WINCO

PORTABLE DIESEL SERIES

OWNERS MANUAL

MD15

SHD15000-4E/A
SHD15000-17E/A

CAUTION: EQUIPMENT DAMAGE

NEVER ATTEMPT TO "JUMP START" THIS ENGINE. IF THE BATTERY SHOULD ACCIDENTALLY BECOME DISCHARGED DISCONNECT THE BATTERY CABLES AND RECHARGE THE BATTERY BEFORE ATTEMPTING TO START THE UNIT. BOOST/ JUMP STARTING THIS UNIT IMPROPERLY WILL RESULT IN PERMANENT DAMAGE TO THE ENGINE CONTROL MODULE (ECM).

WINCO®
INCORPORATED

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A GUIDE TO PRODUCT SAFETY.

This Portable Diesel System has been designed and manufactured to allow safe, reliable performance. Improper or careless use can result in potentially deadly hazards; from electrocution or serious electrical shock, exhaust gas asphyxiation, or burns from fire. Please read all safety instructions carefully before installation or use. Keep these instructions handy for future reference. Take special note and follow all warnings on the unit and in the manuals.

****
CAUTION: Possible Damage to Equipment.
CAUTION notes indicate any condition or practice, which if not strictly observed or remedied, could result in damage or destruction of the equipment.
****

****
WARNING: Personal Danger.
WARNING notes indicate any condition or practice, which if not strictly observed, could result in personal injury or possible loss of life.
****

ELECTRIC SHOCK - The output voltage present in this equipment can cause a fatal electric shock. This equipment must be operated by a responsible person.
A. Do not allow anyone to operate the generator without proper instruction.
B. Guard against electrical shock.
C. Avoid contact with live terminals or receptacles.
D. Use extreme care if operating this unit in rain or snow.
E. Use only three-prong grounded receptacles and extension cords.
F. Be sure the unit is properly grounded to an external ground rod driven into the earth.

2. FIRE HAZARD - Engine fuels always present a hazard of possible explosion and/or fire.
A. Do not refuel when the engine is running or hot. Allow the engine to cool at least two minutes before refueling.
B. Keep fuel containers out of reach of children.
C. Do not smoke or use open flame near the generator set or fuel tank.
D. Keep a fire extinguisher nearby and know its proper use. Fire extinguishers rated ABC by NFPA are appropriate.
E. Store fuel only in an approved container, and only in a well-ventilated area.

3. DEADLY EXHAUST GAS - Exhaust fumes from any internal combustion engine contains carbon monoxide, an odorless and deadly gas that must be mixed with fresh air.
   A. Operate only in well ventilated areas.
   B. Never operate indoors.
   C. Never operate the unit in such a way as to allow exhaust gases to seep back into closed rooms (i.e. through windows, walls or floors).

4. NOISE HAZARD - Excessive noise is not only tiring, but continual exposure can lead to loss of hearing.
   A. Use hearing protection equipment when working around this equipment for long periods of time.
   B. Always operate with the housing doors closed to reduce the operational noise level.

5. CLEANLINESS - Keep the generator and surrounding area clean.
   A. Remove all grease, ice, snow or materials that create slippery conditions around the unit.
   B. Remove any rags or other material that could create potential fire hazards.
   C. Carefully wipe up any gas or oil spills before starting the unit.
   D. Never allow leaves or other flammable material to build up around the engine exhaust area.

6. SERVICING EQUIPMENT - All service, including the installation or replacement of service parts, should be performed only by a qualified technician.
   A. Use only factory approved repair parts.
   B. Do not work on this equipment when fatigued.
   C. Never remove the protective guards, cover or receptacle panels while the engine is running.
   D. Never wear neckties or other loose clothing that can be caught in moving parts while you are servicing or operating this equipment.
   E. Use extreme caution when working on electrical components. High output voltages from this equipment can cause serious injury or death.
   F. When servicing this unit always avoid hot mufflers, exhaust manifolds, and engine parts. They all can cause severe burns instantly.
   G. Installing and wiring a standby generator is not a "do it yourself" project. Consult a qualified, licensed electrician or contractor. The installation must comply with all national, state, and local codes.

7. LIFTING THE EQUIPMENT - When lifting, always make sure that the area under the equipment is kept clear.
   A. Be certain that rigging is designed to lift unit safely.
   B. Never attempt to lift the equipment unless you are certain the lifting device has sufficient capacity.
   C. Never allow the equipment to swing while suspended.
   D. Be certain the supporting structure is adequate to handle the load.

8. TOWING THE EQUIPMENT - When towing this equipment, always use a vehicle large enough for safe operation.
   A. Never tow without the safety chains secured.
   B. Always use the proper size hitch ball on the vehicle.
   C. Never attempt to tow with a vehicle that does not have side mirrors installed.
   D. Always retract the tower and lock it into the horizontal retracted position before moving the unit.
   E. Always put all jacks into ("foot up") horizontal position before moving the tower.

SPECIFICATIONS

MODEL	SHD15000-17 /A
GENERATOR SPECIFICATIONS	
Kilowatt	15 KW
Amperage	
120/240 V.A.C. Single Phase	125/62.5
240 V.A.C. Three Phase	30
Motor Starting Capacity (Code G, Cap. Start)	7 HP
Receptacles	
NEMA 5-15 Duplex (120 V. 15 Amp)	1
NEMA 5-20 Duplex (120 V. 20 Amp)	1
NEMA L5-20 (120 V. 20 Amp)	1
NEMA L5-30 (120 V. 30 Amp)	1
NEMA L6-20 (240 V. 20 Amp)	1
Hubbell CS 6369 (240 V. 50 Amp) (Uses Plug Hubbell CS 6365)	1
NEMA L15-30 (3 Phase 240 V. 30 Amp)	1
Generator Resistances	
Field Coils	
Armature	

ENGINE SPECIFICATIONS

See Kubota Operator's Manual for complete engine specifications.

