KS-15929 DIESEL ENGINE-ALTERNATORS

225 KW (J86631)

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1. GENERAL

1.1 Scope

1.11 This section covers installation and test of KS-15929 diesel engine-alternator. The engine-alternator is rated at 225 KW and supplied by Detroit Diesel Engine Division of General Motors Corp. It uses a two-cycle 12-cylinder V-type Series 71 engine.

1.12 Tests in this section are based on the following drawings:

SD-81535-01 Manual Reserve Power Plant
SD-81534-01 Manual Engine-Alternator
SD-81533-01 Automatic Reserve Power Plant
SD-81532-01 Automatic Engine-Alternator
SD-81100-01 Alarms - Unattended Office
SD-81223-01 Alarms - Central Office
SD-81489-01 Typical Transfer Breaker

1.13 Paragraphs marked with a star (*) apply only to automatically controlled sets. Other methods and requirements apply to both manual and automatic sets except where noted.

1.14 The term "hardened set" used in this section refers to the sets used in 50 psi or 10 psi sites.

1.15 The installer should refer to Schematics, to operating instructions furnished with the set (E-5355 and E-5356) and to any other descriptive information available as an aid in performing the following tests. Usually there is an advantage in reading ahead several paragraphs, however, the test procedure should be followed in the same sequence listed.

"NOTICE: NOT FOR USE OR DISCLOSURE OUTSIDE THE BELL SYSTEM EXCEPT UNDER WRITTEN AGREEMENT"

Printed in U.S.A.

1.2 Precaution

1.21 Observe general precautions listed in Handbook 0.

1.22 Lethal voltages exist between line and neutral on 416-480 volt alternators. At 480 volts the phase voltage line to neutral, is 277 volts. The neutral connection on these alternators is insulated from the frame.

1.23 When any work is being done in the room over or around the machine, be sure all openings on the engine and alternator are closed or covered to prevent dust, dirt and other debris from entering any part of the equipment.

1.24 The exhaust systems, including the water-cooled manifolds, becomes extremely hot during engine operation. The manifolds are not guarded unless mesh guards are furnished separately, but other parts of the exhaust are suitably insulated and guarded on the machine. Do not touch any part of the exhaust system until it cools.

1.25 If engine adjustments involve turning the crankshaft by hand, disable the starting circuit by disconnecting the minus (-) lead at the starting battery. For an automatic turn OPERATION SELECTOR Switch to OFF before disconnecting the battery.

1.26 If slide-wire resistors R1 (range adjust) or R11 (damping adjust) in the voltage regulator require adjustment, stop the set to adjust.

1.3 Inspection

1.31 As soon as possible after the unit is received on the job, remove shipping materials and make a complete inspection of engine-alternator and associated equipment. Examine carefully for visible defects and damage. Check the interior of the control cabinet for concealed damage Check that loose parts and tools were received.

1.32 Report any defects, damage or missing parts in accordance with authorized routines.

1.4 Description of Sets

1.41 The standard engine-alternator is pictured in Figures 2, 3 and 4. These sets can be furnished for manual control or for automatic control. The control may operate remote transfer switches or other switching equipment furnished by the customer.

1.42 The following options are available on these sets: Alternator voltage of 208-240 or 416-480; cooling by radiator on the set, remote radiator or heat exchanger; equipment for parallel operation.

1.43 An immersion heater may be ordered for an automatic set to keep engine block temperature about 85-100°F. A fuel burning air-box heater may be ordered to aid in manual starting in extreme cold temperatures.

1.44 Approximate dimensions and weights are as follows:

Item	Weight (Lbs)	Length	Width	Height
Engine-Alternator with Radiator and Control	10,000	10'-4"	4'-1"	6'-1"
Control Cabinet	1,000	2'-9"	4'-1"	6'-1"
Remote Radiator	1,500	3'-7"	4'-9"	5'-7"
Exhaust Silencer	515	5'-6"	2'-6"	Diameter

NOTE 1: Width is 4'-5" for a set with heat-exchanger cooling.

NOTE 2: The base (without cradle attached) of the engine-alternator for 10 psi sites is 10'-9" long. Outside dimensions of the cradle for 50 psi sites are 12' x 4'-9. Weight of cradle is about 500 pounds.

1.45 The standard set has a floor-mounted cabinet with the engine set supported by eight vibration isolators. The hardened sets have cabinet, engine and exciter mounted on a single base. The 10 psi sets have the base supported by four brackets. The 50 psi sets have the base slung in a cradle which in turn is supported by four brackets.

1.46 More recent sets are equipped with a Delco alternator as opposed to the original vintage with an Electric Machinery alternator. The exciter for the Delco alternator is in the bell housing, an integral part of the alternator, as opposed to a separate exciter box used with the Electric Machinery alternator.

1.5 Description of Automatic Set Operation

1.51 When the commercial power falls below 93% the engine starts cranking after the SDT timer times out. The WUT timer starts. After it times out terminals LB6 and TR16 will supply engine-alternator potential to cause the remote transfer device to transfer load to the set. At this time the timer (HOT-45) will start to time out.

1.52 After commercial power is restored (at 93% of nominal or higher), the positioning of the OPERATION SELECTOR Switch (OSS) and the TRANSFER SELECTOR Switch (TSS) determine the method of load transfer to commercial power.

1.521 OSS & TSS in the AUTO Position
The set will run a minimun of one hour carrying office load. When commercial power returns and after the HOT-45 has timed out, the HOT-15 is energized. The set will shutdown and the transfer takes place after the HOT-15 times out..

1.522 OSS in the AUTO position & TSS in the HAND position
The load will be carried indefinitely and transferred to commercial power by an operator.

1.53 The OPERATION SELECTOR Switch position are:

OFF: All automatic starting, control, and trouble protection circuits are inoperative.

NO LOAD TEST: The set will start without delay and go through its normal warm up sequence. Transfer does not occur.

FULL LOAD TEST: Simulates a power failure by energizing the SDT timer. The START, warm-up and transfer are the same as for a power failure under normal conditions. Restoration to commercial power does not occur.

AUTO - Described in paragraph 1.51 - 1.52.

2. TOOLS, TEST SETS AND RECORDS

2.1 Tools and Test Sets

QUAN.	CODE	DESCRIPTION	NOTE
1	R-3076	Manometer, Water	-
1	-	Manometer, Mercury	1
1	R-2705	Tachometer	-
1	R-3404	Indicator, Phase Sequence	-
-	R-3413	Wire & Lug Assembly	2
1	R-1412	Eye Bolt	-
1	R-1497	Rope Hoist	-
1	ITE-5250	Digital Multimeter	
1	ITE-4824	Tachometer, Hasler	-
1	ITE-4785	Test Load, 250 KW	-
	or		
2	ITE-4782	Test Load, 150 KW	-
1	ITE-4297	Autotransformer	3
1	ITE-9114	Test Cord	3
1	ITE-9115	Test Cord	3
2	R-4296	Ear Protector	-
1	R-3242	11/32" Twist Drill	4
1	R-3283	1/8" Tapered Pipe Tap	4
1	R-3284	1/4"-1/2" Tap Wrench	4

NOTE 1: It will be necessary to borrow a mercury manometer (reading 4" of mercury) from the customer.

NOTE 2: The artificial loads must be placed outside or in a well-ventilated area. Order a sufficient quantity of R-3413 (in groups of 3) to reach the load.

NOTE 3: For automatic sets only.

NOTE 4: To drill and tap the hole in the exhaust pipe to connect a manometer.

2.2 Records

SD-97.946	Engine-Alternator Test Record
SD-4-1275	Lubrication Record
SD-4-1285	Storage Battery Report
SD-4-1313	Test Trouble Record
SD-4-1315	Summary of Tests

3. ENGINE-ALTERNATOR

3.1 Installing A Standard Set

NOTE 1: If required to bolt isolators to the floor (such as in earthquake areas) remove the 1/4" thick ribbed material on the base of each isolator. Turn isolators so that the base holes are toward the outside of the base.

NOTE 2: If isolators will not be bolted to the floor turn isolators so that the base holes face inward.

3.11 Before placing the set, check the general slope of the mounting area. Refer to Section 129 in this handbook for method of checking slope. If the area slopes more than 1/4 inch in ten feet in any direction the customer should be requested to correct the condition.

3.12 Remove any floor covering such as asphalt tile or linoleum at all vibration isolator support points so that isolators will rest directly on the concrete. Refer to Section 129 in this handbook for operations involved.

3.13 When the machine is received have the riggers move it into position. Also have the riggers raise the base and place the eight vibration isolators under the set.

3.131 To place the isolators raise the base about two inches off the floor. Isolators fit under brackets inside the base. The base can be raised with the jacking screws for this operation. Place steel plates on the floor under the screws so that they do not cut into the floor.

3.132 To install the isolators remove the bolt with attached locknut from the top of each isolator, place the isolator under the hole in the right-angle bracket inside the base and insert the bolt through the bracket hole into the tapped hole in the isolator. After this has been done on all isolators. the base can be lowered. The base will sit about 1/2" above the floor. Remove jack screws from the base and turn them over to the customer.

3.133 Turn down the locking bolt at each isolator position until it firmly contacts the spring tension plate on the isolator. Take about one more turn on the bolt and then securely tighten the locknut.

