KS-22673 GAS TURBINE ENGINE ALTERNATOR 900/750 KW (J-86653) E/W J-85520 & J-85529 MICROCOMPUTER CONTROLLERS

CONTENTS

1. GENERAL
1.1 Scope
1.2 4160V and 480V Sets
1.3 Specifications
1.4 Drawings
1.5 Supplier's Representative
1.6 Glossary of Abbreviations
1.7 Tools and Test Sets
1.8 Records
1.9 Job Connections
2. DESCRIPTION OF OPERATION
2.1 Logic Control
2.2 Pre-Start Conditions
2.3 Operational Modes
2.4 Engine Start Sequence
2.5 Simulated Power Failure
2.6 Purge Crank
2.7 Reduced Speed
2.8 Remote Operation
2.9 Trouble Shutdowns and Alarms
3. WARNINGS
4. CAUTIONS
5. INSPECTION
6. PURPOSE
7. DESCRIPTION
8. PLACING THE UNIT
9. BATTERY CHARGING RECTIFIER
10. PARALLELING
11. STATIC TESTING
11.1 General
11.2 Preparation
11.3 Operation
12. PREPARATION FOR INITIAL START
13. BLEEDING FUEL SYSTEM
14. READY TO START CONDITIONS
15. EMERGENCY STOP SWITCHES
16. STARTING AND DYNAMIC TESTING
16.1 General
16.2 Initial Start
16.3 Low Oil Pressure
16.4 High Oil Temperature
16.5 Open Temp Probe (T5)
16.6 Open Temp Probe (T7)
16.7 Major Circuit Breaker
16.8 Over Speed
16.9 Under Speed
16.10 Open Speed Probe
16.11 Over Voltage
16.12 Under Voltage
16.13 Crank Failure
16.14 Over Crank
16.15 Minor Circuit Breakers
16.16 Rectifier Fail
16.17 Fuel System Malfunction
17. FULL-LOAD TEST
17.4 Exhaust Back Pressure and Inlet Vacuum (Restriction)
17.5 Normal (Commercial Power) and Emergency Circuit Breakers
17.6 Preliminary Operations
17.7 Preliminary Full Load Tests
17.8 Auto Start - Auto Transfer
17.9 Auto Start - Manual Restore
17.10 Simulated Power Failure
17.11 Reduced Speed
18. FINAL ACCEPTANCE TEST

1. GENERAL

1.1 Scope

1.1.1 This section covers installation and test of the automatic or manual KS-22673. 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 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 the unit still functions properly after shipment and (2) to verify job made connections and to verify compatibility with job conditions and requirements.

1.1.2 The automatic controller consists two microcomputer boards and is wired, factory tested and shipped in place. When the set is installed at the job site, and the various office interfaces are complete, it is a requirement that the abbreviated microcomputer controller tests covered herein, be followed in their entirety.

1.1.3 A full load test at the job site is redundant 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.

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

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

1.1.6 The functioning of timers, with the exception of the Overload and Powerdown timers, can be determined by indicating lights that flash or blink while the timers are in operation. The interval between blinks in

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seconds is approximate to the setting of the timer in minutes.

1.2 4160V and 480V Sets

1.2.1 4160 volt sets and 480 sets are tested the same as the 208, 230, 240 volt sets. The basic difference is the use of transformers to bring the voltage down to 208-240 volts for all sensing or testing purposes.

1.2.2 The operating company will normally arrange to have the high voltage system (4160V) complete from the turbine alternator to the step down transformer. On occasion, the Western Electric Company Area Manager may agree to assume responsibility for this work in which case Western may subcontract the job or with the assistance of the Bell Telephone Laboratories and the line or equipment engineer, do the work themselves. The details will be included in the job specifications.

1.3 Specifications

J-86653D 240V or 480V, 3 phase, 4W, 60Hz Gas Turbine Engine Alternator Manual/Auto On Set Control.

J-86653E 240V or 480V, 3 phase, 4W, 60Hz Gas Turbine Engine Alternator Manual/Auto Remote Control.

J-86653F 4160V, 3 phase, 4W, 60Hz Gas Turbine Engine Alternator Manual/Auto Remote Control.

1.4 Drawings

SD-80700-01 Power Systems Breaker Circuits - Custom Furnished

SD-81223-01 Alarm Circuits

SD-81489-01 Typical Transfer Breaker

SD-82585-01 Low Voltage - Application

SD-82586-01 High Voltage (4160) - Internal Application

SD-82581-01 Low Voltage - Internal Engine Set

SD-82582-01 High Voltage (4160) - Internal Engine Set

SD-82583-01 Low Voltage - Remote Control Cabinet

SD-82531-01 Microcomputer Controller (Digital)

SD-82575-01 Microcomputer Controller (Analog)

1.5 Supplier's Representative

1.5.1 As part of the contract with Solar, arrangements should be made to have a supplier's representative available during the initial start and test of the unit. The set is shipped with the coupling disassembled between the gear box and the alternator. Assembly requires critical alignment and torquing by the supplier at the job site.

1.6 Glossary of Abbreviations

ACB	Alternator Circuit Breaker
ACO	Alarm Cut Off
ALT	Alternator
ALM	Alarm
AM	Ammeter
AUD	Audible
AUTO	Automatic
B	Both (controller boards)
BALOS	Bell Alarm Lockout Switch
BAT	Battery
C	Contactor or Customer Connections
CB	Circuit Breaker
CF	Crank Failure
CHRG	Charger
CL	Close
CRK	Crank
CUR	Current
DN	Down
E	Emergency or Engine
ECB	Emergency Circuit Breaker or Engine Control Battery
EMG	Emergency
FAIL	Failure
FF	Louvers Operating or Open
G	Ground
GND	Ground
HI	High
HZ	Hertz (cycles per second)
I	Internal Circuitry
IGN	Ignitor
INTER	Interlock
INTR	Interlock
L	Lamp
LA	Local Automatic
LIT	Light
LM	Local Manual
LO	Low
LOUV	Louver
LOWR	Lower
M	Master (digital controller board)
MAN	Manual
MAJ	Major
MIN	Minor
NCB	Normal Circuit Breaker
NLT	No-Light Timer or No Lightoff Timer
NOLGT	No Light
NORM	Normal
OP	Operation or Open or Open Probe
OS	Overspeed or Operation Selector Switch
OSS	Operation Selector Switch
OV	Over or Overvoltage
PB	Pushbutton
PF	Power Factor
PRE	Preliminary
PROB	Probe
PROP	Proper
PRS	Pressure
PURG	Purge
PWR	Power
R	Relay

RA	Remote Automatic
RECT	Rectifier
RED	Reduce
REG	Regulator
REM	Remote
RET	Return
RF	Rectifier Fail
RM	Remote Manual
RST	Restore
RTL	Ready To Load
RVP	Reverse Power
S	Slave (analog controller board)
SEL	Selector
SIM	Simulated
SPD	Speed
STRT	Start
SW	Switch
T5	Engine Turbine Temperature
T7	Engine Exhaust Temperature
TB	Terminal Block
TEMP	Temperature
TERM	Terminal
TIM	Time
TMP	Temperature
TMR	Timer
TOP	Topping
TRNS	Transfer
TST	Test
US	Under Speed
UV	Undervoltage
VIB	Vibration
VIS	Visual
VOL	Voltage
%	Tests with the % suffix exist only on sites that are equipped with a remote control panel. These tests are on the remote control panel only. Tests without the % suffix may exist on the local or remote or on both panels.

1.7 Tools and Test Sets

1.7.1 Tools:

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

1.7.2 Test Sets:

ITE-6253 Display Terminal

ITE-4442A Multimeter

ITE-4785 Test Load (as required)

ITE-4782 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
- ITE-5519 100MHz Counter (Frequency Counter)
- ITE-5520 Digital Multimeter
- ITE-5521 Temperature Simulator (Recorder Calibrator or Calibration Tester)

R-3076 Manometer (water type) (two)

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

R-3404 Phase Sequence Indicator

R-4296 Ear Protector (minimum two)

1.8 Records

ID-1275 Lubrication Record

ID-1285 Storage Battery Report

SD-4-1313 Test Trouble Record

SD-4-1315 Summary of Tests

SD-97-946 (11-75) Engine Alternator Test Record or old number ID-946

SD-4-948 (3-64) Turbine Alternator Performance Test Data Sheet may be substituted by altering the KS-22673 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: 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.

1.9 Job Connections

1.9.1 Standing at the rear of the set and facing the control panel, the majority of the installer run wire is on the left side directly behind the control panel. Terminal strips are numbered from the rear of the set TB301 toward the front TB308. On the right side, behind the control panel, are circuit breakers CB-202, CB-203, CB-205, CB-206, CB-207, CB-309, CB-310, CB-311 and the speed adjust pushbutton switch. The command control switches, the status indicating lamps and status indicating meters are all mounted on the rear or remote control panel. The rear control panel may be tilted down to expose the two controller boards, control relays and terminal strips TB201 through TB206.

2. DESCRIPTION OF OPERATION

2.1 Logic Control

2.1.1 The KS22673 Gas Turbine Alternator operates under the control of two controller boards which are located immediately behind the rear control panel.

2.1.2 The digital controller board (J85520) senses all digital type input signals such as switches, pushbuttons, contact

closures etc. These signals are interpreted and processed by the controller board. Digital output signals are initiated to operate the control relays and alarm relays and to provide power to status indicating LED lamps on the rear or remote control panel. The frequency and speed meters are also driven by the digital board.

2.1.3 The analog controller board (J85529) senses variable input signals such as thermocouples, cold junction, accelerometer, amps and volts. These signals are multiplexed and changed to digital signals for processing. Analog outputs are use to drive one-milliampere full scale meters. These meters are used to display AC currents, kilowatts, power factor, and turbine temperature.

2.1.4 Before operational tests, a display terminal is connected to the digital controller to verify circuit integrity to all input and output controller ports. Each port is individually accessed by inputing keyboard commands on the display terminal. The display terminal will indicate which port is under test and the condition that it is testing for (continuity or open circuit). If the condition is verified (e.g. pushbutton depressed) then the terminal will initiate an audible signal. If the condition is not verified, then the terminal will not initiate an audible signal. As each port is accessed the associated switch, circuit or sensor may be manually opened or closed to verify both open and closed circuits. During operation, the display terminal may be adjusted to continuously display the voltage, current and power factor of each phase and the total power, temperatures, vibration, speed and bus voltage of the turbine alternator.

2.2 Pre-Start Conditions

2.2.1 It is assumed:

1. All plant connections as covered in the application schematic are in place.
2. Both the crank and control batteries are operating under float conditions.
3. Commercial service is connected.
4. All plugs are connected to the two controller boards.
5. Circuit breakers CB-202, CB-203, CB-205, CB-206, CB-207, CB-309, CB-310, CB-311 and CB-104 are closed. The MAJOR CIRCUIT BREAKER (CB-104) on the control panel must be closed last.

2.3 Operational Modes

NOTE: The OPERATION SELECTOR SWITCH has three positions, OFF, MANUAL, and AUTO. The TRANSFER SWITCH RESTORE SELECT has two positions, AUTO and MANUAL. The following is a description of the operation of both switches.