Model	VH1100-B
Type	4 cycle, liquid cooled
Starting System	12V electric
Governor	Mechanical
Battery (Group 27, 70 AH)	12V 510 CCA
Filters	
Oil Filter	Kubota# 15241-32099
Air Filter	Kubota# 70000-11081
Fuel Filter	Kubota# 15231-43560
Fuel Filter/Water Seperator	Racor# R-12

HOUSING

Sound Attenuated, Weather Protective Enclosure	Standard
Single Point Lifting	Standard
Fuel Capacity	20 gals

OPTIONAL TRAILER

Capacity	1500 lbs
Axles	Single
Hitch Height	Fixed
Tires	P175/80B13 4 Ply Tread
Tire Pressure	35 psi

NOTE: This booklet covers the entire unit, EXCEPT THE ENGINE. See the engine manufacturer's operator manual for specific maintenance and care information regarding the engine. The engine information provided in this manual is for your convenience only, and in no way supercedes the engine manufacturer's instruction. If a conflict should arise regarding engine instruction, the engine manual should be considered the authority, unless specifically instructed in this manual to ignore an engine manual instruction.

Read ALL instructions in the manuals provided before attempting to operate the generator set.

UNPACKING

When unpacking the unit, be sure to inspect it carefully for freight loss or damage. Check the nameplate to be sure it is what you ordered (proper KW, voltage, fuel, etc.). If you have questions, contact your local authorized dealer. If you see evidence of loss or damage at the time of delivery, have the driver sign and describe the loss or damage in the "memo of loss or damage" section on the freight bill. Then contact the carrier to get instructions on filing a claim.

When loss or damage is discovered after the equipment is delivered, but not seen at the time of delivery, it is referred to as "concealed damage." Separate any damaged material and contact the carrier for proper procedures to file a "concealed damage" claim.

OIL REQUIREMENTS

Engine oil should be MIL-L-2104B/MIL-L-2140C or have properties of API classification CC/CD grades. Change the type of engine oil according to the ambient temperature.

above 77°F	SAE30
32 to 77°F	SAE20
below 32°F	SAE10 or SAE10W-30

OIL QUANTITY	US Qts.
SHD15000-17R/A	6

FUEL REQUIREMENTS

ASTM No. 2 diesel fuel is recommended for these engines. The use of No. 2 diesel fuel will result in optimum engine performance. When normal operating temperatures are below 0°C, it is acceptable to use a seasonal blend of No. 2 fuel. The use of lighter fuel will reduce fuel economy. (SEE THE ENGINE OPERATORS MANUAL FOR ADDITIONAL FUEL INFORMATION.)

PREPARATION

Filling the Fuel Tank

Standard Trailer - The standard trailer is equipped with a single 20 gallon fuel tank. Use caution when filling the tank to prevent it from overflowing.

COOLANT REQUIREMENTS

CAUTION: EQUIPMENT DAMAGE

> *Failure to keep the engine full of coolant will result in the high water temperature being inoperative. This sensor must be in coolant to properly measure the water temperature. Allowing the engine to operate low on coolant may allow the water level to drop below the sensor. When this happens the engine may overheat causing engine damage.*

Premium antifreeze with corrosion inhibitor should be used during all seasons to protect the engine cooling system from corrosion as well as freezing damage.

The cooling system of the engine has been filled at the factory with a 50% water and 50% ethylene-glycol antifreeze mixture. This mixture provides protection to -34° F.

CAUTION: ENGINE DAMAGE

> *Use premixed coolant. Always maintain a 50/50 ratio water and antifreeze for refilling the cooling system.*

COOLANT QUANTITY	US Gal
SHD15000	2.0

BATTERY CONNECTION INSTRUCTIONS

NOTE: TO INSURE THE BEST PERFORMANCE, BATTERIES NEED TO BE RECHARGED BEFORE CONNECTING TO THE SYSTEM.

CAUTION: EQUIPMENT DAMAGE

> *Insure the control switch is in the 'off' position before connecting or disconnecting either of the battery cables. Failure to turn the control switch 'off' can cause equipment damage when the battery cables are connected or disconnected.*

The standard Winco Portable Diesel is equipped with a single 12 volt (group 27) battery for starting. The battery has been disconnected from the battery cables prior to shipment of this unit. When re-connecting the battery, ALWAYS CONNECT THE POSITIVE CABLE FIRST and THE NEGATIVE CABLE LAST!

Disconnecting the battery is done in reverse, disconnecting the negative cable first and then the positive cable.

WARNING! POTENTIAL BATTERY EXPLOSION!

This unit uses a negative ground. Connecting the negative cable first makes the battery positive terminal 'HOT'. Connecting the positive cable last may result in accidental short circuit of the positive battery terminal to any of the surrounding metal surfaces. (i.e. dropping a tool, wrench swing etc.) Use extreme caution whenever making or breaking the battery connections and follow the correct sequence carefully.

OPERATION

DESCRIPTION AND IDENTIFICATION

A. FRONT PANEL

1. Starting Controls - This unit is equipped for manual start only. A four position MODE switch controls the engine starting.

   a. "Preheat" - This switch position controls the glow plug solenoid. When rotated to this position the switch energizes the glow plug solenoid which provides power to the glow plugs and glow plug indicator.

   b. "Off" - This switch position stops the engine and disconnects the power from the engine control module. It is intended to safely allow service and maintenance checks on the engine.

   c. "Run" - This switch position turns on the engine control module. When activated the engine control module provides power to the front panel gauges and the holding coil of the fuel solenoid through a control relay (CR1).

   c. "Start" - This switch position engages the engine starter and the pull-in coil of the fuel solenoid. The switch must be held in this position until the engine starts.

2. DC control Circuit Breaker (DCCB) - The 15 amp DC Circuit Breaker protects the engine controller and wiring harness against faults in wiring or control equipment. The DCCB also prevents a discharge of the battery due to a circuit fault. Turn the DCCB to the "off" position to allow personnel to safely work on the panel, especially the ECM, completely powered down.

3. Engine instruments

   a. Oil pressure monitor gauge (OPG) - The oil pressure gauge is mounted on the front control panel and indicates the engine oil pressure. A dual function pressure sensor mounted on the engine provides the pressure signal and also provides the safety shutdown signal to the engine control monitor. The shutdown signal is factory preset at 15 psi (103 kPa/m sq).

   b. Coolant temperature monitor gauge (CTG) - The

coolant temperature gauge indicates engine coolant temperature. A dual function temperature sensor mounted on the engine provides the temperature signal and also provides the safety shutdown signal to the engine control monitor. The shutdown signal is preset to operate at 220 f (398k)

c. Battery Voltage Meter (VM-2) - This DC voltmeter monitors the VOLTAGE of the battery under static (at rest) conditions, cranking, and charging conditions. The voltmeter indicates not only the condition of the charging system, but also indicates the battery reserve under cranking load in cold weather. Replace or recharge any battery that drops below 10 volts dc when cranking.

d. Running Time Meter - This DC meter records the total hours the engine has run.

e. Fuel Level Gauge - This gauge monitors the level of fuel in the tank. DO NOT USE THIS GAUGE FOR FILLING.