3.14 When installing engine sets equipped with an Electric Machinery Alternator, lower the Exciter Box to the floor. It is shipped bolted to the alternator end bell and to a base cross-member. Remove the grill under the control cabinet. Remove the top covers of the exciter box. Insert the four jacking screws (found in loose parts) into the four tapped holes in the channel supports for the box and turn the screws down until they contact the floor. Then remove the four bolts that secure the exciter to the alternator and the cross-member.

3.14 Cont'd

Turn the four jacking screws out until the Exciter Box rests on the floor. Find the two bolts in the loose parts that fit the holes in the alternator and insert these bolts and tighten. The Exciter Box will have to be slide away from the alternator in order to put in the bolts. Reposition the exciter, leaving about one inch clearance between the exciter and the end of the alternator.

NOTE: There is sufficient slack in the alternator leads to allow the Exciter Box to sit on the floor. It may be necessary to rearrange these leads to obtain sufficient slack, or it may be necessary to use the four jacking screws as feet if interference is encountered between the engine base angle and the cabling hole in the exciter box.

3.15 When a Delco alternator is provided, the exciter is contained by the end bell. There is no separate exciter box.

3.16 The Delco voltage regulator, associated with the Delco alternator, is located in the lower left-hand corner of the control panel. The VR terminal strip is located on the rear of the voltage regulator.

3.161 Table A and Figure 1 shows the connections from the alternator harness to the VR terminal strip. The harness leads are marked as shown in the table. Table A shall be applied until final drawings are available.

TABLE A PAR. 3.161

Voltage Regulator Terminal Strip Harness Lead Designations	
T1	1
T3	2
CBT3	3
CBT4	4
3E	5
4E	6
P1	7
P2	8
10E	9
9E/FNG (9E & F Neg.)	10
F POS	11
CBT1	12
CBT2	13

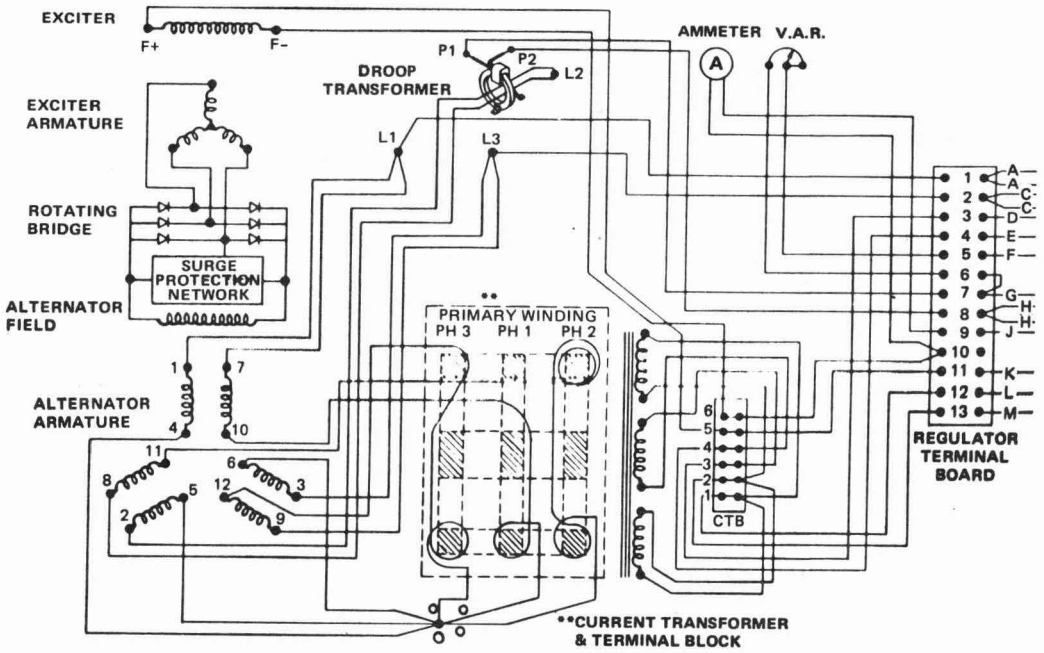


FIG. 1 PAR. 3.161

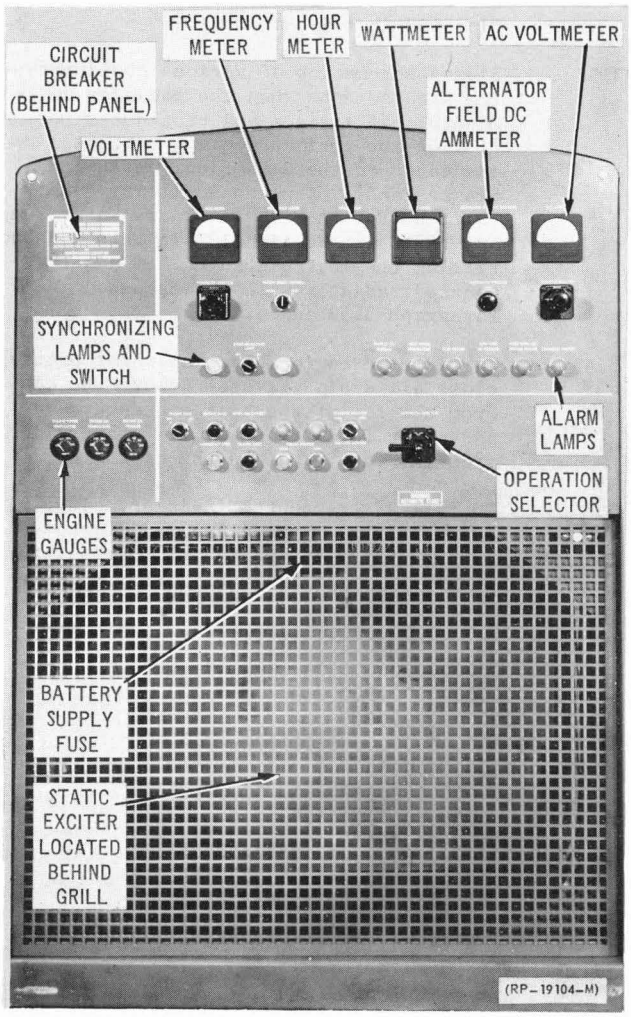


FIG. 2 CONTROL CABINET-AUTOMATIC SET PAR. 1.41

3.17 The control cabinet has to be removed from the base and lowered onto four 1/2 inch thick spacers. It is shipped bolted to the rear end of the subbase. After the machine is in place and supported by isolators place wooden spacers or slats on the floor under the feet of the cabinet. Since the control cabinet is top heavy, bolt the R-1412 Eye Bolt to the top of the control cabinet, and use the R-1497 Rope Hoist to secure the cabinet to the superstructure, and thereby avoid tipping.

3.18 Remove the bolts holding the cabinet to the subbase. The cabinet can then be slide back on the slats so that alternator connections can be made to the breaker in the back of the cabinet after removing the grill. Slide the cabinet back to line up with the base, pry it off the slats and position the 1/2 inch thick spacers under the four corner holes in the cabinet. The cabinet should clear the base by at least 1/4 inch.

NOTE: Arrangements should be made to bolt the cabinet to the floor in all cases whether it is an earthquake area or not. Standard 3/8-16 Expansion Bolts will be used.

3.2 Installing A Hardened Set

3.21 These sets have the cabinet, exciter and engine all mounted on a rigid base. The 50 psi set has a cradle and these sets are shipped with the cradle attached. The cradle may be removed in order to clear doorways or for easier handling which case the width of the base will be reduced to 4' -1".

3.22 When the set is received have the riggers move it into position and raise the base or cradle and attach the base or cradle to the four pedestals.

3.3 Lubrication

3.31 Drain out any oil or residue in the crankcase by removing the pipe plug in the oil drain. (Right side of engine) Replace the lube oil drain plug.

3.32 Use SAE 30 lube oil for temperatures usually above 32°F, SAE 20W for air temperatures between 32°F and 0°F, and SAE 10W for air temperatures below 0°F. These oils are all Type A. Refer to Section 1A in this Handbook for list of recommended oils.

3.33 Remove oil filler cap (top of rocker arm cover on right side of engine) and add lube oil to the crankcase as follows:

3.331 Without Ren Valve: Fill the crankcase with oil to the H mark on the dip-stick. Capacity of the crankcase is about 94 quarts.

3.332 With Ren Valve: Close the globe valve in the line from lube oil supply tank to engine and add an initial amount of oil (about 48 quarts) directly to the crankcase. Add lube oil to the crankcase until oil appears in the window of the Ren Valve. Open the globe valve to the supply tank.

3.34 Fill air cleaners. Use the same lube oil as in the engine. Remove the cup on the bottom of the air cleaner, fill to the line with oil and replace. About five quarts of oil are needed.

3.35 Fill the governor lube oil reservior at the front of the engine and the governor lube oil filter at the rear of the engine with the same lube oil used in the crankcase. Remove the plug in the top of each one, fill with oil and replace the plug. About one quart each is needed.

3.36 Remove the rocker arm covers on each cylinder bank and pour about one quart of diesel lube oil over the rocker arms and push rods of each cylinder bank. Replace the covers.

3.37 The alternator bearing is packed for about 3000 hours operation and requires no greasing at installation.

3.4 Starter Cables

3.41 Before installing starter cables raise the hinged panel on which the temperature and pressure gauges are mounted and lock in position. A heavy wire link is provided to hold it up.