2.3.1 OPERATION SELECTOR SWITCH to OFF

2.3.1.1 With the OPERATION SELECTOR SWITCH to OFF position, the set is not available for operation. The OPERATION SELECTOR SWITCH OFF lamp (red LED) and the MAJOR CIRCUIT BREAKER lamp (red LED) are lighted.

2.3.2 OPERATION SELECTOR SWITCH and TRANSFER SWITCH RESTORE SELECT to MANUAL

2.3.2.1 When the OPERATION SELECTOR SWITCH and the TRANSFER SWITCH RESTORE SELECT is in MANUAL position, the set is ready for manual start. The OPERATION SELECTOR SWITCH OFF lamp (red LED) is extinguished. The OPERATION SELECTOR SWITCH MANUAL lamp (green LED) and the ACB OPEN lamp (green LED) will be lighted.

2.3.2.2 Depressing the MANUAL START pushbutton until the CRANKING lamp (green LED) lights, will initiate cranking. No other action is required.

2.3.2.3 The set will run through the engine start sequence (see paragraph 2.4).

2.3.2.4 Depressing the CLOSE ACB pushbutton will operate the main alternator circuit breaker to closed and the alternator output is connected to emergency bus. The ACB OPEN lamp (green LED) will extinguish. The ACB CLOSED lamp (red LED) will light. The READY TO LOAD lamp (green LED) will extinguish.

2.3.2.5 Manually operating the AC transfer switchgear will transfer the station load from commercial bus to the emergency bus. The set will assume the station load. The PROPER OPERATION lamp (green LED) will light.

2.3.2.6 To return to commercial power, first verify that the OPERATION SELECTOR SWITCH and the TRANSFER SWITCH SELECT are in MANUAL position.

2.3.2.7 Depress the TRANSFER SWITCH RESTORE pushbutton until the switchgear transfers. The Station load transfers from emergency bus to commercial bus. The ACB circuit breaker opens and disconnects the alternator from the emergency bus. The ACB CLOSED lamp (red LED) extinguishes. The ACB OPEN and READY TO LOAD lamps (green LED's) will light.

2.3.2.8 Operate the OPERATION SELECTOR SWITCH to OFF. The engine circuit breaker opens and causes the engine to shut down. The OPERATION SELECTOR SWITCH MANUAL lamp (green LED) will extinguish. The OPERATION SELECTOR SWITCH OFF lamp (red LED) and the COAST DOWN lamp (amber LED) will light.

NOTE: If the engine is allowed to run continuously for approximately 15 minutes, before being shutdown with commercial power connected to the commercial sense terminals, the READY TO RESTORE lamp (green LED) will light.

2.3.2.9 The engine cannot be restarted until the COAST DOWN lamp (amber LED) extinguishes about 4 minutes after shutdown.

2.3.2.10 After the engine has coasted to stop, move the OPERATION SELECTOR SWITCH to the desired position.

2.3.3 OPERATION SELECTOR SWITCH and TRANSFER SWITCH RESTORE SELECT to AUTO

2.3.3.1 When the OPERATION SELECTOR SWITCH and TRANSFER SWITCH RESTORE SELECT is in the AUTO position, the set is ready for automatic start when commercial power fails. The OPERATION SELECTOR SWITCH OFF lamp (red LED) is extinguished. The OPERATION SELECTOR SWITCH AUTO and ACB OPEN lamps (green LED's) are lighted.

2.3.3.2 When commercial power fails the POWER FAILURE lamp (amber LED) will light. The start delay timer times out (see paragraph 18.2). The set will run through the engine start sequence (see paragraph 2.4).

2.3.3.3 The alternator circuit breaker closes connecting the alternator to emergency bus. The ACB OPEN and READY TO LOAD lamps (green LED's) will extinguish. The ACB CLOSE lamp (red LED) and TRANSFER TO EMERGENCY lamp (green LED) will light.

2.3.3.4 The AC transfer switchgear will transfer the Station load from commercial bus to emergency bus. The TRANSFER TO EMERGENCY and PROPER OPERATION lamps (green LED's) will light.

2.3.3.5 If the RUN TIMER switch is ON then the set committed to run and carry the Station load for at least 25 minutes even if commercial power returns.

2.3.3.6 When commercial power returns, the POWER FAILURE lamp (amber LED) is extinguished. The 15 minute holdover timer is started and the set is committed to run and carry the Station load for 15 minutes. If the run timer is still on then the set will continue to run and assume the Station load until both the run and holdover timers have independently timed out.

2.3.3.7 After the timers have timed out, the READY TO RESTORE and TRANSFER TO NORMAL lamps (green LED's) will light. The AC transfer switchgear transfers the Station load from emergency bus to commercial bus and the alternator circuit breaker opens. The PROPER OPERATION, ACB CLOSED and TRANSFER TO NORMAL lamps will extinguish and the ACB OPEN lamp will light.

2.3.3.8 The unloaded set continues to operate for a 2 minute cool-down period, then the engine shuts down and the COAST DOWN lamp will light. The engine cannot be restarted until the COAST DOWN lamp extinguishes (about 4 minutes after shutdown) and then the READY TO RESTORE lamp will extinguish.

2.3.4 OPERATION SELECTOR SWITCH to AUTO and TRANSFER SWITCH RESTORE SELECT to MANUAL

2.3.4.1 When the OPERATION SELECTOR SWITCH is in the AUTO position and the TRANSFER SWITCH RESTORE SELECT is in the MANUAL position, the set is ready for automatic start when commercial power fails. The OPERATION SELECTOR SWITCH OFF lamp (red LED) is extinguished. The OPERATION SELECTOR SWITCH AUTO and ACB OPEN lamps (green LED's) are lighted.

2.3.4.2 When commercial power fails the POWER FAILURE lamp (amber LED) will light. The start delay timer times out (see paragraph 18.2). The set will run through the engine start sequence (see paragraph 2.4).

2.3.4.3 The alternator circuit breaker closes connecting the alternator to emergency bus. The ACB OPEN and READY TO LOAD lamps (green LED's) will extinguish. The ACB CLOSE lamp (red LED) and TRANSFER TO EMERGENCY lamp (green LED) will light.

2.3.4.4 The AC transfer switchgear will transfer the Station load from commercial bus to emergency bus. The TRANSFER TO EMERGENCY and PROPER OPERATION lamps (green LED's) will light.

2.3.4.5 When commercial power returns, the POWER FAILURE lamp (amber LED) is extinguished and the 15 minute holdover timer is started.

2.3.4.6 When the holdover timer times out, the READY TO RESTORE and TRANSFER TO NORMAL lamps (green LED's) will light.

2.3.4.7 Depress the TRANSFER SWITCH RESTORE pushbutton. The Station load transfers from emergency bus to commercial bus and the alternator circuit breaker opens. The ACB OPEN and READY TO RESTORE lamps (green LED's) will light. The PROPER OPERATION, TRANSFER TO NORMAL lamps (green LED's) and the ACB CLOSED lamp (red LED) will extinguish. The unloaded set will operate for a 2 minute cool-down period and then shut down.

NOTE: If the TRANSFER SWITCH RESTORE pushbutton is depressed before the holdover timer times out, the switchgear will transfer the Station load. The unloaded set will continue to run until the holdover and cool-down timers time out and then the set will shut down.

2.3.4.8 The engine cannot be restarted until the COAST DOWN lamp (amber LED) extinguishes about 4 minutes after shutdown.

2.4 Engine Start Sequence

2.4.1 When the set is started in MANUAL or AUTO position the following sequence of events should alway take place.

2.4.2 The RUN TIMER ON lamp (amber LED) will light provided the RUN TIMER switch is ON.

2.4.3 When the set speed increases to 13% of full speed, as indicated on the % SPEED meter, the fuel valve opens admitting fuel and the FUEL ON lamp (green LED) will light.

2.4.4 Fuel lightoff is also initiated. Following a proper light off, the LIGHT OFF TEMP lamp (green LED) will turn on.

2.4.5 As the set speed continues to increase to within 30%-40% of full speed, the turbine inlet temperature reaches 1340°F. At this point the temperature topping relay will operate and control the fuel flow during acceleration to limit increasing temperatures and to avoid overtemperature shutdown.

CAUTION: OBSERVE THE TURBINE EXHAUST TEMPERATURE AND SPEED METERS. IF THE EXHAUST TEMPERATURE SUDDENLY RISES ABOVE 850°F WHILE SPEED LAGS, SHUT DOWN THE ENGINE IMMEDIATELY BY DEPRESSING THE EMERGENCY STOP PUSHBUTTON.

2.4.6 As the set speed continues to increase to 66% of full speed, the crank motor and ignition relay will release, and the CRANKING (green LED) lamp will extinguish.

2.4.7 At 85% of full speed the voltage regulator and flash relays will operate. When the alternator voltage builds up, the flash relay releases. The alternator voltage is indicated on the AC VOLTS meter when the AC VOLTAGE switch is adjusted to the ALTERNATOR position.

2.4.8 At full speed the set continues to run for a 15 second warm up period after which the READY TO LOAD lamp (green LED) turns on.

2.5 Simulated Power Failure

2.5.1 With the OPERATION SELECTOR SWITCH in AUTO position and with commercial power supplying the AC transfer switchgear, a simulated power failure can be initiated by depressing the SIMULATED POWER FAILURE pushbutton until the SIMULATED POWER FAILURE lamp (amber LED) is lighted.

NOTE: Operating the SIMULATED POWER FAILURE pushbutton causes an audible alarm to sound and the MINOR ALARM lamp (amber LED) to light. Depress the ALARM CUT OFF pushbutton to silence the alarm.

2.5.2 The set will start and transfer the Station load in accordance with the sequence of events as outlined in paragraphs 2.3.3 or 2.3.4 depending on the position of the TRANSFER SWITCH RESTORE SELECT.

NOTE: The holdover time period will begin upon releasing the SIMULATED POWER FAILURE pushbutton.

2.6 Purge Crank

2.6.1 The purge crank is used for maintenance purposes. The set will crank to approximately 20% speed without fuel or ignition.

2.6.2 Operate the OPERATION SELECTOR SWITCH to the OFF position.

2.6.3 Depress and hold the PURGE CRANK pushbutton. The CRANKING lamp (green LED) will light. The starter relay energizes and starter cranks engine to approximately 20% engine speed. The overcrank timer begins to time out.

NOTE: The PURGE CRANK pushbutton is ineffective if engine is in a start sequence, engine is running, or any engine shutdown malfunction exits. If the pushbutton is not released before the overcrank timer times out (60 seconds), a crank failure alarm will occur and the purge crank sequence will abort. The CRANK FAILURE lamp will light.

2.6.4 Release the PURGE CRANK pushbutton. The starter relay deenergizes and the starter disengages. The overcrank timer resets. The engine coasts to a stop.

2.7 Reduced Speed

2.7.1 An excessively contaminated compressor can be the cause of the engine failing to accelerate to full speed and results in a general lack of acceleration, compressor surge, or an inability of the engine to pull full load. Whenever any of these symptoms become apparent, or when troubleshooting procedures indicates, a compressor cleaning is recommended. Reduced engine speed is used for engine compressor cleaning operations only. Engine cleaning is not necessary on new sets. Therefore, reduced speed tests will be limited to testing for the correct speed reduction.

