Installation Engineering Handbook 19
Western Electric
Kearny Works

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KS-21264 GAS TURBINE ENGINE ALTERNATOR 435 KW (J-86654) E/W J-86743 UNIVERSAL CONTROLLER

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

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1. GENERAL

1.01 Purpose

1.011 This KS unit is designed to furnish 60 hertz a.c. power service on an emergency basic to supply essential power circuits in a telephone office when the regular commercial power fails. Various options are available and may be furnished at the operating companie's request. Depending on the commercial supply voltage to the office and the distance the set is away from the main switchboard, a choice of 208/240 or 416/480 volts may be furnished. The unit is rated at 435 kW base. This takes into account some elevation of air intake temperature above + 20°F and some restrictions in air intake and exhaust ducting as well as altitude. Its maximum rating of 500 kW is based on ideal conditions such as operation at sea level and at + 75°F or lower intake air temperature.

1.02 Scope

1.021 This section covers installation and test of the automatic or manual KS-21264 (J-86654) Gas Turbine Engine Alternator. Each unit is tested at the factory under Western Electric Company Source Inspection supervision to verify that all Bell System requirements are met, including a full load test. All functioning components, including the W.E.Co. J-86743 Universal Engine Controller are tested to determine they function properly and are correctly adjusted. The field test covered herein are considered, for the most part, operational tests and are intended (1) to make sure that the unit still functions properly after shipment and (2) to verify job made connections and to verify compatibility with job conditions and requirements (3) to determine the specific control cabinet and engine are compatable.

1.022 A full load test at the job site is redundent but usually requested by the operating company and so it is included in this test procedure. The verified full load test results are on file at the factory through the Western Electric - Source Inspection Organization.

1.023 Record trouble encountered in performing the tests on SD-4-1313 Form.

1.024 Be sure to read Warnings and Cautions before attempting any tests herein.

1.03 480V Set

1.031 The customer must furnish the proper potential transformer for the commercial power sense voltage when required.

1.032 The control circuitry monitors alternator and commercial voltage of 208 or 240. Commercial potentials of 480V require a step-down transformer.

1.04 Specifications

J-86654A	208/240V, 3Ø, 4W, 60 Hz Gas Turbine Engine Alternator with local control. Auto/Manual.
J-86654B	416/480V, 3Ø, 4W, 60 Hz Gas Turbine Engine Alternator with local control. Auto/Manual.
J-86654C	208/240V, 3Ø, 4W, 60Hz Gas Turbine Engine Alternator with remote control. Auto/Manual.
J-86654D	416/480V, 3Ø, 4W, 60Hz Gas Turbine Engine Alternaotr with remote control. Auto/Manual.

1.041 The above sets are designed to be used with a J-86743 Universal Controller.

1.042 The controller is ordered separately, installed on the set and connected with four plug-in cable assemblies. Testing the controller is included herein as part of the overall engine set test. Do not install until reading Cautions and installation Procedure.

1.05 Drawings

1.051 Keysheets

SD-80700-01

1.052 Engine Circuit Schematics

SD-82407-01	208 to 240V and 416 to 480V Engine Alternator Sets with Remote Control and with Electric or Hydro-Mechanical Governor
SD-82408-01	208 to 240V and 416 to 480V Engine Alternator Sets with Local Control and with Electric or Hydro-Mechanical Governor.
SD-82413-01	Remote Control Cabinet

1.053 Universal Control Module(J-86743)

SD-82369-01	Interconnect of Universal Control Module
SD-82362-01	Circuit Packs for Universal Control Module

1.054 Application Schematics

SD-82367-01	KS-21264 435kW Plant Application Schematic
SD-81905-01	Plant Application for J-86637 200 kW Turbine. Figures 9 and 10 for Fuel and Ventilation.
SD-81489-01	Typical AC Transfer Circuit Breaker Arrangement

1.055 Alarms

SD-81100-01	Power System Alarm Circuit
SD-81223-01	Power System Alarm Circuit

1.056 Typical Fuel Tank, Lines and Accessories

ED-82800-30

1.057 Exhaust and Inlet Duct Work

ED-82801-30

1.058 Conduit Arrangement
ED-82802-30

1.06 Supplier's Representative

1.061 As part of the contract with Onan, a supplier's representative will be made available for the three days before the initial start and portions of the dynamic testing of the set. See Paragraph 49.

1.062 Field Service shall be notified a minimum of 30 days before the Onan representative is required on the job site for the start-up and running tests.

1.0621 The installation of the set, the duct work, piping, wiring, continuity testing and static testing can all be completed before the representative is required. The set is started for the first time (Dynamic Testing) in Paragraph 49.

1.063 The coupling is shipped in place and blocked. The Onan representative will work with the installer in removing, aligning, lubricating and replacing the coupling. See Paragraph 41. Critical realignment and torquing is required, Spare gaskets for the coupling and lubricants for the coupling will be shipped loose.

1.07 Glossary of Abbreviations

ACB	Alternator Circuit Breaker
ALT	Alternator
AT	Alarm Test
AUTO	Automatic
BALOC	Bell Alarm Lock Out Circuit
C	Contactor
CB	Circuit Breaker
CCC	Cross Current Compensation
CCO	Cranking Cut Out relay
CDT	Cool Down Timer
CF	Crank Failure
CML	Commercial
COMML	Commercial
CSCB	Control System Circuit Breaker
DWN	Down
E	Emergency
ECB	Engine Control Battery
ECB	Emergency Circuit Breaker
EG	Equipment Ground
ES	Emergency Stop switch
FC	Fan Control
FPS	Fuel oil Pressure Switch
FPSS	Fuel Pump Selector Switch
FSF	Fuel System Failure
FSFA	Fuel System Filter Alarm
FT	Feed Through terminal
HET	High Exhaust Temperature
HF-	High Fuel relay (high fuel in day tank)
HOT	Hold Over Timer
ICS	Integrated Control System
LF-	Low Fuel (in day tank)
LG	Low Fuel (in main tank)
LHF	Low High Fuel
LOC	Local
LOP	Low Oil Pressure
LOPS	Low Oil Pressure Switch
MA	Major Alarm
Man	Manual
MALF	Malfunction

MF	Malfunction
MI	Minor Alarm
MJ	Major alarm
NCB	Normal CIrcuit Breaker (commercial power)
MLT	No-Light Timer or No lightoff Timer
Nos	Engine Overspeed
NSDO	Normal Starter Dropout
OLT	Over Load Timer
OP	Operation
OS	Operation Selector switch
OSS	Operation Selector Switch
OV	Over Voltage
PC	Purge Crank switch
PF	Power Failure
PFA	Power Failure Alarm
PHET	Pending High Exhaust Temperature
PLF	Preliminary Low Fuel
PO	Proper Operation
POA	Proper Operation ALARM
PSIG	Pounds per Square Inch Gravity
PWR	Power
RMT	Remote
RP	Reverse Power
RPM	Revolutions Per Minute
RRP	Remote Routine Operation
RSI-7	Reed Switch (day tank fuel level)
RT	Run Timer
RTL	Ready To Load
SI	low fuel reset
SDO	Starter Drop Out
SDT	Start Delay Timer (when commercial power fails this starts timing)
SEL	Selector switch, selector
SEQ	Sequence
ST	Starting switch or Start
SW	Switch
SYS	System
TA	Test Alarm
TB	Terminal Board
TD	Timed Out, Time Delay
TERM	Terminal
TS	Transfer Select switch
TSS	Transfer Select Switch
T	Temperature
V1N, V2N, V3N	AC voltages of Lines 1, 2 and 3 in respect to the neutral line.
WUT	Warm Up Timer

1.08 Tools and Test Sets

1.081 Tools:

R-3184 3 Wire "U" pin adapter

R-4783 Precision Mechanic's Level

R-5460 Three-Position Stool

Tool Kit No.3 should be on hand. Few if any additional tools will be required.

R-3413 Wire and Lug Assembly (see Note 1)

R-4296 Ear Protector (minimum two)

815A Extender Card (see Note 2)

1.082 Test Sets:

ITE-5913 Portable Phase Angle Meter (see Note 3)

ITE-4442A Multimeter

ITE-4785 250 KW Test Load (as required)

ITE-4782 150 KW Test Load (as required)

ITE-5516 EMERGENCY ENGINE ALTERNATOR TEST PACKAGE (Total package of the following including combination shipping and carrying case);

ITE-5517 Power Module

ITE-5518 RC Oscillator (Signal Generator)

ITE-5519 100MH Counter (Frequency Counter)

ITE-5520 Digital Multimeter

ITE-5521 Temperature Simulator (Recorder Calibrator or Calibration Tester)

R-3076 Manometer (water type) (two)

R-3404 Phase Sequence Indicator

1.09 Records

ID-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 Tests 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-21264 and using columns a to k, p, and, r and s as required. Write in "Power Factor" in column v and "Hertz" in column w.

NOTE 1: Due to the heat produced by the loads they should be placed outside whenever possible or in a well-ventilated area. This distance will determine the number of R-3413 leads required for connecting them.

NOTE 2: Normally the Extender Card will be furnished as part of the controller. After use by the installer it should be turned over to the customer. If not furnished, an attempt should be made to borrow one, otherwise, its need is not mandatory. A number were furnished without indexing slots. These will have to be job modified.

NOTE 3: The ITE-5913 Portable Phase Angle Meter may be used to an advantage over the three synchronizing lights furnished with the sets when this unit is to be paralleled with another. See Paragraph 7.2.

