

Installation Engineering Handbook 19
Western Electric Company, Incorporated
Kearny Works

Section
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KS-20523, KS-20524, KS-20525 AND KS-20526

MANUAL DIESEL ENGINE-ALTERNATORS

30, 45, 75 AND 115 KW (J86645)

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1. GENERAL

1.1 Scope

1.11 This section covers installation and test of manually-controlled 30, 45, 75 and 115 KW diesel engine-alternators supplied by Detroit Diesel Engine Div., General Motors Corp., Detroit, Mich.

1.12 Tests are based on the following circuit diagrams:

SD-81223-01	Central Office Alarm
SD-81796-01	J87249B Rectifier
SD-82021-01	Power Plant Schematic
5143962	Engine-Alternator (Supplier Diagram)
SD-81934-01	Engine-Alternator Schematic

1.2 Inspection

1.21 As soon as possible after the unit is received remove shipping materials and make a complete inspection of the engine-alternator and associated equipment and parts. Examine carefully for visible defects and damage. Examine the interior of the control cabinet for concealed damage.

1.22 Report any defects, damage or missing parts in accordance with established routines.

1.3 Associated Information

1.31 Section 129 in this handbook covers levelling and vibration isolator adjustments.

1.32 Section 132 in this handbook covers piping information.

1.33 Section 130 in this handbook covers paralleling information, where this is applicable.

1.34 Section 19 in Handbook 18 covers information on charging the starting batteries.

1.35 Section 133 in this handbook covers information antifreeze and rust inhibitor information for cooling systems.

1.4 Description of Engine-Alternator

1.41 The basic set consists of an engine-alternator mounted on vibration isolators and a floor-mounted control cabinet. A set-mounted radiator is always furnished on the 30, 45 and 75 KW sets. For the 115 KW set, the radiator can be ordered on the set or remote. Shutters are optional on a set-mounted radiator and always furnished with a remote radiator.

1.42 The standard set is not enclosed. Covers may be ordered as an option. Covers with sound-absorbing material may also be ordered as an option.

1.43 The control cabinet is placed about 1/2 inch away from the alternator end of the set and bolted down. The upper part of the cabinet has a hinged front cover on which is mounted meters, alarm lamps and control switches. The interior of the cabinet contains relays, fuses and a main breaker. The lower portion of the cabinet houses the J87249 Rectifier and the voltage regulator.

1.44 The alternator is a Delco single-bearing unit close-coupled to the engine flywheel. The exciter is a brushless type using rotating diodes to provide dc for the alternator field. The voltage regulator is a static type.

1.45 An extended lube oil supply is available as an option. It uses a Ren lube oil regulator valve to keep a constant crank-case oil level. A shut-off valve is furnished in the input line of the Ren valve.

1.46 Optional cold weather starting aids consist of an ether capsule device or an immersion heater for the engine water jacket.

1.47 The exhaust silencer furnished may be either a straight-through type or a side-entrance type, as ordered.

1.48 These sets are furnished with an SG governor which has a 4-1/2% speed droop from no-load to full-load. However, a PSG governor, capable of being set for isochronous, or no-droop, operation may be ordered as an option.

1.49 The Reverse Power Relay may be ordered as an option when parallel operation of the set is desired.

1.5 Description of Operation

1.51 These sets are arranged for manual starting and manual loading.

1.52 When the set is running the following major troubles will stop the set, trip the circuit breaker, light an alarm lamp on the cabinet and provide a major alarm signal to connected alarm circuits:

Water temperature reaches 205-215°F.	HIGH WATER TEMP lamp.
Lube oil pressure 20-30 psi.	LOW OIL PRESSURE lamp.
Engine speed 2050-2250 rpm.	OVERSPEED/REVERSE POWER lamp.
Alternator draws more than 20 KW reverse power in parallel.	OVERSPEED/REVERSE POWER lamp.

