

KS-15777 DIESEL ENGINE-ALTERNATORS
MANUALLY AND AUTOMATICALLY CONTROLLED
500 AND 550 KW (J86627)

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1. GENERAL

1.1 Scope

1.11 This section covers installation of a 500 KW and 550 KW in-Line, eight cylinder, four cycle, 900 rpm diesel engine-alternators. The 500 KW engine-alternator is built to specification KS-15777. The 550 KW set is identical except for a different alternator, regulator and radiator. Either set may be ordered for manual or automatic control. Other options are described under Paragraph 1.5.

1.12 Paragraphs marked with an asterisk (*) apply only to automatically controlled sets. Other methods and requirements apply to both manual and automatic sets except where noted.

1.13 Tests in this section are based on the following circuit drawings:

<u>Drawings</u>	<u>Title</u>
SD-81464-01	Manual Reserve Power Plant
SD-81465-01	Manual Engine-Alternator
SD-81475-01	Automatic Reserve Power Plant
SD-81476-01	Automatic Engine-Alternator
SD-81100-01	Alarms - Unattended Office
SD-81223-01	Alarm - Central Office
SD-81489-01	Typical Transfer Breaker

1.2 Precautions

1.201 Observe general precautions listed in Handbook 0 and in Section 131 of this Handbook.

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

1.203 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 machine.

1.204 Installers must wear the R-4296 ear protectors for hearing protection whenever the engine is running.

1.205 The exhaust system including turbocharger and water-cooled manifold become extremely hot during engine operation. Do not touch any part of the exhaust system until it cools.

1.206 Before doing any work on the manual set, pull the 6A and 15A battery fuses in the diesel cabinet, disconnect the start battery B minus (-) lead, taping the lead carefully to prevent accidental shorting to ground, or disable an air starting system by closing all valves in the air line from the tank to the engine.

*1.207 Before doing any work on the automatic diesel turn the OPERATION SELECTOR Switch to OFF, then pull the 6A and 15A battery fuses in the diesel cabinet and disconnect the start

battery B minus (-) lead, taping the lead carefully to prevent accidental shorting to ground, or disable an air starting system by closing all valves in the air line from the tank to the engine.

1.208 Before doing any work in the control cabinet of the manual set in addition to the operations shown in Paragraph 1.206 pull the fuses in the ac service cabinet feeding lines CA, CB and CC into the cabinet. On completion of work replace all fuses that were removed, replace B minus (-) lead on the battery or open all valves in the air line from the tank to the engine.

*1.209 Before doing any work in the control cabinet of automatic diesel in addition to the operations shown in Paragraph 1.207 pull the fuses in the ac service cabinet feeding lines CA, CB and CC into the cabinet and open the COMMERCIAL POWER CONTROL Breaker. On completion of work replace all fuses that were removed, close the COMMERCIAL POWER CONTROL Breaker, replace the B minus (-) lead on the battery or open all valves in the air line from the tank to the engine and turn the OPERATION SELECTOR Switch to the desired position.

1.210 Remove all filings, rust or other debris from the exhaust pipe or silencer before installing. Should any of this material fall into the turbocharger, serious damage to the turbocharger may result.

1.3 Supplier's Representative

1.31 A factory-trained man will be made available by the supplier for the initial start and test of the unit if the customer desires this service and will pay for this service.

1.32 The installer shall notify the Field Service at least 30 days in advance of the date that the factory-trained man will be required for the initial start and acceptance tests if their service is so desired by the customer.

1.4 Inspection

1.41 As soon as possible after the unit is received on the job remove shipping materials and make a complete inspection of the engine-alternator and associated equipment and parts. Examine carefully for visible defects and damage. Remove alternator inspection plates and exciter guard to look for concealed damage and defects. Observe condition of bearings, commutator, brushes, etc. Examine interior of the control cabinet for concealed damage. Check that parts and tools were received.

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

1.5 Description of Sets

1.51 The KS-15777 engine-alternator is pictured in Figures 1, 2 and 3 and control cabinets in Figures 4 and 5.

1.52 These sets can be furnished for manual starting and control or for automatic start and control. Equipment for automatic start and control will be furnished in the cabinet with the set except for a remote transfer switch furnished by the customer.

1.53 Besides the manual or automatic control feature, the following options are also available: 208-240 volts or 416-480 volts output, battery or air starting, cooling by remote radiator or heat exchanger and equipment for parallel operation.

1.54 All control cabinets require 48 volt dc alarm and control voltage. This is obtained from the 48 volt starting battery, when one is provided, or from central office battery when air starting is used. Audible and visual alarms are provided on the cabinet to indicate engine troubles, proper operation and power failure and return. Remote alarms can be transmitted using an SD-81223-01 alarm circuit modified as necessary.

1.55 Approximate dimensions and weights of the set and associated equipments are as follows:

Item	Weight (Lbs.)	Dimensions		
		Length	Width	Height
Engine-Alternator (Complete)	35,000	19'-0"	5'-1"	8'-9"
Engine (Only)	20,500			
Alternator (Only)	9,300			
Base (Only)	5,000			
Exhaust Silencer	1,035	8'-7"	2'-6" Diameter	
Remote Radiator	4,100	8'-4"	5'-9"	8'-8"
Control Cabinet	3,300	3'-0"	4'-0"	8'-2"
Air Compressor (Single)	400	3'-0"	2'-1"	2'-0"
Air Compressor (Double)	800	3'-0"	5'-0"	2'-0"
Air Storage Tank (Single)	275	1'-4" Dia.		7'-9"

1.6 Description of Automatic Sets

1.61 An automatic set, under control of the associated cabinet, starts the engine-alternator if the commercial power fails or drops to about 88% of nominal voltage in any one phase. Once one of these conditions takes place the engine starts cranking after the SDT timer times out. The WUT timer starts and after it times out terminals LB6 and TR16 will supply engine alternator potential to signal the remote transfer device to connect load to the engine alternator.

1.62 After commercial power is restored (at 94% of nominal or higher), an alarm is given and the load then has to

be manually returned to the commercial power. Once the load has been transferred from the set to commercial power, the engine is then free to be stopped manually.

1.63 The OPERATION SELECTOR Switch positions are:

OFF - all automatic starting, control, and trouble protection circuits are inoperative.

NO LOAD TEST - the set starts and goes through its normal warmup sequence. Load transfer does not take place since the TR relay remains operated preventing the transfer switch from operating.

FULL LOAD TEST - simulates a power failure by energizing the SDT timer. The start, warmup and transfer are the same as for a power failure under normal conditions.

AUTO - when commercial power drops below 88% nominal voltage, the SDT timer will be energized and go through the normal transfer procedure. The set will carry the load until manually returned to commercial power.

2. TOOLS, TEST SETS AND RECORDS

2.1 Tools and Test Sets

Code	Quantity	Description	Note
R-3076	1	Manometer, Water	1
R-3413	-	Wire and Lug Assembly	2
R-2705	1	Tachometer	
R-4296	-	Ear Protectors	4
ITE-4785	2	250 KW Three Phase AC Test Lead	
ITE-4824	1	Tachometer - Hasler	
ITE-4137	1	AC Continuity Test Set	
With Unit -		Shims for leveling	

NOTE 1: Order R-3076 Manometer and use the drill, tap and tap wrench in the box to drill and tap the hole in the exhaust pipe to connect a manometer.

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: Full KW load must be provided for the engine-alternator. For parallel tests the load must equal half the combined KW ratings of two sets in parallel unless otherwise desired by the customer. If a dummy load for routine testing has been ordered and will be available in time, ask permission to use it as part of the test load. Refer to Section 24 in this handbook for information on test loads and hookup wire.

