

**KS-19583, KS-19584, KS-19585 AND KS-19586 DIESEL ENGINE-ALTERNATORS
30, 45, 75 AND 115 KW (J86841)**

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1. GENERAL**1.1 Scope**

1.11 This section covers installation and test of 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-81100-01	Alarm Circuit
SD-81223-01	Alarm Circuit
SD-81489-01	Transfer Breaker Circuit
SD-81692-01	J86634 Solid State Control
SD-81693-01	Automatic Plant Schematic
SD-81738-01	Engine-Alternator Circuit
SD-81796-01	J87249 Battery Charger

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 Description of Engine-Alternator

1.31 The basic set consists of an engine-alternator mounted on vibration isolators and a floor-mounted control cabinet. The radiator is on the set except for KS-19586 where a remote radiator is optional. Shutters are available for the set-mounted radiator and always furnished with a remote radiator. Four jack screws, inside the base, are furnished to raise the base to place the isolators.

1.32 The set may be open or enclosed.

If the set is enclosed the covers may or may not include sound-absorbing material, according to the list number. Pans, coated with sound-absorbing material are mounted under the set to further reduce noise if the list number includes the sound absorption.

1.33 An extended lube oil supply is available. 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.

1.34 The control cabinet is placed about 1/2 inch away from the alternator end of the set. The upper part of the control cabinet has a hinged front cover on which is mounted meters, alarm lamps and control switches. The interior of the cabinet contains relays, fuses, small breakers, one or two main breakers and customer connections. The lower portion of the cabinet houses the J86634A Solid-State Control, the J87249 Rectifier and the voltage regulator.

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

1.36 Available cold weather starting devices consist of an ether capsule device or an immersion heater for the engine water jacket.

1.37 The set may be furnished with a PSG governor, capable of Isochronous or Droop operation, or, the set may be furnished with an SG governor, capable of Droop operation only.

1.38 Room Exhaust Louvers will always be furnished. Discharge Shutters or Recirculating Shutters will also be furnished. The discharge duct may include a KS-20023 Load Bank which may be ordered with Discharge Shutters. Where the supplementary load bank is ordered with Recirculating Shutters the load resistors will be mounted in the radiator end of the KS-5704 Duct feeding into the shutters.

1.39 Alarm lamps on the cabinet are illustrated in Figure 1.

RECTIFIER FAILURE		PRELIMINARY WATER TEMP	
POWER FAILURE		JACKET HEATER FAIL	
LOW OIL PRESSURE	CRANK FAILURE	REVERSE POWER	SWITCH OFF NORMAL
HIGH WATER TEMPERATURE	OVERSPEED	CONTROL FUSE FAIL	BREAKER TRIP

FIG. 1 ALARM LAMPS ON CABINET

1.4 Description of Operation

NOTE: The Operation Selector Switch has five positions, OFF, MANUAL, AUTO NO LOAD, FULL AUTO and AUTO MAN RESTORE. Operation is described below for each position of the switch.

1.41 Selector Switch at OFF

1.411 With the OSS switch in OFF the set is not available for operation. The SWITCH OFF NORM lamp is lit on the control panel.

1.42 Selector Switch at MANUAL

1.421 With the OSS in this position the set will not automatically start on a commercial power failure. The set is started by depressing the START button.

1.422 If the set has the On-Set Transfer (List 7 equipment) load will be transferred to the set by depressing the CIRCUIT BREAKER CLOSE button. This opens the Normal breaker and closes the alternator or Emergency breaker.

1.423 Closing the alternator breaker (by depressing the CIRCUIT BREAKER CLOSE button) has no effect on a Remote Transfer Breaker Circuit. Load can be transferred manually to the emergency bus or by operating the necessary switches in the remote circuit.

1.424 To shut the set down it is necessary to depress the CIRCUIT BREAKER OPEN button and then the STOP button. Depressing the CIRCUIT BREAKER OPEN button does not affect a Remote Transfer Circuit but will cause transfer of load back to commercial power, if available, where On-Set Transfer equipment is furnished.

1.43 Selector Switch at FULL AUTO

1.431 When commercial power fails the engine starts after about a 5-15 second delay (DT). When alternator voltage and speed are normal the Warm-Up Timer (WUT) starts.

1.432 After a warm-up period, with a remote Transfer Breaker Circuit, the alternator breaker closes, provided no other set is already on the emergency bus, and a signal is given to the customer's remote transfer breaker circuit to transfer load to the set. With an On-Set Transfer Breaker, the Normal Breaker will be opened after the warm-up time and then the alternator or Emergency breaker will close to transfer the load to the set.

