Installation Engineering Handbook 19
Western Electric
Kearny Works

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KS-22344 DIESEL ENGINE ALTERNATOR 24/28KW AND 40KW (J-86657) E/W J-85520 MICROPROCESSOR CONTROLLER

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1. GENERAL

1.1 This handbook section covers the installation and test of the 24kW or 40kW emergency engine alternator set. The set is used to provide standby power in telephone offices.

1.2 Different 60Hz alternators may be furnished depending on the voltage and phase requirements. The engine drive remains the same.

1.3 The automatic controller is a microprocessor and is wired, factory tested and shipped in place. When the set is installed at the job site, and the various office interfaces are complete, it is a requirement that the abbreviated microprocessor tests covered herein, be followed in their entirety. In addition, a full load test at the job site is required.

1.4 Record any troubles encountered in performing the tests on SD-4-1313 Form.

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

Printed in U.S.A.

2. PURPOSE

2.1 This set is intended for use in ESS offices, Radio Relay Stations, Operation Support Systems, as a replacement in TD-2 offices, and anywhere else an emergency engine alternator of this capacity is required for providing emergency power. See paragraph titled "Specifications" for the various alternators available.

3. DESCRIPTION

3.1 This diesel engine driven alternator differs from most emergency engine driven alternator packages in that it is vertically oriented. The alternator sits on end in the bottom of an enclosed sound attenuated bay with its driven shaft directed upward. The diesel engine is also turned on end and is placed over the alternator and directly connected to the alternator, i.e., with no speed increase or speed reduction unit.

3.2 The complete package, including a microprocessor controller, converter, power supplies, start battery, control battery and battery charging rectifier are all contained in a single cabinet type bay 34 inches wide, 36 inches deep (front to back) and 86 inches high. The unit is floor supported, weighs 1,400 pounds for the 24/28KW set or 1700 pounds for the 40kW set and must be located adjacent to an outside wall.

3.3 Two openings in the building structure are required and are usually arranged for by the Operating Company. One opening will coincide with the air intake near the bottom and at the rear of the bay and the other opening above the top of the bay to which is attached a 90° duct and will carry cooling air and engine exhaust gasses to the outdoors.

3.4 The engine is a basic 4 cylinder (24/28KW) or 6 cylinder (40kW) fuel injected diesel engine with a number of modifications which includes alterations in the lubricating oil system and water cooling system.

3.5 The alternator may be a 208V to 240V, 3 Phase, 4 Wire, 60 Hertz unit or a 230V to 240V, (115V to 120V) Single Phase, 3 Wire, 60 Hertz unit. The engine and alternator operate at 3,600 Revolutions Per Minute to generate 60Hz Power.

3.6 The entire package is assembled and tested by :

Alturdyne
8050 Armour Street,
P. O. Box 22226
San Diego, California 92122
714-565-2131

3.7 Service on the product, however, should be requested through W. E. Co., Purchased Products Engineering and Inspection located at 50 Lawrence Road, Springfield, N. J. 07081.

3.8 The Microprocessor is manufactured by the Western Electric Co., Kearny Works, 200 Central Ave., Kearny, N. J. 07032.

3.9 The eight bit microprocessor (J-85520) is the engine controller. The whole microprocessor is arranged on a board 14" wide, 10" high and approximately 1" thick. It weighs 2 pounds. All connections to the board are made through 4 plug and jack connectors. The plugs are secured to the board and the jacks are attached to the cable assemblies. The processor is located behind the front panel and is shipped in place after factory testing.

4. SPECIFICATIONS

J-86657B 24/28KW, 208-240 Volt, 3 Phase, 4 Wire, Isochronous Operation, Single Set System

J-86657E 24/28KW, 230-240 Volt (115-120V), Single Phase, 3 Wire, Isochronous Operation, Single Set System

J-86657G 40kW, 208-240 Volt, 3 Phase, 4 Wire, Isochronous Operation, Single Set System

J-86657H 40kW, 208-240 Volt, 3 Phase, 4 Wire, Isochronous Operation, Parallel Set System

J-86657K 40kW, 230-240 Volt (115-120V) Single Phase, 3 Wire, Isochronous Operation, Single Set System

5. DRAWINGS

SD-82525-01 Engine Alternator 3 Ø

SD-82526-01 Engine Alternator 1 Ø

SD-82527-01 Application Drawing (connection of the set into the power plant)

SD-82531-01 Micro-computer controller

SD-82324-01 202 Type Power Unit

SD-82326-01 203 Type Power Unit

SD-82501-01 281 Type Power Unit

SD-1A210-01 External Alarm Circuit

SD-81100-01 Power System Alarm Circuit

ED-82902-30 Building Installation Requirements

ED-82902-30 Typical Conduit, Fuel Ventilation and Exhaust Arrangements (will be reissued to cover fastening in earthquake areas)

ED-82826-30 Typical Inlet and Exhaust Layout

6. TOOLS

Tool kit No. 3 should be on hand, in which case few if any additional tools will be required.

R-3413 Wire and Lug Assembly (Each conductor is 50' long. Order one per phase and neutral as required)

R-4296 Ear Protector (minimum two)

R-3404 Phase Sequence Indicator

7. TEST SETS

ITE-4782 150 kW Test Load
ITE-4442A Volt-Ohmmeter (See Note 1)

ITE-5516 Emergency Engine Alternator Test Package. (See Note 1)
- which contains -

ITE-5517 Power Module

ITE-5518 RC Oscillator (Signal Generator)

ITE-5519 100 M Hz Counter (Frequency Counter)

ITE-5520 Digital Multimeter

ITE-5521 Temperature Simulator

NOTE 1: The two items required from the ITE-5516 are ITE-5519 Frequency Counter and the ITE-5520 Digital Multimeter, however, they cannot be used unless plugged into the ITE-5517 Power Module. In leu of the ITE-5516, the ITE-4442A and most any Frequency Counter such as ITE-5535, ITE-5674, ITE-5244, etc., can be used.