NOTE 4: The installers must wear the R-4296 Ear Protectors for hearing protection whenever the engine is running.

2.2 Records

SD-4-1275 Lubrication Record

SD-4-1285 Storage Battery Report

SD-4-1313 Test Trouble Record

SD-4-1315 Summary of Tests

ID-946 Engine-Alternator Test Record

3. ENGINE-ALTERNATOR

FORWARD: Check of mounting area and other operations in Paragraph 3.1 should be done before placing the machine.

3.1 General

3.11 Before machine is in place check general slope of mounting area. Refer to Section 129 in this Handbook for method of checking slope and to Handbook 30 for floor layout. Approximate dimensions of the mounting area are 17'-6" by 3'-10". If the area slopes more than 1/4 inch in ten feet (1/2 inch in 20 feet) in any direction the customer should be requested to correct the condition.

3.12 Isolator mounting areas should not vary more than 1/4 inch from the general slope of the floor. The customer should be requested to correct any deviations greater than 1/4 inch. If the floor appears to be quite flat during check of the slope in Paragraph 3.11, a specific check of individual areas need not be made.

3.13 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. Isolators are 16 inches long by 7 inches wide. As a matter of information it would be advisable for the customer to permit removal of the floor covering over the whole mounting area.

3.14 When the engine-alternator is received, either complete or in parts, have the riggers move the engine-alternator or the base into position. Whenever possible have the riggers raise the base and place the vibration isolators under the base which requires raising the base slightly over five inches. The riggers will probably have jacking equipment for this operation, or the eleven jack screws provided with the engine-alternator can be used. Isolators and jack screws will be used. Isolators and screws will be found in one of the crates of equipment with the set. If the riggers will not place the isolators ask them to put 1/8 inch plates, which may be obtained locally, under the tapped holes in the base so that the jack screws can be used later to raise the base. Without the plates the jack screws will cut into the floor.

3.2 Lubrication

3.21 Drain out any oil or residue in engine crankcase. To drain this, remove the one inch pipe plug at the bottom of the 3-way lube oil valve which is next to the lube oil valve which is next to the lube oil priming pump, turn the 3-way valve to the DRAIN position (full counterclockwise) and open the globe valve in the line to the hard pump. Operate hand pump for several minutes, catching any residue coming out of the drain in a can or other container.

3.22 Replace the pipe plug. Add sufficient oil (See Note below) to the crankcase through the oil filler opening, after removing the 1-1/2 inch pipe plug in this opening, to bring oil level to HIGH mark on the dipstick. Oil filler opening and dipstick Oil filler opening and dipstick are under a removable plate in the cat walk. About 60 gallons of oil are required (See Paragraph 3.23).

NOTE: SAE 20 Type A for temperatures below 32°F.
SAE 30 Type A for temperatures above 32°F.

3.23 Approximately 20 gallons more oil will be required to fill the oil conditioners and the rest of the lube oil system.

3.24 Check oil level of alternator bearings. Sight glasses are provided for each bearing housing and oil level should be between the two marks on the glass. Add sufficient oil (same as used for engine) to one of the filler tubes on each bearing housing to bring oil to proper level. Remove inspection plates for access to filler tubes.

3.25 Check that the oil rings at each bearing (two rings per bearing) are in the slots provided for them in the sleeve bearing. An oil ring will be found directly under each filler tube. Remove inspection plates on the alternator, lift the caps on the filler tubes and look down each to be, using a light. If the rings are not in the bearing slots move them there with a long screwdriver or rod.

3.26 Check governor oil level. This should be up to the marked on the front of the governor. Add oil to the oil cap on the top of the governor until oil level reaches the line. Use only a good grade of 10W30 oil purchased locally.

3.3 Thermometers

3.31 Five thermometers are furnished in the loose parts. Three are for the cooling system and two for the lube oil system.

3.32 In the cooling system, install thermometers as follows: one in the rear of the thermostat housing, one at the water outlet at the turbo-charger which leads to the thermostat housing and one in the cooling water manifold at the front of the engine.

3.33 The lube oil thermometers are placed as follows: one in the lube oil connection to the block from the front end of the lube oil cooler and one in the lube manifold just ahead of the first lube oil conditioner.

3.4 Cooling System

FOREWORD: Installation of the remote radiator, associated water tanks and piping to within ten feet of the engine is usually the customer's responsibility. If the installer is to do any of this work refer to Section 132 in this Handbook. Observe rust inhibitor and anti-freeze information in Section 133.

3.41 **Arrangements:** Piping schematics of various cooling system arrangements are shown in Section 133 in this Handbook.

3.42 **Capacities:** Capacities are approximately as follows:

Engine	86 Gallons
Radiator	55 Gallons

NOTE: Quantities above do not include piping between radiator, engine, and tanks nor that required by the tanks themselves, which may vary in size for each installation.

3.43 **Filling the Cooling Systems:** When required to fill any of these systems, proceed in accordance with the routines in Section 133 of this Handbook. When filling any system open vent cocks or plugs at high points of the system to remove any trapped air and prevent air locks.

3.5 Starting System

3.51 Engine Starting Battery and Charger

3.511 Install charger and battery.

3.512 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 charger selected (List 13) operates from a single-phase nominal 120 volt source. Be sure the proper ac input lead is grounded. 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.

Type of Battery	Float Volts
Lead-Acid (KS-15577) (24 cells)	52.00 - 52.70
Nickel-cadmium (KS-15578) (38 cells)	53.40 - 54.00

