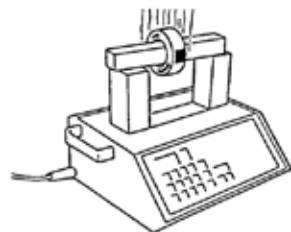
Beating with an appropriate rubber-hammer on the shaft, opposite coupling side.



EXTRACT THE ROTOR USING A HOISTING MECHANISM WITH SOFT ROPES OF SUFFICIENT STRENGTH. SLOWLY AND CAREFULLY EXTRACT THE ROTOR AND PLACE IT IN THE WORK AREA WHICH HAS BEEN PREVIOUSLY PREPARED.



To replace the bearing/s, use a puller of the type shown in the figure.



To reassemble the bearing, heat it with a special magnetic device of the type shown in the figure.



Wear special anti-scorch gloves, reassemble the bearing/s.

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Generator

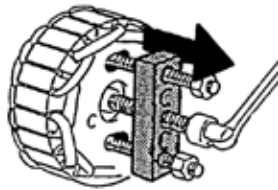
MAC 6000 Hydronic Heater

MAINTENANCE

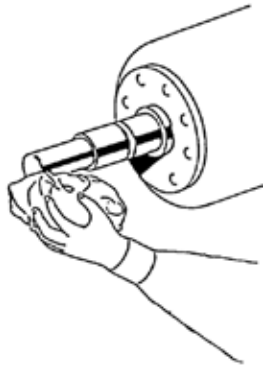


When replacing the exciter stator, follow the instructions below.

Unsolder the two cable of connection of the main rotor.



Insert a suitable puller, that can be easily made or supplied by our company, as shown in the picture.
This puller will enable to take out the exciter very easily.



Before replacing the exciter, clean the shaft seat thoroughly and cover it with a thin layer of "Permabond A022" of Angst-Pfister or a similar product.



Reassemble the exciter following the above-described steps inversely, carefully check that the diode connecting cables are turned toward the outside.

Using a tool similar to the one shown in the figure, reassemble the exciter.

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Generator

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MAINTENANCE

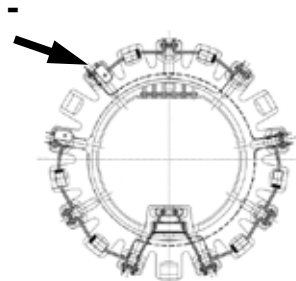
Procedure to check the diodes of the exciter rotor.

Necessary equipment :

- 12V battery
- 12V-21W lamp (or alternatively 6.8Ω-30W Resistance)
- Voltmeter (for instance, multimeter on scale VOLT d.c.)

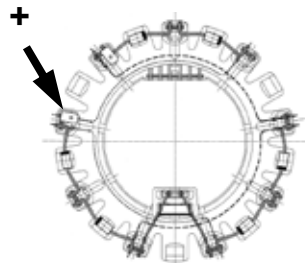
Warning: before performing the following actions, it is necessary to disconnect the 2 cables connecting the main rotor to the diode bridge (+and-)

IMPORTANTE
IMPORTANT
WICHTIG



TEST OF THE DIODES ON THE "NEGATIVE"

- Connect the equipment, as it is pointed out in the picture A (table 7 page 41)
- Fix the cable connected to the lamp to the negative terminal of the bridge, as it is pointed out in the picture A (table 7 page 41)
- Connect the terminal "Probe" to the point A1 (it is checked the diode 1), then to the point A2 (it is checked the diode 2) and finally to the point A3 (it is checked the diode 3); check the readings on the voltmeter in relation with what is reported on the table (table 7 page 41).



TEST OF THE DIODES ON THE "POSITIVE"

- Connect the equipment, as it is pointed out in the picture B (table 7 page 41)
- Fix the cable connected to the negative terminal of the battery to the positive terminal of the bridge, as it is pointed out in the picture B (table 7 page 41)
- Connect the terminal "Probe" to the point A4 (it is checked the diode 4), then to the point A5 (it is checked the diode 5) and finally to the point A6 (it is checked the diode 6); check the readings on the voltmeter in relation with what is reported on the table (table 7 page 41).

INSTRUCTIONS TO REPLACE THE DIODE

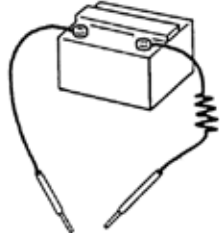
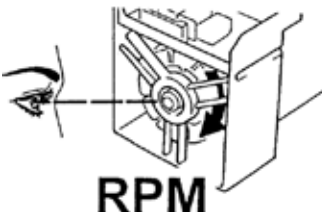
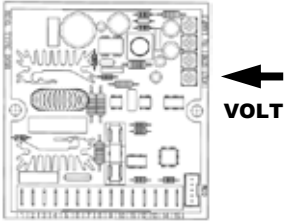
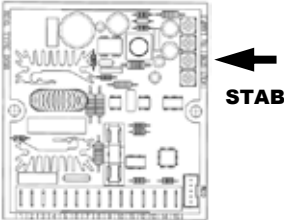

When the values measured point out a diode damaged, it is necessary to replace the component.

For this purpose it is recommended to not pull the rheophores out from their locations, but to cut them near to the body of the component; then fit in the new component respecting the polarity and soft-solder accurately the rheophores with the pieces remained in their locations.

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DEFECTS AND REMEDIES	
	<p>ALTERNATOR DOES NOT EXCITE</p> <ul style="list-style-type: none"> - Check the connection cables using the attached diagrams. - Increase speed by 15%. - For an instant apply on the electronic regulator a 12 V battery voltage with a 30Ω resistor in series respecting the polarities.
	<p>AFTER BEING EXCITED ALTERNATOR DOES NOT EXCITE</p> <ul style="list-style-type: none"> - Check connection cables as per attached drawings.
 <p style="text-align: center;">RPM</p>	<p>LOW VOLTAGE AT NO LOAD</p> <ul style="list-style-type: none"> - Calibrate the voltage using the special potentiometer. - Check the number of turns. (possible safety device activation) - Check the windings.
	<p>HIGH VOLTAGE AT NO LOAD</p> <ul style="list-style-type: none"> - Calibrate the voltage using the special potentiometer. - Check the regulator and replace it if necessary.
 <p style="text-align: center;">VOLT</p>	<p>AT LOAD CONDITIONS, VOLTAGE LOWER THAN RATED VALUE</p> <ul style="list-style-type: none"> - Calibrate the voltage using the special potentiometer. - Current too high, $\cos\phi$ lower than 0.8, speed lower than 4% of the rated value. (possible safety device activation) - Check the regulator and replace it if necessary. - Disconnect the cables and check the diodes; replace them if necessary.
	<p>AT LOAD CONDITIONS, VOLTAGE HIGHER THAN RATED VOLTAGE</p> <ul style="list-style-type: none"> - Calibrate the voltage using the special potentiometer. - Check the regulator and replace it if necessary.
 <p style="text-align: center;">STAB</p>	<p>UNSTABLE VOLTAGE</p> <ul style="list-style-type: none"> - Check that rotation is uniform. - Regulate the stability of the regulator with the "STAB" potentiometer.
	<p>NOISY GENERATOR</p> <ul style="list-style-type: none"> - Check if the bearings must be replaced. - Check if the coupling can be improved.
	<p>For any other defect, please contact the seller, the after-sales service or Mecc Alte Spa directly.</p>

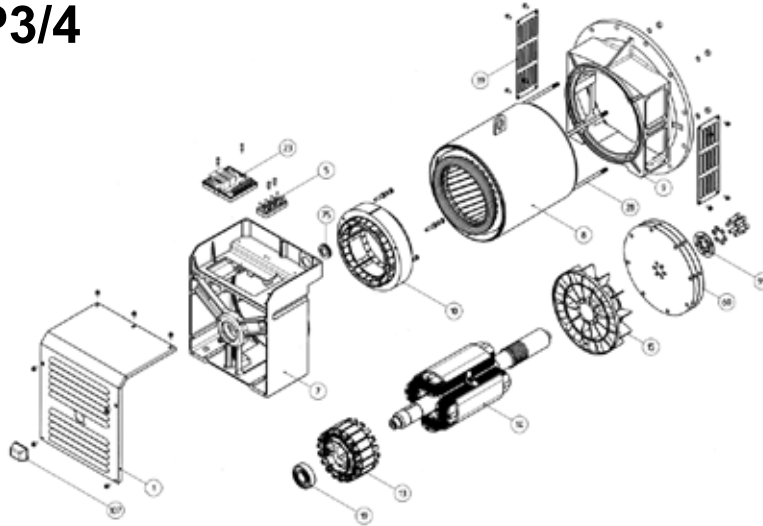
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Generator

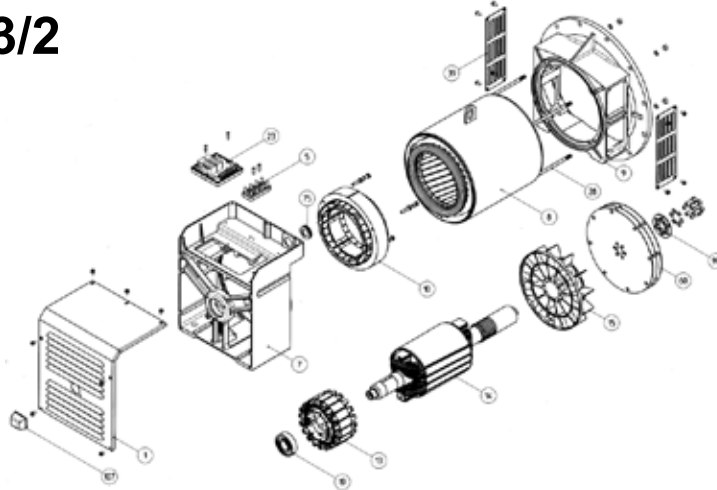
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Exploded view and terminology

ECP3/4



ECP3/2



When requesting spare parts always indicate the alternator's type and code.

