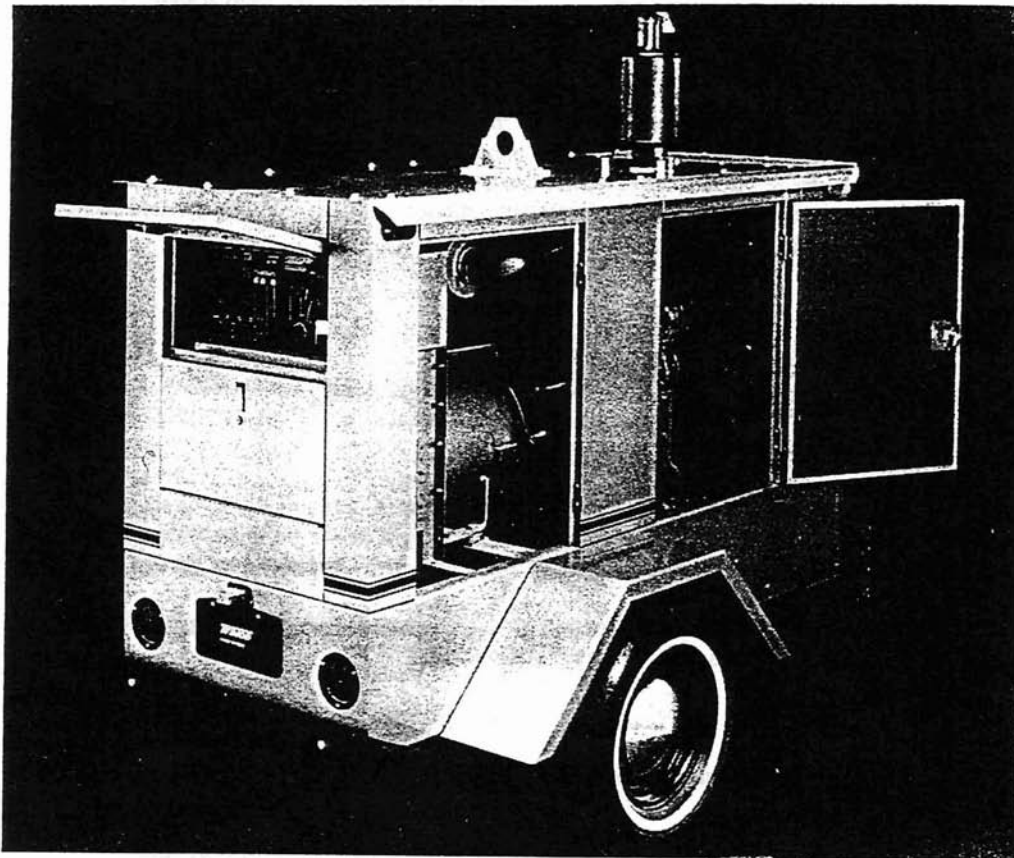


WINGCO

**Mobile
Power
Systems**

OWNERS MANUAL

**MD45
MD65**



WARNING: PERSONAL DANGER

This unit is equipped with automatic/remote start capabilities. Be sure all the control switches are in the Stop/Off position before connecting the battery.

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).

WINGCO[®]
INCORPORATED

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A GUIDE TO PRODUCT SAFETY

This Mobile Diesel generator set has been designed and manufactured to allow safe, reliable performance. Improper or careless use can result in potential deadly hazards; from electrocution or serious electrical shock, exhaust gas asphyxiation, burns, or 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.

1. **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 electric 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

A GUIDE TO PRODUCT SAFETY

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 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.

A GUIDE TO PRODUCT SAFETY

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.

SPECIFICATIONS

GENERATOR SPECIFICATIONS	MD45	MD65
KILOWATT	35 KW	50 KW
KILOVOLT-AMPS (.8 PF)	44 KVA	62 KVA
AMPERAGE		
277/480 VOLT 3 PHASE	53 AMPS*	75 AMPS*
120/240 VOLT 3 PHASE	105 AMPS*	150 AMPS*
120/208 VOLT 3 PHASE	121 AMPS*	173 AMPS*
120/240 VOLT 1 PHASE	146 AMPS	187 AMPS

*Based on .8 power factor at 130 degrees C.

Derate 3% per 1000 feet (305 meters) between 300 feet (90 meters) and 7,500 feet (2,286 meters) above sea level. Contact the factory for rating data for operation in altitudes above 7,500 feet (2,286 meters).

GENERATOR RESISTANCES	MD45	MD65
Main Stator	0.110 ohms	0.075 ohms
Main Rotor	2.6 ohms	3.6 ohms
Excitor Stator	25 ohms	25 ohms
Excitor Rotor	.350 ohms	.350 ohms
	-- Excitor Voltage (F1-F2) --	
No Load	9.5 VDC	9.5 VDC
Full Load	34.0 VDC	39.0 VDC
	Excitor Amperage (F1-F2)	
No Load	0.4 Amps	0.4 Amps
Full Load	1.3 Amps	1.5 Amps

ENGINE SPECIFICATIONS

See Cummins Operation and Maintenance Manual (3810205-03) for complete 'B Series' engine specifications.

TRAILER/HOUSING	MD45	MD65
Capacity	4000 lbs	4000 lbs
Fuel Capacity	50 gals	50 gals
Axle	Single	Single
Hydraulic Surge Brakes	Optional	Optional
Hitch Height	Adjustable	Adjustable
Tires	-- P235/75B15	4 Ply Tread -
Tire Pressure	35 psi	35 psi
Sound Attenuated Housing	Standard	Standard

PREPARATION

NOTE: This manual covers the entire unit, EXCEPT THE ENGINE. See the engine manufacturer's operator manual for specific maintenance and care information regarding the engine.

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

The use of a multi-grade lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures. A multi-graded oil 15W-40 is recommended, meeting API Classification CC/CD. The use of single grade lubrication oil is not recommended except in Arctic conditions

See your engine operators manual for recommended oil grades when operating in extreme cold conditions (ambients under -10 deg. C.) and Arctic conditions.

OIL QUANTITY	US Qts.
MD45	11.5
MD65	11.5

PREPARATION

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 degrees C. it is acceptable to use a seasonal blend of No. 2 and No. 1 fuel. The use of lighter fuel will reduce fuel economy.

Filling the Fuel Tank - The trailer is equipped with a 50 gallon fuel tank and a remote reading electric fuel gage. Use the gage only for operating reference. DO NOT USE THE FUEL GAGE IN THE CONTROL PANEL FOR FILLING THE TANK.

COOLANT REQUIREMENTS .