1.10 Job Connections

1.101 Standing at the rear of the set and facing the control panel, the majority of the installer run control wiring is on the right side directly behind the control panel. The Feed Through Terminal Strips FTA through FTG run from top to bottom. The TB terminals are in the same location except for TB3 terminals 25 through 38 located behind the left side of the control cabinet and to the right of the ACB.

1.102 Make sure the J-86743 Universal Controller is disconnected (P1, P2, P3 and P4 disconnected) before connecting the control battery. The P1 to P4 plugs are located on the control panel end of the set behind the lower right door.

2. WARNINGS

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

Move OPERATION SELECTOR switches to OFF on local and remote control panels.

Switche off all control circuit breakers located in the alternator set control panels, CB2 to CB9 if furnished.

Determine that the ACB (alternator circuit breaker) located on the set is opened by manually triggering it to open.

2.2 If any work is contemplated on the ACB Alternator Circuit Breaker, make sure the breaker springs are discharged (unloaded). The springs are automatically charged by a motor which is connected directly to alternator power, and upon command, the spring closes the switch, The charged springs, if accidentally tripped, has sufficient stored energy to cause serious bodily injury. Also verify for absence of LINE AND LOAD potential on the main breaker terminals before attempting any work operation hereon.

2.3 Commercial power may still be connected to the set such as FTG 8, FTG 10, FTG 11, FTG 12, etc. With the ITE-5520 or equivalent, check all ac points, line to line, line to neutral and line to ground. Some high voltage components store and maintain a residual voltage for hours after power has been disconnected. Check and discharge with a lamp or resistor.

2.4 Avoid contact by removing potentials or when impractical, provide adequate personnel protection.

2.5 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.

2.6 Ear Protectors must be worn during operation of the turbine set.

2.7 The ignition system is a high voltage system so avoid any contact until the ignition exciter has been rendered inoperative. Do not operate exciter without the igniter plug connected and grounded.

3. CAUTIONS

3.01 Do not connect the J-86743 Universal Solid State Controller until the Control Battery polarity has been checked. Follow the procedure in Paragraph 14.1.

3.02 Make sure CB4, CB5 and CB6 control circuit breakers are off before removing or inserting solid state circuit packs, otherwise, damage to circuit packs can result.

3.03 Static electricity picked up by the body can easily ruin the integrated circuit chips. Never touch these terminals unless all static has been discharged from the body, especially on a low humidity day or in a low humidity area.

3.04 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.

3.05 Check for and remove shorting straps on the turbine control cabinet meters and remote control cabinet meters before starting the set. The straps electrically dampen the meter movements during shipment.

3.06 Disconnect the Rectifier by removing an ac input fuse from the rectifier before disconnecting the charge battery leads if this is found to be necessary.

3.07 After five successive starts wait about one hour before making another start. The starting motor will cool during this period and some charge will be given to the batteries.

3.08 DURING THE ASSEMBLY OF AIR INTAKE AND EXHAUST DUCTS, MAKE CERTAIN THAT NO LOOSE ITEMS, DIRT OR DEBRIS ARE LEFT IN THE SYSTEM. NO SELF TAPPING SCREWS SHALL BE INSTALLED FROM THE INSIDE OUT ON THE INTAKE DUCT. STANDARD NUTS SHALL NOT BE PLACED ON THE INSIDE OF THE INTAKE DUCT.

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

3.10 The engine shall not be rotated in any manner for any purpose in a reverse direction.

4. INSPECTION

4.1 As soon as possible after receiving the set on the job, remove the shipping materials and make a complete physical inspection. Inspect for damage, defects of finish, missing parts, etc. Note any damage on the driver's copy and job copy of the shipping papers, when possible to detect such damage, before signing for receipt of the set. Report defects, damage and missing parts in accordance with established routines.

4.2 If shipped separately, make sure accessories are received such as coupling gaskets, coupling lubricants, isolation pads, etc.

5. DESCRIPTION AND RECOMMENDED FUELS

5.1 Independent of ducting and attachments, the unit is rectangular in shape, rests on the floor on isolating pads and measures 54 inches wide, 72 inches high and 130 inches long. The unit weighs 9,000 pounds.

5.2 The unit is completely enclosed with removable sound deadening doors. It is not adequately weather proofed for use outdoors. Where placed on roof tops, etc., a water proof enclosure (module) may be furnished.

5.3 The gas turbine is furnished by Air Research, a division of Garrett Corporation in Phoenix, Arizona and the total assembled package, less the J-86743 Universal Controller, is furnished by Onan, Division of Onan Corporation, 1400 73rd Avenue NE, Minneapolis, Minn. 55432. The J-86743 Universal Controller is manufactured by Western Electric Co. at the Kearny Works.

5.4 The Garrett engine (IE-831-800) is a 800 horsepower gas turbine driving a 544 KVA 3 phase alternator through a gear reduction arrangement. The engine operating speed is 41,730 RPM and the alternator speed is 1800 RPM.

5.5 It operates on any one of the following fuels;

KEROSENE
DF 1
DF 2
JET A
JET A1
JET B
JP 5

See Paragraph 46.806.

5.6 The engine picks up air through the duct connected to the Compressor Air Intake, compresses it (11 to 1) through a two stage centrifugal air compressor and forces it into the combustion chambers where it is mixed with fuel from the fuel nozzles and then ignited. The hot expanding gases are forced through three stages of turbine blades fixed to the rotor. The reaction of the expanding hot gases with the turbine blades produces the axial power. The exhaust gases are then expelled into the exhaust duct straight out from the front of the set.

5.7 The automatic version can be operated from a remote control cabinet.

6. BATTERY CHARGING RECTIFIER

6.1 The charger recommended is manufactured by La Marche. It is connected to both the 24V engine start battery and the 24V control battery with blocking diodes in the circuit to prevent interaction between the two batteries when their state of charge is not the same.

6.2 Install the batteries and bring the electrolyte up to the minimum level with approved water. Verify the polarity.

6.3 Verify the output taps on the rectifier and determine the voltage and polarity matches that of the batteries. Also verify the input requirements and the applied ac power before fusing and before the initial TURN ON.

No. CELLS	TYPE	SET CHARGER AT	ACCEPTABLE RANGE OF FLOAT VOLTAGE AFTER FULL CHARGE
12	Lead-ACID LOW GRAVITY	26.1	26.0 TO 26.4
12	LEAD-ACID HIGH GRAVITY	27.0	26.7 TO 27.3
19	NICKEL-CADMIUM	27.1V	26.8 TO 27.4
20	NICKEL-CADMIUM	28.5V	28.2 TO 28.8

6.4 Verify all connections for tightness.

6.5 Completely connect and fuse the output before applying the ac power.

6.6 Start the charge in accordance with Installation Engineering Handbook 18, Section 19 as soon as possible and record results on ID-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, static and dynamic, are demanding enough to necessitate a continuous recharge. Usually, at the conclusion of the tests, the batteries still require additional charge, however, a small overcharge will cause no harm.

7. PARALLELING

7.1 When two sets are manually paralleled, one set must be in the MANUAL operation mode, OSS in MAN.

7.2 See Section 130 of this Handbook for paralleling procedures. Proper phase sequence is required along with correct voltage and simultaneous peaking of the two sources of power before paralleling can be accomplished. A phase sequence indicator, voltmeter and three synchronizing lights will be required. The ITE-5913 Portable Phase Angle Meter may also be used to an advantage in conjunction with the synchronizing lights.

8. MAJOR ALARMS - TROUBLE SHUTDOWNS

8.1 With the OPERATION SELECTOR switch (OSS) in MAN or AUTO the major troubles listed below will stop the set, transfer the load back to commercial power if available, and bring in appropriate lamps on the Fail Indicator module, Temp Monitor module and/or Power Supply module. A customer furnished horn will sound and a signal sent out to any connected alarm circuit.

MAJOR ALARM	INDICATING CONTROL MODULE
High Exhaust Gas Temperature (HET)	Fail Indicator
Engine Overspeed (OS)	Fail Indicator
High Lube Oil Temperature (LOT)	Fail Indicator
Low Lube Oil Pressure (LOP)	Fail Indicator
Reverse Power (REV PWR)	Fail Indicator
Overcurrent/Short Circuit (OV C)	Fail Indicator
Overvoltage (OV V)	Fail Indicator
Major Circuit Breaker Open (MJ CB)	Fail Indicator
Control Breaker Off (Control BRKR Off)	Fail Indicator
Underspeed/Probe Open (US PROBE)	Fail Indicator
Cranking Failure 1 (CRANK 1)	Fail Indicator
Cranking Failure 2 (CRANK 2)	Fail Indicator
Cranking Failure 3 (CRANK 3)	Fail Indicator
Open or Short Circuit Temperature Probe (TEMP PROBE)	Temperature Monitor
Control Power Supply Failure (CONT PWR SUPPLY FAIL)	Power Supply

8.2 After shutdown from any malfunction or emergency stop, it is necessary to operate the OSS switch to the OFF position and then back to the desired operating position to reset the alarms. If shutdown was a result of operating the EMERGENCY STOP pushbutton or a Control Power Supply Failure it will also be necessary to reset the control circuit breaker CB6.

9. TIMERS

9.1 All of the timers (lights) flash when they are timing and burn steady after they time out with the one exception of the FUEL HEAT lamp on the Start Logic module. This timer locks out the start circuit while the lamp is illuminated and releases when it goes out.