1.53 The following minor alarms are indicated by lighting the associated alarm lamp. There is no shutdown if the set is running. A minor alarm signal is provided to the customer's alarm circuit.

PREL WATERTEMP	Jacket water temperature reaches 191-197°F.
RECT FAILURE	Failure of battery charging rectifier.
JACKET HEATER-FAIL	Jacket water temperature falls below 50°F.

2. PRECAUTIONS

2.1 Engine-Alternator

2.11 When working on the engine, disconnect the B- battery lead on the Starting Battery.

CAUTION: Before disconnecting the lead it will be necessary to remove an input fuse on the J87249B Rectifier, or damage will occur to the rectifier. Then remove the OUTPUT fuse from the rectifier.

2.12 The starting motor should not be operated more than 30 seconds at a time to avoid overheating the motor. Also, wait one minute between cranking attempts. If the engine fails to start DO NOT press the START button again until the engine stops rotating.

2.13 Immediately after starting observe lube oil pressure on the gauge. If no oil pressure is shown after 10-15 seconds immediately stop the engine with the STOP button.

2.14 The AIR BOX DRAIN must be drained weekly.

2.15 When an Immersion Heater is furnished be sure that H1 and H2 fuses (in the cabinet) are removed until the radiator is filled with solution. Also, be sure that the valves opening into the Immersion Heater chamber are open when filling the cooling system.

2.16 Routine runs should not be made on these sets without loading the set to at least 30% rated capacity. Also, when started for short demonstration runs, the set should not be shut down before water temperature has reached 125°F.

2.2 J87249 Rectifier

2.21 Install output fuse (F4) before installing the input fuse because resultant open-circuit voltage will damage the charger. When disconnecting the rectifier remove an ac input fuse before removing the output fuse.

2.22 For 208 volt input insert COM & 208V fuses. For 220-240 volt input insert COM & 240V fuses. In no case shall 208V and 240V fuses be inserted at the same time.

2.23 If the J87249 Rectifier is to be off for several days be sure to disconnect the rectifier by pulling out the rectifier connection plug as well as removing the rectifier fuses. A bleeder resistor in the rectifier is not disconnected by removing the output fuse and this resistor will discharge the battery.

3. TOOLS, TEST SETS AND RECORDS

3.1 Tools and Test Sets

Note	Quan.	Code	Description
	1	R-2705	Tachometer, Hand
	1	R-3404	Phase Sequence Indicator
1	3	R-3413	Wire & Lug Assembly
	1	ITE-1000	AC Voltmeter
	1	ITE-4442	Volt-Ohmmeter
	1	ITE-4474	DC Power Voltmeter
2	1	ITE-4782	150 KW AC/DC Test Load
	1	ITE-4824	Hasler Tachometer
3	2	ITE-9501	Test Cord

NOTE 1: For connecting ITE-4782 Test Load.

NOTE 2: Due to the heat produced by this load it should be placed outside or in a doorway for the test.

NOTE 3: For ITE-1000 Voltmeter

3.2 Records

ID-946	Engine-Alternator Test Record
ID-1275	Lubrication Record
ID-1285	Storage Battery Report
SD-4-1313	Test Trouble Record
SD-4-1315	Summary of Tests

4. INSTALLATION

4.1 Preliminary

NOTE: Refer to Section 129 in this handbook for information on installing isolators and levelling the engine set.

4.11 The floor or pedestal under the unit shall slope not more than 1/4" in 10 feet. Also, the mounting areas for the isolators shall not vary more than 1/32 inch in height from each other. Floor coverings such as linoleum or tile must be removed under the isolators so that the base of the isolator rests on the floor.

4.12 Lay out and drill for isolator hold-down bolts when it is required to bolt the engine-alternator to the floor, as in Earthquake areas. The control cabinet should be bolted down in all cases. When bolting down the isolators the anti-walk ribbed material on the bottom should be removed.

4.13 When the set is received have the riggers move it into position and install the vibration isolators. Isolators can be installed later, however, using the jack screws provided with the set to raise it high enough to place the isolators.

