

**KS-22673, LISTS 1 THROUGH 8**  
**TURBINE ENGINE-DRIVEN ALTERNATOR**  
**750/900 KW AUTOMATICALLY OR MANUALLY CONTROLLED**  
**OPERATING METHODS**

	CONTENTS	PAGE		CONTENTS	PAGE
1.	<b>GENERAL</b> . . . . .	2	E.	<b>Automatic Shutdown Sequence</b> . . . . .	32
	<b>CONTROL EQUIPMENT DESCRIPTION</b> . . . . .	7	F.	<b>Purge Crank Sequence</b> . . . . .	32
	A. <b>Metering Controls (Local Set and Remote Set)</b> . . . . .	7	4.	<b>ROUTINE CHECKS</b> . . . . .	33
	B. <b>Alarms Controls</b> . . . . .	11		<b>ROUTINE RUN</b> . . . . .	33
	<b>WORKING ON A SET OR ITS CONTROL EQUIPMENT</b> . . . . .	17		<b>TESTING SET</b> . . . . .	33
2.	<b>APPARATUS</b> . . . . .	18	5.	<b>GENERAL TROUBLES</b> . . . . .	34
3.	<b>OPERATION</b> . . . . .	18		<b>OPERATION</b> . . . . .	35
	<b>GENERAL DESCRIPTION OF OPERATION OF THE SET AND CONTROL PANEL</b> . . . . .	18	6.	<b>ACCESSORIES CLEANING</b> . . . . .	63
	<b>AUTOMATIC OR MANUAL OPERATION</b> . . . . .	20		<b>ENGINE COMPRESSOR CLEANING</b> . . . . .	63
	<b>NORMAL OPERATING PROCEDURES</b> . . . . .	20		A. <b>Water Washing</b> . . . . .	64
	<b>PARALLEL OPERATION</b> . . . . .	23		B. <b>Abrasive Cleaning</b> . . . . .	65
	<b>SEQUENCE OF OPERATIONS</b> . . . . .	24	<b>Figures</b>		
	A. <b>Manual Start Sequence (With Commercial Power Present)</b> . . . . .	24	1.	<b>Alternator Set Major Components—Right Side</b> . . . . .	4
	B. <b>Manual Start Sequence (With Actual or Simulated Commercial Power Failure)</b> . . . . .	26	2.	<b>Alternator Set Major Components—Left Side</b> . . . . .	5
	C. <b>Manual Shutdown Sequence</b> . . . . .	29	3.	<b>Lubrication System</b> . . . . .	6
	D. <b>Automatic Start Sequence (With Actual or Simulated Commercial Power Failure)</b> . . . . .	29	4.	<b>Fuel System Schematic</b> . . . . .	8
			5.	<b>Local Control Panel Without Remote Control Option</b> . . . . .	12
			6.	<b>Control Panel—Local Panel With Remote Option</b> . . . . .	14

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CONTENTS	PAGE
7. Control Panel—Remote Panel . . . . .	15
8. Abrasive Injector Kit and Lines . . . . .	66
<b>Tables</b>	
A. Indicator LEDs Located On Control Panel Local and Remote . . . . .	10
B. Relays and Their Functions . . . . .	17
C. Operating Mode of the OPERATION SELEC- TOR SWITCH . . . . .	18
D. Proper Position for Switches on SW1 or CRT for 1200 Baud Operation . . . . .	34
E. Proper Position for Switches on SW2 on CRT . . . . .	35
F. Proper Position for Switches on SW3 on CRT . . . . .	35
G. Identification of Inputs on CRT Screen and Logic Definition . . . . .	36
H. Input Testing of Microcomputer Control Sys- tem . . . . .	37
I. Trouble Chart 1 Input Testing of Microcomputer Control System . . . . .	41
J. Identification of Outputs on CRT Screen and Logic Definition . . . . .	47
K. Output Testing of Microcomputer Control System . . . . .	49
L. Trouble Chart 2 Output Testing of Microcomputer Control System . . . . .	53
M. Cleaning Table . . . . .	64

## 1. GENERAL

1.01 This section describes the method of operating the KS-22673, List 1 through List 8, automatically or manually controlled turbine engine-driven alternators (set). Control circuits are also covered.

1.02 Whenever this section is reissued, the reason for reissue will be specified in this paragraph. The Equipment Test List is affected.

**Warning:** *This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. As temporarily permitted by regulation, it has been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of Federal Communications Commission (FCC) Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.*

1.03 The sets are manufactured by Solar Turbines Incorporated and, depending upon the list number, are rated at 208, 230/240, 480, or 4160 volts and are arranged for 60-Hz, 3-phase, 4-wire, ABC-phase rotation with manual or automatic control. List numbers are used to identify sets as follows:

**List 1**—208-Volt Alternator Set, On-Set Control

**List 2**—230/240 Volt Alternator Set, On-Set Control

**List 3**—480-Volt Alternator Set, On-Set Control

**List 4**—208-Volt Alternator Set, Arranged for Remote Control and Equipped with Remote Control Circuit for Mounting in a List 9 or 10 Remote Control Cabinet

**List 5**—230/240-Volt Alternator Set, Arranged for Remote Control and Equipped With Remote Control Circuit for Mounting in a List 9 or 10 Remote Control Cabinet

**List 6**—480-Volt Alternator Set, Arranged for Remote Control and Equipped With Remote Control Circuit for Mounting in a List 9 or 10 Remote Control Cabinet

**List 7**—4160-Volt Alternator Set, Arranged for Remote Control and Equipped With a 208-Volt Re-

Remote Control Circuit for Mounting in a List 9 or 10 Remote Control Cabinet.

**List 8**—4160-Volt Alternator Set, Arranged for Remote Control and Equipped With a 480-Volt Remote Control Circuit for Mounting in a List 9 or 10 Remote Control Cabinet.

**List 9**—Remote Control Cabinet For One or Two List 4, 5, 6, 7, or 8 Remote Control Circuits.

**List 10**—Remote Control Cabinet For One, Two, or Three List 4, 5, 6, 7, or 8 Remote Control Cabinet

**List 11**—Inlet Silencer

**List 12**—Inlet Flexible Section

**List 13**—Turbine Exhaust Silencer (Moderate Degree of Attenuation)

**List 14**—Turbine Exhaust Silencer (High Degree of Attenuation)

**List 15**—Turbine Oil Mist Precipitator

**1.04** The KS-22673 engine-driven alternator set (Fig. 1 and 2) is intended for indoor installation as a standby electrical power plant of a 900 KW/peak and 750 KW/base capacity; and is designed for automatic or manual start, automatic loading, automatic restore, and automatic shutdown. Manual synchronizing equipment is included. Automatic synchronizing can be accomplished by using the J86742A Automatic Controller (ordered separately).

**1.05.** The engine is a multistage, single-shaft, constant speed, axial-flow unit. The principal rotating components are an 8-stage compressor and a 3-stage turbine which are joined by a connecting shaft on a common axis of rotation and turn as one unit. The aft end of the turbine engine is spline-coupled to a planetary reduction drive on the same axis of rotation. Accessory drive gears are driven from the forward end of the compressor through an interconnect shaft and gear train. The engine control system operates on a power supply of 24 volts direct current. The alternator is a 2-bearing, 3-phase, 60-Hz, brushless alternator. All bearings and gears in the engine, accessory drives, and reduction drive are lubricated and cooled by the lubricating oil system (see Fig. 3). Ventilating air for the alternator is drawn by the alternator through the screen under the

instrumentation panel and is discharged into the reduction gear compartment. The ventilation air then exhausts through an opening at the top of the generator set. Major control functions of the set are provided by the microcomputer controller. The system consists of two microcomputers: one for the analog signal processing, and one for digital signal processing. Each computer circuit is mounted on a separate circuit board.

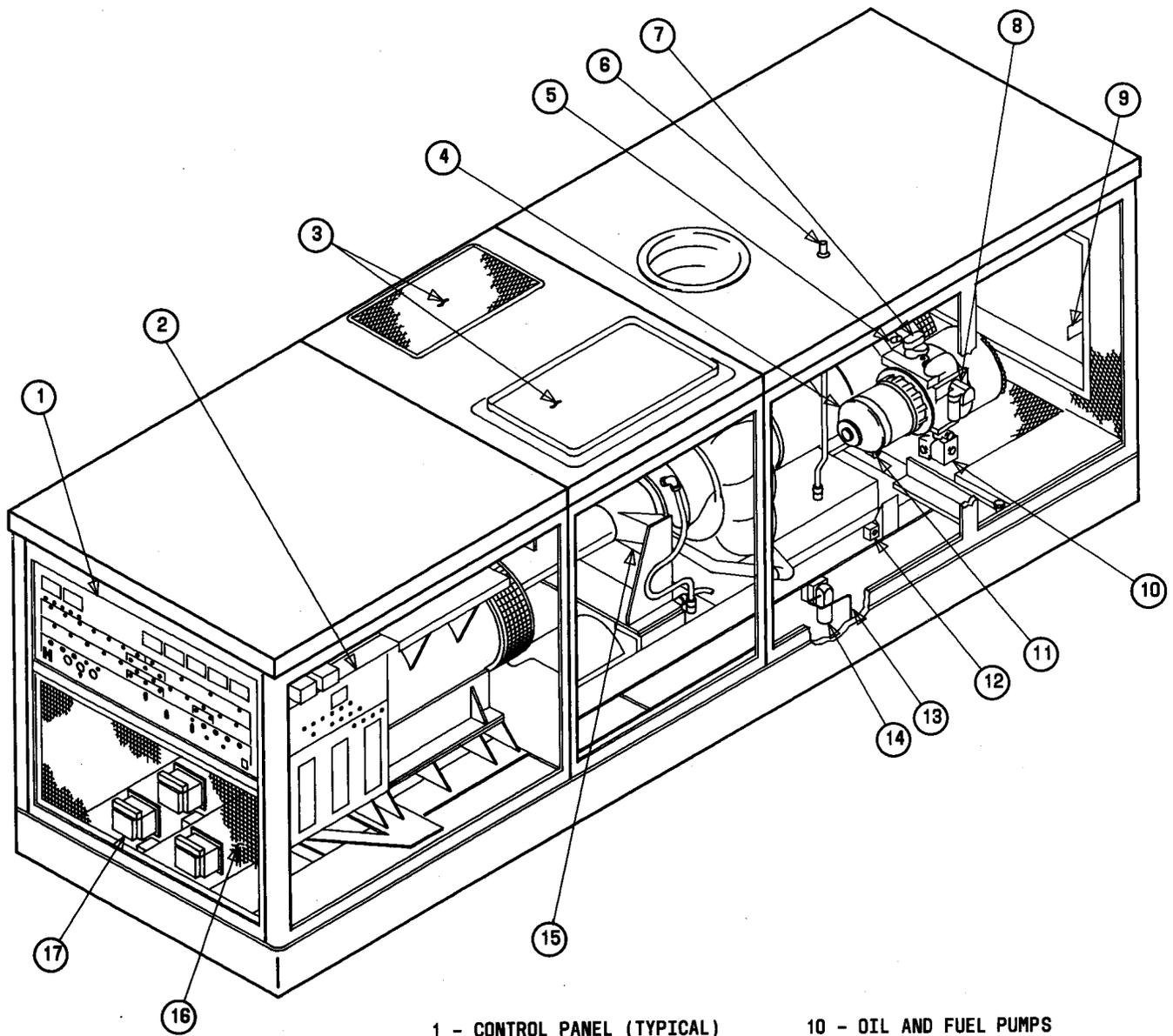
**1.06** The microcomputer controller for engine-alternators digital processing (J85520) operates to process all digital-type signals such as switch/pushbutton inputs and relay/light emitting diode (LED) drives as outputs. The frequency and speed meters are also driven from the digital processor board. A portion of the digital input/output signals controlled by the J85520 processor is located on the analog signal processing board (J85529) and is controlled through a ribbon cable.

**1.07** The microcomputer controller for analog signal processing (J85529) inputs include thermocouples, cold junction, accelerometer, alternator phase currents, and voltages. The analog processor inputs are multiplexed and changed to digital format by means of an analog-digital converter. The output ports drive 1 milliampere meters that display ac current, kilowatts, power factor, and turbine temperature. Vibration is displayed by a series of five LEDs also controlled by the analog signal processing board.