Generator

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N.	NAME	CODICE CODE
1	terminal box lid	8500611200
5	terminal board	9909915061
7	non drive end bracket	6102204136
8	frame and stator	***
9	drive end bracket	***
10	exciter stator	4500478657
13	exciter armature	4500568151
14	rotor assy	***
15	fan d.40	9909514075
15	fan d.50	9909514076
17	front bearing 6308-2RS C3	9900905110
19	rear bearing 6305-2RS C3	9900905095
23	electronic regulator DSR	4505005560
28	cover stay bolt S	9911190296
28	cover stay bolt L	9911190297
29	securing stud	***
39	protection screen	8500626095
60	disc plates	***
75	cable grommet	9909509105
99	disc locking ring-spacer	6110611508
107	rubber cap	9909505006
123	ring spacer	7502212040

Generator

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1

RESISTENZA DEGLI AVVOLGIMENTI A 20°C AMBIENTE
WINDING RESISTENCES AT 20°C ROOM TEMPERATURE
RESISTANCE DES BOBINAGES A 20°C DE TEMPERATURE AMBIANTE
WIDERSTAND DER WICKLUNG BEI 20°C RAUMTEMPERATUR
RESISTENCIA DE LOS BOBINADOS A 20°C DE TEMPERATURA AMBIENTE

GENERATORI 2 POLI - 2 POLE GENERATORS - ALTERNATEURS 2 POLES GENERATOREN 2 POLIG - GENERADORES 2 POLOS 3000 RPM 115/200/230/400V

TIPO TYPE TYP	GENERATORE GENERATOR PARTIE PUISSANCE GENERADORES			ECCITATRICE EXCITER EXCITATRICE ERREGER EXCITATRIZ	
	STATORE STATOR	ROTORE ROTOR	AVVOLGIMENTO AUSILIARIO AUXILIARY WINDING HILFS WICKLUNG BOBINADO AUXILIAR	STATORE STATOR	ROTORE ROTOR
	1-2 Ω	Ω	Ω	Ω	Ω
ECP3 - 1S	1,608	6,702	2,200	15,71	1,453
ECP3 - 2S	1,084	7,364	1,930	15,71	1,453
ECP3 - 3S	0,678	8,238	1,740	15,71	1,453
ECP3 - 1L	0,512	9,487	1,680	15,71	1,453
ECP3 - 2L	0,443	9,627	1,480	15,71	1,453

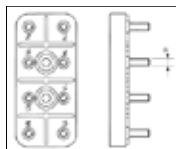
GENERATORI 4 POLI - 4 POLE GENERATORS - ALTERNATEURS 4 POLES GENERATOREN 4 POLIG - GENERADORES 4 POLOS 1500 RPM 115/200/230/400V

TIPO TYPE TYP	GENERATORE GENERATOR PARTIE PUISSANCE GENERADORES			ECCITATRICE EXCITER EXCITATRICE ERREGER EXCITATRIZ	
	STATORE STATOR	ROTORE ROTOR	AVVOLGIMENTO AUSILIARIO AUXILIARY WINDING HILFS WICKLUNG BOBINADO AUXILIAR	STATORE STATOR	ROTORE ROTOR
	1-2 Ω	Ω	Ω	Ω	Ω
ECP3 - 1S	1,938	6,078	4,380	15,71	1,453
ECP3 - 2S	1,272	7,141	3,900	15,71	1,453
ECP3 - 1L	0,914	8,539	3,800	15,71	1,453
ECP3 - 2L	0,732	9,743	3,500	15,71	1,453
ECP3 - 3L	0,628	10,884	3,750	15,71	1,453

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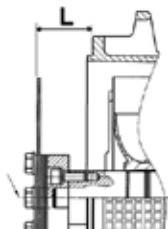
2

TABELLA COPPIE DI SERRAGGIO PER MORSETTIERE - TERMINAL BOARD TIGHTENING TORQUE TABLE
TABLEAU DE COUPLE DE SERRAGE POUR PLANCHETTE A BORNES
KLEMMENBRETT ANZUGSMOMENT TABELLE
TABLA PAR DE TORQUE POR PLACA DE BORNES



DIAMETRO DI FILETTATURA Df THREAD DIAMETER Df DIAMETRE DE FILETAGE Df GEWINDE DURCHMESSER Df DIAMETRO DE FILETEADO Df	TIPO TYPE TYP	COPPIA DI SERRAGGIO (Nm) TIGHTENING TORQUE (Nm) COUPLE DE SERRAGE (Nm) ANZUGSMOMENT (Nm) PAR DE TORQUE (Nm)
M5	ECP 3	5 ± 7%

TABELLA COPPIE DI SERRAGGIO PER DISCHI - COUPLING DISCS TIGHTENING TORQUE TABLE
TABLEAU DE COUPLE DE SERRAGE POUR DISQUES - KUPPLUNG ANZUGSMOMENT TABELLE
TABLA PAR DE TORQUE POR DISCOS



TIPO TYPE TYP	SAE	L	DIMENSIONE VITI SCREWS DIMENSIONS DIMENSIOES VIS SCHRAUBENMESSUNGEN DIMENSIONES TORNILLOS	COPPIA DI SERRAGGIO (Nm) TIGHTENING TORQUE (Nm) COUPLE DE SERRAGE (Nm) ANZUGSMOMENT (Nm) PAR DE TORQUE (Nm)
			TCCEI	CL. 8.8
ECP3	6 ½	30,2	M8 x 25	25
	7 ½	30,2	M8 x 25	25
	8	62	M8 x 55	25
	10	53,8	M8 x 50	25
	11 ½	39,6	M8 x 35	25

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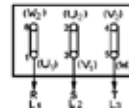
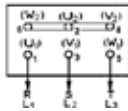
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COLLEGAMENTI GENERATORI A 6 FILI
CONNECTIONS FOR 6 LEAD ALTERNATORS
CONNECTIONS ALTERNATEURS 6 FILS
ANSCHLUSSE DER GENERATOREN MIT 6 WICKLUNSENDEN
CONEXION ALTERNADOR DE 6 HILOS



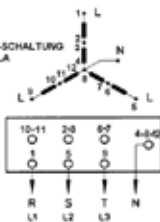
COLLEGAMENTO A STELLA
STAR CONNECTION
CONNECTION ETOILE
STERN-SCHALTUNG
CONEXION EN ESTRELLA



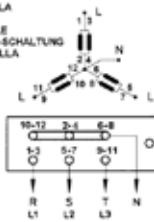
COLLEGAMENTO A TRIANGOLO
DELTA CONNECTION
CONNECTION TRIANGLE
DREIECK-SCHALTUNG
CONEXION EN TRIANGULO

COLLEGAMENTI GENERATORI A 12 FILI
CONNECTIONS FOR 12 LEAD ALTERNATORS
CONNECTIONS ALTERNATEURS 12 FILS
ANSCHLUSSE DER GENERATOREN MIT 12 WICKLUNSENDEN
CONEXION ALTERNADOR DE 12 HILOS

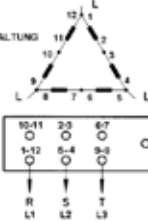
SERIE STELLA
SERIES STAR
SERIE ETOILE
STERN-REIHEN-SCHALTUNG
SERIE ESTRELLA



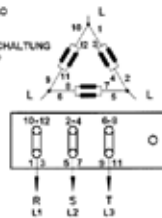
PARALLELO STELLA
PARALLELE STAR
PARALLELE ETOILE
STERN PARALLELE-SCHALTUNG
PARALELO ESTRELLA



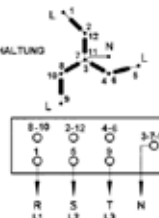
SERIE TRIANGOLO
SERIES DELTA
SERIE TRIANGLE
DREIECK-REIHEN-SCHALTUNG
SERIE TRIANGULO



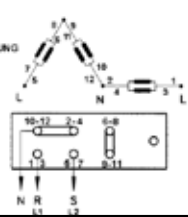
PARALLELO TRIANGOLO
PARALLELE DELTA
PARALLELE TRIANGLE
DREIECK PARALLELE-SCHALTUNG
PARALELO TRIANGULO



ZIG-ZAG TRIFASE
THREE-PHASE ZIG-ZAG
ZIG-ZAG TRIFASE
DREIPHASIGEN ZIG-ZAG SCHALTUNG
ZIG-ZAG TRIFASCA



MONOFASE PARALLELO ZIG-ZAG
SINGLE PHASE PARALLELE ZIG-ZAG
MONOPHASE PARALLELE ZIG-ZAG
DIPHASIGEN ZIG-ZAG PARALLELE-SCHALTUNG
MONOPHASE PARALELO ZIG-ZAG



DOPPIO TRIANGOLO
DOUBLE DELTA
DOUBLE TRIANGLE
DOPPEL DREIECK-SCHALTUNG
DOBLE TRIANGULO

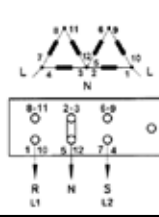
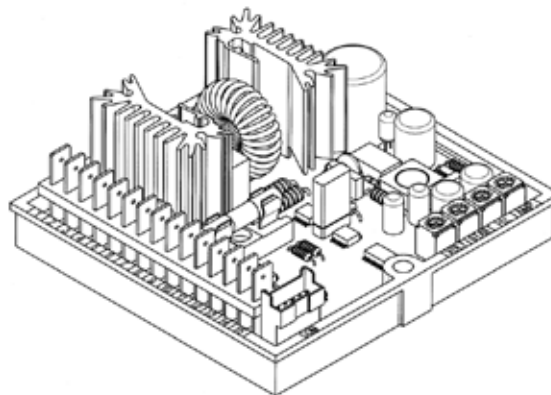