4. Warning Lamps - These units all come equipped with the four basic indicator lamps; three failure lamps and a system normal lamp. When one of the failure lamps is lighted and the unit is stopped, the lamp indicates the reason for the stoppage.

a. Low Oil Pressure Lamp (LOP) - Indicates that the unit did not maintain a minimum oil pressure of 15 psi.

b. High Water Temperature Lamp (HWT) - Indicates the coolant temperature in the engine exceeded upper coolant temperature limits.

c. Overspeed Lamp (OS) - Indicates the engine speed exceeded the allowable speed limit while operating. An OS lamp may also indicate that the ECM has lost its frequency sensing signal (from the engine alternator) during the last run period.

d. System Normal Lamp (SN) - Indicates that everything is operating normal. Any fault detected in the engine operating system will cause this lamp to go out.

If any one of the failure lamps is lighted always find and correct the problem BEFORE restarting the unit. To reset the shutdown circuit, move the mode switch to the "off" position. The lamp will go out. The switch can then be moved to the "preheat" position if still cold or the "start/run" position for restarting.

5. Warning Lamp Test Switch - The lamps can be tested by pressing the lamp test switch. When depressed all four lamps will come on, as soon as the switch is released the lamps will go out. To replace a burned out bulb snap off the front cover and pull the tab out.

6. Panel Light Switch and Light - A panel light is provided for your convenience. It is activated by the panel light switch.

7. Receptacles and Circuit Breakers - All of the receptacles on the panel are protected by circuit breakers.

a. 125 Volt 15 Amp duplex, NEMA Spec. 5-15R. This duplex receptacle is protected by a 15 Amp circuit breaker mounted just to the right of the duplex.

b. 125 Volt 20 Amp duplex, Nema Spec. 5-20R. This duplex receptacle is protected by a 20 Amp circuit breaker mounted just to the right of the duplex. With the "T" slot design both 15 and 20 amp 120 volt cords can be plugged in.

c. 125 Volt 20 Amp 3 wire twistlock, Nema Spec L5-20R. This twistlock receptacle is also protected by a 20 Amp circuit breaker mounted just to the right of the receptacle.

d. 125 Volt 30 Amp 3 wire twistlock, Nema Spec L5-30R. This twistlock receptacle is also protected by a 30 Amp circuit breaker mounted just to the right of the receptacle.

e. 250 Volt 20 Amp 3 wire twistlock, Nema Spec L6-20R. This twistlock receptacle is protected by a two pole 20 Amp 240 volt circuit breaker mounted just to the left of the receptacle.

f. 125/250 Volt 50 Amp 4 wire twistlock receptacle. This is a Hubbell receptacle part# CS-6369. The plug required for this receptacle is a Hubbell part# CS-6365. This twistlock receptacle is protected by a two pole 50 Amp 240 volt circuit breaker mounted just to the left of the receptacle.

g. 250 Volt 30 Amp 4 wire three phase twistlock, NEMA spec. L15-30R. This receptacle is protected by a three pole 30 Amp 50 Volt circuit breaker mounted just to the left of the receptacle.

B. ENGINE CONTROL MODULE (ECM) - The ECM is a microprocessor based module that controls the complete unit.

It monitors all the engine safety sensors such as oil pressures, water temperature, overspeed and shuts the unit down should any one of the sensor circuits show a fault.

1. Control switch inputs - The following front panel controls are wired into the microprocessor through the ECM terminal blocks.

   a. Preheat-Off-Run-Start switch:

      1). "Preheat" - position has no effect on the ECM. The mode switch drives the glow plug solenoid directly.

      2). "Off" - position prevents unit operation by disconnecting all power to the ECM.

      3). "Run" - position energizes the ECM. This allows the ECM to power up the panel gauges and the holding coil of the fuel solenoid, through a CR1 relay on the back panel. This CR1 relay is powered from the ECM by lead #24.

      4). "Start" - This position powers up the ECM, energizes the start solenoid coil, and the pull-in coil of the fuel solenoid.

   b. Lamp test -Push button energizes all four lamps simultaneously. This feature is disabled when the control switch is in the "off" position, and has no other effect on unit operation.

2. Safety inputs - The following safety controls are wired into the microprocessor through the ECM terminal blocks.

   a. Low oil pressure shutdown -(LOP)- Monitoring of oil pressure begins 12 seconds after the unit starts, and remains in effect until unit is shutdown by normal control circuits (except as noted in "loss of frequency input" below). The 'LOP' signal is derived from an oil pressure switch mounted on the engine.

   b. High water temperature shutdown -(HWT)- The engine coolant sensor temperature monitoring begins immediately with the start signal. If water temperature is excessive at time of start, (i.e. heat soak after shutdown), the unit is still permitted to start. The 'HWT' condition is permitted to exist for up to 60 seconds after the unit initially starts before a shutdown WITH ALARM occurs. If the excessive water temperature condition is corrected within the initial 60 second period, the 'HWT' circuit begins normal monitoring

of the engine temperature and the 'safety shutdown' circuit is reactivated. The 'HWT' signal is derived from a temperature sensor switch mounted on the engine.

c. Overspeed adjustment -(OS)- Overspeed protection is provided by a frequency sensing network within the controller. The trip point of the frequency network is adjustable via a rheostat located on the top of the controller, at the right hand side. Clockwise (CW) rotation increases the trip frequency, and thereby raises the shutdown speed. The frequency input is obtained from the engine battery charging alternator.

3. E.C.M. - Program notes

a. Loss of frequency input - In the event the input frequency goes to zero (engine runs out of fuel, battery charging alternator fails, etc), the L.O.P. shutdown circuit is by-passed, and a 12 second wait period is initiated. If frequency returns within this time period, L.O.P. monitoring resumes and operation continues normally. If frequency has not returned at the end of this time period, the engine oil pressure status is observed to determine whether the engine is actually running or stopped. If the engine has stopped (i.e.- air in fuel, (etc), the unit is shut down with an "overspeed" indication and alarm. If the engine is running the "System Normal" lamp is shut off and the unit is allowed to continue to run.

b. "Overspeed" indicator lamp can mean a loss of control signal during the previous run period (i.e. battery charging alternator failure, broken or loose control wire).

