KS-21879 GAS TURBINE ENGINE ALTERNATOR
1250/1500 KW (J-86655)
E/W J-86743B UNIVERSAL CONTROLLER

CONTENTS

1. GENERAL
1.01 Purpose
1.02 Scope
1.03 4160V Set
1.04 480V Set
1.05 J-86743B Universal Controller
1.06 Supplier's Representative
1.07 Specifications
1.08 Drawings
1.09 Glossary of Abbreviations
1.10 Tools and Test Sets
1.11 Records
1.12 Job Connections
1.13 Manual Sets
1.14 Using This Test Method
2. WARNINGS
3. CAUTIONS
4. INSPECTION
5. DESCRIPTION
6. BATTERIES
7. BATTERY CHARGING RECTIFIER
8. PARALLELING
9. MAJOR ALARMS - TROUBLE SHUTDOWWS
10. TIMERS
11. OSS SWITCH OPERATION INCLUDING TS SWITCH - REMOTE AND LOCAL
12. MINOR ALARMS - CAUTION
13. CIRCUIT BREAKERS
14. SET POINTS
15. PLACING THE UNIT
16. INSTALLING THE J-86743B UNIVERSAL CONTROLLER
17. INSTALLING THE DUCTS
18. CONNECTING THE FUEL LINES AND COMBUSTOR DRAIN
19. GENERAL - STATIC TESTING
19.1 Switches and Breakers
19.2 Alarms
19.3 Wiring
19.4 Circuit Packs
20. LESS THAN 2 PSI LUBE OIL PRESSURE - CRANK INHIBIT
21. LAMP TEST
22. CRANK 1 TEST
23. CRANK 2 TEST
24. CRANK 3 TEST
25. CRANK 4 TEST
26. OVERSPEED
27. LOW LUBE OIL PRESSURE - LESS THAN 10 PSI
28. GOVERNOR AND SPEED (FREQUENCY) DROOP
29. VOLTAGE DROOP
30. MAGNETIC PICK-UP NO. 99T2
31. LIGHT OFF TEMPERATURE
32. PENDING HIGH EXHAUST TEMPERATURE
33. HIGH LUBE OIL TEMPERATURE
34. LOW OIL-SUMP-TEMPERATURE
35. DIFFERENTIAL FAULT SHUTDOWN
36. VIBRATION SHUTDOWN
37. LOW FUEL ALARM
38. BATTERY CHARGING RECTIFIER FAILURE
39. OVER CURRENT SHUTDOWN
40. MINOR CIRCUIT BREAKER ALARM
41. MAJOR CIRCUIT BREAKER ALARM
42. COUPLING REQUIREMENTS
43. LUBE OIL DRAIN
44. FILLING THE ENGINE WITH LUBRICATING OIL
45. PRIMING THE LUBRICATING OIL LINES
46. PRIMING THE FUEL SYSTEM
47. AUXILIARY SYSTEMS.
48. PREPARATION FOR INITIAL START
49. HIGH CURRENT STARTING CIRCUIT
50. EMERGENCY STOP SWITCHES
51. START DYNAMIC TESTING - EXHAUST TEMPERATURE - OPEN PROBE
52. UNDER SPEED AND OPEN SPEED-PROBE

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

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53. OVERVOLTAGE

54. UNDER VOLTAGE SHUTDOWN

55. REVERSE POWER TEST

56. NORMAL (COMMERCIAL POWER) AND EMERGENCY CIRCUIT BREAKERS

57. POWER FAILURE DETECTOR TEST

58. POWER FAILURE TEST - TSS AUTO

59. POWER FAILURE TEST - TSS MANUAL

60. FUEL SYSTEM MALFUNCTION

61. FULL LOAD TEST
- 61.1 Time
- 61.2 Parallel
- 61.3 Records

62. FINAL OPERATIONAL TESTING
- 62.1 General:
- 62.2 Exhaust Back Pressure and Inlet Vacuum (Restriction):
- 62.3 Preliminary Operations:
- 62.4 Preliminary Load Test:
- 62.5 Final Full-Load Acceptance Test:

63. MAINTENANCE

64. TROUBLE SHOOTING

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 circuits in a telephone office when the regular commercial power fails.

1.012 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 480 volt or 4160 volt alternators may be furnished. The unit is rated at 1250 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 1500 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 480V or 4160V KS-21879 (J-86655) 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. The verified full load test results are on file at the factory through the Western Electric - Source Inspection Organization. All functioning components, including the W.E.Co. J-86743B Universal Engine Controller are tested to determine they function properly and are correctly adjusted. The field tests 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 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.

1.023 Record trouble encountered in performing the tests on SD-97-1313.

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

1.03 4160V Set

1.031 Alternators that generate 4160 volts are normally ordered where the separation between the alternator and the point of distribution is a considerable distance apart. For example, the engine alternator set may be located on the 12th floor and the 4160 to 208, 220 or 440 volts transformer may be located in the basement.

1.032 All current monitoring and sensing is done on the alternator tap leads that terminate on ground, and therefore, are at near ground potential.

1.033 No work is ever done by the installer on the 4160 Volt circuit while it is alive.

1.034 When the 4160V alternator is furnished, all voltage sensing, as well as monitoring for the Universal Controller, is accomplished through step-down potential transformers. A 20 to 1 potential transformer is provided which reduces the voltage to 208V.

1.04 480V Set

1.041 When the 480V alternator is furnished, all sensing, as well as monitoring for the Universal Controller, is accomplished through step-down potential transformers. A 2.4 to 1 potential transformer is the usual one provided which reduces the voltage to 200.

1.05 J-86743B Universal Controller

1.051 The Universal Controller monitors commercial voltage as well as alternator voltage through appropriate transformers, as required. Before connecting these ac service leads, verify the voltage.

1.06 Supplier's Representative

1.061 As part of the contract with NATCO, a supplier's representatives will be made available for the three days before the initial start and portions of the dynamic testing of the set. See Paragraph 51.

1.062 Field Service shall be notified a minimum of 30 days before the NATCO 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 51.

1.063 The coupling is shipped in place and lubricated. The NATCO representative will work with the installer in checking the alignment of the alternator. Critical realignment is required. Spare gaskets for the coupling and lubricants for the coupling will be shipped loose. These are to be turned over to the customer for use in doing a subsequent periodic maintenance routine.

1.07 Specifications

J-86655A	1250 to 1500 kW, 480V, 3Ø, 5 wire, 60Hz Gas Turbine Engine Alternator, Manual or Automatic with Local Control.
J-86655B	1250 to 1500 kW, 4160V, 3Ø, 4 wire, 60Hz Gas Turbine Engine Alternator, Manual or Automatic with Local Control.
J-86655C	1250 to 1500 kW, 480V, 3Ø, 5 wire, 60Hz, Gas Turbine Engine Alternator, Manual or Automatic with Remote Control.
J-86655D	1250 to 1500 kW, 4160V, 3Ø, 4 wire, 60Hz, Gas Turbine Engine Alternator, Manual or Automatic with Remote Control.

1.071 The above sets are designed to be used with a J-86743B Universal Controller, which must be ordered separately.

1.08 Drawings

Keysheets

SD-80700-01

Engine Alternator Circuit Schematic

SD-82486-01	480 Volt Engine Alternator Set with or without remote control
SD-82494-01	4160 Volt Engine Alternator Set with or without remote control
SD-82487-01	Remote Control Cabinet 480V and 4160V

Universal Control Module (J-86743B)

SD-82496-01	Universal Controller and Universal Controller Interconnect See Note 1
SD-82362-01	Circuit Packs for Universal Control Module

Application Schematics

SD-82488-01	480V Plant Application Schematic
SD-82495-01	4160V Plant Application Schematic
SD-81489-01	Typical AC Transfer Circuit Breaker Arrangement.

Alarms

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

Typical Fuel Tank, Lines and Accessories

ED-82828-30

Exhaust and Inlet Duct Work

ED-82826-30

Conduit Arrangement

ED-82827-30	480V
ED-82853-30	4160V

NOTE 1: If two or more of these engines are to be controlled by the J-86742 Paralleling and Load Management Bay, the handbook section covering the testing of the Paralleling Bay shall not be utilized until this handbook test has been completed for each engine and its controller.