10. OSS SWITCH OPERATION INCLUDING TS SWITCH - REMOTE AND LOCAL

10.1 When the engine is arranged for local control only (no remote cabinet furnished) the OSS switch is the principal status switch for the engine and determines the CIRCUIT OPERATING MODE. The three positions are OFF, MAN, and AUTO.

10.2 When the OSS is in OFF the set is not available for operation. (All functions are blocked except purge cranking). The red SW OFF NOR lamp will be illuminated informing the operator that the set cannot be started manually or will not start automatically.

10.3 When the OSS is in MAN position the set must be operated manually. That is to say, the set must be started manually (MANUAL START button), the alternator circuit breaker must be closed manually (CIRCUIT BREAKERS - OPEN green light and switch, and CIRCUIT BREAKERS - CLOSE red light and switch), and the office load must be transferred manually at the ac switchboard, i.e., NCB opened and ECB closed.

10.4 When restoring to commercial power, and with the TRANSFEER SELECTOR switch in MAN, operate the TRANSFEER RESTORE pushbutton on the engine control panel and the office load will be transferred back to commercial power. If the TRANSFEER RESTORE push button is held operated after the transfeer back to commercial power is made, the ACB will open automatically. Otherwise the ACB can be opened by operating the CIRCUIT BREAKERS - OPEN switch. A built in green light will illuminate indicating the ACB has opened. If the OSS is left in the MAN position and a power failure occurs the set will <u>not</u> start automatically.

10.5 When the OSS is in AUTO and there is a commercial power failure, the set will automatically start and the ACB will close, provided no other set is on the Emergency Bus at that time. It will also provide signals to operate the customer furnished transfer device to transfer the office load to the turbine set via the EM bus. See Figure 1. When commercial power returns and remains on continuously for a preset time, the control circuit will transfeer the load back to commercial power, assuming the TRANSFEER SELECTOR switch is left in the AUTO position, and the set will automatically open its ACB and shut down after several timing circuits function and time out. The set will power down the control circuits. No "resets" are required before the next power failure and automatic engine start and run operation.

10.6 When a remote panel is furnished, many of the engine control switches are duplicated including the OSS. In this case, the control switches on the local panel are provided primarily for maintenance purposes while the remote control panel is the intended and normal location for operating the set.

10.7 When a remote control bay is furnished, the two OSS switches are wired in such a manner that the Circuit Operating Mode agrees with the lowest priority position of the two switches. The lowest priority is OFF, the second priority is MAN and the highest priority is AUTO. For example; if the OSS on the remote panel is OFF the Operating Mode is OFF regardless of the position of the local OSS switch. For automatic operation, both the remote and local (set) OSS switches must be in the AUTO position.

11. MINOR ALARMS - CAUTION

11.1 The following minor alarms do not affect an engine shutdown but serve as a caution. A minor alarm will be provided to the connected alarm circuits.

MINOR ALARM	INDICATING CONTROL MODULE
Pending High Exhaust Temperature (PHET)	Fail Indicator
Low Fuel (L FUEL)	Fail Indicator
Rectifier Failure (RECT FAIL)	Fail Indicator
Minor Circuit Breaker (MNCB)	Fail Indicator

12. SET POINTS

12.1 The following Systems Set Points are approximate and are listed for general information. When different values are referred to in the text, those values shall be used.

Crank 1 (NO-CRANK Timer) (Locked Rotor)	< 10% Speed in 10 Seconds
Crank 2 (NO-LIGHT Timer)	< 30% Speed in 16 Seconds
Crank 3 (Fail to Accelerate) (START TIMER)	< 95% Speed in 64 Seconds
Cool Down Timer	5 Minutes
Warm-Up Timer	8 Seconds
Run Timer	35 Minutes (adjustable 35-102 MIN.)
Start Delay Timer	8 Seconds (adjustable 2-30 Sec.)
Hold Over Timer	17 Minutes (adjustable 8-25 Min.)
Main Fuel Solenoid Open	10% Speed
Engine Light-Off	10-20% Speed
Starter Drop-Out	70% Speed
Alternator Excitation	95% Speed
Overspeed Shutdown	109.5% Speed
Alternator Reverse Power Protection	150KW ± 25KW
Pending High Exhaust Temperature	> 90% of HET
High Lube Oil Tempeature	165°F ± 3°F
Fuel Heating Signal	22 Seconds
Coast Down Timer	3.5 Minutes

High Exhaust Temperature Shutdown
(1) when temperature is > 1,575°F during start-up two to six seconds after 95% Speed
(2) with air in - 20°F = 885°F
(3) with air in + 70°F = 1,055°F
(4) with air in + 120°F = 1,082°F

Low Lube Oil Pressure	<5 PSI when engine speed is > 30% rated speed - OR - <55 PSI when engine speed is > 95% rated speed
Low Fuel Storage Tank Level Alarm	Fuel level < gauge setting fuel tank
Alternator Over Current or Short Circuit	Overload tripping of set breaker
Overvoltage	>120% ± 2% of rated alternator output after Warm-Up timer times out.
Rectifier Failure	Battery charger failure
Minor CB lamp	CB4 open or tripped
Major CB lamp	CB2, CB3 or CB6 open or tripped
Control Breaker Off	CB5 open or tripped (major)
Under Speed Probe	<95% speed after attaining >95% speed
Temperature Probe	Inlet compression air probe open - OR - <400°F on exhaust probe and > 30% rated speed (exhaust temperature probe open or shorted)

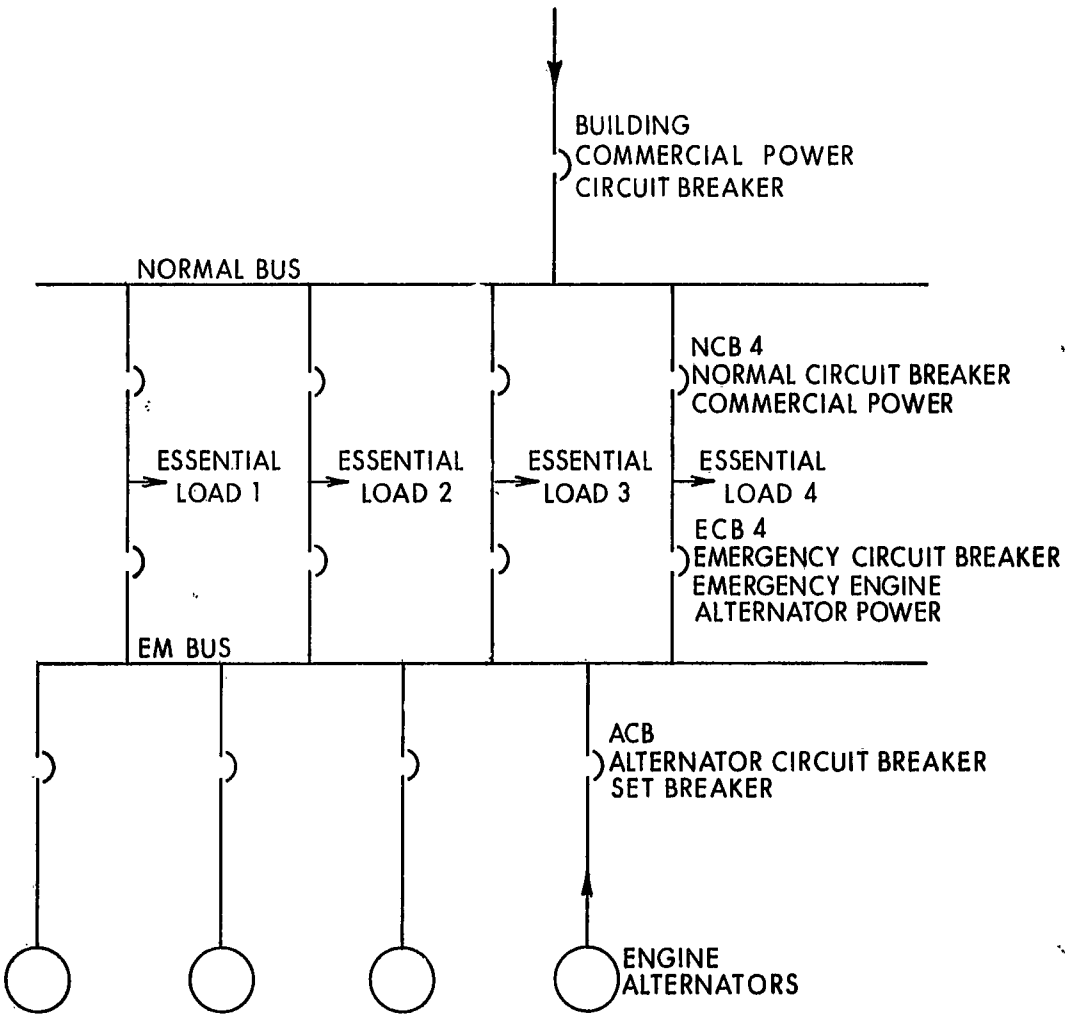

FIGURE 1.

TYPICAL CENTRAL OFFICE CIRCUIT BREAKER
AND BUS ARRANGEMENT.
PAR: 10.5, 46.6, 53.2

13. PLACING THE UNIT

13.01 The floor area designated for the set shall be checked to make sure it is level within 1/4" in 10', If not acceptable, discuss this with the Operating Company Representative for corrective action.

13.02 The floor shall be laid out in agreement with job drawings which correspond to the outside dimensions of the set.

13.03 Arrange with the rigger to place the set in its final location, The unit is furnished with two fork lifting slots, one under the center of gravity of the alternator and the other under the center of gravity of the gear box. Place a steel bearing plate, obtained locally, under each of the four leveling screws or leveling screw locations so the set may be raised and leveled.