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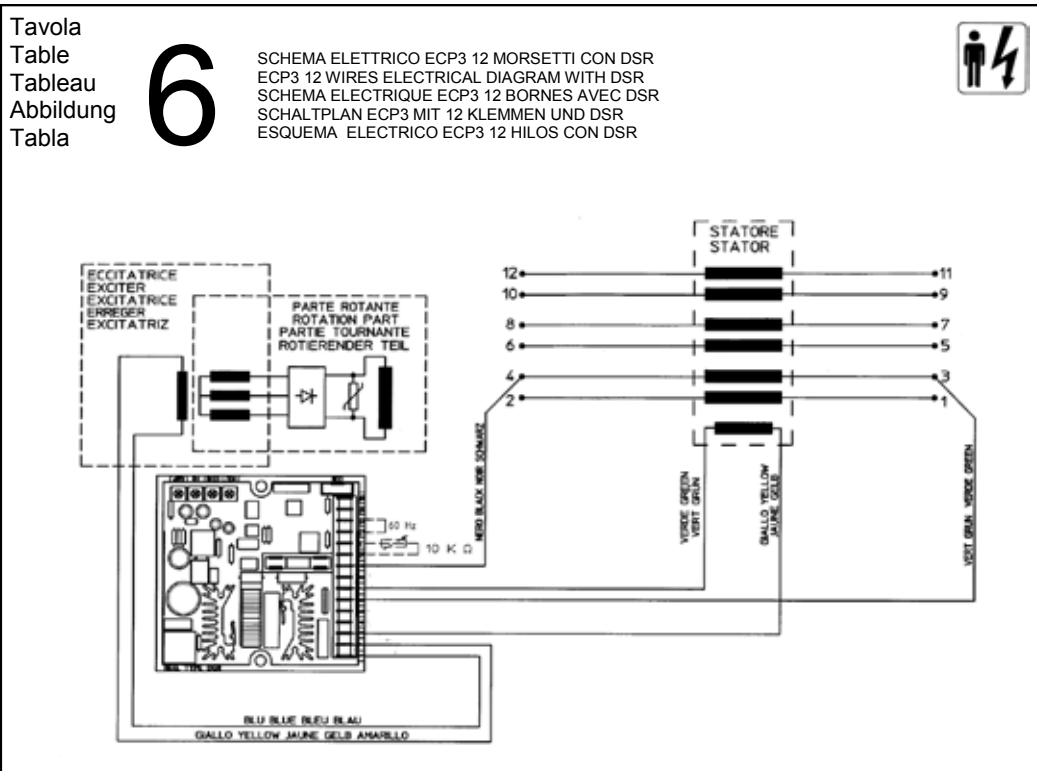
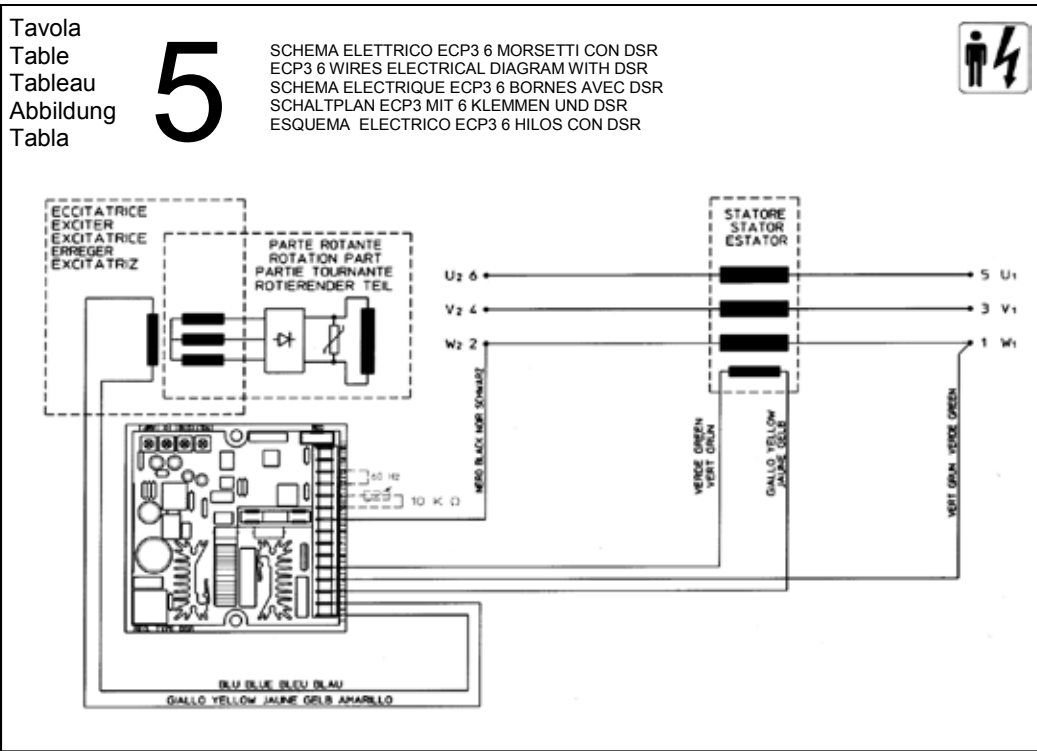
REGOLATORE ELETTRONICO DSR
ELECTRONIC REGULATOR DSR
RÉGULATEUR ÉLECTRONIQUE DSR
ELEKTRONISCHER REGLER DSR
REGULADOR ELECTRONICO DSR



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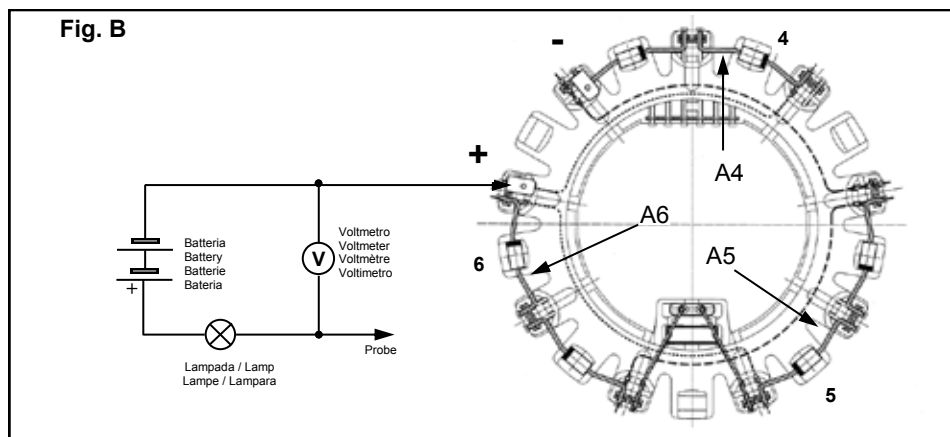
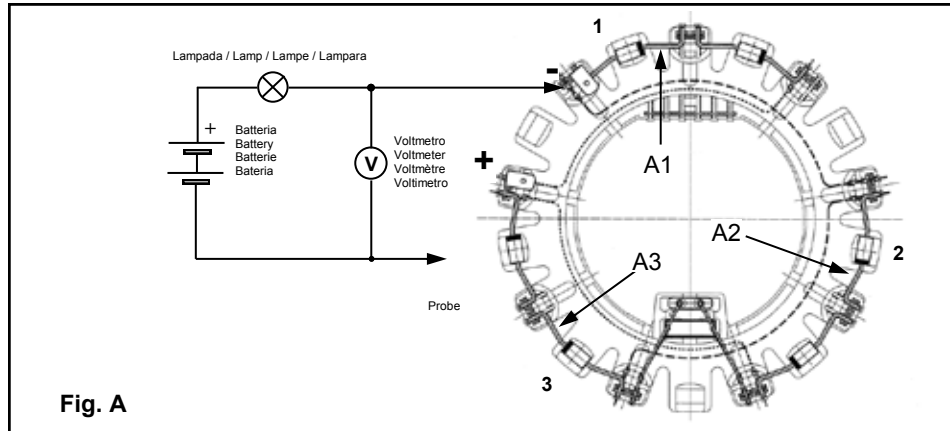
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PROCEDURA DI VERIFICA PER DIODI ROTORE ECCITATRICE.
PROCEDURE TO CHECK THE DIODES OF THE EXCITER ROTOR.
PROCEDURE POUR CONTROLER LES DIODES DU STATOR D'EXCITATRICE.
VORGEHENSWEISE ZUR PRÜFUNG DER DIODEN IM ERREGERROTOR.
PROCEDIMIENTO DE CONTROL PARA DIODOS ROTOR EXCITATRIZ.



2 and 4 pole ALTERNATORE TIPO ALTERNATOR TYPE ALTERNATEUR TYPE GENERATOR TYP ALTERNADOR TIPO	TENSIONE MISURATA / VOLTAGE MEASURED TENSION MESUREE / GEMESSENE SPANNUNG TENSION MEDIDA (fig. A-B)		
	Diodo buono Good diode Diode bonne Diode gut Diodo bueno	Diodo in corto <i>Diode in short</i> diode en court-circuit Diode in Kurzschluss Diodo en corto	Diodo aperto <i>Diode open</i> diode ouverte Diode offen Diodo abierto
SERIE 3 / SERIES 3	da from de von de	a to à bis a	inferiore a lower than Inférieure à Kleiner als Inferior a
			superiore a <i>more than</i> supérieure à grösser als Superior a
			0,7V 2V

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SCATOLA REGOLAZIONE ECP3
ECP3 TERMINAL BOX
BOITIER DE REGULATION
ECP3
REGLERKASTEN ECP3
CAJA DE REGULATION ECP3

REGOLATORE ELETTRONICO DSR
ELECTRONIC REGULATOR DSR
REGULATEUR ELECTRONIQUE DSR
ELEKTRONISCHER REGLER DSR
REGULADOR ELECTRONICO DSR

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VOLUMI D'ARIA E RUMOROSITA' (PRESSIONE SONORA (A) A VUOTO)
AIR FLOW AND NOISE LEVEL (NO LOAD (A) SOUND PRESSURE LEVEL)
VOLUME D'AIR ET NIVEAU SONORE (NIVEAU SONORE (A) à VIDE)
LUFTMENGE UND GERÄUSCHPEGEL (LAUTSTÄRKE (A) BEI LEERAUF)
VOLUMEN DE AIRE Y RUIDO (PRESION SONORA (A) EN VACIO)

Tipo Type Typ	Volume d'aria Air volume Volume d'air Luftmenge Volumen de aire		Rumore Noise Bruit Gerausch Ruido		Rumore Noise Bruit Gerausch Ruido	
	m ³ /min		3000		3600	
	3000 RPM	3600 RPM	7m dBA	1m dBA	7m dBA	1m dBA
ECP3-1S/2	6,4	7,8	70	85	73	89
ECP3-2S/2	6,3	7,8	70	85	73	89
ECP3-3S/2	6,2	7,8	70	85	73	89
ECP3-1L/2	6	7,2	70	85	73	89
ECP3-2L/2	5,8	6,8	70	85	73	89

Tipo Type Typ	Volume d'aria Air volume Volume d'air Luftmenge Volumen de aire		Rumore Noise Bruit Gerausch Ruido		Rumore Noise Bruit Gerausch Ruido	
	m ³ /min		1500		1800	
	1500 RPM	1800 RPM	7m dBA	1m dBA	7m dBA	1m dBA
ECP3-1S/4	3,5	3,9	58	72	60	78
ECP3-2S/4	3,5	4,1	58	72	60	78
ECP3-3S/4	3,3	4	58	72	60	78
ECP3-1L/4	3	3,5	58	72	60	78
ECP3-2L/4	3	3,5	58	72	60	78

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MOMENTI DI INERZIA E PESI
MOMENTS OF INERTIA AND WEIGHTS
MOMENT D'INERTIE ET POIDS
TRAGHEITSMOMENT UND GEWICHT
MOMENTO DE INERCIA Y PESO

Tipo Type Typ	J			Peso Weight Poids Gewicht		
	Kg ^m ²			Kg		
	FORMA / FORM / FORME			FORMA / FORM / FORME		
	B3/B14	B3/B9	MD35	B3/B14	B3/B9	MD35
ECP3-1S/2	0,03561	0,03549	0,03591	52	50	56
ECP3-2S/2	0,03955	0,03943	0,03985	58	56	62
ECP3-3S/2	0,04564	0,04568	0,04594	64	62	68
ECP3-1L/2	0,05148	0,05144	0,05187	76	74	80
ECP3-2L/2	0,05735	0,05731	0,05774	84	82	88

Tipo Type Typ	J			Peso Weight Poids Gewicht		
	Kg ^m ²			Kg		
	FORMA / FORM / FORME			FORMA / FORM / FORME		
	B3/B14	B3/B9	MD35	B3/B14	B3/B9	MD35
ECP3-1S/4	0,05231	0,05219	0,05261	56	54	59
ECP3-2S/4	0,05933	0,05921	0,05963	62	60	65
ECP3-1L/4	0,07231	0,07227	0,07270	76	74	79
ECP3-2L/4	0,08409	0,08405	0,08448	84	82	87
ECP3-3L/4	0,09027	0,09023	0,09066	90	88	93