8. RECORDS

SD-4-1275 Lubrication Record
SD-97-1285 Storage Battery Report
SD-97-1313 Test Trouble Record
SD-97-1315 Summary of Tests
SD-97-946 (11-75) Engine Alternator Test Record or old number ID-946
SD-4-948 (3-64) Turbine Alternator Performance Test Data Sheet may be substituted by altering the KS number to KS-22344 and remarking columns as required.

9. RECEIVING AND PLACING

9.1 The set is not considered top heavy, however, care must be exercised when moving the unit since it is two and a half times higher than it is wide or deep. The cabinet must be shipped, stored and operated in a vertical plane at all times. However, when moving the cabinet through areas where the vertical clearances are restricted by low overhead cable racks, pipes, doorways, etc., the cabinet may by tilted horizontally using the following precautions:

9.11 Remove the external packing crate. Do not remove the shipping details, such as the engine bracing brackets, that are supplied with the cabinet. This additional rigidity is required when tilting the cabinet.

9.12 On occasions, Engine-Alternator Sets may be delivered with Oil and/or Coolant. If this is the case, drain the engine of all liquids before tilting the Set. At the final cabinet sight, install Coolant and Oil in accordance with paragraphs 18 and 19.

9.13 To prevent acid leakage from the Starter and Control batteries, remove these batteries before tilting the cabinet. These batteries are located on the inside bottom of the cabinet. At the final cabinet sight, install the Starter and Control batteries.

9.14 Using the rigger, the cabinet may now be tilted onto its right or backside only and moved past the restricted area. Stand the cabinet into its vertical position before further movement. At the final cabinet sight, remove all shipping details.

9.2 Arrange with the rigger, not only to bring the unit into the building, but to place it in its final location. There may be an advantage in removing most of the shipping material when moving the unit within the office. Attachment at the base or around the base is necessary should the unit be raised or lowered with a winch or crane since no provision is made for a hook or yoke attachment at the top of the bay. A spreader bar is required, however.

10. INSPECTION

10.1 As soon as practical after the unit is delivered and before the riggers leave the building, make an inspection for any shipping damage. Note any damages on both copies of the shipping papers before afixing signature acknowledging receipt.

10.2 A more detailed inspection should be made later as well as a check of all shipped loose items.

10.3 Arrange with the riggers to assist with the installation (next section) while they are still in the building.

11. INSTALLING

11.1 The floor layout rectangle should correspond with the base dimensions of the set. It is not necessary to remove the floor tile. Check the floor in the area that the set will rest to determine that it is level. The floor should not be out of level by more then 1/4" in 10 feet. If corrective measures are necessary they should be discussed with the operating company.

11.2 Determine the fuel supply and return lines are accessible. Remove any shipping cover from the air intake and exhaust openings on the set and attach both ducts. See ED drawing. Slip the wall flange over the ducts on both the intake and exhaust and direct the rigger to place the unit in its final location on the rubber mat. The smooth side of the mat faces up and the ribbed side against the floor.

11.3 With an R-1314 Plumb Bob, align the set front to back and left to right. If shimming is required, place single shims (multiple shims folded from a single piece, riveted or welded) between the set and the isolation mat and within the designated corner area. The minimum size of each shim shall be 4" by 4". The maximum amount of shimming shall not exceed 3/16 inch.

11.4 The set is free standing and does not require floor fasteners except in Disaster Control buildings, Hardened Buildings or in earthquake areas.

11.5 Attach the air intake flanged section to the wall and the exhaust flanged section to the wall.

11.6 Remove shorting straps placed across the terminals of the meters.

11.7 Remove the bracing from the engine to the cabinet.

11.8 The alternator isolation pads are made functional by removing the four (4) shipping bolts that attaches the base of the alternator to the base of the set. The bolt heads are painted red.

11.9 With no power connected, the FREQUENCY meter will return to the right side of the scale. "Zero" adjust to 65 Hz.

12. SUPPLIER'S REPRESENTATIVE

12.1 Normally, a supplier's representative will not be required. The set is designed to be installed in a simple straight forward manner since there are no critical factory checks or readjustments to be made at the job site. If engine or alternator service should be required a Route "G" JIM should be originated on Purchased Products Engineering and Inspection. See Paragraph 3.7.

13. WARNINGS

13.1 When necessary to work within the engine alternator unit and on the control circuits, hazardous voltages are present. It is necessary to render the control system inoperative because the set may be arranged to start automatically.

13.2 On front panel, operate CONTROL POWER BREAKER (CB4) to STOP.

13.3 Switch all remaining Circuit Breakers to OFF. Determine that the CB1 MAIN CIRCUIT BREAKER (ACB1) located on the set is opened by manually operating it to the OFF position.

13.4 Even when all circuit breakers are off, commercial ac power is still present in the set. Sensing leads are energized and hazardous voltages may also be present on the microprocessor board.

13.5 If any work is contemplated within the set, use the Schematic and the ITE-4442A or equivalent, to check for absence of potential on all connections in the area where servicing is anticipated. Avoid contact by removing potentials or when impractical, provide adequate personnel protection.

13.6 Short circuit hazards exists with the starter battery and its controls as well as the control battery. Disconnect the battery cables if working with the starter contactor. Avoid contact by removing potentials or when impractical, provide adequate personnel protection.

13.7 Ear Protectors must be worn when operating the set with the front or sides open.

14. CAUTIONS

14.01 When disconnecting and reconnecting the cord connected jacks from the plugs mounted on the processor board, always open CB3, Control Power Breaker (CB4), and CB2 in that order. Reverse the order when turning power back on. Disconnecting power to the board is necessary to prevent damage to the integrated circuits on the processor.