3.42 Route the cable around this panel so that the hinged panel can be lowered or raised freely.

3.43 Upon completion of installing cables, unlock and lower hinged panel into original position.

3.44 Check to see that the hinged panel moves freely and the panel is free of interference with starter cables.

3.5 Cooling System

3.51 Installation of a remote radiator, associated water tanks and piping to within ten feet of the engine is usually the customers' responsibility. Refer to Section 132 in this Handbook if necessary to do any of this work. Observe rust inhibitor and antifreeze information in Section 133 in this Handbook.

3.52 Piping schematics of various cooling system arrangements when the radiator is mounted off the set and procedures for filling the various Cooling Systems (Radiator on the Same Floor as Engine, Single Tank System, No Auxiliary Pump; Two Tank System With Auxiliary Water Pump) are listed in Section 133 in this Handbook. Filling the heat exchanger and a set mounted radiator will be discussed in Paragraph 3.53 and 3.54.

3.53 To fill the engine block and heat exchanger. close all drain valves. Remove the cap from the top of the heat exchanger and add water until the level is about 2 inches from the top. Replace the cap.

3.54 To fill a set-mounted radiator, close all drain valves. Remove the radiator cap and add water to the top of the radiator until the water is level with the top of the tubes. Replace the cap.

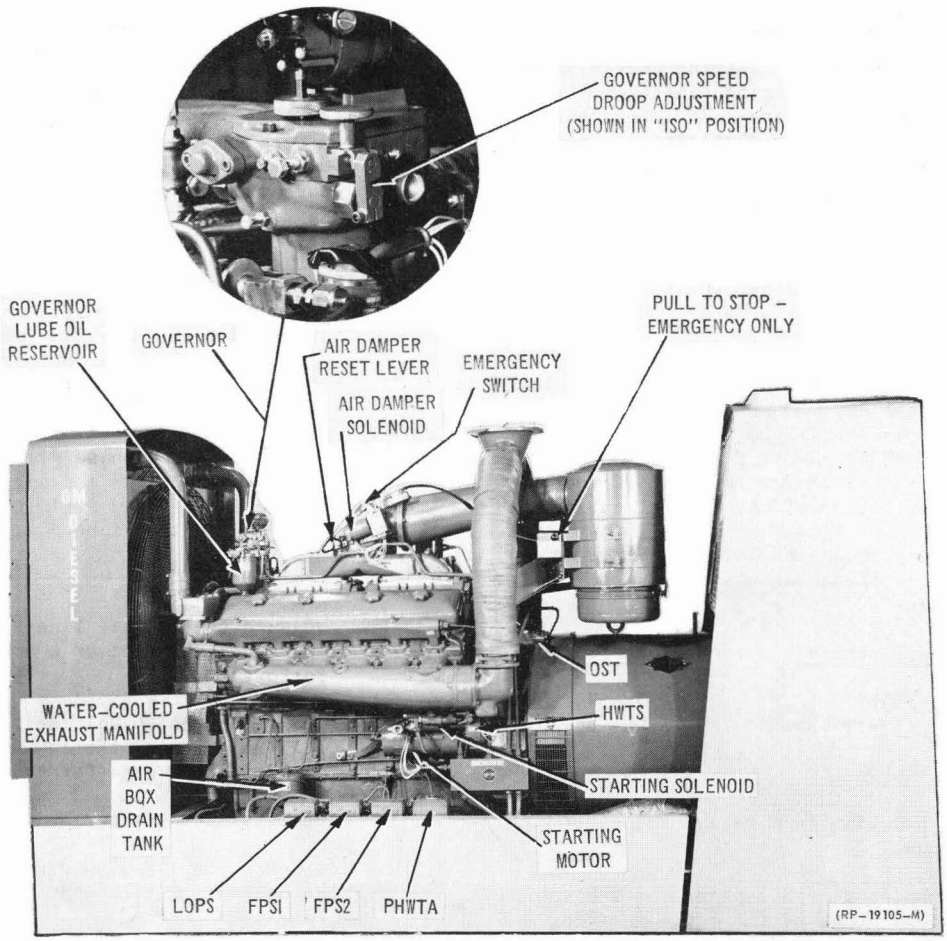


FIG. 3 LEFT SIDE OF ENGINE WITH SET-MOUNTED RADIATOR-PAR. 1.41

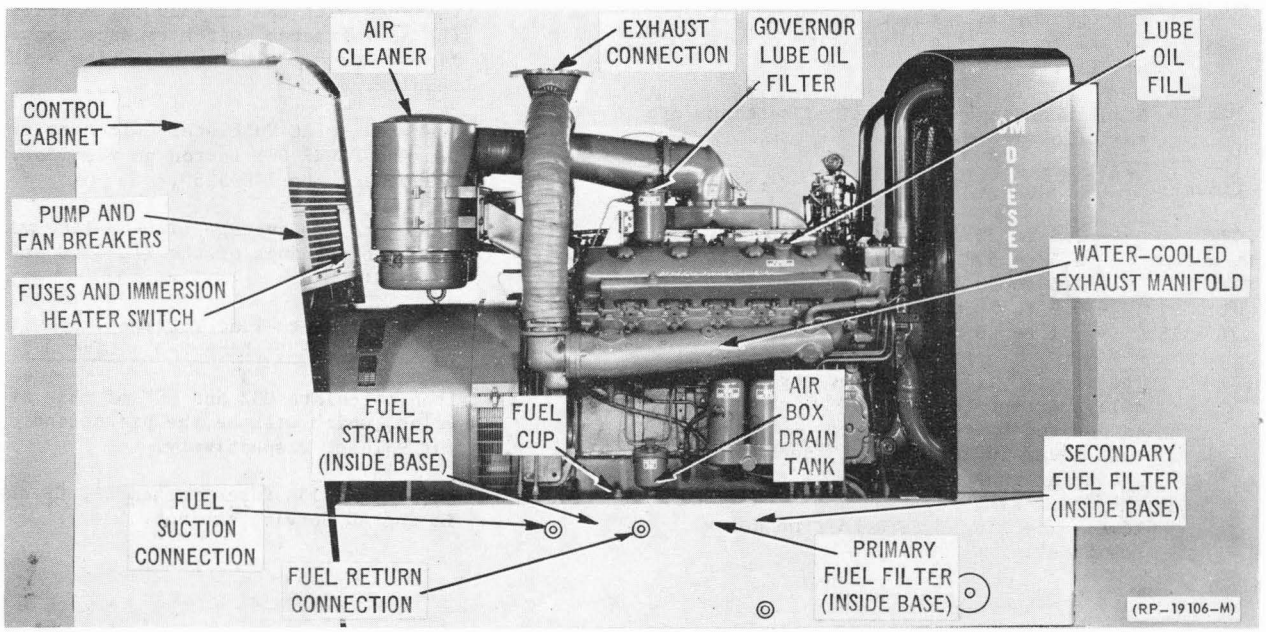


FIG. 4 RIGHT SIDE OF ENGINE WITH SET-MOUNTED RADIATOR-PAR. 1.41

3.6 Starting Battery Charge

3.61 Give the battery the initial charge indicated in engine starting battery section of Handbook 18. Where a KS-15661 charger is furnished, verify that correct input ac taps have been selected. The List 24 charger operates from two lines of a 208-240 volt source, usually from essential load bus. Adjust coarse and fine output taps as necessary. Refer to supplier's manual with the charger for this information. Install all fuses in the charger.

3.62 If control and alarm connections have been run from the battery to the control cabinet the control may be made inoperative during the charging period by removing the 15 ampere BATTERY SUPPLY FUSE and associated alarm fuse. This fuse block is directly under the bottom of the control cabinet.

3.63 After completing the initial charge adjust charger to float battery within the following ranges:

Type of Battery	Float Volts
Lead- Acid (KS-15577)	34.5 - 35.0
Nickel Cadmium (KS-15578)	35.0 - 36.25

3.7 Control Cabinet

3.71 Remove blocking from relays and other apparatus.

3.72 Adjust pointer of all meters on the cabinet to zero by means of the zero-adjusting screws except the frequency meter.

4. TIMERS

4.1 Agastat timing relays are furnished for LOPT, LS/OCT, SDT, WUT and HOT-15. LOPT will be the only timer furnished with the manual set but the automatic set will have all listed timers.

4.2 Adjustmen ranges and desired settings are as follows:

Timer	Range	Setting
LOPT	- 2.5 to 50 sec.	20 sec.
LS/OCT	- 2.5 to 50 sec.	30 sec.
SDT	- 2.5 to 50 sec.	15 sec.
WUT	- 0.5 to 10 min.	2 min.
HOT - 15	- 1 to 20 min.	15 min.

4.3 The Timers will be set for correct time delays except SDT and WUT which may be set as desired by the customer. WUT setting must never be less than 10 seconds, DIAL lettering runs A through E with A being the short time position and E the long time. (Setting 0 is a no-time delay position).

4.4 The Eagle Type Timer (HOT-45) is a clock type with an adjustment range from 0-60 minutes. Adjustment is made by releasing the locknut and moving the pointer to the desired value. If an adjustment is necessary and the glass is removed, be sure to replace the glass with the curved surface outward so as not to restrict the movement of the pointer.

5. VOLTAGE SENSING RELAYS

NOTE 1: Voltage sensing relays should release when line-to-line voltage falls to 88% of normal or below. These relays should operate when line-to-line voltage is 93% of normal or higher.