**1.08** The instructions in this section are based on drawings SD-82581-01 through SD-82583-01 which refer to engine control circuits and remote control circuits; SD-82585-01 and SD-82586-01 concern the interconnection of engine control, remote control (if provided), and power output with the power distribution, fuel transfer, ventilation, and alarm systems; SD-82531-01 refers to microcomputer controller for engine-alternators digital processing (J85520); SD-82575-01 refers to microcomputer controller for analog signal processing (J85529). For a detailed description of the operation of the individual circuits, see the corresponding circuit description.

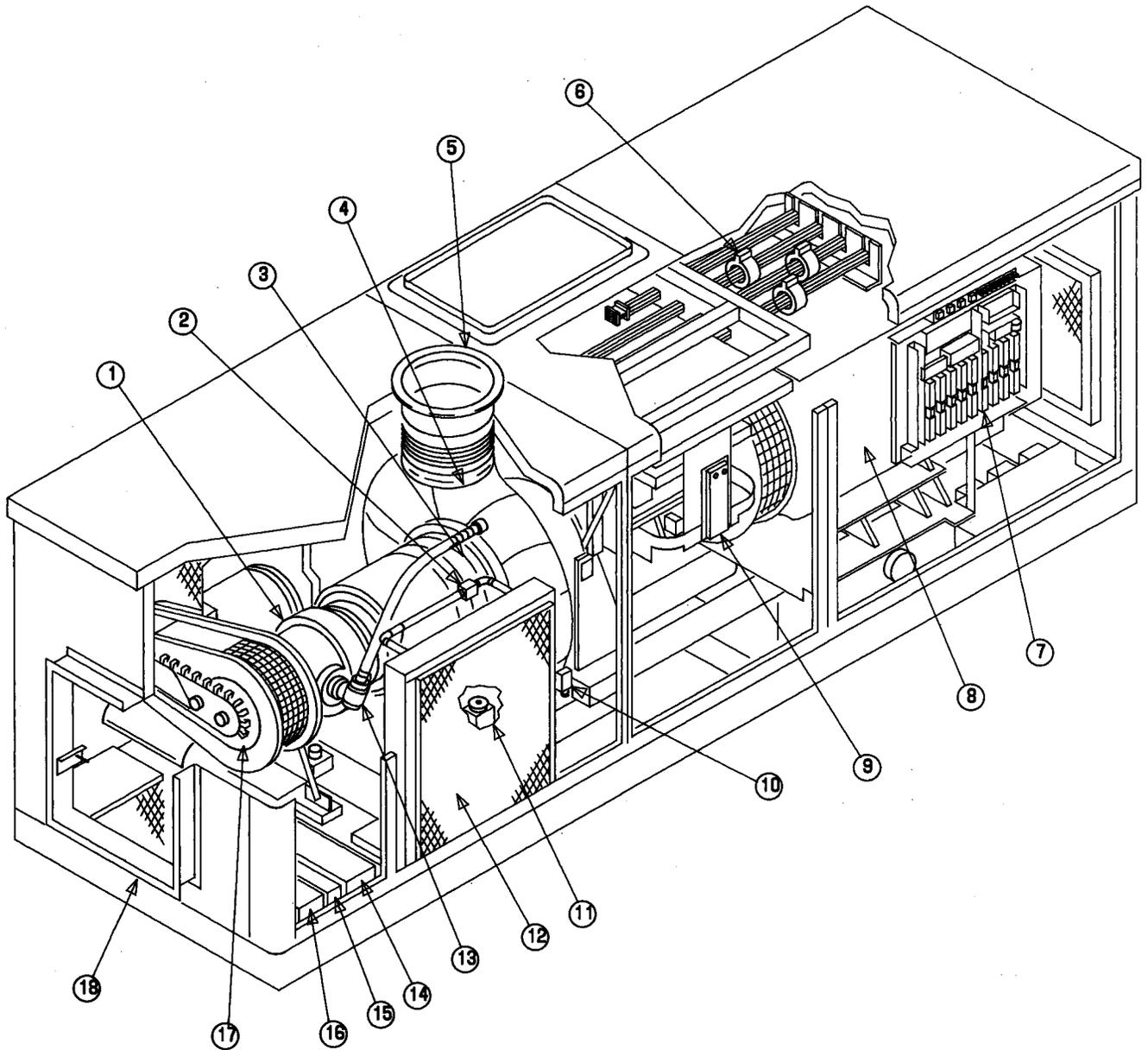
**1.09** Reference should be made to Section 155-211-701 for information necessary for the proper maintenance of the equipment referred to herein. If maintenance procedures needed are not specified in Section 155-211-701, contact Solar Field Service through Western Electric in accordance with Section 010-700-010.

**Note:** Operating instruction charts (wall charts) are to be conspicuously posted by the



- |  |   |
|--|---|
| 1 - CONTROL PANEL (TYPICAL)                | 10 - OIL AND FUEL PUMPS                   |
| 2 - VOLTAGE REGULATOR PANEL                | 11 - IGNITION EXCITER                     |
| 3 - COOLING VENTS                          | 12 - CRANK/PURGE SWITCH                   |
| 4 - STARTER                                | 13 - CUSTOMER FUEL INLET                  |
| 5 - MAGNETIC PICKUP NO. 1<br>SPEED MONITOR | 14 - FUEL STRAINER                        |
| 6 - OIL TANK VENT                          | 15 - REDUCTION DRIVE                      |
| 7 - HYDRAULIC PUMP                         | 16 - ALTERNATOR VENTILATION<br>AIR INTAKE |
| 8 - HIGH PRESSURE FUEL FILTER              | 17 - POTENTIAL TRANSFORMERS               |
| 9 - T1 SENSOR                              |   |

Fig. 1—Alternator Set Major Components—Right Side



- |   |  |
|---|--|
| 1 - TURBINE ENGINE                          | 10 - OIL TEMPERATURE SWITCH                  |
| 2 - THERMOSTATIC MIXING VALVE               | 11 - OIL FILLER                              |
| 3 - TEMPERATURE SENSORS (T5)                | 12 - OIL COOLER AND FAN MOTOR                |
| 4 - TEMPERATURE SENSORS (T7)                | 13 - BLEED AIR VALVE                         |
| 5 - EXHAUST                                 | 14 - FUEL BOOST PUMP                         |
| 6 - CURRENT TRANSFORMERS (TYPICAL)          | 15 - OIL FILTER                              |
| 7 - CUSTOMER TIE POINTS                     | 16 - FUEL FILTER                             |
| 8 - ALTERNATOR                              | 17 - MAGNETIC PICKUP NO. 2<br>(FUEL CONTROL) |
| 9 - ALTERNATOR CIRCUIT BREAKER<br>(TYPICAL) | 18 - ENGINE AIR INTAKE                       |

Fig. 2—Alternator Set Major Components—Left Side



operating company near the engine-alternator set as required by local regulation or ordinance. See Section 155-010-300 for information on ordering these charts.

**1.10** In connection with the storage of fuel oil, care should be exercised to prevent dirt from entering the fuel storage tanks. Refer to Section 065-320-301 for information on recommended fuels and requirements for handling and storage. See Fig. 4 for the fuel schematic. A fuel filter/water separator assembly (if provided) is to be installed between the main tank and the day tank (if provided) to assure cleaner fuel; if a day tank is not provided, the filter assembly will be installed between the main tank and the alternator set.

**Note:** If a fuel system filter assembly is provided, it will be necessary to take into account a pressure drop of 4-1/2 pounds per square inch (psi) maximum (11 feet of fuel) across the filter in computing the total lift required for the engine boost pump or auxiliary pumps.

#### CONTROL EQUIPMENT DESCRIPTION

**1.11** The local configured alternator set is fully controlled from the control panel mounted on the aft end of the set. The remote configured sets are fully controlled from a separate remote control panel. It should be noted that on remote alternator sets some of the essential controls are duplicated. The alternator set controls and indicators are grouped and are designated as follows:

- Metering Controls
- Alarms Engine/Alternator Indicators (Table A)
- Status Indicators (Table A)
- Command Controls
- Secondary Controls (Control Circuit Breakers).

#### A. Metering Controls (Local Set and Remote Set)

**1.12** The metering (Fig. 5, 6, and 7) on the control panel consists of the following:

(1) **ENGINE SPEED METER:** The ENGINE SPEED METER employs a 0- to 1-milliamperere movement driven by an output from the J85529 analog processing board but controlled by the J85520 digital processing board. The meter is scaled from 0 to 120 percent rated engine speed.

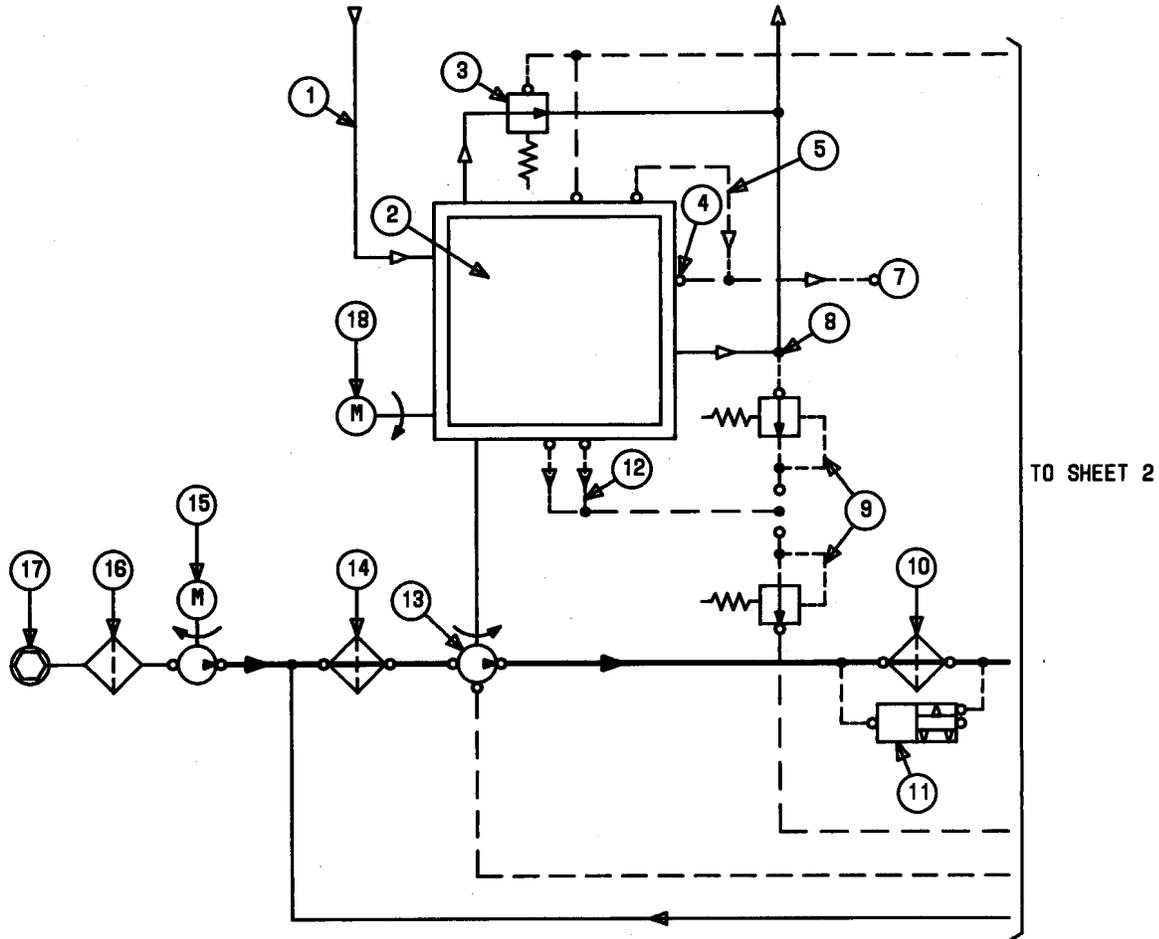
(2) **EXHAUST GAS TEMPERATURE METER:** The EXHAUST GAS TEMPERATURE METER employs a 0- to 1-milliamperere movement driven by an output from the J85529 analog signal processing board. The meter is scaled from 0 to 1500°F.

(3) **VIBRATION:** The VIBRATION system employs five light emitting diode (LED) lamps. The LED lamps are displayed in a series and labeled 1G through 5G. These five LEDs are controlled by an output from the J85529 analog signal processing board.

(4) **AC AMMETER:** The AC AMMETER employs a 0- to 1-milliamperere movement driven by an output from the J85529 analog signal processing board. The AC AMMETER displays alternator output current on the phase selected with the selector switch. The meter is scaled from 0 to 1600 amperes.