1.09 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
CBCR	Circuit Breaker Close Relay
CBOR	Circuit Breaker Open Relay
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	Energency
ECB	Engine Control Battery
ECB	Emergency Circuit Breaker
EG	Equipment Ground
EGT	Exhaust Gas Temperature
ES	Emergency Stop switch
FC	Fan Control
FIR	Fuel Isolation Relay
FL	Full Load
FPS	Fuel oil Pressure Switch
FPSS	Fuel Pump Selector Switch
FS	Fuel Solonoid
FSF	Fuel System Failure
FSFA	Fuel System Filter Alarm
FSR	Fuel Solonoid Relay
FT	Feed Through terminal
HET	High Exhaust Temperature
HF-	High Fuel relay (high fuel in day tank)
HOT	Hold Over Timer
ICS	Intergrated Control System
IGN	Ignition
LCR	Louver Control Relay
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
N	speed
NCB	Normal Circuit Breaker (commercial power)
NLT	No-Light Timer or No Lightoff Timer
Nos	Engine Overspeed
NSDO	Normal Starter Dropout
OC	Over Current
OLT	Over Load Timer
OP	Operation
OS	Operation Selector switch
OSR	Operation Selector Relay
OSS	Operation Selector Switch
OV	Over Voltage
OV, C	Over Current
PC	Purge Crank switch
PF	Power Failure
PFA	Power Failure Alarm
PHET	Pending High Exhaust Temperature
PLF	Preliminary Low Fuel
PMNV	minor alarm visible
PMN	minor alarm audible
PO	Proper Operation
POA	Proper Operation Alarm
PSIG	Pounds per Square Inch Gravity
PWR	Power
RMT	Remote
RP	Reverse Power
RPM	Revolution 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
STR	crank
SW	Switch
SYS	System
TA	Test Alarm
TB	Terminal Board
TD	Timed Out, Time Delay
TERM	Terminal
TS	Terminal Strip
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

1.10 Tools and Test Sets

1.101 Tools:

R-4783 Precision Mechanic's Level

R-1032 Thermometer, Centigrade - 5 to 150°

R-5460 Three-Position Stool

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

R-3076 Manometer (water type) (two)

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

R-3404 Phase Sequence Indicator

R-4296 Ear Protector (minimum two)

815A Extender Card (see Note 2)

R-3295 Three Conductor Extension Cord. (30 feet long)

NOTE 1: These are Very Flexible 500,000 circular mill single conductor cables 50 feet long with a lug on each end. Each will carry approximately 660 amps. 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 8.2.

1.102 Test Sets:

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

ITE-4442A Multimeter

ITE-4785 250kW Test Load (as required)
-or-
ITE-4782 150kW 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)

1.11 Records

SD-4-1275 Lubrication Record
SD-4-1285 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-21879 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.

1.12 Job Connections

1.121 Facing the control panel, the majority of the Terminal Strips are behind door 6 (the first "adjacent" door on the right). See Paragraph 1.144.

1.122 Make sure the J-86743B Universal Controller is disconnected (P1, P2, P3 and P4 disconnected) before connecting the control battery. The P1 to P4 plugs and J1 to J4 jacks are located behind the Control Panel.

1.13 Manual Sets

1.131 When testing the manual sets, the majority of the tests called for in this section applicable to automatic sets cannot be applied. It will be necessary to select only those tests that apply which will verify operation of the safety devices and insure the set can be started, loaded, unloaded and stoped.

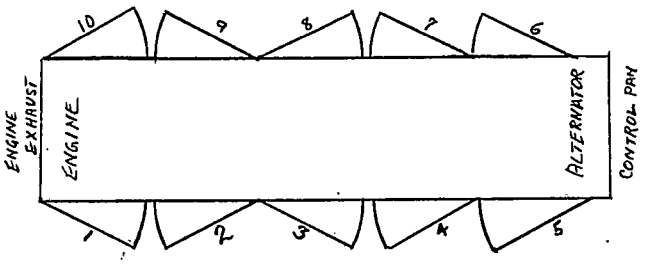
1.14 Using This Test Method

1.141 When installing and testing the J-86655 for the first time, it is suggested this entire section be read through at least once. Locating the terminal blocks (strips) and apparatus as they are referred to will prove beneficial when actually performing the test.

1.142 While actually performing the tests, occasionally there is an advantage in reading ahead a couple of paragraphs before starting that part of the test. For example, see Paragraphs 23.2 and 49.1.

1.143 Reference throughout the section to terminal strips or terminal boards are referred to as TB's, such as TB1, TB2, etc. Most of the TB's have 13 terminals, however, on the first shipments the terminals may not be marked. REFERENCE IN THIS SECTION TO TERMS (TERMINALS) ACTUALLY REFERS TO WIRE NUMBERS.

1.144 When door numbers are referred to throughout the section, the arbitrary numbering scheme is as follows:



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.

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

2.12 Switch off all control circuit breakers located in the alternator set control panels, CB2 to CB18 with the exception of CP8 and CP15.

2.13 On the 480V set, determine that the ACB (alternator circuit breaker) located on the set is opened by manually triggering it to open.

2.2 On the 4160 volt set the circuit breaker is located in a separate cabinet. Before any work is anticipated on or around the breaker, verify that no potential is present. Block and tag the engine alternator set so it cannot start.

2.3 Under no circumstances shall the Western Electric installer work on or around the 4160V breaker when it is alive.

2.4 If any work is contemplated on the 480V 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.

2.5 Commercial power may still be connected to the set, such as TB2, Terms 701, 702, 703 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.

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

2.7 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.

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

2.9 The ignition system is a high voltage system so avoid any contact until the ignition exciter has been rendered inoperative. Do not operate exciter with out the igniter plug connected and grounded.

3. CAUTIONS

3.01 Do not connect the J-86743B Universal Solid State Controller until the Control Battery polarity has been checked. Follow the procedure in Paragraph 16.

3.02 Make sure CB7 and CB8 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 rectifiers by removing an ac input fuse from the rectifier before disconnecting the charge battery leads, if disconnecting is found to be necessary.

3.07 After six 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 Remove any shipping details that may have been used around the coupling, oil cooler, etc.

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

3.11 Do not hand rotate the engine in a reverse direction.

3.12 THE ENGINE IS SHIPPED VOID OF LUBRICATING OIL. APPROXIMATELY 175 GALLONS OF OIL MUST BE ADDED BEFORE CRANKING OR BEFORE ATTEMPTING TO START THE ENGINE FOR THE FIRST TIME. See Paragraph 44.

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 A shipment of accessories will be furnished with the engine along with a complete check list. Included will be such items as two ball valves, three isolation pads, touch-up paint, mechanical installation drawing, exhaust flex section with bolts and gasket, transition section with bolts and gasket, two NATCO manuals, etc.

5. DESCRIPTION

5.1 The emergency turbine engine alternator set is rectangular in shape and weighs 24,555 pounds when equipped with the 480 volt alternator. When equipped with the 4160 volt alternator the unit weighs 24,150 pounds. It measures 16 foot 9 inches long, 5 foot 7 inches wide and 8 foot 3 1/2 inches high. The set is equipped with four lifting eyes attached to the four corners of the base. In its final location, the set rests on three isolation pads, two under the alternator and one at the end of the turbine.

5.2 The Viking II gas turbine engine is built by the KONGSBERG VAPENFABRIKK Company in Kongsberg, Norway. Its poorest performance rating is 1800 horsepower and under optimum conditions (air temperature, altitude, etc.) the engine will develop 2200 horsepower. (Its ISO rating is 2162 shaft horsepower.) When used with this package, it operates at 18,000 RPM. Intake air is picked up by the single stage air compressor and compressed 3.5 to 1. This compressed air is forced into the combustion chamber and mixed with fuel from the fuel nozzles. It is ignited and the expanding gases drive a single stage set of turbine blades. The reaction of the expanding hot gases with the turbine blades produce the axial power. The exhaust gases are then expelled into the exhaust duct and straight out the rear of the set. The 18,000 RPM engine connects to the input shaft of a 10 to 1 gear reduction unit. The output drives an 1800 RPM alternator.