NOTE 2: Assume phase #1 relay and associated connections and adjustments to be on the left, phase #2 in the middle and phase #3 on the right.

5.1 Preliminary

5.11 Measure the average line-to-line voltage for a 208 Volt set or a 480 Volt set as follows:

NOTE: For a 480 Volt set, these readings will be taken on the low voltage side of the step-down transformer.

5.111 Operate AC Voltmeter Switch to OFF.

5.112 Connect the ITE-5250 Digital Multimeter across the AC Voltmeter on the Control Panel.

5.113 On ITE-5250 depress VAC and RANGE 1000 buttons. Turn on ITE-5250 by depressing POWER ON button.

5.114 Measure the three commercial line-to-line voltages with the ITE-5250 by operating the AC Voltmeter Switch to each commercial line voltage position and noting each reading.

5.115 Operate the AC Voltmeter Switch to OFF. Depress POWER OFF button on ITE-5250. Disconnect the ITE-5250.

5.116 Calculate the average line-to-line voltage from the readings of the ITE-5250 as follows:

$$\text{Average line-to-line Voltage} = \frac{\text{Line 1-2} + \text{Line 2-3} + \text{Line 3-1}}{3}$$

Then calculate 93% and 88% of this average value, which will be the pickup and drop-out values, respectively.

5.12 Remove the 15A fuses marked CA, CB and CC in the AC Service cabinet.

CAUTION: If commercial ac is present on on these fuses, use a fuse puller.

5.13 Block the TR relay non-operated and if the EXV relay is furnished, insulate all the contacts of EXV relay.

5.14 Disconnect leads from all terminals on the terminal strip at the bottom of the VF relay. Tape and mark each lead so that it can be reconnected later to the correct terminals.

5.15 Loosen the locknuts on each PICK-UP and DROPOUT potentiometer shaft. Turn each PICKUP potentiometer full CW and each DROPOUT potentiometer full CCW.

5.16 Leave the relay for phase #1 in place, but remove the relays for phase #2 and phase #3.

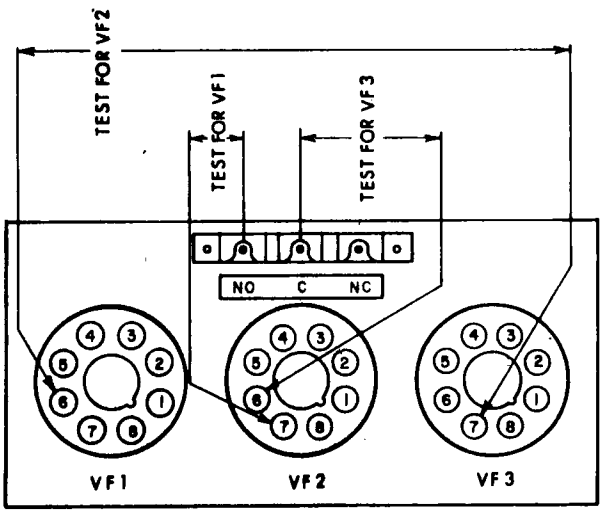


Fig. 5 - Front view of Voltage Sensing Showing Socket of Relays. Par. 5.2

5.2 Test

NOTE: Refer to Fig. 5 for ITE-4442 connections.

5.21 Connect the ITE-4297 with the ITE-5250 Digital Multimeter across it to monitor output voltage to phase #1 terminals as follows:

5.211 Connect spade tips at one end of the ITE-9364 to the terminals on the voltage relay terminal strip for phase #1 (Terminal 0 and 208, 0 and 240).

5.212 Put the plug end of ITE-9114 and ITE-9115 cords into the OUTPUT Socket on ITE-4297. Connect the free spade tips of the ITE-9364 cord and the alligator clips from the ITE-9114 and ITE-9115 to the ITE-5250 Digital Multimeter.

5.213 Det dial on ITE-4297 to 0. With ITE-4297 turned off, plug the cord into a convenient 110 volt ac outlet.

5.22 Connect the ITE-4442 Volt-ohmmeter (R x 1 scale) between terminal NO and pin #7 of the scoket for phase #2 relay (Refer to Fig. 4). There should be no continuity.

5.23 Depress POWER ON button on ITE-5250. Turn on the ITE-4297. Increase output until voltage indicated on the ITE-5250 is 93% of the average line-to-line voltage (calculated in paragraph 5.116). Turn PICKUP potentiometer for phase #1 slowly CCW until continuity is indicated on the ITE-4442.

5.24 Reduce the autotransformer output 88% of the average line-to-line voltage (calculated in paragraph 5.116). Turn DROPOUT potentiometer slowly CW until no continuity is indicated on the ITE-4442.

5.25 Increase voltage slowly until the ITE-4442 indicates continuity and note the voltage on the ITE-5250; this should be within 2 volts of the original dropout setting. Decrease voltage until no continuity is indicated on the ITE-4442 and note the voltage on the ITE-5250; this should be within 2 volts of the original dropout setting.

5.26 Decrease autotransformer voltage to zero and turn it off. Disconnect the ITE-4442 Volt-ohmmeter. Disconnect the autotransfromer. Turn off ITE-5250 Digital Multimeter by depressing POWER OFF button and disconnect the ITE-5250.

5.27 Remove the phase #1 relay and insert phase #2 into its socket. Connect the ITE-4297 and ITE-5250 to 0 and 208, or, 0 and 240 terminals of phase #2. Connect the ITE-4442 Volt-Ohmmeter between pin #6 of the socket for phase #1 relay and pin #7 of the socket for phase #3 relay. There should be no continuity indication on the ITE-4442. Perform operations indicated in Paragraphs 5.23 through 5.26 for phase #2 relay.

5.28 Remove the phase #2 relay and insert phase #3 relay into its socket. Connect the ITE-4297 and ITE-5250 to 0 and 208, or , 0 and 240 terminals of phase #3. Connect the ITE-4442 between terminals C and pin #6 of the socket for phase #2 relay. There should be no continuity indication on the ITE-4442. Perform operations indicated in Paragraphs 5.23 through 5.26 for phase #3 relay.

5.3 Final Operations

5.31 Restore phase #1 and phase #2 relays to their original locations.

5.32 Reconnect the leads to all terminals on the terminal strip at the bottom of the VF relay.

5.33 Remove insulation from all the contacts of the EXV relay if furnished.

5.34 Replace the CA, CB and CC 15A fuses in the AC Service Cabinet that were removed.

5.35 Operate the AC Voltmeter Switch to its original position.

6. INITIAL START

NOTE: No alarm lamps should be lit on a manual set. A lighted SWITCH OFF NORMAL lamp on a manual set indicates the EMERG SWITCH was not reset. The SWITCH OFF NORMAL lamp will be lighted on an automatic set because OPERATION SELECTOR Switch is OFF.

6.1 Preliminary

6.101 Position controls and switches on the control cabinet as follows:

CONTROL	POSITION
Circuit Breaker	OFF (Note 1)
ENGINE RUN Switch	OFF
SYNCHRONIZING LAMPS Switch	OFF
C. C. C. Switch	OUT (Note 2)
REMOTE RADIATOR FAN MOTOR Switch	HAND
HEAT EXCH RAW WATER PUMP MOTOR	HAND
* TRANSFER SELECTOR Switch	HAND
* OPERATION SELECTOR Switch	OFF
* SUMMER OFF - WINTER ON Switch	(Note 3)
FAN SUPPLY Breaker	OFF
ALUX WATER PUMP Breaker	OFF
HEAT EXCHANGER Breaker	OFF

NOTE 1: If this breaker is ON it will have to be manually operated to OFF position. Open the hinged front cover of the control cabinet. Insert the handle provided with the breaker over the sleeve under the indicator window on the breaker. Push the handle in and pull down to operate breaker to OFF position.

NOTE 2: This switch is on the right side of the exciter box.

NOTE 3: This is on the rear of the automatic control cabinet, on the right side facing rear of the cabinet. Set according to the weather conditions to keep engine block about 100°F.

6.102 Remove tools and any other loose items from the machine.

6.103 Open the valves in the fuel suction line. Close exhaust system condensate drain valves when provided. The condensate drains will be opened on a periodic basis.

6.104 On the automatic sets disconnect leads CB9, LB6, TR15 and TR16 on the control cabinet terminal strip. Tape the loose ends of the wires. This prevents accidental operation of the remote transfer switch.

6.105 Close disconnect switches for the auxiliary water pump, remote radiator, or heat exchange raw water pump.

6.106 Unscrew the cap on the rear of the alternator shaft so that speed readings can be taken.

6.107 Close air box drain valves at the bottom of the air box drain tanks. There are two tanks, one on each side of the engine.

6.108 Position governor speed droop control for zero speed droop ("ISO" position). Loosen the knurled knob at the top rear of the governor, push the slider and arm all the way to the left stop (facing the governor) and lock the setting by turning down the knurled knob.

6.109 For heat exchanger cooling check the indicator position on the thermostatic valve. The indicator should be at the marked position. The indicator can be moved up or down by inserting the tool provided in the adjusting nut and turning the nut.

6.110 Connect the starting battery to the set and close any switches provided in the circuit. Replace BATTERY SUPPLY FUSE (main and alarm) if these were removed earlier.

6.111 Start the room ventilating fan, where one is provided, or open windows or doors as necessary to provide adequate ventilation.