2.8 Remote Operation

2.8.1 When the set is equipped with remote control features, the set may be operated in the same manner as local control. However, in selecting an operating mode, the local and remote OPERATION SELECTOR SWITCH must be in the same operating position. If the two switches are not set in the same position, the resultant operating mode will be of the lower order of operation. The order of operation highest to lowest is AUTO, MANUAL,

and OFF as illustrated below:

SWITCH POSITIONS

LOCAL	REMOTE	RESULTANT OPERATION
OFF	MAN	OFF
OFF	AUTO	OFF
MAN	OFF	OFF
MAN	AUTO	MAN
AUTO	OFF	OFF
AUTO	MAN	MAN

2.9 Trouble Shutdowns and Alarms

2.9.1 MAJOR ALARMS: When the set is running, major troubles will stop the set, transfer the Station load back to commercial power, if it is available, light the associated alarm lamp and provide a major alarm signal to the connected alarm circuits. Refer to TABLE A and B at the end of this section for major alarm set point conditions.

2.9.2 MINOR ALARMS: Minor alarms do not affect an engine shutdown but serve as a caution. A minor alarm will be provided to the connected alarm circuits. Refer to TABLE C at the end of this section for minor alarm set point conditions.

2.9.3 Alarms may be silenced by depressing the ALARM CUT OFF pushbutton.

2.9.4 After shutdown from any malfunction or emergency stop, the set cannot be restarted until the OPERATION SELECTOR SWITCH is first adjusted to OFF, all tripped circuit breakers are adjusted to ON and then the OPERATION SELECTOR SWITCH is adjusted to the desired operational mode.

3. WARNINGS

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

3.1.1 Move the OPERATION SELECTOR SWITCH to OFF on the local and remote control panels.

3.1.2 Switch off all control circuit breakers located in the alternator set control panel.

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

3.2 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 thereon.

3.3 Commercial power may still be connected to the set at TB-312 terminals 22, 23, 24 and 25. 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.

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

3.5 Short circuit hazards exists with the starter battery and its controls as well as the control battery, even when CB-104, CB-202 and CB-203 are switched off. Disconnect cables from TB-301 terminals 18 and 20 or the battery cables if working with CB-104, CB-202, CB-203 or with the starter contactor. Avoid contact by removing potentials or when impractical, provide adequate personnel protection.

3.6 Ear protectors must be worn during operation of the turbine set.

3.7 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.

4. CAUTIONS

4.1 Make sure all control circuit breakers CB-104, CB-0202, CB-205, CB-206, CB-207, CB-310 and CB-311 are off before removing or installing the microcomputer controller boards otherwise, damage to the controllers can result.

4.2 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.

4.3 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.

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

4.5 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.

4.6 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.

4.7 DURING THE ASSEMBLY OF AIR INTAKE AND EXHAUST, MAKE CERTAIN THAT NO LOOSE ITEMS, DIRT OR DEBRIS ARE LEFT IN THE SYSTEM.

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

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

4.10 The engine is shipped void of LUBRICATING OIL. Approximately 30 gallons of oil must be added before cranking or before attempting to start the engine for the first time.

5. INSPECTION

5.1 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.

6. PURPOSE

This KS unit is designed to furnish 60 hertz AC power service on an emergency basis 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 companies request. Depending on the commercial supply voltage to the office and the distance the set is away from the main switchboard, a choice of the following voltages may be furnished; 208V, 230/240V, 480V or 4160V from the generator through a transformer to supply various voltage requirements of the customer. The unit is rated at 750 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 dual rating of 900 KW PEAK is based on ideal conditions such as operation at sea level and at + 75°F or lower intake air temperature.

7. DESCRIPTION

7.1 Independent of ducting and attachments, the unit is rectangular in shape, rests on the floor on isolating pads and measures 5 feet wide, 6 foot 2 inches high and 16 foot 6 inches long. The unit weights 14,425 pounds.

7.2 The engine is a 1200 horsepower "SATURN" gas turbine manufactured by Solar (Division of International Harvester), and drives a 1,000 KVA (nominal) 60 hertz 3 phase, 4 wire alternator manufactured by the Marathon Electric Company. The control cabinet is built by Continental Controls. Solar assembles the package. The engine is located in the front of the cabinet away from the control panel. It operates on white kerosene, JP5, or Diesel 1 or 2 fuel. It starts with a 24V electric starter, lights off with an igniter plug at 13 to 15% speed and accelerates to its operating speed of 22,300 RPM within one minute. The engine shaft drives the alternator at 1800 RPM through a two-stage planetary reduction gear box. The engine picks up air through the combustion air intake at the accessory drive end of the engine and compresses it to 6.5 to 1 through an 8 stage axial vane type compressor. The air is forced into the combustion chamber where it is mixed with fuel from the 9 nozzle locations and then ignited. The hot expanding gasses are forced through three stages of turbine blades fixed to the rotor and then pass into the exhaust manifold.

7.3 The package is completely enclosed with removable panels of sound deadening material.

8. PLACING THE UNIT

Furnished with the set are three isolating pads which are located between the structural base and the floor. The pads are of a two piece design. The isomode or upper portion of the pad is in place on the bottom of the set when shipped. The bottom portion, shipped loose and placed by the installer, is a vibration absorbing isolator pad.

8.1 The floor area designated for the set shall be checked to make sure it is level within 1/4" in 10'.

8.2 The floor should be laid out in agreement with the job drawing which corresponds with the outside dimensions of the set. As the rigger brings the set into its final location, the pads should be slipped in under the isomodes. Verify dimensions. Two of the pads measure 10" x 10" and are placed near the front or generator end. The other pad measures 14" x 14" and is placed slightly past center toward the engine end.

8.3 The three pads may be placed directly on the concrete floor or on top of asphalt or vinyl tile covered concrete.

8.4 Since vibration is very low, no floor fastening is required in soft sites. Anchor bolts are required (two per pad) for fastening the unit to the floor in Earthquake Areas.

8.5 Hardened areas such as in 50 PSI sites or Disaster Control buildings, will require special retaining and/or hold-down arrangements. The material and instructions will be provided by the line or equipment engineer.

9. BATTERY CHARGING RECTIFIER

9.1 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.

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

9.3 Install the batteries and bring electrolyte level up to minimum level with approved water. Make all connections and verify for tightness. Completely connect and fuse the output before applying the AC power. Start the charge in accordance with Installation Engineering Handbook 18, Section 19 as soon as possible and record results on ID-1285 Battery Report. Once the charge is started it should not be removed or shut off 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, furthermore, a small overcharge will cause no harm.

10. PARALLELING

10.1 When two sets are paralleled, one set must be in the MANUAL operation mode.

10.2 See Section 130 of this Handbook for paralleling procedures and paragraph 12.10 in this section. Proper phase sequence is required along with correct voltage and simultaneous sine wave peaking of the two sources of power before paralleling can be accomplished. A phase sequence indicator, voltmeter and three synchronizing lights will be required.

10.3 See paragraph 12.10.

11. STATIC TESTING

11.1 General

11.1.1 In static testing, an ADM5 external display terminal (ITE-6253) is connected to the microcontroller board (J-85529 - plug P2) using the RS232 adapter cable that is supplied with each set. All circuit breakers are off except CB-203 which supplies control battery power for the controller boards.

11.1.2 The two controller boards are used to individually sense the electrical continuity of 40 input circuits that are connected to its input ports. These circuits consists of pushbuttons, switches, temperature sensors, etc. Each circuit can be directly accessed for testing by inputing keyboard commands on the display terminal. The display terminal will indicate which port is under test by displaying an asterisk (*) next to the name of the condition that it is testing for. If the test condition is verified then the terminal will initiate an audible signal. If the condition is not verified then the terminal will not initiate an audible signal. As each port is accessed the associated pushbutton, switch, sensor, etc. may be manually opened or closed to verify both open and closed circuits.

11.1.3 The controller boards are then adjusted to individually send signals to 60 output ports that are connected to circuits which operate lamps, relays, etc. Each circuit can be directly accessed for testing by inputing keyboard commands on the display terminal. The display terminal will indicate which port is under test by displaying an asterisk (*) next to the name of the condition that it is testing for. The selected output will pulse on and off.

11.1.4 Each input and output circuit should be tested for proper operation. External wiring errors should be checked before the circuit boards are declared faulty.

11.2 Preparation

11.2.1 Verify that the OPERATION SELECTOR SWITCH is OFF.

11.2.2 Operate controls as follows:

CONTROL	POWER FUNCTION	ADJUST TO POSITION
MAJOR CIRCUIT BREAKER (CB-104)	Relays	OFF
CB-202	ACB Fuel Starter Igniter	OFF
CB-203	Control Battery Converters Microcontrollers	OFF
CB-205	Commercial Bus Sense	OFF
CB-206	Emergency Bus Sense	OFF
CB-207	Set Volt Sense	OFF
CB-309	(NCB) Normal Control Breaker	OFF
CB-310	(ECB) Emergency Control Breaker	OFF
CB-311	Series Boost Contactor	OFF

11.2.3 For static testing, inhibit starting by disconnecting the starter contactor terminal A2 on relay K354. Relay K354 is mounted on the right front side of the set when looking at the rear control panel.

11.2.4 Inhibit the boost pump by disconnecting the contactor terminal A1 on relay K386. This relay is mounted next to relay K354.

11.2.5 Adjust the ADM5 CRT Display Terminal (ITE-6253) as follows:

11.2.5.1 Set the microswitches on S1, located on the back panel of the display terminal as indicated below:

SWITCH S1

NUMBER	BAUD RATE	POSITION
1	75	OFF
2	110	OFF
3	150	OFF
4	300	OFF
5	600	OFF
6	1200	ON
7	2400	OFF
8	4800	OFF
9	9600	OFF
10	19.2K	OFF

11.2.5.2 Set microswitches on S2, located on the back panel of the display terminal as indicated below:

SWITCH S2

NUMBER	NAME	POSITION
1	RESERVE - RESERVE	UP
2	AUNL EN - AUNL DIS	AUNL DIS
3	50 Hz - 60 Hz	60 Hz
4	RS232 - CUR LP	RS232
5	HDX - FDX	FDX
6	BIT8=0 - BIT8=1	BIT8=0
7	ENPR - DISPR	DISPR
8	1STOP - 2STOP	2STOP
9	OFF - EVEN	EVEN
10	7BIT - 8BIT	8BIT

11.2.5.3 Remove the two phillip head screws in the bottom front of the display terminal. Open the display terminal by lifting its top panel from the front of the keyboard and swinging it towards the back over its rear hinge. Set the microswitches on S3 located on the inside back of the display terminal as indicated below:

SWITCH S3

NUMBER	NAME	POSITION
6	LC	OFF
5	13	ON
4	22	OFF
3	CD	OFF
2	EX	OFF
1	ET	OFF

11.2.5.4 Set the microswitch S4, on the inside left, to LK position.

11.2.5.5 Set the microswitch S5, on the inside right, to NORM position.

11.2.5.6 Replace the front panel and screws.

11.2.5.7 Verify that the POWER ON/OFF switch on the rear of the display terminal is set to OFF.

11.2.5.8 Open the rear control panel of the set. Place the display terminal on a chair or a stand near the rear of the set. Using the RS232 adapter cable that is supplied with each set, connect one end to plug P2 on the upper right corner of the J-85529 microcomputer board (ZZ211). Connect the other end of the cable to the MODEM RS232 connector J6 on the rear of the display terminal.