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Generator

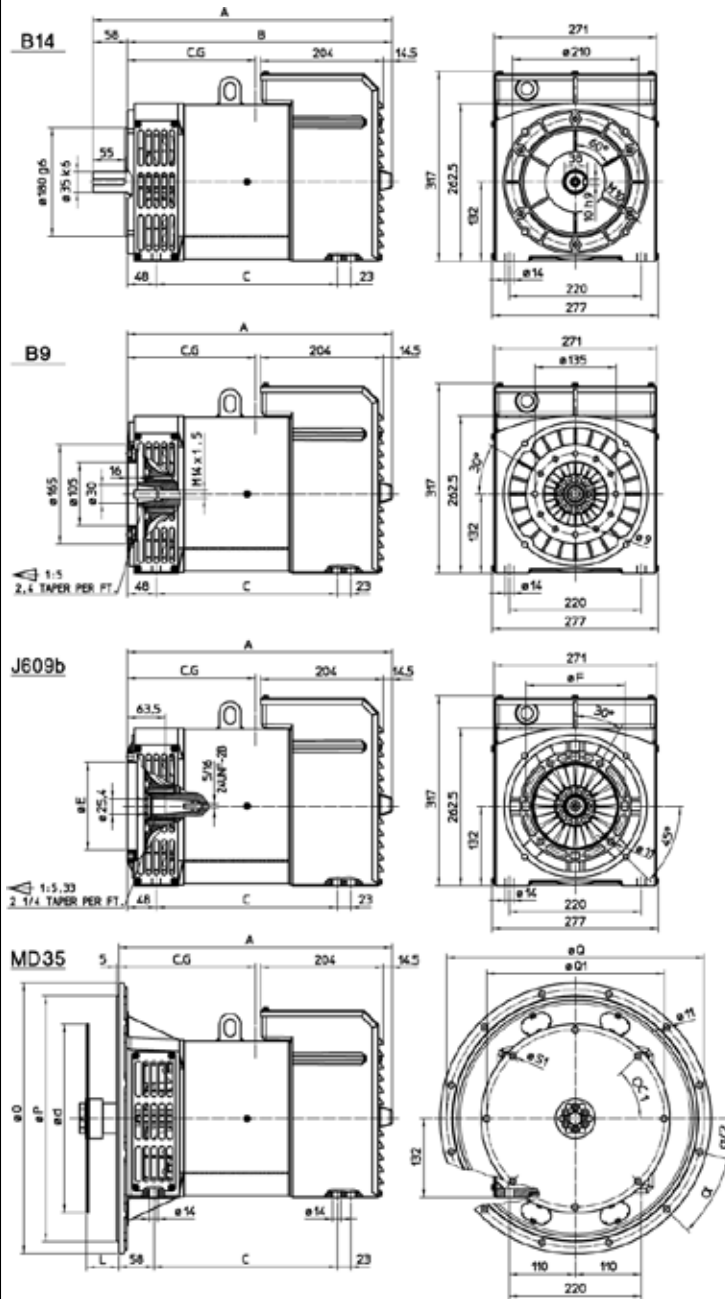
MAC 6000 Hydronic Heater

Tavola
Table
Tableau
Abbildung
Tabla

11

DIMENSIONI DI INGOMBRO
OVERALL DIMENSIONS
ENCOMBREMENT
BAUBMESSUNGEN
DIMENSIONES EXTERNAS

dimensions in mm



Forma Form Forme	A	B	C	E	F	
B14	S	498	440	301	-	-
	L	568	510	371	-	-
B9	S	440	-	301	-	-
	L	510	-	371	-	-
J609b	S	440	-	301	146.1	165.1
	L	510	-	371	163.6	196.8
MD35	S	454	-	305	177.8	196.8
	L	524	-	375	-	-

Forma Form Forme	Centro di gravità Center of gravity Centre de gravité Schwerpunkt Centros de gravedad 2 Poli - Pole - Polig - Polos				
	1S	2S	3S	1L	2L
B14	239	233	220	267	256
B9	243	237	223	274	261
J609b	245	239	225	275	262
MD35	237	232	221	271	260

Forma Form Forme	Centro di gravità Center of gravity Centre de gravité Schwerpunkt Centros de gravedad 4 Poli - Pole - Polig - Polos				
	1S	2S	1L	2L	3L
B14	237	228	270	256	249
B9	241	231	277	261	254
J609b	243	232	278	262	255
MD35	235	228	273	261	255

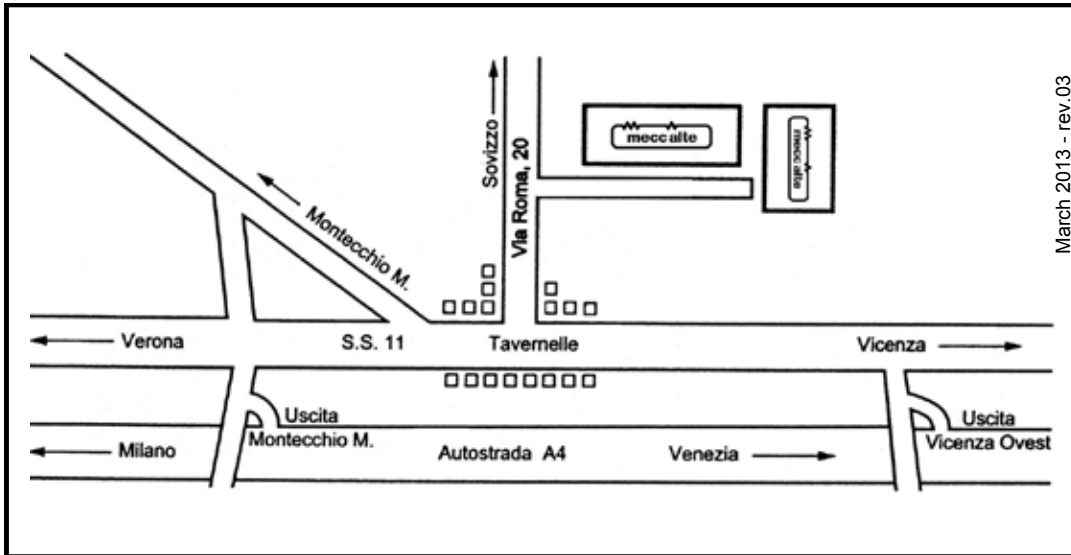
SAE N°	Flangia / Flange / Bride Flansch / Bidas				
	O	P	Q	n° fori	α
6	308	266,7	285,75	8	22°30'
5	356	314,3	333,4	8	22°30'
4	403	362	381	12	15°
3	451	409,6	428,6	12	15°

SAE N°	Giunti a dischi Disc coupling Disque de monopalerie Scheibenkupplung Juntas a discos					
	L	d	Q1	n° fori	S1	α1
6 ½	30,2	215,9	200	6	9	60°
7 ½	30,2	241,3	222,25	8	9	45°
8	62	263,52	244,47	6	11	60°
10	53,8	314,32	295,27	8	11	45°
11 ½	39,6	352,42	333,37	8	11	45°

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Generator

MAC 6000 Hydronic Heater



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Single stage operation oil burner



NON-RETROFIT APPLICATIONS

If this burner is being installed in a packaged unit (ie. burner comes with a boiler or furnace), follow the installation and set-up instructions supplied with the heating unit, as settings may differ from those shown in this manual.

- *The following pages contain information, descriptions and diagrams for the proper installation and wiring of the burner. Please read carefully before attempting final installation.*
- *This manual is to remain with the final installation designation. It is the installer's responsibility to ensure that the burner installation and operation instructions mentioned in this manual are followed and operated within local code authority limits.*

RIELLO 40

CODE	MODEL	TYPE
3726512	F20 WITH HYDRAULIC JACK	265T

2902453 (2) - 07/2008

Riello Burner

MAC 6000 Hydronic Heater

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INSTALLATION PRECAUTIONS

AIR FOR COMBUSTION

Do not install burner in room with insufficient air for combustion. Be sure there is an adequate air supply for combustion if the boiler/furnace room is enclosed. It may be necessary to create a window to permit sufficient air to enter the boiler/furnace room. The installer must follow local ordinances in this regard.

CANADA It is suggested that the installer follow CSA standard B139.

USA It is suggested that the installer follow NFPA manual #31.

CHIMNEY

Be sure chimney is sufficient to handle the exhaust gases. It is recommended that only the burner be connected to the chimney. Be sure that it is clean and clear of obstructions.

OIL FILTER

An external oil filter is REQUIRED, even though there is an internal strainer in the pump. The filter should be replaced at least once a year, and the filter container should be thoroughly cleaned prior to installing a new filter cartridge.

DRAFT

Follow the instructions furnished with the heating appliance. The pressure in the combustion area should be kept as close to zero as possible. The burner will operate with a slight draft or pressure in the chamber.

ELECTRICAL CONNECTIONS

CANADA All electrical connections should be done in accordance with the C.E.C. Part 1, and all local codes. The system should be grounded.

USA All electrical connections should be done in accordance with the National Electrical Code, and all local ordinances. The system should be grounded.

CONTROL BURNER OPERATION

Check out the burner and explain its operation to the homeowner. Be sure to leave the Owner's Instruction sheet with the homeowner.

FIRE EXTINGUISHER

If required by local codes, install an approved fire extinguisher.

ELECTRICAL CONNECTIONS

In most localities, a number 14 wire should be used inside a metal conduit. The system should be grounded. A service switch should be placed close to the burner on a fireproof wall in an easily accessible location.

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PACKAGE CONTENTS LIST

Your Riello 40 burner should include the following parts. Please check to make sure all parts are present before beginning the installation.

Quantity	Description	Code
1	Burner chassis with cover	3726512
1	Universal mounting flange + mounting gasket	2567395
1	Parts bag	2566283
1	Parts bag	2567338
1	Installation manual	2902453
1	By-pass plug	
1	Separate carton - OEM burners shipped with combustion head mounted Air Tube/Drawer Assembly	

Parts bag 2566283

Quantity	Description
1	Female 1/4" NPT adapter
1	Male 3/8" NPT adapter
1	Oil pump connector (supply)
1	Oil pump connector (return)
2	Mounting flange bolts (short)
2	Nuts
2	Chrome nuts

Parts bag 2567338

Quantity	Description
2	Semi-flange bolts (long)
2	Semi-flange
2	Cover screws
2	Nuts

SERIAL NUMBER IDENTIFICATION

Your Riello burner may have been manufactured in more than one location and therefore there are two possible serial number identification.

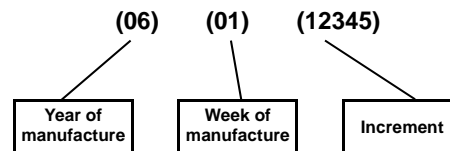
The Riello 9 character serial number, example,

06 01 12345, is identified as follows:

06 = Last two digits of the year of manufacture;

01 = Week of manufacture;

12345 = Increment of 1 for each burner produced – specific to product code – reset to zero each January 1st.