4.14 Remove R1 and R2 fuses from inside the cabinet. These will be installed when the J87249 Rectifier is connected. Remove H1 and H2 fuses from inside the cabinet when an Immersion Heater is provided.

4.15 Remove the grill from the lower front of the control cabinet.

4.16 Five small leads are coiled up by the alternator. These leads are numbered 115, 183, 184, 185 and 186 and they connect to a terminal strip on the rear of the control cabinet.

4.2 J87249 Rectifier

NOTE: Insert the output fuse before inserting the input fuses as the high open-circuit voltage will damage the rectifier.

4.21 Install the J87249 Rectifier, and the output capacitor, in the area provided (lower left-hand corner of the cabinet).

4.22 Remove all fuses from the rectifier. Remove the cover from the rectifier and ascertain that the following list number is marked on the card (according to the battery used):

List TB - 12 cell lead-acid battery (setting is 26.0 volts)
List TA - 20 cell nickel-cadmium battery (setting is 28.5 volts)

4.23 With ac input to the rectifier disconnected put the plug into the socket on the rectifier.

NOTE: Later rectifiers have a capacitor box assembly connected to the output. In this case, plug the capacitor into the rectifier and connect the plug provided with the engine set to the capacitor box.

4.24 Install the output fuse (F4) on the J87249. Then install the ac input fuses (COM and 208V or 240V) on the rectifier.

CAUTION: Insert 208V or 240V fuse according to the commercial line voltage.

4.25 Install the remote ac line fuses for the rectifier, where these are provided. Install R1 and R2 fuses in the cabinet.

4.26 With the charger operating check charging voltage. Use the ITE-4474 DC Power Voltmeter for checking the voltage. Connect the voltmeter across the DC OUTPUT jacks on the rectifier unless these are inaccessible, in which case connect the voltmeter across the start battery.

4.27 Measure charging current with a voltmeter across the 4A/VOLT jacks on the J87249. The voltmeter used for this should be a good 3V dc meter, or the 3 volt dc scale of ITE-4442 may be used. Each volt indicated = 4 amperes, less 0.4 ampere for R15 bleeder resistor current.

4.28 Give the start battery an Initial Charge in accordance with the information in Section 19 of Handbook 18.

4.3 Engine-Alternator and Control

4.31 Open the lube oil drain valve and drain out any oil or residue left in the system. Then close the drain valve. If a Ren Valve is furnished also close the shutoff valve in the inlet line to the valve.

4.32 Add oil to the crankcase as follows:

4.321 Remote Lube Oil Supply: Add lube oil in the oil filler opening until crankcase oil level passes the "L" mark on the dipstick. Check after lube oil has been allowed to settle for about 20 minutes. First addition of lube oil is as follows:

30 KW:	13 1/2 quarts
45 KW:	21 quarts
75 KW:	27 quarts
115 KW:	37 quarts

Then open the inlet line to the Ren Valve (from the remote supply) and observe that oil level in the sightglass of the Ren Valve is close to the center-line.

4.322 No Remote Lube Oil Supply: Add lube oil to the oil filler opening until crankcase oil level reaches the "F" range on the dipstick. Check

after the oil has been allowed to settle for about 20 minutes. The following quantities will be required:

30 KW:	15 1/2 quarts
45 KW:	21 quarts
75 KW:	27 quarts
115 KW:	40 quarts

4.323 Recommended Lube Oils:

MIL-L-2104B Lubricants are recommended for use in these engines. SAE-30 oil should be used until the initial oil drain and is recommended for continued use thereafter in all ambients.

NOTE: The following lube oils meet this specification and are acceptable.