5.3 The alternator is built by Ideal, in Mansfield, Ohio. It is a two bearing, forced air cooled frame, 3Ø - 3W when 4160 volt or 3Ø - 4W when 480 volt. It is rated at 1562.5 kVA and 1250 kW (.8 power factor)

5.4 The whole package, except for the J-86743B Universal Controller, is assembled by the

NORTH AMERICAN TURBINE CORPORATION
11500 CHARLES STREET,
P.O. BOX 40510
HOUSTON, TEXAS 77040

NATCO provides service on all components except the controller. Service for the set may be obtained through W. E. Purchased Products Engineering and Inspection located at 50 Lawrence Road, Springfield, N. J. 07081. When referring to the engine identify it as a NATCO II and not a Viking II.

5.5 The Universal Controller is built by W.E. at the Kearny Works, 200 Central Ave., Kearny, N. J. 07032.

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

6. BATTERIES

6.1 Two Lead-Calcium type industrial version battery strings are provided. One string is made up of six four-cell units and is used for engine start. This battery has a fully charged specific gravity of 1.250, rated at 420 Ampere Hours and connected to furnish -48 Volts.

6.2 The other battery is made up of four three-cell units and is used for systems control (for operation of the J-86743B Controller, relays, etc.) This battery too, has a fully charged specific gravity of 1.250, rated at 10 Ampere Hours and connected to furnish -24 Volts.

6.3 Install the batteries and bring the electrolyte up to the minimum level with approved water. Connect and verify the polarity.

6.4 Adding larger amounts of water over a longer period of time is preferred to frequent additions, however, water must be added when the low-level mark is reached.

7. BATTERY CHARGING RECTIFIERS

7.1 Two La Marche battery chargers are furnished, one for each of the batteries.

7.2 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.

7.3 Verify all connections. Because of the high current required for starting the engine, cleaning, greasing and tightening is a very important procedure and requires careful attention.

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

7.5 Start the charge in accordance with Installation Engineering Handbook 18, Section 19 as soon as possible and record results on SD-4-1285 Storage Battery Report. Indicate on the form for each battery, that the fully charged specific gravity is 1.250. 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.

7.6 After fully charging the batteries, set the charger at 2.23 volts per cell. On the 24V charger it would amount to 26.75 and on the 48V charger it would be 53.5. After several days with no discharge from the batteries the voltage range should be readjusted as required, to between 2.2 and 2.25 volts per cell.

8. PARALLELING

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

8.2 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 ITE-5913 Portable Phase Angle Meter may also be used to an advantage in conjunction with the synchronizing lights.

8.3 When the J-86742 Automatic Paralleling and Load Management Bay is provided with two to six engines, it is necessary to first manually parallel each engine with the others. This assures correct droop settings, cross current compensation,,phasing, etc. See Section 265.

9. MAJOR ALARMS - TROUBLE SHUTDOWNS

9.1 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 Fault Indicator module, Temp Monitor module Alarm Control, Auxiliary Alarm Control module or Power Supply module. A customer furnished horn will sound and a signal sent out to any connected alarm circuit.

MAJOR ALARM	FAULT INDICATING MODULE
HET High Exhaust Gas Temperature	Fail Indicator Fail Indicator
OS Engine Over Speed	Fail Indicator
LOT High Lube Oil Temperature	Fail Indicator
LOP Low Lube Oil Pressure	Fail Indicator
REV PWR ALTNR Reverse Power	Fail Indicator
OC ALTNR Overcurrent - Short Circuit	Fail Indicator
OV ALTN Overvoltage	Fail Indicator
UNDERVOLT Undervoltage	Aux Alarm Cont
DIFF FAULT Differential Current Fault	Aux Alarm Cont
VIB FAULT Vibration Fault	Alarm Cont
MJ CB Major Circuit Breaker Open	Fault Indicator
US PROBE Underspeed Probe	Fault Indicator
CRANK 1 Cranking Failure 1	Fail Indicator
CRANK 2 Cranking Failure 2	Fail Indicator
CRANK 3 Cranking Failure 3	Fail Indicator
CRANK 4 Cranking Failure 4	Aux Alarm Cont
TEMP PROBE Open Temperature Probe	Temperature Monitor
Control Power Supply Failure	Power Supply

NOTE: After shutdown from any malfunction or emergency stop, it is necessary to operate the OSS to OFF and then back to the desired operating position to reset the alarms. If shutdown was the result of operating the EMERGENCY STOP push button, or a control power supply failure, it will also be necessary to reset the control circuit breaker CB7.

10. TIMERS

10.1 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.

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

11.1 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.

11.2 When the OSS is in OFF the set is not available for operation. (All functions are blocked except purge cranking). The red SW OFF NORMAL lamp will be illuminated informing the operator that the set cannot be started manually or will not start automatically.

11.3 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 BREAKER - OPEN green light and switch, and CIRCUIT BREAKER - CLOSE red light and switch), and the office load must be transferred manually at the ac switchboard, i.e., NCB opened and ECB closed.

11.4 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 transfer back to commercial power is made, the ACB will open automatically. Otherwise the ACB can be opened by operating the CIRCUIT BREAKER - 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 not start automatically.

11.5 When the OSS is in AUTO and there is a commercial power failure, the set will power up the control circuit, 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.

11.6 When a remote bay 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 intended as the normal location for operating the set.

11.7 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.

12. MINOR ALARMS - CAUTION

12.1 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

13. CIRCUIT BREAKERS

13.1 The following circuit breakers, either manually opened or electrically tripped, will bring in a Major Alarm:

CB3	Voltage regulator 240V 1Ø
CB6	General metering and relaying circuits
CB7 and CB8	Engine Control Circuit Packs (CB7 operates on under voltage and will trip CB8, therefore CB8 must be closed first)
CB9	3Ø Voltage regulator
CB16	Speed and load controller

13.2 The following circuit breakers, either manually opened or electrically tripped, will bring in a Minor Alarm:

CB2	480V to 240V transformer for control circuits
CB4	Customer Commercial Power - 208V 3Ø sensing circuit
CB5	Watt tranducer and CB1 motor
CB10	Lube oil cooler motor
CB11	3Ø 480V Customer Protected Service (Lube oil cooler motor)
CB12	Sync lights 3Ø
CB13	Oil sump heater
CB14	120V AC Customer Protected Power (Generator winding heater)
CB17	Power factor transducer, Watt transducer Voltmeter
CB18	Sync lights 3Ø

14. SET POINTS

14.1 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. > = Greater Than - < = Less Than.

Fuel Isolation Valve Open	Opens when starter is enabled.
Crank 1 (NO-CRANK Timer) (Locked Rotor)	< 5% Speed in 5 Seconds after starter is enabled.
Crank 2 (NO-LIGHT Timer)	After 5% Speed, > 400°F EGT within 24 Seconds
Crank 3 (Fail to Start or Accelerate)	After 95% Speed, within 200 Seconds after start initiation.
Crank 4 (Overcrank)	After light-off and with EGT > 400°F, engine fails to attain 45% Speed in 40 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.)
Oil cooler timer or Post Lube Timer	35 Minutes
Igniter on	12% Speed
Main Fuel Solenoid Open	12% Speed
Engine Light-Off	12-20% Speed
Starter Drop-Out	45% Speed
Igniter off	45% Speed
Alternator Excitation	95% Speed
Overspeed Shutdown	108% Speed
Alternator Reverse Power Protection	200kW ± 25KW
Pending High Exhaust Temperature	1070°F
High Lube Oil Temperature	147°F ± 2°F
Coast Down Timer	3.5 Minutes
High Exhaust Temperature Shutdown	1189°F
Low Lube Oil Pressure	< 10 PSI when engine speed is > 45% rated speed
Oil Pressure - Permit to Crank	2 PSI or greater
Low Fuel Storage Tank Level Alarm	fuel level < gauge setting fuel tank
Alternator Over Current or Short Circuit	Overload tripping of set breaker
Ground Fault	Adjustible from 2.8% to 18% FL Current

14.1 cont'd

Overvoltage	$>$120% $\pm$ 2% of rated alternator output after Warm-Up timer times out.
Rectifier Failure	battery charger failure
Low Oil Sump Temperature	$<$50°F
Control Breaker Off	CB8 open or tripped
Under Speed Probe	$<$95% speed after attaining $>$95% speed
Temperature Probe	Inlet compression air probe open - OR - $<$400°F on exhaust probe and $>$45% rated speed (exhaust temperature probe open or shorted)
Vibration Fault	$>$9G $\pm$ 0.2G

14.2 The nominal output voltage of the alternator is monitored to determine it does not fall below an acceptable minimum. Paragraph 9 indicates the Under Volt lamp is on the Aux Alm-Cont board and indicates a Major Alm resulting in an engine shutdown. The setting is as follows:

Under Voltage	$>$ 85% $\pm$ 2% nominal alternator output voltage after Warm Up Timer times out

14.3 The Control Power Supply Fail lamp on LL38B will shut the set down when the DC system control voltage fails or fails to regulate. CB7 will trip on under-voltage and trip CB8. CB8 must be closed first.