NOTE: TROUBLE SHOOTING HINT

This is of particular note since the tendency is to pursue only overspeed faults. The overspeed signal source (battery charging alternator) is a key component in this system and must be checked out thoroughly whenever an "OS" shutdown occurs.

Please note: The controller does not provide protection against loss of signal during start-up. A shutdown with alarm due to any of the above conditions will prevent any subsequent operation of the generator set. The control switch on the control panel must be momentarily placed in the "off" position to reset.

OPERATING THE UNIT

A. STARTUP CHECKLIST - Before initial start up and each subsequent start complete the following checklist:

1. Check oil level, refill with proper grade oil.
2. Check coolant level, refill with 50/50 mix of demineralized water and a permanent ethylene-glycol antifreeze.
3. Check for loose bolts or hardware.
4. Check tire pressure. (35 psi)
5. Trailer level.
6. Battery securely fastened, connection clean and tight, and proper fluid level.
7. Fuel tank filled with the proper grade of diesel fuel.
8. Check the fan belt for tightness and excessive wear.
9. Check hoses and clamps for leakage.
10. Check the air cleaner indicator. Service only when indicated. DO NOT OVER-SERVICE.

B. ELECTRIC STARTING

CAUTION: EQUIPMENT DAMAGE

DO NOT ATTEMPT TO JUMP/BOOST START THIS UNIT. TO DO SO MAY DAMAGE THE ELECTRONIC MICROPROCESSOR IN THE ENGINE CONTROL. TURN THE DC BREAKER "OFF" AND RECHARGE THE BATTERY WITH A BATTERY CHARGER.

1. Turn the control switch to the "preheat" position. Hold in this position until the glow plug indicator glows red.

CAUTION: EQUIPMENT DAMAGE

NEVER USE STARTING FLUIDS ON ANY PRECHAMBER ENGINE! Immediate engine damage will result!

2. Turn to the "start" position. The starter will engage and the engine will start. The control switch is spring loaded so it can't be accidentally left in the "start" position. Releasing the switch in the "start" position will automatically return it to the "run" position.

3. With the mode switch in the run position and the engine running the "System Normal" lamp should be on.

4. Allow the engine to stabilize in speed and warm up, before powering your external loads.

5. When stopping the unit, first disconnect the external loads, and allow the engine to cool down at no-

load for 5 minutes. Then turn the selector switch to the 'off' position.

C. CONNECTING THE LOADS - A variety of convenience receptacles have been provided on the front panel. The 120/240 volt receptacles are powered whenever the engine is running. Each of the receptacles is protected by a circuit breaker. Keep in mind that the total generator load must not exceed 7000 watts. A 30 Amp four wire three phase receptacle has been provided on the front panel for your three phase loads.

D. GROUNDING THE UNIT - To comply with current safety standards, this generator set must be grounded. Ground the Mobile Diesel generator set by driving an 8 ft copper ground rod into the earth. Connect a #8 AWG or larger ground cable from the grounding lug on the generator to the ground rod using approved connectors.

E. UNIT STORAGE - Certain precautions must be taken if a Mobile Light System is to be stored for a long period of time. The unit must be stored in a dry location to prevent the generator winding from drawing moisture. The unit should also be thoroughly cleaned prior to storage.

For long term engine storage procedures, consult your local Kubota engine dealer. They have special procedures that must be followed in order to prevent engine damage, such as cylinder rust and injector deterioration.

MAINTENANCE

The ultimate aim of any preventive maintenance program is to maintain the equipment in optimum condition, either in service or ready for service, for the maximum amount of time during the useful life of the equipment. The detection of faults before they develop into major sources of difficulty will decrease the incidence of repair. To this end, a regular schedule of cleaning and inspection will go far toward assuring trouble-free operation. Personnel responsible for maintenance should set up a schedule for inspection, and cleaning at intervals calculated to keep the equipment in good condition. In making up a schedule, keep the following in mind:

A. New equipment must be carefully monitored until extended operation has demonstrated that it is performing satisfactorily.

B. Old equipment requires more frequent inspection, and possibly servicing, than similar equipment that has seen less service.

C. Time spent in cleaning, inspecting and correcting minor defects before they become major troubles means time saved in overhaul and repair.

PREVENTIVE MAINTENANCE

A. Daily Maintenance Checklist

** Oil level is maintained between the "L" Low mark and the "H" high mark on the dipstick.
** Fuel tank full of proper grade of diesel fuel.
** Water and sediment drained from water separator.
** Radiator filled with the proper coolant mixture.
** Air cleaner restriction gauge checked regularly. Do not over service.
** Inspect for any fluid leaks.
** Look for any loose or damaged parts.
** Belts checked for tightness, cracks or frays.
** Generator control panel checked for loose or damaged parts.
** Unit checked for general appearance and cleanliness.
** Battery checked for proper fluid level.

OPTIONAL TRAILER

** Trailer hitch and safety chains checked for fitness.
** Tires checked for tread wear, damage and proper pressure.

CAUTION: EQUIPMENT DAMAGE

Failure to keep the engine full of coolant will result in the high water temperature being inoperative. This sensor must be in coolant to properly measure the water

temperature. Allowing the engine to operate low on coolant may allow the water level to drop below the sensor. When this happens the engine may overheat causing engine damage.

B. Engine Routine Maintenance - A good preventive maintenance program begins with a good day-to-day maintenance check and continues with a rigid routine maintenance program at the proper service intervals. The chart below is to be used as a guide for your maintenance program. Shorter maintenance intervals are required if the engine is operated in a dusty environment or if frequent stops are made. If the engine is operated in consistent ambient temperatures below 0 or above 100 degrees F maintenance should be performed at shorter intervals. Consult your Kubota authorized repair location for recommended intervals.

Interval	Item
Every 100 hours	Change engine oil and oil filter Check air cleaner restriction gauge Check fuel filter Check injector nozzles Check fuel pipes Check fan belts Check battery electrolyte
Every 150 hours	Check radiator hoses
Every 500 hours	Clean radiator core Remove sediment in the fuel tank
Every one year	Change radiator cleaner and coolant Replace air cleaner element
Every two years	Replace radiator hoses and clamps Replace fuel pipes and clamps

C. Generator Routine Maintenance - Very little routine maintenance is required on the generator itself as it contains few consumable parts. The generator and control panel should be kept free of oil and dirt. The generator air intake and exhaust must be kept clear of all debris.