11.2.5.9 Connect the display terminal power cord to a 110 Volt, 60Hz AC power outlet.

11.2.6 Locate the J-85520 Microcomputer Controller board (ZZ210) behind the rear control panel of the turbine engine alternator. Locate the small red and white microswitch assembly in in the upper right hand corner of the controller board. Operate the microswitches as follows:

SWITCH	FUNCTION	POSITION
SW1	SDT	OPEN
SW2	SDT	OPEN
SW3	STATIC TEST	CLOSED
SW4	ALM CLK	CLOSED
SW5	NOT CONNECTED	OPEN
SW6	NOT CONNECTED	OPEN
SW7	NOT CONNECTED	OPEN

NOTE: A) When the SW3 microswitch is CLOSED the controller boards are set for STATIC TESTING only. The turbine engine alternator cannot be started. To reset the turbine engine alternator for normal operation, operate SW3 microswitch to OFF, then operate CB-203 circuit breaker to OFF and wait 5 seconds. Operate CB-203 to ON and adjust the OPERATION SELECTOR SWITCH to the desired position.

B) The Start Delay Timer (SDT) is set using microswitches SW1 and SW2. These switches may be left in the position selected in paragraph 18.2. However, if desired, during operational test, the start delay timer may be adjusted to minimum using the switch positions indicated above.

11.2.7 Locate the J-85529 Microcomputer Controller board (ZZ211) behind the rear control panel of the turbine engine alternator. Locate the small microswitch assembly (S1) near the middle of the board. Operate the microswitches as follows:

SWITCH S1

NUMBER	FUNCTION	POSITION
1	ALM CLK	CLOSE
2	NOT CONNECTED	OPEN
3	208V SET	OPEN
	480V SET	OPEN
	4160V SET	CLOSED
4	208V SET	OPEN
	480V SET	CLOSED
	4160V SET	CLOSED
5	T5 - T7	CLOSE (T7)

NOTE: With the microswitches set as shown, the microcomputer clock is in, the Controllers are set to respond to the proper output voltages and the temperature meter is set to read the exhaust temperature (T7).

11.2.8 Provide temporary communications between the engine set and the remote control panel if one is provided.

11.3 Operation

11.3.1 Operate the POWER ON/OFF switch on the rear of the display terminal to ON. Adjust the screen brightness control as required.

11.3.2 Operate CB-203 circuit breaker to ON. This will provide control battery power to the microcomputer controller boards.

11.3.3 To set the controllers in a state for testing circuits that are connected to its input ports, depress the "I" key on the display terminal keyboard. The display terminal screen will print a list of all inputs as shown in TABLE D at the end of this section. To interpret the screen print, refer to the Glossary of Abbreviations in paragraph 1.6 and TABLE E. Each test is labeled with a 2-digit number. The 2-digit number, in the upper left side of the screen, indicates which input is currently being tested. An asterisk (*) will also appear next to the number of the selected input.

11.3.4 To advance the test and the asterisk (*) to the next number, depress the space bar on the keyboard of display terminal. To decrement the test and the asterisk (*) to the previous number, depress the minus key (-) on the keyboard.

11.3.5 Direct test selection can also be obtained by typing on the keyboard the desired 2-digit test number.

11.3.6 Start by adjusting the keyboard so as to display the 2-digit number "01" on the screen as indicated above. An asterisk (*) will be displayed on the screen next to the test number as "*01 B ACO-PB". Refer to the Glossary of Abbreviations in paragraph 1.6 and TABLE E. "01 B ACO-PB" should be interpreted as test 01, under the control of both microcomputer controller boards (ZZ210 & ZZ211), when the alarm cut-off pushbutton (ACO) is depressed an audible beep should be heard. Release the ACO pushbutton and the beep should stop. Follow the instructions as labeled in TABLE E.

NOTE: Always return the pushbutton, switch, temperature sensor, etc. to its original position before proceeding to the next test.

11.3.7 If the circuit did not test correctly, do not attempt to start the set until the circuit is corrected.

11.3.8 To trace for troubles, first look for the indicated apparatus in the Turbine Engine Alternator schematic drawings then, using a ITE-5520 Multimeter or equivalent, trace both ends to their final destination. As an example, if test "01" failed, look for the ALARM CUT OFF pushbutton in schematic drawing SD-82581-01 (SHEET B4). One end is connect to a +12 volt source and the other end is connected to terminal strip TB204, pin 4 and onto plug P4, pin N of the Analog Controller board (ZZ211). Depressing the ALARM CUT OFF pushbutton should put +12 volts on pin N.

11.3.9 Increment the test using the space bar or enter a 2-digit number on the display terminal keyboard and proceed to test for each input condition as indicated on the display screen and TABLE E.

NOTE: Do not OPEN switch SW3 in test 20 or STATIC TESTING will terminate.

11.3.10 To simulate defective transducers, such as temperature sensors, voltage level detectors etc., follow the instructions as labeled in TABLE E.

11.3.11 To set the controllers in a state for testing circuits that are connected to its output ports, depress the "o" key on the display terminal keyboard. The display terminal screen will print a list of all outputs as shown in TABLE F at the end of this section.

11.3.12 Testing the output circuits is the same as testing the input circuits except that there is no audible beeps. The controllers will initiate signals on its output ports to blink a lamp or operate a relay on and off. Verify the output conditions by sight, sound and feel. Test for each output condition as indicated on the display screen and TABLE G.

11.3.13 End of STATIC TESTING. On the J-85520 controller board (ZZ210) reset the microswitch SW3 to OPEN. Operate the CB-203 circuit breaker to OFF.

11.3.14 Reconnect the starter contactor lead to TB202 terminal 25.

11.3.15 Reconnect the boost pump contactor lead to TB202 terminal 24.

11.3.16 The display terminal may be left connected to the controller board. When CB-203 circuit breaker is operated to ON, during run conditions, the display terminal will continuously display the voltage, current, and power factor of each phase and the power, temperatures, vibration, speed and bus voltage of the turbine engine alternator.

12. PREPARATION FOR INITIAL START

12.1 After approximately 10 engine starts, remember to drain the fuel oil accumulator tank. When the pressure on the fuel line drops down in the range of 160 to 100 PSIG the purge valve opens and combustion chamber air pressure forces fuel from the nozzles and lines, through the valve and into the accumulator tank.

12.2 Drain lube oil residue and close drain plug or cap on line from oil reservoir tank.

12.3 The dip stick is marked "30 GAL FULL". Add approved oil until oil reaches full mark. Do not add 30 gallons as experience has shown this to be excessive. After the set has been run at the job site for the first time and then shut down, add oil as necessary to keep level at the full mark. Record type, quantity and date on ID-1275.

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

12.5 Verify with an ITE-4442A, ITE-5520 or equivalent that the Emergency Bus is dead. Then determine with an ohmmeter, the absence of continuity between the buses and from the buses to neutral or ground.

12.6 Connect the ITE-4728 or ITE-4785 Test leads. 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 will have to be closed during these operational tests, the load leads should be run in such a manner so as not to interfere with any mechanically operating or rotating parts. This can best be accomplished by properly dressing the leads and running them under the base of the set.

12.7 Verify the following:

12.7.1 All output leads 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.

12.7.2 Control leads and other customer connections secure.

12.7.3 Batteries are fully charged and polarities correct.

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

12.7.5 Fuel line connections tight.

12.7.6 Day Tank clean.

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

12.7.8 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.

12.7.9 Room sufficiently ventilated.

12.7.10 Shipping covers removed from engine inlet and exhaust duct.

12.7.11 Engine exhaust duct properly supported.

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

12.7.13 Wiring of boost pump, fuel shut off and control valves, ignition exciter, magnetic pickups No. 1 and No. 2, temperature sensors T5 and T7, low oil pressure switch and temperature switch, starter mounting bolts tight and insulating blankets on the compressor and the exhaust system in place and secured.

12.7.14 Air intake screen over compressor intake in place, clean, secure and free of any obstructions. This air intake area behind the engine door handles large volumes of air and experiences high turbulence which will pickup any dirt or debris present which may cause serious engine damage. See paragraph 12.7.8.

12.8 Disconnect and tag the external leads CB9 on TB312 terminal 7 and TR15 on TB312 terminal 8. These are the control leads that operate the NCB Normal Circuit Breaker (commercial power).

12.9 Disconnect and tag the external leads LB6 on TB312 terminal 3 and TR16 on TB312 terminal 4. These are the control leads for the ECB Emergency Circuit Breaker.

12.10 For single set operation, operate Cross Current Compensator switch on Voltage Regulator to OUT. Verify that contacts are closed with an ohmmeter. OUT = Closed and IN = Open. In the absence of this switch on some sets, make sure that a strap is in place between terminals 1 and 2 of the voltage regulator. For parallel operation, see paragraph 10.

12.11 Place the local and remote OPERATION SELECTOR SWITCH to OFF. Operate the TRANSFER SWITCH RESTORE SELECT to MANUAL. Close all CB circuit breakers. The OPERATION SELECTOR SWITCH OFF lamp should be on.

13. BLEEDING FUEL SYSTEM

13.1 To insure proper operation of the turbine the fuel system must be primed to fill the day tank, filters and lines and the system must be free of air.

13.2 The low-pressure fuel filter is a circular container located on the left front side of the set when looking at the rear control panel. Loosen the vent cap to provide an air bleed. Circle (not cover) vent with a rag to collect vented fuel.

13.3 Depress and hold the PURGE CRANK pushbutton. The CRANKING lamp will light. The starter relay energizes and starter cranks engine to approximately 20% of rated speed while the boost pump operates. When the filter is full and all air is exhausted, close the vent cap and then release the PURGE CRANK pushbutton. The starter relay deenergizes and the starter disengages. The overcrank timer resets and the engine coasts to a stop.

NOTE: If the PURGE CRANK pushbutton is not released before the overcrank timer times out (60 seconds), a crank failure alarm will occur and the purge crank sequence will abort. The CRANK FAILURE lamp will light.

13.4 Remove the dust seal or cap from the end of the FUEL PURGE valve connected to the output side of the high pressure fuel filter and located adjacent to the low pressure fuel filter. Furnished with each set is a short length of hose with a quick-connect coupler on one end. Attach this to the FUEL PURGE valve. Place a suitable container under the free end of the hose. Open the valve (usually accomplished by turning the handle 90°).

13.5 Depress and hold the PURGE CRANK pushbutton. The engine cranks and the fuel boost pump operates. Allow the engine to crank until fuel flows steadily and without bubbles into the container. Close valve and then release the PURGE CRANK pushbutton. Disconnect hose and replace the dust cap.