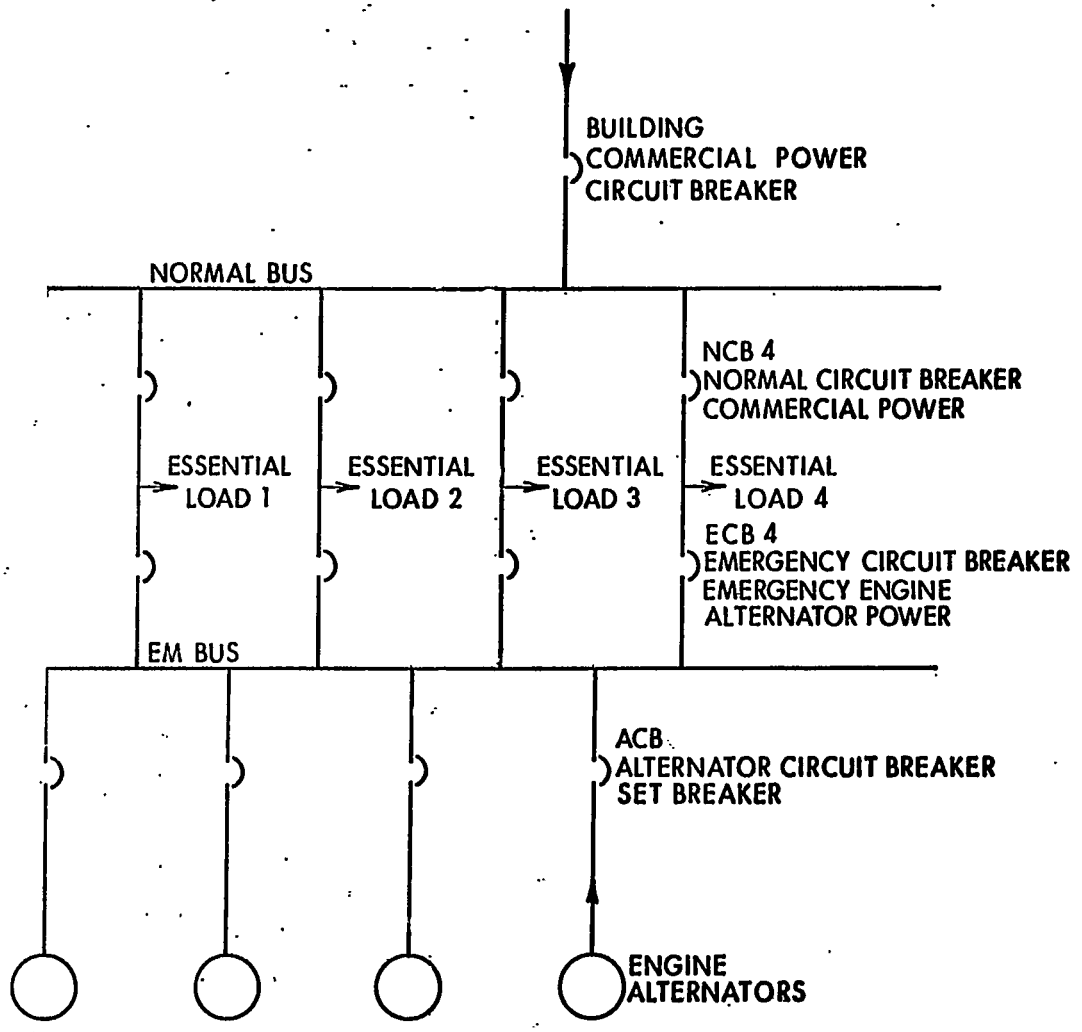


FIGURE 1.

TYPICAL CENTRAL OFFICE CIRCUIT BREAKER
AND BUS ARRANGEMENT.

PAR; 11.5, 56.2

15. PLACING THE UNIT

15.01 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.

15.02 The floor shall be laid out in agreement with job drawings which correspond to the outside dimensions of the set. Lift out the floor tiles or any other floor covering in the area where the three isolation pads will rest. The pads must rest directly on the concrete floor. Tiles need not be cut and fitted around the isolation pads except in the area when they would show from the outside of the set.

15.03 Arrange with the rigger to place the set in its final location. To obviate the need for subsequent jacking and lifting for the purpose of leveling, it is suggested the three isolation pads be placed and shimmed as necessary while the rigger is still there. The set is not equipped with jacking screws. When necessary to lift with jacks they should be placed under the lifting eyes. Three point support eliminates the need for assuring the proper loading on each pad and facilitates greatly the leveling procedure.

15.04 Level the set from side to side first. Use steel shims obtained locally. The shims should be cut so they are the same size as the pads. When more than one shim is required between the pad and the floor they shall be made up by folding a single piece, or, separate shims shall be rivited or welded together.

15.05 Level the set from end to end by shimming the single isolation pad or by shimming the two opposite pads, as required, until the set is level $\pm$ 1/8" end to end.

15.06 The set is equipped with 4 lifting eyes bolted to the base. After the set is in its final location and leveled, remove the eyes and turn them over to the customer.

15.07 To insure proper air flow and sound attenuation, the area between the base and the floor has to be sealed.

15.071 Strips of sealing material, furnished with the engine, shall be cut to length and friction fitted completely around the periphery between the base and the floor.

15.072 If appreciable shimming was necessary to level the set it is possible that heavier sealing material may have to be procured locally.

15.08 See additional information in the NATCO Manual furnished with the set.

15.09 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.

15.10 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.

16. INSTALLING THE J-86743B UNIVERSAL CONTROLLER

16.1 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 (-).

16.2 With control circuit breakers open (CB7 and CB8), install the chassis of the Controller, with all circuit packs removed.

16.3 Mount the chassis and align with shims furnished.

16.4 Install P1, P2, P3 and P4 into the bulkhead connectors. These bulkhead connector sockets J1, J2, J3 and J4 are found behind the control panel.

16.5 Install LL38B Power Supply into the correct slot and socket.

16.6 Close CB8. This verifies battery polarity and connections to the circuit packs. If CB8 cannot be closed check battery polarity, connections and Remote Emergency Stop Buttons for correct operation. Emergency Stop Buttons are normally closed. CB8 must be closed first. While observing the CONTROL POWER SUPPLY FAIL lamp on LL38B, close CB7. The lamp should blink red for approximately 1/2 second and then go out.

16.7 Open CB7 and CB8.

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

17. INSTALLING THE DUCTS

17.1 Four duct connections are required.

(1) The combustion air into the engine air compressor

(2) Engine exhaust air

(3) Enclosure cooling air intake and

(4) Enclosure cooling air exhaust. This duct is located on the engine end and is arranged to vent out the end or straight up depending on the location of a blocking plate.

17.2 Duct work is usually arranged for, by WE, with those experienced in this field. The engine exhaust duct temperature operates at approximately 1,000°F at full load and must be insulated. The W.E. installer should not be involved in applying any insulating material containing asbestos since extensive preparation, including monitoring and protective clothing with forced filtered air attachments, is required. The BTL recommended insulating material, void of asbestos, is eleven inches of KALO-10 insulation by Owens Corning.

17.3 Before any duct work is started, verify the wiring to the thermo couples. Check junction boxes for correctness and tightness.

17.4 The combustion air inlet duct shall not be assembled with common nuts or sheet metal screws on the inside of the duct. Self locking nuts, similar to Elasta-Stopnuts, are acceptable. After complete assembly, this duct shall be vacuum cleaned.