6.2 Priming The Fuel System

6.21 Open the shut-off valve in the fuel line to the hand pump. Operate the handle of the hand pump until considerable pressure is encountered.

6.22 Close the shut-off valve in the line to the hand pump.

6.3 No-Load Test

Foreword: Before starting the engine-alternator perform all operations in Paragraph 3 and 4. Associated equipment and systems must be completely installed and ready-to-use. However, the water pump and remote radiator fan motor connections can be made on a temporary basic until it is found that the motors operate in the correct direction.

6.301 The air damper and EMERG Switch may have to be reset. First check that the PULL TO STOP - EMERGENCY ONLY knob (near air cleaner, left side of engine) is pushed all the way in. The air damper lever should point toward the front of the engine and the ADS solenoid shaft should be latched into the notch of the cam on the air damper. Reset the air damper lever by pulling it toward the front of the engine until it latches with the ADS shaft. This should reset the EMERG Switch but push EMERG. Switch lever toward the front end of the engine to make sure.

6.302 In a cooling system other than a set-mounted radiator or heat exchanger is furnished, operate cooling system valves as shown on the Operating Chart or in Figures 1, 2, or 3 of Section 133 in this Handbook.

6.303 Start the Engine

6.3031 For a manual set operate the ENGINE RUN Switch to ON. Depress ENGINE START Button and hold until engine starts, but not longer than 20 seconds. If engine fails to start in this time, release ENGINE START Button and check for possible causes of starting failure.

6.3032 For an automatic set turn OPERATION SELECTOR Switch to NO LOAD TEST. Engine starts to crank immediately. If it fails to start in 20 seconds return OPERATION SELECTOR to OFF and check for possible causes of starting failure.

6.3033 If the engine fails to start on the first attempt, wait at lease two minutes before another start to allow the starting motor to cool.

6.304 After the engine runs a few minutes check speed with a tachometer. Adjust speed to 1800 RPM using the ENGINE SPEED CONTROL.

6.305 Adjust output voltage to the desired value with ALTERNATOR VOLTAGE control on the panel.

6.306 Observe the lube oil pressure. At least 30 pounds should be indicated but the pressure will probably be above the normal operating range of 30-55 pounds. If no pressure is indicated shut down immediately. Open ENGINE RUN switch on a manual set or turn OPERATION SELECTOR to OFF on an automatic set.

6.3061 If no pressure or very low pressure is indicated, a ground strap from the control cabinet to the engine base may be required as the gauge has a remote electrical sensing device.

6.3062 There is no adjustment for lube oil pressure. If the pressure is too low, the oil pressure regulator is dirty or defective. Refer to the supplier's manual for information on this regulator.

6.307 When a remote radiator is furnished, intake and discharge louvers will begin to open when alternator voltage is normal.

6.308 When a set-mounted radiator is furnished, intake louvers will begin to open when alternator voltage is normal. If the discharge louver control is connected to R2-B2-W2 terminals, the discharge louvers will also begin to open at this time. If discharge louver control connects to R-B-W terminals, the discharge louvers will not begin to open until ENGINE WATER TEMPERATURE gauge indicated 155-165°F.

6.309 With engine-alternator voltage available check direction of rotation of radiator fan and water pump motors.

6.310 If this is a new set operating alone, check to make sure the Emergency Bus is dead and clear of grounds and close the Set Breaker, which will energize the EM Bus.

6.3101 Check to make sure phase rotation is correct (in the same direction) on the Emergency Bus as compared to the Commercial Bus. Check phasing at all transfeer locations.

6.3102 Use the R-3404 Phase Sequence Indicator or an induction motor. Further verification can be made with the Synchronizing lights on the sets. See Section 135 in this handbook. Check to see that only the output leads are connected to the lugs on the bus in the cabinet.

6.311 If this is an added set, energize the EM Bus with the existing set & check phase rotation at each added set at the Set Circuit Breaker but do not close the Set Breaker on the added sets. They must each be properly synchronized first.

6.312 If installing two or more sets where no sets were installed previously, follow Paragraph 6.310 for the first set and Paragraph 6.311 for all other sets.

6.313 Before shut-down check that the engine water temperature is at lease 125°F. If not keep the engine running till 125°F is acquired.

6.314 Have someone watch the pump or fan. Close the associated breaker on the back of the cabinet. Push the LOW Button for the fan and then immediately push the STOP Button. Push the START button for the pump and then immediately push the STOP Button.

6.315 Shut the set down. Operate the ENGINE RUN Switch to OFF for a manual set or turn the OPERATION SELECTOR Switch to OFF for an automatic set.

7. REVERSE POWER TEST

NOTE 1: This test will be made if the set has a reverse power relay (parallel sets only).

NOTE 2: This test requires an artificial load, perferable ITE-4782 although ITE-4785 may be used.

7.1 With the set shutdown reverse the leads at terminals No. 5 and No. 6 on the Reverse Power Relay current coil.

7.2 Start the diesel as follows:

7.21 Manual Set: operate ENGINE RUN switch to ON. Depress ENGINE START button and hold until engine starts, but not longer than 20 seconds. If engine fails to start in this time, release ENGINE START button and check for possible causes of starting failure.

7.22 Automatic Set: turn OSS to NO LOAD TEST. Engine starts to crank immediately. If it fails to start in 20 seconds return OSS to OFF and check for possible causes of starting failure.

7.3 CLOSE CIRCUIT BREAKER by depressing CLOSE button. Turn on artificial load and increase the load to about 35 KW.

7.4 Increase the load from the 35 KW point in minimum steps available. Observe the engine alternator breaker trips and the set shuts down at about 50 KW. Record on the ID-946 Form the KW reading at which the set shuts down and the breaker trips.

7.5 Observe that the Reserve Power lamp goes on and the horn sounds at shutdown. Cancel all alarms as follows:

7.51 Manual Set: Depress TROUBLE RESET Button to restore circuits to normal and remove alarms.

7.52 Automatic Set: Depress TROUBLE RESET Button to restore circuits to normal and to remove alarms. Turn OPERATION SELECTOR Switch to OFF position.

7.6 Operate artificial load switches to OFF position.

7.7 With set shutdown restore leads on terminals No. 5 and No. 6 of Reserve Power Relay to original connections.

7.8 Reset the Reserve Power Relay button in the lower left hand corner of the relay. Red-flag indication is removed.

7.9 Manually operate the circuit breaker to its open position by using the operating handle supplied with the circuit breaker. Also reset the air damper and EMERGENCY Switch.

8. OVERSPEED TRIP TEST

CAUTION: Do not exceed 125% speed (2250 rpm) in this test.

8.1 Start the set as follows:

8.11 Manual Set - Operate the ENGINE RUN Switch to "ON". Depress ENGINE START Button and hold until engine starts, but not longer than 20 seconds. If engine fails to start in this time, release ENGINE START Button and check for possible causes of starting failure.

8.12 Automatic Set: Turn the OPERATION SELECTOR Switch to "NO LOAD TEST".

8.2 To overspeed the engine and check the setting of the overspeed trip two men are required. One man will overspeed the engine by placing a 12" Crescent wrench on the external terminal shaft lever on the governor and forcing the lever upward while the second man checks the speed with a tachometer (R-2705).

NOTE: Exert a slow gradual upward force with the 12" Crescent wrench on the external terminal shaft lever on the governor not going above the 125% limit.

8.3 Shutdown should occur in the range of 2050-2250 rpm. Upon shutdown the horn will sound and the OVERSPEED or REVERSE POWER lamp will light. Record shutdown values on the ID-946 Form.

8.4 Cancel all alarms after shutdown as follows:

8.41 Manual Set: Depress TROUBLE RESET Button to restore circuits to normal and remove alarms.

8.42 Automatic Set: Depress the TROUBLE RESET Button to restore circuits to normal and to remove alarms. Turn OPERATION SELECTOR Switch to "OFF".

8.5 Reset the air damper and EMERGENCY Switch.

8.6 If shutdown does not occur in the specified range (2050 rpm - 2250 rpm), do the following:

8.61 Shutdown before 2050 rpm: Remove the dust cover marked "2". Through the hole in the dust cover, using the R-2959 wrench, turn the high speed adjusting screw clockwise to increase the trip. Start the set (Paragraph 8.1) and repeat the operations in Paragraph 8.2 through 8.5.

8.62 No Shutdown by 2250 rpm: Restore engine back to normal no load speed. Remove the dust cover marked "2" through the hole in the dust cover to decrease the trip. With engine operating repeat operations in Paragraph 8.2 through 8.5.

8.7 If adjustment was necessary start the engine and repeat the operations in Paragraph 8.3 through 8.5.

9. OVERVOLTAGE SHUTDOWN

9.1 When the overvoltage feature is specified by the operating company for manual or automatic sets, mount and wire the OV relay, the OVA socket and relay, and the OV lamp. The overvoltage feature is furnished as an "S" apparatus and wiring option and typically, is shown as Figure 8 on SD-81535-01, Sheet 2. The Time Dial on the OV relay should initially be set at 1 but may have to be altered to meet requirements. The tap setting should agree with the input voltage, i.e., 210 setting for 208 V in. Refer to Table B.

9.11 The shutdown feature shall be tested at 105%, 115% and, with the Electric Machinery alternator and voltage regulator, 130% of alternator output voltage. (at 480V a tapped voltage is used).