13.6 Operate the OPERATION SELECTOR SWITCH to OFF.

14. READY TO START CONDITIONS

14.1 The microcomputer controllers contains logic to start, sequence and shut down the engine. For ready to start conditions all of the following logic conditions must be true:

1. OPERATION SELECTOR SWITCH is in any position except OFF.
2. All CB circuit breakers has are closed.
3. ACB alternator circuit breaker has not been tripped (see paragraph 16.1.6).
4. Inlet shutter and exhaust vents are open.
5. Major Alarm (shutdown conditions) does not exist.
6. Blast shutdown is not present.
7. REDUCED SPEED switch is set to NORMAL.
8. COAST DOWN lamp (amber LED) is not lighted.

15. EMERGENCY STOP SWITCHES

15.1 The EMERGENCY STOP pushbuttons are located on the engine control panel, on the remote control panel when furnished and just inside of the doors to the power room and/or emergency engine alternator room.

15.2 The test consists of operating each switch at least once to determine if it is functioning properly. To do this, operate all CB circuit breakers to ON and adjust the OPERATION SELECTOR SWITCH to MANUAL position. Depress the EMERGENCY STOP pushbutton and the MAJOR CIRCUIT BREAKER (CB-104) should trip open. Operate CB-104 to ON and repeat the above procedure for each pushbutton.

16. STARTING AND DYNAMIC TESTING

16.1 General

16.1.1 This first start should be made at the turbine. When a remote control cabinet is furnished and if two men are available, station one man at the turbine and one at the remote cabinet. Allow the operator at the turbine to make the initial start. At this start, or on any start, the operator should be ready to shut down the turbine with the EMERGENCY STOP pushbutton if one of the following malfunctions occur and the engine does not shutdown automatically.

WARNING: R-4296 EAR PROTECTOR MUST BE WORN DURING OPERATION OF THE SET.

16.1.2 MISFIRE: This is caused by low crank battery voltage or no fuel lightoff or restricted fuel flow (see CRANK FAILURE in TABLE A).

16.1.3 SURGE: Caused by momentary malfunction of fuel or air supply systems. At low speed the engine may fail to accelerate but exhaust temperature may rise, accompanied by a sudden high-pitched pulsating sound. At higher speeds a surge may cause the engine to fall to reach rated speed accompanied by a loud roar and/or popping noises (see HIGH EXHAUST TEMP in TABLE A).

16.1.4 Observe instruments and indicator lamps carefully during the initial run. Depress the EMERGENCY STOP pushbutton and/or turn the OPERATION SELECTOR SWITCH to OFF to stop the turbine should a malfunction occur that fails to automatically stop the set.

16.1.5 When instructions throughout the section refer to their performance from the remote cabinet and no remote cabinet was furnished then all controls will be found on the turbine control cabinet.

16.1.6 The alternator circuit breaker has three positions; closed, normal open and tripped open. The set will not start if the breaker has been tripped open. It must be in the normal open position. If it was previously tripped it must be manually reset.

16.1.7 Verify that the proper amount of lubricating oil is in the "reservoir" tank (see paragraph 12.3).

16.1.8 The events following occur in a rather rapid sequence so it is suggested the remaining information in this main paragraph be read and reviewed before starting the set. When all of the lamps cannot be observed by those present, small pieces of masking tape can be placed adjacent to the lamps that should come on, or, additional starts may be necessary to make the verifications called for.

16.2 Initial Start

16.2.1 Adjust the OPERATION SELECTOR SWITCH and the TRANSFER SWITCH RESTORE SELECT to MANUAL position. Follow the instructions in paragraphs 2.3.2.1 through 2.3.2.3 and all of paragraph 2.4. Should any malfunction exist, be prepared to depress the EMERGENCY STOP pushbutton. Observe the CAUTION statement in paragraph 2.4.5. Verify all engine sequences and lamp operations.

16.2.2 Verify that the FREQUENCY ADJUST controls on both the local and remote panels can be raised and lowered to control the frequency by 60 ± 3 Hz and can be set at 60 ± 0.25Hz.

16.2.3 Verify that the VOLTAGE ADJUST controls on both the local and remote panels can be altered to control the voltage up and down by $\pm10\%$ from the nominal value.

NOTE: When a remote cabinet is furnished the frequency meter and volt meter are not duplicated at the engine control location and the results of changing the potentiometers at the engine will have to be noted at the meters on the remote cabinet.

16.2.4 Observe that the exhaust temperature increases steadily to about 480 to 600°F. Many variables, some depending on the actual job site, will determine the final unloaded temperature so a precise value cannot be predetermined.

16.2.5 Adjust alternator voltage with the VOLTAGE ADJUST potentiometer to normal value (same voltage as read on the commercial bus with the voltmeter switch).

16.2.6 Check that the % SPEED meter reads $100\pm1\%$.

16.2.7 Verify the absence of potential on the Emergency Bus. Absence of continuity checks were previously made in paragraph 12.5.

16.2.8 Depress the CLOSE ACB pushbutton. The ACB circuit breaker closes and the alternator output is connected to emergency bus. The ACB OPEN lamp (green LED) extinguishes and the ACB CLOSED lamp (red LED) lights.

16.2.9 With alternator voltage available check phase sequence of the alternator voltage at the emergency bus with R-3404 Phase Sequence Indicator (see Figure 1). Refer to Section 135 in this handbook for method. 1-2-3 is required. Tag the buses.

CAUTION: FOR 4160 VOLT SETS MAKE THIS TEST ON THE LOW-VOLTAGE SIDE OF THE STEP-DOWN TRANSFORMER.

16.2.10 Depress the OPEN ACB pushbutton. The ACB circuit breaker opens and disconnects the alternator from the emergency bus. The ACB CLOSED lamp (red LED) extinguishes. The ACB OPEN and READY TO LOAD lamps (green LED's) will light.

16.2.11 Check the set over carefully for fuel and lube oil leaks.

16.2.12 After a short run at no load, operate the EMERGENCE STOP pushbutton on the remote cabinet, when furnished, to shut the turbine down. When not provided, operate EMERGENCY STOP pushbutton on the set (see paragraph 15). The MAJOR CIRCUIT BREAKER

EMERGENCY STOP lamp (red LED) shall light. Should either fail to stop the engine, operate the MAJOR CIRCUIT BREAKER (CB-104) to OFF and clear the trouble.

16.2.13 Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL lamp shall extinguish. The OPERATION SELECTOR SWITCH OFF lamp shall light.

16.2.14 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER EMERGENCY STOP lamp shall extinguish.

16.2.15 Adjust the OPERATION SELECTOR SWITCH back to MANUAL position and restart the set in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

NOTE: The engine cannot be restarted until the COAST DOWN lamp extinguishes.

16.2.16 Adjust the OPERATION SELECTOR SWITCH to OFF. The MAJOR CIRCUIT BREAKER will trip OFF, the set immediately shuts down, the MANUAL lamp extinguishes and the OFF lamp will light.

NOTE: If the engine is allowed to run continuously for approximately 15 minutes, before being shut down with commercial power connected to the commercial sense leads then the READY TO RESTORE lamp will light.

16.2.17 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.3 Low Oil Pressure

16.3.1 In normal operation, if the oil pressure at the sensor drops to below 30±1 pound per square inch gage (PSIG), the sensor will open and the set shuts down.

16.3.2 Adjust the OPERATION SELECTOR SWITCH to MANUAL. The OFF lamp will extinguish and the MANUAL lamp will light.

16.3.3 Start the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.3.4 Simulate low oil pressure by disconnecting one of the wires on terminal strip TB301-7. Check that the engine shuts down, LOW OIL PRESSURE and MAJOR CIRCUIT BREAKER lamps shall light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

16.3.5 Reconnect the wire to terminal strip TB301-7.

16.3.6 Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL, LOW OIL PRESSURE and the MAJOR CIRCUIT BREAKER lamps shall extinguish. The OPERATION SELECTOR SWITCH OFF lamp should light.

16.4 High Oil Temperature

16.4.1 In normal operation, if the oil temperature exceeds 200±25°F, the high oil temperature sensing switch closes and the set shuts down.

16.4.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to NORMAL.

16.4.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.4.4 Simulate high oil temperature by connecting a jumper between terminals TB301-6 and TB301-26. Check that the engine shuts down, MAJOR CIRCUIT BREAKER and HIGH LUBE OIL TEMP lamps light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

16.4.5 Remove the jumper wire between terminals TB301-6 and TB301-26.

16.4.6 Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL, HIGH LUBE TEMP and the MAJOR CIRCUIT BREAKER lamps shall extinguish. The OPERATION SELECTOR SWITCH OFF lamp shall light.

16.5 Open Temp Probe (T5)

16.5.1 In normal operation, if the turbine temperature probe circuit (T5) is open, the engine shuts down.

16.5.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.5.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.5.4 Simulate open temperature probe (T5) by disconnecting one of the wire on terminal strip TB308-5. check that the engine shuts down, OPEN TEMP PROBE (blinking) and MAJOR CIRCUIT BREAKER lamps light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

16.5.5 Reconnect the wire on terminal TB308-5. Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL, OPEN TEMP PROBE and the MAJOR CIRCUIT BREAKER lamps shall extinguish. The OPERATION SELECTOR SWITCH OFF lamp shall light.

16.6 Open Temp Probe (T7)

16.6.1 In normal operation, if the exhaust temperature probe circuit (T7) is open, the engine shuts down.

16.6.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.6.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.6.4 Simulate open temperature probe (T7) by disconnecting one of the wire on terminal strip TB308-7. check that the engine shuts down, OPEN TEMP PROBE and MAJOR CIRCUIT BREAKER lamps light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

16.6.5 Reconnect the wire on terminal TB308-7. Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL, OPEN TEMP PROBE and the MAJOR CIRCUIT BREAKER lamps shall extinguish. The OPERATION SELECTOR SWITCH OFF lamp shall light.

16.7 Major Circuit Breaker

16.7.1 In normal operation, if major circuit breakers CB-104, CB-202, CB-203, CB-207 or CB-310 is tripped, the set shuts down. Perform the following test for each major circuit breaker.

16.7.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.7.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.7.4 Operate a major breaker to the off position. Check that the engine shuts down and the MAJOR CIRCUIT BREAKER lamp lights.

16.7.5 Operate the major circuit breaker back on. Repeat the above operation for each major circuit breaker.

16.8 Over Speed

16.8.1 In normal operation, if the speed of the engine exceeds 108% of rated speed the engine will shut down.

16.8.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.8.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.8.4 Slowly operate the FREQUENCY ADJUST switch to the RAISE position. Check that shutdown occurs at 108% of rated speed, the OVER SPEED and MAJOR CIRCUIT BREAKER lamps are lighted. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

NOTE: Prior to the next start, it will be necessary to lower the RATED SPEED pot on the 2301 LOAD SHARING & SPEED CONTROL Panel (located on the left front side of enclosure). Carefully mark the position of the RATED SPEED pot before adjusting. Adjust the RATED SPEED pot to the C.C.W. position (approximately 1/4 turn) before attempting to restart the engine.