The Generator frequency should be checked periodically to insure that the engine is operating at the right speed. The voltage should be checked with an external voltmeter to be certain the voltmeter on the control panel is correct.

1. Brushes

Under ordinary circumstances, brushes will operate for long periods without requiring replacement. They should be inspected after the first 1000 hours of operation, and every 100 hours of operation thereafter. Remove brushes one at a time and check for length, and be sure that each moves freely in it's brush holder. Brushes should be replaced when worn down to 3/8". Replace brushes in complete sets, never singly. When replacing brushes, be careful to reconnect the lead wires properly.

Poor contact (or "skipping") between brush and slip ring is caused by oil and grit, flint, or other hard substance on the brush, or by the brush not being "seated" (properly shaped to fit the slip rings). Remedy these defects by fitting the brushes to the slip-ring curvature. Place # 00 sandpaper under the brushes with the abrasive side to the brushes, and work it back and forth until the brushes are the same shape as the slip-rings.

2 Slip rings

The four continuous copper rings located at the end of the armature are the power collector rings. For proper generator output, the surface of the slip rings must have a highly polished finish. Under sustained use, it is advisable to check and occasionally polish the ring surfaces with a crocus cloth to maintain the finish.

TROUBLESHOOTING

A. General - Check for loose wires, connections, and hardware whenever the engine or generator control panels are opened. If the troubleshooting chart indicates a particular component discrepancy, proceed to that portion of the test procedure.

To properly check out electronic components and generator wiring, they must be isolated from associated circuitry. Always mark leads disconnected to insure correct reconnection after testing.

Test equipment required to accomplish the static and operational tests:

1. Volt-ohmmeter - 20,000 ohms per volt (or higher).

2. Frequency meter - 58 to 62 hertz (cycles per second).

3. Clamp-on ammeter 0-600 ampere range.

B. Problem isolation - Malfunctions are generally

classified and described by symptoms, with the symptoms pointing to causes.

Start failure, poor speed regulation, high voltage, low voltage, etc., are only SYMPTOMS. To find and correct CAUSES of these malfunctions, it is necessary to isolate the problem to one of the basic system components.

1. Engine - including fuel and cranking systems.

2. Generator - including voltage regulator

3. Control panel - manual start or meters

4. Other external influences - such as load, fuel, battery, accessory equipment (remote control panels, exhaust system, etc).

C. Eliminate external causes of malfunction

1. Installation - restrictions in exhaust, ventilation, fuel, low battery etc.

2. Load - two basic checks regarding apparent overload:

a. Verify load is within nameplate capacity using a clamp-on ammeter.

b. If within nameplate capacity on all legs, determine if speed drops below specifications.

1. If speed drops, engine/fuel etc., problem:
   a. Fuel filters plugged.
   b. Tank empty.
   c. Water in system.
   d. Lines broken or disconnected.
   e. Air filter plugged

2. If speeds OK, generator/electrical problem.

Efficient troubleshooting will rapidly narrow the number of possible causes of malfunction with the minimum of checks, To do this, a general understanding of the total system operation is necessary. Each system component has unique input and output characteristics that provide clear messages that properly interpreted will point directly to the cause of malfunction. Verify defect and repair or replace as required.

For resolution of specific failure symptoms, isolate to system or component and refer to section of this manual covering the suspected system.

DIAGNOSTIC TABLE

GENERATOR

SYMPTOM	POSSIBLE CAUSE	CORRECTION
Low Voltage (under 230 volts no-load)	Engine Speed too Slow	Check the no-load engine speed with a frequency meter and adjust the governor to 61.5 Hertz at no-load.
	Defective Armature	Measure armature resistance (0.1 ohms). Check for grounds and shorts. Replace if defective.
	Defective Rectifier	Follow test procedure and replace if defective.
	Defective Field Coils	Measure coil resistance (25-27.9 ohms). Check for grounds. Replace if defective.
Low Voltage (under 205 volts loaded)	Engine Speed too Slow	Check the no-load engine speed with a frequency meter and adjust the governor to 61.5 Hertz at no-load. Troubleshoot engine and determine why it will not hold the proper speed.
	Generator Overloaded	Measure load being run and compare with name plate rating. The load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
(3 to 5 volts)	Defective Rectifier	Follow test procedure replace if defective.
	Defective Field Coils	Measure coil resistance (25-27.9 ohms). Check for grounds. Replace if defective.
(0 Volts)	Short Circuit on the AC Output	Disconnect all external loads. Check all the AC wiring in the control cabinet for shorts. Repair or replace as required.
	Shorted Capacitor	Troubleshoot, replace as required.
	Defective Armature	Measure armature resistance (0.1 ohms). Check for ground shorts. Replace if defective.
	Loss of Residual Magnetism	Flash the field coils with a 12 volt battery.
Fluctuating Voltage	Erratic Engine Speed	Refer to the Engine manufacturer's maintenance manual.
	Loose terminal or Load	Check all AC wiring

	Connections	connections.
High Voltage	Engine Speed too High	Check engine speed reset to 1845 RPM (61.5 HZ) no-load.
Generator Overheating	Air Vents Obstructed	Clear Obstruction.
	High Intake Air Temperature	Improve ventilation. Allow at least two feet clearance around generator.
	Generator Overloaded or Unbalanced	Measure load being run and compare with name plate rating. The load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
	Shorted Turns in either the Armature or Field Coils	Measure rotor and stator resistance for shorted turns. Replace if defective.
Generator noisy and or vibrates	Loose Sheetmetal	Check nuts, bolts and doors for tightness.
	Armature Rubbing	Repair or replace defective part.
	Bearing Defective	Replace Bearing.
	Engine Unbalanced	Consult local engine dealer.
ENGINE		
Glow Plug Indicator Inop	DC Circuit Breaker Tripped	Reset.
	DC Circuit Breaker Defective	Check DC breaker for continuity. Replace.
	Defective Mode Switch	Troubleshoot and replace.
	Defective Glow Plug Solenoid	Troubleshoot and replace.
	Defective Glow Plug Indicator	Troubleshoot and replace.
	Corroded Battery Cable Connections	Remove cables from battery and clean.
	Battery Dead	Check battery with a hydrometer. Recharge or replace as required.
Diesel Set will not crank.	DC Circuit Breaker Off	Turn on.
	DC Circuit Breaker Defective	Check DC breaker for continuity. Replace.
	Corroded Battery Cable Connections	Remove cables from battery and clean.
	Battery Dead	Check battery with a hydrometer Recharge or replace as required.
	Mode Switch Defective	Check start switch for proper continuity. Replace
	Defective Starter or Solenoid	Test start solenoid and starter. Refer to engine manufactures manual.
	Defective ECM (Engine	Troubleshoot and replace