1.433 The set will carry the connected load for the period of the Run Timers (RT2 and RT3), which will cover a total time period of 46-64 Minutes, plus the Hold-Over Time of 9-11 Minutes. The Hold-Over-Timer will not be started until commercial power returns so that the set will continue to carry the load for about ten minutes after power is restored, if not re-stored during the Run-Time period.

1.434 After the power is restored, and after the Hold-Over Time period, the control signals the remote transfer breaker circuit to transfer the load to commercial power, which in turn causes the alternator breaker to open. With the On-Set Transfer breaker the control opens the alternator breaker, which in turn closes the Normal breaker. As soon as the load is transferred to commercial power the set will be shut down.

1.435 With the OSS switch in the FULL AUTO position the set may be started manually with the START button. When started this way the set and control will run through the sequence above, except DT. Load will be transferred to the set after Warm-Up Time and be carried by the set during the Run-Time and Hold-Over Time. Then the load will be transferred back to commercial power, provided it is still available, and the set will shut down.

1.436 With the OSS switch in this position a Remote Routine Start may be initiated by grounding the RS lead. The set will start immediately, warm-up and load will be transferred to the set. After the Run-Time and Hold-Over-Time periods the load will be transferred back to commercial power, if available, and the set will shut down.

1.44 Selector Switch at AUTO NO LOAD

NOTE: If commercial power fails with the OSS switch in this position the sequence of operation will be the same as for FULL AUTO position.

1.441 The set can be started with the OSS switch in this position with the START pushbutton. Once started the set

will run at no-load for the Run-Time and Hold-Over-Time periods and then shut down, provided commercial power does not fail during this time.

1.442 With the switch in this position the set can be started manually for tests and transfer of load to the set will not occur as long as commercial power is available.

1.45 Selector Switch at AUTO MAN RESTORE

1.451 The set will start automatically on a commercial power failure and the load will be transferred to the set as shown for the FULL AUTO position of the OSS switch.

1.452 The load will not transfer back automatically to commercial power. To do this it will be necessary to operate the OSS switch to FULL AUTO position. With commercial ac available the load will transfer back to commercial power after the Run-Time and Hold-Over time and the set will shut down.

1.46 Trouble Shutdowns and Alarms

1.461 When the set is running the following major troubles will stop the set, transfer load back to commercial power, if it is available, light the associated alarm lamp and provide a major alarm signal to connected alarm circuits. The horn will sound if the HORN SW (inside the cabinet) is in the ON position.

LOW OIL PRESSURE	Lube oil pressure 20-30 psi
OVERSPEED	Engine speed 2050-2250 rpm
BREAKER TRIPPED	SET or EMER Breaker tripped
REVERSE POWER	Alternator draws more than 20KW reverse power
HIGHWATER TEMP	Jacket water reaches 205-215° F
CONTROL FUSE FAIL	Blown CF fuse or open CB1 or CB2 breakers

1.462 During starting certain failures light the CRANKING FAILURE lamp, sound the horn and provide remote Engine Failure alarms. These are failures of the engine to reach 100 rpm speed in 3 seconds or if the engine fails to reach 600 rpm in 30 seconds.

1.463 The following minor alarms are also indicated by lighting the associated alarm lamp and sounding the horn. 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 193-197° F.
RECT FAILURE	Failure of battery charging rectifier
JACKET HEATERFAIL	Jacket water temperature falls below 50° F.

1.5 Associated Information

1.51 The test of the engine-alternator should be done in conjunction with Section 254 in this handbook which covers the J86634A Control Module.

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

1.53 Section 132 in this handbook covers piping information and Section 133 covers information on the cooling system.

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

2. PRECAUTIONS

2.1 Engine-Alternator

2.11 When working on the engine first turn OPERATION SELECTOR Switch to OFF. 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 When cold-weather starting equipment is furnished (Z Option) be sure that H1 and H2 fuses are removed until the radiator is filled.

2.13 When working inside the control cabinet (front portion) first turn OPERATION SELECTOR Switch to OFF. Then disconnect commercial ac from the cabinet whenever possible. This can be done on an Off-Set Transfer unit by removing the three ac fuses feeding the control cabinet from the ac service cabinet.

2.14 Where the unit has the On-Set Transfer Breaker take extreme care when working in the area behind the breakers. Commercial ac is always present on both sides of the NORMAL Breaker. The only way to remove this commercial ac is to open the main power service to the station.

2.15 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.

2.16 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.