16.8.5 Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL and The OVER SPEED lamps shall extinguish.

16.8.6 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.9 Under Speed

16.9.1 In normal operation, if the engine speed decreases to less than 95% of rated speed the engine will shut down.

16.9.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.9.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4. Wait 2 minutes before proceeding.

16.9.4 Slowly operate the FREQUENCY ADJUST switch to the LOWER position. Check that the engine shuts down at 95% of rated speed, UNDER SPEED and MAJOR CIRCUIT BREAKER lamps shall light. Depress the ALARM CUTOFF pushbutton to silence the office alarms. Return the RATED SPEED pot to its original marked position.

NOTE: Readjust the speed to 60Hz (Immediately) on the next restart after completing the under speed test.

16.9.5 Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL and the UNDER SPEED lamps shall extinguish.

16.9.6 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.10 Open Speed Probe

16.10.1 In normal operation, if the magnetic speed probe is open, the engine shuts down.

16.10.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.10.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.10.4 Adjust the FREQUENCY ADJUST switch to obtain 60 Hz on the HERTZ meter.

16.10.5 Simulate an open speed probe by disconnecting one of the wire on terminal strip TB306-11. check that the engine shuts down, OPEN SPEED PROBE and MAJOR CIRCUIT BREAKER lamps light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

16.10.6 Reconnect the wire on terminal TB306-11. Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL and the OPEN SPEED PROBE lamp shall extinguish. The OPERATION SELECTOR SWITCH OFF lamp shall light.

16.10.7 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.11 Over Voltage

16.11.1 IN normal operation, if the output voltage exceeds 120% of rated voltage, the engine will shut down.

16.11.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.11.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.11.4 Remove the cover of the voltage regulator which is behind the front screen panel. Locate the VOLT REG ADJUST control on the voltage regulator and carefully mark the position of the control before adjusting. Adjust the control to obtain 115% of nominal voltage as read on the local or remote AC VOLTS meter.

16.11.5 Slowly increase the front panel VOLTAGE ADJUST control to 120% of nominal output voltage. check that the engine shuts down at about 120% of nominal output voltage, OVER VOLTAGE and MAJOR CIRCUIT BREAKER lamps shall light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

NOTE: Prior to restart, readjust the VOLT REG ADJUST control back to its original marked position and reposition the front panel VOLTAGE ADJUST control to the mid position.

16.11.6 Turn the OPERATION SELECTOR SWITCH to OFF. The OVER VOLTAGE and OPERATION SELECTOR SWITCH MANUAL lamps shall extinguish. The OPERATION SELECTOR SWITCH OFF shall light.

16.11.7 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.12 Under Voltage

16.12.1 In normal operation, if the voltage drops to below 85% of nominal output voltage, the engine shuts down.

16.12.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.12.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.12.4 Remove the cover of the voltage regulator which is behind the front screen panel. Locate the VOLT REG ADJUST control on the voltage regulator and carefully mark the position of the control before adjusting. Adjust the control to obtain 90% of nominal voltage as read on the AC VOLTS meter.

16.12.5 Slowly decrease the front panel VOLTAGE ADJUST control to 85% of nominal output voltage. check that the engine shuts down at about 85% of nominal output voltage, UNDER VOLTAGE and MAJOR CIRCUIT BREAKER lamps shall light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

NOTE: Prior to restart, readjust the VOLT REG ADJUST control back to its original marked position and reposition the front panel VOLTAGE ADJUST control to the mid position.

16.12.6 Turn the OPERATION SELECTOR SWITCH to OFF. The UNDER VOLTAGE and OPERATION SELECTOR SWITCH MANUAL lamps shall extinguish. The OPERATION SELECTOR SWITCH OFF shall light.

16.12.7 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.13 Crank Failure

16.13.1 If the engine did not exceed 5% of rated speed within 6 seconds, the engines shuts down.

16.13.2 Prior to restarting the engine, inhibit the starter and boost pump by disconnecting the wires on relay K354 terminal A2 and relay K386 terminal A1.

16.13.3 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.13.4 Restart the engine in accordance with paragraphs 2.3.2.1 and 2.3.2.2. Check that the engine shuts down (no crank) in 6 seconds, CRANK FAILURE and MAJOR CIRCUIT BREAKER lamps shall light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

16.13.5 Reconnect the wires on relay K354 and K386.

16.13.6 Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL and the CRANK FAILURE lamps shall extinguish.

16.13.7 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.14 Over Crank

16.14.1 If the engine did not exceed 66% of rated speed within 60 seconds, the engines shuts down.

16.14.2 Prior to restarting the engine, inhibit the boost pump by disconnecting relay K386 terminal A1.

16.14.3 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.14.4 Restart the engine in accordance with paragraphs 2.3.2.1 and 2.3.2.2. Check that the engine shuts down (no crank) in 60 seconds, CRANK FAILURE and MAJOR CIRCUIT BREAKER lamps shall light. Depress the ALARM CUTOFF pushbutton to silence the office alarms.

16.14.5 Reconnect the wire on relay K386.

16.14.6 Turn the OPERATION SELECTOR SWITCH to OFF. The OPERATION SELECTOR SWITCH MANUAL and the CRANK FAILURE lamps shall extinguish.

16.14.7 Operate the MAJOR CIRCUIT BREAKER to ON. The MAJOR CIRCUIT BREAKER lamp shall extinguish.

16.15 Minor Circuit Breakers

16.15.1 In normal operation, if some of the minor circuit breakers trips (CB-205, CB-206 and CB-309), the engine does not shut down. Minor alarms are provided to the office alarms circuits.

16.15.2 Wait until the COAST DOWN lamp extinguishes and adjust the OPERATION SELECTOR SWITCH to MANUAL.

16.15.3 Restart the engine in accordance with paragraphs 2.3.2.1 through 2.3.2.4.

16.15.4 Individually operate each minor circuit breaker to OFF and then to ON. Check that when the circuit breaker is OFF, the MINOR CIRCUIT BREAKER lamp is lighted, office alarm circuits can be silence by depressing the ALARM CUTOFF pushbutton, the engine does not shut down and the alternator circuit breaker does not trip.

16.15.5 Do not shut the engine down and proceed to the test below.

16.16 Rectifier Fail

16.16.1 In normal operation, if the battery charging rectifier fails, the engine does not shut down and minor alarms are sent to the office alarm circuits.

16.16.2 While the engine is running, disconnect the AC input power to the La Marche battery charging rectifier. Check that the MINOR RECTIFIER FAILURE lamp lights and that depressing the ALARM CUTOFF pushbutton silences the office alarm.

16.16.3 Reconnect the the AC input power to the charger. The MINOR RECTIFIER FAILURE lamp shall extinguish.

16.16.4 Open the door of the La Marche charger and remove the DC output fuse. Check that the MINOR RECTIFIER FAILURE lamp lights and that depressing the ALARM CUTOFF pushbutton silences the office alarms.

16.16.5 Reinsert the DC fuse to the charger. The MINOR RECTIFIER FAILURE lamp shall extinguish.

16.16.6 Shut the set down by adjusting the OPERATION SELECTOR SWITCH to OFF.

16.17 Fuel System Malfunction

16.17.1 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 FUEL SYSTEM MALFUNCTION. (the operation of the lamp is tested elsewhere).
2. a smooth acceleration to 100% speed (response of the fuel control value to the fuel command signal from the fuel control circuit).
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 Full Load Test.

17. FULL-LOAD TEST

17.1 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.

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

17.3 Records: Record the results of tests on the forms listed in paragraph 1.8.

17.4 Exhaust Back Pressure and Inlet Vacuum (Restriction)

17.4.1 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-82118-30. 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).

17.4.2 If the attachments are not furnished, this omission 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.

17.4.3 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.

17.4.4 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 in error.

17.5 Normal (Commercial Power) and Emergency Circuit Breakers

17.5.1 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.

17.5.2 Reconnect breaker leads disconnected in paragraphs 12.8 and 12.9 as required for automatic operation and test for proper operation and interlock. See SD-81489-01 listed in paragraph 1.4 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.

17.6 Preliminary Operations

17.6.1 Operate the ITE-5520 Digital Multimeter to EXTERNAL and connect to TB321 terminals 3 and 4 to read 1/2 of the alternator output voltage (500 AC range).

NOTE: These readings across phases 1 and 3 are to be taken only on the 208V, 230/240V and 480V sets. They will not be taken on the 4160 volt set.

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

17.7 Preliminary Full Load Tests

17.7.1 Turn the OPERATION SELECTOR SWITCH to MANUAL and start the set.

17.7.2 When the READY TO LOAD lamp appears, close the ACB CLOSE pushbutton.

17.7.3 Add about 750 KW of load.

17.7.4 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.

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

17.7.6 With the ACB closed, check for correct voltage and phase sequence of the alternator at the Emergency Breaker in the Remote Breaker Circuit.

NOTE: Refer to Section 135 in this handbook for information on "phasing-out" at the 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 other side.

17.7.7 Depress the TRANSFER SWITCH RESTORE SELECT pushbutton and adjust the OPERATION SELECTOR SWITCH to OFF.

17.8 Auto Start - Auto Transfer

17.8.1 Adjust the OPERATION SELECTOR SWITCH to AUTO, the TRANSFER SWITCH RESTORE SELECT to AUTO and the RUN TIMER switch to ON.

17.8.2 Simulate a commercial power failure by adjusting the circuit breaker CB-205 to OFF.

17.8.3 Follow the instructions as outlined in all of paragraphs 2.3.3 and 2.4. Adjust the output voltage and frequency as required. In paragraph 2.3.3.6, simulate commercial power return by operating circuit breaker CB-205 to ON.

17.9 Auto Start - Manual Restore

17.9.1 Adjust the OPERATION SELECTOR SWITCH to AUTO, the TRANSFER SWITCH RESTORE SELECT to MANUAL and the RUN TIMER switch to OFF.

17.9.2 Simulate a commercial power failure by adjusting circuit breaker CB-205 to OFF.

17.9.3 Follow the instruction as outlined in all of paragraphs 2.3.4 and 2.4. Adjust the output voltage and frequency as required. In paragraph 2.3.4.5, simulate commercial power return by operating the circuit breaker CB-205 to ON.

17.10 Simulated Power Failure

17.10.1 Follow the instructions as outlined in all of paragraph 2.5. Adjust the output voltage and frequency as required.

17.11 Reduced Speed

17.11.1 Adjust the OPERATION SELECTOR SWITCH and the TRANSFER SWITCH RESTORE SELECT to MANUAL.

17.11.2 Follow the instructions in paragraphs 2.3.2.1 through 2.3.2.3. Adjust the output voltage and frequency as required.

17.11.3 After the engine reaches 100% speed, and with the breaker opened, and the READY TO LOAD lamp lighted, check that when the REDUCED SPEED switch is held depressed, that the engine speed reduces to 50%.

17.11.4 Adjust the OPERATION SELECTOR SWITCH to OFF to shut the engine down.

18. FINAL ACCEPTANCE TEST

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

18.2 The Start Delay Timer (SDT) may be set for 5, 12, 30, or 60 seconds by operating the microswitches SW1 and SW2 on the microcomputer board (ZZ210) as indicated below:

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

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

18.4 Turn the OPERATION SELECTOR SWITCH and the TRANSFER SWITCH RESTORE SELECT to MANUAL. Start the set and adjust speed and voltage as necessary.