The Riello 15 character serial number, example,

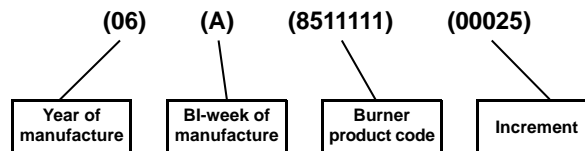
06 A 8511111 00025, is identified as follows:

06 = Last two digits of the year of manufacture;

A = BI-week of manufacture;

8511111 = Burner product code;

00025 = Increment of 1 for each burner produced – specific to product code – reset to zero each January 1st.



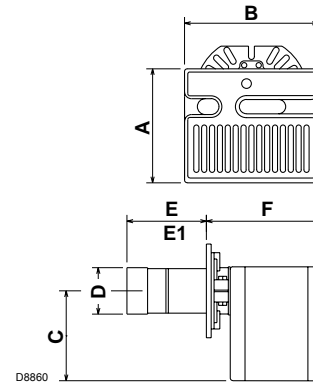
Riello Burner

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TECHNICAL DATA SPECIFICATIONS

Fuel	No. 2 Fuel Oil
Firing rate	3.50 to 6.40 GPH 11.3 to 20.7 kg/h
Effective output	490,000 to 896,000 BTU/h - 143.5 to 262.5 kW 123,480 to 225,790 kcal/h
Voltage (single phase)	120V 60Hz (+ 10% - 15%)
Absorbed electrical power	465 Watts
Motor (rated)	3250 rpm Run Current 4.3 AMP
Capacitor	16 Microfarads 260V
Pump pressure	100 to 200 psi
Primary control	RIELLO 530 SE/C 24V
Ignition transformer	8kV 16mA

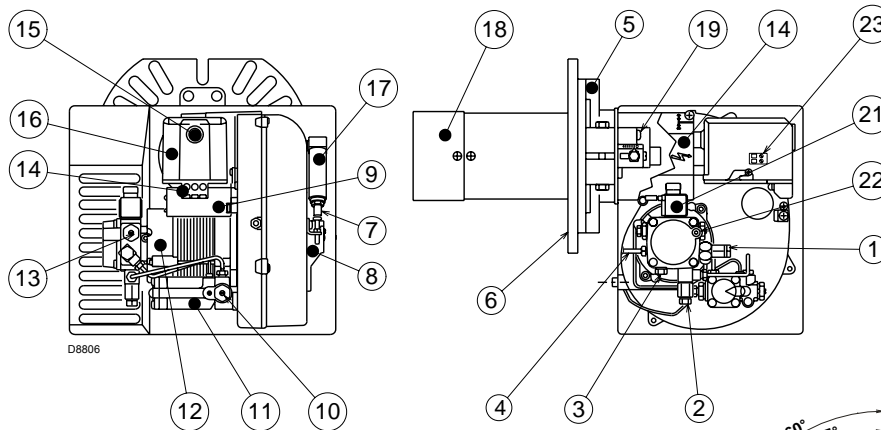


BURNER AND MOUNTING FLANGE DIMENSIONS

Model F20	A	B	C	D	E	F	G	H	I	L
Inches	11 3/4	13 25/32	9 1/16	4 11/16	5	11 27/32	1 1/2	1/4	7/16	2 7/8
mm	298	350	230	119	127	301	38	6	11	73

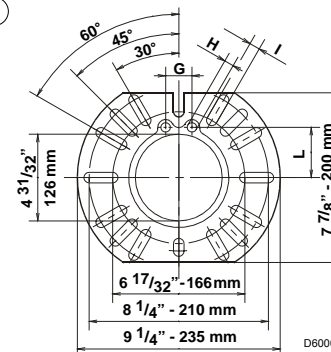
E1: 10-inch long (254mm) tubes are also available.

BURNER COMPONENTS IDENTIFICATION



BURNER COMPONENTS

- | | |
|--|---|
| 1 Pressure gauge connection port | 13 Pump pressure regulator adjustment screw |
| 2 Return fuel line port | 14 Primary control sub-base |
| 3 Inlet fuel line port | 15 Lockout indicator lamp and reset button |
| 4 Capillary tube | 16 Primary control |
| 5 Adjustable collar | 17 Hydraulic jack |
| 6 Mounting flange with gasket | 18 End cone |
| 7 Air adjustment fixing screws | 19 Turbulator adjustment screw |
| 8 Hydraulic air shutter | 20 Air tube cover |
| 9 Capacitor | 21 Coil |
| 10 Fuel pressure adjustment screw low fire | 22 Vacuum gauge connection port |
| 11 Hydraulic delay valve low fire start | 23 24V thermostat connections |
| 12 Motor | |



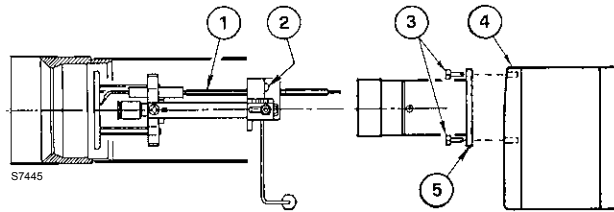
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INITIAL SET-UP

- A) Remove burner and air tube from cartons. Check parts list (inside cover) to ensure all parts are present.
- B) Remove burner cover by loosening the three screws securing it. Remove control box and air tube cover.
- C) Remove drawer assembly from air tube, insert nozzle and set Turbulator adjustment for specific input required, then set aside.
- D) Mount air tube to burner chassis.

ASSEMBLY OF AIR TUBE TO BURNER CHASSIS

The air tube and drawer assembly are shipped in a carton separate from the burner chassis. Choose the proper air tube length to obtain the tube insertion for the specific installation.



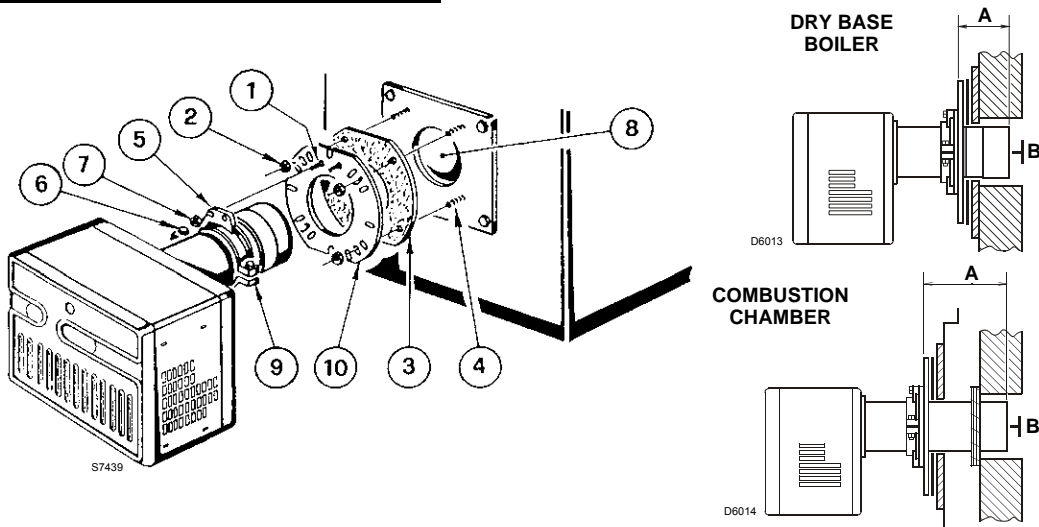
- A) Remove the AIR TUBE and BURNER CHASSIS from their respective cartons.
- B) Remove the DRAWER ASSEMBLY (1) from inside the AIR TUBE by loosening the screw (2). Carefully pull the DRAWER ASSEMBLY out of the AIR TUBE, install the required nozzle (see page 7) and set aside.
- C) Align the two holes on the AIR TUBE HOLDING PLATE (5) with the two holes left open on the BURNER CHASSIS FRONT PLATE (4) with the BOLTS (3) removed. Replace the BOLTS and finger tighten only. Re-install DRAWER ASSEMBLY into AIR TUBE. Tighten SCREW (2) securely (see page 7).
- D) Tighten the two bolts (3) securely.

MOUNTING THE BURNER TO THE BOILER OR FURNACE

There are three possible methods to mount the burner, depending on the individual application. These are:

- 1) Universal flange bolted to Boiler/Furnace unit.
- 2) Semi-flange collar bolted to Boiler/Furnace unit.
- 3) Universal flange mounted to optional Pedestal mount, where flange mounting direct to appliance is not possible. Pedestal kit must be ordered separately.

METHOD 1 – UNIVERSAL MOUNTING FLANGE



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- A) Insert the two BOLTS (1) into the UNIVERSAL MOUNTING FLANGE (10) from the flat side, ensuring the bolt heads are flush with the flat surface. Secure in place using two special CHROME NUTS (2) provided.
- B) Position the MOUNTING GASKET (3) between the flat surface of the UNIVERSAL MOUNTING FLANGE (10) and the appliance. Line up the holes in the UNIVERSAL MOUNTING FLANGE with the STUDS (4) on the appliance mounting plate and securely bolt the UNIVERSAL MOUNTING FLANGE to the plate.
- C) Secure the two semi-flanges of the ADJUSTABLE COLLAR (9) to the AIR TUBE using the two long BOLTS (6). Be sure that the ADJUSTABLE collar is properly positioned so the outside edge of the END CONE will be at least 1/4 inch (6.5 mm) back from the inside wall of the refractory of the combustion chamber (see dimension B). The measured length (A), is to include MOUNTING GASKET and FLANGE, if used.
- D) The burner may now be attached to the heating unit by inserting the AIR TUBE through the BURNER ACCESS HOLE (8) and into the appliance, making sure the BOLTS (1) line up with the two HOLES (5) in the ADJUSTABLE COLLAR. Secure the burner in place using two NUTS (7).

A visual verification of the air tube insertion into the combustion chamber of the heating unit is suggested. Dimension B should be at least 1/4" (see drawing).

NOTE:

A suggested method for creating mounting bolt holes in the mounting gasket: Hold the gasket against the appliance mounting bolts using the mounting flange for proper positioning. Lightly tap the flange with a hammer to form the holes.

METHOD 2 – SEMI-FLANGE COLLAR

- A) Follow item C from METHOD 1.
- B) Align the air tube and attached adjustable collar so air tube is centered in the burner access hole of the boiler/furnace unit. Mark the center of the two holes in the ADJUSTABLE COLLAR on to the front plate of the heating unit. Then drill 1/4 inch (6.5 mm) holes through the front plate of the unit, using marks as a guide.
- C) Install two short BOLTS (1) through the front plate of the heating unit from the inside, and secure on the outside using the two special CHROME NUTS (2).
- D) Follow item D from METHOD 1.

METHOD 3 – PEDESTAL MOUNT

Secure the MOUNTING FLANGE to MOUNTING PEDESTAL using the hardware provided with the pedestal. Secure burner to MOUNTING FLANGE as in METHOD 1, items A, C and D.

NOTE:

It is suggested that the pedestal be anchored in position on the floor by installing brackets over the pedestal tube and securing brackets to the floor.

WARNING:

WHEN THE COMBUSTION CHAMBER IS LINED WITH A REFRACTORY MATERIAL, IT IS IMPERATIVE THAT THE END CONE NOT PROTRUDE INTO THE CHAMBER AREA, AS EXCESSIVE HEAT AT BURNER SHUT-DOWN WILL DAMAGE THE END CONE.