2.17 The AIR BOX DRAIN must be drained weekly.

2.2 J86634 Control Module

2.21 Be sure that polarity of the control battery is correct (+ on GG terminal and - on N terminal) on the plug before inserting the plug into the rear of the module.

NOTE: It will be necessary to turn the OPERATION SELECTOR Switch to MANUAL before battery is present

on the N lead. After the check-re-store OPERATION SELECTOR Switch to OFF before inserting the plug.

2.22 Except where indicated for test purposes do not pull out or insert circuit packs in the module without first turning OPERATION SELECTOR Switch to OFF to disconnect the battery from the module.

2.23 There are a number of duplicate circuit packs that have specific adjustments. These are timers and frequency monitors, for example. To prevent a mixup of these boards they should be marked with the Equipment Location.

2.3 J87249 Rectifier

2.31 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.

2.32 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.

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
	1	ITE-4297	Auto-Transformer
	1	ITE-9114	Test Cord
	1	ITE-9115	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.

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

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 moved 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 them down, 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 all fuses from inside the cabinet. Wire all external control circuits. Control leads terminate on terminal strips inside the upper rear of the control cabinet.

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

4.2 J87734 Solid-State Control

4.21 After unpacking the J86634A Control Module, turn it over and remove the bottom cover. Check all connections carefully for broken leads, damaged leads, etc. Correct as necessary.

CAUTION: Do not insert the plug into the socket on the back of the control module at this time.

4.22 Check the unit carefully for signs of damage. Check that each circuit pack is secure in its socket.

4.23 Compare the placement of the circuit packs with the diagram on the cover. Certain packs are duplicates and are adjusted for specific times or frequency. The Equipment Location should be marked on these packs.

4.24 Install the J86634 Solid-State control on the slides furnished in the lower portion of the control cabinet.

4.3 J87249 Rectifier and Batteries

NOTE 1: Insert the output fuse before inserting the input fuses as the high open-circuit voltage will damage the rectifier.

NOTE 2: If required to use the J87249 Rectifier before commercial ac is connected to a set arranged for On-Set Transfer, internal connections to R1 and R2 fuses may be disconnected and separate temporary lines run to these fuses. The temporary lines should be #10 gauge with each line protected at the ac service cabinet with 15 ampere fuses.

4.31 Install the J87249 Rectifier in the area provided (lower left hand corner). Install the starting battery and the control battery, where furnished.

4.32 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)

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

4.34 Install the output fuse (F4) on the J87249. When a separate control battery is furnished install the remote CBF fuse. 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.

4.35 Install the remote ac line fuses for the rectifier, where these are provided. For the Off-Set Transfer unit fuses for the rectifier are furnished in the Essential AC Load Service Cabinet (from LL1 and LL2 cabinet terminals). Install R1 and R2 fuses in the cabinet.

4.36 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.

4.37 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.

4.38 Measure voltage and current and observe that after several hours the voltage reaches the required float voltage and that charging current reduces to a very low value.

4.4 Engine-Alternator and Control

4.401 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.

4.402 Add oil to the crankcase as follows:

4.4021 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.

CAUTION: If the Ren Valve is not vented to the atmosphere, the crankcase will overflow. Remove the plug in the top of the Ren Valve before opening the inlet valve and make certain that the plug has a small hole in it before replacing it.

4.4022 No Remote Lube Oil Supply: Add lube oil to the oil filler opening until crankcase oil level reaches the "F-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

4.4023 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

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

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

4.405 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.

4.406 Add water and antifreeze or rust inhibitor to the cooling system. Rust inhibitor is used unless antifreeze is used. Section 133 in this handbook covers information on antifreeze and rust inhibitors.

CAUTION: Be sure that the valves at each end of the Immersion Heater are open.

CAUTION: Never plug the radiator drain opening in the base nor install a valve at this opening.

4.407 The following terminals on the customer terminal strips should be strapped:

ECB+ to RG3 (unless Remote Gov. Control)
 RC+ to GRD
 EVS1-EVS2 (unless Exhaust Line Valve is used)
 MB1-MB2 (except for parallel operation)
 PHR1-PHR2 (unless Phase Reversal Relay is furnished)

4.408 Install the following fuses in the Essential Load Cabinet for the following figures and options which may be furnished under SD-81693-01:

Fig. 12 Auxiliary Room Ventilating Circuit.

NOTE: Install the 5 amp control fuses for the circuit before installing the fuses in Ess. Load Cab.

Fig. 13 Supplementary Load Bank.

NOTE: Do not install fuses for SLB1, SLB2 and SLB3 leads at this time but do install fuses for LC1 and LC3 leads.