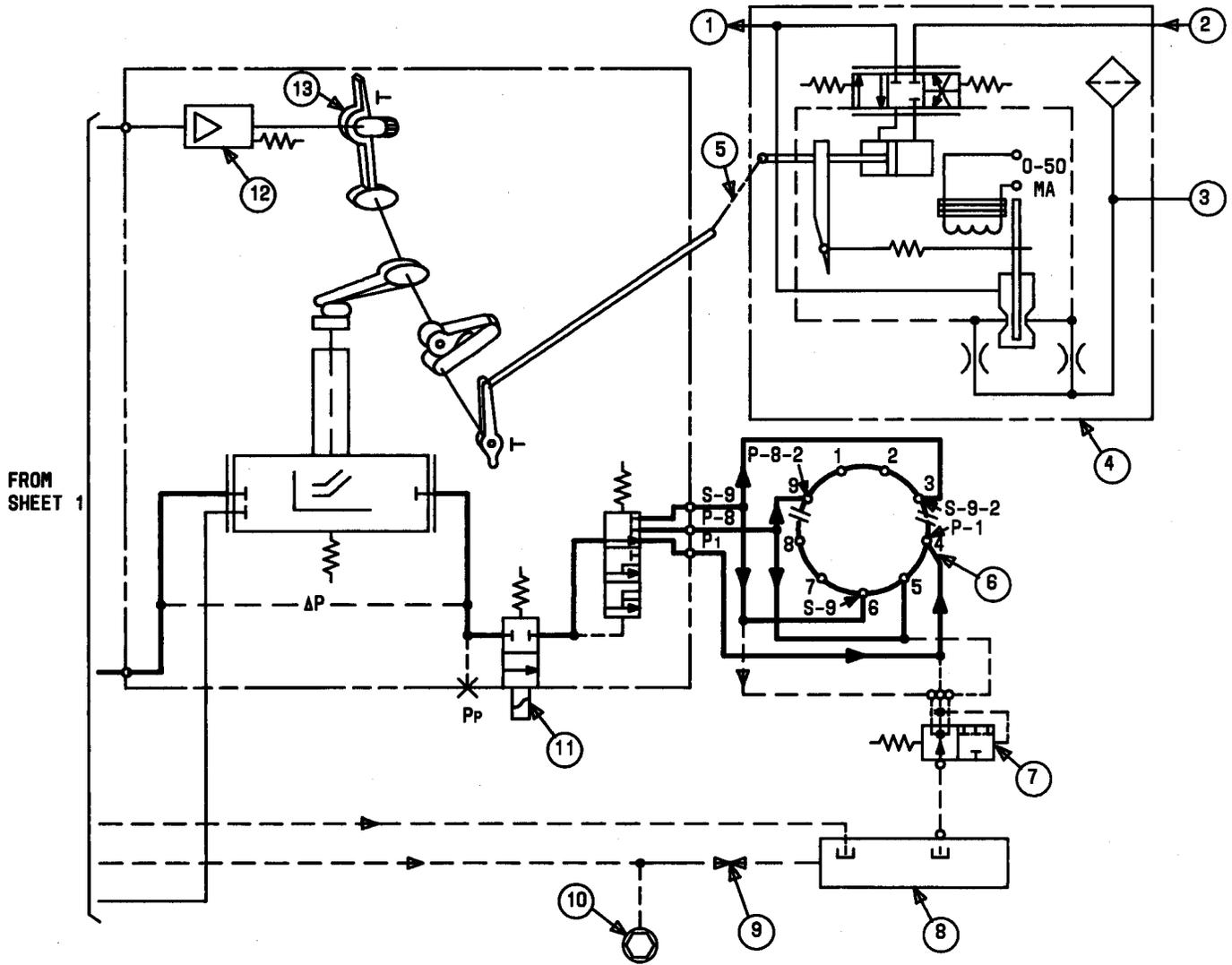
(5) **POWER FACTOR METER:** The POWER FACTOR METER employs a 0- to 1-milliamperere movement driven by an output from the J85529 analog signal processing board. The meter is scaled from 0 leading to 0 lagging. The mechanical rest position of the meter is at 0 leading. The rest position of the meter with the controller powered up is at unity.

(6) **AC WATTMETER:** The AC WATTMETER employs a 0- to 1-milliamperere movement



- |                                  |                           |                  |
|----------------------------------|---------------------------|------------------|
| 1 - AIR INTAKE DUCT              | 10 - FILTER               | --- LOW PRESSURE |
| 2 - TURBINE ENGINE               | 11 - INDICATOR FOR FILTER | — HIGH PRESSURE  |
| 3 - GEAR PUMP                    | 12 - COMBUSTION DRAINS    |                  |
| 4 - TURBINE OUTPUT SHAFT SEAL    | 13 - CONTROL VALVE        |                  |
| 5 - SEAL BUFFER AIR LINE         | 14 - FILTER               |                  |
| 6 - EXHAUST COLLECTOR            | 15 - BOOST PUMP           |                  |
| 7 - TO GEARBOX OUTPUT SHAFT SEAL | 16 - STRAINER             |                  |
| 8 - EXHAUST COLLECTOR DRAIN      | 17 - FUEL INLET           |                  |
| 9 - PRESSURE VALVE               | 18 - STARTER MOTOR        |                  |

Fig. 4—Fuel System Schematic (Sheet 1 of 2)



FROM SHEET 1

- 1 - RETURN OIL TO LUBE TANK
- 2 - OIL SUPPLY - 3 GPM AT 1000 PSIG PRESSURE
- 3 - ANALOG SIGNAL FROM ELECTRONIC CONTROL SYSTEM
- 4 - ACTUATOR
- 5 - LINKAGE
- 6 - FUEL NOZZLE MANIFOLD VIEW FACING NOZZLES
- 7 - FUEL NOZZLE PURGE VALVE
- 8 - PURGE TANK
- 9 - HAND VALVE
- 10 - DRAIN PORT
- 11 - MAIN FUEL SHUT-OFF VALVE
- 12 - ACCELERATOR CONTROL
- 13 - FUEL CONTROL VALVE

— HIGH PRESSURE FUEL  
 - - - LOW PRESSURE FUEL (DRAIN)

Fig. 4—Fuel System Schematic (Sheet 2 of 2)

TABLE A

**INDICATOR LEDS LOCATED ON CONTROL PANEL  
LOCAL AND REMOTE**

INDICATOR LEDS	MICROCOMPUTER UNIT OR DEVICE OPERATING THE LED
CRANK FAILURE	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
UNDER SPEED/OPEN PROBE	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
LOW OIL PRESSURE	ZZ210 (J85520) Microcomputer board
OVER SPEED/REV POWER	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
OPEN TEMP PROBE	ZZ211 (J85529) Microcomputer board
HIGH EXHAUST TEMP	ZZ211 (J85529) Microcomputer board
HIGH LUBE OIL TEMP	ZZ210 (J85520) Microcomputer board
OVER/UNDER VOLTAGE	ZZ210 (J85520) Microcomputer board
OVER CURRENT	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
GROUND FAULT	ZZ211 (J85529) Microcomputer board
MAJOR CIRCUIT BREAKER EMERGENCY STOP	ZZ210 (J85520) Microcomputer board
PRE HIGH EXHAUST TEMP	ZZ211 (J85529) Microcomputer board
RECTIFIER FAILURE	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
MINOR CIRCUIT BREAKER	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
POWER FAILURE	ZZ210 (J85520) Microcomputer board and Power Relay
SIMULATED POWER FAILURE	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
CRANKING	ZZ210 (J85520) Microcomputer board and Crank Relay
FUEL ON	ZZ210 (J85520) Microcomputer board and Fuel Relay
LIGHT OFF TEMP	ZZ211 (J85529) Microcomputer board
READY TO LOAD	ZZ210 (J85520) Microcomputer board
TRANSFER TO EMERGENCY PROPER OPERATION	ZZ210 (J85520) Microcomputer board and Proper Operation Relay
RUN TIMER ON	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
READY TO RESTORE	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards and Power Return Relay

TABLE A (Contd)

INDICATOR LEDS LOCATED ON CONTROL PANEL  
LOCAL AND REMOTE

INDICATOR LEDS	MICROCOMPUTER UNIT OR DEVICE OPERATING THE LED
TRANSFER TO NORMAL	ZZ210 (J85520) Microcomputer board
COAST DOWN	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer board
OFF (OPERATION SELECTOR SWITCH)	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
MANUAL (OPERATION SELECTOR SWITCH)	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
AUTO (OPERATION SELECTOR SWITCH)	ZZ210 (J85520) and ZZ211 (J85529) Microcomputer boards
CLOSED (ACB)	ACB Auxiliary Contact Relay
OPEN (ACB)	ACB Auxiliary Contact Relay
1G (VIBRATION)	ZZ211 (J85529) Microcomputer board
2G (VIBRATION)	ZZ211 (J85529) Microcomputer board
3G (VIBRATION)	ZZ211 (J85529) Microcomputer board
4G (VIBRATION)	ZZ211 (J85529) Microcomputer board
5G (VIBRATION)	ZZ211 (J85529) Microcomputer board

driven by an output from the J85529 analog signal processing board. The kilowatt meter monitors alternator output power. The meter is scaled from 0 to 1000 kilowatts.

(7) **FREQUENCY METER:** The **FREQUENCY METER** employs a 0- to 1-milliampere movement driven by an output from the J85520 digital processing board. The **FREQUENCY METER** monitors output frequency (frequency may be controlled by the **FREQUENCY ADJUST** switch). The meter is scaled from 55 to 65 hertz. The mechanical rest position of the meter is at 55 hertz.

(8) **AC VOLTMETER:** The **AC VOLTMETER** employs a true RMS movement driven directly by 2.4 to 1 power transformers on the alternator and commercial buses. The **AC VOLTMETER** displays commercial or alternator line-to-line voltage selected with the voltmeter selector switch.

## B. Alarms Controls

1.13 The **ALARMS ENGINE/ALTERNATOR** (Fig. 5) on the control panel consists of separate LEDs that light to indicate:

(a) **Engine:** Engine control indicators and conditions are as follows:

(1) **CRANK FAILURE Indicator LED:** The **CRANK FAILURE** indicator LED is lighted when the engine fails to attain 5 percent speed in 6 seconds, 13 percent speed in 15 seconds, or 66 percent speed in 70 seconds. The set will automatically shut down and an audible alarm is given if this trouble condition occurs.