	Control Module)	
Cranks but will not start.	Out of Fuel	Fill fuel tanks.
	Air in the Fuel Lines	Bleed air out of fuel system See engine manual.
	Defective Fuel Solenoid	Troubleshoot and Replace. See engine manual for details.
	Defective CRl Relay	Troubleshoot and Replace.
	Water/Fuel Separator full of water	Drain water from separator.
	Fuel Filter Plugged	Replace Filters.
	Defective ECM	Troubleshoot and repair.
	Defective Preheat	Troubleshoot glow plug solenoid and glow plugs.
Starts but stops when the start switch is released	Low Battery	Recharge or replace
	Defective Holding Coil on Fuel Solenoid	Troubleshoot and repair or replace as required.
FAILURE LAMPS		
Low Oil Pressure	Engine Low on Oil	Fill to required level.
	Oil Pump Failure	Troubleshoot and repair.
	Defective Pressure Sensor	Check actual oil pressure, replace sensor if defective.
	Oil is thinning out when the engine gets hot	Check oil for contamination and change the oil.
	Defective EMC	Troubleshoot and replace.
High Water Temperature	Engine Low on Water	Fill to required level.
	Engine Thermostat Defective	Check for water circulation. Repair as required.
	Coolant Mixture Incorrect	Check for required 50/50 mix.
	Plugged Radiator	Clean or repair as required.
	Broke/Loose Fan Belt	Repair.
	Defective Sensor	Troubleshoot and replace.
	Defective Water Pump	Repair or replace.
	Defective ECM	Troubleshoot and replace.
Overspeed (Actual overspeed)	Engine Speed High	Reset engine speed to 1800 RPM
	Broken/Loose Fan Belts	Repair or replace as required.
	Defective Governor	Repair or replace as required.
(Engine runs normal but shuts down on overspeed)	Defective Alternator	Test and repair.
	Defective Sensor Lead	Troubleshoot and repair.
	Defective ECM	Troubleshoot adjust and/or repair.
System Normal (Not Lighted Unit Stopped)	Defective ECM	Repair or replace.
	Defective Bulb	Replace
	DC Circuit Breaker Off	Turn on.
	DC Circuit Breaker Defective	Check DC breaker for continuity. Replace.
	Corroded Battery Cable	Remove cables from battery and

	Connections	clean.
	Battery Dead	Check battery with a hydrometer Recharge or replace as required.
	Mode Switch Defective	Check start switch for proper continuity. Replace.
(Engine Running)	Defective Sensor lead from Engine Alternator	Troubleshoot and repair.
	Defective Engine Alternator	Repair or replace.
Engine Speed Drops too low Under Load	Air Cleaner Plugged	Replace.
	Generator overloaded	Remove External load and Troubleshoot generator.
	Water/Fuel Separator full of water	Drain water from separator.
	Fuel Filter Plugged	Replace Filters.
	Injector Pump Defective	Repair or Replace.

COMPONENT TESTING

A. CONTROL PANEL

The control systems are simplified to minimize control components. Normal control relays have been replaced by a single engine control module. This engine control module is controlled by a single three position switch. To access the inside of the control cabinet remove the front panel.

1. ECM (Engine Control Module) - Static test of the ECM is done using a VOM (Volt-Ohm Meter).

   a. Turn on the DC circuit breaker.

   b. Turn the mode switch to the run position.

   c. Set your VOM for 15 to 30 volts DC.

   d. Clip the Negative (blacklead) lead to Wire #1 (ground)

   e. Check for voltage at the following points:

   Reference Wiring Diagram C97422-000

Test	Wire #	Voltage
#1	6	12 VDC
#2	24	12 VDC
#3	18	12 VDC

   Results:
   Test #1; Voltage present indicates the ECM is being properly powered through the DC circuit breaker and the Control switch. If voltage is not present, check the control switch and the DC circuit breaker.

Test #2; Lead # 24 is ignition relay (CR1) control. Voltage present here indicates the ECM has energized the CR1 relay that will power up the meters, fuel solenoid and the excitation lead to the engine alternator regulator. No voltage here indicates the ECM is defective.

Test #3; Voltage present here indicates the lamp test switch is powered. Depressing the test switch should light all four lamps. No voltage present indicates the ECM is defective.

2. FRONT PANEL SWITCHES

a. Mode Switch

1. Move the DC circuit breaker to the open position.

2. Move the control switch to "preheat".

3. Set your VOM set to Ohms Rx1

4. You should have continuity between wire #5 and #91.

5. Move the mode switch to "run".

6. Check for continuity between wire #5 and #6.

7. Move the switch to "start".

8. Check for continuity between wire #5 and #9.

9. With the switch in the "stop" position you should have NO continuity between any combination of #5, #91, #6, or #9

10. If you get incorrect readings in any of these tests, the switch is defective and must be replaced.

b. Lamp Test Switch

1. Move the DC circuit breaker to the open position.

2. Move the mode switch to "stop".

3. Set your VOM set to Ohms Rx1.

4. While the lamp test switch is depressed,

check for continuity between wire #1 (ground) and wire # 18 . Your VOM should indicate NO circuit when the switch is released.

5. Replace if defective.

c. Panel Light Switch

1. Move the DC circuit breaker to the open position.

2. Set your VOM set to Ohms Rx1.

3. While the panel light switch is depressed check for continuity between wire #5 to Wire # 26 . Your VOM should indicate NO circuit when the switch is released.

4. Replace if defective.

3. METERS

a. Oil Pressure Gauge - This meter consists of two parts; one is the electric meter in the panel, and the other is the sender mounted on the engine.

WARNING: EQUIPMENT DAMAGE.

If the system has shut down with a LOP warning light DO NOT ASSUME that the fault is in the meter or shut down system just because the engine is full of oil. Insure you do have oil PRESSURE before proceeding to test the monitoring system and meters.

1. The Portable Diesel system must be running to properly test both the meter and the sender unit.

2. Set your VOM for 15 to 30 volts DC.

3. Test between lead #21 on the back of the meter and lead #1 for 12 VDC. If you do not have the proper voltage trace the #21 lead back to the CR1 and retest the relay.