13.04 Do not place the weight of the set on the isolation pads until all leveling and shimming is complete since the pads take a permanent set. The 4" x 4" Type "S" AIR-LOC isolation pads (Onan part number 4250126) are placed under the eight holes in the base adjacent to the lifting screws with the thick pad next to the base and the thin pad directly on the concrete floor. The four corner holes in the base are not used.

13.05 Lift out asphalt or vinal tiles so they may be cut and refitted after leveling has been completed. Four inch by four inch metal shims are obtained locally when required and when multiple shims are needed, they shall be folded, reveted or welded. Shims are placed between the thick and thin pads.

13.06 The set shall be leveled by using a precision level on the machined pads supporting the gear box and the alternator. Until a precision level can be standardized under the "R" code number of 4783 it will be necessary to buy or rent a level. Otherwise check with the Onan representative who may be able to supply a level since he will be checking for correct leveling of the set as part of the initial start-up procedure.

13.07 With the jacking screws raise the set approximately 1/2". Adjust screws until set is approximately level in both directions. Check to determine the highest point on the floor by measuring at the eight locations for the pads. At the highest point, place one thick pad next to base and on thin pad directly on the concrete floor. Lower the jacking screws in small increments all the way around until the base is just touching the one pad lightly. The set shall be leveled from end to end within + .05 inches. Each graduation on the R-4783 vile is 1/10" apart and the set shall not be out more than 1 graduation. (Each graduation represents .005" per foot).

13.07 cont'd

Check level across the set and lower or raise the two jacking screws on the opposite side from the installed pad. Repeat leveling longitudinally raising or lowering the two screws the same amount on the end away from the installed pad. Install the other seven pads and place only 4" x 4" metal shims between the two pads until each is touching the set lightly. See Paragraph 13.05. Lower the set by turning the jacking screws until they are clear of the bearing plate.

13.08 See additional information in the Onan Manual furnished with the set.

13.09 Since vibration is very low, no floor fastening is required in soft sites. Anchor bolts are required for fastening the unit to the floor in Earthquake areas.

13.10 Hardened areas such as the 50 PSI sites and Disaster Control buildings, will require special retaining and/or hold down arrangements. The material and methods will be furnished by the Equipment Engineer.

13.11 To insure proper air flow and sound attenuation, the area between the base and the floor will have to be sealed. At present, 4" "Armaflex" tubes are furnished and will have to be split longitudinally and forced on edge between the base and the floor around the periphery of the set as well as across the structure directly below the bulkhead that separates the electrical controls from the engine compartment. Smaller diameter tubes may be furnished in the future in which case they will not have to be split.

14. INSTALLING THE J-86743 UNIVERSAL CONTROLLER

14.01 Before installing the Controller, check the polarity of the Control Battery. Using a voltmeter, check polarity by reading approximately 24V between Terms FTG 6 (+) and FTG 4 (-). Also check polarity by reading approximately 24V between Terms FTG 7 (+) and FTG 4 (-).

14.02 With all control circuit breakers open (CB2, CB3, CB4, CB5, and CB6), install the chassis of the Controller, with all circuit packs removed.

14.03 Mount the chassis and align with shims furnished.

14.04 Install P1, P2, P3 and P4 into the bulkhead connectors. These connector sockets are found behind the lower right door.

14.05 Install LL38 Power Supply into the correct slot and socket.

14.06 While observing the CONTROL POWER SUPPLY FAIL lamp on LL38, close CB5. The lamp should blink red for approximately 1/2 second and then go out.

14.07 Close oil cooler fan circuit breaker CB10.

14.08 Close CB6. This verifies battery polarity and connections to the circuit packs. If CB6 cannot be closed check battery polarity, connections and Remote Emergency Stop Buttons for correct operation. Emergency Stop Buttons are normally closed.

14.09 Open CB5 and CB6.

14.10 Install remaining circuit packs into the correct slots. Make sure they are fully seated.

15. CONNECTING THE FUEL LINES

15.1 The drawing usually furnished as a typical arrangement for the fuel tank, lines etc., is ED-82800-30.

15.2 Attach the fuel lines, feed and return, to the base at the end adjacent to the turbine engine. Three openings are on the right side of the base at the turbine end. The left opening is the Return line, the middle opening is the Feed line or suction line and the right opening is a Drain for excess fuel from the accumulating tank. DO NOT CAP OR BLOCK THIS OPENING. If fuel should appear at the opening it indicates the tank is full. Open the FUEL DRAIN VALVE in the base and drain the tank into an appropriate container.

16. GENERAL - STATIC TESTING

16.1 Switches and Breakers

16.11 The beginning of these tests assumes both the local and remote OSS (Operation Selector Switch), which determines the circuit operating mode, is in the OFF position.

16.12 AC Circuit Breakers CB2, CB3 and CB4, located behind the lower right door, and CB10 should be closed. All other circuit breakers including CB5 and CB6 (dc control CB's) should be open. The breakers are sometimes referred to as CSCB (Control System Circuit Breaker).

16.13 After each test, turning off the OSS and dc CB's before the next test; and, before the next test, turning on the OSS and the dc CB's has been eliminated in some instances to save time and unnecessary exercising the apparatus. However, when it is necessary to stop testing for a period of time, it should be remembered to turn the OSS to OFF on both the local and remote cabinets and CB5 and CB6 to OFF, restoring them before the next test.

16.2 Alarms

16.21 Throughout the tests, when the audible alarm is activated, depress the ALARM CUT OFF button to silence the alarm. In addition, turn the OSS to OFF and back to one of the "on" positions to reset the alarm circuit after the real or simulated trouble has been cleared. Throughout the static portion of the tests the OSS is turned to OFF and then back to MAN.

16.3 Wiring

16.31 The beginning of these tests also assumes all wiring is complete and verified including the remote cabinet, when provided.

16.4 Circuit Packs

16.41 Make sure all circuit modules (LL31 to LL47) are installed and fully seated.

16.42 On the 416/480V sets potential transformers are used to reduce the voltage to 208/240 before applying to the AC Voltage Monitor module LL31. Verify this arrangement.

16.43 When two or more sets are arranged for parallel operation, an additional circuit module, Multi Set Module LL39, will be provided. The factory will set the internal screw switch to account for 208/240 or 416/480V input.

16.5 Inhibiting Starting

16.51 For static testing, inhibit starting by disconnecting lead CP24, small control wire, from the starter relay (not starter solenoid) located on the left side of the engine between the air intake plenum and the gear box.

17. LAMP TEST

17.1 With CB5 and CB6 closed, depress the BULB TST pushbutton on the Fail Indicator module and observe that the following lamps light on the engine control panel:

MAJOR ALARM	RED
MINOR ALARM	AMBER
ALARM CUT OFF	AMBER

18. CRANK 1 TEST

18.1 The Crank 1, 2 and 3 lamps on the Fail Indicator module indicates three cranking failures under various modes and times. Crank 1 condition exists if the engine fails to attain 10% speed within 5 seconds (locked rotor test).

18.11 In actual practice, immediately after a shutdown an attempt to start (actual or simulated) is delayed 3 1/2 minutes while a Coast Down Timer times out and approximately 22 seconds while a fuel heater signal times out. These delays will be evidenced by a blinking COAST DOWN lamp on the Time Control Logic module when it is timing and a steady FUEL HEAT lamp on the Start Logic module while the fuel is heating.

18.12 Open CB5 and CB6.

18.2 Unscrew the plug from the connector that leads to magnetic pickup No. 2. This connector is located near the middle at the rear of the turbine engine. The connector pins faces the side of the cabinet.

18.3 Connect the sine wave output of the ITE-5518 Oscillator between TBA Term 2 and shield side to Term 3 using instrument clip leads. Make sure ITE-5518 Oscillator is not grounded (ungrouded "U" pin adapter R-3184 or third wire not connected on the ITE-5517). After plugging the instrument into ac, check with a voltmeter from the instrument framework to a known ground to determine no unsafe potential exists, which could cause a shock to operating personnel. Tag the ITE-5517 "WARNING. NOT GROUNDED" and place the instrument on an R-5460 Three-Position Stool.

NOTE: The oscillator requires no patch cords to the ITE-5520 Digital Multimeter or to the ITE-5519 Frequency Counter as they are internally connected. Be sure to operate the switches on the test sets to "Internal". The digital multimeter reads the voltage output of the oscillator and the frequency counter reads, much more accurately, the frequency output of the oscillator than can be read on the oscillator dial. Make sure ITE-5517 Power Module is ungrounded.

18.4 Vary the oscillator to 200 Hz. Set the output to full clockwise position. Close all breakers. Turn OSS to MAN and allow the Coast Down Timer to time out (lamp fully illuminated on LL32) before proceeding. Depress the MANUAL START pushbutton. If engine begins to crank, immediately turn OSS to OFF and check earlier Paragraph 16.5 where start leads were disconnected. Observe the CRANK lamp on the Start Logic module comes on. Within 5 ± 1 seconds the CRANK 1 lamp on the Fail Indicator module should light, the COAST DOWN lamp on the Time Control Logic module should light and the local and remote major alarm should function indicating a shutdown condition. Operate the ALARM CUTOFF and turn OSS to OFF and back to MAN to clear the alarm.