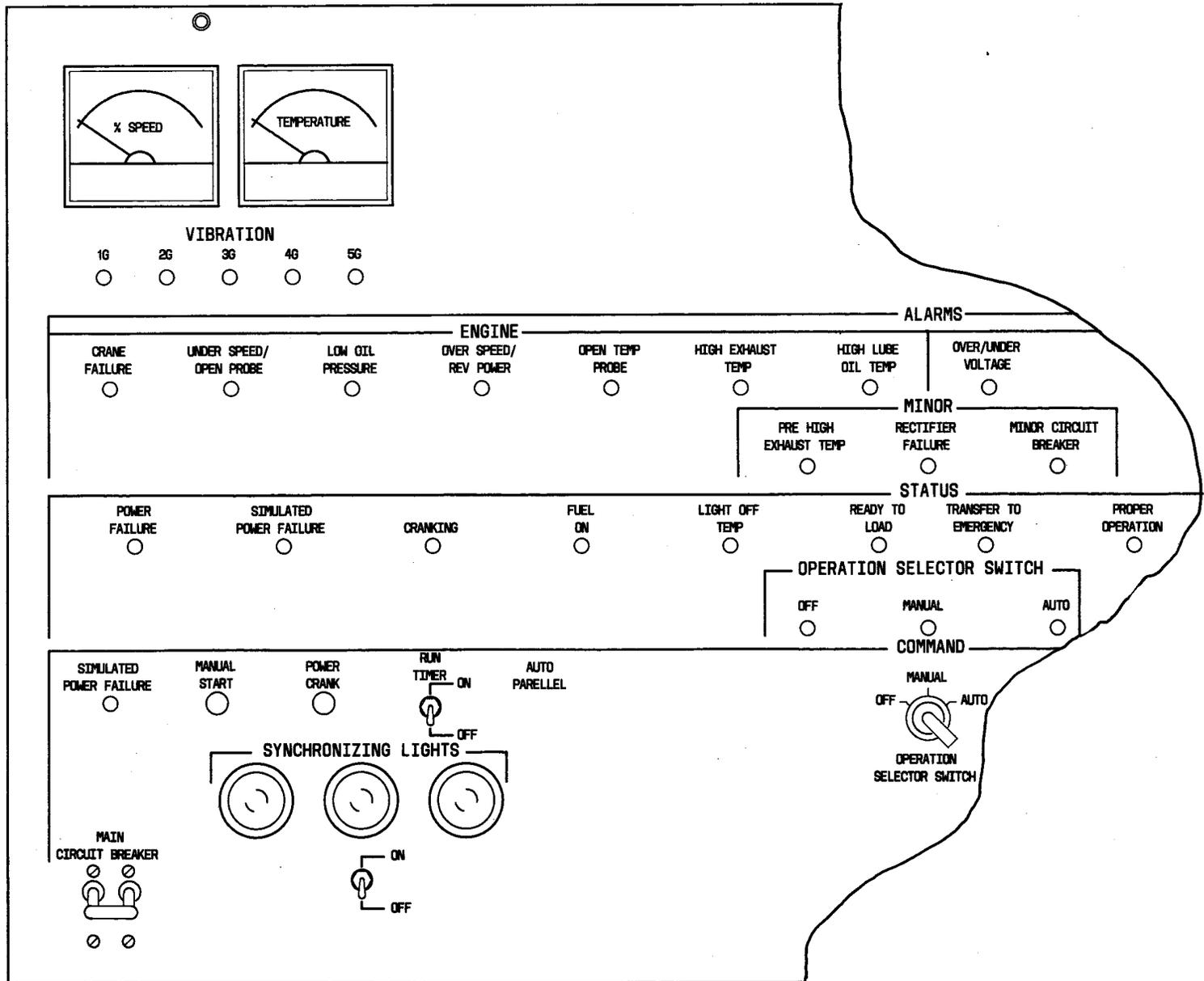


Fig. 5—Local Control Panel Without Remote Control Option (Sheet 1 of 2)

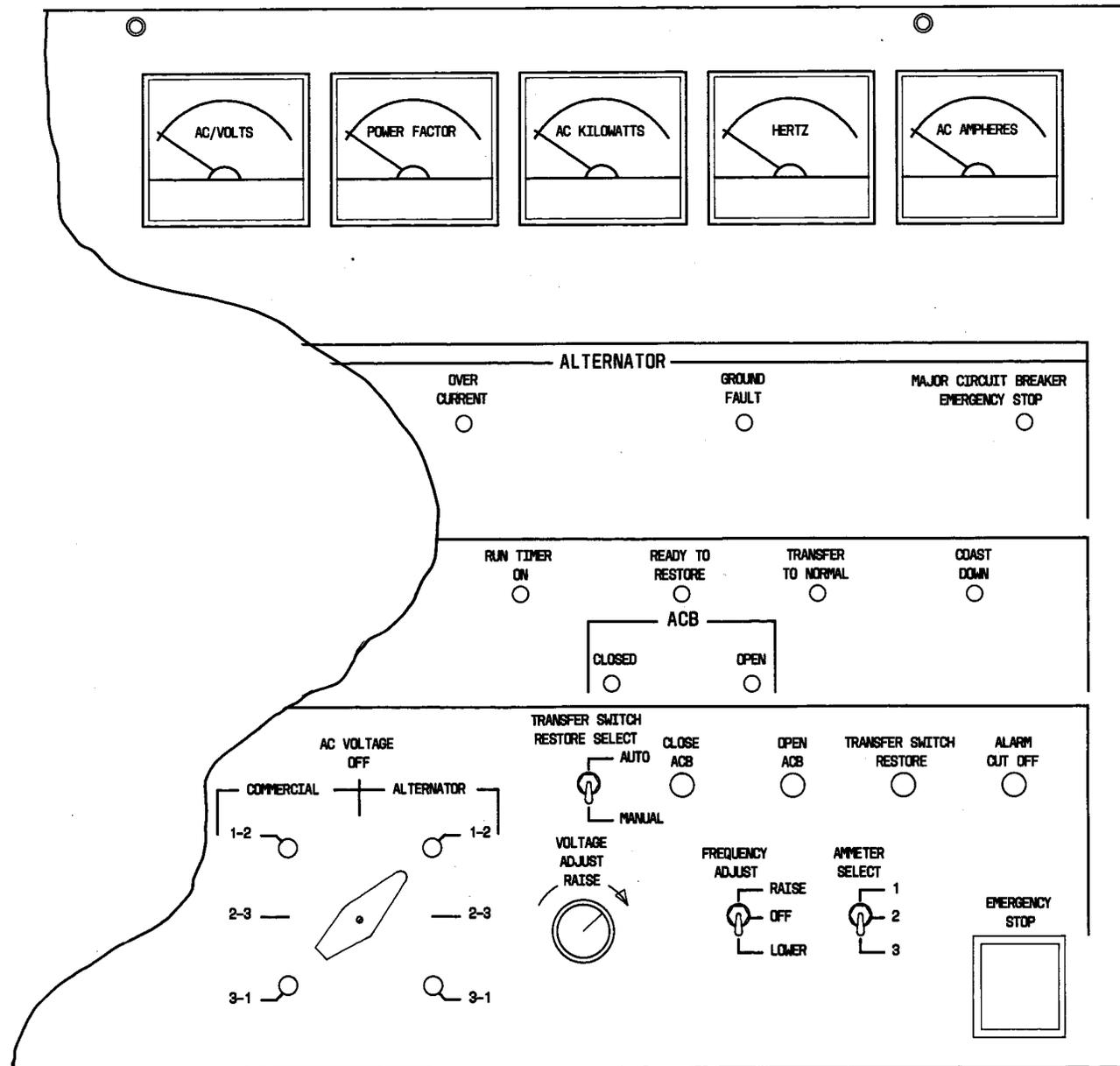


Fig. 5—Local Control Panel Without Remote Control Option (Sheet 2 of 2)