Gulf Oil Corp.	-	Gulflube Motor Oil X. H.D.
Phillips 66	-	HDS Motor Oil
Shell Oil Co.	-	Shell Rotella T Oil Shell MIL-B Oil
Sinclair Refining Co.	-	Sinclair Super Tenol
Standard Oil of Calif.	-	RPM DELO Multi-service Oil
Sun Oil Co.	-	Sun Fleet MIL-B Sunoco Ocnus 4500 Series
Texaco, Inc.	-	Ursa Oil Extra Duty

4.33 Add engine lube oil to each Air Cleaner to the level indicated on the body of the cleaner. Reinstall the Air Cleaner(s).

4.34 Remove the rocker arm cover on the engine and pour about one pint of lube oil over the rocker arms. Replace the cover.

4.35 Remove rear cap on alternator and check that grease is up to the bottom of the shaft. Add grease, when required, through this hole. Use grease Code No. BRB-2 (Standard Oil of California) or equivalent. Replace rear cap.

4.36 Add water and antifreeze or rust inhibitor to a set-mounted radiator. Capacity of the cooling system is marked on the radiator. Rust inhibitor must always be used, unless antifreeze is used. Refer to Section 133 in this handbook for information on antifreeze and rust inhibitor.

CAUTION: If there is an Immersion Heater be sure that the valves at each end of the chamber are open.

4.37 After the cooling system has been filled, the Immersion Heater can be turned on. Insert the ac fuses in the AC Service Cabinet and install H1 and H2 fuses in the cabinet.

4.4 Remote Radiator and Cooling System

4.41 Install piping and wiring in accordance with job drawings.

4.42 Install isolators under the remote radiator at the marked locations and bolt the radiator down in accordance with job drawings.

4.43 Install the thermometers in the engine inlet and outlet connections.

4.44 Fill the cooling system when all piping is complete. Capacity of the remote radiator will be marked on the radiator and engine block capacity will be marked on the engine. Capacity of the complete system, including piping, will have to be calculated and the correct amount of rust inhibitor or antifreeze added. Refer to Section 133 in this handbook.

5. INITIAL START

NOTE: To prevent external alarms from coming in disconnect external alarm connections until Paragraph 9.

5.1 Preliminary

5.11 Verify that all fuses are installed in the control cabinet. Close CBI Breaker in the control cabinet. Where a Remote Radiator is furnished be sure that RFM Breaker is open; then close Disconnect Switch on the Remote Radiator.

5.12 Check the Air Damper Shutdown Relay (ADSR) on the blower (intake) housing. Pull down the armature of the solenoid to make certain that the flapper valve is open. This also resets the spring-loaded switch (SON) on the other end of the flapper valve shaft.

5.13 If the set is to be paralleled, operate SW1 (CCC) on the Voltage Regulator to IN position, which puts the Cross-Current-Compensating Resistor in the circuit. If the set will not be paralleled, operate SW1 to OUT position.

5.14 If an SG Governor is furnished no speed droop adjustment is available. An external speed droop adjustment is available on the PSG Governor, when this is furnished. Set the governor arm on the PSG Governor to the desired operating position in accordance with the following instructions:

5.141 Solo Operation: Set the governor arm to ISO, when the engine-alternator will not be paralleled. Loosen the knurled knob securing the adjustment, push the arm in toward the engine to the end of the slot and tighten the knurled knob.

5.142 Parallel Operation: DROOP position has always been used in the past on the governors of all units operating in parallel. Loosen the knurled knob securing the adjustment, pull the arm out away from the engine to the end of the slot and tighten the knurled knob. However one unit in a parallel system may be set at ISO, if droop/isochronous paralleling will be used.

5.15 Remove the cap on the rear of the alternator so that a tachometer can be used. A nut is furnished which fits the hexagonal indent on the rear plate of the alternator so that the cover can be removed with an adjustable wrench.

5.16 Turn ALTERNATOR VOLTS ADJUST control full CCW. Turn Voltmeter Selector Switch to ALTERNATOR 1-2 position.

5.17 Close any condensate drains in the exhaust system.

5.18 Open the valve in the fuel suction line.

5.2 Priming Fuel System

5.21 Turn the RUN/PRIME valve to PRIME position and then operate the Deming hand pump until considerable restriction is felt, indicating the fuel cup is filled and the system is primed. Stop pumping and turn RUN/PRIME valve to RUN position.