3.52 Air Starting System

3.521 Refer to Section 134 in this Handbook for installation and test information on air starting system.

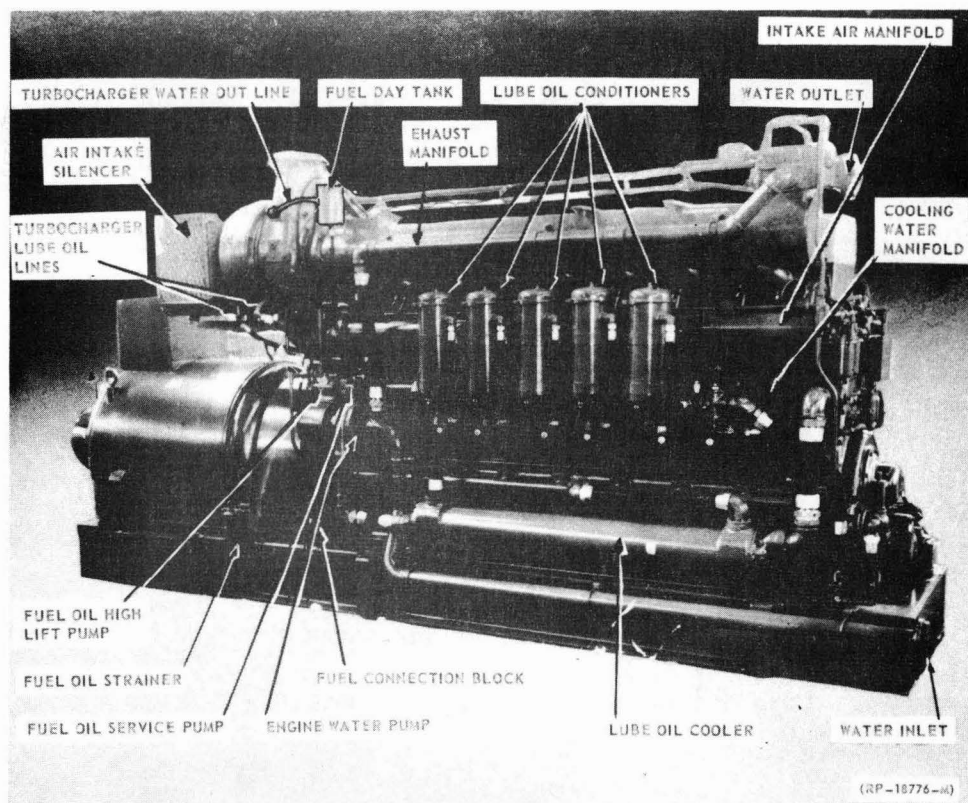


FIG. 1 KS-15777 ENGINE-ALTERNATOR - MANIFOLD SIDE

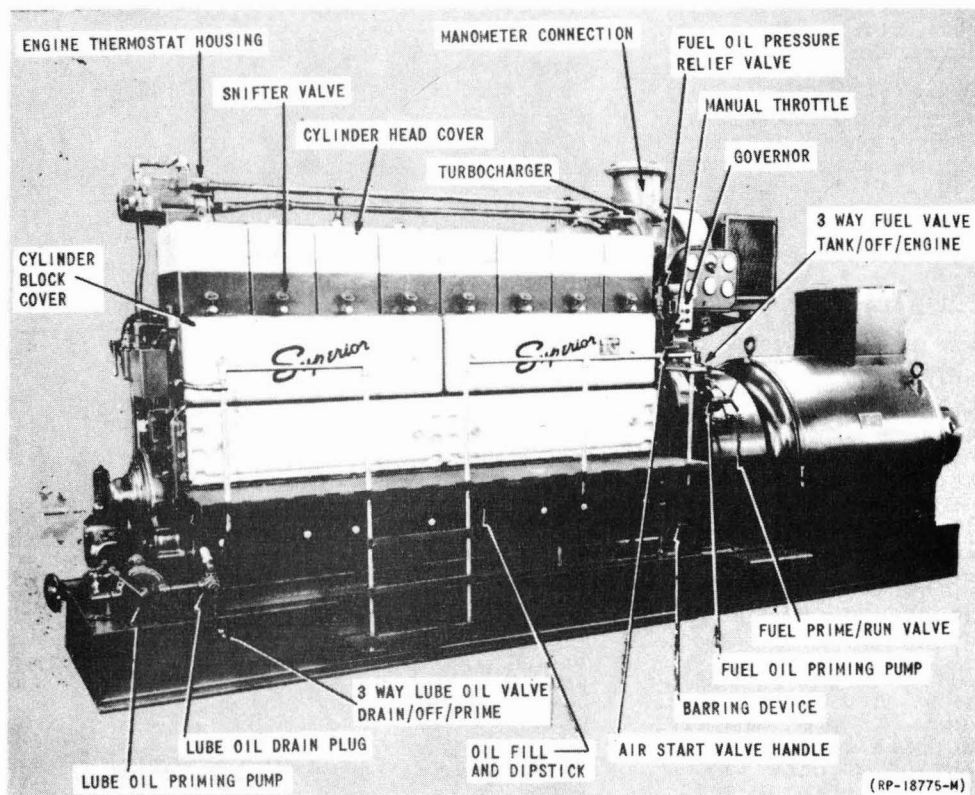


FIG. 2 KS-15777 ENGINE-ALTERNATOR - CONTROL SIDE

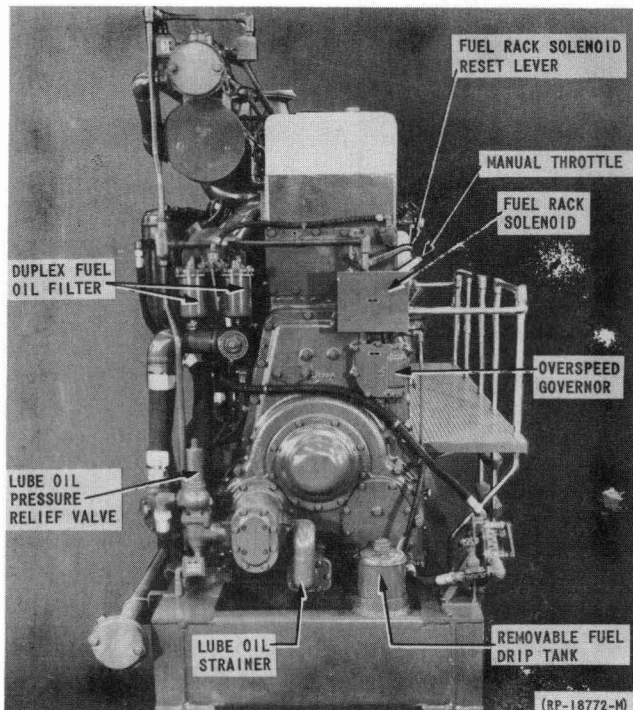


FIG. 3 KS-15777 ENGINE-ALTERNATOR - FRONT END

3.6 Fuel, Ventilation and Exhaust Systems

3.61 Installation of fuel and exhaust piping to a point ten feet from the engine is usually the customer's responsibility. If the Installer is responsible for any of this work refer to Section 132 of this Handbook.

3.62 Ductwork for ventilation systems is usually provided by customer. If the Installer is called upon to install motor-operated louvers in openings provided by customer, refer to Section 22 in this Handbook before proceeding with the work.

3.63 Job made ducts should be painted as specified by the telephone company.

4. CONTROL CABINET AND RELAYS

4.1 General

4.11 Layout mounting area for cabinet and install, using job drawings and information in Handbook 30 on floor layout and in Handbook 18 on leveling and fastening to floor. Cabinets are shown in Figures 4 and 5.

4.12 Remove blocking from relays, voltage regulator and other apparatus.

4.13 Check all switches, fuses and fuse mountings in accordance with Section 3 of this Handbook.

4.14 Check all components carefully for defects as necessary. Correct any loose connections.

4.2 Meters

4.21 Adjust pointers of all meters on the cabinet to zero by means of the zero adjusting screws. Information on meter can be found in Section 20 of this Handbook. Meter information is also included in the manual with the power plant.

4.3 Timers

4.31 The timing relays, OCT, OPD, SDT and WUT are Agastat pneumatic timers. The OCT timer has an available range of 2.5-30 seconds, the OPD and SDT timers have an available range of 2.5-50 seconds and the WUT, a range of 10-200 seconds.

4.32 Timers will be set for correct time delays except SDT and WUT which may be set as desired by the customer. WUT timer must never be less than 10 seconds. Dial lettering runs A through E the long time. (Setting 0 is a no-time delay position).

4.4 Power Failure Relays

4.41 Refer to Section 114 of this Handbook as a reference for testing and adjusting these power failure relays, which are similar to the KS-15519 list #1. The Circuit Requirements indicate the connection for adjusting the relay.

4.5 Barring the Engine Over

4.51 Turn the engine over one or more turns with the barring tool on the ring gear only to be sure it is free to rotate.

CAUTION: Bar the engine over by using the barring tool on the ring gear only and not on the alternator cooling fan.