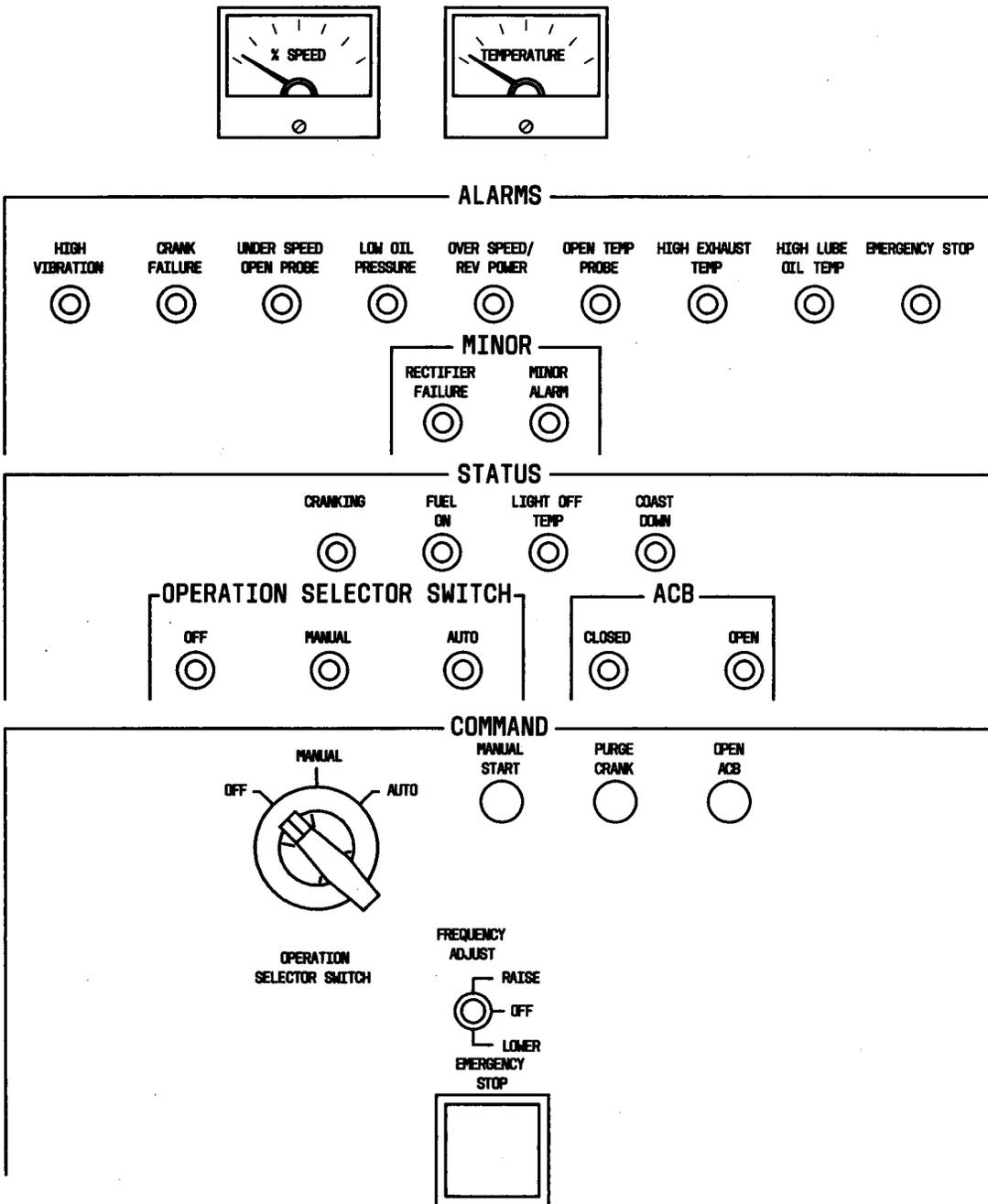


Fig. 6—Control Panel—Local Panel With Remote Option

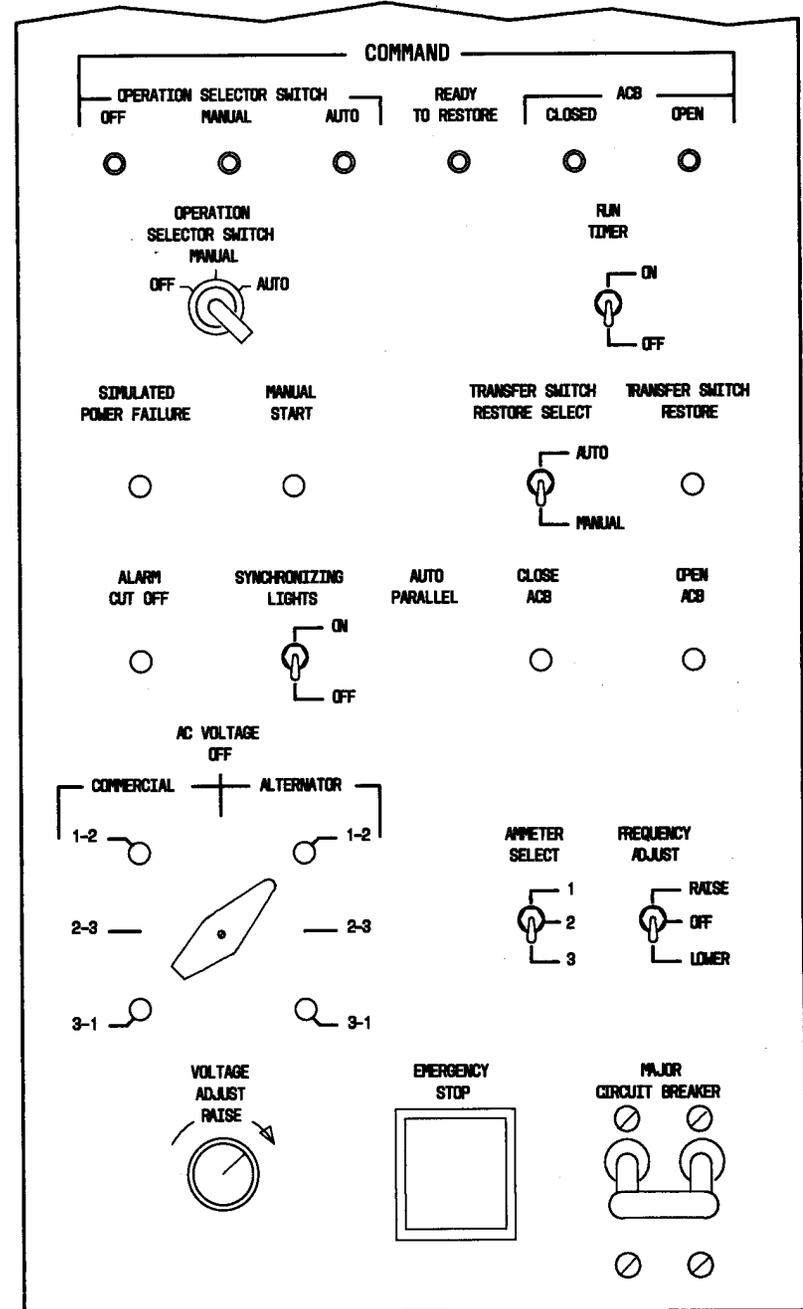
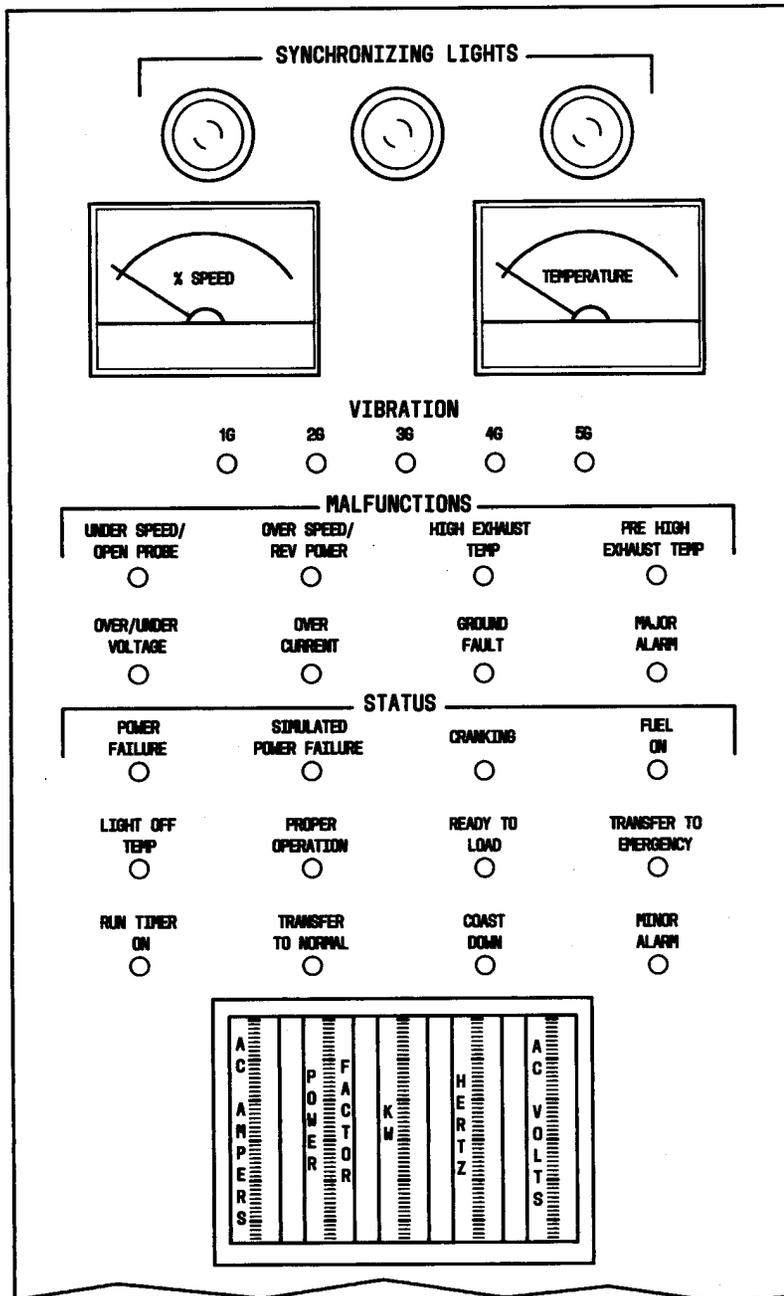


Fig. 7—Control Panel—Remote Panel

- (2) **UNDER SPEED/OPEN PROBE Indicator LED:** The UNDER SPEED/OPEN PROBE indicator LED is lighted and the set will shut down if the engine speed drops below 95 percent of rated speed during running. This shutdown may be caused by an underspeed or failed speed pickup probe condition.
- (3) **LOW OIL PRESSURE Indicator LED:** The LOW OIL PRESSURE indicator LED is lighted and the set will shut down if the oil pressure drops to  $25 \pm 1.25$  pounds per square inch gauge (psig).
- (4) **OVER SPEED/REV POWER Indicator LED:** The OVER SPEED/REV POWER indicator LED is lighted and the set will shut down when the speed of the set reaches 108 percent. Also, the LED is lighted and the set will shut down at approximately 150 kW of reverse power. The unit's circuit breaker will open within 2 seconds.
- (5) **OPEN TEMP PROBE Indicator LED:** The OPEN TEMP PROBE indicator LED is lighted and the set will shut down if either the inlet or exhaust temperature probes should open or short during operation of the engine.
- (6) **HIGH EXHAUST TEMP Indicator LED:** The HIGH EXHAUST TEMP indicator LED is lighted and the set will shut down when the temperature exceeds 945°F.
- (7) **HIGH LUBE OIL TEMP Indicator LED:** The HIGH LUBE OIL TEMP indicator LED is lighted and the set will shut down if the engine lube oil temperature exceeds 160°F.
- (b) **Alternator:** Alternator control indicators and conditions are as follows:
- (1) **OVER/UNDER VOLTAGE Indicator LED:** The OVER/UNDER VOLTAGE indicator LED is lighted and the set will shut down when the generated voltage exceeds 120 percent of nominal voltage or when generated voltage drops to 85 percent of nominal voltage.
- (2) **OVER CURRENT Indicator LED:** The OVER CURRENT indicator LED is lighted and the set will shut down when the alternator circuit breaker trips due to an overcurrent or short circuit condition.
- (3) **GROUND FAULT Indicator LED:** The GROUND FAULT indicator LED is lighted and the set will shut down when a ground fault condition is detected.
- (4) **MAJOR CIRCUIT BREAKER/EMERGENCY STOP Indicator LED:** The MAJOR CIRCUIT BREAKER/EMERGENCY STOP indicator LED is lighted and the set will shut down when central circuit breakers CB104, CB202, CB203, CB207, or CB310 are tripped or opened, or when the EMERGENCY STOP push-button is depressed.
- (c) **MINOR:** The following conditions are indicated by warning LEDs on the control panel. The engine does not shut down during these conditions, but action is needed to avoid damage. Minor alarms control indicators and conditions are as follows:
- (1) **PRE HIGH EXHAUST TEMP Indicator LED:** The PRE HIGH EXHAUST TEMP indicator LED is lighted when the exhaust gas temperature exceeds 900°F after 66 percent speed has been attained. This is a minor alarm and no shutdown occurs.
- (2) **RECTIFIER FAILURE Indicator LED:** The RECTIFIER FAILURE indicator LED is lighted when the battery charging rectifier fails. This is a minor alarm and no engine shutdown occurs.
- (3) **MINOR ALARM Indicator LED:** The MINOR ALARM indicator LED is lighted when the minor circuit breaker is opened or tripped. This is a minor alarm and no engine shutdown occurs.
- 1.14 Relays and their functions are shown in Table B.
- 1.15 Routine checks (Part 3) should be made during a period when they will cause the least service

**TABLE B**  
**RELAYS AND THEIR FUNCTIONS**

RELAY	FUNCTION
K201	Open ACB*
K217	Starter Low Voltage
K243	Crank
K244	Temperature Topping
K245	Ignition
K249	Fuel*
K294	Reduced Speed
K297	Under Voltage Trip*
K302	Power Major Alarm Visual*
K303	Shutters*
K305	Power Return*
K306	AUTO*
K307	Power Minor Alarm Audible*
K308	Power Minor Alarm Visual*
K310	Proper Operation*
K311	Ready To Load*
K312	Power Major Alarm Audible*
K313	Voltage Regulator
K316	Close ACB*
K325	Open NCB
K326	Close NCB
K327	Open ECB
K328	Close ECB
K353-1	ACB-1*
K353-2	ACB-2*
K354	Start Motor Control
K355-1	Frequency Adjust (INCR)
K355-2	Frequency Adjust (DECR)
K360	Field Flash
K386	Field Boost Pump Control
K388	Power Failure*

\* Customer Interface

interruption. It is imperative that the prescribed checks be made at the intervals stated.

#### WORKING ON A SET OR ITS CONTROL EQUIPMENT

***Danger 1: Since the sets are arranged to start automatically and because of the presence of hazardous ac voltages within the control panel, it is necessary to render the automatic control inoperative before performing any work on either the set or its control equipment.***

***Danger 2: Some high-voltage devices can store and maintain a residual voltage for several hours after the unit has been stopped. A lethal electrical shock can result. Discharge all high-voltage circuits by using a heavy insulated cable, and short each phase to ground before working on or around the equipment.***

1.16 To make the set fully inoperative, proceed as follows:

- (1) Move the OPERATION SELECTOR SWITCH to the OFF position on the local and remote control panels.
- (2) Operate to the OFF position all control circuit breakers located in the alternator set control panel.
- (3) Ensure that the Alternator Circuit Breaker (ACB) is open by manually operating the OPEN ACB pushbutton.
- (4) Remove the starting and control batteries from service.

***Danger: If the customer-furnished circuit breakers, switches, or fuses are opened before the OPERATION SELECTOR SWITCH is set to OFF position or before the batteries are disconnected, the set will start and run.***

- (5) Open the customer-furnished devices (fuses, switches, breakers, etc.).

1.17 When work on the set or control equipment has been completed, proceed as follows:

- (1) Close the customer-furnished devices.
- (2) Connect the starting and control batteries.
- (3) Operate to ON position all control circuit breakers on set control panel.
- (4) Move the OPERATION SELECTOR SWITCH on local and remote panels to the desired position.

1.18 In selecting an operating mode, both the local and remote OPERATION SELECTOR

SWITCH must be in the same operating mode 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. Table C illustrates the resultant position if both switches are not set to the same position.

TABLE C

**OPERATING MODE OF THE OPERATION  
SELECTOR SWITCH**

SWITCH POSITIONS		RESULTANT OPERATION
LOCAL	REMOTE	
OFF	OFF	OFF
OFF	MAN	OFF
OFF	AUTO	OFF
MAN	OFF	OFF
MAN	MAN	MAN
MAN	AUTO	MAN
AUTO	OFF	OFF
AUTO	MAN	MAN
AUTO	AUTO	AUTO

## 2. APPARATUS

**2.01 List of Test Equipment and Materials (Equivalents may be substituted):** In addition to the tools and instruction information furnished with the engine, the following list of test equipment is required for the completion of the operating methods in this section.

TEST EQUIPMENT	DESCRIPTION
ADM5	Cathode-Ray Tube (CRT)* Terminal
KS-20599, L4	Digital Multimeter (DMM) or equivalent
KS-20538	Volt-Ohm-Milliammeter
—	RS-232 Adapter Cable

\*Manufactured by Lear Siegler, Inc.

## MATERIALS

Solar Part Number 39399-0	Abrasive Inject Kit
Solar Part Number 917426C1	Abrasive Cleaner
—	3/8-Inch AN Flexible Line (8 feet)
—	1/2-Inch AN Flexible Line (4 feet)
—	35/60 Mesh Cleaning Material, Jet Engine Grade
—	Cleaning Solvent
—	Lintless Cloth
—	Soft-Wire Brush
—	Face Shield or Safety Goggles

## 3. OPERATION

### GENERAL DESCRIPTION OF OPERATION OF THE SET AND CONTROL PANEL

**3.01** Power plant application schematics SD-82585-01 and SD-82586-01 should be consulted as to wiring required for the differences in operation—MANUAL or AUTO. Provisions are made for remote, manual, or automatic operation; remote visual and audible alarms; and remote metering of alternator output power, current, frequency, power factor, and voltage. Synchronizing lamps are provided at the remote location to enable paralleling two or more sets. A remote rheostat is provided to enable remote control of output voltage and a remote potentiometer is provided to enable remote control of frequency.

**Danger:** These sets may be arranged to start automatically when commercial power drops in all phases, or should the power fail entirely. Do not work on set until its automatic devices have been rendered inoperative by setting the local and remote OPERATION SELECTOR SWITCH to the OFF position.