5.22 If any leaks are observed in the fuel lines during the priming operation fix these leaks before attempting to start and then reprime.

5.3 Starting

5.31 On the top of the governor turn the knurled brass knob or ring several turns CCW and then turn it several turns CW. Observe that it moves freely. If there is paint in the threads, preventing it from turning freely, remove the top of the governor, clean paint from the threads on the shaft and knurled ring and then reassemble.

5.32 Operate ENGINE SPEED control in RAISE direction for a few seconds and observe that the motor turns freely. Then operate ENGINE SPEED control in LOWER direction for about 10 seconds and observe that the brass knurled ring turns CCW. This will cause the set to start at reduced speed on the Initial Start.

5.33 Push the START button on the cabinet and hold operated until the engine fires. The set may also be started by using the ESE button on the engine.

5.34 With the engine running increase engine speed by holding ENGINE SPEED Switch at RAISE position. Speed will be checked by holding the R-2705 Tachometer on the end of the alternator shaft. Adjust speed into the range 1870-1875 rpm, unless a PSG Governor is furnished which is to be used in ISO, in which case adjust speed to approximately 1800 rpm. Observe that output voltage is indicated when speed is approximately 1400 rpm or above.

NOTE 1: As soon as voltage builds up (about 1400 rpm.) continue to increase speed to 1870 or 1800. Do not continue operation at the voltage buildup speed or reduce below that point, as this may cause damage to the Voltage Regulator. It will be satisfactory to shut the engine down at this time, however, if other operating conditions are unsatisfactory.

NOTE 2: If voltage does not buildup it will be necessary to flash the field. To do this leave the set running at no-load speed. Apply 1-1/2 volts (flashlight cell) to terminals 186 (+) and 115 (-) at the terminal strip in the rear of the cabinet until build-up occurs. Remove flashing battery as soon as voltage starts to build-up.

5.35 When no-load speed is correct adjust alternator voltage to desired value. Check engine speed here and throughout the load run with either the ITE-4824 or R-2705 Tachometer.

5.36 With alternator voltage available check phase sequence of the output with the R-3404 Phase Sequence Indicator. 1-2-3 order is required. Where a remote radiator is furnished close the RFM Breaker. Observe that the remote fan starts and turns in the correct direction.

5.361 If the fan on a remote radiator does not turn in the correct direction it will be necessary to shut the set down to change the phase sequence of the ac leads at some convenient point between the RFM breaker and the disconnect switch on the Remote Radiator.

5.362 Do not shut the set down to change the phase sequence of these leads unless block water temperature has reached at least 125°F.

5.363 After shutting down and correcting the phase sequence of line connections to the Remote Radiator Fan, start the set and observe that the fan turns in the correct direction.

5.37 Where engine-mounted shutters are furnished observe that these shutters begin to open when water temperature reaches the range 130-160°. These shutters should be fully open when water temperature reaches 160-170°F.

5.38 Allow the engine to run for about 30 minutes at no-load. Observe that lube oil pressure remains above 30 psi. Also observe that engine water temperature steadily increases but remains approximately 185°F.

5.39 After the no-load run shut the set down with the EMERGENCY STOP Button. The SWITCH OFF NORM lamp lights.

5.4 After Shutdown

5.41 After shutdown check the set over carefully for oil and water leaks and correct any leaks that have been observed.

5.42 Before the exhaust system cools check tightness of all bolts holding the flanges together, taking extreme care not to get burned on the pipe or silencer.

5.43 Change alternator output for correct phase sequence, if sequence was not 1-2-3 order.

5.44 Where a remote lube oil system is not furnished check lube oil level in the crankcase and add oil as necessary to bring level on the dipstick near the F mark.