14.02 Static electricity picked up by the body can easily ruin the integrated circuit chips on the microprocessor. Never touch these devices.

14.03 Never open the secondary windings on the current transformers with the set running as high voltages are present. If it becomes necessary to disconnect the circuit, be sure it is deenergized and then short circuit the secondary transformer terminals after disconnecting the circuit leads.

14.04 Make sure all shorting straps are removed from the meters before starting the set. The straps electrically dampen the meter movements during shipment.

14.05 Make sure all shipping details, such as the engine bracing details are removed.

14.06 Disconnect the Rectifier by removing an ac input fuse or operating the Battery Charger Switch to OFF before disconnecting the charge battery leads, if this is found to be necessary.

14.07 Before starting the engine make certain that all tools and loose items are removed from the set.

14.08 Do not connect leads LB6, TR16, CB9, TR15, POA2, SD2, SD1 and POA1 on terminals 9, 10, 11, 12, 22 (two leads), 23 and 24 respectively on the engine alternator until each lead is first terminated at the transfer switch and then checked for an absence of AC potential to frame ground. Using an AC voltmeter check each lead for no potential with the transfer switch set to NORMAL position and again with the transfer switch set to EMERGENCY position. Measure continuity between leads POA1 and POA2. Measure an open circuit between leads SD1 and SD2. Operate the transfer switch back to NORMAL position and measure continuity between leads SD1 and SD2. Measure an open circuit between leads POA1 and POA2. Correct any trouble condition before these leads are connected to the terminal strip on the engine alternator set.

14.09 THE ENGINE IS SHIPPED VOID OF LUBRICATING OIL. APPROXIMATELY 13 QUARTS OF OIL MUST BE ADDED BEFORE CRANKING OR BEFORE ATTEMPTING TO START THE ENGINE FOR THE FIRST TIME. See Paragraph 18.

14.10 THE ENGINE IS SHIPPED VOID OF COOLANT. IT MUST BE FILLED BEFORE ATTEMPTING TO START THE ENGINE FOR THE FIRST TIME. See Paragraph 19.

15. PARALLELING

15.1 Parallel operation of Diesel Engine-Alternator Sets is only available with the 40kW, 208-240 Volt, 3 Phase, Parallel Set System. These sets are equipped with additional controls and indicators for manually paralleling two or more sets.

15.2 Under normal conditions, one parallel set is adjusted for automatic standby service (OSS switch in AUTO position) and all other sets are adjusted to OFF (OSS switch in OFF position). Should commercial power fail, one set will automatically start and provide power to essential loads. The operating personnel must then manually start each set (OSS switch in MANUAL position) and adjust each set to match the voltage, frequency and phase of the first set. The on going set may now be operated in parallel (ALTERNATOR CIRCUIT BREAKER CLOSE pushbutton depressed). The sets are then checked for load sharing before providing power to additional loads.

15.3 During installation each parallel set is tested and adjusted as an individual set. In addition, phasing-out tests are performed in accordance with Installation Handbook 19 Section 135. Finally, all sets are tested for parallel operation.

16. FUEL

16.1 The operating company (customer) will provide the diesel fuel.

16.2 The acceptable fuel type is D2 per ASTM 975, i.e., American Society for Testing Materials Specification 975.

16.3 Consumption of fuel is approximately as follows:

	24kW	40kW
1/4 load	1.32 GPH	1.98 GPH
1/2 load	1.85 GPH	2.77 GPH
3/4 load	2.20 GPH	3.3 GPH
full load	2.75 GPH	4.13 GPH

17. CONNECTING FUEL LINES

No galvanized pipe or fittings are permitted in the fuel system.

18. LUBRICATING OIL - FILLING

18.1 The engine is shipped void of lubricating oil. It must be filled before attempting the first start.

18.2 The customer will provide the oil. The recommended oil is;

API (American Petroleum Institute), CD Service, 15W-40

18.3 The crankcase holds 13 quarts.

18.4 Attach the hose furnished to the quick-connect coupling at the bottom of the oil sump casting and catch any residue oil remaining in the engine. Disconnecting the hose recloses the valve. Discard the residue.

18.5 At the top of the sump, remove the filler cap from the casting and add 12 quarts of oil. Allow time for the oil to drain down and check the dip stick. Two quarts are required to bring the level up from the LOW mark to the FULL mark. Add the remaining quart as required to bring the oil level to FULL or slightly above. Replace the cap.

18.6 The engine consumes approximately one pint each 24 hours of operation.

19. COOLANT - FILLING

19.1 The engine is shipped void of coolant. It must be filled before attempting the first start.

19.2 Permanent type ethylene glycol base antifreeze must be added to the coolant system. The customer will either furnish two gallons of antifreeze or direct the installer to purchase it.

19.3 The cooling system holds approximately 4 U.S. gallons.

19.4 Make sure the drain plug is in place (valve closed if equipped with a valve) and add two gallons of antifreeze. Continue filling with approved water until the coolant level is 1 1/2 inches below the filler cap. Replace the cap.

19.5 If there is any question as to whether or not the local water is acceptable, purchase two or three gallons of distilled water to complete the filling.

20. BATTERIES

20.1 Contained in the cabinet are two 12 Volt lead-acid storage batteries. Both batteries have their negative terminals grounded. One battery is used for engine start (+12V) and the other battery for control voltage (+12V). They are both charged in parallel from the same self contained battery charger, with a blocking diode between batteries to prevent the control battery from assisting the engine start battery when the starter is engaged. The batteries are maintenance free and therefore do not normally require any water additions.

20.2 When received on the job both batteries should have their ground side disconnected. Reconnect the ground side (-side) of each battery in a permanent manner, i.e., clean as necessary and use NO-OX-ID "A" Special on the connection and over the post.