Antifreeze should be used during all seasons to protect the engine cooling system from corrosion as well as freezing damage. It is also recommended that a corrosion inhibitor be used in the coolant system.

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 degrees F.

Never exceed a 70/30 antifreeze/water mix ratio and never use 100% antifreeze for makeup coolant.

COOLANT QUANTITY	US Quarts
MD45	20.0
MD65	20.0

BATTERY CONNECTION INSTRUCTIONS

WARNING: PERSONAL DANGER

THIS UNIT IS EQUIPPED WITH AUTOMATIC/REMOTE START CAPABILITIES. BE SURE ALL THE CONTROL SWITCHES ARE IN THE STOP/OFF POSITION BEFORE CONNECTING THE BATTERY.

The Mobile Power System is equipped with a dual 12 (group 24F) volt battery starting system. The two heavy duty batteries must be connected in PARALLEL. Both batteries have been disconnected from the battery cables prior to shipment of this engine generator set. When re-connecting these batteries, 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.

PREPARATION

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.

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).

WARNING: EQUIPMENT DAMAGE!

FAILURE TO PUT THE ENGINE CONTROL SWITCH IN THE 'OFF' POSITION PRIOR TO CONNECTING THE BATTERY CABLE(S) MAY RESULT IN DAMAGE TO THE ECM. (SOLID STATE ENGINE CONTROL MODULE).

ETHER STARTING AID

These units are equipped with an automatic ether injection system. This system is designed to meter the proper amount of ether to the engine any time the engine coolant temperature drops below 45 deg F. A temperature switch has been installed in the engine water jacket. Any time the starter is engaged and the engine coolant temperature is below the required 45 deg F. the switch is closed and ether is metered to the engine.

This system then allows a hot engine to be restarted in cold weather without the ether injection system being activated.

CAUTION; ENGINE DAMAGE

DO NOT USE ADDITIONAL ETHER WHEN STARTING THESE UNITS. THE AUTOMATIC ETHER INJECTION SYSTEM WILL METER THE PROPER AMOUNT INTO THE ENGINE. THE USE OF ADDITIONAL ETHER MAY CAUSE ENGINE DAMAGE.

The ether canister is located on the left hand side of the control panel. Access to the ether canister is through the left rear door. Only use KBI replacement canisters.

OPERATIONS

DESCRIPTION AND IDENTIFICATION

A. FRONT PANEL

1. Starting Controls - This unit is equipped for automatic start. It may be started either of two ways, directly from the front panel or remotely. For remote starting a customer supplied automatic transfer switch or a remote start switch must be used. The three position MODE switch controls where the engine is started from.

a. "Run" - This "local control" switch position starts the engine automatically at the unit.

b. "Stop" - This switch position locks out all engine start signals - both local and remote - and is intended to safely allow service and maintenance checks on the engine.

c. "Auto" - Auto position allows a remote mounted automatic transfer switch or other remote start signal to start the unit automatically.

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 (WTG) - 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 210 f (372 k)

c. Battery Voltage Meter (VM-2) - This DC voltmeter monitors the VOLTAGE of the battery under static (at rest) conditions, under cranking and charging

OPERATIONS

conditions. The voltmeter indicates not only the condition of the charging system, but also indicates the battery reserve under cranking load in cold weather.

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 center tank. With the leveling lines open between the tanks, the gauge will indicate the total fuel level. DO NOT USE THIS GAUGE FOR FILLING.

4. A.C. Generator Controls

a. Voltage adjust rheostat - Controls the output voltage of the generator by varying voltage regulators reference voltage.

b. Field circuit breaker (FCB) - Protects voltage regulator and exciter field in the event of a load short circuit or equipment malfunction.

c. Voltage selector power switch - This heavy duty three position switch allows the operator to quickly and safely reconnect the 12 wire generator to any one of three output voltages. Once the output voltage is selected, the switch may be locked to prevent it from accidentally being changed during operation.

Three output voltage combinations are available with this selector switch:

1. 120/240 Three Phase* (series Delta configuration)
2. 120/208 Three Phase (Low or Parallel "WYE" configuration)
3. 277/480 Three Phase (High or series "WYE" configuration)

*This selector position is also used for single phase 120/240 output by using only the L1 and L2 leads. The three phase L3 output lead is the "wild" leg in the delta configuration.

5. AC Generator Instruments

a. AC voltmeter (VM) - Monitors generator output voltage, dual scale for 208/240/480v operations.

6. Warning Lights - These units all come equipped with the four basic failure indicator lamps. When one of

OPERATIONS

these lamps are 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. Overcrank Lamp (OC) - Indicates that the unit did not start properly during the last cranking cycle. An OC light may also indicate that the ECM has lost its frequency sensing signal (from the engine alternator) during the last run period.
- d. Overspeed Lamp (OS) - Indicates the engine speed exceeded the allowable speed limit while operating.

If any one of these 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 light will go out. The switch can then be moved to the "run" or "auto" position and the unit will be able to restart automatically.

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

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

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

- a. 120 Volt 20 Amp duplex, Nema Spec. 5-20. This duplex receptacle is protected by two 20 Amp circuit breakers mounted just above the duplex. With the "T" slot design both 15 and 20 amp 120 volt cords can be plugged in.
- b. 120 Volt 20 Amp 3 wire twist lock, Nema Spec L5-20. This twistlock receptacle is also protected by a 20 Amp circuit breaker.
- c. 240 Volt 20 Amp 3 wire twist lock, Nema Spec L6-20. This twistlock receptacle is protected by a two pole 240 volt circuit breaker.

OPERATIONS

d. 120/240 Volt 50 Amp 4 wire twistlock. This receptacle is rated for dual voltage, 120 or 240 volt use. It is a four wire receptacle, with a center grounding pin. Four wire drop cords plugged into this receptacle may be split into 120 volt receptacles at a distribution box. This receptacle is protected by a two pole 50 amp circuit breaker mounted just above it. THIS RECEPTACLE UTILIZES A SPECIAL HUBBELL PLUG.(HUBBELL PART NUMBER "CS 6365".)

B. Full Power Load Connections and Breakers - This Mobile Diesel Power System is equipped with both high voltage (480) and low voltage (208/240) main line breakers. The breakers are interlocked with a lockable bar to insure that only one breaker can be turned on at a time.

A full power output terminal block is provided. This terminal block is located below the main power breakers and is accessible through the rear door.

C. ENGINE CONTROL MODULE (ECM) - The ECM is a microprocessor based module that controls the complete unit. It is designed to start the engine either in the "automatic" remote or "run" local mode and disconnect the starter once the unit is running. It monitors all the engine safety sensors such as oil pressures, water temperature, overspeed and overcrank, shuts the unit down should any one of the sensor circuits show a fault in either manual or automatic mode.