17.5 Make sure all ducts are clean and clear of tools and debris.

18. CONNECTING THE FUEL LINES AND COMBUSTOR DRAIN

18.1 The drawing usually furnished as a typical arrangement for the fuel tank, lines etc., is ED-82828-30.

18.2 Attach the fuel lines, feed and return, to the base at the end adjacent to the turbine engine.

18.21 Facing the front of the set (standing in front of the control panel) the fuel suction (feed) and fuel return (excess from the pump returned to the tank) connections are on the left side of the set below doors 1 and 2.

18.22 Facing the left side, the first connection on the left (30 3/4" from the rear of the set) is the "combustor" Fuel Oil Drain. If fuel oil appears at this overflow drain it indicates the fuel collector reservoir is full and must be emptied. This drain must be left open. DO NOT CAP OR BLOCK. The next connection (3/4") is the Fuel Oil Inlet or suction line (feed) and this is 35 1/4" from the rear of the set. The next connection (3/4") is the Fuel Oil Bypass Return line and this is 53 1/4" from the rear of the set. The fourth opening is the Reservoir Drain and this opening must be kept plugged.

19. GENERAL - STATIC TESTING

NOTE: On start-up, the prelube/postlube pump will run until the engine has reached 95% speed. It also operates when the engine is running and the ACB is open. The pump continues to run 30 minutes after a normal shutdown, but, if only Purge Cranked, it operates only for as long as the Coast Down timer setting.

19.1 Switches and Breakers

19.11 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.

19.12 AC Circuit Breakers CB2, CB3, CB4, CB5, CB6, CB9, CB10, CB11 and CB15, the majority of which are located behind doors No. 4, should be closed. All other circuit breakers including CB7 and CB8 (dc circuit pack power), CB13, etc., should be open.

19.13 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 CB7 and CB8 to OFF, restoring them before the next test.

19.2 Alarms

19.21 Throughout the tests, when the audible alarm is activated, depress the ACO 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.

19.3 Wiring

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

19.4 Circuit Packs

19.41 This 1250KW Gas Turbine Engine Alternator uses the J-86743B Universal Controller equipped with the following circuit packs;

CIRCUIT PACK NUMBER	NAME	APPARATUS CODE
CP1	AC VOLT MONITOR	LL31
CP4	CKT BRKR CONTROL	LL34
CP	POWER SUPPLY	LL38B
CP9	MULTI-SET MODULE	LL39
CP10	AUX. ALM CONT	LL40
CP11	TIME CONT LOGIC	LL42
CP12	START LOGIC	LL43
CP13	FAIL INDICATOR	LL35B
CP14	TEMP MONITOR	LL46
CP15	SPEED MONITOR	LL47

Make sure all circuit packs are installed and are fully seated.

19.42 Potential transformers are used to reduce the 480 volts to 200 (2.4 to 1) or the 4160 volts to 208 (20 to 1) as an input voltage to the LL31 AC Voltage Monitor module. Verify this arrangement.

19.43 When two or more sets are arranged for parallel operation, an additional circuit module LL39, will be provided. The factory will set internal screw switches and make internal adjustments to account for the 480V or 4160V sets.

20. LESS THAN 2 PSI LUBE OIL PRESSURE - CRANK INHIBIT

20.1 On initiation of Crank (START CRANK OR PURGE CRANK) the electrically operated lube oil pump is energized. The engine is permitted to crank when the 2 PSI minimum LOP switch operates. If for any reason the switch fails to operate (failure of lube system or switch) a crank attempt will be aborted.

20.2 In order to test this feature separate and insulate the leads on TB19, Term 361. TB19 can be found behind door 6. With CB7 and CB8 closed (all other breakers closed and OSS OFF) depress and hold PURGE CRANK push button on the Start Logic module. Note that the lube oil pump is running and the fan is running. They may have been running due to other timers not being reset when CB7 and CB8 were closed. Note that the CRANK lamp on the Start Logic module does not illuminate and the starter does not energize. Observe for fifteen seconds and release PURGE CRANK push button.

20.3 Open CB7 and CB8.

20.4 Replace leads on TB19 Term 361.

20.5 For the remainder of static testing, inhibit starting by disconnecting lead 370 from the STR stater relay located behind the front panel.

21. LAMP TEST

21.1 Close CB7 and CB8. 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

22. CRANK 1 TEST

22.1 The Crank 1, 2 and 3 lamps on the Fail Indicator module and Crank 4 lamp on the Aux. Alm Cont module indicates four cranking failures under various modes and times. Crank 1 condition exists if the engine fails to attain 5% speed within five seconds (locked rotor test).

22.11 In actual practice, immediately after a shutdown an attempt to start (actual or simulated) is delayed 3 1/2 minutes while the Coast Down Timer times out. These delays will be evidenced by a blinking COAST DOWN lamp on the Time Control Logic module when it is timing.

22.12 Open CB7 and CB8.

22.2 Remove, tag and tape Magnetic Speed Pickup No. 99T1 leads from TB19, Terms 120 and 121. Make sure the Magnetic Pickup leads are removed and not the internal wiring to the circuit packs.

22.3 Connect the square wave output of the ITE-5518 Oscillator between Terms TB19, 120 and 121 using instrument clip leads. Make sure ITE-5518 Oscillator is not grounded ("U" grounding pin not connected on the ITE-5517). Use R3184 Adapter and insulate the third wire or grounding wire. 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.

22.4 Vary the oscillator to 100 Hz. Set the output to approximately 3 volts as read on the digital multimeter. Close all breakers except CB13. Turn OSS to MAN and allow the Coast Down Timer to time out (lamp fully illuminated on LL42) before proceeding. Depress the MANUAL START pushbutton. If engine begins to crank, immediately turn OSS to OFF and check earlier Paragraph 20.2 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 and the local and remote major alarm should sound indicating a shutdown condition. Operate the ALARM CUTOFF and turn OSS to OFF and back to MAN to clear the alarm.

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

23. CRANK 2 TEST

23.1 The Crank 2 Failure condition exists if, after 5% speed, the engine does not reach an exhaust temperature greater than 400°F within 24 seconds.

23.2 Set the oscillator to 450 Hz (equivalent to approximately 15% speed) at a level of approximately 3 volts. Turn oscillator off. Allow Coast Down Timer on LL42 to time out (COAST DOWN lamp fully illuminated) before proceeding. Depress the MANUAL START push button. When Crank 2 lamp (lamp between 1 and 3) on LL35B comes on, within three seconds turn on oscillator. The FUEL LAMP on LL43 will illuminate for 24 ±3 seconds and shutdown should occur. The local and remote major alarm should function indicating a shutdown condition.

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

24. CRANK 3 TEST

24.1 The CRANK 3 failure condition exists if the engine fails to reach 95% speed within 200 ±20 seconds as measured from when a start signal was initiated.

24.11 To mask an open probe shut-down it will be necessary to simulate a temperature greater than 400°F.

24.12 It will also be necessary to mask a low oil pressure shut down by temporarily installing a jumper.

24.2 With the OSS in OFF and CB's 7 and 8 open, remove Temp Monitor module LL46.

24.3 Close screw switch S1-1. If an extender board is available insert into the socket and connect the Temp Monitor module to the extender. Attach alumel lead-(Red) to TP-1 and chromel lead + (Yellow) to TP-2 from the ITE-5521 Temperature Simulator using extensions of smaller gauge wire if necessary. If an extender is not available, attach alumel-chromel leads to LL46 with small gauge extensions and reinsert LL46 back into its socket. Behind the control panel, disconnect thermocouple connector plug P4.

24.4 Place temporary jumper between TB4, Term 326 and TB5, Term 343. TB4 and 5 are behind door 6.

24.5 Close CB's 7 and 8 and with the ITE-5521 Temperature Simulator connected to 115V ac, vary the setting to 500°F ± 20°F.

24.6 Set the oscillator to 2,500 Hz at a level of approximately 3 volts. Place the OSS in MANUAL and allow the COAST DOWN TIMER (LL42) to time out (fully illuminated lamp) before proceeding.

24.7 Depress the MANUAL START pushbutton. Observe that the FUEL lamp on the Start Logic module is illuminated for 200 ± 20 seconds.