18.5 Close the ACB and add artificial load until the set is loaded to full-load.

18.6 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.

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

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

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

18.10 Turn the OPERATION SELECTOR SWITCH to OFF and disconnect artificial load.

18.11 Remove the manometer connections and cap lines into ducts.

18.12 Disconnect and remove the Display Terminal Test Set. Do not remove the RS232 adapter cable from plug P2 on the J-85529 microcomputer board (ZZ211). Dress and tie this cable to the existing harness on the inside top of the control panel in front of the microcomputer board.

TABLE A

MAJOR ENGINE ALARMS

ALARM LAMP	LAMP STATUS	PROBABLE CAUSE	SET POINT CONDITIONS
CRANK FAILURE	On	Locked rotor or low crank battery voltage	Turbine did not exceed 5% of rated speed within 6 seconds or 13% of rated speed within 15 seconds or 66% of rated speed within 60 seconds
CRANK FAILURE	Blinking	No fuel lightoff or restricted fuel flow	Turbine internal temperature (T5) did not exceed 400°F at 13% of rated speed within 15 seconds or did not attain 95% of rated speed within 10 seconds after reaching 66% of rated speed
UNDER SPEED	On	Overload or no fuel	Turbine speed decreases to less than 95% of rated speed after first operating at 100% of rated speed for at least two minutes
OPEN PROBE	Blinking	Open magnetic probe or defective magnetic circuit	No magnetic pickup pulses when turbine rotates
LOW OIL PRESSURE	On	No oil or defective oil pump	Oil pressure at sensor drops to below 30±1 pound per square inch gage (PSIG)
OVER SPEED	Blinking	Defective speed regulator circuit	Turbine speed increases above 108% of rated speed
REV POWER	On	Cross current compensation circuit	For parallel operation only. More than 150±10kw of reverse power
OPEN TEMP PROBE	On	Exhaust temperature probe (T7) or probe circuit defective	Exhaust temperature is less than 200°F when engine speed is greater than 25% of rated speed
OPEN TEMP PROBE	Blinking	Turbine temperature probe (T5) or probe circuit defective	Turbine temperature is less than 400°F when engine speed is greater than 25% of rated speed
HIGH EXHAUST TEMP	On	Turbine surge	Exhaust temperature (T7) is greater than 945°F when engine speed is less than 66% of rated speed
HIGH EXHAUST TEMP	Blinking	Turbine surge	Turbine temperature (T5) is greater than 1425°F when engine speed is less than 66% of rated speed or greater than 1300°F when engine speed is greater than 66% of rated speed
HIGH LUBE OIL TEMP	On	High oil temperature	Lube oil temperature sensing switch closes at 200±25°F
VIBRATION	On (5G)	Excessive engine vibration	Vibration exceeds 5 g's

TABLE B

MAJOR ALTERNATOR ALARMS

ALARM LAMP	LAMP STATUS	PROBABLE CAUSE	SET POINT CONDITIONS
OVER VOLTAGE	Blinking	Defective regulator circuit	The set is in unloaded READY TO LOAD condition and the output voltage is greater than 120% of rated voltage or the set is loaded and the output voltage exceeds 120% of rated voltage for more than 2 seconds
UNDER VOLTAGE	On	Defective regulator circuit	Output voltage decreases to less than 85% of rated voltage after first reaching rated voltage and remains there for more than 2 seconds
OVER CURRENT	On	Excessive load or short circuit	Excessive current will operate either the long-time or the short-time tripping device, the ACB will trip
GROUND FAULT	On	Unbalance load	An output current difference of more than 20% of rated current in any two phase and lasting more than 1 second
MAJOR CIRCUIT BREAKER	On	Circuit breaker open	CB-104 or CB-202 or CB-203 or CB-207 or CB-310 is open or 24 volt battery supply drops below 18 volts
EMERGENCY STOP	On	EMERGENCY STOP push-button depressed	Major circuit Breaker CB-104 is open

TABLE C

MINOR ALARMS

ALARM LAMP	LAMP STATUS	PROBABLE CAUSE	SET POINT CONDITIONS
PRE HIGH EXHAUST TEMP	On	Preliminary high engine temperature	Turbine exhaust gas temperature (T7) exceeds 954°F or the turbine temperature (T5) exceeds 1250°F
RECTIFIER FAILURE	On	Defective battery circuit	No battery charging or over charging or control battery float voltage is less than 18 volts at controller
RECTIFIER FAILURE	Blinking	Defective air intake shutter circuit if provided	Loop closure across TB306-14 and TB301-24 provided by open shutter limit switch
MINOR ALARM	On	Circuit breakers open or tripped	CB-205 or CB-206 or CB-309 or CB-311 is open or tripped

TABLE D (Refer to TABLE E)

INPUT SCREEN PRINT

01	B	ACO-PB	11	S	AM-SEL2-SW	21	S	SW3-CL-SW	31	M	ALT-OV-I
02	B	CL-ACB-PB	12	B	AUTO-TRNS-SW	22	S	SW4-CL-SW	32	M	ALT-UV-I
03	B	MAN-RST-PB	13	M	OSS-LA-SW	23	S	SW5-CL-SW	33	M	PWR-FAIL-I
04	B	OP-ACB-PB	14	M	OSS-LM-SW	24	M	ALT-CB-E	34	M	RECT-FAIL-I
05	M	PURG-PB	15	B	OSS-RA-SW	25	M	HI-OIL-TMP-E	35	B	ACB-INTER-I
06	M	RED-SPD-PB	16	B	OSS-RM-SW	26	M	LO-CRK-BAT-E	36	M	CHRG-FAIL-C
07	M	REM-STRT-PB	17	S	RUN-TIM-SW	27	M	LO-OIL-PRS-E	37	M	EMG-CB-C
08	B	STRT-PB	18	M	SW1-CL-SW	28	M	MAJ-CB-E	38	S	LOUV-OP-C
09	B	TST-RUN-PB	19	M	SW2-CL-SW	29	M	MIN-CB-E	39	S	NORM-CB-C
10	S	AM-SEL1-SW	20	M	SW3-CL-SW	30	M	OV-CUR-E	40	B	STRT-INTR-C

TABLE E

INPUT INSTRUCTIONS FOR TABLE D (See NOTE A)

TEST NUMBER	ACTION TO BE TAKEN TO MAKE DEVICE ACTIVE
01	Depress the ALARM CUT OFF pushbutton (Local if no Remote or on Remote only, if provided)
02	Depress the CLOSE ACB pushbutton (Local if no Remote or on Remote only, if provided)
03	Depress the TRANSFER SWITCH RESTORE pushbutton (Local if no Remote or on Remote only, if provided)
04	Depress the OPEN ACB pushbutton (Local and Remote)
05	Depress the PURGE CRANK pushbutton (Local only)
06	Depress the REDUCE SPEED pushbutton on the right rear of the set
07	Depress the remote MANUAL START pushbutton if provided
08	Depress the Local MANUAL START pushbutton
09	Depress the SIMULATED POWER FAILURE pushbutton (Local if no Remote or on Remote only, if provided)
10	Operate the AMMETER SELECT switch to the 1 position (Local if no Remote or on Remote only, if provided)
11	Operate the AMMETER SELECT switch to the 2 position (Local if no Remote or on Remote only, if provided)
12	Operate the TRANSFER SWITCH RESTORE SELECT to the AUTO position (Local if no Remote or on Remote only, if provided)
13	Adjust the OPERATION SELECTOR SWITCH on the Local panel to AUTO position

TABLE E

INPUT INSTRUCTIONS FOR TABLE D (See NOTE A)

TEST NUMBER	ACTION TO BE TAKEN TO MAKE DEVICE ACTIVE
14	Adjust the OPERATION SELECTOR SWITCH on the Local panel to MANUAL position
15	Adjust the OPERATION SELECTOR SWITCH on the remote panel to AUTO position if provided
16	Adjust the OPERATION SELECTOR SWITCH on the remote panel to MANUAL position if provided
17	Operate the RUN TIMER switch to the ON position (Local if no Remote or on Remote only, if provided)
18	Operate SW1 switch on the Master Controller board (ZZ210) to CLOSED position
19	Operate SW2 switch on the Master Controller board (ZZ210) to CLOSED position
20	Switch SW3 is in the CLOSED position, do not OPEN this switch or STATIC TESTING will end. The display terminal should beep
21	Operate switch SW3 in the Slave Controller board (ZZ211) to CLOSED position
22	Switch SW4 in the Slave Controller board (ZZ211) should be in the CLOSED position and the display terminal should beep. Adjust the switch to OPEN to stop the beep. Return the switch to its normally CLOSED position and the beep should return
23	Switch SW5 in the Slave Controller board (ZZ211) should be in the CLOSED position and the display terminal should beep. Adjust the switch to OPEN to stop the beep. Return the switch to its normally CLOSED position and the beep should return
24	Short (ACB) TB2 terminal 7 (first) to terminal 8 (See NOTE B)
25	SIMULATE - TB301 terminal 6 to ground (See NOTE B)
26	SIMULATE - Manually close the K-217 relay
27	SIMULATE - TB301 terminal 7 to ground (See NOTE B)
28	(1) NORMAL - All MAJOR CIRCUIT BREAKERS are closed CB-104, CB-202, CB-203, CB-207 AND CB-310 (2) SIMULATE - Open each CB one at a time except CB-203 which supplies power to microcomputors (See NOTE A)
29	(1) NORMAL - All MINOR CIRCUIT BREAKERS are closed CB-205, CB-206, CB-309 and CB-311 (2) SIMULATE - Open each CB one at a time (See NOTE A)
30	SIMULATE - Short TB5 terminal 25 to TB5 terminal 26 on the ALTERNATOR CIRCUIT BREAKER
31	(1) NORMAL - INACTIVE (2) SIMULATE - Use AC SIMULATOR (See NOTE C)

TABLE E

INPUT INSTRUCTIONS FOR TABLE D (See NOTE A)

TEST NUMBER	ACTION TO BE TAKEN TO MAKE DEVICE ACTIVE
32	(1) NORMAL - ACTIVE (2) SIMULATE - Use AC SIMULATOR (See NOTE C)
33	Open CB-205
34	Turn BATTERY CHARGER OFF to allow batteries to discharge to below 24 volts (See NOTE C)
35	(TEST ONLY IF ANOTHER SET IS IN PARALLEL) SIMULATE A) If the parallel set is a KS-15992, then short terminals T114 (first) to T113 on the parallel set (See NOTE B) B) If the parallel set is a KS-22673, then short TB-305 terminal 20 (first) to terminal 19 on the parallel set (See NOTE B)
36	Pull Rectifier AC Input fuse
37	SIMULATE - Apply +24 volts to TB307-7 (+) and TB307-8 (-) (See NOTE C)
38	SIMULATE - Apply +24 volts to TB306-13 (+) and TB306-14 (-) (See NOTE C)
39	SIMULATE -Apply +24 volts to TB307-24 (+) and TB307-25 (-) (See NOTE C)
40	(TEST ONLY IF ANOTHER SET IS IN PARALLEL) SIMULATE - Apply +24 volts to TB307-11 (+) and TB307-12 (-) (See NOTE C)

NOTE: A) Always return the circuit breakers and transducers back to their original position before proceeding to the next test. Remove all shorts.