**3.02** Precautionary Procedures should be observed to ensure the safety of operating per-

sonnel and to prevent damage to the alternator set and its control equipment. The following precautionary procedures must be followed.

**Danger:** Do not make physical contact with or allow wiring to contact hot engine surface as serious injury may result.

**Warning 1:** Do not allow foreign objects or a solid stream of water to enter air inlet duct.

**Warning 2:** Do not attempt to operate engine by wiring around or opening circuits to automatic shutdown devices.

**Warning 3:** A condition that produces warnings or shutdown demands attention. Shutdown protection is incorporated to prevent engine damage. Damage could far exceed the advantages of continued operation.

**Warning 4:** Always maintain a clean engine installation. Solid material gaining access into the compressor presents the greatest hazard to turbine operation.

**Warning 5:** Carefully observe panel indicators and instruments; of these, engine speed and exhaust temperature indications are the best indicators of performance.

**Warning 6:** If surge occurs, do not wait for controls to activate; **SHUT DOWN THE ENGINE IMMEDIATELY, using the EMERGENCY STOP pushbutton.**

**3.03 Surge:** All gas turbines are subject to compressor surge under certain conditions. Momentary malfunction of fuel or air systems can cause the engine to surge as described.

- (1) Surge in the lower speed range may be indicated by failure of the engine to accelerate, along with increasing exhaust temperature, and a sound of buffeting or fluttering air.
- (2) Surge in the higher speed range may be indicated by a loud roar and/or popping noise plus failure of the engine to accelerate to the rated speed.
- (3) If surge occurs, shut down engine immediately to prevent the rapid buildup of harmful tur-

bine inlet temperatures. After engine has coasted to a complete stop, attempt a restart in the prescribed manner. If surge occurs a second time, shut down and check for responsible components before attempting further starts.

**3.04 Inspection:** Before each manual start and before leaving the engine when it is set for automatic operation, perform the following:

- (1) Visually check for excessive lube oil or fuel on or around the engine. If present, locate and eliminate the cause.
- (2) Verify flexible hoses are not chafing or contacting hot engine parts.
- (3) Ensure engine air inlet screen is clear and no solid object is restricting air intake.
- (4) Verify exhaust system is clear and no combustible material is close to duct work or exhaust chamber.
- (5) Make a visual inspection to verify all locking devices and fastening components are in place and secure.
- (6) Check all electrical connections for tightness, corrosion, and condition of insulation. Replace wires having oil-soaked or damaged insulation. Correct conditions which cause insulation damage.
- (7) Bleed all drains ensuring that no obstructions exist in drain ports and lines.
- (8) Verify adequate fuel supply is available.
- (9) Check the lube oil level in lube oil tank using lube oil dipstick.

**Danger:** Avoid creation of sparks, including those from static electricity, or the use of an open flame near batteries since the gas given off by the battery is explosive.

- (10) Batteries should be checked and maintained in accordance with manufacturer's requirements and specifications.
- (11) Check the control power sources for the set and verify power is of the proper magnitude

and available to the generator set circuits. With OPERATION SELECTOR SWITCH in the OFF position, the OPERATION SELECTOR SWITCH OFF LED is lighted.

#### **AUTOMATIC OR MANUAL OPERATION**

**3.05 Automatic or Manual Operation** of the set(s) is explained as follows:

(1) With the set in the automatic mode of operation, low commercial supply voltage is sensed. After a delay period to verify a power failure has occurred rather than a momentary voltage dip, the set will start automatically. After a warm-up interval, a signal is sent to transfer critical load to the engine-alternator. When normal commercial power returns, the critical load automatically retransfers to the commercial power supply, the alternator circuit breaker (ACB) is opened, the set will shut down and coast to a stop.

(2) With the set in the manual mode, the set will not start automatically when a power failure occurs. The engine operator must initiate the starting cycle. The set will then crank, light off, and accelerate as in the automatic mode. After the set is running at speed, and after the warm-up period has elapsed, the operator must close the set breaker and transfer the load to engine-alternator or the set will run at no load until the operator manually transfers the load. If the transfer selector switch is in the manual mode position when power returns, the engine operator will manually transfer the load, open the set breaker, and shut down the set.

**3.06 Emergency Shutdown:** When the EMERGENCY STOP pushbutton is activated at the local or remote panel, the following occurs: The MAJOR CIRCUIT BREAKER/EMERGENCY STOP indicator LED is lighted on the local and remote panel, and remote signals are provided to close the main fuel valve. The engine then coasts to a stop. (See paragraph 3.25 for Shutdown Sequence.)

#### **NORMAL OPERATING PROCEDURES**

**3.07** Operational procedures for the set are defined herein and the description of occurrences after each step is given to enable analysis of the set performance, or in the event of malfunction, a basis for troubleshooting.

**3.08 General Start Conditions:** Verify that the following conditions are met.

(1) The OPERATION SELECTOR SWITCH is set to the OFF position and the OPERATION SELECTOR SWITCH OFF indicator LED is lighted.

(2) The control circuit breaker CB203 is closed, connecting 24-volt dc power to engine control system and ac metering circuits to alternator and commercial power.

(3) The REDUCED SPEED switch is set to NORMAL.

(4) Circuit breakers CB202, CB205, CB206, CB207, CB309, CB310, CB311, and CB104 (MAJOR CIRCUIT BREAKER on control panel) are closed, connecting voltage to the set.

(5) Verify that the correct float voltage of  $26.7 \pm 0.1$  volts is being maintained on the engine start and control batteries.

**3.09** A synopsis of events which take place during a normal start are as follows:

(1) When the engine is started manually or automatically, the engine begins to crank.

(2) As engine speed increases through approximately 13 percent, the fuel valve opens admitting fuel to the engine combustion chamber where it is mixed with air and ignited.

(3) At this point, exhaust temperature increases rapidly until engine reaches 100 percent speed.

(4) The exhaust temperature will rise to between  $700^{\circ}$  and  $850^{\circ}$ F, and then drop to between  $450^{\circ}$  and  $600^{\circ}$ F as engine speed stabilizes at 100 percent (no load). However, these temperatures may vary considerably according to ambient conditions, and indications outside these ranges do not necessarily constitute a malfunction.

**3.10 Manual Start—Manual Transfer:** To operate the set in the manual start-manual transfer mode of operation, proceed as follows:

(1) Verify the OPERATION SELECTOR SWITCH in OFF position, circuit breakers CB202, CB203, CB205, CB206, CB207, CB310, CB311, and CB104 are closed, REDUCED SPEED switch set to NORMAL, and OPERATION SELECTOR SWITCH OFF LED is lighted.

**Note:** The REDUCED SPEED switch is located on the right side of the set.

- (2) Operate the OPERATION SELECTOR SWITCH to the MANUAL position.
- (3) Operate TRANSFER SWITCH RESTORE SELECT switch to MANUAL.
- (4) Depress the MANUAL START pushbutton and hold momentarily. Engine cranks and accelerates automatically to rated speed. Observe exhaust temperature and engine speed meters. If exhaust temperature suddenly rises above 850°F while speed lags, **SHUT DOWN ENGINE IMMEDIATELY** by pressing EMERGENCY STOP pushbutton.
- (5) The warm-up timer times out and engine is ready to assume load. READY TO LOAD LED is lighted.
- (6) Depress the CLOSE ACB pushbutton. The alternator circuit breaker closes and the alternator output is connected to the emergency bus. The OPEN ACB and READY TO LOAD LED extinguish.
- (7) Manually operate building transfer device to connect station load to emergency bus. The PROPER OPERATION LED is lighted.
- (8) Periodically observe instruments for normal set operation.

**3.11 Manual Shutdown—Manual Restore:** To operate the set in the manual shutdown-manual restore mode of operation, proceed as follows:

- (1) Verify the OPERATION SELECTOR SWITCH is in MANUAL position and TRANSFER SWITCH RESTORE SELECT switch is in MANUAL position.
- (2) Depress the TRANSFER SWITCH RESTORE pushbutton. Station load is transferred from emergency bus to commercial bus. The READY TO LOAD LED is lighted. The PROPER OPERATION and CLOSE ACB LEDs are extinguished.
- (3) Operate the OPERATION SELECTOR SWITCH to the OFF position. The engine cir-

cuit breaker opens and causes the engine to shut down. The OPERATION SELECTOR SWITCH MANUAL LED is extinguished and the OPERATION SELECTOR SWITCH OFF LED is lighted.

- (4) After engine has coasted to a stop, move OPERATION SELECTOR SWITCH to the desired position.

**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 terminals, the READY TO RESTORE LED will be lighted after 15 minutes of operation.

### **3.12 Automatic Start—Automatic Transfer:**

To operate the set in the automatic start-automatic transfer mode of operation, proceed as follows:

**Note:** The commercial power failure circuit must be energized, or the REMOTE switch must be activated for an automatic start to be initiated. Also, only one alternator set can be selected for automatic start. See PARALLEL OPERATION paragraph 3.16.

- (1) Verify that the OPERATION SELECTOR SWITCH is in the OFF position, control circuit breakers CB202, CB203, CB205, CB206, CB207, CB310, CB311, and CB104 (MAJOR CIRCUIT BREAKER on control panel) are closed, and REDUCED SPEED switch is set to NORMAL.
- (2) Operate the TRANSFER SWITCH RESTORE SELECT switch to the AUTO position.
- (3) Operate the OPERATION SELECTOR SWITCH to the AUTO position. The OPERATION SELECTOR SWITCH OFF LED extinguishes, and the OPERATION SELECTOR SWITCH AUTO and ACB OPEN LEDs are lighted.
- (4) Commercial power failure occurs. The POWER FAILURE LED is lighted. The start delay timer times out; engine starts and accelerates automatically to rated speed. The CRANKING, FUEL ON, LIGHT OFF TEMP, and RUN TIMER ON LEDs are lighted.

**Note:** If the engine has operated for at least 30 minutes, the RUN TIMER ON LED will extinguish after 30 minutes.

- (5) The warm-up timer times out, READY TO LOAD LED is lighted, and the ACB closes connecting alternator to emergency bus. The OPEN ACB and READY TO LOAD LEDs are extinguished. The CLOSE ACB and TRANSFER TO EMERGENCY LEDs are lighted.
- (6) Station load is transferred from commercial power to emergency bus. The PROPER OPERATION LED is lighted. The TRANSFER TO EMERGENCY LED is extinguished.
- (7) Periodically observe instruments for normal alternator set operation.

**3.13 Automatic Shutdown—Automatic Restore:** To operate the set in the automatic shutdown-automatic restore mode of operation, proceed as follows:

- (1) Verify that the OPERATION SELECTOR SWITCH is in the AUTO position and the TRANSFER SWITCH RESTORE SELECT SWITCH is in the AUTO position.
- (2) When commercial power returns, the POWER FAILURE LED is extinguished. The set will begin a 15-minute hold over time delay and continue to furnish power.

**Note:** If the OPERATION SELECTOR SWITCH is in the AUTO position and the RUN TIMER is engaged and running, the set will stay loaded until the RUN TIMER has timed out.

- (3) The hold over timer times out. The TRANSFER TO NORMAL and READY TO RESTORE LEDs are lighted provided that the RUN TIMER is disengaged or timed out. The load is transferred to the commercial bus and the alternator circuit breaker opens. The PROPER OPERATION, CLOSED ACB, and TRANSFER TO NORMAL LEDs are extinguished. The OPEN ACB LED is lighted.
- (4) The unloaded set continues to operate for a 2-minute cool-down period, then the engine shuts down and the COAST DOWN timer LED is lighted and the READY TO RESTORE LED is extinguished. After approximately 3 minutes, the COAST DOWN timer LED is extinguished.

**3.14 Automatic Shutdown—Manual Restore:** To operate the set in the automatic shutdown-

manual restore mode of operation, proceed as follows:

- (1) Verify that the OPERATION SELECTOR SWITCH is in the AUTO position and TRANSFER SWITCH RESTORE SELECT switch is in the MANUAL position.
- (2) When commercial power returns, the POWER FAILURE LED is extinguished. The set will begin a 15-minute hold over time delay and continues to furnish power.
- (3) The hold over timer times out; the READY TO RESTORE LED is lighted. The cool-down timer begins to time out.

**Note:** The set will stay loaded until the hold-over timer times out. The set will continue to run until the run timer times out with the OPERATION SELECTOR SWITCH in the AUTO position.