Fig. 14 Recirculating Louver Control and Discharge Louver Control.

Fig. 15 Auxiliary Automatic Fuel Pumping System.

4.409 Close any disconnect switches provided for the figures in Paragraph 4.408.

4.410 With commercial air available on Fig. 13 and 14 observe that shutters are held closed.

4.5 Remote Radiator and Cooling System

4.51 Install piping and wiring in accordance with job drawings.

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

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

5. INITIAL START

NOTE: If Off-Set Transfer Breaker Circuit (SD-81489-01) is furnished, temporarily disconnect LB6, TR16, CB9 and TR15 leads at the customer connection strip in the control cabinet. Also, to prevent external alarms from coming in disconnect external alarm connections until Paragraph 9.

5.01 The start battery and separate control battery (where furnished) shall have had a satisfactory Initial Charge.

5.02 Separately test associated systems such as Automatic Fuel Pumping System, Auxiliary Room Ventilating Circuit, Remote Radiator Circuit and Recirculating Louver Circuit insofar as possible.

5.03 Turn OPERATION SELECTOR Switch to OFF.

5.04 Install T1, T2, T3, CF and AF fuses in the control cabinet. Close CB1 and CB2 Breakers in the control cabinet. Where a remote radiator is furnished be sure that RFM Breaker is open.

NOTE 1: H1 and H2 fuses for Immersion Heater and R1 and R2 fuses for the J87249B Rectifier may already be installed.

NOTE 2: Fuses L1 and L3 will not be required unless the set is to be paralleled.

5.05 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 should be paint in the threads preventing it from turning freely it will be necessary to remove the top of the governor, clean paint from the threads on the shaft and knurled ring and then reassemble.

5.06 Check the Air Shutdown Solenoid (ADS) on the blower (intake) housing. Pull down the armature of the solenoid to make certain that the flapper valve is open. This will also reset the spring-loaded switch (SON) on the other end of the flapper valve shaft.

5.07 Operate SW1 on the Voltage Regulator as follows:

OUT position for single-set operation.

IN position for parallel operation.

Position the governor arm on the PSG governor as follows:

ISO position for single-set operation.

DROOP position for parallel operation.

NOTE 1: SW1 at OUT cuts out the Cross-Current-Compensating Resistor on the Voltage Regulator.

NOTE 2: ISO position of the PSG governor arm eliminates speed droop from no-load to full-load. The arm can be moved after loosening the knurled knob. Tighten the knob securely after positioning the arm.

NOTE 3: The SG governor has a built-in speed droop and cannot be operated as an Isochronous Governor.

5.08 Open the front cabinet panel and manually close the SET Breaker. When a NORM Breaker is furnished manually open it.

NOTE: If a breaker is in the tripped position (operating knob at midpoint) it will be necessary to relatch the breaker before operating it to the desired position. Relatch the breaker by pulling the manual operating handle downward toward the OFF position as far as it will go and then release the handle.

5.09 Open the valve in the fuel suction line and prime the fuel system. Turn the RUN/PRIME valve to PRIME position and then operate the Dearing 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.

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

5.10 Turn OPERATION SELECTOR Switch to MANUAL. 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.

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

5.12 Push the START button and hold operated until the engine fires.

NOTE: The set may also be started by using the ESE button on the engine.

5.13 As soon as the engine fires and starts have one man check speed with the R-2705 Tachometer while another man is raising engine speed by holding ENGINE SPEED Switch at RAISE position. Speed is checked by inserting the R-2705 Tachometer in the opening of the transducer (speed pickup) housing. Adjust speed to 1800 rpm. Observe that output voltage is indicated when speed is approximately 1400 rpm.

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

5.14 When the alternator voltage is available observe that intake louvers open and that the shutters on a KS-20023 Supplementary Load also open.

5.15 Set no-load speed to desired value: 1800 rpm for PSG governor at ISO; 1890 rpm for PSG governor at DROOP or for SG governor. Then set alternator voltage to desired value. Check engine speed here and throughout the load run with either the ITE-4824 or R-2705 Tachometer.

5.16 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.

5.17 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.

5.18 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.

5.19 Check the set over carefully for oil and water leaks. After the no-load run shut the set down with the EMERGENCY STOP button. This button will light. SWITCH OFF NORMAL lamp also lights.

5.20 Depress ALARM RESET to cancel EMERGENCY STOP lamp. Reset the Air Damper and the toggle switch on the Blower Housing to cancel SWITCH OFF NORMAL lamp. Turn OPERATION SELECTOR Switch to OFF; SWITCH OFF NORMAL lamp lights.