1. Control switch inputs - The following front panel controls and instruments are wired into the microprocessor through the E.C.M. terminal blocks.

a. Run-Off-Auto switch:

1). "Run" - run position causes the generator set to start and run immediately.

2). "Off" - off position prevents unit operation regardless of status of remote control signal status.

3). "Auto" - auto position allows unit to be controlled via any remote single-pole "dry" contact (transfer switch, etc). Contact closure causes unit to start and run, while contact opening causes unit to shutdown.

b. Lamp test -Push button energizes all four alarm lights simultaneously. This feature is disabled with the run-stop-auto switch in the "stop" position, and has no other effect on unit operation.

OPERATIONS

2. Safety inputs:

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. (See fig. above). Clockwise (CW) rotation increases the trip frequency, and thereby raises the shutdown speed. The frequency input is obtained from the engine battery charging alternator.

d. Overcrank protection -(OC)-These Mobile Diesel units are designed to use cycle cranking. This feature provides a series of five cranking cycles lasting 12-seconds with a 12 second rest period between each. Failure of the engine to start by the end of the fifth crank period results in an "overcrank" shutdown and alarm indication.

3. Cranking disconnect adjustment -(C.D.S. adj.)- The cranking disconnect signal is obtained by a frequency 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 left hand side. (See fig. above). C.W. rotation increases the trip frequency, and thereby raises the starter motor drop-out speed.

OPERATIONS

The frequency input is obtained from the engine battery charging alternator.

4. E.C.M. - Program notes

a. Loss of frequency input - Internal protection against loss of frequency input to the cranking disconnect circuit is programmed in after the unit has started normally. In the event the 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 unit is shutdown with an "overcrank" indication and alarm.

b. "Overcrank" indicator light can mean a loss of crank disconnect signal during the previous run period (i.e.- bat. charging alternator belt broken). The manufacturer has installed an additional backup relay operated by the AC output voltage. If this redundant cranking system lockout is not operational, attempting to restart the engine without a cranking disconnect signal will destroy the starter motor and pose a potentially serious personnel hazard.

NOTE; TROUBLE SHOOTING HINT

This is of particular note since the tendency is to pursue only cranking and start related faults. The cranking disconnect signal source (battery charging alternator) is a key component in this system and must be checked out thoroughly whenever an "OC" 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 run-stop-auto selector switch on the control panel must be momentarily placed in the "stop" position to reset.

D. VOLT/HERTZ VOLTAGE REGULATOR - The purpose of the voltage regulator is to maintain the voltage output of the Generator Set within a specified percentage of its rated output from no load to full load. The voltage regulator controls the voltage output of the main generator by

OPERATIONS

regulating the amount of current delivered to the exciter field.

1. Location - Access to the voltage regulator assembly is gained by removing the control panel access door located through the left rear housing door.

2. Description - The Basler model APR125-5X voltage regulator is an encapsulated unit contained in a metal case. The regulator controls the DC exciter fields power of medium sized 50 or 60 Hz brushless generators to regulate the output voltage.

Regulation is provided by sensing the generator output voltage, converting it to a DC signal and comparing the signal to a reference voltage signal. An error signal is developed and used to control the DC field power in order to maintain a constant generator output.

3. Operation of voltage regulator - The voltage regulator has been installed in the Mobile Diesel Generator set and tested at the factory prior to shipment. No additional set-up is required when changing from one voltage to another. The only adjustment required is to fine tune the exact voltage you want using the voltage adjustment rheostat located on the front panel. The adjustment range is 10% of the nominal voltage.

Some minor changes must be made for 50 cycle operation. Refer to 50 Hz operation later in this section for set up procedures.

a. During periods of operation at reduced speed use the field circuit breaker to remove the power from the regulator.

b. If the exciter field voltage exceeds 95 VDC, the regulator senses overexcitation and automatically removes the field current after a time delay. This time delay is inversely proportional to the magnitude of the detected overvoltage condition. At approximately 140 VDC, the field voltage is removed instantaneously.

Upon detection of overexcitation and the resulting field voltage shutdown, the regulator will not reset or return to an operational condition until the generator output voltage drops to less than 6 VAC for ten seconds (minimum). TO ACCOMPLISH THIS ON A MOBILE DIESEL GENERATOR SET THE FIELD CIRCUIT BREAKER MUST BE TURNED OFF FOR TEN SECONDS.

For additional information on the Basler Voltage

OPERATIONS

regulator model APR125-5X see Basler Electric
publication number: 9 1688 00 992.

OPERATING THE UNIT

A. SELECTING THE CORRECT VOLTAGE - A variety of voltages are available from the three position selector switch. The three basic connection patterns are, Delta (120/240), Low or Parallel WYE (120/208), and High WYE (277/480). Single phase 120/240 is available with the switch in the 120/240 (Delta) position.

Before connecting this unit to a distribution panel or any other loads be sure you have the selector switch set for the right voltage and locked. If you have any doubts as to the voltage in your area compare your incoming power or load name plates to the voltage table below.

1. 120/240 Three Phase* (Delta/Series configuration) - This configuration will produce the following line-to-line and line-to-neutral voltage. In this selector switch position, all of the receptacles on the front panel are powered.

L1 - L2 - L3	240 Volts three phase
L1 - L2	240 volts single phase
L2 - L3	240 volts single phase
L1 - L3	240 volts single phase
L1 - N	120 Volts
L2 - N	120 Volts
L3 - N	208 volts

*This selector position is also used for single phase 120/240 output, using only the L1 and L2 leads. The L3 three phase output lead is the "wild" leg in the delta configuration and is used only for three phase loads.

2. 120/208 Three Phase (Low/Parallel WYE configuration) This configuration will produce the following line-to-line and line-to-neutral voltage. Use of this selector switch position allows utilization of the 120 volt receptacle only. The 240 volt receptacles can not be used as the voltage at them will be 208 volts, the line-to-line voltage.

L1 - L2 - L3	208 Volts three phase
L1 - L2	208 volts single phase
L2 - L3	208 volts single phase
L1 - L3	208 volts single phase
L1 - N	120 Volts
L2 - N	120 Volts
L3 - N	120 volts

OPERATIONS

3. 277/480 Three Phase (High/Series WYE configuration)
This configuration will produce the following line-to-line and line-to-neutral outputs. None of the front panel receptacles are powered in this voltage configuration.