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

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

25. CRANK 4 TEST

25.1 Crank 4 failure exists if the engine does not reach 45% speed before the Overcrank timer times out in approximately 40 seconds after EGT is >400°F.

25.2 Set the oscillator to 1200 Hz (equivalent to approximately 40% speed) at a level of approximately 3 volts. Turn Temperature Simulator off. Allow Coast Down Timer on LL42 to time out (lamp fully illuminated) before proceeding. Depress the MANUAL START push button and turn Simulator on. Observe that the CRANK on the Start Logic module illuminates. Shutdown should occur in 40 ± 4 seconds after Simulator is turned off.

25.3 The CRANK 4 lamp lights and shutdown should occur.

25.4 Clear the alarms as covered in Paragraphs 19.21.

26 OVERSPEED

26.1 The overspeed failure condition exists if the engine reaches 108% of its nominal operating speed.

26.2 Increase the oscillator frequency output from 2,500 Hz until the OS lamp lights on the Fail Indicator module. This should occur at 3240 Hz ± 20 Hz. The local and remote alarm should sound. Clear alarm as covered in Paragraph 19.21.

27. LOW LUBE OIL PRESSURE - LESS THAN 10 PSI

27.1 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 10 PSI when the engine speed is greater then 45%.

27.2 Set oscillator at 1450 Hz (approximately 48% speed) and at a level of 3 volts. With OSS in MAN, remove jumper between TB4, Term 326 and TB5, Term 343.

27.3 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. Clear alarms as covered in Paragraph 19.21.

27.4 Turn OSS to OFF and open CB's 7 and 8. Disconnect the oscillator and reconnect Magnetic Pickup No. 99T1 to Terms 120 and 121 on TB19 (door 6) observing the proper poliarity. (white lead to 121 and black lead to 120.)

28. GOVERNOR AND SPEED (FREQUENCY) DROOP

28.1 No test is contained in this section 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.

28.2 Behind the control panel in the lower left corner is a panel mounting a rheostat and two switches. The lower switch is marked DROOP SW and works in conjunction with Woodward 2301 Load Sharing and Speed Control panel at the top of the panel. When the switch is operated up to the ISOCHRONOUS position all droop is eliminated and when operated down to the DROOP position the amount of droop is determined by the settings of the two potentiometers on the right side of the Woodward 2301. One is marked DROOP and the other DE-DROOP.

29. VOLTAGE DROOP

29.1 The Voltage droop is controlled by the upper switch and the rheostat. The switch is marked PARALLEL SW. The up position is marked PARALLEL and down position is marked UNIT.

29.2 For single set operation, the voltage droop switch should be operated to the UNIT position.

29.3 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.

30. MAGNETIC PICKUP NO. 99T2

30.1 Magnetic pickup No. 99T2 feeds signals to the governor. Since proper operation of the governor depends upon proper operation of Magnetic pickup No. 99T2, a separate test for this pickup is not indicated.

31. LIGHT OFF TEMPERATURE

31.1 The temperature monitor circuit has been factory calibrated to monitor the inlet and exhaust air temperatures. Verify the set points as follows:

31.2 With the ITE-5521 Temperature Simulator connected, as covered in Paragraph 24, reduce the setting to about 200°F.

31.3 Increase the temperature and approach 400°F slowly and check that the EXH TEMP >400°F lamp on the Temperature Monitor module lights within the range of 400°F ± 20°F.

32. PENDING HIGH EXHAUST TEMPERATURE

32.1 Further increase the temperature setting on the Simulator and observe that the PHET lamp on the LL35B Fail Indicator module lights at 1025 ± 20°F. Increase the temperature until the HET lamp on LL35B Fail Indicator module lights. The temperature at which it comes on should be 1189°F ± 25°F. The Major alarm will sound.

32.2 Open CB's and turn OSS to OFF.

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

32.4 Open screw switch S1-1.

32.5 Reconnect the P4 thermocouple connector.

33. HIGH LUBE OIL TEMPERATURE

33.1 Close CB7 and CB8.

33.2 With OSS in MAN, momentarily jumper with a length of wire, Terms 320 to 402 on TB19 (door 6).

33.3 Verify that the LOT lamp on Fail Indicator module is lit and that MAJOR ALARM lamps on the local and remote panels are lit. See Paragraph 19.21.

34. LOW OIL-SUMP-TEMPERATURE

34.1 The OIL TEMP LOW lamp on the LL40 Aux Alm Cont module will illuminate and the minor alarm will respond if the temperature of the lube oil falls below 50°F.

34.2 With OSS in MAN and CB's 7 and 8 closed, momentarily place a jumper across TB19, Term 406 and TB4, Term 326. Observe that the OIL TEMP LOW lamp lights and the Minor alarm sounds.

35. DIFFERENTIAL FAULT SHUTDOWN

35.1 The Dif Flt Relay located on the set will operate when a ground occurs on one of the alternator (current) conductors. Operation of the relay will shut the set down and illuminate the DIFF FAULT lamp on the LL40 Aux Alarm Cont module. The Major Alarm will sound.

35.2 Momentarily place a jumper from TB4, Term 326 to TB19 Term 403 and observe the DIFF FAULT lamp lights and the Major Alarm sounds. Clear the alarm as explained previously.

36. VIBRATION SHUTDOWN TEST

36.1 Turn OSS to OFF and open CB7 and CB8.

36.2 Disconnect and tag vibration pickup leads from Terms 140 and 142, both on TB19. Take care not to disconnect the leads going into the controller. Turn the output (voltage level) of the oscillator all the way down and connect to Terms 140 and 142 on TB19. Set oscillator to 300 Hz as read on the dial.

36.3 Turn on oscillator and close CB7 and CB8. Observe the milivolt output of the oscillator as the oscillator voltage level is slowly increased. On the Aux Alm Cont. module, observe the following lamps correspond to the voltage indicated:

100 millivolt	± 20mV	GREEN 2G's LAMP
200	30	GREEN 4G's
300	30	AMBER 6G's
400	30	AMBER 8G's
500	30	AMBER 10G's

After reaching 500mV decrease oscillator output voltage to 100mV. Turn OSS to OFF and then to MAN. Slowly increase voltage and observe that the VIB FLT (vibration fault) lamp on the Aux Alarm Cont. module illuminates and the Major Alarm sounds when the voltage level reaches 450mV ± 20mV. Clear alarm, open CB7 and CB8, disconnect oscillator and reconnect vibration pickup leads to TB19, Term 140 and 142.

37. LOW FUEL ALARM

37.1 With CB7 and CB8 open, jumper with a length of wire between TB4, Term 320 and TB5, Term 350. Close CB's. TB4 and TB5 are behind door 6.

37.2 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.

37.3 Open CB's and disconnect jumper between Term 320 and 350.

38. BATTERY CHARGING RECTIFIER FAILURE

38.1 With CB7 and CB8 open, temporarily jumper with a length of wire between TB4, Term 326 and TB6, Term 358. Close CB's.

38.2 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.

38.3 Open CB's and remove jumper between Terms 326 and 358.

39. OVER CURRENT SHUTDOWN

39.1 With CB7 and CB8 open, temporarily jumper with a length of wire between TB17, Terms 320 and 401. Close CB's.

39.2 Observe that the OC lamp on the Fail Indicator module lights and that MAJOR ALARM lamps on the local and remote panels are lit.

39.3 Open CB's and remove jumper between Terms 320 and 401.

40. MINOR CIRCUIT BREAKER ALARM

40.1 See Paragraph 12. With dc CB7 and CB8 closed, open ac CB2 (Breakers were closed in paragraph titled "General-Static Testing - Switches and Breakers").

40.2 Observe that the MNCB lamp lights on the Fail Indicator module and that the MINOR ALARM lamp on the local and remote panel is lit. Close CB2.

40.3 Repeat the two above paragraphs for each of the following circuit breakers: CB4, CB5, CB10, CB11, CB12, CB13, CB14, CB17 and CB18.

41. MAJOR CIRCUIT BREAKER ALARM

41.01 See Paragraph 9.1

41.02 Close all control CB's and turn OSS to OFF.

41.03 Depress EMERG STOP (Emergency Stop) push-button on the front of the control panel. CB7 should trip open.

41.04 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.