5.21 With the set stopped turn OPERATION SELECTOR Switch to MANUAL and check for correct polarity of control battery on the plug to the J86634A module. Polarity must be as follows:

- + on terminal GG (from ECB+)
- on terminal N (from ECB-)

5.22 When assured that correct battery polarity is present on GG and N terminals turn OPERATION SELECTOR Switch to OFF and insert the plug into the rear of the J86634A module. The SWITCH OFF NORM lamp and POWER FAILURE lamp should be lighted.

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

5.24 Turn OPERATION SELECTOR Switch to MANUAL. The SWITCH OFF NORM lamp should go out. Turn Horn Switch to ATTENDED position.

5.25 Press ALARM TEST button. Observe that all major alarm lamps light except CONTROL FUSE FAIL, and that minor alarm lights also light. The horn sounds. Release ALARM TEST button and observe that minor alarm lamps go out (except POWER FAILURE). Press ALARM SILENCE button and observe that the horn stops. The ALARM SILENCE button lights.

5.26 Press ALARM RESET button and observe that major alarm lamps go out. Turn OPERATION SELECTOR Switch to OFF. Observe that SWITCH OFF NORM lamp lights and the other lamps go out. Reset the Air Shutdown Solenoid and SON Switch on the Blower Housing.

5.27 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.

5.28 Connect the ITE-4782 Test load to the load side of the alternator or EMER Breaker.

NOTE: Where the On-Set transfer Breaker is furnished it is assumed that commercial ac is not yet connected to the NORM Breaker.

5.29 Start the set and load it to full load. Start with OPERATION SELECTOR Switch at MANUAL using the START button. Close breaker and add load.

5.30 Allow the set to run about 30 minutes at full load. Observe lube oil pressure, water temperature, voltage, current and KW. If necessary to correct speed for 60 hertz do so with RAISE/LOWER speed switch.

NOTE: DC field current on the DC AMMETER will be about 2 amperes.

5.31 After a 30 minute run open the circuit breaker and stop the set. Reduce load to zero on ITE-4782.

5.32 Install CA, CB, and CC fuses for the voltage monitors and external fuses feeding these leads for an Off-Set Transfer Breaker Circuit. Observe that the POWER FAILURE lamp on the control cabinet (turn OPERATION SELECTOR Switch to MANUAL) is off. Then restore switch to OFF.

6. FULL LOAD TEST

TIME: A Preliminary Load Test of one hour and a Final Acceptance Test of 2-1/2 hours in length, two hours at full-load and the last half-hour at the usual office load value, or, at full-load.

LOAD: Supplementary load and artificial load equal to full capacity of the set.

6.1 Preliminary

6.11 Install the side covers on the engine, where these are furnished.

6.12 Install the fuses for the Supplementary Load Bank SLB1, SLB2, and SLB3 in the Essential Load Cabinet.

6.2 Preliminary Load Test

6.21 Turn OPERATION SELECTOR Switch to MANUAL. Start the set. Adjust speed and voltage.

6.22 Take a set of readings at no-load. This will include Time, Frequency, Volts, Water Temperature, Lube Oil Pressure, Ambient Temperature and Time Meter.

6.23 Close the alternator circuit breaker. Observe that supplementary load is connected to the set, if this is furnished.

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

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

6.26 Take readings every 30 minutes until the set has run one hour at full-load. The requirements in Paragraph 6.4 shall be met during the hour run.

6.27 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.

6.28 Turn OPERATION SELECTOR Switch to OFF.

6.3 Final Acceptance Test

6.31 Turn OPERATION SELECTOR Switch to MANUAL. Start the set and adjust speed and voltage as necessary.

6.32 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.

6.33 Take a set of test readings at full-load. Then take readings every 30 minutes until the set has run two hours at full-load. The requirements in Paragraph 6.4 shall be met during this run.

6.34 After two hours at 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.

6.35 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.

6.36 Allow the set to run about 3 minutes. Then shut the set down by pushing the EMERGENCY STOP button. The button lights. The horn sounds. Press ALARM SILENCE button to silence the horn.

6.37 After the set has coasted to a stop turn OPERATION SELECTOR Switch to OFF. The EMERGENCY STOP lamp goes out.

6.38 Reset the Air Damper Solenoid (ADS) and the SON. Switch on the blower housing.

6.4 Requirements

6.41 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

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

6.43 Water temperature shall not exceed 195°F.

6.44 Speed at full-load, or at a derated full-load, shall not change more than $\pm 1/4$ hertz under steady load conditions. Also, speed changes shall not be cyclic (hunting).