- (4) Depress TRANSFER SWITCH RESTORE pushbutton. The TRANSFER TO NORMAL LED is lighted. Station load transfers from emergency bus to commercial bus and alternator circuit breaker opens. The OPEN ACB and READY TO RESTORE LEDs are lighted. The PROPER OPERATION, CLOSED ACB and TRANSFER TO NORMAL LEDs are extinguished.
- (5) The unloaded set continues to operate for a 2-minute cool-down period then the engine shuts down and the COAST DOWN timer LED is lighted. The READY TO RESTORE LED is extinguished. After approximately 3 minutes, the COAST DOWN timer is extinguished.

**3.15 AUTO Load Test:** To perform an AUTO load test, proceed as follows:

**Note:** The alternator set can be operated in AUTO load test while performing periodic check runs with full or station load.

- (1) Operate the OPERATION SELECTOR SWITCH to the AUTO position. The OPERATION SELECTOR SWITCH AUTO LED is lighted.
- (2) Simulate a commercial power failure by depressing the SIMULATED POWER FAIL-

URE pushbutton. The SIMULATED POWER FAILURE LED is lighted.

**Note:** The hold over time period will begin upon releasing the SIMULATED POWER FAILURE pushbutton.

- (3) The engine starts and accelerates automatically to rated speed.

**Note:** When the engine begins to crank, the RUN TIMER ON LED will be lighted for a 30-minute period and then extinguishes, at which time retransfer will take place. The retransfer of the load back to commercial power will depend upon the position of the TRANSFER SWITCH RESTORE SELECT switch.

- (4) Upon completion of the hold over time period (15 minutes), the READY TO RESTORE LED is lighted.

- (5) After a 30-minute period, the RUN TIMER ON LED is extinguished and the TRANSFER TO NORMAL LED is lighted. The load is transferred from the emergency bus to the commercial bus and the alternator circuit breaker opens. The OPEN ACB and READY TO RESTORE LEDs are lighted. The PROPER OPERATION, CLOSED ACB, and TRANSFER TO NORMAL LEDs are extinguished.

- (6) The unloaded set continues to operate for a 2-minute cool-down period, then the engine shuts down and the COAST DOWN timer LED is lighted. The READY TO RESTORE AND SIMULATED POWER FAILURE LEDs are extinguished. After approximately 3 minutes, the COAST DOWN timer LED is extinguished.

#### PARALLEL OPERATION

**Danger:** *Never attempt to parallel alternators with different phase rotation. Damage to engine or alternator or personal injury can result if alternators are paralleled with incorrect phase rotation or out of synchronization.*

- 3.16 Parallel operation of the alternator sets may be accomplished by manual methods. The following procedures apply to paralleling alternator sets with similar voltage, frequency, and droop char-

acteristics. Speed and voltage droop must be set equal on each alternator set being paralleled.

- 3.17 **Manual Synchronizing Procedure:** To manually synchronize the set, proceed as follows:

- (1) Operate the OPERATION SELECTOR SWITCH to the MANUAL position.
- (2) Start engine as described in paragraph 3.10.
- (3) Check alternator no-load voltage on all three phases. The voltmeter should indicate normal no-load voltage.

**Warning:** *The synchronizing lamps must light and extinguish simultaneously. If lamps do not fluctuate simultaneously, phase rotation is incorrect.*

- (4) Operate the SYNCHRONIZING LIGHTS switch to the ON position.
- (5) Match the frequency of the oncoming set to the frequency of the operating set by operating the FREQUENCY ADJUST control on the oncoming set to the RAISE or LOWER position, as necessary, until both sets are operating at the same frequency. A slow decrease in brilliancy of the SYNCHRONIZING LIGHTS will indicate when both sets are operating at the same frequency.
- (6) Estimate the time interval during the period when the lamps are dark or least brilliant.
- (7) When synchronizing lamps are in the middle of the dark period, depress the CLOSE ACB pushbutton. The CLOSE ACB LED is lighted when alternator circuit breaker closes to emergency bus.
- (8) Operate the SYNCHRONIZING LIGHTS switch to the OFF position.

- 3.18 **Dividing the Load Between Sets:** To divide the load between sets, proceed as follows:

- (1) Adjust the FREQUENCY ADJUST control in the RAISE direction until the load of the oncoming set is the same as the load of the set

already on line. This is indicated by observing the kilowatt meters of both sets.

**Note:** In order to maintain stable parallel operation, a small load is required.

- (2) Periodically observe instruments to ensure alternator sets are operating properly.

**Note:** Automatic synchronizing may be accomplished by use of the J86742A automatic controller (ordered separately) which is designed for automatic control, automatic paralleling, and local management of multiengine ac reserve energy systems up to 4500 kW capacity.

### SEQUENCE OF OPERATIONS

**3.19** A component oriented sequence of action of the control system during normal operating and alarm conditions is presented in the following test. Familiarity with the following will aid in understanding and locating malfunction symptoms and trouble areas.

#### A. Manual Start Sequence (With Commercial Power Present)

**3.20** To manually start the set with commercial power present, proceed as follows:

- (1) Operate the OPERATION SELECTOR SWITCH to the OFF position. The OPERATION SELECTOR SWITCH OFF LED is lighted.

**Caution 1:** *If commercial power should fail during the test, the signals will be sent to the customer-furnished transfer device to transfer the load on the essential bus to the engine.*

**Caution 2:** *Closing Emergency Circuit Breaker (ECB) with TRANSFER SWITCH RESTORE SELECT switch in AUTO position should be avoided when commercial power is present. This may result in a closed Normal Circuit Breaker (NCB) and a closed ECB simultaneously.*

- (2) Operate the TRANSFER SWITCH RESTORE SELECT switch to the MANUAL position.

- (3) The following indicator LED circuits are operative and LEDs will light if condition exists:

- OFF (OPERATION SELECTOR SWITCH)
- RECTIFIER FAILURE
- ACB OPEN.

- (4) Operate the OPERATION SELECTOR SWITCH to the MANUAL position. The OPERATION SELECTOR SWITCH OFF LED is extinguished.

- (5) The following indicator LEDs are lighted.

- MANUAL (OPERATION SELECTOR SWITCH)
- ACB OPEN
- TRANSFER TO NORMAL.

- (6) To start the engine, depress the MANUAL START pushbutton. The TRANSFER TO NORMAL LED is extinguished. The following LEDs are lighted.

- CRANKING
- RUN TIMER ON
- READY TO RESTORE.

**Note:** If engine fails to reach 5 percent speed in 6 seconds, the locked rotor timer times out. The crank failure logic, generated in the microcomputer controller unit, will abort engine start. The CRANK FAILURE LED is lighted.

- (7) The engine attains 13 percent speed, de-energizing the overload timer (OLT) before it times out. The FUEL ON LED is lighted, and then the LIGHT OFF TEMP LED is lighted.

**Note:** If engine fails to reach 13 percent speed before the OLT times out, the crank failure logic, generated in the microcomputer controller unit, will abort engine start. The CRANK FAILURE LED is lighted.

- (8) The fuel ignites and the engine speed begins to accelerate. The exhaust gas temperature reaches 400°F, de-energizing the no light timer (NLT) before it times out.

**Note:** If exhaust gas temperature fails to reach 400°F before NLT times out, the crank

failure logic generated in the microcomputer controller unit will abort engine start. The CRANK FAILURE LED blinks on and off.

- (9) The oil pressure reaches 25 psig as engine continues to accelerate to 66 percent speed. The CRANKING LED is extinguished.

**Note:** If engine attains 66 percent speed before oil pressure builds up to 25 psig, the low oil pressure logic in the microcomputer controller unit will abort the engine start. The LOW OIL PRESSURE LED is lighted.

- (10) The engine reaches starter dropout speed at 66 percent speed de-energizing the overcrank timer (OCT) before it times out. The starter relay and ignition relay are de-energized. The CRANKING LED should have already extinguished.

**Note:** If engine fails to reach starter dropout speed before the OCT times out, the crank failure logic generated in the microcomputer controller unit will abort the engine start. The CRANK FAILURE LED is lighted.

- (11) The engine attains 85 percent speed and the voltage regulator relay is energized. The voltmeter will indicate alternator voltage.

- (12) The engine attains 100 percent speed and governs at that speed. The warm-up timer (WUT) begins at 100 percent speed. Approximately 15 seconds after 100 percent speed is reached, the WUT times out and the READY TO LOAD LED is lighted.

**Note:** When the OPERATION SELECTOR SWITCH is in the MANUAL position, the FREQUENCY ADJUST switch (located on both the local and remote control panels) is effective. Consequently, small speed changes are manually achievable.

- (13) The following indicator LEDs are lighted during 100 percent engine speed.

- MANUAL (OPERATION SELECTOR SWITCH)
- FUEL ON
- READY TO LOAD
- LIGHT OFF TEMP

- ACB OPEN
- READY TO RESTORE
- Possibly one or more of the VIBRATION LEDs.

- (14) Check the following to determine if the engine is functioning properly.

(a) **No-Load Frequency:** This should be  $60 \pm 0.25$  Hz in the isochronous mode.

(b) **No-Load Voltage:** This should be within  $\pm 1$  percent of nominal system voltage at this site.

**Warning:** The synchronizing lamps must light and extinguish simultaneously. If lamps do not fluctuate simultaneously, phase rotation is incorrect.

- (15) Verify that the phase rotation of the alternator matches the commercial power phase rotation of A, B, and C.

- (16) Verify that the voltage can be raised and lowered approximately 10 percent by operating the VOLTAGE ADJUST rheostat on the front control panel.

- (17) Verify that the frequency can be raised and lowered approximately  $\pm 3$  Hz by operating the FREQUENCY ADJUST switch on the front control panel.

- (18) To load the set, depress the CLOSE ACB pushbutton. The ACB OPEN LED is extinguished and the ACB CLOSED LED is lighted.

- (19) Close the emergency circuit breaker on the transfer gear. The READY TO LOAD LED is extinguished and the PROPER OPERATION LED is lighted. The set is now carrying the load and the following LEDs are lighted.

- MANUAL (OPERATION SELECTOR SWITCH)
- FUEL ON
- LIGHT OFF TEMP
- ACB CLOSED

- READY TO RESTORE
- PROPER OPERATION
- Possibly one or more of the VIBRATION LEDs.

**Caution:** *If there was a commercial power failure during this test, the POWER FAILURE LED will light and the load should not be retransferred until the POWER FAILURE LED has extinguished.*

(20) To restore the load to the commercial bus, depress the TRANSFER SWITCH RESTORE pushbutton. The TRANSFER TO NORMAL LED is lighted until the normal circuit breaker closes; the PROPER OPERATION and the READY TO LOAD LEDs are lighted.

**Note 1:** The TRANSFER SWITCH RESTORE pushbutton has no effect in the MANUAL operation mode if the TRANSFER SWITCH RESTORE SELECT switch is in the AUTO position.

**Note 2:** The automatic transfer switch restore operation is not possible with the set in the MANUAL mode of operation.

(21) Depress the OPEN ACB pushbutton. The alternator circuit breaker opens and the ACB CLOSED LED is extinguished. The ACB OPEN LED is lighted.

**Note 1:** If the engine is allowed to run continuously for approximately 15 minutes, before being shut down with commercial power connected to the commercial sense terminals, the READY TO RESTORE LED will be lighted.

**Note 2:** If a commercial power failure occurs while set is carrying the load, the POWER FAILURE LED is lighted and the READY TO RESTORE LED will not light until the POWER FAILURE LED has extinguished for approximately 15 minutes. The power should not be transferred to commercial power until this time.

**Note 3:** The position of the RUN TIMER switch does not affect the operation of the set

in the MANUAL operation mode. However, the RUN TIMER ON LED is lighted at any time the RUN TIMER switch is in the ON or IN position during the 30-minute interval after initial cranking of the engine.

#### B. Manual Start Sequence (With Actual or Simulated Commercial Power Failure)

3.21 To manually start the set with an actual or simulated power failure, proceed as follows:

- (1) Operate the OPERATION SELECTOR SWITCH to the OFF position. The OPERATION SELECTOR SWITCH OFF LED is lighted.

**Note:** The SIMULATED POWER FAILURE pushbutton on the front control panel is not operative with the OPERATION SELECTOR SWITCH in the MANUAL position.