41.05 Reclose CB7 and open CB9.

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

41.07 Reclose CB9 and open CB16.

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

41.09 Reclose CB16 and open CB3.

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

41.11 Reclose CB3 and open CB17.

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

41.13 Reclose CB17.

42. COUPLING REQUIREMENTS

42.1 The coupling is shipped in place. It need not be removed but must be checked by the NATCO field representative in connection with maintaining alignment of the alternator after shipment. No initial lubrication is required, however, the operating company will have to arrange for relubrication of the coupling and installation of new coupling gaskets after 2,000 operating hours. Other documentation covers this instruction to the customer.

43. LUBE OIL DRAIN

43.1 The engine is drained of lubricating oil before it is shipped from the factory.

43.2 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.

43.3 Sixty-Six and seven sixteenths inches from the rear of the set on both sides is the Lube Oil Reservoir Drains. If equipped with valves, open both valves and drain any residue oil that would have drained down during shipment. Close valves. If not equipped with valves, remove plugs or caps and drain residue. Install one ball valve (furnished with the accessories) on each side of the set. Close valves.

44. FILLING THE ENGINE WITH LUBRICATING OIL

44.1 The lube oil sump is equipped with an oil heater that maintains the oil temperature at 80°F + 5°F. The thermostat is adjustable from 50°F to 250°F. Verify that CB13 that feeds the sump heater is OFF. See Paragraph 19.1.

44.2 Verify the two drain valves on each side of the engine (Paragraph 43.3) are closed. Also verify the third Lube Oil Reservoir Clean Out opening is closed. Usually this will appear as a 4" 150# capped flange located in the front center of the set.

44.3 The approved lubricating oil is KS-21273. One of the oils satisfying the KS spec is a synthesized hydrocarbon, Mobil SHC 824. The oil will be furnished by the customer. A lube oil level indicator shall be furnished and factory mounted on the top right side of the lube oil sump.

Yellow = low

Green = acceptable level

Red = too full

44.4 Add 175 U. S. gallons of approved oil. Add the last portion slowly allowing time for the oil to settle while observing the level indicator.

44.41 Cleanliness of the oil and of the handling equipment is of utmost importance since the input shaft speed, from the turbine, is 18,000 RPM.

45. PRIMING THE LUBRICATING OIL LINES

45.1 The oil cooler is situated in the uppermost area behind door 7 and extends slightly into the area behind door 8. The oil is cooled with a fan which pulls air down through the cooler and into the engine compartment.

46. PRIMING THE FUEL SYSTEM

46.1 To ensure proper operation of the turbine the day cup must be filled and all the lines and filters on the set must be filled with fuel and free of air. Low on the right side behind door 1 is the rotary fuel priming pump.

46.2 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 Day Cup.

46.21 The Day Cup is located behind door 2.

46.3 The fuel priming pump is a rotary hand pump located low on the right side behind door 1. There's a bypass valve located low in the base below the pump. Operate the handle 90° to Prime and crank the pump until fuel is freely flowing into and out of the Day Cup. Return the bypass valve to the Run position. (closed)

46.4 Operate the FUEL PRIMING pump until the Fuel Cup is filled.

46.41 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.

47. AUXILIARY SYSTEMS

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

48. PREPARATION FOR INITIAL START

48.1 Place the OSS in OFF on both the local and remote cabinet. If open, close CB7 and CB8. Turn TRANSFER SELECTOR switch to MAN. SW OFF NORMAL lamp should light. Open CB7 and CB8.

48.2 Reconnect lead 370 on STR starter relay. See Paragraph 20.5.

48.3 For single set operation, operated the voltage droop switch marked PARALLEL SW to the UNIT position. See Paragraph 29.1. For parallel operation, see Paragraphs 8 and 29.

48.4 Disconnect and tag the external leads CB9 on TB10, Term 440 and TR15 on TB10, Term 442. These are the control leads that operate the NCB Normal Circuit Breaker (commercial power).

48.5 Disconnect and tag the external leads LB6 on TB10, Term 436 and TR16 on TB10, Term 438. These are the control leads for the ECB Emergency Circuit breaker. Potential transformers are required on both the 480V set and the 4160 volt set.

48.6 Turn synchronizing light switches to OFF.

48.7 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. On the 4160 volt alternator the load boxes must be connected to the load side or output of the transformers. The 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.

48.8 Verify the following;

48.801 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.

48.802 Control leads and other customer connections secure.

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

48.804 Lubricating system drain valve closed and not leaking and lube oil at proper level. Condensate drain valve in exhaust system closed if provided.

48.805 Fuel line connections tight.

48.806 Verify with the operating company that the fuel meets Bell System requirements for this set.

48.807 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. See Paragraph 17.

48.808 Room sufficiently ventilated.

48.809 Shipping covers removed from engine inlet and exhaust duct.

48.810 Engine exhaust duct properly supported.

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

48.812 Check wiring to boost pump, fuel shut off and control valves, ignition exciter, and magnetic pickup. Thermocouple plugs were verified in Paragraph 17.3 before the duct work was complete.

48.813 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.

48.814 Check to make sure the air stop strips are in place all the way around the base between the base and the floor.

49. HIGH CURRENT STARTING CIRCUIT

49.1 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.

50. EMERGENCY STOP SWITCHES

50.1 The EMERGENCY STOP pushbutton is located slightly lower left of center on the engine control panel. They are also located on the remote cabinet, when furnished, and just outside of the doors to the emergency engine alternator room.

50.2 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 stopped because of the testing of a major malfunction.

51. START DYNAMIC TESTING - EXHAUST TEMPERATURE - OPEN PROBE

NOTE: The NATCO 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, of the coupling and line-up of the alternator, (2) the pre lube and post lube of all bearings and purging of air from all lube oil lines, (3) that the set is level, etc. See Paragraph 1.06.

NOTE: If at any time it is necessary to shut the set down in an emergency, depress the EMERGENCY STOP pushbutton located on the control panel.

51.1 Operate CB7 and CB8 to ON and turn OSS to MAN. Depress the MANUAL START pushbutton located directly above the OSS. The prelube pump starts and remains energized until 95% speed has been reached. 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. Be receptive to any unusual or excessive vibration or noise.

51.2 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 to the controller. The set will shut down. The postlube pump will remain energized four minutes after the stop command. The TEMP PROBE lamp on the Temp Monitor will illuminate and the Major alarm will sound.

51.3 Reconnect P4.

52. UNDER SPEED AND OPEN SPEED-PROBE

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

52.2 Separate the two leads on TB19, Term 120. The US PROBE lamp at the bottom of the Fail Indicator module should light and the engine should stop. In addition, the CRANK 3 lamp may illuminate if the set has been run more than 200 seconds from the initial start.

52.3 Reconnect the two leads on Term 120.

53. OVERVOLTAGE

53.1 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.

53.2 Connect the ITE-5520 Digital Multimeter (500V range and internal function switch released) to the following terminals:

53.21 On the 4160 volt alternator, on TB18, behind door 3 connect to Terms 711 and 712 for nominal 208V reading. On the 480 volt alternator, on TB3, behind door 6 connect to Terms AV1 and AV2.

53.3 On the control panel, open the lower left door and find the Voltage Regulator. Remove the cage from the regulator.

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

53.5 Mark the setting of the VOLTAGE ADJUST potentiometer on the voltage regulator card.

53.6 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 desire. (Check incoming voltage as a reference by operating the voltage SELECTOR switch).

53.7 Note the value and increase the voltage slowly by readjusting the VOLTAGE ADJUST potentiometer on the voltage regulator until the engine shuts down (approximately 120% of the nominal value).

NOTE: For the 4160V sets the ratio is 20:1 or 208V nominal. For the 480V sets the ratio is 2.4:1 or 200V nominal.

53.8 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.

53.9 Return the VOLTAGE ADJUST potentiometer on the voltage regulator to its original marked position.

54. UNDER VOLTAGE SHUTDOWN

54.1 With the ITE-5520 Digital Multimeter connected, place OSS in MAN. Start the engine by depressing the MANUEL START push-button. After the warm-up timer times out and the set stabilizes, decrease the output voltages by turning the VOLTS ADJ potentiometer on the front of the engine. Rotate the potentiometer slowly. The engine should shut down when the voltage decreases to approximately 85%.