21. POWER SUPPLIES AND CONVERTER

21.1 The set uses a 281B Converter powered through CB2 from the +12 volt control battery. The output feeds 24 volts to a 202E1 power supply and a 203B power supply. The 202E1 furnishes +12V and -12V to the microprocessor while the 203B furnishes +5V to the microprocessor.

22. PRIMING THE FUEL SYSTEM

22.1 Remove the left panel. High on the left side of the engine there is a small swingout panel that holds a fuel cup. Unlock the retaining screws and swing the cover out enough to expose the fuel cup. Open the fuel cup and fill with fuel to approximately two-thirds (2/3) of its capacity. Close the fuel cup. Close and lock the swingout cover.

22.2 Slightly below and in front of the first fuel cup is a second fuel cup. Open this cup and fill with fuel to approximately two-thirds (2/3) of its capacity. Close the fuel cup.

22.3 In 24/28kW set the fuel injection pump is self priming. However, after filling the fuel cups, allow at least ten minutes for self priming before attempting to start the set.

22.4 In the 40kW set the fuel injection pump is not self priming. Priming the fuel injection pump is done once on initial engine crank as you proceed through to paragraph 33. MANUAL ENGINE START.

23. PREPARATION FOR TEST

23.1 Operate controls as follows:

23.11 On Control Panel

CONTROL	POWER FUNCTION	ADJUST TO POSITION
CONTROL POWER BREAKER (CB4)	Relays	STOP
OSS*	Operation Selector Switch	OFF
SYNCH*	Synchronizing Lights	OFF
ALTERNATOR* BREAKER OPEN	Alternator Circuit Breaker Pushbutton	DEPRESS MOMENTARILY

* For Parallel Sets only.

23.12 On edge of front door

CONTROL	POWER FUNCTION	ADJUST TO POSITION
CB2	Converter, Power Supplies, Microprocessor	OFF
CB3	Fuel Solenoid, Starter Solenoid, Governor	OFF
CB5	Watt Transducer, Run Time Meter, Voltmeter	OFF
CB6	Battery Charger Input Circuit (Overload switch)	DEPRESSED
CB7	Battery Charger Output Circuit (Overload switch)	DEPRESSED
COMMERCIAL POWER (S109)	Commercial Power Sense	OFF
BATTERY CHARGER (S110)	Battery Charger	OFF
IMMERSION HEATER (S111)	Coolant Immersion Heater	AS REQ'D

23.13 On inside bottom of Set.

CONTROL	POWER FUNCTION	ADJUST TO POSITION
CB1 MAIN CIRCUIT BREAKER (ACB1)	Alternator Circuit Breaker	OFF

23.14 On microprocessor board (see FIG. 1)

CONTROL	ADJUST TO POSITION
SW3	OPEN
SW4	CLOSED

23.2 Inside the Set, near the front door hinge, disconnect leads 9, 10, 11 and 12 on the installer's side of the terminal strip. These leads are respectively LB6 and TR16 which controls the Emergency Circuit Breaker, and leads CB9 and TR15 which controls the Normal or Commercial Circuit Breaker.

23.3 Permanently connect engine start battery and control battery if not already connected. See Paragraph 20.2.

23.4 Using a voltmeter, measure the polarity and potential between the top wire of circuit breaker CB2 and frame ground. The voltmeter should read approximately +12 volts with the negative lead on frame ground. Repeat this measurement with circuit breaker CB3.

23.5 Operate the BATTERY CHARGER switch to ON. Adjust the voltmeter for ac voltage measurements. Measure the potential between the top wire of circuit breaker CB6 and frame ground. The voltmeter should read approximately 120 volts ac.

23.6 Verify output of the Battery Charger by observing the BATTERY CHARGER METER which is mounted on the edge of the front door. The output of the Battery Charger is factory set. However, just before turnover to the customer, at least two days of charging, check the float voltage by making measurements at the battery posts. The Engine Battery should measure 13.8±.25 volts and the control Battery should measure 13.1±.25 volts. If these voltages are not correct, adjust the rectifier potentiometer as necessary. The potentiometer is a trimpot adjustment on printed wiring board PC1 of the battery charger labled as BC1 12V. The battery charger is mounted on the backside of the front door at approximately mid position.

23.7 Record results on SD-97-1285 Storage Battery Report. Once the charge is started it should not be removed or shut off provided the alarms are connected as the testing procedures are demanding enough to necessitate a continuous recharge.

23.8 Adjust the voltmeter to measure approximately 120 volts ac. Inside the Set, near the front door hinge, verify that commercial power sense leads are connected to terminals 1, 2, 3 and 6. Measure approximately 120 volts ac between terminals 1 and 6 and between terminals 2 and 6. For 208 volt 3Ø systems, also measure 120 volts ac between terminals 3 and 6.

24. STEP 1 - MICROPROCESSOR SELF CHECK

24.01 The first test, step 1, is made to determine the microprocessor is operational.

24.02 WARNING: **This set is inherently automatic and starts when commercial power is not present. Do not close any circuit breaker unless instructed to do so.**

24.03 To power the microprocessor, operate CB2 to ON. On parallel sets operate the OSS switch to MANUAL.

24.04 On the Microprocessor Board, near the left edge, locate S1 pushbutton switch (see Fig. 1) and depress momentarily. All ENGINE FAILURE lamps on the Control Panel should extinguish. The microprocessor then initiates a series of internal sanity checks of itself which takes approximately 20 seconds after which all ENGINE FAILURE lamps should again turn back on. If all ENGINE FAILURE lamps did not initially extinguish, then the microprocessor is at fault, proceed to Paragraphs 24.07 through 24.14.

CAUTION: Do not touch other parts of microprocessor as static electricity picked up by the body can easily ruin integrated circuit chips.