18.41 If the engine had been running instead of this simulated test, this crank failure would have aborted the start.

19. CRANK 2 TEST

19.1 Before CRANK 2 Test can be performed, a "low oil pressure shutdown" must be inhibited.

19.11 Open CB5 and CB6.

19.12 Add jumpers between FTG5, FTF6 and FTF8.

19.13 Close CB5 and CB6.

NOTE "FTG5" is Feed Through terminals located on the side of the engine to the right of the control panel. G means G terminal strip, terminal 5.

19.2 The Crank 2 failure condition (no light) exists if the engine does not reach 30% speed before the Overcrank Timer times out in approximately 16 seconds.

19.3 Set the oscillator to 1,000 Hz (equivalent to approximately 25% speed), the 10% SPEED lamp should light on the SPEED monitor. Allow the Coast Down Timer (LL32) to time out (lamp fully illuminated) before proceeding. Depress the MANUAL START pushbutton. Observe that the CRANK lamp on the Start Logic module comes on in 16 ± 1 seconds after the FUEL HEATER lamp goes out (LL33). The CRANK 2 lamp should light and shutdown should occur. The FUEL lamp may come on at this time. The local and remote major alarm should function idicating a shutdown condition.

19.4 Operate the ALM CUT-OFF and turn the OSS to OFF and back to MAN to clear the alarms.

20. CRANK 3 TEST

20.1 The CRANK 3 failure condition exists if the engine fails to reach 95% speed within 64 ± 6 seconds. To mask an open probe shut-down it will be necessary to simulate a temperature greater than 400°F.

20.2 With the OSS in OFF and CB's 5 and 6 open, remove Temp Monitor module LL41. Close screw switches S1-1, S1-2 and open screw switches S2-1, S2-2. If an extender board is available insert into the socket and connect Temp Monitor module to the extender. Attach alumel lead - (Red) to TP1 and chromel lead + (Yellow) to TP2 from the ITE-5521 Temperature Simulator using extensions of smaller gauge wire. If an extender is not available, attach alumel-chromel leads to LL41 with small gauge extensions and reinsert LL41 back into its socket.

20.3 On the control panel end, behind the lower right door, disconnect thermocouple connector plug P4.

20.4 Close CB's 5 and 6 and with the ITE-5521 Temperature Simulator connected to 115V ac, vary the panel meter setting to 500°F ± 20°F.

20.5 Set the oscillator to 3,500 Hz. Place the OSS in MANUAL and allow the COAST DOWN TIMER (LL32) to time out (fully illuminated lamp) before proceeding. The 10%, 30% and 70% SPEED lamps should light (LL47).

20.6 Depress the MANUAL START pushbutton. Observe that the FUEL lamp on the Start Logic module is illuminated for 64 ± 6 seconds.

20.7 The CRANK 3 lamp on the Fail Indicator module should light and the local and remote MAJOR ALARM lamps should light.

20.8 Clear the alarms by operating the ALM CUT-OFF and then turn the OSS to OFF and back to MAN.

21. OVERSPEED

21.1 The overspeed failure condition exists if the engine reaches 109.5% of its nominal operating speed.

21.2 Increase the oscillator frequency output from 3,500 Hz until the OS lamp lights on the Fail Indicator module. This should occur at 4,570 Hz ± 30 Hz. Disregard the LOP lamp. The local and remote major alarm should function.

22. LOW LUBE OIL PRESSURE - LESS THAN 5-PSI

22.1 The Low Oil Pressure (LOP) lamp on the Fail Indicator module will illuminate and the set will shut down if the lube oil pressure is less than 5-PSI when the engine speed is greater than 30%.

22.2 Set oscillator at 1500 Hz (approximately 36% speed) and at a level of 3 volts. With OSS to OFF first and then to MAN, remove jumpers between Terms FTG5, FTG6 and FTF8.

22.3 Observe that the LOP lamp on the Fail Indicator module illuminates and that the Major Alarm is actuated both at the local and remote locations.

22.4 Turn OSS to OFF and open CB's 5 and 6. Disconnect the oscillator and reconnect the plug that leads to the connector of Magnetic Pickup No. 2.

23. GOVERNOR AND SPEED (FREQUENCY) DROOP

23.1 No test is indicated in this instruction as proper operation of the governor is self evident when dynamic testing is performed. The fact that it maintains engine speed within limits from no-load to full-load and does not hunt is indicative of its proper operation.

23.2 Behind the upper control panel is a small panel containing one switch and a potenitometer at the bottom. The top switch is a governor switch and is marked GOV. If the set is to be paralleled with another set that has a Woodward electric governor similar to this set, operate the switch down to the DROOP position, otherwise, operate the switch up to ISOCH for isochronous operation unless directed otherwise by the operating company.

24. CROSS CURRENT COMPENSATION - VOLTAGE DROOP

24.1 The voltage regulator provides for a voltage droop of from 0 to 5% so this set can be paralleled with other sets. A potentiometer marked VOLTAGE DROOP and a voltage switch with positions marked NO DROOP and DROOP are located behind the upper control panel. For single set operation the voltage droop switch should be operated to the NO DROOP position.

24.1 cont'd

When the set is intended to be run in parallel with one or more additional sets, the switch should be operated in the DROOP position and the VOLTAGE DROOP potentiometer operated clockwise to effect a 0 to 5% range of voltage droop. All sets should be in DROOP for parallel operation and all sets adjusted for the same amount of voltage droop between no load and full load, as determined by the operating company.

25. MAGNETIC PICKUP No. 1

25.1 Magnetic pickup No. 1 feeds signals to the governor. Since proper operation of the governor depends upon proper operation of Magnetic pickup No. 1, a separate test for this pickup is not indicated.

26. LIGHT OFF TEMPERATURE

26.1 Disconnect P4 thermocouple connector. The temperature monitor circuit has been factory calibrated to monitor the inlet and exhaust air temperatures. Verify the set points as follows:

26.2 With the ITE-5521 Temperature Simulator connected, as covered in Paragraph 20, reduce the setting to about 200°F.

26.3 Increase the temperature and approach 400°F slowly as indicated on the control panel meter and check that the EXH TEMP > 400°F lamp on the Temperature Monitor module lights within the range of 400°F ± 20°F.

27. PENDING HIGH EXHAUST TEMPERATURE

27.1 Further increase the temperature setting on the Simulator to 1,000°F and check that the temperature indicating meter on the front of the panel reads the same within ± 50°F. Observe that the PHET lamp on the Fail Indicator module is lit. The temperature setting for this lamp is checked later.

28. RUNNING HIGH EXHAUST TEMPERATURE

28.1 Further increase the temperature setting on the Simulator to 1600°F and check the panel meter. This extremely high temperature (simulated) should appear as a full scale reading on the panel meter.

29. RUNNING HIGH EXHAUST TEMPERATURE No. 1

29.1 Reset simulator to 900°F.

29.2 Unplug the SPEED module (LL47). Using a small insulated clip lead, strap the left side of resistor R26 to the left side of resistor R33. Reconnect the SPEED module, carefully dressing the strap close to the printed board.

29.3 Add jumpers between FTG5, FTG6 and FTF8.

29.4 Operate OSS to MAN and hold operated the OVER SPEED TEST pushbutton on the Speed Monitor module. Slowly increase the temperature on the Simulator and observe when the HET lamp lights. This should occur at 1,060°F ± 50°F. The local and remote MAJOR ALARM lamp should light.

29.5 Release the OVER SPEED TEST pushbutton and turn Simulator back to 800°F. Reset alarm by turning OSS to OFF and then to MAN.

29.6 Again slowly increase the temperature on the Simulator until the PHET lamp on the Fail Indicator module lights. This should be at approximately 960°F + 50°F. The MINOR ALARM lamp on the local and remote control panels should light.

30. STARTING HIGH EXHAUST TEMPERATURE

30.1 Slowly increase the temperature on the Simulator until the HET lamp on the Fail Indicator module lights. Ignore PHET lamp and alarm. This should occur at 1575°F ± 75°F. The MAJOR ALARM lamps on the local and remote panels should light.

30.2 Return the Simulator to 800°F and operate the OSS switch to OFF. Open CB's 5 and 6.

31. RUNNING HIGH EXHAUST TEMPERATURE No. 2

31.1 Remove Temp Monitor module, unless connected to an extender, open screw switch S1-2 and close screw switch S2-2. Reinsert Temp Monitor leaving Temperature Simulator connected as before and close CB's. Operate OSS to MAN.

31.2 Increase temperature slowly while holding operated the OVER SPEED TEST pushbutton on the Speed Monitor module. Observe that the HET lamp lights at 950°F ± 50°F. Ignore other lamps. The local and remote MAJOR ALARM lamp should light.

31.3 Release the OVER SPEED TEST pushbutton and turn Simulator back to 800°F. Reset alarms by turning OSS to OFF.

32. RUNNING HIGH EXHAUST TEMPERATURE No. 3

32.1 Open CB's 5 and 6. Remove Temp Monitor module, unless connected to an extender, open screw switch S2-2 and close screw switch S2-1. Reinsert Temp Monitor module and close CB's. Turn OSS to MAN.

32.2 Increase temperature slowly while holding operated the OVER SPEED TEST pushbutton. Observe the HET lamp under the following conditions;

With an inlet plenum temperature (nearly the same as room temperature) of 25°F to 110°F the HET lamp should light between 950°F and 1080°F. If outside of limits, recheck inlet temperature probe connections and probe.

32.3 Open CB's and turn OSS to OFF.

32.4 Disconnect power from the Temperature Simulator and remove connections from TP1 and TP2 on the Temp Monitor module. Remove extender if used.