NOTE: About 2 quarts of oil will be required as this amount of oil is retained in the lube oil filters.

5.45 Reset the Air Damper Shutdown Relay, which also resets the SON Switch. SWITCH OFF NORM lamp goes out.

6. OVERSPEED TRIP TEST

6.1 With the set running at no-load overspeed the engine and observe the point at which shutdown occurs.

6.2 Have one man insert the R-2705 Tachometer in the opening at the rear of the alternator. Have a second man overspeed the engine by pushing the fuel rod on the governor in, which overrides the load limit adjustment on the governor. For the 30 and 45 KW sets it will be necessary to protect the hand with a wrench handle or similar metal tool.

6.3 Shutdown should occur in the range 2050-2250 rpm.

6.31 The OST (Overspeed Trip) and OCCO (Overcrank Cutout) switches are combined in one centrifugal switch, which is mounted on the rear end of the engine block.

6.32 Adjusting screws are under the plugs in the back end of the switch. OCCO adjustment is under the plug marked 1; OST adjustment is under the plug marked 2.

NOTE: As a matter of information the OCCO Switch should open in the range 700-800 rpm (53 Series engine) or 650-750 rpm (71 Series engine) to stop the cranking effort.

6.33 To adjust OST operating point, remove the plug and insert a 1/16 inch Allen wrench through the opening into the end of the adjusting screw. Turn the adjusting screw CW to raise the switch operating point, or, CCW to lower the operating point.

6.4 Observe that at shutdown the OVERSPEED/ REVERSE POWER and SWITCH OFF NORM lamps light. After shutdown reset the Air Damper Solenoid Relay (ADSR) and the SON Switch. The lamps go out.

7. REVERSE POWER TEST

7.1 This Reverse Power Relay cannot be tested satisfactorily without the set being in parallel with another set. Refer to Paragraph 9 in Section 130 in this handbook for the test.

7.2 Shutdown should occur in the following ranges:

KS-20523	14-16 KW
KS-20524	19-21 KW
KS-20525	19-21 KW
KS-20526	19-21 KW

7.3 Observe that when shutdown occurs the breaker trips open. The OVERSPEED/REVERSE POWER and SWITCH OFF NORM lamps light. Manually reset the breaker to OFF position and reset the Air Damper Solenoid Relay (ADSR) and the SON Switch. The lamps go out.

7.4 If shutdown occurred before the beginning of the range turn the CALIBRATE potentiometer full CW. Start the set, parallel it with the other set and reduce speed on this set for the desired reverse power. Then slowly turn CALIBRATE potentiometer CCW until shutdown occurs.

7.5 There should be a 1 second time delay between the time the reverse power reaches the shutdown range and the actual shutdown. The TIME DELAY potentiometer should be set full CW to obtain this delay.

8. FULL LOAD TESTS

TIME: Make a one-hour Preliminary Full-Load Test before a Final Acceptance Test. The Final Acceptance Test will be 2-1/2 hours in length and witnessed by a customer's representative; two hours will be at full-load and the last half-hour at the usual office load value, or, at full-load.

LOAD: Artificial load equal to full KW capacity of the set.

PARALLEL: If the set is to be paralleled, additional Preliminary and Final Acceptance Tests in parallel will be required, in accordance with Section 130 in this handbook.

8.1 Preliminary Operations

8.11 Connect the artificial load to the load side of the alternator circuit breaker or to the Emergency Bus.

8.12 Install all the side covers on the enclosure, when these are provided.

8.13 Start any Auxiliary Fuel Pump or Auxiliary Room Ventilating Fan. Open doors to provide ventilation if this will be the normal method of ventilating the room.

8.14 Open the valve in the fuel suction line.

8.15 Close any condensate drain valve in the exhaust line.

8.2 Preliminary Full-Load Tests

8.21 Start the set. When speed and voltage are at normal no-load value, take a set of readings at no-load. This will include Time, Speed, Frequency, Volts, Water Temperature, Lube Oil Pressure Ambient Temperature and Time Meter.