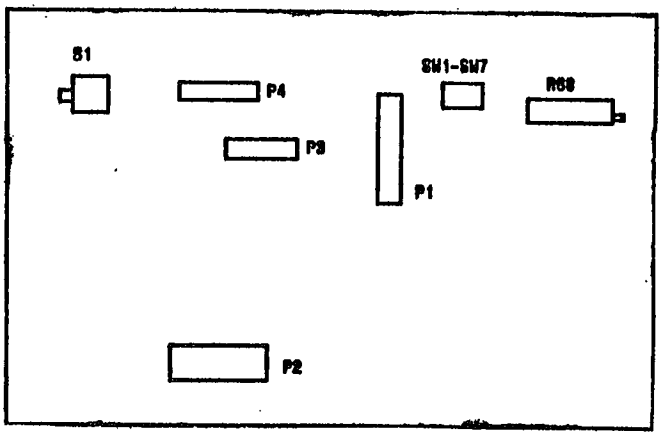

FIG. 1 MICROPROCESSOR BOARD

24.05 If some of the lamps do not come back on they may be defective. Tests that follow under Step 2 will determine whether or not they are functioning correctly.

24.06 End of Step 1 test. Continue testing at Paragraph 25, STEP 2.

24.07 Operate CB2 to OFF.

24.08 Measure continuity between frame ground and terminal 138. Measure continuity between frame ground and test point TP10 on the Microprocessor Board (see Fig. 1).

24.09 Operate CB2 and CB3 to ON.

24.10 Check for approximate voltages (used to power the board) between test point TP10 and test points as listed below on the Microprocessor Board.

VOLTAGES	TP TEST POINTS
-12 to -13.2	TP51
+4.9 to +5.3	TP52
+12 to +13.2	TP50
+12 to +14	TP49

24.11 If all voltages are present and correct the board is defective.

24.12 If any voltage is missing or incorrect or if polarity is incorrect this must be corrected before any additional testing can be done.

24.13 Operate CB2 and CB3 to OFF.

24.14 Make any necessary corrections.

24.15 Start test over at Paragraph 24.03.

25. STEP 2 - MICROPROCESSOR CHECK OF LIGHT EMITTING DIODES ON FRONT PANEL

25.01 Step 2 tests the microprocessor's ability to operate the LED's on the front panel and the FREQUENCY meter.

25.02 The FREQUENCY meter should be reading 60 Hz. If not on 60, adjust as follows: In the upper right hand corner of the Microprocessor Board (see FIG. 1) adjust the trim pot R68 until the FREQUENCY meter reads 60 Hz. Do not adjust the pots under the high voltage shield.

WARNING: Avoid potential shock from battery charger near trim pot R68.

25.03 In the next series of tests, each time the ALARM CUT OFF pushbutton is depressed the testing circuit advances to the next test.

25.04 To repeat a test it is necessary to operate CB2 to OFF and return to the beginning of step 1.

25.05 Momentarily depress the ALARM CUT OFF pushbutton once. The FREQUENCY meter will drop to below 56.

25.06 Momentarily depress the ALARM CUT OFF pushbutton once again. The MAJOR BREAKER OPEN (RED) lamp will continue to flash on and off. If it does not flash on and off see Paragraph 25.10 and correct before proceeding.

25.07 Again depress the ALARM CUT OFF pushbutton once. The CRANK FAILURE (RED) lamp will continue to flash on and off. If it does not flash on and off see Paragraph 25.10 and correct before proceeding.

25.08 Continue depressing the ALARM CUT OFF pushbutton once for each of the following lamps as detailed above:

GLOW PLUG FAILURE (RED)
OIL, TEMP-LEVEL, PRESSURE (RED)
WATER, LOW LEVEL, HIGH TEMP (RED)
OVERSPEED, REVERSE POWER (RED)
UNDERSPEED, OPEN PROBE (RED)
OVERVOLTAGE, UNDERVOLTAGE (RED)
MINOR ALARM (RED)
READY TO LOAD (GREEN)
PROPER OPERATION (GREEN)
OVERLOAD (RED)

25.09 If all lamps operate correctly, continue testing at Paragraph 26, STEP 3.

25.10 If any of the lamps do not blink on and off check with a dc voltmeter across the Light Emitting Diode. If the voltage alternates from 0 to a value of from 5 to 12 volts, replace the LED observing polarity. If the voltage does not alternate from 0 to 5-12 check the wiring from the LED back to the microprocessor. If defective, correct. If not defective, the microprocessor is defective. Clear trouble each time before proceeding with test.

26. STEP 3 - MICROPROCESSOR CHECK OF ENGINE RELAYS, SOLENOIDS AND OTHER COMPONENTS

26.01 Operate CB3 to ON. Leave CB2 ON. Depress ALARM CUT OFF pushbutton once. The PMJV (Major visual alarm relay K8) will alternately operate and release (see Fig. 2).

26.02 If it does not alternately operate and release see Paragraph 26.04 and correct before proceeding.

26.03 Continue depressing the ALARM CUT OFF pushbutton observing each time, that the following relays alternately operate and release as they are pulsed by the microprocessor (see FIG. 2):

PMJ (Major audible alarm relay K11)
PMNV (Minor visual alarm relay K12)
PMN (Minor audible alarm relay K13)
PO (Proper Operation relay K15)
RO (Rectifier off relay K14)
PF (Power Failure relay K16)
GLOW PLUG (relay K5 is mounted inside the set below the main terminal strip)

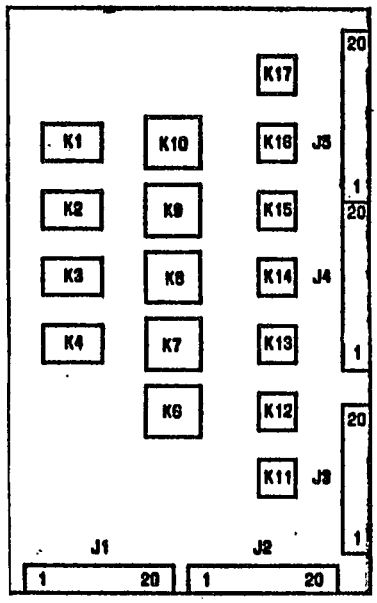

FIG. 2

RELAY BOARD

26.04 If any of the relays do not alternately operate and release check across the relay winding with a dc voltmeter. If the voltage alternates from 0 to approximately 12 volts, the relay is defective. If the voltage does not alternate from 0 to less than 12 volts, check the wiring back from the relay to the microprocessor. If defective, correct. If not defective, the microprocessor is defective. Clear trouble each time before proceeding with test.