32.5 Open screw switch S1-1.

32.6 Check to make sure that screw switch S1-2 is the only one closed.

32.7 Reconnect P4 thermocouple connector.

32.8 Remove the strap from the SPEED monitor and reconnect the monitor.

32.9 Remove jumpers between Terms FTG5, FTG6 and FTF8.

33. INLET TEMPERATURE - OPEN PROBE

33.1 With CB5 and CB6 open, lift off and insulate one of the two leads on dummy terminal TBA5. Close CB's and place OSS in MAN. Verify that TEMP PROBE lamp on Temp Monitor module is lit and that MAJOR ALARM lamps on the local and remote panels are lit. Open CB's and replace lead on TBA5.

34. HIGH LUBE OIL TEMPERATURE

34.1 Close CB5 and CB6.

34.2 With OSS in MAN, momentarily jumper with a length of wire, Term FTF5 to FTG7.

34.3 Verify that the LOT lamp on Fail Indicator module is lit and that MAJOR ALARM lamps on the local and remote panels are lit.

35. LOW LUBE OIL PRESSURE - LESS THAN 55 PSI

35.1 The Low Oil Pressure (LOP) lamp on the Fail Indicator module will illuminate and the set will shut down if the lube oil pressure is less than 55 PSI when the engine speed is greater than 95%.

35.2 Open CB5 and CB6, Place a temporary jumper from Term FTG5, FTG6 to Term FTF8. Close CB5 and CB6.

35.3 With OSS in MAN, depress OVER SPEED TEST button on the Speed Monitor module. Observe that the LOP lamp on the Fail Indicator module lights. Ignore the alarms initiated by this test.

35.4 Turn OSS to OFF and open CB5 and CB6. Remove jumper from Terms FTG5 and FTF8.

36. LOW FUEL ALARM

36.1 With CB5 and CB6 open, jumper with a length of wire between Terms FTD10 and FTG7. Close CB's.

36.2 Observe that the L FUEL lamp on the Fail Indicator module lights and that MINOR ALARM lamp on the local and remote panels are lit.

36.3 Open CB's and disconnect jumper between Term FTD10 and FTG7.

37. BATTERY CHARGING RECTIFIER FAILURE

37.1 With CB5 and CB6 open, temporarily jumper with a length of wire between Terms FTD7 and FTG5. Close CB's.

37.2 Observe that the RECT FAIL lamp on the Fail Indicator module lights and that MINOR ALARM lamps on the local and remote panels are lit.

37.3 Open CB's and remove jumper between Terms FTD7 and FTG5.

38. OVER CURRENT SHUTDOWN

38.1 With CB5 and CB6 open, temporarily jumper with a length of wire between Terms FTF4 and FTG7, Close CB's.

38.2 Observe that the OV.C lamp on the Fail Indicator module lights and that MAJOR ALARM lamps on the local and remote panels are lit.

38.3 Open CB's and remove jumper between Terms FTF4 and FTG7.

39. MINOR CIRCUIT BREAKER ALARM

39.1 See Paragraph 11. With dc CB5 and CB6 closed, open ac CB4 (ac CB2, CB3 and CB4 were closed in paragraph titled "General-Static Testing Switches and Breakers").

39.2 Observe that the MNCB lamp lights on the Fail Indicator module, the COML PWR FAIL lamp lights on the AC Voltage Monitor and that the MINOR ALARM lamp on the local and remote panel is lit. Close CB4.

40. MAJOR CIRCUIT BREAKER ALARM

40.1 See Paragraph 8.1.

40.2 Close all control CB's and turn OSS to MAN.

40.3 Depress EMERG STOP (Emergency Stop) push-button on the front of the control panel. CB6 should trip open.

40.4 Observe that the MJCB lamp lights on the Fail Indicator module and that the MAJOR ALARM lamp on the local and remote panel is lit.

40.5 Reclose CB6 and open CB2. Operate the OSS to OFF and back to MAN.

40.6 Observe that the MJCB lamp lights and the MAJOR ALARM lamp on the local and remote panel is lit.

40.7 Close CB2 and open CB3. Operate the OSS to OFF and back to MAN.

40.8 Observe that the MJCB lamp lights and the MAJOR ALARM lamp on the local and remote panel is lit.

40.9 Close CB3.

41. LUBRICATING THE COUPLING

41.1 Lubrication of the coupling between the gear box and alternator is required at the job site. The supplier's representative usually will install or supervise the installation of the coupling and new gaskets and will lubricate it. Check with the representative to ascertain that this has been done and note this on the ID-1275 Lubrication Record. If not lubricated, proceed as follows;

41.2 Turn over engine and alternator by rotating coupling in a forward direction by hand until opposite plugs in one coupling are turned until located approximately 45° from a horizontal or vertical line through the coupling. Remove both plugs on opposite sides and squeeze in about 1/2 of the 10 oz tube of 140 - AGMA8 (by Metal Cote) furnished. Allow time for oil to drain and observe that the oil begins to drip from the lower hole. Replace both plugs and turn coupling so the second set of holes are set at 45° and repeat the oiling and plugging procedure.

41.3 Record on ID-1275 that both coupling halves were oiled and the weight and kind of oil.

42. CHECKING AND FILLING THE ENGINE WITH LUBRICATING OIL

42.1 The first engines furnished under KS-21264 were drained of all lubricating oil before shipment. The installer was required to fill the gear reduction unit with an approved mineral or synthetic oil.

42.2 Presently, the engines are shipped from the factory with the correct amount of "Stauffer Jet II" synthetic oil in the gear reduction unit (approximately 13 gallons). When the units come filled, all additions of oil to maintain a full level, shall be made with "Stauffer Jet II". This oil is available in quarts, gallons, 5 gallon cans and 55 gallon drums.

42.3 Should an occasion arise when replacing the oil is necessary, any of the following synthetic oils are approved where the outside air temperature is at or between -20°F and +110°F.

SYNTHETIC OILS
CASTROL 205
EXXON/ESSO TURBO OIL 2380
MOBIL JET II
STAUFFER JET II
TEXACO 7730

42.4 DO NOT USE MINERAL OIL.

42.5 Do not mix different brands of synthetic oil.

42.6 The oil will be furnished by the operating company.

42.7 If the unit should happen to be received with no lubricating oil in the gear reduction unit, follow the procedure detailed in the remaining sub paragraphs:

42.71 The engine shall not be rotated under power (starter power or normal turbine power from the running engine) until the proper amount of lubricating oil has been added.

42.72 Before adding oil, drain the gear reduction unit of any residue oil by opening the valve located at the bottom right facing the sight glass. Drain any residue oil through the hose provided into a suitable container and discard. Close valve.

42.73 Remove cap from the top of the gear reduction unit and add 10 gallons of oil. Observe sight glass and continue adding oil until level reaches approximate midpoint between FULL and ADD. Replace filling cap. Record make, type, quantity, hours from "hour meter" and date. Sometime after the engine has been run the first time, again add oil to bring level up to the midpoint. (record on SD-4-1275). Allow oil time to seek its level in the sight glass. Usually 10 to 13 gallson will fill the unit.

42.74 Cleanliness of the oil and of the handling equipment is of utmost importance since the input shaft speed, from the turbine, is over 40,000 RPM.

43. PRIMING THE LUBRICATING OIL LINES

43.1 The oil cooler is situated near the middle of the set in the uppermost area. The oil is cooled with a hydraulically operated fan which pulls air down through the cooler and into the engine compartment.

43.2 The manifold on the cooler is equipped with a bleed tube and check value back to the oil sump. This automatically eliminates any air in the lines at the cooler.

43.3 On the rear right side of the engine, operate the Deming hand pump (lubricating oil pump) until a change in the effort required will signal the pump has picked up the oil and is pumping. Operate the pump on additional 100 single strokes to fill the lines and clear the system of air.

44. PRIMING THE FUEL SYSTEM

44.1 To ensure proper operation of the turbine the day tank must be filled and all the lines and filters on the set must be filled with fuel and free of air.

44.2 Open all the valves in the fuel feed line (suction line) and return line. Two valves are usually located just inside the engine room and one valve is located on each side of the Deming hand operated FUEL PRIMING pump.

44.3 With two wrenches, loosen the outgoing line at the top of the 1.58 gallon Fuel Cup located at the left and above the hand pump. i.e., the line between the Cup and the brass check value.

44.4 Place a container under the break in the line and loosly cover with a cloth to prevent spraying. Operate the FUEL PRIMING pump until the Fuel Cup is filled and fuel comes out of the break free of bubbles.

44.5 Occasionally the pump will fail to seal internally and not afford sufficient suction in which case fuel will have to be placed into the pump to wet the parts.

44.6 After priming, reconnect the line, tighten securely and reclose the two valves on each side of the Deming hand pump.

45. AUXILIARY SYSTEMS

45.1 Test associated systems for proper operation such as the Auxiliary Room Ventilating Circuit.

46. PREPARATION FOR INITIAL START

46.1 Place the OSS in OFF on both the local and remote cabinet. Close CB5 and CB6. Turn TRANSFER SELECTOR switch to MAN. SW OFF NORMAL lamp should light. Open CB5 and CB6.

46.2 Reconnect lead CP24 to starter relay. See Paragraph 16.51.

46.3 For single set operation, operate the Voltage Droop Switch located behind the front upper control panel to OFF position. For parallel operation, see Paragraphs 7 and 24.