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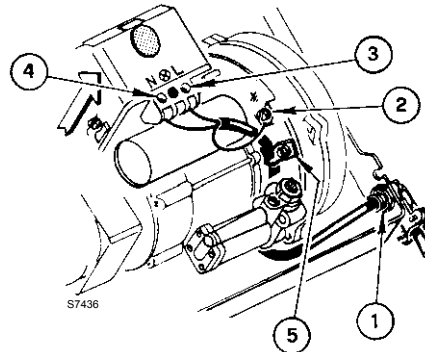
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ELECTRICAL CONNECTIONS

It is advisable to leave the control box off the sub-base while completing the electrical connections to the burner.

- 1) Wire access hole (Use BX electrical connector)
- 2) Earth ground conductor terminal (GREEN WIRE)
- 3) Hot conductor terminal (BLACK WIRE)
- 4) Neutral conductor terminal (WHITE WIRE)
- 5) Strain relief clamp



WARNING:

The hot (black) wire must be connected to the L terminal and the neutral (white) wire must be connected to the N terminal or the primary safety control will be damaged.
Do not connect wither wire to the terminal marked ⊗.

The burner may be controlled using either a DIRECT LINE VOLTAGE control circuit (120V AC 60 cycle) OR a LOW VOLTAGE thermostat input (T-T). Using the appropriate diagram below, make electrical connections to burner. All wiring must be done in accordance with existing electrical codes, both national and local.

When all electrical connections have been made, the control box may be put back in place on the sub-base.

WARNING: DO NOT activate burner until proper oil line connections have been made, or failure of the pump shaft seal may occur.

APPLICATION FIELD WIRING

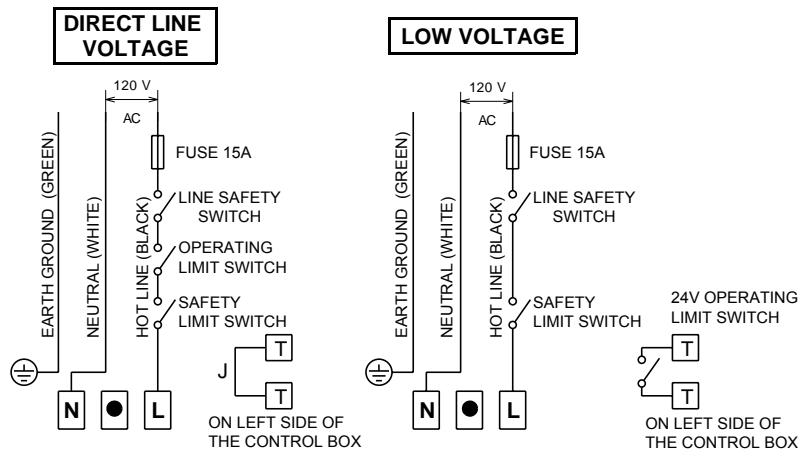
REMOTE SENSING OF SAFETY LOCKOUT:

The SAFETY SWITCH in the 530SE/C 24V CONTROL BOX is equipped with a contact allowing remote sensing of burner lockout.

The electrical connection is made at terminal 4 (●) on the SUB-BASE.

Should lockout occur the 530SE/C 24V CONTROL BOX will supply a power source of 120Vac to the connection terminal.

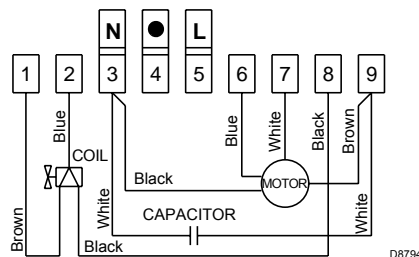
The maximum allowable current draw on this terminal (4) is 1 Amp.



WARNING:

If a neutral or ground lead is attached to this terminal, the CONTROL BOX on the burner will be damaged should lockout occur.

FACTORY WIRED SUB-BASE



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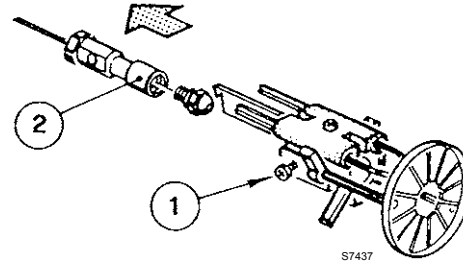
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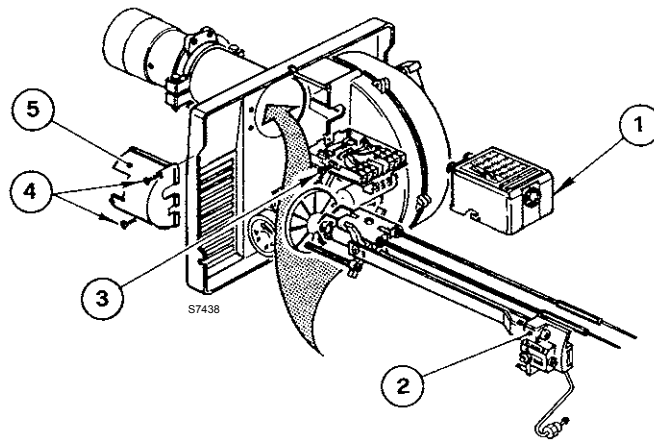
NOZZLE PLACEMENT

- Determine the proper firing rate for the boiler or furnace units, considering the specific application, and then use the Burner Setup Charts to select the proper nozzle and pump pressure to obtain the required input from the burner.
- Remove the NOZZLE ADAPTER (2) from the DRAWER ASSEMBLY by loosening the SCREW (1).
- Insert the proper NOZZLE into the NOZZLE ADAPTER and tighten securely (Do not over tighten).
- Replace adapter, with nozzle installed, into drawer assembly and secure with screw (1).



INSTALLATION/REMOVAL OF DRAWER ASSEMBLY

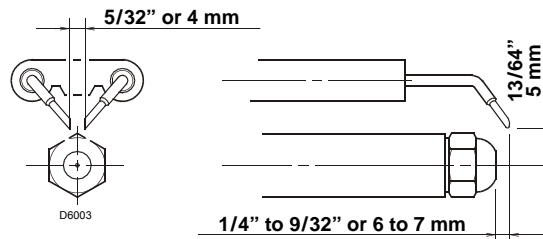
- To remove drawer assembly, loosen SCREW (3), then unplug CONTROL BOX (1) by carefully pulling it back and then up.
- Remove the AIR TUBE COVER PLATE (5) by loosening the two retaining SCREWS (4).
- Loosen SCREW (2), then slide the complete drawer assembly out of the combustion head as shown.
- To insert drawer assembly, reverse the procedure in items A to C above, then attach fuel line to the pump.



ELECTRODE SETTING

IMPORTANT:

These dimensions must be observed and verified.

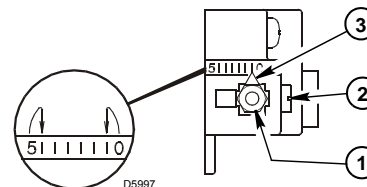


TURBULATOR SETTING

- Loosen NUT (1), then turn SCREW (2) until the INDEX MARKER (3) is aligned with the correct index number as per the Burner Set-up chart.
- Retighten the RETAINING NUT (1).

NOTE:

Zero and five are scale indicators only. From left to right, the first line is 5 and the last line 0.



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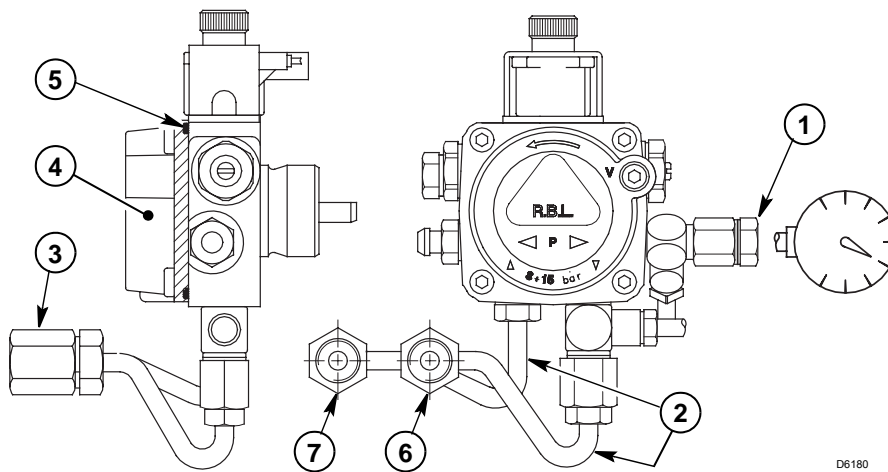
OIL LINE CONNECTIONS

WARNING:

The burner is shipped from the factory with the pump set to operate on a TWO line system.

NOTE:

- THIS BURNER **MUST** BE INSTALLED WITH A TWO LINE SYSTEM TO ALLOW THE HYDRAULIC DELAY VALVE TO OPERATE.
- Pump pressure **must** be set at time of burner start-up. A pressure gauge is attached to the PRESSURE PORT (1) for pressure readings.



Two PIPE CONNECTORS (2) are supplied with the burner for connection to either a single or a two-pipe system. Also supplied are two adapters (3), two female 1/4" NPT, to adapt oil lines to burner pipe connectors.

All pump port threads are **British Parallel thread design**. Direct connection of NPT threads to the pump will damage the pump body.

Riello manometers and vacuum gauges do **not** require any adapters, and can be safely connected directly to pump ports.

An NPT (metric) adapter **must** be used when connecting other gauge models.

NOTE:

If the **pump cover** (4) is removed for any reason, be sure the O-ring (5), is properly seated in the pump cover (4) before re-attaching the pump cover to the pump housing.

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TWO LINE (LIFT SYSTEM)

A) The burner is shipped with the pump set to operate on a two line system. Suction and return lines (6 & 7 in drawing on page 7) should be the same diameter and both should extend to the same depth inside the fuel tank.

Be sure there are no air leaks or blockages in the piping system. Any obstructions in the return line will cause failure of the pump shaft seal. Do not exceed the pipe lengths indicated in the table.

B) Attach the two PIPE CONNECTORS (2) to the pump SUCTION and pump RETURN PORTS (6 and 7).

Attach the required piping to these two pipe connectors using the NPT/METRIC ADAPTERS that are supplied with the burner.