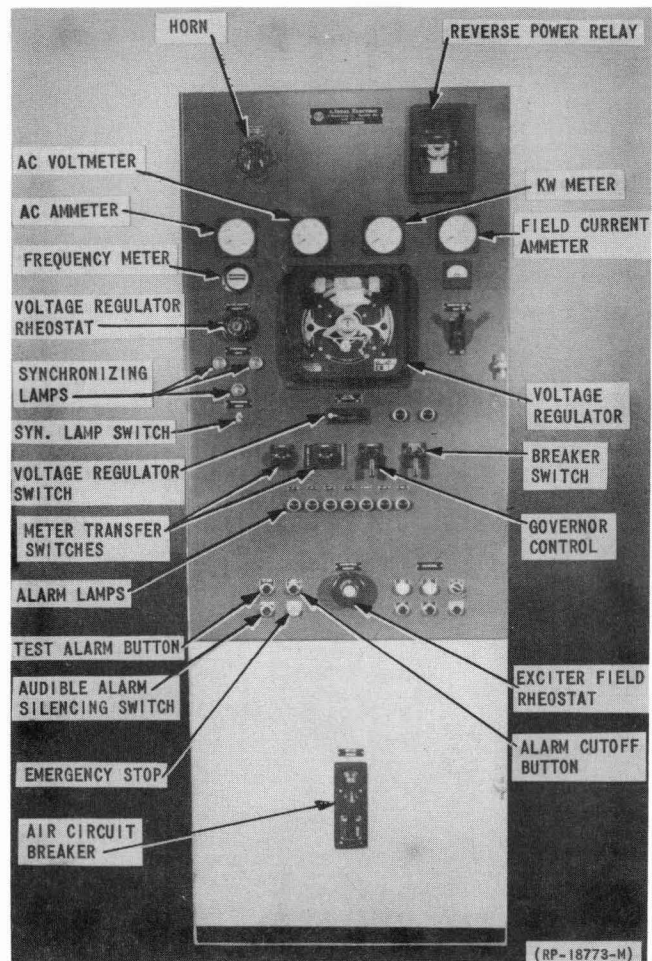


FIG. 4 TYPICAL CONTROL CABINET FOR MANUAL SET

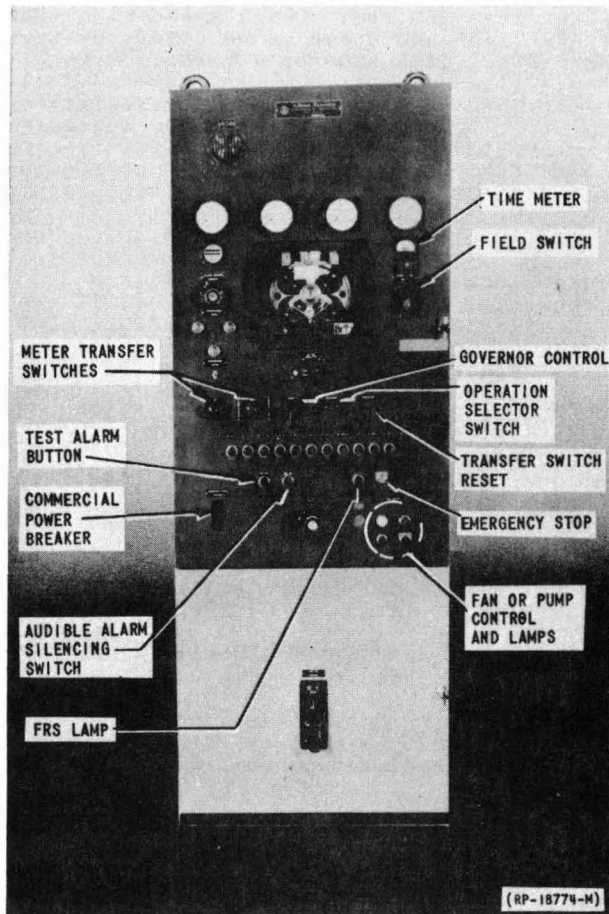


FIG. 5 TYPICAL CONTROL CABINET FOR AUTO-MATIC SET

5. INITIAL START

FOREWORD: Before starting the engine-alternator perform all operations in Paragraphs 3 through 4. Associated equipments and systems must be completely installed and ready-to-use. However, water pump and radiator fan motor power connections can be made on a temporary basis at some convenient point until it is found that the motors operate in the proper direction.

5.1 Preliminary

5.101 Disable the starting system by disconnecting one starting motor lead or by closing valves in the air lines to the engine. Open all snifter valves on the engine and turn engine over several times with the barring device. Close snifter valves if engine will not be started in the next few hours.

5.102 Prime lubricating oil system. Operate the 3-way valve by the lube oil hand pump to PRIME position (full counter clockwise) open the globe valve in the line to the hand pump. Remove vent plugs on top of each oil conditioner. Have a second person watch these vents. Operate the lube oil hand pump until oil comes out

of the vents without foam. Stop pumping and replace vent plugs. Close the globe valve and operate 3-way valve to "OFF" (center) position. Then check crankcase oil level on the level up to HIGH mark. This requires about 20 gallons of oil which will be in addition to the 60 gallons put in initially.

5.103 Open valves in the fuel supply line and exhaust system. Close exhaust system drain valves.

5.104 Prime fuel system as follows:

5.1041 Operate bypass shutoff valve, just below the hand fuel pump, to PRIME position (full clockwise) and the 3-way valve just above the pump to TANK position (full counter clockwise). Operate hand fuel pump about 30-35 strokes, or until a strong pressure is felt against it. This fills the day tank.

5.1042 Operate the 3-way valve to ENGINE position (full clockwise). Open both vents on top of the duplex fuel oil filter. Be sure drains on the bottom of these filters are closed and that the handle on the front of the filter is turned to BOTH. Operate hand fuel pump until solid fuel flows from both vents. Stop pumping and close vents.

5.1043 Unscrew the knurled hand nuts on the two cylinder block covers and remove the covers.

5.1044 Remove air bleeder screw and gasket from the injection pump at the rear of the engine. The bleeder screw is on the front of the pump just above the inlet hose connection. Operate hand fuel pump until solid fuel flows out of the bleeder hole. Replace bleeder screw and gasket on the injection pump.

5.1045 Bleed each injection pump in turn by repeating operations in Paragraph 5.1044 working toward the front of the engine until all pumps are bled. Replace cylinder block covers.

5.1046 Turn bypass shutoff valve to RUN position.

5.1047 Empty the removable fuel drip can on the front of the engine.

5.105 Remove cylinder head covers and apply a quantity of engine lube oil over valve stems with R-1298 Oil Can. Replace cylinder head covers.

5.106 On automatic sets disconnect leads CB9 and LB6 on the control cabinet terminal strip and tape the loose ends of the wires. This prevents accidental operation of the remote transfer switch.

5.107 Position controls, switches and rheostats on control cabinet as follows:

Control	Position
Air Circuit Breaker	OPEN
GENERATOR FIELD SWITCH	OPEN
EXCITER FIELD RHEOSTAT	Full Clockwise
SYNCHRONIZING SWITCH	OFF
VOLTAGE REGULATOR SWITCH	OFF

<u>Control</u>	<u>Position</u>
PUMP CONTROL Switch	HAND
FAN CONTROL Switch	HAND or MAN
*OPERATION SELECTOR SWITCH	#1 (Off)
*COMMERCIAL POWER BREAKER	OFF

5.108 Open disconnect switches for remote radiator and water pump.

5.109 No alarm lamps should be lit on a manual set and only ACD lamp on an automatic set. If lamps are lighted that should not be, determine the condition and correct.

5.110 Pull up FRS (Fuel Rack Solenoid) reset arm to be sure it is reset.

5.111 Position governor knobs as follows:

SPEED DROOP	0
LOAD LIMIT	5

NOTE: SYNCHRONIZER knob cannot be turned until engine is running and SYN INDICATOR knob shows number of turns of SYNCHRONIZER knob. Neither knob has a definite setting.