L1 - L2 - L3	480 Volts three phase
L1 - L2	480 volts single phase
L2 - L3	480 volts single phase
L1 - L3	480 volts single phase
L1 - N	277 Volts
L2 - N	277 Volts
L3 - N	277 volts

After you have selected the correct voltage for your application and locked the selector switch, do the same with the main line circuit breakers. Be sure to secure the lock bar in place, as this will prevent the incorrect breaker from being turned on.

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

WARNING: PERSONAL DANGER

THIS MOBILE DIESEL GENERATOR IS EQUIPPED FOR AUTOMATIC START. TO PREVENT AN ACCIDENTAL STARTUP DURING SERVICING INSURE THE DC BREAKER ON THE CONTROL PANEL IS IN THE "OFF" POSITION BEFORE BEGINNING ANY MAINTENANCE.

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. (32 psi)
5. Trailer level to within 15 degrees
6. Battery securely fastened, connection clean and tight, and proper fluid level.
7. Fuel tanks filled with the proper grade of diesel fuel.
8. Check the fan belt for excessive wear.
9. Check hoses and clamps for leakage.
10. Check the air cleaner indicator. Service only when indicated. Do not over-service.
11. Clean out dust cup on the air cleaner.

C. MANUAL STARTING (Normal portable use)

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

OPERATIONS

BATTERY WITH A BATTERY CHARGER.

1. Select the desired voltage on the voltage selector switch and lock in place.
2. Turn off both main line circuit breakers.
3. Turn the field circuit breaker "off".
4. Depress the DC breaker to the "on" position to power the engine control panel.
5. Depress the start mode switch to the "run" position.
 - a. The engine control module will now take over and start the engine using up to five 12 second crank intervals followed by a 12 second rest period. If the engine should fail to start during this time, the engine control will disconnect the starter circuits and turn on the overcrank lamp.
 - b. Do Not use additional ether or other starting aids. The automatic ether injection system provided will take care of these needs. The use of additional starting fluid may cause serious engine damage.
6. Turn on the field circuit breaker.
7. Adjust the voltage to the desired level using the external voltage rheostat.
8. Turn on the proper main line breaker (either high or low voltage) and padlock the lock bar to prevent the incorrect breaker from being turned on.

D. REMOTE STARTING AND CONNECTIONS (Standby applications)

1. Complete the manual starting procedure above to insure the system is set up properly.
2. Insure the DC breaker and the mode switch are in the "off" position during the installation of the remote start wire.
3. Locate the remote start terminal block. Identify the remote start leads (wire #23 and #1) on terminals three and four of the terminal strip.
4. Locate the remote start terminals in your remote automatic transfer switch (ATS). This ATS terminal block and wire numbers will vary with each ATS manufacturer. The Mobile Diesel generator set requires a contact closure upon normal power failure for a start

OPERATIONS

signal. THIS REMOTE "SIGNAL" MUST BE A "DRY" (NON POWERED) CONTACT CLOSURE.

5. Connect the two sets of remote start contacts.
 - a. Sixteen gauge wire is sufficient for most installations up to 100 feet.
 - b. On long runs increase wire size to minimize voltage drop.
 6. Locate the neutral and full power output load connection blocks on the generator.
 7. Locate and identify the neutral and generator connection in the automatic transfer switch.
 8. Connect the load block to the transfer switch using the proper wire sizes. Refer to the National Electric Code Handbook (NFPA 70) for sizing. Use table 310-16 for wiring run through conduit and table 310-17 for free air wiring.
- Use extreme caution when installing the Delta voltage pattern. One power leg of this 3 phase pattern produces 208 volts measured from line to neutral. Be sure to match the location of the generator wild leg to the location of the wild leg on the incoming power service. Failure to do so will cause equipment damage to any 120 volt load incorrectly connected to this line.
9. Connect the neutral to the transfer switch using the same wire size.
 10. For isolated neutral operation remove the jumper wire between the ground lug and the neutral connection block.
 11. Ground the Mobile diesel generator set using an 8 ft copper ground rod or other approved grounding system. Connect #4 AWG copper cable from the ground lug on the generator to the ground rod.
 12. Set the selector switch on the transfer switch to the "off" position.
 13. Depress the DC breaker on the control panel to the "on" position.
 14. Depress the mode switch to the "run" position. The generator set will now start.
 15. Check the voltage at the transfer switch. Verify that it matches the incoming power line voltage line-to-line and line-to-neutral, on each leg.

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16. Check three phase rotation pattern. Insure that you have the same rotation, with both the generator and normal power source.

17. Depress the mode selector switch on the engine control to the "stop" position and let the unit stop. Once the engine has stopped depress the mode switch to the "auto" position.

18. Move the selector switch on the transfer switch to the "auto" position. This is the normal position for the switch to have automatic start operation.

19. Use the test switch on the transfer switch or shut off the incoming power to test the complete system. The Mobile Diesel set should start up and the transfer switch should transfer the load to the generator set.

20. Compare the amperage reading from each leg on the generator and insure that none of the legs is exceeding the nameplate rating on the generator.

21. Upon completion of the test, leave all control mode switches in the "auto" position.

22. The system is now ready to start and power the loads should the power fail.

E. CONNECTING THE LOADS - There are two ways the loads may be connected to a Mobile Diesel Generator.

1. FRONT PANEL - A variety of receptacles have been provided for your convenience on the front panel. The 120 volt receptacles are powered when the voltage selector switch is in the 120/240 or 120/208 volt position. The 240 volt receptacles although powered in both positions are only usable in the 120/240 volt position. In the 120/208 volt position the 240 volt receptacles have only 208 volt at them.

2. FULL POWER LOAD CONNECTION TERMINAL BLOCK - For remote connections and connecting load distribution boxes heavy duty terminal blocks have been provided. These terminal blocks are located on the rear of the unit just below the main line circuit breakers.

The neutral and ground are connected together at this panel. For use with an isolated neutral, remove the jumper strap between the neutral connection block and the ground lug. This will isolate the neutral from the ground and allow you single point grounding at a distribution panel.

When using these terminal blocks be sure to use wire

OPERATIONS

rated to carry your full load or the full rated load of the generator.

3. GROUNDING THE UNIT - To comply with current safety standards this generator set must be properly grounded. Ground the Mobile Diesel generator set by driving an 8 ft copper ground rod into the earth. Then connect a #4 AWG ground cable from the grounding lug on the generator to the ground rod.

F. AUXILIARY BATTERY CHARGER - For units installed in standby situations provisions have been made for the installation of an auxiliary battery charger. Only isolated float type charger should be utilized. In addition the charger must have a disconnect built into it that will disconnect the charger any time the Mobile Diesel Generator set is energized to start.

The connection points for the auxiliary battery charger are on the same terminal strip as the remote start connections.