54.2 Observe after shutdown to determine the Under Volt lamp on LL40 is lit. The MAJOR alarm will sound and the local and remote lamp will light.

54.3 Disconnect the ITE-5520 Digital Multimeter. Return the VOLTS ADJ potentiometer on the front of the engine to the nominal value for the office.

54.4 If VOLTS ADJ potentiometer on the front of the panel cannot be turned far enough to reduce the voltage to 85%, it will be necessary to reduce the Volts Adjust potentiometer on the front of the voltage regularor. After the test return the Volts Adjust to the original setting.

55. REVERSE POWER TEST

55.01 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.

55.02 200 kW of load is required. The set is provided with a Reverse Power Test switch located behind the front panel and behind LL39.

55.03 Open CB7 and CB8 and remove the Multi-set Module LL39. Insert extender card and reinsert LL39 into extender. Close CB7 and CB8 and turn OSS to MAN.

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

55.05 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.

55.06 Apply 150 kW of artificial load.

55.07 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.

55.08 Increase the artificial load to 225 kW and again depress and hold the REV PWR TEST switch. The engine shuts/down and the REV PWR lamp lights on the Fail Indicator module. The alternator circuit breaker trips open and the Major Alarm sounds. Release the REV PWR TEST switch.

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

55.10 Turn off CB7 and CB8 and remove extender board. Restore LL39 making sure it is firmly seated.

56. NORMAL (COMMERCIAL POWER) AND EMERGENCY CIRCUIT BREAKERS

56.1 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.

56.2 Reconnect breaker leads disconnected in Paragraphs 48.4 and 48.5 as required for automatic operation and test for proper operation and interlock. See SD-81489-01 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.

57. POWER FAILURE DETECTOR TEST

57.1 With OSS in OFF, turn CB7 and CB8 to ON.

57.2 Verify presence of commercial power on leads CA, CB, and CC by measuring between them. The value should be a nominal 208V if alternator output is 4160V and nominal 200V if alternator output is 480V.

57.3 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 COML PWR FAIL lamp lights on the AC Voltage Monitor module and on the remote cabinet when furnished.

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

57.5 Repeat Paragraphs 57.3 and 57.4 for the CB and CC fused leads. Make sure COML PWR ON lamp is restored after each of the three tests.

58. POWER FAILURE TEST - TSS AUTO

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

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

58.3 Remove one of the commercial power fuses on the commercial bus distribution panel which feeds commercial power to the sensing circuit on the set. (Usually leads designated CA, CB or CC). This will simulate a commercial power failure.

58.4 The set will start, accelerate and come up to 100% speed. After a series of delays (timers) the set breaker or remote 4160V breaker should close energizing the Emergency Bus if the bus is clear.

58.5 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.

58.6 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.

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

58.8 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 or the remote 4160V breaker 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.

58.9 After shutdown a cooling and lubrication period follows. The oil cooler timer will be energized and the post lube pump will be on. The electric oil cooler and electric lube pump will remain in operation for a period after shutdown but they need not be timed out before proceeding.

59. POWER FAILURE TEST - TSS MANUAL

59.1 Operate Transfeer Selector Switch to MAN.

59.2 With the OSS in AUTO, remove a different fuse than removed in the "Power Failure Test - Auto".

59.3 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.

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

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

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

59.7 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 as provided.

60. FUEL SYSTEM MALFUNCTION

60.1 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.

61. FULL-LOAD TEST

61.1 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 or acceptance person must witness the test. Two hours of the Final Acceptance Test will be a full-load and the last half-hour should be at the usual office load or at full-load, (office load suplemented with artificial load) or a combination of the two.

61.2 Parallel: If the set will be paralleled an additional Acceptance Test, in parallel, will be required, in accordance with Section 130 in this handbook and/or Section 265 if the J-86742 Automatic Paralleling and Load Management is provided.

61.3 Records: Record the results of tests on the forms listed in Paragraph 1.11.

62. FINAL OPERATIONAL TESTING

62.1 General:

62.11 Because of the large electrical capacity of the alternator it usually is not necessary to provide sufficient test load (resistive) to cover the maximumm output of the set, i.e., 1250 to 1500 kilowatts. Using out largest test load to date, the ITE-4785 (250kW), would necessitate connecting 5 or 6 units and that would amount to 15 to 18 R-3413 500MCM Wire and Lug Assemblies, approaching a somewhat unwieldly situation at best.

62.12 Each unit is tested at the factory under Western Electric Source Inspection supervision to verify that all Bell System requirements are met, including a full load test. The results of these tests are available to the customer in leu of a full load test.

62.13 An alternative, usually acceptable to the operating company, is to use some office load and some test load. The office load, which usually reflects a lagging Power Factor, is a more stringent test and a more realistic test since it will be imposing the same loads on the set that it would see under an emergency condition.

62.14 Determine from the operating company how much office load can be obtained for the load tests (usually inductive-lagging) up to the limit of the capacity of each machine being tested and this should be supplemented with artificial resistive load.

62.15 Record the results of the preliminary test as well as the final acceptance test on the forms listed earlier.

62.2 Exhaust Back Pressure and Inlet Vacuum (Restriction):

62.21 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 fittings in the ducts are not blocked or otherwise covered when the ducts are lagged (insulated).

62.22 If the fittings 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.

62.23 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 from the combustion air inlet duct can cause the engine irreparable damage.

62.24 When the fittings 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, it will be necessary to connect the open end, via a tube, to the outdoors.

62.3 Preliminary Operations:

62.31 Be sure all side covers on the set are in place and secure.

62.32 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.

62.33 Load boxes should all be checked to make sure they are in working condition and all temporary line and control connections are tight.

62.34 Verify lubricating oil level in the turbine sump tank. The gauge should be in the Green or NORMAL range.

62.4 Preliminary Load Test:

62.41 Prior to the acceptance load test, a one hour full load test shall be made. During this test, careful examination of all aspects of the operating set shall be observed. Especially watch for fuel leaks, oil leaks, air leaks etc., as well as excessive noise (vibrations in the air ducts, engine, alternator etc).

62.42 Turn OSS to MANUAL and start the set.

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

62.44 Add 1250kW of office load, supplemented with artificial load as necessary. Re-adjust the voltage to the value indicated by the customer or to the value of the commercial voltage.

62.45 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. To convert ambient temperature in Centigrade to Fahrenheit use this formula: (C X 1.8 + 32 = F.)

62.46 Take initial readings, readings at 30 minutes and a final set of readings after one hour.

62.47 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 to the load first will be the reference for phase sequence, and the other source voltage must be "phased-out" to match this sequence. At this point, voltage from the alternator will appear on one side of the emergency breaker from the emergency bus and commercial power to the essential load on the other-side. DO NOT CLOSE THE EMERGENCY BREAKER.

62.48 Reduce the load to 100 kW and press an EMERGENCY STOP button not yet tested or, do not reduce load and continue with Paragraph 62.5.

62.5 Final Full-Load Acceptance Test:

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

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

62.53 Close the ACB. After phasing out the emergency power with the commercial power and 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.

62.54 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. (Five Readings).

62.55 After two hours at full-load reduce load to the office load value normally carried by the set, or at the option of the operating company, continue at full-load.

62.56 After an additional 30 minutes at partial load, or full load, take a set of readings. Then decrease artificial load to zero and remove office load. Open the ACB.

62.57 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.

62.58 To demonstrate fully automatic operation on an automatic set, operate TRANSFER SELECTOR switch to AUTO and the local and remote 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 the OSS's to AUTO unless directed otherwise by the operating company.

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

63. MAINTENANCE

63.1 Maintain lubricating oil in the green or NORMAL area. 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 oil to bring level up within the green range.

63.2 Check electrolyte level in both the engine start battery and the control battery and bring up to the full mark by adding approved water. See Paragraph 6.4.

63.3 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.

63.4 The turbine must be run at least 30 minutes a month until turned over to the customer. Running at no load or short runs, such as demonstration runs, have no adverse effect on the turbine.

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

64. TROUBLE SHOOTING

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

64.2 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 and some minor repairs in the field. See Paragraph 5.5.

Manager, Product Engineering