9.12 When connecting the Over-voltage relay circuit per Fig 15 on SD-81533-01 Automatic Plant Drawing, or, Fig 8 on SD-81535-01 Manual Plant Drawing an error exists on Issues 10B and 7B respectively. On SD-81533-01 Figure 15, lead 1 should go to 32M in Figure 1, not 77 or T77. On SD-81535-01 Figure 8, lead 1 should go to 32M in Figure 1, not 77 or T77.

Table B. Par. 9.1

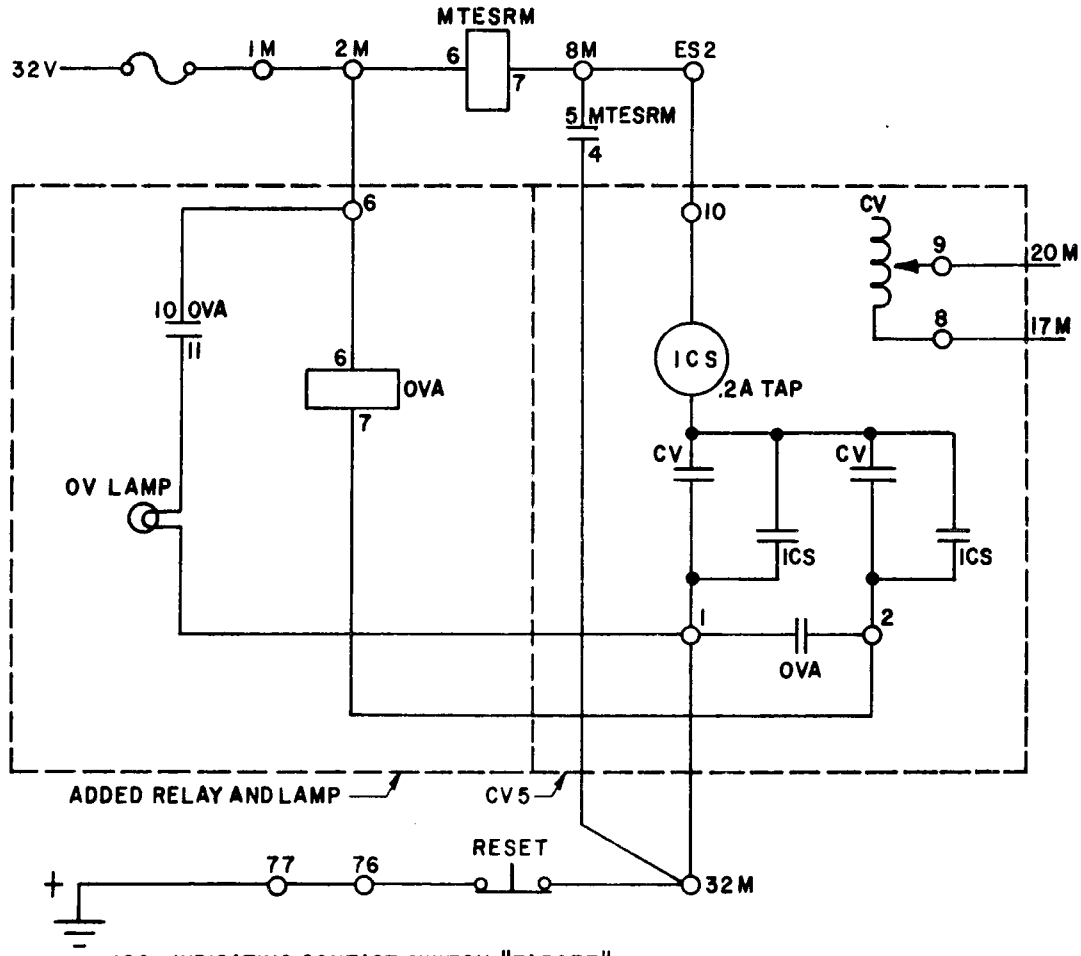
CV5 SETTING								
TAP		TIME DIAL						
210	240	1/2	1	2	3	4		
208	240 / 480 *						100	PERCENT OVERVOLTAGE
218	252 / 504 *	16					105	
239	276 / 552 *	1.5	3.4	6.7	10	13	115	
270	312 / 624 *	0.7	1.2	3	4.8	6.4	130	
LINE VOLTAGE		SECONDS						

*Higher voltages must be connected through a Potential Transformer. 208V and 240V usually is connected directly.

9.2 As an aid in understanding the circuitry of the optional OV relay circuit, refer to Figure 6. The Bell Telephone Laboratories have provided on OV lamp as an indication of a over-voltage condition. The operation of the ICS "target" or "flag" would be redundent, however, if the operating company insists on its operation as well, a resistor must be added across the MTESRM winding or from 2M to 8M to pass sufficient current for the ICS. (On the SD drawings the "A" terminals are the same as the "M" terminals, i.e., 2A = 2M.) For the manual set, connect a KS-14603 L-1GA 205 ohm resistor (5 watt Comcode 401320643) or equivalent, across the MTESRM. On the automatic set, two relays are connected in parallel (MTESRM and MTESRA) and requires a KS-20289 L-6C 562 ohm resistor (2 watt Comcode 400760161) or equivalent across the MTESRM. In addition, the locking path through contacts 4 and 5 on the MTESRM must be disconnected. If more than one wire is removed from one contact, they must be spliced and insulated.

9.3 Start set and raise voltage of alternator output to 105% of the nominal voltage (e.g. 208V times 1.05 equals 218.4 Volts) by turning the voltage adjust potentiometer on the front of control panel usually marked "alternator voltage". At this voltage, the set continues to function indefinately and does not shut down.

9.4 With the voltage adjust potentiometer, elevate the voltage to 115%. The OV lamp shall not light at or less than the values shown in Table A. This is a check to determine the Over-voltage relay can handle transients and not shut down at or in less than the time indicated. The lighting of the OV lamp may or may not occur after the time indicated. Return the voltage adjust potentiometer to a lower setting.



ICS INDICATING CONTACT SWITCH "TARGET"
MTESRM RELAY THAT SHUTS SET DOWN IN AN "ORDERLY" FASHION.

MAN.	SD-81534-01
AUTO	SD-81532-01

FIG. 6 PAR. 9.2

9.5 For engines equipped with the Electric Machinery alternator and voltage regulator a ceiling voltage shutdown check shall be made.

9.51 Remove the lead or leads from one side of the "alternator voltage" potentiometer. Wire a single pole single throw switch in series with the potentiometer and the previously connected lead or leads. Use 14 gauge wire and extend this temporary switch and leads external to the control panel so the panel may be closed. Insulate the splice. Verify that the switch is closed.

9.52 Start the set and adjust the potentiometer to nominal voltage. Open the switch and observe that the voltage rises and the set shuts down. The overvoltage light will light and the set must shut down within but not more than the time indicated in Table A. The unregulated alternator voltage may rise to or exceed 130% of nominal. This voltage is a result of the regulator going to ceiling and need not be measured.

9.53 Disconnect the temporary switch and wiring. Reconnect original wires to "alternator voltage" potentiometer.

9.6 Engine equipped with the Delco alternator and voltage regulator need not be checked for a ceiling voltage since the regulator is designed to maintain the voltage near the set-point value should the voltage regulator sense leads inadvertantly open.

10. FULL LOAD TEST

Time: The Preliminary Full Load Test will be one hour in length at 225 KW. The final Acceptance Test will be 2 1/2 hours in length, two hours at full load and a 1/2 hour at the normal load value, or, at full load. A customer's representative must witness the acceptance test.

Load: Artificial loads equal to the full capacity of the set connected either to the emergency bus or to the bus bar on the load side of the current transformer opposite the breaker side.

Parallel: If the set is to be paralleled the Final Acceptance Test will be made in parallel in accordance with Section 130 in this Handbook. Before paralleling operate CCC switch to IN (on back of the exciter box) and set the governor speed droop adjustment to DROOP.

10.1 Preliminary Full Load Test

10.101 Remove the 1/8 inch pipe plug in the exhaust pipe and connect a mercury manometer capable of reading 4" of mercury to this point. Adjust the manometer for zero.

10.102 Connect the ITE-5250 Digital Multimeter across line 1 and 2 of the alternator output terminals.

10.103 Start the set as follows:

10.1031 Manual Set - Operate the ENGINE RUN Switch to ON. Depress the ENGINE START Button and hold until engine starts, but not longer than 20 seconds. If the engine fails to start in this time, release ENGINE START Button and check for possible causes of starting failure.

10.1032 Automatic Set: To prevent the set from automatically shutting down in approximately one hour (HOT 45 plus HOT 15 equals one hour), while performing the next series of tests it will be necessary to temporarily remove the strap from 19A to 19M. Disconnect one end and tape. If more convenient, disconnect one end and tape the strap between Terms SD1 and SD2 instead of 19A and 19M. Turn the OPERATION SELECTOR Switch to NO LOAD TEST.

10.104 Observe gauges and thermometers on the engine set and pressure check during a 15 minute warm up at no load, then record all readings required on the first line of the SD-97.946 Form.

NOTE: No column is shown for the Generator Field. This current has no requirement and will not be read. However, normal values are about 10 amperes at no load and 14-18 amperes at full-load.

10.105 Check speed with a Hasler Tachometer (ITE-4824). Adjust speed to 1800 rpm ISO or 1875 DROOP if the governor arm is at DROOP. Also check the Voltage on panel voltmeter and adjust to the desired value with ALTERNATOR VOLTAGE rheostat.