1. The battery positive lead from the battery charger is connected to terminal #1 (wire #2) of the terminal strip.

2. The battery negative lead from the battery charger is connected to terminal #3 (wire #1) of the terminal strip.

3. The disconnect relay leads from the battery charger will be connected to terminal #2 (wire #8) and to terminal #3 (wire #1). The disconnect relay on most chargers are not polarity sensitive, but if yours is, terminal #2 is positive and terminal #3 is negative.

G. UNIT STORAGE - Certain precautions must be taken if a mobile Diesel Generator set 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 engine storage procedures consult your local Cummins engine dealer. They have certain procedures that must be followed in order to prevent engine damage, i.e. cylinder rust and injector deterioration.

50 CYCLE (HZ) OPERATION

With a couple of minor changes these Mobile Diesel Generators are capable of producing 50 hz power. Two changes must be made.

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A. The engine must be reduced to 1500 RPM governed speed. Consult your local Cummins Service center for the proper procedure for reducing the engine speed and setting up the governor to operate at 1500 RPM.

B. The automatic volt/hertz regulator must also be reset to operate at 50 hz instead of the standard 60 hz. This is done by changing one jumper lead on the regulator.

1. Locate the voltage regulator and identify the top three terminals marked "60 Hz", "Comm", and "50 Hz".
2. Remove the metal jumper between the "60 Hz" and the "Comm" terminal.
3. Reinstall the metal jumper between the "50 Hz" and the "Comm" terminal.
4. Start the engine and readjust the voltage to the desired level. All other functions including the voltage selector switch are still functional, except that all the receptacles are now powered 50 Hz instead of 60 HZ.

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 tanks full of proper grade of diesel fuel.
- ** Water and sediment drained from water separator.
- ** Radiator filled with the proper coolant mixture.
- ** Air cleaner service indicator checked regularly. Change the filter element when the red indicator flag is at the raised position
- ** Inspect for any fluid leaks
- ** Look for any loose or damaged parts
- ** Belts checked for cracks or frays
- ** Trailer hitch and safety chains checked for fitness
- ** Tires checked for proper pressure
- ** Battery fluid level checked.
- ** Generator control panel examined for loose or damaged parts.
- ** Unit inspected for general appearance and cleanliness.

B. Routine Engine 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

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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 Cummins authorized repair location for recommended intervals.

ENGINE

DAILY	EVERY 3 MONTHS OR 250 HOURS	EVERY 6 MONTHS OR 500 HOURS	EVERY 12 MONTHS OR 1000 HOURS	EVERY 2 YEARS OR 2000 HOURS
-------	--------------------------------	--------------------------------	----------------------------------	--------------------------------

CHECK	-----CHANGE OR REPLACE-----			
Oil Level	Lube Oil	Lube Oil	Lube Oil	Lube Oil
Coolant Level	Lube Filter	Lube Filter	Lube Filter	Lube Filter
Fuel Water Trap	Coolant Filter	Coolant Filter	Coolant Filter	Coolant Filter
Voltage Level		Fuel Filter	Fuel Filter	Fuel Filter
Battery Water Level	-----ADJUST-----			
Air Cleaner Service Indicator			Valve Lash Clearance	Valve Lash Clearance
	-----CHECK AND INSPECT-----			
	Air Cleaner Intake System	Air Cleaner Intake System	Air Cleaner Intake System	Air Cleaner Intake System
		Antifreeze	Antifreeze	antifreeze
			Fan Hub	Fan Hub
			Belt Tensioner Bearing	Belt Tensioner Bearing
			Belt Tension	Belt Tension Damper

C. Generator Routine Maintenance

There is very little routine maintenance that is required on the generator itself as it contains no consummable parts. The generator and control panel should be kept clean of oil and dirt and 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. Inspecting generator insulation - Routine non-destructive testing of the stator windings may be required where the unit is subjected to excessive humidity, and/or dirty environment. This is especially important when the Generator Set is used for prime power.

CAUTION: EQUIPMENT DAMAGE

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When making an insulation test on the exciter armature or main field disconnect all diodes (including the rotating rectifiers). This is done to protect diode elements and rectifiers from high-voltage breakdown during megger test.

Measure insulation resistance with a megger. If reading of less than 200 megohm is obtained at 75 degrees f (297k) ambient temperature and moisture is suspected, dry the insulation as described later in this section.

Note: Measurement of insulation resistance is an important part of an adequate program for the maintenance of electric equipment. The measured values of insulation resistance serve as a useful guide in determining whether or not insulation is defective, drying, or overhauling is necessary to prevent failure.

- a) Check windings, connections, load cables, and other components for excessive dirt and grime. Clean if applicable.
- b) Make sure all mounting bolts have been installed and are tight. Refer to applicable portions of the text for torque specifications.
- c) Make certain no foreign objects are lodged in the generator. Remove all tools and shop clothes from the vicinity of the Generator Set.
- d) Be sure that all covers and guards are re-installed.

2. Cleaning - Cleanliness is of primary importance in preventive maintenance. Do not allow dust, moisture, oil, or other substances to remain in or on the equipment. The importance of keeping all insulation clean cannot be over-emphasized. Dust, dirt and other foreign materials tend to block ventilating ducts and retard dissipation of heat, which in turn, leads to local overheating. If the particles are allowed to build up, the windings may eventually be short circuited or grounded. Abrasive particles may puncture insulation. Iron dust is especially harmful because the particles are continually agitated by magnetic pulsations. For these reasons, equipment must be kept clean, both externally and internally, and particularly, all air ducts must be kept clean and unobstructed.

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There are four (4) acceptable methods of cleaning insulation associated with electrical equipment:

- a) clean with a vacuum cleaner with suitable plastic attachments.
- b) Wipe clean with a cloth.
- c) Blow off with direct stream of filtered, oil-less low pressure compressed air.
- d) Clean with solvent and soft bristle brush.

Of the methods listed above, the vacuum cleaner method is the most practical for removing loose, dry particles because it does not redeposit them on other parts of the equipment as is done when compressed air is used. Also, a vacuum cleaner is capable of removing dust from coils and from grooves between wires that is otherwise inaccessible to a wipe cloth.

Substances such as grease and oil can best be removed by wiping whenever possible with a cloth or a brush, and flushing inaccessible windings and other areas with a minimum volume of trichloroethane solvent. Flush windings with trichloroethane beginning at the top or 12 o'clock position and proceeding to the bottom or 6 o'clock position, on either side. After cleaning and drying (which is rapid with trichloroethane), take megger readings to determine whether resistance has increased to above the acceptable 200 megohm level. If resistance is still low, clean the affected areas again.