26.05 Operate the CONTROL POWER BREAKER to NORMAL.

26.06 Depress the ALARM CUT OFF pushbutton again. The FUEL RELAY (K6) will alternately operate and release. The FUEL SOLENOID will operate and release. Detect by sound and feel. If either fail to operate and release, check with a voltmeter.

26.07 Operate CB3 to OFF.

CAUTION: Failure to operate CB3 to OFF could result in damage to the starter.

26.08 Depress ALARM CUT OFF pushbutton once. The START relay (K7) should alternately operate and release.

26.09 Connect a voltmeter across the START relay coil (K7) or across J2-17 and J1-8 (see FIG. 2). At the instant of time when the START relay is energized, voltage will also indicate on the voltmeter. Depressing the MANUAL STOP/RESET pushbutton will freeze the sequential operation of this relay. At this time, if the relay is in the released position, the voltmeter will indicate 0 volts and if the relay is in the operate position, the voltmeter will indicate voltage. To continue the sequential operation of this relay, depress the MANUAL STOP/RESET pushbutton again.

26.10 Depress the MANUAL STOP/RESET pushbutton at the instant when the relay is in the operate position. The voltmeter will indicate approximately 12 volts. If not, depress the MANUAL STOP/RESET pushbutton and repeat this paragraph (refer to Paragraph 26.09).

26.11 With constant 12V on the starter relay, momentarily operate CB3 to ON. When engine attempts to crank, operate CB3 to OFF. Don't allow starter to crank the engine for more than three seconds. This checks the start solenoid and start motor. Disconnect voltmeter.

26.12 Depress the ALARM CUT OFF pushbutton once for each of the relays as listed below. Using a dc voltmeter, check that each relay alternately operates and releases by measuring the voltage drop across each relay coil. To measure these voltages connect the positive lead of the dc voltmeter to pin 7 of jack J1 (see FIG. 2) and connect the negative lead to the designated jack as shown in the following table. The voltage shall alternate between 0 and 5 volts approximately.

26.12 CONT'D

NOTE: These are solid state relays which don't vibrate are not audible and do not provide a visual indication when they are activated or deactivated.

RELAY	FUNCTION	J3 PIN #	FLASHING LAMP
K1	ECB CLOSE	1	EMERGENCY BREAKER CLOSE (RED)
K2	ECB CLOSE/OPEN	2	NONE
K3	NCB CLOSE	3	NORMAL BREAKER CLOSE (GREEN)
K4	NCB CLOSE/OPEN	4	NONE

26.13 Depress the ALARM CUT OFF pushbutton once again. WATER, LOW LEVEL, HIGH TEMP and OVERSPEED, REVERSE POWER will light.

26.14 If testing a parallel set check that relay K9 also operates and releases.

26.15 End of STEP 3 test. Continue testing at Paragraph 27, STEP 4.

27. STEP 4 - PHASE 1 - MICROPROCESSOR CHECK OF INPUT SWITCHES AND SENSORS

27.01 Ignore unmentioned lamps below.

27.02 Operate CB3 and CB5 to ON.

27.03 Depress MANUAL STOP/RESET pushbutton once and hold. CRANK FAILURE lamp will light while pushbutton is depressed. Otherwise, MANUAL STOP/RESET pushbutton is defective. Release pushbutton.

27.04 Depress MANUAL START pushbutton once and hold. GLOW PLUG FAILURE lamp will light while MANUAL START pushbutton is depressed. Otherwise, the MANUAL START pushbutton is defective. Release the pushbutton.

27.05 If office option includes a REMOTE START feature, locate the REMOTE START pushbutton depress and hold. The OIL, TEMP-LEVEL, PRESSURE lamp will light while the pushbutton is depressed. If it does not light, the REMOTE START feature is defective. Release the pushbutton.

27.06 Operate CB3 to OFF. WATER, LOW LEVEL, HIGH TEMP lamp will light. If it does not light, the AUX contacts on CB3 are defective.

27.07 Operate CB3 to ON and lamp will go out. If the lamp does not go out the AUX contacts on the major circuit breakers CB3, CONTROL POWER BREAKER (CB4) or CB5 are defective.

27.08 Operate CONTROL POWER BREAKER (CB4) to STOP. WATER, LOW LEVEL, HIGH TEMP lamp will light again. If it does not light, the AUX contacts on the CONTROL POWER BREAKER are defective.

27.09 Operate CONTROL POWER BREAKER to NORMAL and the lamp will go out.

27.10 Operate CB5 to OFF. WATER, LOW LEVEL, HIGH TEMP lamp will light again. If it does not light, the AUX contacts on CB5 are defective.

27.11 Operate CB5 to ON and the lamp will go out.

28. STEP 4 - PHASE 2 - MICROPROCESSOR CHECK OF INPUT SWITCHES AND SENSORS

28.1 Depress ALARM CUT OFF once. CRANK FAILURE lamp will not light. If lamp is lit High Water Temperature Switch is defective. Make sure water and oil levels are correct.