5.112 Operate cooling system valves as indicated under "To Run Engine" on appropriate piping schematic in Section 133.

5.113 Connect starting battery or open air starting system valves.

5.114 Start the room ventilating fan when one is furnished or open windows or doors as necessary to provide adequate ventilation.

→ **NOTE:** The installer must wear the R-4296 Ear Protectors for hearing protection whenever the engine is running.

5.115 See that all snifter valves are open. Crank engine five or ten seconds with the starter to blow off any condensation in the cylinders. Turn OPERATION SELECTOR SWITCH to Position No. 3 (No Load Test) for automatic sets but start of cranking is delayed from 5-120 seconds, depending on setting of SDT. Pull down air starting valve handle or push START button on manual sets. Stop cranking by releasing the valve or button or by turning OPERATION SELECTOR SWITCH to Position No. 1. Close all snifter valves.

NOTE: If liquids are emitted from the valves in this test determine the source and correct before attempting to run the engine.

5.116 With snifter valves closed start the engine with START button, air valve handle or OPERATION SELECTOR SWITCH. ACD lamp goes out when switch is operated from Position No. 1. Again start of cranking is delayed until SDT timer operates.

5.117 If engine does not fire in about 15 or 20 seconds, stop the cranking. Check reason for not starting.

5.118 Wait at least one minute before another starting attempt. Check air tank pressure. If it has fallen to about 150 p.s.i. after the first starting attempt operate the necessary valves to connect the reserve air tank to the engine.

5.119 Allow engine to run at slow speed for about ten minutes. Observe that pressures are indicated on engine panel gauges. Engine idling speed should be higher than 450 rpm. Check speed with tachometer. Increase speed as necessary by turning SYNCHRONIZER knob on governor.

NOTE: The supplier's representative may want to stop the engine after a few minutes run at idling speed to remove crankcase covers and check crankshaft bearing temperatures.

5.120 Increase speed to 900 rpm. Turn LOAD LIMIT knob on governor to 10 (full clockwise). Check speed with R-2705 Tachometer, or a Hasler tachometer, if one is available, and adjust SYNCHRONIZER knob on the governor in FAST or SLOW direction to set speed at 900 rpm.

5.121 Close GENERATOR FIELD SWITCH. Turn EXCITER FIELD RHEOSTAT knobs in counterclockwise direction to set output voltage to same value as outside power. Operate VOLTAGE REGULATOR switch to ON and then turn EXCITER FIELD RHEOSTAT knobs full counterclockwise. This position is marked AUTO on some cabinets; on other cabinets it may not be marked but white lines on the knobs line up in center of the panel.

5.122 Turn VOLTAGE ADJUSTING RHEOSTAT for desired output voltage.

5.123 With engine-alternator power available check direction of rotation of radiator fan and auxiliary water pump motors.

5.1231 Have someone watch the pump or fan. Close associated disconnect switch. 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.

5.1232 Arrows on the motors indicate correct direction of rotation. If either motor rotates in the wrong direction, remove power from the motor by opening its disconnect switch and interchange two of the three motor leads at some convenient point between the disconnect switch and motor. Then repeat the test in Paragraph 5.1231 as a check.

NOTE: The engine may be shut down to interchange these leads if desired. However, it will be necessary to run the engine for at least ten minutes, or until the lube oil temperature indicated on the thermometer on the oil conditioner inlet manifold is at least 120°F., before shutting down.

5.1233 If a motor fails to start, check associated fuses in the control cabinet and depress the reset button on the starter.

5.124 Run the engine about 30 minutes. Observe engine panel gauges and check that gauge pressures meet requirements of Paragraph 8.3. Then shut down the engine by pulling down the manual throttle as far as it will go and holding it there until engine stops on a manual set, or by turning OPERATION SELECTOR SWITCH to Position 1 on an automatic set.

5.125 Radiator fan and pump motors can now be permanently connected. Open disconnect switches for these motors, make the connections and leave the disconnect switches open.

5.2 Regular Starting Routine

5.201 Check lube oil levels in engine, governor and alternator bearings.

5.202 If engine has been idle for more than a week, or is being started after repair, remove cylinder head covers and apply diesel lube oil to valve stems with an oil can. Replace cylinder head covers.

5.203 Open valves in fuel supply line, exhaust system and air starting system. Close exhaust system drain valves, if any are provided.

5.204 Check position of control cabinet switches and rheostats. These are as follows:

Control	Position
GENERATOR FIELD SWITCH	CLOSED
EXCITER FIELD RHEOSTAT	Full CCW or AUTO
VOLTAGE REGULATOR Switch	ON
PUMP CONTROL Switch	AUTO
FAN CONTROL Switch	AUTO
*OPERATION SELECTOR SWITCH #1	(OFF)
*COMMERCIAL POWER BREAKER	ON
AIR CIRCUIT BREAKER	OPEN

5.2041 Certain control settings on the automatic set are required during the testing period and are not the normal automatic position settings in Paragraph 10.

5.205 Check governor knob settings. LOAD LIMIT at 10, SPEED DROOP at 0 or 100, depending on whether the set is to operate alone or in parallel.

5.206 Close disconnect switches for radiator fan or auxiliary water pump.

5.207 To start a manual set, hold throttle lever to mid-range, pull down air start lever or depress START button. When engine fires, release button or air start lever, hold throttle back until pressure is felt against it, then slowly move lever toward top position and release. To start an automatic set, turn OPERATION SELECTOR SWITCH to Position No. 3 (No Load Test).

5.208 Adjust SYNCHRONIZER knob on governor or speed control on cabinet until 60 cycles is indicated on frequency meter of a single set and 62-1/2 cycles for a set to be paralleled. Turn VOLTAGE ADJUSTING RHEOSTAT for desired output voltage. Check engine gauges for proper pressures.

5.209 Close engine starting air supply shut-off valve for a manual set.

5.3 Stopping Routine

5.31 Automatic Set - Solo Operation

5.311 With commercial power available and OPERATION SELECTOR SWITCH on Position No. 2, operate TSR switch to Reset position and release. Switch returns

to NORMAL position. The customer's remote transfer switch transfers the load to normal line and PO lamp goes out.

5.312 Leave circuit breaker closed in normal automatic operation

5.313 Stop engine by holding down manual throttle. Power return alarm bell will stop when engine slows down.

5.32 Automatic Set - Parallel Operation

5.321 Same as Paragraph 5.311.

5.322 Open circuit breaker by operating Breaker Switch to TRIP position after making sure that any sets left running are capable of carrying the remaining load.

5.323 Same as Paragraph 5.313.

5.33 Manual Set

5.331 Open circuit breaker by operating BREAKER CONTROL switch to TRIP. If the set is in parallel with others make sure that any sets left running are capable of carrying the remaining load.

5.332 Hold ACO button depressed and stop engine by holding down manual throttle. When ABA lamp goes out the ACO button can be released, or it can be held depressed until the engine comes to a full stop.

5.333 Close valves in fuel lines to the set.

5.334 Stop the ventilating fan where provided or close windows as weather conditions indicate.

5.335 Close exhaust system valves where provided.

5.336 Open condensate drain valves in exhaust line and silencer.

5.337 Operate cooling system valves as indicated in Section 133 in this handbook for After Shutdown.

NOTE: If it is necessary to drain the whole cooling system to prevent freezing, do so by opening all drain valves provided in the cooling system as well as those on the engine.