WARNING PERSONAL DANGER:

The explosive and fire hazards of trichloroethane are negligible and it has the least toxic effect of all the chlorinated hydrocarbons; however, avoid prolonged skin contact with the solvent and perform cleaning operations in a well ventilated area. If the solvent is splashed on the skin, wash off with soap and water. If splashed into the eyes, flush with water and get medical help. Avoid prolonged breathing of fumes.

3. Drying insulation - It is sometimes necessary to dry insulation in order to recondition electrical equipment that has been submerged or splashed with water. It may also be necessary to dry equipment that has absorbed moisture from the air after standing idle for an extended

MAINTENANCE

period of time.

Heat and circulation of dry air, or the application of a vacuum, is required in order to effectively remove moisture from insulation. Heat may be provided by either of 2 methods or a combination of both.

- a) By external application of heat.
- b) By circulation of electrical current at low voltage through the conductors.

The best method to use on a specific case depends upon local conditions and the facilities/equipment available. Do not use the second method until after insulation has been partially dried by the first method. Regardless of heating method used, keep a close check on temperature of the insulation. This can be done by means of temperature detectors, either permanently or temporarily installed, or by thermometers so placed that they can be easily read at the hottest areas on the equipment. Heat applications should be continuous. Interruption of the heating operation to the extent that the equipment cools and approaches ambient temperature, may allow moisture to condense in the insulation and retard the drying process. Drying cannot be hurried. Many hours, or even days, may be required to achieve satisfactory results.

4. Revarnishing insulation - In some cases, after long periods of operation, or if repeated cleaning and drying has been necessary, the results of insulation resistance tests may indicate that revarnishing of insulation is necessary. However, the application of varnish will not permanently increase the insulation resistance or dielectric strength of the insulating material and should not be done in lieu of repairing defective insulation.

TROUBLESHOOTING

Note: Testing in this section is generally limited to the use of a VOM (volt-ohmmeter) and a clamp-on ammeter.

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.

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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. The symptoms point 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 - auto or manual start.
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, 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.
3. External control malfunction - does the unit perform properly when operated from the front panel but not from the remote location. (automatic units only).

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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 the system or component and refer to section of this manual covering the suspected system.

DIAGNOSTIC TABLE

SYMPTOM	POSSIBLE CAUSE	CORRECTION
Voltage is good : no-load, but under load	Defective Rectifier (Rotating)	Follow test procedure and replace if defective.
Low Voltage (under 208 volts) Test with selector switch in 120/208 position	Engine Speed too Slow Defective Voltage Regulator Voltage Adjust Rheostat defective Generator Overloaded Defective Main Rotor (Rotating Fields) Defective Voltage Selector Switch	Check the no-load engine speed with a frequency meter and adjust the governor to 61.5 Hertz at no-load. Follow test procedure and replace if defective. Rotate knob back and forth look for change in output voltage. If no change check Voltage Regulator and replace as required. Measure load being run and compare with name plate rating With 3-phase generator, the load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg. Measure rotor resistance (3 to 5 ohms). Check for grounds. Replace if defective. Troubleshoot and repair.
(40 to 60 Volts)	Load Circuit Breaker open Field Circuit Breaker open Voltage Adjust Rheostat dirty Loose or shorted wires in control cabinet Defective Voltage Regulator Defective Rectifier	Reset/Replace. Reset/Replace. Rotate knob back and forth then rest. Test/Replace. Check all wiring and repair as needed. Follow test procedure and replace if defective. Follow test procedure and replace if defective.

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	Defective Excitor Stator (Field Coils)	Measure excitor stator resistance (25 ohms minimum). Test for opens and shorts. Replace if defective.
	Defective Main Rotor (Rotating Fields)	Measure rotor resistance (3 to 5 ohms). Check for grounds. Replace if defective.
(3 to 5 volts)	Defective Rectifier	Follow test procedure and replace if defective.
	Defective Surge Suppressor	Follow test procedure. Replace if defective.
	Rotating Rectifier Assembly Wired incorrectly	Check wiring and correct as necessary.
	Defective Excitor Rotor (Armature)	Measure rotor resistance line to line (.3 ohms). Check for grounds and growl for internal shorts. Replace if defective.
	Defective Main Rotor (Rotating Fields)	Measure rotor resistance (3 to 5 ohms). Check for grounds. Replace if defective.
(0 volts)	Loss of Initial Exciter Magnetism	Flash the exciter stator (F1 and F2 leads) with a 12 volt battery.
	Defective Main Stator	Measure stator resistance (.3 ohms). Check for ground shorts. Replace if defective.
Fluctuating Voltage	Erratic Engine Speed	Refer to the Engine manufacturer's maintenance manual.
	Loose terminal or Load Connections	Check all AC wiring connections at circuit breakers and voltage selector switch.
	Voltage Regulator unstable	Follow voltage regulator test procedures. Replace if defective.
	Defective Voltage Selector Switch	Troubleshoot and repair.
High Voltage	Defective Voltage Regulator	Readjust voltage level at voltage regulator, if it will not adjust replace regulator.
Generator Overheating	Air Vents Obstructed High Intake Air Temperature	Clear Obstruction. Improve ventilation. Allow at least two feet clearance around generator.
	Engine Radiator Blocked or plugged	Clear the blockage from the radiator and clean it.
	Engine exhaust leaking into trailer	Repair exhaust system.

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	Generator Overloaded or Unbalanced	Measure load being run and compare with name plate rating With 3-phase generator, the load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg. Measure rotor and stator resistance for shorted turns. Replace if defective.
	Shorted Turns in either the Rotor or Stator	
Generator noisy and/or vibrates	Loose Sheetmetal Rotor Rubbing Bearing Defective Rotor unbalanced Engine Unbalanced	Check nuts, bolts and doors for tightness. Repair or replace defective part. Replace Bearing. These rotors are spin balanced before assembly. Small washers or bars are used as balancing weights. Check around inside the generator. If these have broken loose consult your dealer. Consult local engine dealer.
Mobile Diesel Set will not crank.	DC Circuit Breaker Off DC Circuit Breaker Defective corroded Battery Cable Connections Battery Dead Start Switch Defective Defective PRL Relay Defective Starter or Solenoid Defective ECM (Engine Control Module)	Turn on. Check DC breaker for continuity. Replace. Remove cables from battery and clean. Check battery with a hydrometer Recharge or replace as required. Check start switch for proper continuity. Replace. Troubleshoot and replace. Test start solenoid and starter. Refer to engine manufactures manual. Troubleshoot and replace.
Cranks but will not start.	Out of Fuel Air in the Fuel Lines Defective Fuel Solenoid Defective Ether Injection System (cold weather only) Water/Fuel Separator full of water Fuel Filter Plugged Defective ECM	Fill fuel tanks. Center tank must have fuel in it. Bleed air out of fuel system See engine manual. Troubleshoot and Replace. See engine manual for details. Check ether canister to insure it contains ether. Troubleshoot ether injection system. Drain water from separator. Replace Filters. Troubleshoot and repair.