28.2 OIL, TEMP - LEVEL, PRESSURE lamp should be lit. Otherwise, low water level sensor is faulty.

28.3 WATER, LOW LEVEL, HIGH TEMP lamp should be extinguished. Otherwise, Oil - High Temperature transducer is faulty.

28.4 OVER SPEED, REVERSE POWER lamp should be lit. Otherwise, Oil - Low Pressure sensor is defective.

28.5 UNDER SPEED, OPEN PROBE lamp should be lit. Otherwise, Oil - Low Level sensor is defective.

29. STEP 4 - PHASE 3 - MICROPROCESSOR CHECK OF INPUT SWITCHES AND SENSORS

29.1 Depress ALARM CUT OFF once. WATER, LOW LEVEL, HIGH TEMP lamp should remain off. Otherwise, the Battery Charger is faulty or the 281B Converter may be delivering low voltage.

29.2 Operate COMMERCIAL POWER switch to ON. The OVER SPEED, REVERSE POWER lamp should be lit. Otherwise the commercial power sensing monitors are not functioning.

29.3 Operate COMMERCIAL POWER switch to OFF. The OVER SPEED, REVERSE POWER lamp should be extinguished. Otherwise, the commercial power sensing leads or the microprocessor is defective.

29.4 For non-parallel sets proceed to paragraph 31.

30. STEP 4 - PHASE 4 - AUTOMATIC BREAKER TEST

30.1 For parallel sets only proceed as follows:

30.2 Operate the OSS switch to MANUAL. If more than one parallel set is provided, check that all other OSS switches are OFF. The OVERSPEED, REVERSE POWER lamp should light. If not, the OSS switch or circuit is faulty.

30.3 Operate the OSS switch to AUTO position. The OVERSPEED, REVERSE POWER lamp shall extinguish.

30.4 If more than one parallel set is provided, operate the OSS switch on one of the additional set to MANUAL. The WATER, LOW LEVEL, HIGH TEMP lamp on the main set will extinguish. Operate the OSS switch on the additional set to AUTO. The WATER, LOW LEVEL, HIGH TEMP lamp on the main set with light. The CRANK FAILURE lamp should be extinguished.

30.5 Momentarily depress the ALTERNATOR BREAKER CLOSED pushbutton. The CRANK FAILURE lamp should light. The GLOW PLUG FAILURE lamp should be extinguished.

30.6 Momentarily depress the ALTERNATOR BREAKER OPEN pushbutton. The GLOW PLUG FAILURE lamp will light. If not, check the pushbutton and lamp circuits.

30.7 If the OIL, TEMP-LEVEL, PRESSURE lamp is not extinguished, the circuit to relay K18 may be defective.

30.8 Operate the OSS switch on the additional set to OFF.

31. CIRCUIT BREAKER TEST - FRONT PANEL

31.1 Operate CB2 and CB3 to OFF. Wait approximately five seconds.

31.2 Operate CB2 to ON and CONTROL POWER BREAKER to NORMAL.

31.3 Depress MANUAL STOP/RESET and hold pushbutton for about 5 seconds. This clears all alarms except MAJOR BREAKER OPEN and OVERLOAD.

31.4 Depress EMERGENCY STOP pushbutton. CONTROL POWER BREAKER will trip to STOP. The MINOR ALARM lamp will light.

31.5 Operate CONTROL POWER BREAKER to NORMAL and check all externally mounted EMERGENCY STOP pushbuttons located near the engine and in accordance with the operating company's preference. Each time an EMERGENCY STOP pushbutton is operated the CONTROL POWER BREAKER will trip to STOP. Operate CONTROL POWER BREAKER to NORMAL each time.

31.6 With CONTROL POWER BREAKER in NORMAL, locate SW1 on the microprocessor board. This is a DIP (Dual Inline Package) containing seven switches (see FIG 1). SW5, SW6 and SW7 switches are not in use. Using a small pointed object, press SW4 to the OPEN position. CONTROL POWER BREAKER will trip to STOP. Reclose SW4.

32. PREPARATION FOR START UP

32.1 Check all factory and job connections.

32.2 The main output leads into and out of the alternator circuit breaker should be checked for tightness, dress, and protection where required. Check all connections in the battery-to-starter circuit as low resistance connections are essential. Check for cleanliness and for tightness.

32.3 Check coolant level in radiator expansion tank at top of cabinet and fill with water as required.

32.4 Check that diesel fuel supply and return lines are tight and all external fuel valves open.

32.5 Check crank case or lubricating oil sump for proper level of lubricating oil. Correct level to "FULL" by adding proper quantity and type.

32.6 Verify that CONTROL POWER BREAKER is in STOP position.

32.7 Close all other circuit breakers, including the alternator CB1 MAIN CIRCUIT BREAKER (ACB1) and verify that the OSS switch is in AUTO position on parallel sets.

32.8 Verify that the Emergency Bus is clear. Check with a voltmeter for absence of potential and then verify for absence of grounds by checking with an ohmmeter from each phase to neutral.

33. MANUAL ENGINE START

33.01 Open the front and left side of the set to expose the engine.

33.02 Operate CONTROL POWER BREAKER to NORMAL.

33.03 Depress MANUAL STOP/RESET pushbutton and hold for 5 seconds to clear all alarms. The set will be in Automatic Standby mode.

33.04 Each person in the immediate area should protect themselves with a R-4296 Ear Protector in preparation for running the engine with the sound attenuation panels removed.

33.05 On parallel sets operate the OSS switch to MANUAL position.

33.06 For 24/28KW sets proceed to paragraph 33.12.

33.07 For 40KW sets the fuel injection pump must be primed once on initial engine crank. The fuel injection pump is located at about the middle front of the set. The pump has six injection hoses surrounding a hex nut. Loosen the hex nut with a 12 mm socket wrench in preparation for priming the pump.