5.34 Stopping During Test Period

5.341 Automatic Set

5.3411 Until the set is accepted by the customer and valves and cabinet controls can be left in the automatic starting position, it will be necessary to perform the operations in Paragraphs 5.332 through 5.337 after each test period.

6. 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, preferably ITE-4782 although ITE-4785 may be used.

6.1 With set shutdown, reverse the leads at terminals No. 8 and No. 9 on the Reverse Power Relay.

6.2 Start the diesel as follows:

6.21 Manual Set: depress the START Button and hold until engine starts, but not longer than 20 seconds. If engine fails to start in this time, release START Button and check for possible causes of starting failure.

6.22 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 Switch to OFF and check for possible causes of starting failure.

6.3 Apply artificial load and increase the load to 90KW. Set shall tripout at this point.

6.4 Observe that the REVERSE POWER lamp goes on and the horn sounds at shutdown. Cancel all alarms as follows:

6.41 Manual Set: Depress ACO Button to cancel alarm.

6.42 Automatic Set: Turn the OPERATION SELECTOR Switch to "OFF" to cancel alarms.

6.5 Operate load toggle switches to "OFF".

6.6 With set shutdown restore leads on terminals No. 8 and No. 9 of Reserve Power Relay to original connections.

6.7 Reset the target from the outside of the case by a push rod located at the bottom of the cover. Orange-flag (target) indication is removed.

6.8 Reset the Fuel Rack Shutdown (FRS) device lever.

6.9 When set is started again it will be necessary to manually operate the circuit breaker to its open position by using the operating handle supplied with the circuit breaker.

7. OVERSPEED TRIP TEST

CAUTION: Do not exceed 125% speed (1080 rpm) in this test.

7.1 Starting Procedure

7.11 Manual Set: Hold throttle lever to mid-range, pull down air start lever or depress START button and hold until engine starts, but not longer than 20 seconds. If engine fails to start in this time, release START button and check for possible causes of starting failure.

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

7.2 To overspeed the engine and check the setting of the overspeed trip is an operation requiring two men. One man will overspeed the engine by operating the throttle lever while the second man checks the speed with a tachometer (R-2705).

NOTE: Exert a slow gradual upward force on the governor's throttle lever not exceeding the 125% limit.

7.3 Shutdown should occur in the range of 1040-1080 rpm. Operates to shutdown the engine and record on the ID-946 form.

7.4 Cancel all alarms after shutdown as follows:

7.41 Manual Set: Depress ACO button to cancel alarm.

7.42 Automatic Set: Turn the OPERATION SELECTOR Switch to "OFF" to cancel alarms.

7.5 Reset the Fuel Rack Shutdown (FRS) device lever.

7.6 If shutdown doesn't occur in the specified range, have the supply representative make adjustment to correct range.

7.7 If adjustment was necessary by supply representative start the engine (Paragraph 7.1) and repeat the operation in Paragraph 7.2 through 7.5.

8. FULL LOAD TEST

Time: The Preliminary Full Load Test will be one hour in length at 500KW or 550KW depending on the set (Before applying the 500KW or 550KW load depending on the set, stabilize the set by placing 200KW load for 15 minutes). 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 fuel 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 proceeding to Section 130 verify that the short across secondary of the cross-current compensating transformer (strap on to CCC resistor having a cardboard tag) is removed.

8.1 Preliminary Load Test

8.11 Remove the 1/8 inch pipe plug in the exhaust connection just above the turbocharger and connect the R-3076 Manometer. Adjust manometer as in Section 131 of this Handbook.

8.12 Prepare system for starting as in paragraph #5.2.

8.13 Run the engine about 15 minutes at no-load to warm it up. Observe gauges and thermometers on the engine and see that pressures do not fall below minimum values indicated in Paragraph 8.3.

8.14 Check speed with the R-2705 Tachometer. Adjust SYNCHRONIZER Knob on the governor to see engine speed at 908 for a single set and at 938 rpm for a set that is to be paralleled.

8.105 After 15 minutes at no-load, record all readings required on the first line on ID-946 Engine Alternator Test Record.

NOTE: No column is shown for Generator Field Current. There is no need to read this and it has no requirement. Normal values are at about 18 amperes at no-load and 35 amperes at full load.

8.106 Close the circuit breaker. Apply one-fourth of the load. With one-fourth of the load on the set, adjust the alternator voltage to the desired value with VOLTAGE REGULATOR RHEOSTAT.

8.107 When temperature of the water out of the engine (thermometer at the thermostat) reaches 150-155°F, the radiator fan should automatically start on low speed. The auxiliary water pump when one is required with the radiator will also start at this time. This switch is marked LTS. A switch marked WPS will also operate in the range 150-155°F. to start the water pump when a heat exchanger is furnished. A switch marked HTS starts the radiator fan on high speed when water out temperature reaches 175-177°F. It runs on high until temperature drops to 167-170°F. then switches to low speed.

8.1071 If an auxiliary water pump is furnished with a remote radiator, observe the pump discharge pressure as read on the pressure gauge. The reading on this gauge must be equal to the head in feet, which appears on the pump, divided by 2.304. For example, if the nameplate shows the head to be 250 feet, correct gauge pressure is 250/2.304, or 108 pounds.

8.1072 If a heat exchanger is furnished, adjust the temperature regulator to maintain engine out temperature about 175°F. Turn the adjusting wheel on the regulator up to raise engine temperature, down to lower engine temperature. If the temperature regulator does not control the water into the heat exchanger, that is, there is a full flow of water at all times the bulb and connecting tubing on the regulator has been damaged.

8.108 Run 15 minutes at 1/4 load, readjust voltage regulator as desired at this time and again take a set of readings. This voltage is the one that will be used for the voltage check in Paragraph 8.3.

8.109 Apply 1/2, 3/4 and full KW load, each load being carried for 15 minutes. Take a set of readings at the end of each 15 minute period.

NOTE: Engine power decreases as altitude above sea level increases. Derating is indicated below. The engine-alternator must be able to carry the load listed for the altitude.

Feet Above Sea Level	KW Output
Up to 4500'	500
6000'	475
7500'	450
9000'	425

8.110 With the set running at full-load determine exhaust back pressure with the R-3076 Manometer in accordance with Section 131 of this handbook.

8.111 Throughout the run check meters for evidence of internal damage or lack of freedom of movement.

8.112 Observe leaks during the run and tighten fittings as necessary to minimize leaks. If necessary to stop the set to correct a leak, do so and then repeat the Preliminary Test.

8.113 Sometime during this test, check the phase sequence of the alternator leads with the outside power. Refer to Section 135 in this handbook for methods.

8.114 This test must meet requirements in Paragraph 5.3 except for cylinder exhaust temperatures. After the test is completed reduce load to minimum open the circuit breaker and stop the set as in Paragraph 5.3. Be sure to leave regulator and governor set as they are.

8.2 Full-Load Acceptance Test

8.201 If office and building load is to be used, it will be necessary to reconnect leads LB6 and CB9 in the automatic control cabinet so that the remote transfer switch will operate.

8.202 If engine-alternator is not already running, start the machine as in Paragraph 6.2.

8.203 Allow engine to warm up for about 15 minutes at no-load. (circuit breaker open). Check speed and adjust governor for 908 rpm for a single set and 938 rpm for a set to be paralleled.

8.204 Close the circuit breaker.

8.205 Apply 1/4 load with the artificial load and adjust voltage to desired value if it is not correct.

8.206 Run 15 minutes at 1/4 load and then record all data on the Test Form, ID-946. The voltage may be readjusted before the reading but should not be changed throughout the rest of the run.