2 LINE (LIFT) SYSTEM - PIPE LENGTHS					
H		3/8" OD		1/2" OD	
Feet	Meters	Feet	Meters	Feet	Meters
0	0.0	115	35	330	100
1 1/2	0.5	100	30	330	100
3	1.0	80	25	330	100
5	1.5	65	20	295	90
6 1/2	2.0	50	15	230	70
9 1/2	3.0	25	8	100	30
11	3.5	20	6	65	20

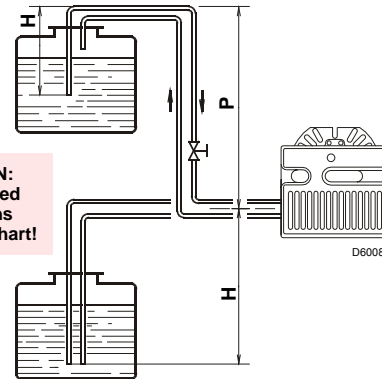
WARNING:

- Pipe dope or Teflon tapes are NOT to be used on any direct oil connection to the fuel pump.
- The height 'P' in Pipe Length Charts should not exceed 13 feet (4 m).
- The vacuum should not exceed 11.44 inches of mercury.

IMPORTANT:

An external, appropriately listed and certified oil filter must be placed in the fuel line between the fuel tank and the burner pump.

ATTENTION:
do not exceed
pipe lengths
indicated in chart!



PUMP PURGE

TWO LINE (GRAVITY OR LIFT SYSTEM)

Turn off the main power source to the burner and remove the air tube cover. Shine a light source on the photo cell on the control box (now visible where the air tube cover was removed), return power to the burner and activate the burner.

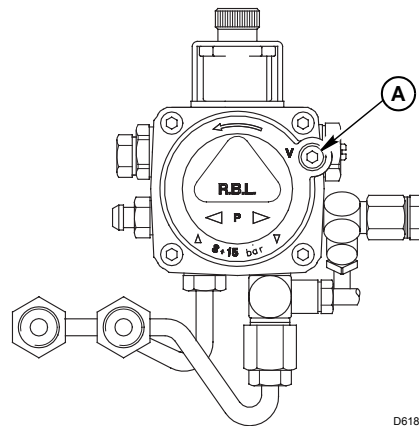
With the light source in place, the burner will operate in prepurge only.

When the pump is sufficiently purged, the hydraulic air shutter will open.

Once the burner is purged, turn off the power source and replace the air tube cover. Return power to the burner. The burner is now ready to operate.

NOTE: To protect the pump gears, it is advisable to lubricate the pump prior to purging a lift system.

Apply oil through the VACUUM PORT (A).



ATTENTION:

It is important that the fuel line be completely sealed and free from air leaks or any internal blockages.

WARNING!

WHEN THE BYPASS PLUG IS INSTALLED, A TWO PIPE SYSTEM MUST BE USED OR FAILURE OF THE PUMP SHAFT SEAL WILL OCCUR.

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AIR SHUTTER SETTING

LOW FIRE SETTING

- A) Loosen PRESSURE RELEASING SCREW (1). (One turn is sufficient). This permits the fuel pressure to bleed off to the pump return port and the burner to operate continuously at the low fire rate.
- B) Loosen RETAINING NUT (2).
- C) Turn the ADJUSTING SCREW (3) until the top of the air shutter (9) is correctly positioned according to the Burner Set-up Chart, column 5, on page 12.
- D) Use instruments to establish the proper settings for maximum CO₂ and a smoke reading of zero.
- E) Hold ADJUSTING SCREW (3) in position and secure by tightening RETAINING NUT (2).
- F) Retighten PRESSURE RELEASE SCREW (1).

Note:

The low fire pressure regulator is pre-set at the factory to 100 PSI (7 bar).

To vary or regulate this pressure it is necessary to attach a pressure gauge to the PRESSURE PORT (6).

Loosen the PRESSURE RELEASE SCREW (1) as in step A above. Regulate the pressure by turning the PRESSURE REGULATING SCREW (5).

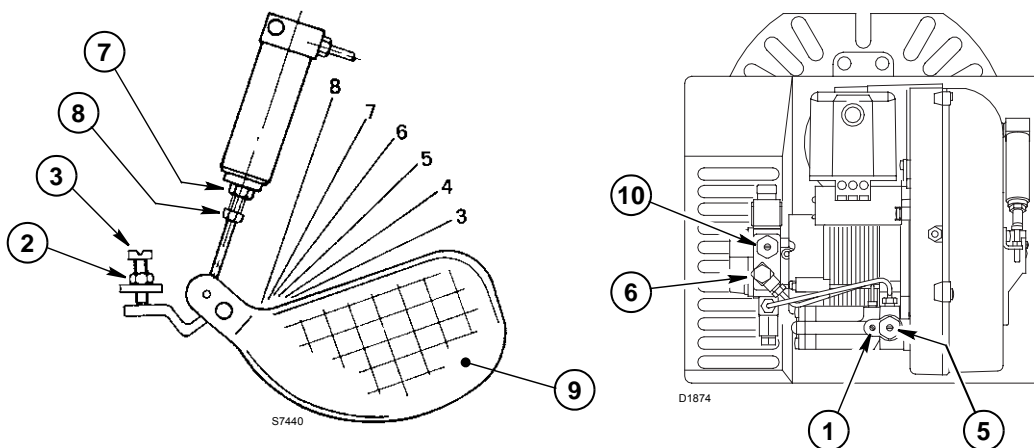
The corresponding pressure can be read on the pressure gauge attached to the PUMP PRESSURE PORT (6).

MAIN FLAME SETTING

- A) Be sure that the burner is operating at high fire.
- B) Set the pump pressure by attaching a pressure gauge to the Pressure port (6) and adjust the pressure by turning the pressure regulator adjustment screw (10).
Loosen the RETAINING NUT (7), and turn the BOLT (8) in a counterclockwise direction until about 3/4 of an inch of thread is visible. Using the setting taken from the Burner Set-up Chart, column 5, position the air shutter (9) so that the top of the shutter is aligned with the proper index line indicated on the air intake side of the burner housing. Holding the shutter in this position, turn ADJUSTING BOLT (8) in a clockwise direction until a resistance is met.
- C) The final position of the air adjustment plate will vary on each installation. Use instruments to establish the proper settings for maximum CO₂ and a smoke reading of zero.

NOTE:

Variations in flue gas, smoke, CO₂ and temperature readings may be experienced when the burner cover is put in place. Therefore, the burner cover **must** be in place when making the final combustion instrument readings, to ensure proper test results.



Riello Burner

MAC 6000 Hydronic Heater

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BURNER SET-UP CHART

NON-RETROFIT APPLICATIONS

If this burner is being installed in a packaged unit (ie. burner comes with a boiler or furnace), follow the installation and set-up instructions supplied with the heating unit, as settings will differ from those shown in this manual.

1		2	3		4	5	
Actual Firing Rate \pm 5%		Nozzle Size	Pump Pressure		Turbulator Setting	Air Damper Setting	
GPH	Kg/h	GPH	PSI	bar		Low Fire	Main Flame
3.50	11.3	2.50 x 45°/60°	190	13.0	0.0	2.3	2.8
4.00	12.9	3.00 x 45°/60°	178	12.0	1.0	2.5	3.2
4.65	15.0	3.50 x 45°/60°	178	12.0	2.0	2.8	3.7
5.30	17.1	4.00 x 45°/60°	178	12.0	3.0	3.2	4.5
6.00	19.4	4.50 x 45°/60°	178	12.0	4.0	3.5	5.0
6.40	20.7	5.00 x 45°/60°	165	11.4	5.0	3.8	6.0

NOZZLES RECCOMANDED:

Monarch R-PLP, Delavan W-B, Danfoss S-B, Steinen SS-S, Hago P.

NOTE:

A 45° degree nozzle is suggested, however, a 60° degree nozzle may be used in cases where the flame is unstable at light-off when operated at low ambient temperatures.

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DUCTED COMBUSTION AIR INTAKE APPLICATIONS

The "Ducted combustion air intake kit" (see P.N. 3002762 in the spare parts list - OPTIONAL), allows ducting of external air directly into the burner. A 4" diameter air intake is provided in the kit.

To mount this kit on the burner, please follow the installation description given in the kit instruction sheet. Use a 4" to 6" pipe adapter (not supplied in the kit) to use a 6" diameter pipe.

The settings of the burner must be according to the BURNER SETUP CHART – AIR INTAKE APPLICATIONS below.

MODEL F20 BURNER SETUP CHART with 4" diameter pipe.											
Actual Firing Rate GPH	Nozzle Size	Pump Pressure PSI	Head Setting	20 Ft. pipe length		50 Ft. pipe length		80 Ft. pipe length		100 Ft. pipe length	
				Air Setting		Air Setting		Air Setting		Air Setting	
				Low fire	Main flame	Low fire	Main flame	Low fire	Main flame	Low fire	Main flame
3.50	2.50 x 45°/60°	195	0.5	2.3	2.9	2.3	2.9	2.3	3.0	2.5	3.0
4.00	3.00 x 45°/60°	177	2.0	2.4	3.1	2.4	3.3	2.4	3.5	2.6	3.8
4.65	3.50 x 45°/60°	176	3.5	2.9	3.9	3.0	4.2	3.0	4.5	3.5	5.0
5.16	4.00 x 45°/60°	160	5.0	3.1	4.8	3.2	5.0	3.3	5.0	3.8	5.8

MODEL F20 BURNER SETUP CHART with 6" diameter pipe.											
Actual Firing Rate GPH	Nozzle Size	Pump Pressure PSI	Head Setting	20 Ft. pipe length		50 Ft. pipe length		80 Ft. pipe length		100 Ft. pipe length	
				Air Setting		Air Setting		Air Setting		Air Setting	
				Low fire	Main flame	Low fire	Main flame	Low fire	Main flame	Low fire	Main flame
3.50	2.50 x 45°/60°	195	0.5	2.1	2.8	2.1	2.8	2.1	2.9	2.1	2.9
4.00	3.00 x 45°/60°	177	2.0	2.2	3.0	2.2	3.0	2.3	3.1	2.3	3.1
4.65	3.50 x 45°/60°	176	3.5	2.7	3.4	2.7	3.5	2.9	3.8	3.1	4.5
5.30	4.00 x 45°/60°	160	4.5	3.0	3.8	3.0	4.0	3.0	4.1	3.1	4.5
6.00	4.50 x 45°/60°	177	5.0	3.0	5.3	3.3	5.4	3.3	5.4	3.5	5.7

NOZZLES RECCOMANDED:

Monarch R-PLP, Delavan W-B, Danfoss S-B, Steinen SS-S, Hago P.

NOTE:

A 45° degree nozzle is suggested, however, a 60° degree nozzle may be used in cases where the flame is unstable at light-off when operated at low ambient temperatures.

NOTES:

- A) This kit is not suitable for direct vent applications.
- B) Always try to minimize the length of the air intake pipe.
- C) Reduce pipe length by 10 feet for every 90° elbow, 5 feet for every 45° elbow.
- D) Reduce pipe length by 6 feet for the 4" to 6" pipe adapter (if used).
- E) Air intake venting should be insulated 10 feet from air intake source with a minimum R7 foil lined insulation, to prevent condensation or corrosion of air intake venting.
- F) Use an approved type of air intake vacuum breaker and install it in the same room of the burner.
This device should be tested to prove that the vacuum breaker balancer is set correctly and, in the event of intake air source being blocked, can provide enough combustion air for the burner. If the room where the burner is installed cannot provide enough air or air quality is a concern, an additional air inlet source must be provided to this room.
- G) On the outside of the wall, use an approved intake air hood, located above the snow line and in such way as to prevent leaves and/or other debris from blocking the air flow. Refer to local codes for proper location of inlet.