6.45 With the engine hot, the speed droop from no-load to full-load (or to the derated full-load) shall not be greater than the following:

NOTE: The cold speed setting is taken after a minimum of 15 minutes operation of the set.

PSG GOVERNOR

ISO SETTING: $\pm 1/4$ hertz (± 8 rpm)

DROOP SETTING: 90 rpm

SG GOVERNOR: 90 rpm

6.46 The voltage throughout the load run should not vary more than $\pm 1\%$ from the original cold setting at no load.

7. REVERSE POWER TEST

NOTE 1: The RP will not require checking and adjustment unless the set will be paralleled. In this case, it is suggested that RP (CP12, Equip. Loc. 25) be removed from the J86634A Module to prevent nuisance tripping of the breaker. If the card is not removed, turn R8 potentiometer on CP12, EQUIP. Loc. 25 full CCW.

NOTE 2: RP cannot be adjusted without operating the set in parallel with another set in accordance with Section 130 in this handbook. The REV PWR TST Switch, furnished on the J86634A, cannot be used at all.

7.1 As a matter of information the amount of reverse power that will trip the circuit breaker should be 19-21 KW. If the set draws this amount of reverse power in parallel with another set the circuit breaker trips and the set shuts down. The REVERSE POWER lamp lights and the horn sounds. A major office alarm will be brought in.

7.2 The horn is silenced and the office alarm is removed by depressing ALARM SILENCE and ALARM RESET Buttons on the set. After shutdown the OPERATION SELECTOR Switch should be turned to OFF.

7.3 Before the set can be restarted the Air Shutdown Solenoid and the SON Switch will have to be reset. Also, the alternator circuit breaker will have to be manually relatched.

7.4 The circuit breaker is relatched by pulling the manual operating handle downward toward the breaker OFF position as far as it will go and then releasing the handle. Observe that the breaker knob has been moved from the tripped (mid-position) to the OFF position.

8. OVERSPEED TRIP TEST

8.1 Turn OPERATION SELECTOR Switch to AUTO NO LOAD. Start the set with the START button.

8.2 Increase speed by operating ENGINE SPEED Switch in RAISE direction. It should be possible to increase speed to about 65 hertz. If shutdown should occur from OSD adjustment at this time turn R4 potentiometer on OSD (CPS, Equip. Loc. 21) CW.

8.3 Restore engine speed to 60 hertz (or 63 hertz if set will be paralleled) with ENGINE SPEED LOWER Switch.

8.4 Remove T1 fuse from the cabinet to protect the Frequency Meter.

8.5 The following operations take two men. Have one man insert the R-2705 Tachometer in the opening on the speed pick-up housing. 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.

8.6 Shutdown should occur in the range 2050-2250 rpm. Adjust R4 potentiometer on OSD as necessary to obtain shutdown in this range. Turn R4 in CCW direction to reduce the shutdown point, or CW to raise the shutdown point.

8.7 Observe that at shutdown the OVER-SPEED lamp lights and the horn sounds. Press ALARM SILENCE and ALARM RESET buttons.

8.8 After shutdown turn OPERATION SELECTOR Switch to OFF. Reset the Air Shutdown Solenoid and SON Switch. Restore the T1 fuse.

9. AUTOMATIC CONTROL TESTS

NOTE: Where a Remote Breaker Circuit is furnished, do not connect leads CB-9, TR-15, LB-6 and TR-16 leads until the test shown in Paragraph 9.12 has been completed.

9.1 Preliminary

9.11 For both the On-Set and Off-Set Transfer units connect commercial ac to the engine-alternator. Observe that the NORMAL Breaker closes when the commercial ac is connected to an On-Set Breaker set. For the Off-Set Transfer set, commercial ac is applied on CA, CB and CC leads by installing the 15 ampere fuses in the AC Service Cabinet.

CAUTION: Be certain that the 3-phase commercial ac power leads are "phased-out" to match the phase sequence of the alternator output leads.

9.12 For the Off-Set Transfer unit check voltages on CB-9, TR-15, LB-6 and TR-16 leads as follows:

9.121 Open the J86634A Control Module cover and operate the OUT-IN Switch on CP19, Equip. Loc. 34 to OUT. This cuts out the Run Timer.

9.122 Turn OPERATION SELECTOR Switch to FULL AUTO. In turning from OFF stop about 10 seconds on MANUAL position to charge up the timing circuits.