8.207 For manual sets add office and building loads that are going to be used for the test by operating their transfer switches to the emergency position. Readjust artificial load as necessary for full KW load. Power factor will usually be well above 80.

8.208 For an automatic set, reduce artificial load to minimum and turn OPERATION SELECTOR SWITCH to Position No. 4 (FULL LOAD TEST, Manual). This causes the remote automatic transfer switch to operate, throwing office and building load on the engine-alternator. Add additional office loads, as available, and then adjust artificial load so that the engine alternator is carrying full KW load.

8.209 Run a few minutes at full load and then take a set of readings on the Test Record.

8.210 Adjust load as necessary every 30 minutes and take a reading until 2-1/2 hours run is completed. Do not change speed or voltage throughout the run.

8.211 After one hour run at full load read and record cylinder exhaust temperatures. The temperature difference between any two cylinders should not exceed 50°F. If this requirement is not met, adjust fuel pump rack positions as in Paragraph 12.2 and repeat check.

8.212 At the end of the Acceptance Test, reduce load to minimum. For a manual set operate the transfer switches for the various loads to commercial service position. For an automatic set, turn OPERATION SELECTOR SWITCH to Position No. 2 (Auto) and then turn TRANSFER SWITCH RESTORE switch to RESET position. This causes customer's remote transfer switch to operate and throw the office load back on commercial power.

8.213 Open circuit breaker. Allow the engine to run a few minutes then shut down with the manual throttle or by turning OPERATION SELECTOR SWITCH to Position No. 1 (Off).

8.214 The engine-alternator shall meet all requirements in Paragraph 8.3.

8.215 Tighten all exhaust system bolts if this was not done earlier. Remove manometer connection and replace 1/8 inch pipe plug.

8.216 Disconnect the artificial load.

8.217 Correct any leaks that were observed.

8.3 TEST REQUIREMENTS

8.31 Speed shall stay within one of the following ranges, according to where SPEED DROOP knob on the governor is set:

SPEED DROOP Setting	Speed Range - RPM
0	000-908
100	000-938

8.32 Voltage shall stay within 2 percent of the voltage recorded after the machine has operated 15 minutes at 1/4 load. (Multiply this voltage by .02 to calculate allow variation above and below this setting).

8.33 The various pressures in Table 1 shall not fall below the minimum values listed. Adjustments for engine lube oil and fuel oil are covered in Paragraph 12.2.

TABLE 1
Pressures

Pressure	Minimum Pressure	Normal Range
Engine Lube Oil	35	35-43
Turbocharger Lube Oil	15	15-25
Fuel Oil	15	15-20
Engine Jacket Water	-	20-35
Air Manifold (Full Load only)	8	8-8.5
Air Manifold (No Load)	-	1-1 1/2

8.34 The various temperatures in Table 2 shall not be exceeded.

8.35 Exhaust back pressure at full-load shall not exceed 20.4 inches of water (1-1/2 inches of mercury).

8.36 After engine runs at full-load at least one hour, the difference in exhaust temperatures between any two cylinders shall not exceed 50°F.

8.361 It will be necessary to adjust the fuel pump rack position of any cylinder not meeting this requirement. Refer to Paragraph 12.2.

TABLE 2
Temperatures

Thermometer	Maximum Temperature
Lube Oil & Engine Out	205°F.
Water - Engine Out	190°F.

8.362 As a matter of information average exhaust temperatures will be about 750°F. for the 500 KW set and 800°F. for the 550 KW set.

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

9. ENGINE TROUBLE CONTROLS AND ALARMS

FOREWORD: All the engine alarms and associated switches have been tested and properly set at the factory.

9.1 CF Alarm

9.11 Air Starting System

9.111 On a manual set with air starting system check by opening the blowdown valve on each air storage tank in turn and note the pressure gauge reading at the time that APS or APSR pressure switches bring in the alarm. On the automatic set with air starting, turn OPERATION SELECTOR SWITCH to Position No. 2 and perform the above operation. Be sure COMMERCIAL POWER BREAKER is ON or engine will attempt to start.

9.12 Electric Starting System

9.121 It is not possible to check OLT in the field.

9.122 OCT on automatic sets may be checked by cranking the engine for the length of time necessary to cause it to operate. Open the snifter valves and turn OPERATION SELECTOR SWITCH to Position No. 3. Crank engine until CF alarm comes in and cranking stops. Turn OPERATION SELECTOR SWITCH to Position No. 1 to remove alarm and reset OCT. Close snifter valves. Refer to Paragraph 4.3 for information on adjusting the time setting.

9.2 LOP Alarm - LOPS Switch

9.21 Due to the circuit connections on the CCO switch it will not be possible to check this switch on an automatic set. Alarm can be simulated with engine running at no-load with breaker closed. Remove cover of LOPS switch and short the terminals. LOP alarm should come in, circuit breaker should open and set will shut down. Turn OPERATION SELECTOR SWITCH to Position No. 1 to cancel alarms. Remove short across LOPS terminals and replace cover. Reset FRS switch by pulling up the reset lever.

9.22 Check LOPS switch on a manual set running at no-load with breaker closed by reducing engine speed until lube oil pressure reaches a value of 0-15 pounds, in which range LOPS should operate to open circuit breaker and stop the set. Lower speed by pulling manual throttle down slowly, tapping gauge panel lightly so that the lube oil pressure gauge will follow the reduction in pressure. Cancel alarm by depressing ACO button. Reset FRS by pulling up the reset lever.

NOTE: The LOPS switch on these machines is in the box on the base on the right side of the alternator, facing the exciter end of the alternator.

9.3 LOT Alarm - LOTA Switch

9.31 This switch cannot be tested in the field. With the set running at no-load, circuit breaker closed, simulate operation of the switch by removing the cover and shorting the terminals. Circuit breaker opens, LOT alarm comes in and the set shuts down. On a manual set depress ACO button to cancel the alarm. On an automatic set, turn OPERATION SELECTOR SWITCH to Position No. 1 to cancel alarms. Remove short across LOTA terminals and replace the cover. Reset FRS.

9.4 HWT Alarm - WTA and WTS Switches

9.41 With the engine running and circuit breaker closed operate FAN or PUMP CONTROL to OFF position. Engine jacket out water temperature will rise. Add some load to the machine. When engine water out temperature reaches 180-183°F, HWT alarm comes in. Depress AUDIBLE ALARM SILENCING SWITCH to stop the horn. Turn FAN and PUMP CONTROL AUTO. Run engine long enough to cool down.

10. AUTOMATIC CONTROL AND ALARM TESTS

10.1 Preparation for Automatic Operation

10.11 Check that leads TR15, TR16, CB9 and LB6 are connected. If they aren't connected, connect them.

10.12 Operate controls and switches to the following positions

<u>Control</u>	<u>Position</u>
OPERATION SELECTOR Switch	AUTO
COMMERCIAL POWER Breaker	ON
AIR CIRCUIT Breaker	CLOSED
VOLTAGE REGULATOR Switch	ON
EXCITER FIELD RHEOSTAT	AUTO
GENERATOR FIELD Switch	CLOSED
PUMP CONTROL Switch	AUTO
FAN CONTROL Switch	AUTO

10.13 Close disconnect switches for remote radiator and auxiliary water pump.

10.2 Testing the OPERATION SELECTOR Switch

10.21 NO LOAD TEST

10.211 Turn OPERATION SELECTOR Switch to NO LOAD TEST. The engine begins to crank after the start delay period (5-120 seconds). When the cranking begins, the PF lamp lights, the bell rings and a remote power failure alarm is given. Operate AUDIBLE ALARM SILENCING Switch, bell stops and BD lamp lights.