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Starts at control panel but will not start remote.	Defective Remote Wiring Defective Remote Start Sensor Mode Switch not in "Auto"	Troubleshoot and repair remote wiring. Troubleshoot remote start contacts. Repair or replace as required. Move Switch to "Auto".
Failure Lamps		
Low Oil Pressure	Engine Low on Oil Oil Pump Failure Defective Pressure Sensor Oil is thinning out when the engine gets hot Defective EMC	Fill to required level. Troubleshoot and repair. Check actual oil pressure, replace sensor if defective. Check oil for contamination and change the oil. Troubleshoot and replace.
High Water Temperature	Engine Low on Water Engine Thermostat Defective Coolant Mixture Incorrect Plugged Radiator Broke/Loose Fan Belt Defective Sensor Defective Water Pump Defective ECM	Fill to required level. Check for water circulation. Repair as required. Check for required 50/50 mix. Clean or repair as required. Repair. Troubleshoot and replace. Repair or replace. Troubleshoot and replace.
Overspeed (Actual overspeed)	Engine Speed High Broken/Loose Fan Belts Defective Governor	Reset engine speed to 1800 RPM. Repair or replace as required. Repair or replace as required.
(Engine runs normal but shuts down on overspeed)	Defective Alternator Defective Sensor Lead Defective ECM	Test and repair. Troubleshoot and repair. Troubleshoot adjust and/or repair.
Overcrank (Engine cranks but will not start.)	Out of Fuel Air in the Fuel Lines Defective Fuel Solenoid Defective Ether Injection System (cold weather only) Water/Fuel Separator full of water Fuel Filter Plugged Defective ECM	Fill fuel tanks. Center tank must have fuel in it. Bleed air out of fuel system See engine manual. Troubleshoot and Replace. See engine manual for details. Check ether canister to insure it contains ether. Troubleshoot ether injection system. Drain water from separator. Replace Filters. Troubleshoot and repair.
(Engine Starts and then shuts down on overcrank)	Defective Alternator Defective Sensor Lead Defective ECM	Test and repair. Troubleshoot and repair. Troubleshoot and repair.

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Defective Diode or Resistor Troubleshoot and replace.
in alternator Leads

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. The control panel is accessed by removing the top cover on the control cabinet.

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 and check the voltage between the following points:

Reference Wiring Diagram C-95705-003

Test	Wire #	Terminal	Wire #	Terminal	Voltage
#1	1	GND	7		12 VDC
#2	1	GND	21		12 VDC
#3	1	GND		BAT +	12 VDC
#4	1	GND	18	LT	12 VDC
#5	1	GND	8		12 VDC

Results:

Test #1; Voltage present indicates the ECM is being properly powered through the DC circuit breaker and the Mode switch. If voltage is not present check the mode switch and the DC circuit breaker.

Test #2; Lead # 21 is the equivalent of an ignition buss. Voltage present here indicates the ECM has powered up the meters, fuel solenoid and the excitation lead to the engine alternator regulator. No voltage here indicates the EMC is defective.

Test #3; Voltage present here indicates the logic circuits have been energized. No voltage present may indicate that the one AMP inline fuse has been blown in the wire leading to the B+ terminal. If you have voltage in test #1 but not here check the inline fuse and the wiring between the wire #7 connection and the B+ connection point on the terminal strips.

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Test #4; Voltage present here indicates the lamp test switch is powered. Depressing the test switch should light the four failure lamps. No voltage present and voltage normal test #3 indicates the ECM is defective.

Test #5: Voltage present here indicates the starter should be energized. If the unit is not attempting to start trace the 12 volt signal through the PR1 relay on the panel to wire #9. If Wire #9 is powered check the pilot start solenoid and the solenoid and starter on the engine for proper operation. Voltage at lead #7 in test #1 but not here indicates the ECM is defective.

d. Move mode switch to "auto" position.

e. Repeat Test #1, #3 and #4. The results should be the same.

f. Clip a jumper lead from wire #23 on terminal "RR" to wire #1 on terminal "GND". This simulates a start signal from a remote location.

g. Repeat test #2 and #5. The results should be the same.

h. If the unit starts and runs both in the "run" position and in the "auto" position with the jumper lead installed but will not run from a remote location, the problem is either in the wiring from the ECM to the remote start terminal block or the remote start switch.

2. FRONT PANEL SWITCHES

a. Mode Switch

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

2. Move the mode switch to "run".

3. Set your VOM to ohms Rx1 scale.

4. Wire #5 to #7 should have continuity and wire #1 to Wire # 23 should have continuity.

5. Move the mode switch to "auto".

6. Now check for continuity between wire #5 and #7. Wire #1 to #23 should read open circuit.

7. Move the switch to "stop".

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8. Now both combinations #5 to #7 and #1 to #23 should read open circuit.

9. If you get incorrect readings in any of these tests the switch should be considered defective and 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 to ohms Rx1 scale.

4. Check for continuity between wire #1 to Wire # 18 when the lamp test switch is depressed. 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 to ohms Rx1 scale.

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

4. Replace if defective.

3. METERS

a. AC Voltmeter - Testing of the AC voltmeter must be done with the Mobile Diesel set running.

CAUTION: PERSONAL DANGER.

These engine generator sets, when operating, develop sufficient voltage to delivery a fatal shock. Use extreme caution when testing this unit with the engine running and the generator energized.

1. Start the Mobile Diesel Power system.

2. Turn off the field circuit breaker.

3. Set your VOM to at least 600 volt AC.

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4. Test the voltage between the two leads on the back of the voltmeter. Wires #G1 and #G2. This voltage reading should match the reading on the voltmeter.

5. If the meter is functional but the voltage readings are off, confirm that your VOM is reading properly by testing on a standard wall receptacle. If your VOM is correct adjust the AC voltmeter on the control panel by adjusting the small screw located on the face of the meter.

6. If the meter is not functional, replace.

7. It is not necessary to access the back of the meter if you only wish to confirm that the voltage reading on the meter is correct. That can be done by closing the proper main breaker and reading the line to line voltage at the full load terminal block.

b. 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 Mobile 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.

2. 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 ECM and retest the ECM.

3. 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.

4. Using a short jumper lead ground out wire #35 momentarily, should cause the meter to go full scale. If it doesn't the meter is defective.

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

c. 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 INJURY.