9.123 Simulate a commercial power failure by removing one of the 15 ampere fuses feeding CA, CB or CC leads. POWER FAILURE lamp lights.

9.124 Observe that the set starts after the DT time. After the WUT time the alternator breaker closes. Check for alternator voltage on LB-6 and TR-16 terminals with the 300 volt scale of ITE-1000 or ITE-4442.

9.125 After the breaker closes reinstall the 15 ampere commercial power fuse. The POWER FAILURE lamp goes out.

9.126 Disconnect ITE-1000 or ITE-4442 from LB-6 and TR-16 terminals and connect to CB-9 and TR-15 terminals, using the 300 volt ac scale.

9.127 After the HOT timer (about 15 minutes) times out, observe that commercial voltage appears momentarily on CB-9 and TR-15 terminals. The alternator breaker opens and the set shuts down. The voltage is removed from both sets of leads: LB-6 and TR-16; CB-9 and TR-15.

9.128 Turn OPERATION SELECTOR Switch to OFF. Remove the 15 ampere fuses in the AC Service Cabinet that fuse the CA, CB and CC leads.

9.129 Connect the LB-6, TR-16, CB-9 and TR-15 leads to the Remote Breaker Circuit. Then Reinstall the 15 ampere fuses for the CA, CB and CC leads.

9.13 Connect to the alarm circuit (SD-81100-01 or SD-81223-01)

CAUTION: GRD lead from GRD terminal and BAT lead from BAC terminal are not run to the alarm circuit unless a separate control battery is furnished. HG lead is never run.

9.2 Alarms

9.21 Check minor alarm by removing an ac input fuse from J87249 Rectifier. Verify that OC and EF relays operate and EF lamp lights on SD-81100-01 Circuit. Verify that RA relay operates and RA lamp lights on SD-81223-01 Circuit. Restore the fuse to remove alarm indication.

9.22 Check major alarm by depressing the ALARM TEST button on the engine with OPERATION SELECTOR Switch in any position but OFF. (This will also bring in the minor alarm which will be removed when the ALARM TEST button is released.)

9.23 Verify that the relays shown in Paragraph 9.21 operate but in addition the OS relay operates on SD-81100-01 circuit and EF relay operates on SD-81223-01. Release TEST ALARM button and observe that minor alarm indications are removed. Press ALARM RESET button and observe that major alarm indications are removed.

NOTE: Alarms may also be cancelled by turning OPERATION SELECTOR Switch to OFF.

9.3 Automatic Operation

9.31 Turn OPERATION SELECTOR Switch to FULL AUTO. In turning from OFF stop about ten seconds on MANUAL position to charge up the timing circuits.

9.32 Fail commercial power This may be simulated by removing a voltage monitor fuse. For Off-Set Transfer remove one of the 15 ampere fuses feeding CA, CB, or CC leads, or, remove CA, CB, or CC fuse in the engine cabinet. For On-Set Transfer remove CA, CB or CC fuse in the engine cabinet.

9.321 SD-81100-01: PF alarm is given after 1-1/2 to 3 minutes delay. PF lamp lights and office alarm (minor) sounds. PF alarm is sent out on Bl, Cl, etc. systems.

9.322 SD-81223-01: PF lamp lights and office major alarm sounds immediately.

9.33 The engine starts after the DT time and the load transfers from commercial power to the set after the WUT time. Proper operation (PO) alarm is given by circuits SD-81100-01 and SD-81223-01 and PO lamp lights on SD-81223-01. Both circuits transmit PO alarms.

NOTE: For the Off-Set Transfer the breaker sequence is to close the alternator breaker, open the NORM Breaker and then close the EMERG Breaker.

9.34 After PF and PO alarms come in replace the voltage monitor fuse that was removed, or, restore commercial power. Observe that PF alarm is removed.

9.35 The set will carry the load through the Run-Time period (provided the OUT/IN Switch is IN) and the Hold-Over Time period, transfer the load back to commercial power and then shut down.

NOTE: The sequence of breakers with the Off-Set Transfer is to open the remote EMERG Breaker, close the remote NORM Breaker and then to open the alternator breaker.

9.4 Remote Start Test

9.41 With OPERATION SELECTOR Switch at FULL AUTO ground the RS lead to the cabinet or otherwise provide ground on RS lead from the alarm circuit.

9.42 The sequence of events will be the same as that shown in Paragraph 9.3 except that DT will be bypassed (set starts immediately) and no PF alarm will come in.

10. ACCESSORY TESTS AND ALARMS

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

10.1 **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.

10.2 **PHWTS:** This switch closes, lights PRELIMINARY 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.