10.106 On ITE-5250 depress VAC and range 1000 buttons. Turn on ITE-5250 by depressing POWER ON button.

NOTE: ITE-5250 should be turned on only when taking readings. During all other times the ITE-5250 should be off by depressing the POWER OFF Button.

10.107 Make sure a phase rotation check was made for each added set as covered in Paragraphs 6.310 through 6.312. With a clear EM Bus, close the circuit breaker with the CIRCUIT BREAKER CLOSE Button. The breaker CLOSE lamp lights.

10.108 Apply approximately 75 KW artificial load. Record data on the sheet.

CAUTION: Connect load to the load side of the current transformer opposite the breaker side.

10.109 Run for fifteen minutes at this load. Readjust speed and voltage, as necessary and then take another set of readings.

10.110 Apply 225 KW artificial load and take a set of readings. Run thirty minutes at 225 KW and again take a set of readings.

NOTE: Engine power decreases as altitude above sea level increases. The derating is indicated below. Above 3500 feet altitude, the engine-alternator may not carry 225 KW without the engine overheating. In that case, consider the KW output listed for the altitude as the full load KW. The set must carry the KW listed below without overheating.

Feet Above Sea Level	KW Output
Up to 3500	225
5000	218
6000	212
7000	206
8000	197
9000	189
10000	181

10.111 With the set running at full load determine exhaust back pressure. Observe that this meets the requirements in Paragraph 10.3.

10.112 Throughout the run check meters for evidence of internal damage or lack of freedom of movement. Compare panel voltmeter reading (line 1 - line 2) with ITE-5250 readings at least twice during the Preliminary run. Allowed variation is within 6 volts of ITE-5250 indication for 208-240V sets and within 12 volts of ITE-5250 for 416-480 sets.

10.113 Check for leaks during the run and tighten fittings as necessary to minimize leaks. If necessary to stop the set to correct serious leaks, do so and then repeat the Preliminary Test.

10.114 This test must meet requirements in Paragraph 10.3. After the test is completed reduce load to zero. Replace jumper removed in Paragraph 10.1032. Open the circuit breaker by operating the CIRCUIT BREAKER OPEN button. Then shut the set down.

10.2 Final Acceptance Test

10.201 If the customer allows this test to be made with building load combined with artificial load reconnect LB6, CB9. TR15 and TR16 leads. If he requests the tests to made with artificial load only, it will not be necessarty to reconnect LB6, CB9, TR15 and TR16 leads at this time.

10.202 Start the engine alternator as in Paragraph 9.103. Allow engine to warm up about 15 minutes at no-load. Adjust speed to 1800 rpm or 1875 rpm and voltage as desired.

10.203 Close the breaker on a manual set with CIRCUIT BREAKER CLOSE Button.

10.204 Apply load.

10.2041 Add building load, if allowed, by operating various transfer switches and adding sufficient artificial load to approximately 225KW.

10.205 Run a few minutes at full load. Adjust speed and voltage if necessary. Then take a set of readings on the Test Record. Do not change speed or voltage again throughout the run.

10.206 At the end of 30 minutes take another set of readings. Continue the readings every 30 minutes until total running time of 2 hours is completed.

10.207 For the last 30 minutes of the 2 1/2 hour acceptance test either run at full load or at a load equivalent to the normal load value. Take readings at the beginning and of the 30 minute period. Or continue 30 minutes at full load and take a final reading at the end of the period.

10.208 At the end of the 2-1/2 hours reduce load to zero.

10.209 If TR15, TR16, CB9 and LB6 for automatic sets were connected operate TRANSFER SELECTOR Switch to HAND and OPERATION SELECTOR Switch to AUTO. The operator will be able to transfer load to outside power at the end of the test. Engine alternator breaker will open and the set shuts down. Turn the OPERATION SELECTOR Switch to "OFF".

10.210 If TR15, TR16, CB9 and LB6 for automatic sets were not connected shut down set by turning the OPERATION SELECTOR Switch to OFF.

10.211 For a manual set operate transfer switches for the varuous loads to commercial power if building and office loads are used. Depress CIRCUIT BREAKER OPEN Button. Run set a few minutes at no load and then operate ENGINE REN Switch to OFF.

10.212 The engine-alternator shall meet all the requirements in Paragraph 10.3.

10.213 Disconnect the artificial load.

10.214 After the exhaust system has cooled, remove the manometer connection and replace 1/8 inch pupe plug. Before the exhaust system has cooled tighten up all exhaust system bolts.

10.215 Correct any lube oil, fuel and water leaks that were observed.

10.216 If TR15, TR16, CB9 and LB6 were disconnected, reconnect them.

10.3 Test Requirements

10.31 On each test run the speed shall stay within the following ranges at all loads, depending on the setting of the governor speed droop:

ISO setting	1800 - 1815 rpm
DROOP setting	1800 - 1881 rpm

10.32 On each test run the voltage shall stay within ±2 per cent of the setting at the beginning of the run. (Multiply original set voltage by 0.32 to calculate allowed variations above and below the setting).

10.33 Lube oil pressure shall not fall below 30 pounds. Normal operating range is 30-55 pounds.

10.34 Lube oil and water temperatures shall not exceed the following.

Gauge	Maximum
ENGINE OIL TEMPERATURE	225°F
ENGINE WATER TEMPERATURE	185°F

10.35 Exhaust back pressure at full load shall not exceed 3.5 inches of mercury. This is 47.5 inches of water. The limit of the R-3076 Manometer is 36 inches of water.

10.36 Meters shall evidence no lack of freedom of movement or other defects.

11. ENGINE CONTROLS AND ACCESSORIES

11.1 Synchrostart Speed Sensitive Switches

11.11 The manual set will have only one of these switches (overspeed Trip) while the automatic set has two. The switches are mounted on the rear of the engine under the air cleaners.

11.12 Adjusting screws are under the plugs in the back of the switch. The adjustments are numbered as shown below. To adjust use a 1/16 inch Allen wrench through the opening into the end of the adjusting screw and turn clockwise to raise switch operating point, or, counter-clockwise to lower the operating point.

Designation	Marked	Operating Point
OST	2	2050-2250 rpm
*FMCS	1	1650-1750 rpm
*CBCS	1	100-113 rpm
*LSCS	1	100-113 rpm
*OCCO	2	500-600 rpm

11.2 Thermostatic Valve

11.21 The Thermostatic Valve is used on the heat exchanger cooled sets. It is a temperature regulator, which consists of this valve and a thermostatic control unit which is mounted on the valve. The valve shall modulate the quantity of raw water flowing through the heat exchanger so that the engine is satisfactorily cooled.

11.22 The factory setting for the switch will either be marked on the scale or shown on a tag attached to the valve. Set the valve to this point by turning the wheel to the left to raise the indicator, or to the right to lower the indicator. The operating point is also changed by turning the wheel in the directions indicated.

11.3 HTS-LTS or WPS Switches

11.31 These switches (snap-action type) are mounted on the right side of the base toward the rear of the engine. The contacts of the HTS shall operate when the jacket water reaches 180 ± 5°F and shall remain operated on decreasing the temperature until the jacket water temperature reaches 170 ± 5°F. The contacts of the LTS shall close when the jacket temperature reaches 150 ± 5°F. The contacts of the WPS shall close when the jacket water temperature reaches 150 ± 5°F.

11.32 The two switches are separately adjustable by means of the small recessed hexagon head screws. Turning the screw to the right (out or up) will raise the operating temperature and turning it to the left (in or down) will lower the operating temperature.

11.4 FPS1 and FPS2 Switches

11.41 These fuel pressure switches are mounted on the hinged plate inside the base on the left side. The FPS1 operates the air damper shut down relay (ADSR) and FPS2 is in series with the lube oil pressure switch (LOPS) to prevent racing between these switches. These switches will close their contacts when the pressure rises to 19-22 psi.

11.42 They do not require readjustment and no facilities are available for checking these switches in the field.

11.5 Louver Controller

11.51 This louver controller is set so that when the radiator top water is 135°F to 140°F the louver motor will start to open and be completely open at 170°F.

11.52 For adjusting this controller, which is factory set and setting locked, refer to Section 22 of this Handbook for information on the controller.

11.6 Immersion Heater Control

11.61 An immersion heater and control switch are used to keep the engine cooling solution warm as an aid in cold weather starting. A change on the present sets now use a Kimstat non-adjustable switch. The thermostat switch closes at approximately 90°F and opens at approximately 110°F. The water temperature guage cannot be used to indicate the temperature when the engine is not running unless contacts 8 and 9 are temporarily closed on the VMR relay. To determine that the heater is functioning, touch the two hose connections at the switch. They should feel warm.

11.62 On older sets being reused a snap action type switch is mounted on the left side of the engine near the front. A temperature diffential setting of 15°F is fixed. The setting should be approximately 85°F to 100°F, however, the point at which the switch opens and closes may be shifted. To adjust the immersion heater switch, first remove the immersion heater fuses and operate the SUMMER-OFF switch to OFF position. Remove the coverplate of the switch. To raise the operating point of the switch turn the hexagonal adjusting but in a clockwise direction, and to lower the operating point turn the nut in the counter-clockwise direction.