10.212 Engine fires, come up to speed and signal is given to open intake louvers, if any.

10.213 The warm-up timer (WUT) will time out but transfer will not take place and PO alarm will not come in.

10.214 When the engine-alternator temperature has reached 150 degree F, then turn OPERATION SELECTOR Switch to AUTO. BD and PF lamps go out and power failure alarm to remote location is removed.

10.215 Shut the set down by holding manual throttle down until engine stops. Signals are given to close intake and radiator air discharge louvers if any.

10.22 FULL LOAD TEST

10.221 Turn OPERATION SELECTOR Switch to LOAD TEST MANUAL.

10.222 Engine begins to crank after the start delay period (5-120 seconds). When cranking begins, PF lamp lights, the bell rings and a remote power failure alarm is given. Operate AUDIBLE ALARM SILENCING Switch; bell stops and BD lamp lights.

10.223 Engine fires, comes up to speed and signal is given to open intake louvers, if any.

10.224 When WUT operates the customer's remote transfer switch is energized to throw load on the engine-alternator. WUT time can be 10 seconds to 5 minutes. It should not be less than 10 seconds. As soon as transfer occurs PO lamp lights and a proper operation alarm is given. At this time a signal is also given to open radiator air discharge louvers, if any.

10.225 Allow the set to carry the load for ten or fifteen minutes. Then turn OPERATION SELECTOR Switch to AUTO. Bell sounds, indicating return of outside power. PF lamp goes out and remote power failure alarm is removed. Turn TRANSFER SWITCH RESTORE Switch to RESET position and release. Customer's transfer switch transfers load to outside power; PO lamp goes out and remote proper operation alarm is removed.

10.226 Shut the set down with manual throttle. Bell stops. Signals are given to close intake and radiator air discharge louvers, if any.

10.23 AUTO

10.231 Turn OPERATION SELECTOR Switch to "AUTO". Remove the COMMI fuse which will create a power failure. Engine will start up after SDT timer and WUT timer times out. PO lamp will light.

10.232 After fifteen minutes of operation restore COMMI fuse. The set will be ready for transferring the load to the commercial-power by operating the TSR Switch. The PO lamp goes out. Set shuts down.

10.233 Turn OPERATION SELECTOR Switch to "OFF". Disconnect any artificial loads if it was required.

10.3 Alarm Test

10.31 While the engine-alternator set is shut down, commercial power on, the OPERATION SELECTOR Switch in AUTO, press TEST ALARM Button. The following tables describes the operation

LAMP	LIGHT	DARK
BSM	X	
ACD		X
PO	X	
PF	X	
CF	X	
FRS	X	
LOT	X	
HWT	X	
OSRP	X	
LOP	X	
BD		X
HD		X

AUDIBLE ALARM	SOUND	SILENT
BELL	X	
HORN	X	

10.32 To silence audible alarm press the AASS Switch Horn and bell are silence and the BD and HD lamp will light.

10.33 On releasing the TA Switch lamps LOT, HWT, OSRP, LOP, BO and HO will remain lite while the other will go dark.

Note 1: FSR lamp will go out when fuel rack shut down linkage to reset.

Note 2: CF lamp will remain light when battery starting is used.

10.34 Operate OSS Switch to OFF which will release all alarm indications.

11. MAINTENANCE DURING INSTALLATION

11.1 Lubrication

11.11 At the beginning of each run and at eight hour intervals during a run check crankcase oil level, alternator bearing oil level and oil level in the governor. Before a run, with engine idle, add sufficient diesel lube oil to bring crankcase level to HIGH mark on the dipstick. While the engine is running crankcase level should be at NORMAL mark on the dipstick. Add diesel lube oil to alternator bearings or to governor, whether engine is idle or running, to bring oil level to full mark on governor and between marks on gauge glasses on alternator bearings.

11.2 Primary Fuel Strainer

11.21 At the beginning of each run and at eight hour intervals during a run, turn handle on primary fuel strainer one or more turns in a clockwise direction.

11.3 Fuel Drip Can

11.31 Empty fuel drip can about once a month.

11.4 Cooling Systems

11.41 Remote Radiator Only

11.411 When set is running, water level should not fall below 1/2 level in gauge glass on the surge tank. Add sufficient water to the surge tank to bring water 1/2 level in the gauge.

11.42 Remote Radiator, One Tank

11.421 Observe gauge glass during engine operation and add water to the tank if level falls below bottom of the gauge.

11.43 Two Tank System

11.431 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.

12. ADJUSTMENTS - ENGINE AND ACCESSORIES**12.1 Lube Oil and Fuel Oil Pressures**

12.11 Both these systems have pressure regulating valves of similar type to maintain the pressures listed in Paragraph 8.3. For regulator locations refer to figures 1 and 2. To adjust fuel or lube oil system pressure, remove the cap from the regulator, loosen the locknut, and with a large screwdriver turn the adjusting screw clockwise for increase pressure, or, counterclockwise for decrease pressure. When adjustment is satisfactory, tighten the locknut and replace the cap.

12.2 Cylinder Exhaust Temperatures

12.21 The fuel pump racks be adjusted to increase fuel delivery, thus raising exhaust temperature, or to decrease fuel delivery, lowering exhaust temperature.

12.22 Remove the cylinder block cover plate to expose the injector pump for the cylinder to be adjusted. Loosen the locknut on the adjusting screw in the control shaft lever (left side of the pump) and turn the socket head adjusting screw (with an Allen wrench provided for this purpose) in to increase exhaust temperature and out to decrease exhaust temperature.

***12.3 Cranking Cutout Switch**

12.31 This switch is mounted on the opposite side of the water pump drive. For this application it has two adjusting screws. Each adjusting screw is covered by a dust cover screw. Setting marked (1) is for the low range, 300-400 rpm (CCO) and the one marked (2) is for the high range, 825-840 rpm. (FR)

12.32 Adjust either range by removing the dust cap, inserting a 1/16 inch Allen wrench into the adjusting screw and turn screw clockwise to increase operating point, counterclockwise to decrease operating point.

CAUTION: If adjusting screws are turned in too far, switch will no longer operate.

13. GENERAL TROUBLE**13.01 Irregular Engine Speed.**

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

13.02 Erratic Voltage.

Loose connections.
Faulty voltage regulator.
Engine governor unstable.

13.03 No Output Voltage.

Loss of magnetism in exciter field poles.
Loose or open connections.
High contact resistance in the exciter brushes.
Reversed polarity of exciter field.

13.04 Lack of Power.

Improper engine adjustments.
Insufficient fuel.
Insufficient combustion air.

13.05 Smoky Exhaust.**Black or Grey 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.

13.06 Engine Knocks.

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

13.07 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.

13.08 Hard Starting.

Incorrect lube oil.
Low battery output or low air pressure.
Siphoning of fuel from engine when it is idle.
Defective turbo-charger.
Engine overhaul required.
Air in fuel system.
Insufficient fuel pressure.
Clogged Air Cleaner.
Incorrect SAE rating of lube oil.

13.09 Hunting.

Engine not fully warmed up.
Defective voltage regulator.
Instability of the exciter.

13.10 Vibration.

One cylinder is misfiring.
Excessive grease in alternator
bearings.
Loose electrical connections.

13.11 Low Lube Oil Pressure.

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

→ Arrows indicate changes

Manager, Product Engineering

Reasons for Reissue:

1. To include T.I. on Barring the Engine Over
2. To include use of R-4296 Ear Protector
3. To make minor change