46.4 Disconnect and tag the external leads CB9 on FTA8 and TR15 on FRA10. These are the control leads that operate the NCB Normal Circuit Breaker (commercial power).

46.5 Disconnect and tag the external leads LB6 on FTA4 and TR16 on FTA6. These are the control leads for the ECB Emergency Circuit Breaker.

46.6 Verify with an ITE-4442A, ITE-5520 or equivalent that the Emergency Bus is dead. Then, on auto sets only, determine with an ohmmeter, the absence of continuity between the busses and from the busses to neutral, and to ground. See Figure 1.

46.7 Connect the ITE-4782 or ITE-4785 Test Loads. Refer to TMO-4782 or TMO-4785 in Handbook 100 for connecting and operating information. The temporary loads may be connected to the output side of the ACB (Alternator Circuit Breaker) or to the Emergency Bus. Loads should be set at zero.

NOTE: Since the engine cubicle should be closed during the full load test and the final acceptance test, the load leads should be run in such a manner so as not to interfere with placing the side covers or interfere with any mechanically operating or rotating parts. It may be necessary to leave off the one side panel where the temporary load is connected, if no other arrangement is practicable.

46.8 Verify the following;

46.801 All output lead connections from the alternator are properly tightened, no interference or points of potential chafing. Redress when possible or provide a minimum of two layers of Sheet Fiber and secure with sewing twine.

46.802 Control leads and other customer connections secure.

46.803 Batteries are fully charged, polarities correct and connections tight.

46.804 Lubricating system drain valve closed and lube oil at proper level. Condensate drain valve in exhaust system closed if provided.

46.805 Fuel line connections tight.

46.806 Verify with the operating company that the fuel meets Bell System requirements for this set. See Paragraph 5.5.

46.807 All inlet and exhaust ducting secure and cleaned. This is a very important operation and check as dirt or debris drawn into the air intake is the greatest hazard to seriously damaging the turbine engine.

46.808 Room sufficiently ventilated.

46.809 Shipping covers removed from engine inlet and exhaust duct.

46.810 Engine exhaust duct properly supported.

46.811 Internal area around control panels (local and remote), engine and alternator clean.

46.812 Check wiring of boost pump, fuel shut off and control valves, ignition exciter, magnetic pickup, thermocouple plugs and T2 temperature sensor.

46.813 Check wiring for dress and tightness to the two low oil pressure switches, oil temperature switch and starter, Check to make sure the insulation is in place and secure on the exhaust system and the engine compressor.

47. HIGH CURRENT STARTING CIRCUIT

47.1 With the OSS in OFF, depress and hold the PURGE CRANK pushbutton on the Start Logic module. The engine should start to crank but no power is furnished to the ignitor nor is the fuel solenoid open. Keep depressed for 15 seconds then release and immediately check all start-battery post connections to determine they are not overheating. Check with caution in event a terminal has overheated. Correct by cleaning, applying R-3266 NO-OX-ID "A" Compound and retightening.

48. EMERGENCY STOP SWITCHES

48.1 The EMERGENCY STOP pushbuttons are located slightly to the left side of the engine control cabinet at the bottom. They are also located on the remote cabinet, when furnished, and just outside of the doors to the emergency engine alternator room.

48.2 The test consists of operating each switch at least once to determine it is functioning properly and will always shut the set down regardless of its mode of operation. This test can be performed anytime during the testing procedure when it is desired to stop the set and the set is not automatically stoped because of the testing of a major malfunction.

49. START DYNAMIC TESTING - EXHAUST TEMPERATURE - OPEN PROBE

NOTE: The Onan representative should be present for the first start-up. Prior to the first start, the representative will probably want to check, (1) the run-out, lubrication and torquing of the coupling, (2) the lubrication of all bearings and purging of air from all lube oil lines, (3) that the set is level, etc. See Paragraph 1.06.

49.1 Operate CB5 and CB6 to ON and turn OSS to MAN. Depress the MANUAL START pushbutton located directly above the OSS and observe that the turbine starts, accelerates and comes up to 100% speed. Immediately check engine compartment to make sure no fuel or lubricating oil is leaking. If leaks are evident, shut down and correct.

49.2 Behind the lower door on the right side of the control cabinet are the cables, 4 plugs and sockets that interconnect the control module to the set. Disconnect P4 connector and plug that connects the temperature probe to the controller. The set will shut down. The TEMP PROBE lamp on the Temp Monitor will illuminate and the Major alarm will sound.

49.3 Reconnect P4.

50. UNDER SPEED AND OPEN SPEED-PROBE

50.1 With all control circuit breakers on, turn OSS to MAN and depress the MANUAL START button. After various times delays described elsewhere, the engine will start and run at nominal 100% speed.

50.2 Separate the two leads SC2 located on TBA2. The US PROBE lamp at the bottom of the Fail Indicator module should light and the engine should stop.

50.3 Reconnect the two SC2 leads to TBA2.

51. OVERVOLTAGE

51.1 If a remote panel is furnished, the voltmeter will be located thereon, otherwise, it will be located on the engine control panel. The following start-up should be performed where the voltmeter is located.

51.2 Connect the ITE-5520 Digital Multimeter (500V range and internal function switch released) across TBF5 (phase 1) and TBC4 (phase 3).

51.3 Open the door below the circuit pack modules and find the Voltage Regulator attached to the door. Remove the cage from the regulator.

51.4 Start up the engine by depressing the MANUAL START pushbutton.

51.5 Mark the setting of the R8 REG CAL potentiomerer on the voltage regulator card.

51.6 Adjust the VOLTS ADJ potentiometer on the front of the engine control or the VOLTS ADJUST switch on the remote cabinet to the nominal value desired. (Check incoming voltage as a reference by operating the voltage SELECTOR switch).

51.7 Note the value and increase the voltage slowly by readjusting the R8 REG CAL potentiometer on the voltage regulator until the engine shuts down (approximately 120% of the nominal value).

NOTE: For the 416/480V sets the voltage readings will be 1/2 due to the center tapping of these points on the alternator.

51.8 Observe after shutdown to determine the following lamps are lit. The OV lamp on the Fail Indicator module and the MAJOR ALARM on the local and remote cabinet. Operate the OSS to OFF and remove the ITE-5520 from terminals TBF5 and TBC4.

51.9 Return the R8 REG CAL potentiometer on the voltage regulator to its original marked position and replace the cage.

52. REVERSE POWER TEST

52.01 This test is performed when Circuit pack LL39 is provided. The LL39 Multi-set Module is provided when two or more sets are used in parallel.

52.02 175 KW of load is required, The set is provided with a Reverse Power Test switch located behind the front panel and behind LL39.

52.03 Open CB5 and CB6 and remove the Multi-set Module LL39. Insert extender card and reinsert LL39 into extender. Close CB5 and CB6 and turn OSS to MAN.

52.04 Depress the MANUAL START pushbutton and observe that the turbine starts, accelerates and comes up to full speed.

52.05 When the READY TO LOAD lamp illuminate on the Start Logic module, operate the CIRCUIT BREAKERS - CLOSE switch and the red lamp will illuminate in the switch and the set circuit breaker will close.

52.06 Apply 125 kW of artificial load.

52.07 On the Multi-set Module, operate and hold for at least five seconds, the REV PWR TEST switch. The set continues to operate with no shutdown or malfunction indication. Release REV PWR TEST switch.

52.08 Increase the artificial load to 175 kW and again depress and hold the REV PWR TEST switch. The engine shutsdown and the REV PWR lamp lights on the Fail Indicator module. The Major Alarm sounds and the alternator circuit breaker trips open. Release the REV PWR TEST switch.

52.09 Operate the OSS to OFF and the artificial load switches to OFF.

52.10 Turn off CB5 and CB6 and remove extender board. Restore LL39 making sure it is firmly seated.

53. NORMAL (COMMERCIAL POWER) AND EMERGENCY CIRCUIT BREAKERS

53.1 Job conditions dictate the breaker arrangement for each office. The operating company will determine the options as to whether certain breakers are manually or automatically controlled.

53.2 Reconnect breaker leads disconnected in Paragraphs 46.4 and 46.5 as required for automatic operation and test for proper operation and interlock. See SD-82367-01 listed in Paragraph 1.054 and refer to the job block schematic drawing. A typical circuit breaker arrangement is shown in Figure 1, however, a wide variety of arrangements are possible.

54. POWER FAILURE DETECTOR TEST

54.1 With OSS in OFF, turn CB5 and CB6 to ON.

54.2 Verify presence of commercial power on leads CA, CB, and CC by measuring between them. The value should be a nominal 208V ac or 240V ac. (SD-82367-01, Figure 7 for typical).

54.3 Remove the fuse on the commercial bus distribution panel that feeds commercial ac to sense lead CA. Use a fuse puller and exercise care against short circuit and shock as this is a live circuit. Verify that the PWR FAIL lamp lights on the AC Voltage Monitor module and on the remote cabinet when furnished.

54.4 Replace fuse feeding CA sense lead and observe that the PWR FAIL lamp is extinguished and that the COML ON lamp is restored.

54.5 Repeat Paragraphs 54.3 and 54.4 for the CB and CC fused leads. Make sure COML ON lamp is restored after each of the three tests.

55. POWER FAILURE TEST - TSS AUTO

55.1 This test applies only to installations containing automatic switch gear.

55.2 Operate Transfeer Selector Switch to AUTO. On the Time Cont Logic module, operate the Run Timer to ON. Turn the OSS to AUTO.