11.7 PHWTS and HWTS Switches

11.71 The Preliminary High-Water Temperature Switch is mounted on the hinged plate which is located in the channel of the base on the left side of the engine. This switch closes its contacts when the temperature of the cooling water reaches 190 to 195°F and gives a visual indication by lighting the High Water Temperature Lamp, and the horn will sound. These switches are factory adjusted and shouldn't need adjusting.

11.72 The High Water Temperature Switch closes its contacts to shut the engine down when the temperature of the cooling water reaches 205° ± 5°F. There will be a visual indication of the HWT Lamp lighting and the horn sounding. These switches are factory adjusted and further adjustment in the field can not be made.

12. AUTOMATIC CONTROL TESTS

12.1 Check that TR15, TR16, CB9 and LB6 are connected. Also be sure that COMM 1,2 & 3 fuses are inserted as well as the fuses in the AC Service cabinet feeding CA, CB and CC lines to the set.

12.2 Turn the OPERATION SELECTOR Switch to NO LOAD TEST. The set starts without delay and runs at no load. When the engine alternator temperature has reached 150°F, shut down set by operating the OPERATION SELECTOR Switch to OFF.

CAUTION: Do not shut down the set until the water temperature reaches 150°F. Shutting the engine down before lube oil has had a chance to warm up has a harmful effect on the engine.

12.3 Operate the OPERATION SELECTOR Switch to the FULL LOAD TEST. This simulates a power failure by energizing the SDT timer and WUT timer will function after the SDT timer times out.

NOTE: Office and building load will be transferred automatically to the set. If this load is less than 90KW use supplementary artificial load to bring it up to at least 90KW.

12.4 Operate the OPERATION SELECTOR Switch to AUTO and the TRANSFER SELECTOR Switch to HAND. Depress the TRANSFER RESTORE Button to transfer load to commercial power.

12.5 Turn the OPERATION SELECTOR Switch to AUTO and the TRANSFER SELECTOR Switch to AUTO. Remove the COMM 1 or a fuse from AC service cabinet to simulate a power failure. Engine will start up after SDT timer times out. When the WUT timer times out, load is transferred to the set. The HOT-15 timer starts after the transfer.

12.6 Restore COMM 1 fuse or other fuse before the HOT-45 timer times out. After HOT-45 and HOT-15 timers have timed out, the load will be automatically transferred back to commercial power and the set will shut down

12.7 Turn OPERATION SELECTOR Switch to OFF. Disconnect any artificial load except a KS-20023 load if it was required.

13. ENGINE TROUBLE CONTROLS AND ALARMS

NOTE: All the engine alarms and associated switches have been tested and properly set at the factory. Table 1 lists the various visual and audible alarms, shows when they are furnished and lists the condition for operation.

13.1 Low Lube Oil Pressure Alarm

13.11 It will not be possible to reduce lube oil pressure to test the LOPS switch. This would require manual operation of the governor motor clutch to reduce speed and should not be attempted.

13.12 Simulate LOPS switch operation. Start the engine-alternator and close the circuit breaker. Allow the set to run long enough for engine water temperature to reach at least 150°F. Remove the cover from the LOPS switch and short the terminals. In about 15 seconds the breaker opens, the set shuts down and LOW LUBE OIL PRESSURE lamp lights. A remote engine failure alarm is given through the associated power alarm circuit. Depress TROUBLE RESET button to restore circuits to normal and remove alarms.

13.2 Fuse Failure Alarm

13.21 The result of a BATTERY SUPPLY FUSE failure is shown in Table C. For test purposes two operations will be necessary as shown below.

13.22 With the set running at no-load and the breaker closed, put a blown alarm fuse in the BATTERY SUPPLY FUSE holder. The circuit breaker opens, the FUSE FAILURE lamp lights, the horn sounds and a remote alarm will be given on an automatic plant. Depress HORN DISCONNECT button to silence the horn.

13.23 The set will shut down when the 15 ampere BATTERY SUPPLY fuse is blown. Remove the fuse head to simulate a blown fuse. The set shuts down because the throttle solenoid valve (TSCV) is deenergized. The lamp and remote alarms are cancelled in this test because the blown alarm fuse was also removed.

13.24 Replace the blown alarm fuse with a good one and replace the fuse head in the holder. The alarm circuit is restored to normal. Air damper was not operated and does not have to be reset.

13.3 Cranking Failure Alarm

13.31 This alarm comes in under the conditions listed in Table C. It will not be possible to check this alarm in the field.

13.4 No Charge Alarm

13.41 This alarm is due to failure of the KS-15661 starting battery charger. This will bring in a remote alarm only and will not cause any shutdown or alarms on the set. This remote alarm can be checked by turning off the charger and noting that the remote alarm comes in. Start the charger to cancel the remote alarm.

14. MAINTENANCE DURING INSTALLATION

14.1 Lubrication

14.11 At the beginning of each run and at the eight hour intervals during a run check crankcase oil level. With engine stopped add sufficient diesel lube oil to bring crankcase level to H mark on the dipstick. While the engine is running crankcase level should not be below RL mark on the dipstick Shut the set down before adding oil.

14.2 Fuel Strainer and Filters

14.21 Drain approximately 1/4 pint of fuel and sediment from fuel strainer and filters about once a month.

TABLE C: VISUAL AND AUDIBLE ALARMS Par. 13.21, 13,31

LAMP	HORN	FURNISHED ON SET	CONDITION	SHUT-DOWN	OPENS BREAKER
LOW LUBE OIL PRESSURE	YES	ALL	Lube oil pressure drops to 19-22 psi for about 15 seconds.	YES	YES
HIGH WATER TEMPERATURE	YES	ALL	Water temperature rises to 185-195°F.	NO	NO
	YES		Water temperature rises to 205-210°F.	YES	YES
FUSE FAILURE	YES	ALL	LOSS of BATTERY SUPPLY FUSE	YES	YES
SWITCH OFF NORMAL	NO	ALL	EMERG SWITCH not reset On automatic set, if TRANSFER SELECTOR is in HAND position, or OPERATION SELECTOR is OFF	NO	NO
CRANKING FAILURE	YES	AUTOMATIC	Engine fails to start or reach cranking speed in about 3 seconds. Engine cranks for about 30 seconds	YES	Not Closed

14.3 Air Box Drain Tanks

14.31 Open drain on the bottom of the air box drain tanks about every 12 hours of running.

14.4 Cooling Systems

14.41 Remote Radiator only: When set is running, water lever should not fall below 1/2 level in gauge glass on the radiator. Add sufficient water to the surge tank to bring water to 1/2 level in the gauge.

14.42 Remote Radiator, One Tank: Observe gauge glass during engine operation and add water to the tank if level falls below bottom of the gauge to bring level to just the bottom of the gauge.

14.43 Two Tank System: Observe level in hot water tank while set is running. Never let it fall below a point 3 to 4 inches from bottom of gauge glass. Add sufficient water to the hot water tank to bring it up to this point.

15. GENERAL TROUBLES

15.01 Irregular Engine Speed

Water in the fuel.
Air in the fuel system.
Incorrect fuel.
Governor is not functioning properly.
Engine not fully warmed up.

15.02 Erratic voltage

Loose connections.
Faulty voltage regulator.
Engine governor unstable.

15.03 No output voltage

Defective exciter.
Loose or open connections.

15.04 Lack of Power

Improper engine adjustments.
Insufficient fuel.
Insufficient combustion air.
Excessive exhaust back pressure.

15.05 Smoky Exhaust

Black or gray smoke
Incompletely burned fuel.
Clogged air cleaner.
Improper fuel.
Insufficient combustion air.
Excessive exhaust back pressure.
Light Load (less than 30%).

Blue Smoke
Operating temperature too low (open thermostat).
Internal fuel or lube oil leaks.
Injection nozzles not operating properly.
Light load (less than 30%)

White Smoke
Improper fuel.
Faulty injection nozzles.
Engine requires overhaul.

15.06 Engine knocks

Lube oil diluted by fuel.
Injection timing incorrect.
Defective fuel injection pump.

15.07 Engine Overheats

Thermostats fail to open.
Restricted passages in lube oil cooler.
Defective water pump.
Loose or broken fan belt.
Excessive KW load.
Clogged radiator passage.
Low coolant level.

15.03 Hard Starting

Incorrect lube oil.
Low battery voltage.
Siphoning of fuel from engine when idle.
Engine overhaul required.
Air in fuel system.
Insufficient fuel pressure.
Clogged Air Cleaner.

15.09 Hunting

Engine not fully warmed up.
Defective voltage regulator.
Defective governor.

15.10 Vibration

Flexible coupling misalignment.
Cylinder misfiring
Loose electrical connections.
Incorrect adjustment of vibration isolators.

15.11 Low Lube Oil Pressure

Insufficient lube oil in crankcase.
Defective lube oil pressure regulator.
Leaks in lube oil line.
Defective lube oil pump.
Engine required overhaul.
Clogged lube oil filters.

Manager, Product Engineering

Arrows indicate new or changed information

Reason for Reissue:
1. To direct the installer to review engine operating instructions before starting tests.
2. To recognize that the more recent units are equipped with a Delco alternator and voltage
3. To provide connecting information on the Delco voltage regulator until drawings can be re-issued.
4. To correct and expand information on Over-voltage shutdown feature.
5. To inclu..e a method to prevent the engine from shutting down during full load test.
6. To recognize a change in the immersion heater control switch.
7. To rearrange and clarify paragraph on "No Load Test"