4. Locate the sender on the engine and test between lead #35 and ground for 12 VDC. The absence of voltage at this point indicates a problem in the wiring harness. Trace back to the meter and repair as required.

5. Using a short jumper lead, ground wire #35

momentarily. This should cause the meter to go full scale. If it doesn't, the meter is defective.

6. If the meter does go full scale, but will not work normally when connected to the sender, the sender is defective.

b. Coolant Temperature Gauge - This meter consists of two parts; one is the electric meter in the panel and the other is the sender mounted on the engine.

WARNING: PERSONAL DAMAGE.

If the system has shut-down with a Coolant System warning light DO NOT REMOVE THE RADIATOR CAP UNTIL THE ENGINE HAS COOLED FOR AT LEAST 15 TO 30 MINUTES. Hot coolant can cause severe burns. Always assume the radiator is hot until confirmed otherwise.

1. The Portable Diesel system must be running to properly test both the meter and the sender unit.

2. Set your VOM for 15 to 30 volts DC.

3. Test between lead #21 on the back of the meter and lead #1 for 12 VDC. If you do not have the proper voltage trace the #21 lead back to the CR1 and retest the relay.

4. Locate the sender on the engine and test between lead #30 and ground for 12 VDC. The absence of voltage at this point indicates a problem in the wiring harness. Trace back to the meter and repair as required.

5. Using a short jumper lead, ground wire #30 momentarily. This should cause the meter to go full scale. If it doesn't the meter is defective.

6. If the meter does go full scale but will not work normally connected to the sender, the sender is defective.

c. Fuel Level Gauge - This meter consists of two parts: one is the electric meter in the panel, and the other is the sender mounted in the fuel tank.

1. The Portable Diesel system must be running to properly test both the meter and the sender unit.

2. Set your VOM for 15 to 30 volts DC.

3. Test between lead #21 on the back of the meter and lead #1 for 12 VDC. If you do not have the proper voltage trace the #21 lead back to the CR1 and retest the relay.

4. Locate the sender on the fuel tank and test between lead #90 and ground for 12 VDC. The absence of voltage at this point indicates a problem in the wiring harness. Trace back to the meter and repair as required.

5. Using a short jumper lead, ground wire #90 momentarily. This should cause the meter to go full scale. If it doesn't, the meter is defective.

6. If the meter does go full scale but will not work normally connected to the sender, the sender is defective.

d. DC Voltmeter - This meter indicates the condition of your battery and charging system.

1. The Portable Diesel system must be running to properly test this meter.

2. Set your VOM for 15 to 30 volts DC.

3. Test the voltage level between wire #21 and #1. This reading should match the meter reading. If not, replace the defective meter

e. Running Time Meter - This meter accumulates the total number of hours the engine has operated.

1. The Portable Diesel system must be running to properly test this meter.

2. Set your VOM for 15 to 30 volts DC.

3. Test between lead #21 on the back of the meter and lead #1 for 12 VDC. If you do not have the proper voltage trace the #21 lead back to the CR1 and retest the relay.

4. If the proper voltage is present and the running time meter is not operating it is defective and should be replaced.

4. CIRCUIT BREAKERS

a. DC Circuit Breaker - This circuit breaker

controls all the DC voltage to the control panel, for monitoring and starting the engine.

1. Depress the mode switch to the "off" position.

2. Depress the field circuit breaker "on".

3. Set your VOM for 15 to 30 volts DC.

4. Test voltage between wire #5 and #1. You should have battery level voltage (13.5 volts).

5. If you do not get any voltage on wire #5, check the voltage on the opposite side of the breaker (wire #2). If you have good voltage on wire #2, the breaker is defective.

6. If you do not have 13.5 volts on wire #2, recheck the battery for a low charge condition and the battery cables for poor connections.

b. AC Circuit Breakers - Each receptacle on the front panel is protected by a circuit breaker. All of the circuit breakers can be tested in the same manner.

CAUTION: EQUIPMENT DANGER

Do Not assume that because a breaker keeps tripping off that the breaker is defective. Most breaker trips are caused by an overload. If continual breaker interruptions are being experienced, use a clamp-on ammeter to determine the actual load before replacing the circuit breaker.

1. Move the mode switch to the "off" position.

2. Move the DC circuit breaker to the "off" position.

3. Set your VOM on the Ohms Rx1 scale.

4. Test the resistance from the upper to the lower connection on each circuit breaker. The breakers must be in the closed position.

5. You should read a very low resistance between the two terminals on each circuit breaker (less than .5 ohms).

6. Any circuit breaker that has a high resistance or is open and can't be closed must be replaced.

B. GENERATOR

The main components of the generator are: field shell, field coils, armature, brushes, brush holder assembly, and armature-mounted cooling fan. Unless noted otherwise testing of the generator can be accomplished without disconnecting the generator from the engine. To access the generator for testing remove the sheet metal end cover on the end of the generator. This cover is held in place by two sheetmetal screws that must be removed to remove the cover.

Before performing any maintenance on the engine or generator, place the mode switch on the control panel to the stop position and the DC circuit breaker to the off position.

1. Testing generator field for opens and grounds

   a. Tag and disconnect the field leads from rectifier.

   b. Set your VOM on the Ohms Rx1 scale.

   c. Connect the meter leads to the field leads. The field coil resistance should be 25.0 to 27.9 ohms. If field is open, meter will read infinite resistance. If an incorrect resistance reading is obtained or the fields are open, cut the connector between the two coils and determine which is defective and replace.

   d. Next connect one meter lead to the field shell leaving other lead still connected to one of the field leads. If meter indicates continuity (zero ohms) or any reading lower than infinite resistance, the field is grounded and should be replaced. If the fields are grounded, cut the connector between the two coils and retest to determine which coil is grounded.

Fig. 5.

2. Testing armature for opens and grounds.

   a. Remove all brushes.

   b. Set your VOM on the Ohms Rx10,000 scale.

   c. Holding one meter lead against a clean spot on the armature shaft, touch the other lead to each of the four slip rings, one at a time while observing the meter. If the meter indicates continuity (zero

ohms) or any reading lower than infinite resistance, the armature is grounded. Dirt on the slip rings can cause grounding. Carefully clean the dirt off the slip rings if grounding was indicated, then recheck. Replace the armature if it is grounded.

d. Reset your VOM on the Ohms Rxl scale.

e. Touch one meter lead on surface of slip ring #1, and touch other meter lead to surface of collector ring #2 while observing the meter. Meter should indicate a very low resistance (.1 Ohms). If not (i.e. if meter indicates infinite resistance) part of armature windings are open and armature should be replaced.

f. Check the resistance between ring #1 and ring #'s 3 and 4 in same manner.