8.22 Close the alternator circuit breaker.

8.23 Add artificial load until the set is loaded to full-load. Adjust speed and voltage as necessary.

8.24 Take a set of readings at full-load. This will include Time, Speed, Frequency, Volts, Amperes, KW, Power Factor, Oil Pressure, Water Temperature and Ambient Temperature.

8.25 Take readings every 30 minutes until the set has run one hour at full-load. The requirements in Paragraph 8.4 shall be met during the hour run.

8.26 Reduce artificial load to zero and open the alternator circuit breaker. Allow the set to run about three minutes to cool down. Then shut the set down by depressing the STOP button.

8.3 Final Acceptance Test

8.31 Start the set and adjust speed and voltage as necessary.

8.32 Allow the set to warm up for a few minutes. Then close the alternator breaker and add artificial load until the set is loaded to full-load.

8.33 Take a set of test reading at full-load. Then take reading every 30 minutes until the set has run two hours at full-load. The requirements in Paragraph 8.4 shall be met during this run.

8.34 After two hours full-load reduce load to the value of load normally carried by the set, or, continue at full load. Take a set of readings if load is reduced from full-load.

8.35 After 30 minutes at the normal load value (or at full-load) take a set of readings. Then decrease artificial load to zero. Open the alternator circuit breaker.

8.36 Allow the set to run about 3 minutes. Then shut the set down by pushing the STOP button.

8.4 Requirements

8.41 The unit shall be capable of carrying full KW load up to the following altitudes (above sea level):

30 KW set:	9500 Feet
45 KW set:	6000 Feet
75 KW set:	5000 Feet
115 KW set:	5000 Feet

8.42 Lube oil pressure shall not be less than 30 psi.

8.43 Water temperature shall not exceed 204°F.

8.44 Speed at full-load, or at a de-rated load, shall not change more than 1/4 hertz. Also, speed changes shall not be cyclic (hunting).

8.45 The voltage shall not vary throughout the load run more than ±1% from the original cold setting at no-load.

9. ACCESSORY TESTS AND ALARMS

NOTE: The following have been factory-set and tested. If adjustment is necessary, refer to the supplier's manual.

9.1 LOPS: This switch closes when lube oil pressure builds up. If pressure falls into the range 20-30 psi, the switch opens, causing the engine to shut down, lights the LOW OIL PRESSURE lamp and brings in a major alarm. Simulate opening of the switch by removing the cover and pushing the actuating arm in LOPS to operate the microswitch.

9.2 PHWTS: This switch closes, lights PRELIM WATER TEMP lamp and gives a minor alarm when coolant temperature is 191-197°F. Simulate switch operation by removing the cover and pushing the actuating arm to operate the microswitch. Alarms are retired by releasing the switch.

9.3 HWTS: This switch shuts down the engine, lights HIGH WATER TEMP lamp and gives a major alarm when coolant temperature reaches 205-215°F. The switch will remain closed until temperature reduces about 60°F below the operate point. Simulate a failure by removing the cover and connecting a temporary jumper across the switch terminals.

9.4 HCS: This is a non-adjustable switch for the Immersion Heater. Switch contacts are closed in the range 75-110°F and jacket water is kept somewhere in this range.

9.5 JHF: This is an adjustable switch to monitor the jacket water temperature when an Immersion Heater is furnished. Contacts will close if coolant temperature is between 45-55°F to light the JACKET HEATER FAIL lamp. Switch is adjustable by a 9/16 inch hex nut under the switch cover.

10. MAINTENANCE DURING INSTALLATION

10.1 Before Starting (Engine Cold)

10.11 Check lube oil level on the crankcase. Pull dipstick and observe crankcase oil level. Oil level should be as follows:

Ren Valve: Between F marks
No Ren Valve: Between F marks

10.12 Where no Ren Valve is furnished, add oil when level reaches the L mark to bring level between the F marks.

10.13 Check that the voltage of the starting battery is within the following range:

Lead-Acid: 26.0 - 26.3 volts
Nickel-Cadmium: 28.3 - 28.5 volts

Measure across battery terminals with ITE-4474 Voltmeter if the DC OUTPUT jacks on J87249 Rectifier are inaccessible.