If the system has shut-down with a Coolant System warning light DO NOT REMOVE THE RADIATOR CAP ON A HOT ENGINE. The coolant can be hot enough to severely burn a person. Always assume the radiator is hot until confirmed otherwise.

1. The Mobile 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 ECM and retest the ECM.

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 out wire #30 momentarily, 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 Mobile 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

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meter and lead #1 for 12 VDC. If you do not have the proper voltage trace the #21 lead back to the ECM and retest the ECM.

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 out wire #90 momentarily, 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 Mobile 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 Mobile 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 ECM and retest the ECM.

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

4. VOLTAGE SELECTOR SWITCH - This switch must be completely disconnected for proper testing. Access to switch connection is gained by removing the top cover on the control box and the access cover on the right hand side. Each lead should be tagged for its proper location on the selector switch.

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Once the switch has been disconnected each of the switch contacts can be checked for proper operation using a VOM set on the ohms Rx1 scale.

SWITCH POSITION	120/240	120/208	277/480
CONTACTS			
1 TO 2	OPEN	CLOSED	CLOSED
3 TO 4	CLOSED	OPEN	OPEN
5 TO 6	CLOSED	OPEN	CLOSED
7 TO 8	OPEN	CLOSED	OPEN
9 TO 10	CLOSED	CLOSED	OPEN
11 TO 12	OPEN	CLOSED	CLOSED
13 TO 14	OPEN	CLOSED	OPEN
15 TO 16	CLOSED	OPEN	OPEN
17 TO 18	CLOSED	OPEN	CLOSED
19 TO 20	OPEN	CLOSED	OPEN
21 TO 22	OPEN	CLOSED	CLOSED
23 TO 24	CLOSED	OPEN	OPEN
25 TO 26	CLOSED	OPEN	CLOSED
27 TO 28	OPEN	CLOSED	OPEN
29 TO 30	OPEN	CLOSED	OPEN
31 TO 32	OPEN	OPEN	CLOSED
33 TO 34	----- NOT USED IN ANY POSITION -----		
35 TO 36	CLOSED	CLOSED	OPEN
37 TO 38	CLOSED	CLOSED	OPEN
39 TO 40	CLOSED	CLOSED	OPEN

Any deviation from this pattern or contacts that do not fully close indicate the switch is defective.

The switches can be disassembled in the field although it is not recommended as placement of the cams and springs is critical. In some cases the only problem with the switch may be that it has been operated in a very dirty environment and dirt has gotten into the switch. If you suspect that may be the case the switch can be blown out with clean dry air. If the switch proves to be defective it should be replaced

5. 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 wire #5 to wire #1. You should have

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battery level voltage at this point (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 the same way.

CAUTION EQUIPMENT DANGER:

Do Not assume 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.

c. Main Line Circuit Breakers - Both of these circuit breakers are tested the same as the circuit breakers on the front panel.

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B. GENERATOR

1. Generator static tests:

a. Rectifier Assembly - Remove rotating rectifier cover. Disconnect leads from the rectifier to be tested. Mark, if necessary, for identification. Place one ohmmeter lead on the positive terminal and the other lead on each AC terminal in turn. These readings should be the same whether high or low. Reverse the ohmmeter leads and repeat the test. These readings should be opposite. Repeat these tests between the negative terminal and each AC terminal in turn. If resistance readings are incorrect, replace the rectifier.

b. Surge Suppressor - Set volt-ohmmeter to Rx10,000. Disconnect the two field leads, marking if necessary to identify which is positive and which is negative. Disconnect the negative (-) leads from the two rotating rectifiers. Place an ohmmeter lead on each end of the surge suppressor and then reverse the leads. Readings should be infinite one direction, and a high resistance the other direction. If resistance readings are incorrect, replace the surge suppressor.

c. Exciter Field - The exciter field is checked for shorts and opens. Disconnect exciter field leads f1 and f2 from the voltage regulator. The resistance between f1 and f2 should be about 25 ohms. Resistance between either f1 or f2 and ground should be infinite. Replace the exciter field coil and ring assembly if resistance readings are incorrect.

d. Exciter Armature - The exciter armature is checked for shorts and opens. Disconnect the three exciter armature leads from the rotating rectifiers. Connect an ohmmeter lead to one lead of the armature leads, and the other ohmmeter lead to each of the remaining armature leads in turn. The resistance measured should be too small to read on most test equipment. Resistance between each exciter armature lead and the rotor shaft should be infinite.

e. Main Rotor - Disconnect both rotor leads. These are connected to the surge suppressor on the rotating rectifier assembly. Measure the resistance between leads. The resistance should measure approximately 2.5 To 5 ohms (see specifications for exact readings). If the reading is correct, connect one ohmmeter lead to the rotor

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shaft and the other ohmmeter lead to one of the rotor leads. The reading should show infinite resistance. If the rotor has a resistance reading to ground, it is defective and may need to be replaced. Consult factory before replacing.

f. Main Stator - To test the stator for opens and shorts, the windings must be isolated.

Caution: Mark all leads for correct reconnection and disconnect all 12 leads from the selector switch. The six coil groups are lead numbers 1 & 4, 2 & 5, 3 & 6, 7 & 10, 8 & 11, 9 & 12.

Using a volt/ohmmeter, test the coil groups for continuity, and shorts to ground. If the stator proves defective it should be returned for repair or replacement.

2. Flashing the Exciter Field - A newly repaired generator or one returned to service after extended shutdown, may not build up voltage initially due to lost residual magnetism. Correct this temporary condition by flashing the exciter field as follows:

a) Remove the control box cover to gain access to the location of field terminals connected at voltage regulator. Remove field leads F1 and F2 from the voltage regulator and terminal F+ and F-. Connect a 12 volt battery and switch to the F1 and F2 leads.

F1 and F2 polarity is not critical for flashing. However, whichever field lead was connected to the positive battery terminal must be reconnected to voltage regulator F+ terminal and the negative to the F- terminal. Close the switch; allow it to remain closed approximately 5 seconds, then open it. Remove the battery leads from terminals. Residual magnetism has been restored to the exciter field.

Caution: It is good practice to momentarily touch leads F1 and F2 together, to neutralize any stored charge that might damage the solid state components in the voltage regulator before reconnecting to the regulator.

Reconnect F1 and F2 to voltage regulator, start the engine and note the voltage buildup. If voltage does not build up normally, repeat flashing procedure while set is running with the exciter field leads F1 and F2 removed from the voltage regulator. Stop the engine and reconnect leads F1 and F2. Start set and note voltage buildup. If

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voltage did not build up while set was running, check other troubleshooting symptoms listed in this Section.

ENGINE

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