Fig. 6.

3. Testing the armature for internal shorts.

This test should only be performed after all other testing has been completed as the unit must be disassembled to properly growl the armature for internal phase to phase shorts.

a. Remove the armature from the unit.

b. Place the armature in a growler.

c. Turn on the growler.

d. Slide a hacksaw blade across the armature lamination slots.

e. If the hacksaw blade becomes magnetized (buzzes) at any slot location, the armature is shorted.

f. Be sure to rotate the armature during testing to insure that all lamination slots are checked.

4. Testing rectifiers

The field excitation rectifier is a full-wave bridge rectifier. This type of rectifier has four terminals, two AC, one DC positive, and one DC negative. The rectifier is tested in the following manner:

a. Remove and tag the four rectifier leads.

b. Set your VOM on the Ohms Rxl scale.

Note: Some electronic (digital) VOM have a special procedure for testing diodes. If you encounter problem using the Rxl ohms scale, check you meter handbook for specific instruction on testing diodes with your VOM.

c. Connect one ohmmeter lead to the positive DC terminal, and the other lead to each of the AC terminals in turn. A high or low resistance reading will be obtained.

d. Reverse the meter leads, and an opposite reading should be observed.

e. Now check from the negative terminal each of the AC terminals, using the same procedures as above.

g. Check each terminal to the case, and no resistance reading should be observed.

h. If the rectifier fails any of the above tests, it should be considered defective and replaced.

If a battery-powered test light is used, follow the procedures described above. If the rectifier is good, the light will come on in one direction only.

5. Condenser testing

Condensers are built into the generator circuit to minimize radio interference during operation. If a condenser shorts out, it blocks the generator output. To determine whether a condenser is shorted, turn off the engine-generator, and test as follows.

a. Remove the condenser lead from the brushholder.

b. Set your VOM on the Ohms Rxl scale.

c. Touch one meter lead to the condenser lead and the other meter lead to the case of the condenser.

d. The meter should indicate a momentary resistance reading and then taper rapidly to infinite. (on some electronic meters you will not get the momentary resistance reading as it happens too fast.)

e. Replace if defective.

6. Flashing the fields

Under rare circumstances it is possible for the generator to lose it's residual magnetism. If this should happen use the following procedure to remagnetize the generator.

a. Locate and remove the two field coil leads from the positive and the negative terminals on the rectifier.

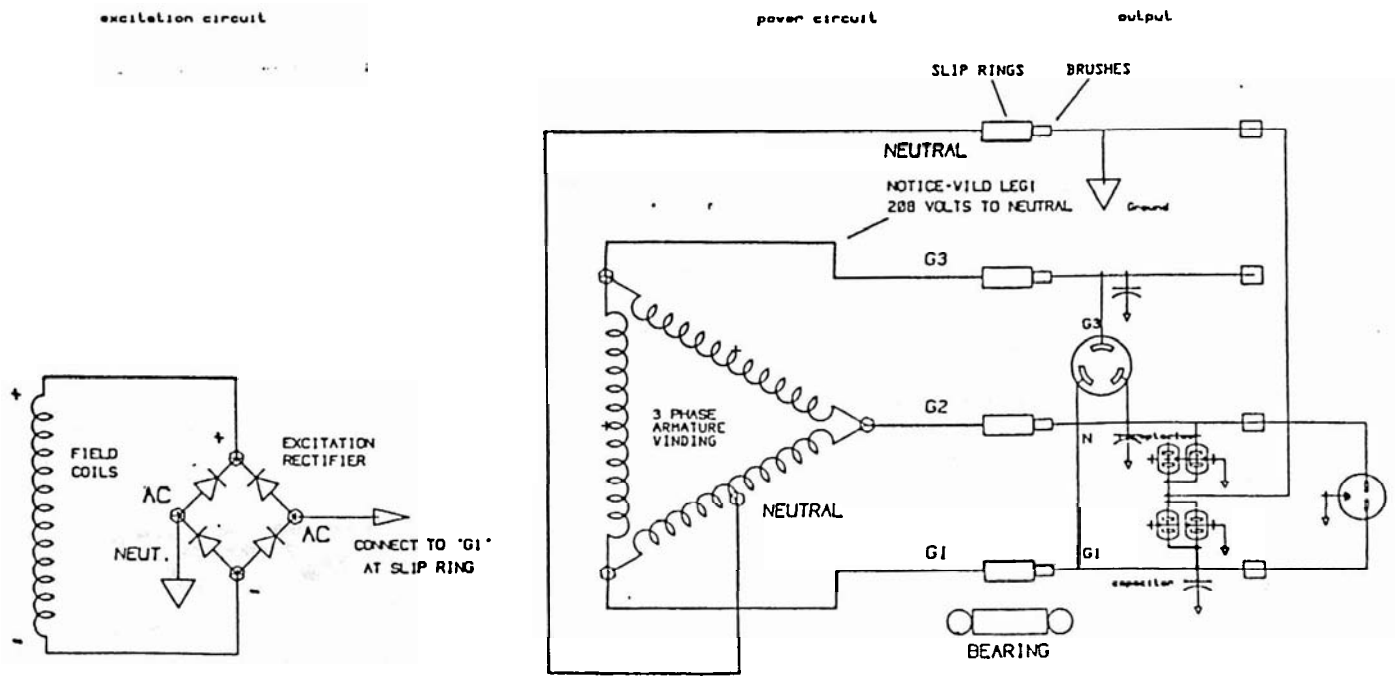
b. Connect, 12 volts DC positive, to the lead removed from the positive terminal of the rectifier.

c. Touch the lead removed from the negative terminal of the rectifier to 12 volts DC negative for about 5 seconds. This will repolerize the generator.

d. Reconnect the two leads to the rectifier. Be sure to reconnect the lead flashed positive to the positive terminal of the rectifier.

ENGINE

A basic engine Operation and Maintenance Manual has been provided with each Portable Diesel set. Additional copies of basic and overhaul manuals can be ordered from Kubota. Order forms are in the back of the engine Operation and Maintenance Manual.



SHD1500-17E/A SCHEMATIC VIRING DIAGRAM