10.3 **HWTS:** This switch shuts down the engine, lights HIGH WATER TEMPERATURE lamp and gives a major alarm when coolant temperature reaches 205-215°F. The switch will remain closed until temperature reduces about 6°F below the operate point. Simulate a failure by removing the cover and connecting a temporary jumper across the switch terminals.

10.4 **FOPS:** This switch is closed at starting and opens when fuel pressure builds up to what is normal pressure when engine speed is about 800-900 rpm. This opens the circuit to STR relay to stop cranking in case the cranking effort is not stopped by the 20CD. It is not necessary to check switch operation.

10.5 **HCS:** This is a non-adjustable switch (part of List 3) for the Immersion Heater. Switch contacts are closed in the range 75-110°F. Water temperature on the gauge may be 130-140°F. ←

10.6 **JHF:** This is an adjustable switch (part of List 3) to monitor the jacket water temperature. 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.

11. MAINTENANCE DURING INSTALLATION

11.1 Before Starting (Engine Cold)

11.11 Check lube oil level in 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

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

11.13 Check that the voltage of the starting and control battery (if furnished) 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 as the DC OUTPUT jacks are likely to be inaccessible.

11.14 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.

11.15 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.

11.2 During Operation

11.21 Check for unusual vibration and/or noise.

11.22 Check for signs of unusual operating conditions.

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

11.3 Other Items

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

11.32 Periodically check battery charging rate (4AMP/VOLT terminals on the J872-49 Rectifier). Also periodically check battery voltage with Ite-4474 Voltmeter by measuring across the battery terminals.

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

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

12 GENERAL TROUBLES AND CAUSES

12.01 Engine will not crank

Weak start battery.
Loose battery connections.
Failure of SC Circuit Pack.
OSS Switch at OFF.
Wrong battery polarity applied to J86634A control module.
Air shutdown device not reset.

12.02 Engine cranks but does not start.

Defective fuel pump.
Restricted fuel filter or strainer.
Insufficient fuel.
Air in fuel system.
Failure of FC Circuit Pack.
Failure of Throttle Solenoid.
Failure of Governor.
Failure of PS Circuit Pack.
Shorted or open speed pickup.
Fuel system not primed.

12.03 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.

12.04 Engine stops.

RUN/PRIME Valve left on PRIME.

Refer to alarm lamp indication below:

(1) CRANK FAILURE.
Shorted or open speed pickup.
Reversed leads on pickup.

(2) CONTROL FUSE FAIL
CF fuse blown.

(3) OVERSPEED.
Speed set too high.
Defective governor.
Defective or misadjusted OSD.

(4) LOW OIL PRESSURE.
See Paragraph 12.06.

(5) HIGH WATER TEMPERATURE.
See Paragraph 12.05.

(6) BREAKER TRIP.
Excessive KW load.

(7) REVERSE POWER.
Failure in parallel operation.
Defective RP Circuit Pack
REV PWR TST button up.

12.05 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.

12.06 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.

12.07 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.

12.08 Engine knocks.

Lube oil diluted by fuel.
 Air box drain is clogged.

Leaking injectors.

12.09 Engine runs unevenly.

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

12.10 Low lube oil level

Insufficient lube oil in crank-case.
 Ren Valve positioned incorrectly.
 Inlet valve to Ren Valve not full open.

12.11 High lube oil level.

Ren Valve positioned incorrectly.
 Defective Ren Valve.
 Ren Valve not vented

[Vertical line at side of paragraph indicates requirement.

→ Arrowed lines indicate new or changed information.

12.12 Vibration on the set.

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

12.13 No output voltage or low output

(Refer to Supplier's Manual)
 Faulty diodes in alternator.
 Loss of exciter residual magnetism (Flash field - see Par. 5.13)
 Speed below 1400 rpm.

12.14 Erratic voltage

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

12.15 High output voltage and voltage is uncontrollable.

(Refer to Supplier's Manual)

Defective voltage regulator circuit.

12.16 Engine starts with OSS Switch at OFF position.

Disconnect strap from ECB - to BAC.

12.17 Alarm lamps light when OSS Switch is turned from OFF position.

ALARM TEST button wiring not correct for the J86634A module wiring.

12.18 Breakers do not close satisfactorily.

Defective mechanical interlock.
 Defective LR relay.

Manager. Product Engineering

Reason for Reissue:

- (1) To show use of SG or PSG governors.
- (2) To change Reverse Power Test, Par. 7
- (3) To change test for voltage signals on LB-6, TR-16, CB-9 and TR-15 leads.