10.14 Check coolant level weekly in the set-mounted radiator. Maintain coolant level near the top of the radiator upper tank. It should be within 2" of the top of the filler neck. Add water as necessary.

10.15 Check coolant level weekly in the remote radiator (115 KW set) when one is furnished. Coolant level should be near the top of the sightglass. Add water as necessary.

10.2 During Operation

10.21 Check for unusual vibration and/or noise.

10.22 Check for signs of unusual operating conditions.

10.23 Check for lube oil, fuel, water and exhaust system leaks. Correct these as soon as possible after shutdown.

10.3 Other Items

10.31 Periodically check electrolyte level in the batteries and fill in accordance with instructions.

10.32 Periodically check battery charging rate (4 AMP/VOLT terminals on the J87249 Rectifier). Also periodically check battery voltage with ITE-4474 Voltmeter by measuring across the battery terminals.

10.33 Check for leaks in fuel system, cooling system and lube oil system and correct as necessary.

10.34 Drain residue from the AIR BOX DRAIN on a weekly basis.

11. GENERAL TROUBLES AND CAUSES

11.01 Engine will not crank.

Weak start battery.
Loose battery connections.
Air shutdown device not reset.

11.02 Engine cranks but does not start.

Defective fuel pump.
Restricted fuel filter or strainer.
Insufficient fuel.
Air in fuel system.
Fuel system not primed.

11.03 Hard starting.

Engine overhaul required.
Air in fuel system.
Insufficient fuel pressure.
Clogged Air Cleaner.
Excessive exhaust system back pressure.
Weak start battery.
Improper fuel.
Low ambient temperature.
Incorrect SAE rating of lube oil.

11.04 Engine stops.

RUN/PRIME Valve left on PRIME.
Observe alarm lamp for trouble indication.

11.05 Engine overheats.

Thermostats fail to open.
Restricted passages in lube oil cooler.
Defective water pump.
Loose or broken fan belts.
Excessive KW load.
Clogged radiator passages.
Low coolant level.
Insufficient air intake in room.

11.06 Low Lube oil pressure.

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

11.07 Exhaust smoke analysis.

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.

Incompletely burned fuel.
Improper fuel.
Internal fuel or lube oil leaks.

White smoke

Improper fuel.
Faulty injectors.
Misfiring cylinders.

11.08 Engine knocks.

Lube oil diluted by fuel.
Air Box requires draining.
Leaking injectors.

11.09 Engine runs unevenly.

Fuel supply erratic or insufficient.
Defective governor.
Operating temperature too low.
Engine requires overhaul.

11.10 Low lube oil level.

Insufficient lube oil in crankcase.
Ren Valve positioned incorrectly.
Inlet valve to Ren Valve not full open.

11.11 High lube oil level.

Ren Valve positioned
incorrectly.
Defective Ren Valve.

11.12 Vibration on the set.

Unbalanced alternator
armature.
Excessive grease in
alternator bearing.
Loose electrical connections.
Fuel system problems.
Erratic governor.

11.13 No output voltage or low output
voltage.

(Refer to Supplier's Manual)
Faulty diodes in alternator.
Loss of exciter residual
magnetism (Flash field - see
Par. 5.34)
Speed below 1400 rpm.

11.14 Erratic voltage.

(Refer to Supplier's Manual)
Faulty diodes in alternator.
Loss of residual magnetism.
Loose connections.

11.15 High output voltage and voltage
is uncontrollable.

(Refer to Supplier's Manual)
Defective voltage regulator
circuit.

[Vertical line at side of paragraph
indicates requirement.

Manager, Product Engineering