COMBUSTION CHAMBER

Follow the instructions furnished by the boiler/furnace manufacturer. Size retrofit application according to the appropriate installation codes (eg. CSA B139 or NFPA #31).

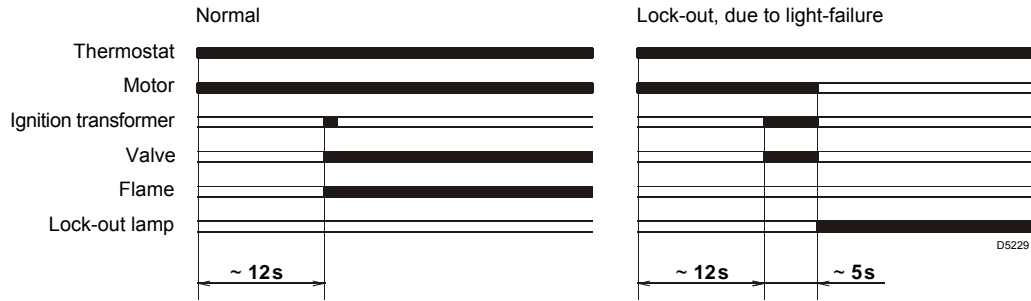
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Riello Burner

MAC 6000 Hydronic Heater

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BURNER START-UP CYCLE

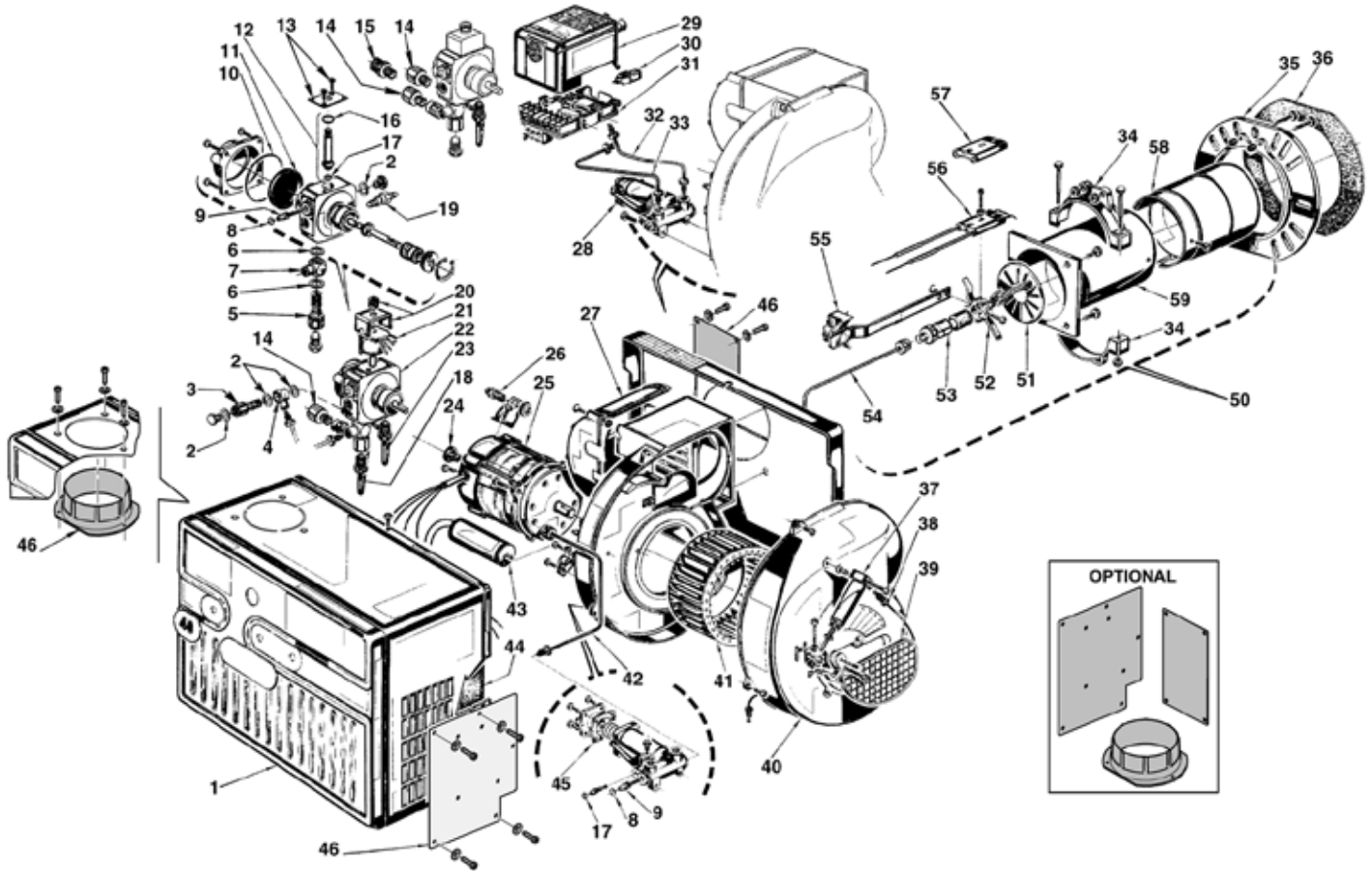


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EXPLODED SPARE PARTS LIST



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SPARE PARTS LIST

No.	CODE	DESCRIPTION	No.	CODE	DESCRIPTION
1	3020510	BURNER BACK COVER	43	3005846	CAPACITOR 16 µF
2	3007077	CRUSHABLE METAL WASHER	44	3007358	ACOUSTIC LINER
3	3005771	BANJO CORE ADAPTER - PRESSURE PORT	45	3005801	GASKET
4	3005803	BANJO FITTING - PRESSURE PORT			
5	3005804	BANJO CORE ADAPTER - RETURN LINE			OPTIONAL
6	3007079	CRUSHABLE METAL WASHER	46	3002762	DUCTED COMBUSTION AIR INTAKE KIT
7	3005805	BANJO FITTING - RETURN			
8	3007028	O-RING - PUMP PRESSURE REGULATOR			
9	3007202	REGULATOR SCREW	50	3949271	SHORT COMBUSTION HEAD 5" (275T1)
10	3007162	O-RING - PUMP COVER	51	3005897	TURBULATOR DISC
11	3005719	PUMP SCREEN	52	3005896	CROSS - CASTING
12	3006925	VALVE STEM	53	3006965	NOZZLE ADAPTER
13	3007203	VALVE STEM PLATE	54	3006987	NOZZLE OIL TUBE - SHORT
14	3005847	1/4" NPT/ METRIC ADAPTER - FEMALE	55	3005900	REGULATOR ASSEMBLY - SHORT
15	3006571	3/8" NPT/METRIC ADAPTER - MALE	56	3005902	ELECTRODE ASSEMBLY - SHORT
16	3007029	O-RING - VALVE STEM UPPER	57	3005869	ELECTRODE PORCELAIN
17	3007156	O-RING - VALVE STEM LOWER	58	3005894	END CONE
18	3006995	PIPE CONNECTOR - RETURN	59	3005892	SHORT AIR TUBE
19	3007893	BLEEDER			
20	3006553	COIL U-BRACKET AND KNURLED NUT	50	3949272	LONG COMBUSTION HEAD 10" (275T2)
21	3002279	COIL	51	3005897	TURBULATOR DISC
22	3007806	PUMP	52	3005896	CROSS - CASTING
23	3006994	PIPE CONNECTOR - SUPPLY	53	3006965	NOZZLE ADAPTER
24	3000443	PUMP DRIVE KEY	54	3006988	NOZZLE OIL TUBE - LONG
25	3005845	MOTOR	55	3005901	REGULATOR ASSEMBLY - LONG
26	3005858	UNION - NOZZLE TUBE / EXTENSION	56	3005903	ELECTRODE ASSEMBLY - LONG
27	3007318	AIR TUBE COVER	57	3005869	ELECTRODE PORCELAIN
28	3006500	HI FIRE DELAY VALVE	58	3005894	END CONE
29	3020487	PRIMARY CONTROL 530SE/C 24V	59	3005893	LONG AIR TUBE
30	3002280	PHOTO-CELL			
31	3002278	PRIMARY CONTROL SUB BASE			
32	3005809	OIL PRESSURE TUBE			
33	3005808	OIL RETURN TUBE			
34	3005849	SEMI FLANGE			
35	3005851	UNIVERSAL MOUNTING FLANGE			
36	3005852	MOUNTING GASKET			
37	3006499	HYDRAULIC JACK			
38	3008050	CAPILLARY TUBE			
39	3000645	HYDRAULIC AIR SHUTTER			
40	3007211	AIR INTAKE HOUSING			
41	3005799	FAN			
42	3005857	NOZZLE OIL TUBE EXTENSION			

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Toll Free: 800-387-3898
Fax: 905-542-1525

BURNER START- UP FORM *

Burner S/N. or Model: _____	Appliance: _____
Installer name: _____	
Company: _____	Installation date: _____
Address: _____	
Phone: _____	Fax: _____
Owner Name: _____	
Address: _____	
Phone: _____	E-mail: _____

Burner Start-up Info (OIL)

Nozzle info: _____	Pump pressure: _____
Air setting: _____	Turbolator setting: _____
Draft overfire: _____	Draft breech: _____
CO ₂ : _____ CO: _____ O ₂ : _____	Smoke density: _____ (Bacharach) _____
Single line: <input type="checkbox"/>	Two lines: <input type="checkbox"/>

* This form was designed and provided in the installation manual for reference and also for providing technical information which can be faxed or mailed to our technical hot-line coordinator when technical assistance is required. Please complete this form, fax it or mail it at the address/fax above, or send an e-mail with the information listed below to: techservices@riellocanada.com

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MAC 6000

QUICK REFERENCE SERVICE/MAINTENANCE GUIDE

This is a quick reference page for your main service/maintenance intervals. More details and further service/maintenance guidelines provided in each components section within this manual.

Isuzu Engine Break-in/oil change intervals:

Page.....

ISUZU 3CA1 Diesel Engine

- 50 Hour break-in (**NO EXCEPTIONS**)
 - Engine oil, engine oil filter, engine fuel filter change
 - Cooling fan V-belt check and adjust
 - Battery
- 250 Hour regular intervals
 - Engine oil and engine oil filter
 - Radiator fins check and clean
 - Cooling fan V-belt check and adjust
 - Governor lever and accelerator check and adjust
 - Engine air filter clean & inspect
- 500 Hour regular intervals
 - Engine air filter change
 - Engine fuel filter change
- 1000 Hour regular intervals or every one (1) year
 - Change engine coolant

Page.....

Riello Burner

- Burner fuel filter - Every 250 hours
- Burner Nozzle - Annually

Page.....

Glycol/Tank



AIR HEATERS

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