55.3 Remove one of the commercial power fuses on the commercial bus distribution panel which feeds commercial power to the sensing circuit on the set. (Leads designated CA, CB or CC such as shown on SD-82367-01, Figure 7.) This will simulate a commercial power failure.

55.4 The set will start, accelerate and come up to 100% speed. After a series of delays (timers) the set breaker should close energizing the Emergency Bus when clear.

55.5 The Normal Breaker will open (commercial power to priority circuits) and the Emergency Breaker will close. Observe the Ckt Brkr Control module to determine the CLOSE EMERGENCY BREAKER lamp is lit and the PROPER OPERATION lamp is lit.

55.6 The RUN lamp will be flashing indicating it is timing. When the RT has timed out in approximately 35 minutes the RUN lamp will be illuminated without interruption.

55.7 Replace the fuse removed in the third paragraph and observe that the HOLD OVER lamp is blinking.

55.8 After the HOT times out in approximately 17 minutes the HOLD OVER lamp will remain lit and the logic circuitry will automatically retransfeer the load back to Commercial Power. The ACB will open and the set will run an additional 5 minutes during the cool down period as evidenced by the blinking COOL DOWN lamp. The set will then shut down.

56. POWER FAILURE TEST - TSS MANUAL

56.1 Operate Transfeer Selector Switch to MAN.

56.2 With the OSS in AUTO, operate the SIM PWR FAIL pushbutton.

56.3 The set will start up and run, and after a series of delays, will assume the essential loads via automatic closure of the ACB and ECB.

56.4 Replace the fuse and after the RT and HOT times out, depress the TRANSFEER RESTORE pushbutton momentarily. The ECB opens and the NCB closes.

56.5 On the ac power switchboard open the NCB and close the ECB.

56.6 Depress and hold the TRANSFEER RESTORE pushbutton. The ECB opens, the NCB closes and the ACB opens.

56.7 Shut the set down by depressing one of the EMERGENCY STOP pushbutton not yet tested. The set must be shut down at least once by operating the EMERGENCY STOP pushbutton from each location, i.e., engine control, remote cabinet and wall mounted switches.

57. FUEL SYSTEM MALFUNCTION

57.1 A distinct test is not included for the fuel system since its proper operation is demonstrated by the running of the set during other tests. Its proper operation is reflected in
(1) the lack of a malfunction lamp on the Fail Indicator module for the Engine.
(2) a smooth accelleration to 100% speed (response of the fuel control valve from the governor).
(3) the absence of a buffeting sound or fluttering air sound or surging at or near operating speed.
(4) its ability to carry full load under the paragraph on Full Load Test.

58. FAIL SAFE CONTROLS

58.1 Place OSS in MAN and start engine.

58.2 With engine running, open CB5 and observe that the engine stops.

58.3 After the set comes to a complete stop restore CB5 to "ON" and restart set. Open CB6 and observe that the engine stops.

58.4 Restore CB6 to the "ON" position.

59. FULL-LOAD TEST

59.1 Time: Make a Preliminary Full-Load Test of one hour duration before a Final Acceptance Test. The Final Acceptance Test is 2-1/2 hours in length, and a customer's representative must witness the test. Two hours of the Final Acceptance Test will be at full-load and the last half-hour should be at the usual office load or at full-load, or a combination of the two.

59.2 Parallel: If the set will be paralleled an additional Acceptance Test, in parallel, will be required, in accordance with Section 130 and 265 in this handbook.

59.3 Records: Record the results of tests on the forms listed in Paragraph 1.09.

59.4 Exhaust Back Pressure and Inlet Vacuum (Restriction):

59.41 Whether the Operating Company accepts responsibility for, W.E. accepts responsibility for, or, W.E. subcontracts the exhaust and inlet duct work, it should be installed per ED-82801-30. The drawing shows air flow attachments to the ducts for use in taking pressure and vacuum (restriction) readings with R-3076 Manometers. Be sure these attachments in the ducts are not blocked or otherwise covered when the ducts are lagged (insulated).

59.42 If the attachments are not furnished, this ommission shall be called to the attention of the operating company. The inlet air vacuum (restriction) and exhaust air pressure is a function of duct design and has been calculated by the line or equipment engineer on a job basis to meet requirements.

59.43 Drilling, tapping and fitting the air intake is an involved procedure and shall not be undertaken by the installer unless specifically requested. If requested on a job basis, the metal particles from the drill and tap must be collected and contained on the inside of the duct and the duct carefully vacuumed after the fittings have been attached. Failure to remove all particles can cause the engine irreparable damage.

59.44 When the attachments are furnished, attach the water manometers and adjust the liquid in each in line with the zero reading. Since the other end of the manometer is open to the atmosphere, be sure there is free air pressure exchange between the turbine room and the outdoors, otherwise, the readings taken during the full load test will be error.

59.5 Preliminary Operations:

59.51 Operate the ITE-5520 Digital Multimeter to EXTERNAL and connect to TBK7 and TBK9 to read the alternator output voltage (500V ac range). These readings are across phases 1 and 3 and are to be used to check the a.c. meter on the local and remote control cabinet via the VM selector switches.

59.52 Be sure all side covers are in place and secure.

59.53 Start any manually operated Auxiliary Room Ventilating Fans, etc. Open doors to provide ventilation if this will be the normal method of ventilating the room.

59.6 Preliminary Full Load Tests:

59.61 Turn OSS to MANUAL and start the set.

59.62 When the READY TO LOAD lamp appears, close the ACB.

59.63 Add 435 kW of load.

59.64 Take a set of readings at full-load, which includes Time, Frequency, Volts, Amperes, kW, Power Factor, Inlet Restrictions (inches of water), Exhaust Back Pressure (inches of water), Exhaust Temperature, Ambient Temperature at the turbine, and external Voltmeter readings.

59.65 Take initial readings and readings every 30 minutes until the set has run one hour at full-load.

59.66 With the ACB closed, check for correct voltage and phase sequence of alternator at the Emergency Breaker in the Remote Breaker Circuit. DO NOT CLOSE THE EMERGENCY BREAKER.

NOTE: Refer to Section 135 in this handbook for information on "phasing-out" at transfer switch circuits. Whichever voltage (commercial voltage or alternator voltage) is connected first will be the reference for phase sequence, and the other source voltage must be "phase-out" to match this sequence. At this point, alternator voltage will appear on one side of the emergency breaker from the emergency bus and commercial power to the essential load on the otherside. DO NOT CLOSE THE EMERGENCY BREAKER.

59.67 Reduce the load to 50 KW and press an EMERGENCY STOP button not yet tested or credit one hour to the final acceptance test and continue with Paragraph 60.

60. FINAL ACCEPTANCE TEST

60.1 In the presence of the operating company acceptance person, perform the Final Acceptance Test.

60.2 Turn OSS to MANUAL. Start the set and adjust speed (frequency) and voltage as necessary.

60.3 Close the ACB. After phasing out the emergency power with the commercial power, determine if the operating company would want to place up to 435 kW of office load on the set. If so, with only one set running, open the normal breaker and close the emergency breaker. Add office load and artificial load until the set is loaded to full-load. Otherwise, add artificial load until the set is fully loaded.

60.4 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.

60.5 After two hours at full-load reduce load to the value of load normally carried by the set, or, continue at full-load. Remove office load by opening emergency breaker and closing the normal breaker.

60.6 After an additional 30 minutes at partial load, take a set of readings. Then decrease artificial load to zero. Open the ACB.

60.7 Allow the set to run about 3 minutes. Then shut down the set by pushing an EMERGENCY STOP Button not yet tested. The set shuts down.

60.8 To demonstrate fully automatic operation on an automatic set, operate TRANSFEER SELECTOR switch to AUTO and the OSS to AUTO, Press the SIM PWR FAIL pushbutton on the AC Volt Monitor module. The set will start, assume the load, return the load to commercial power and shut down. This test can be reduced in time by approximately 25 minutes by operating the Run Timer to "off" after the set has started and reached full speed. Remember to return the Run Timer to "on" after the test and OSS to OFF.

60.9 Disconnect artificial load. Remove manometer connections and cap lines into ducts.

61. MAINTENANCE

61.1 Maintain lubricating oil between the FULL and ADD marks. Check oil level when the set is not running. After four or five days of continuous operation, (100 to 125 hours) a check of the oil level will probably indicate the need for adding a quart.

61.2 Check electrolyte level in both the engine start battery and the control battery and maintain at the full mark by adding approved water.

61.3 Visually check security of all self-locking nuts, capscrews and other fastenings. If lockwires are broken, tighten the nuts or bolts and replace the lockwire. Use stainless steel lockwires, and not a zinc-coated lockwire. Lock-wires are generally .032 inch diameter except for #8 or smaller screws and on electrical harness coupling nuts, where .020 inch diameter wire is used.

61.4 The turbine must be run at least 30 minutes a month. The minimum routine running is 30 minutes at no-load each month and one hour every 3 months carrying the office load. Running at no load or short runs, such as demonstration runs, have no adverse effect on the turbine.

61.5 During the one hour load run the Transfer Breaker Circuit should be exercised, when provided, to transfer the office load to the set.

61.6 No load starting and running is done by turning the OSS to MAN and starting the turbine with the MANUAL START pushbutton.

62. TROUBLE SHOOTING

62.1 Refer to the manual provided by the manufacturer for information on trouble shooting.

62.2 Circuit packs that are found to be defective should be exchanged for new ones rather than to attempt field repair. Some circuit packs do provide for certain adjustments.

Manager, Product Engineering