CAUTION: The following procedure will result in some fuel spillage. Therefore, be prepared to operate the EMERGENCY STOP pushbutton or operate the CONTROL POWER BREAKER to OFF in order to minimize this spillage.

33.08 Depress and hold for approximately one second, the MANUAL START pushbutton. The engine will start or try to start after appropriate delays.

33.09 Examine the fuel injection pump hex nut and observe that fuel will sputter out from underneath the nut. As soon as the sputtering stops and fuel flows out in a steady stream, tighten the hex nut. Operate the EMERGENCY STOP pushbutton or operate the CONTROL POWER BREAKER to OFF. The set will stop. The fuel injection pump is primed.

33.10 Wipe clean any areas where fuel may have spilled.

33.11 Repeat paragraphs 33.02 through 33.05 and continue testing below.

33.12 Depress and hold for approximately one second, the MANUAL START pushbutton. The engine will start after appropriate delays.

33.13 Inspect immediately for any water, oil or fuel leaks. Reexamine again after 5 or 10 minutes of operation. If leaks are detected or if there is unusual noise or vibration, shut the set down by depressing the red EMERGENCY STOP pushbutton in the lower right hand corner of the front panel. Correct leaks and investigate any noise, clearance problems, cause of vibration and restart by following the starting procedure.

33.14 Observe VOLTS meter and compare with commercial power by operating VOLTMETER switch back and forth between COMMERCIAL and ALTERNATOR.

33.15 Adjust VOLTAGE RAISE potentiometer with a screwdriver accordingly.

33.16 After the set has warmed up for about five minutes, adjust ENGINE SPEED INCREASE potentiometer with a screwdriver as necessary to obtain 60 Hertz on the FREQUENCY meter.

33.17 After five to ten minutes of operation, readjust VOLTAGE RAISE potentiometer as necessary and mark setting with a light pencil mark.

33.18 Depress MANUAL STOP/RESET pushbutton. The engine will stop.

33.19 Operate the CONTROL POWER BREAKER to STOP. Operate the OSS switch to OFF.

34. EMERGENCY STOP

34.1 Restart the set (repeat paragraph 33.02 through 33.06 and 33.12). Operate the EMERGENCY STOP pushbutton. The engine will stop. On parallel sets operate the OSS switch to OFF.

34.3 If there is a remote EMERGENCY STOP pushbutton restart the set. Operate the remote EMERGENCY STOP pushbutton. The engine will stop. On parallel sets operate the OSS switch to OFF.

35. AUTOMATIC ENGINE START

35.1 Discuss with the operating company representative as to how long a delay they prefer after a commercial power failure and when the signal is released to start the engine.

35.2 The Start Delay Timer may be set for 5, 12, 30 or 60 seconds by operating the DIP Switches on the microprocessor as indicated below: See Paragraph 31.6 for method of operating the switches.

DELAY TIME IN SECONDS	SWITCHES SW1	SW2
5	OPEN	OPEN
12	OPEN	CLOSE
30	CLOSE	OPEN
60	CLOSE	CLOSE

Unless job information indicates otherwise, SW3 shall be open. SW4 must be closed.

35.3 On parallel sets operate the OSS switch to AUTO.

35.4 Operate the CONTROL POWER BREAKER to NORMAL.

35.5 Depress MANUAL STOP/RESET pushbutton and hold for 5 seconds to clear all alarms.

35.6 Operate COMMERCIAL POWER switch to OFF to simulate a commercial power failure.

35.7 After a delay while the glow plugs are heating, the set will start.

35.8 Operate the CONTROL POWER BREAKER TO OFF. The set will stop.

35.9 Parallel operations of two or more parallel sets will be included in the next reissue of Section 266.

36. PREPARATION FOR FINAL LOAD TEST

36.1 Check the terminal voltage of the engine start battery and control battery. See Paragraph 23.6

36.2 Reconnect leads LB6 and TR16 to terminals 9 and 10 respectively. These leads control the Emergency Circuit Breaker. Reconnect leads CB9 and TR15 to terminals 11 and 12 respectively. These leads control the Normal or Commercial Circuit Breaker.

36.3 If the office load is insufficient to load the set to 24 kW, supplement the office load with the ITE-4782 load box.

36.4 Connect ITE load boxes to the Emergency Bus and turn all load switches off.

36.5 Place office transfer switches to AUTO (House Service Cabinet).

36.6 Operate CONTROL POWER BREAKER to NORMAL. Operate the OSS switch to AUTO on parallel sets. The set will be in the Automatic Standby mode.

37. AUTOMATIC START WITH AUTOMATIC TRANSFER - FULL LOAD TEST

37.1 Arrange for the operating company acceptance person to be present.

37.2 Remove one sensing fuse with a fuse puller, open the circuit breaker located in the building switch gear or otherwise disconnect one of the "sensing leads".

37.3 After appropriate delays (Start Delay Timer, Engine Glow Plugs, etc.) the set will start and come up to speed.

37.4 After the READY TO LOAD lamp comes on the Normal Circuit Breaker will open and the Emergency Circuit Breaker will close. Observe lamps on the front of the panel.

37.5 Add supplementary load from the ITE load box as necessary to bring engine set load to full load.

37.6 Adjust voltage and frequency as necessary. Record voltage, frequency, current on each phase and kilowatts at start of full load test and every 1/2 hour until the set has run 2 hours under full load (five readings). Monitor the set and the load box full time paying particular attention to the display and alarm lamps. Again check for the absence of leaks anywhere in the system.

37.7 Restore power to the sensing leads and after approximately 30 minutes the Emergency Circuit Breaker will open and the Normal Circuit Breaker will close connecting commercial power to the office.

37.8 The set will run for a cool down period of approximately three minutes and then will shut down. The set will return to the Automatic Standby mode.

37.9 Make sure sides are replaced and front cover and doors are closed.

Manager,
Product Engineering