B) When grounding these terminals, prevent static discharge from damaging the integrated circuits that are connected to these terminals. First, connect the strap wire to a solid ground point. Ascertain that it is a ground point by measuring zero volts from the open end of the strap to a known frame ground. The open end of the strap may now be used to ground the indicated terminal.

C) These test are normally perform at the factory and are not practical to perform at the final sight. These test are not field recommended unless difficulties dictate otherwise.

TABLE F (Refer to TABLE G)

OUTPUT SCREEN PRINT

01	B	COAST-DN-L%	16	B	MAN-L	31	B	PWR-RET-R	46	S	VIB1-L
02	B	RF-FF-L	17	B	OFF-L	32	B	FIELD-FLASH-R	47	S	VIB2-L
03	B	COAST-DN-L	18	B	US-OP-L	33	B	CF-NOLGT-L	48	S	VIB3-L
04	B	OVER-CUR-L	19	B	AUTO-L%	34	M	RTL-L	49	S	VIB4-L
05	B	MIN-CB-L	20	B	MAN-L%	35	M	OP-ECB-R	50	S	VIB-FAULT-L%
06	B	SIM-PWR-FAIL-L	21	B	OFF-L%	36	M	OP-NCB-R	51	S	VIB-FAULT-L
07	B	OS-RVP-L	22	M	MAJ-ALM-VIS-R	37	M	CL-ECB-L	52	S	LIT-OFF-TMP-L%
08	B	RUN-TMR-L	23	M	MAJ-ALM-AUD-R	38	M	CL-NCB-L	53	S	LIT-OFF-TMP-L
09	M	HI-OIL-TMP-L	24	M	PWR-FAIL-R	39	M	VOLT-REG-R	54	S	PRE-HI-TMP-L
10	M	LO-OIL-PRS-L	25	M	RTL-R	40	M	CL-ACB-R	55	S	HI-TMP-L%
11	M	OS-RVP-L%	26	M	PROP-OP-R	41	M	OP-ACB-R	56	S	HI-TMP-L
12	M	MAJ-CB-L	27	M	MIN-ALM-AUD-R	42	M	CRANK-R	57	S	TMP-PROB-L
13	M	OV-UV-L	28	M	MIN-ALM-VIS-R	43	M	IGN-R	58	S	GND-FAULT-L
14	B	US-OP-L%	29	B	LOUV-OP-R	44	M	FUEL-R	59	S	TOP-LIMIT-R
15	B	AUTO-L	30	B	AUTO-R	45	B	RED-SPD-R	60	S	LOWR-HZ-R

TABLE G

OUTPUT INSTRUCTIONS FOR TABLE F

TEST NUMBER	CHECK FOR TEST CONDITIONS
01	COAST DOWN lamp will blink (Remote only)
02	RECTIFIER FAILURE lamp will blink (Local only)
03	COAST DOWN lamp will blink (Local only)
04	OVER CURRENT lamp will blink (Local if no Remote or on Remote only, if provided)
05	MINOR ALARM lamp will blink (Local only)
06	SIMULATED POWER FAILURE lamp will blink (Local if no Remote or on Remote only, if provided)
07	OVER SPEED/REV POWER lamp will blink (Local only)
08	RUN TIMER ON lamp will blink (Local if no Remote or on Remote only, if provided)
09	HIGH LUBE OIL TEMP lamp will blink (Local only)
10	LOW OIL PRESSURE lamp will blink (Local only)
11	OVER SPEED/REV POWER lamp will blink (Remote only)
12	MAJOR ALARM lamp will blink (Local only)
13	OVER/UNDER VOLTAGE lamp will blink (Local if no Remote or on Remote only, if provided)

TABLE G

OUTPUT INSTRUCTIONS FOR TABLE F

TEST NUMBER	CHECK FOR TEST CONDITIONS
14	UNDER SPEED/OPEN PROBE lamp will blink (Remote only)
15	OPERATION SELECTOR SWITCH AUTO lamp will blink (Local only)
16	OPERATION SELECTOR SWITCH MANUAL lamp will blink (Local only)
17	OPERATION SELECTOR SWITCH OFF lamp will blink (Local only)
18	UNDER SPEED/OPEN PROBE lamp will blink (Local only)
19	OPERATION SELECTOR SWITCH AUTO lamp will blink (Remote only)
20	OPERATION SELECTOR SWITCH MANUAL lamp will blink (Remote only)
21	OPERATION SELECTOR SWITCH OFF lamp will blink (Remote only)
22	Relay K302 will pulse Remote MAJOR ALARM lamp will blink
23	Relay K312 will pulse
24	Relay K388 will pulse POWER FAILURE lamp will blink (Local if no Remote or on Remote only, if provided)
25	Relay K311 will pulse
26	Relay K310 will pulse PROPER OPERATION lamp will blink (Local if no Remote or on Remote only, if provided)
27	Relay K307 will pulse
28	Relay K308 will pulse Remote MINOR ALARM lamp will blink
29	Relay K303 will pulse
30	Relay K306 will pulse
31	Relay K305 will pulse READY TO RESTORE lamp will blink (Local if no Remote or on Remote only, if provided)
32	Relay K360 will pulse
33	CRANK FAILURE lamp will blink (Local only)
34	READY TO LOAD lamp will blink (Local if no Remote or on Remote only, if provided)
35	Relay K327 will pulse (This is a solid-state relay, therefore, no clicking will be heard. To test, connect a DMM to TB203 terminal 21 (+) and ground (-). A pulsing voltage of 0 to 23 volts will be indicated)
36	Relay K325 will pulse

TABLE G

OUTPUT INSTRUCTIONS FOR TABLE F

TEST NUMBER	CHECK FOR TEST CONDITIONS
	(This is a solid-state relay, therefore, no clicking will be heard. To test, connect a DMM to TB-203 terminal 19 (+) and ground (-). A pulsing voltage of 0 to 23 volts will be indicated)
37	TRANSFER TO EMERGENCY lamp will blink (Local if no Remote or on Remote only, if provided) Relay K328 will pulse (This is a solid-state relay, therefore, no clikng will be heard. To Test, connect a DMM to TB-203 terminal 22 (+) and ground (-). A pulsating voltage of 0 to 23 volts will be indicated)
38	TRANSFER TO NORMAL lamp will blink (Local if no Remote or on Remote only, if provided) Relay K326 will pulse (This is a solid-state relay, therefore, no clikng will be heard. To test, connect a DMM to TB-203 terminal 20 (+) and ground (-). A pulsating voltage of 0 to 23 volts will be indicated)
39	Relay K313 will pulse (Close MAJOR CIRCUIT BREAKER (CB-104) for this test)
40	Relay K316 will pulse (Close MAJOR CIRCUIT BREAKER (CB-104) for this test)
41	Relay K201 will pulse (Close MAJOR CIRCUIT BREAKER (CB-104) for this test)
42	Relay K243 will pulse CRANKING lamp will blink (Local and Remote)
43	Relay K245 will pulse (Close MAJOR CIRCUIT BREAKER (CB-104) for this test)
44	Relay K249 will pulse FUEL ON lamp will blink (Local and Remote) (Close MAJOR CIRCUIT BREAKER (CB-104) for this test)
45	Relay K294 will pulse
46	VIBRATION 1G lamp will blink (Local if no Remote or on Remote only, if provided)
47	VIBRATION 2G lamp will blink (Local if no Remote or on Remote only, if provided)
48	VIBRATION 3G lamp will blink (Local if no Remote or on Remote only, if provided)
49	VIBRATION 4G lamp will blink (Local if no Remote or on Remote only, if provided)
50	VIBRATION 5G lamp will blink (Remote only)
51	VIBRATION 5G (Local) or HIGH VIBRATION (Local if Remote is provided) lamp will blink
52	LIGHT OFF TEMP lamp will blink (Remote only)
53	LIGHT OFF TEMP lamp will blink (Local only)
54	PRE HIGH EXHAUST TEMP lamp will blink (Local if no Remote or on Remote only, if provided)

TABLE G

OUTPUT INSTRUCTIONS FOR TABLE F

TEST NUMBER	CHECK FOR TEST CONDITIONS
55	HIGH EXHAUST TEMP lamp will blink (Remote only)
56	HIGH EXHAUST TEMP lamp will blink (Local only)
57	OPEN TEMP PROBE lamp will blink (Local only)
58	GROUND FAULT lamp will blink (Local if no Remote or on Remote only, if provided)
59	Relay K244 will pulse
60	LOWER HERTZ relay (not in use)

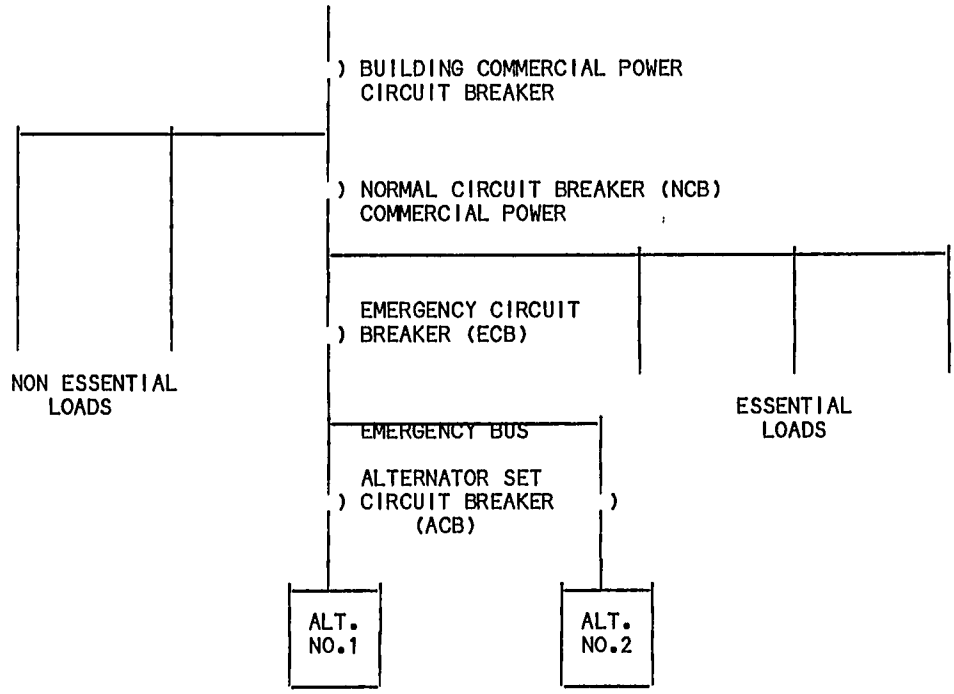

Figure 1. Typical Operating Company Breaker and Bus Arrangement.

Manager - Product Engineering