**Caution 1:** *If commercial power should fail during the test, no signals will be sent to the customer-furnished transfer device to transfer the load on the essential bus to the engine.*

**Caution 2:** *Closing ECB with TRANSFER SWITCH RESTORE SELECT switch in AUTO position should be avoided when commercial power is present. This may result in a closed NCB and a closed ECB simultaneously.*

- (2) Operate the TRANSFER SWITCH RESTORE SELECT switch to the MANUAL position.
- (3) The following indicator LED circuits are operative and LEDs will light if condition exists.
  - OFF (OPERATION SELECTOR SWITCH)
  - RECTIFIER FAILURE
  - ACB OPEN.
- (4) Operate the OPERATION SELECTOR SWITCH to the MANUAL position. The OFF (OPERATION SELECTOR SWITCH) LED is extinguished and the power up relay and open ACB relay are energized.
- (5) An actual power failure exists. The POWER FAILURE LED is lighted.

**Note 1:** Start delay timer (SDT) begins to time out if actual commercial power failure exits.

**Note 2:** A simulated power failure can only be generated with the OPERATION SELECTOR SWITCH in the MANUAL position when a remote routine term is present at the customer tie-points. Remote routine term can be cleared only by moving the OPERATION SELECTOR SWITCH to the OFF position, or running the engine until run timer (RT) times out.

(6) The following indicator LEDs are lighted.

- MANUAL (OPERATION SELECTOR SWITCH)
- ACB OPEN
- TRANSFER TO NORMAL.

(7) To start the engine, depress the MANUAL START pushbutton. The TRANSFER TO NORMAL LED is extinguished. The following LEDs are lighted.

- CRANKING
- RUN TIMER ON
- READY TO RESTORE.

(8) The engine attains 13 percent speed, de-energizing the OLT before it times out. The FUEL ON LED is lighted and then the LIGHT OFF TEMP LED is lighted.

**Note:** If engine fails to reach 13 percent speed before OLT times out, the crank failure logic generated in the microcomputer controller unit will abort engine start. The CRANK FAILURE LED is lighted (continuous).

(9) The fuel ignites and the engine speed begins to accelerate. The exhaust gas temperature reaches 400°F, de-energizing the no light timer (NLT) before it times out.

**Note:** If exhaust gas temperature fails to reach 400°F before NLT times out, the crank failure logic generated in the microcomputer controller unit will abort engine start. The CRANK FAILURE LED blinks on and off.

(10) The oil pressure reaches 25 psig as engine continues to accelerate to 66 percent speed. The CRANKING LED is extinguished.

**Note:** If engine attains 66 percent speed before oil pressure builds up to 25 psig, the low oil pressure logic generated in the microcomputer controller unit will abort the engine start. The LOW OIL PRESSURE LED is lighted.

(11) The engine reaches starter dropout speed at 66 percent speed de-energizing the OCT before it times out. The starter relay and ignition relay are de-energized. The CRANKING LED should have already extinguished.

**Note:** If engine fails to reach starter dropout speed before the OCT times out, the crank failure logic generated in the microcomputer controller unit will abort the engine start. The CRANK FAILURE LED is lighted.

(12) The engine attains 85 percent speed and the voltage regulator relay is energized. The voltmeter will indicate alternator voltage.

(13) The engine attains 100 percent speed and governs at that speed. The WUT begins at 100 percent speed. Approximately 15 seconds after 100 percent speed is reached, the WUT times out and the READY TO LOAD LED is lighted.

**Note:** When the OPERATION SELECTOR SWITCH is in the MANUAL position, the FREQUENCY ADJUST switch, located on both the local and remote control panels, is effective. Consequently, small speed changes are manually achievable.

(14) The following indicator LEDs are lighted during 100 percent engine speed.

- MANUAL (OPERATION SELECTOR SWITCH)
- FUEL ON
- READY TO LOAD
- LIGHT OFF TEMP
- ACB OPEN
- READY TO RESTORE

- Possibly one or more of the VIBRATION LEDs.
- (15) Check the following to determine if engine is functioning properly.
- (a) **No-Load frequency:** This should be  $60 \pm 0.25$  Hz in the isochonous mode.
- (b) **No-Load voltage:** This should be within  $\pm 1$  percent of nominal system voltage at this site.
- Warning: The synchronizing lamps must light and extinguish simultaneously. If lamp does not fluctuate simultaneously, phase rotation is incorrect.**
- (16) Verify that the phase rotation of the alternator matches the commercial power phase rotation of A, B, and C.
- (17) Verify that the voltage can be raised and lowered approximately 10 percent by operating the VOLTAGE ADJUST rheostat on the front control panel.
- (18) Verify that the frequency can be raised and lowered approximately  $\pm 3$  Hz by operating the FREQUENCY ADJUST switch on the front control panel.
- (19) To load the set, depress the CLOSE ACB pushbutton. The ACB OPEN LED is extinguished and the ACB CLOSED LED is lighted.
- (20) Close the emergency circuit breaker on the transfer gear. The READY TO LOAD LED is extinguished and the PROPER OPERATION LED is lighted. The set is now carrying the load and the following LEDs are lighted.

- MANUAL (OPERATION SELECTOR SWITCH)
- FUEL ON
- LIGHT OFF TEMP
- ACB CLOSED
- READY TO RESTORE
- PROPER OPERATION

- Possibly one or more of the VIBRATION LEDs.

**Caution: If there was a commercial power failure during this test, the POWER FAILURE LED will light and the load should not be retransferred until the POWER FAILURE LED has extinguished.**

- (21) To restore the load to the commercial bus, depress the TRANSFER SWITCH RESTORE pushbutton. The TRANSFER TO NORMAL LED is lighted until the normal circuit breaker closes; the PROPER OPERATION and the READY TO LOAD LEDs are lighted.

**Note 1:** The TRANSFER SWITCH RESTORE pushbutton has no effect in the MANUAL operation mode if the TRANSFER SWITCH RESTORE SELECT switch is in the AUTO position.

**Note 2:** The automatic transfer switch restore operation is not possible with the set in the MANUAL mode of operation.

- (22) Depress the OPEN ACB pushbutton. The alternator circuit breaker opens and the ACB CLOSED LED is extinguished. The ACB OPEN LED is lighted.

**Note 1:** 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 LED will be lighted.

**Note 2:** If a commercial power failure occurs while set is carrying the load, the POWER FAILURE LED is lighted and the READY TO RESTORE LED will not light until the POWER FAILURE LED has extinguished for approximately 15 minutes. The power should not be transferred to commercial power until this time.

**Note 3:** The position of the RUN TIMER switch does not affect the operation of the set in the MANUAL operation mode. However, the RUN TIMER ON LED is lighted at any time the RUN TIMER switch is in the ON or IN position during the 30-minute interval after initial cranking of the engine.

**C. Manual Shutdown Sequence**

- 3.22** To perform a manual shutdown sequence operation, proceed as follows:

**Warning:** *If the POWER FAILURE LED is lighted, do not attempt to shut engine down until the POWER FAILURE LED is extinguished. The set will operate for 15 minutes after the commercial power has been restored due to a hold over timer (HOT).*

- (1) Verify that the POWER FAILURE LED is extinguished.
- (2) Verify that the READY TO RESTORE LED is lighted and the RUN TIMER ON LED is extinguished.

**Note:** The RUN TIMER ON LED will be lighted if engine has operated for less than a 30-minute period.

- (3) Depress the OPEN ACB pushbutton. The OPEN ACB LED is lighted and the CLOSED ACB LED is extinguished.
- (4) Operate the OPERATION SELECTOR SWITCH to the OFF position. The OPERATION SELECTOR SWITCH OFF LED is lighted and the main fuel shutoff valve relay is de-energized.
- (5) The set begins to coast down and the COAST DOWN LED is lighted.
- (6) The following LEDs are extinguished during and after coast down.
  - MANUAL (OPERATION SELECTOR SWITCH)
  - READY TO RESTORE
  - READY TO LOAD
  - COAST DOWN (about 3 minutes after shutdown procedure started).
- (7) The LIGHT OFF TEMP LED will remain lighted until engine exhaust area cools down.

**D. Automatic Start Sequence (With Actual or Simulated Commercial Power Failure)**

- 3.23** To operate the set in the automatic start mode with an actual or simulated commercial power failure, proceed as follows:

- (1) Operate the OPERATION SELECTOR SWITCH to the OFF position. The OPERATION SELECTOR SWITCH OFF LED is lighted.

- (2) Operate the TRANSFER SWITCH RESTORE SELECT switch to the AUTO position.

- (3) The following indicator LED circuits are operative and LEDs will light if condition exists.

- OFF (OPERATION SELECTOR SWITCH)
- RECTIFIER FAILURE
- ACB OPEN.

- (4) Operate the OPERATION SELECTOR SWITCH to the AUTO position. The OPERATION SELECTOR SWITCH OFF LED is extinguished.

- (5) The following indicator LEDs are lighted.

- AUTO (OPERATION SELECTOR SWITCH)
- ACB OPEN
- TRANSFER TO NORMAL.

- (6) When commercial power failure occurs, the start delay timer (SDT) begins to time out to ensure that the failure is not just momentary.

**Note:** The SDT can be customer set for 5, 12, 30, or 60 seconds and causes the engine to start after a delay of set time. To set SDT, see Section 155-211-701.

- (7) The SDT times out with the OPERATION SELECTOR SWITCH in the AUTO position. The POWER FAILURE LED or SIMULATED POWER FAILURE is lighted.

- (8) The overload timer (OLT), no light timer (NLT), and overcrank timer (OCT) begin to

time out. The TRANSFER TO NORMAL LED is extinguished, and the CRANKING LED is lighted.

**Note:** If engine fails to reach 5 percent speed in 6 seconds, the locked rotor timer times out. The crank failure logic generated in the microcomputer controller unit will abort engine start. The CRANK FAILURE LED is lighted.

(9) The engine attains 13 percent speed, de-energizing the OLT before it times out. The FUEL ON LED is lighted and then the LIGHT OFF TEMP LED is lighted.

**Note:** If engine fails to reach 13 percent speed before the OLT times out, the crank failure logic generated in the microcomputer controller unit will abort engine start. The CRANK FAILURE LED is lighted.

(10) The fuel ignites and the engine speed begins to accelerate. The exhaust gas temperature reaches 400°F, de-energizing the NLT before it times out.

**Note:** If exhaust gas temperature fails to reach 400°F before NLT times out, the crank failure logic generated in the microcomputer controller unit will abort engine start. The CRANK FAILURE LED blinks on and off.

(11) The oil pressure reaches 25 psig as engine continues to accelerate to 66 percent speed. The CRANKING LED is extinguished.

**Note:** If engine attains 66 percent speed before oil pressure builds up to 25 psig, the low oil pressure logic in the microcomputer controller unit will abort engine start. The LOW OIL PRESSURE LED is lighted.

(12) The engine reaches starter dropout speed at 66 percent speed, de-energizing the OCT before it times out. The start relay and ignition relay are de-energized. The CRANKING LED should have already extinguished.

**Note:** If engine fails to reach starter dropout speed before the OCT times out, the crank failure logic generated in the microcomputer controller unit will abort the engine start. The CRANK FAILURE LED is lighted.

(13) The engine attains 85 percent speed and the voltage regulator relay is energized. The voltmeter will indicate alternator voltage.

(14) The engine attains 100 percent speed and governs at that speed. The warm-up timer (WUT) begins at 100 percent speed. Approximately 15 seconds after 100 percent speed is reached, the WUT times out and the READY TO LOAD LED is lighted.

**Note:** When the OPERATION SELECTOR SWITCH is in the AUTO position, the FREQUENCY ADJUST switch (located on both the local and remote control panels) is effective. Consequently, small speed changes are manually achievable.

(15) The following indicator LEDs are lighted during 100 percent engine speed.

- AUTO (OPERATION SELECTOR SWITCH)
- FUEL ON
- READY TO LOAD
- LIGHT OFF TEMP
- ACB OPEN
- READY TO RESTORE
- Possibly one or more of the VIBRATION LEDs
- POWER FAILURE (if commercial power has not been restored)
- SIMULATED POWER FAILURE (if test is a simulated power failure).

(16) Automatic load transfer begins 15 seconds after 100 percent engine speed is attained and the READY TO LOAD LED is lighted.

(17) The Alternator Circuit Breaker (ACB) closes. The ACB CLOSED LED is lighted. The ACB OPEN LED is extinguished.

(18) The TRANSFER TO EMERGENCY LED is lighted until the emergency circuit breaker closes. The TRANSFER TO EMERGENCY and READY TO LOAD LEDs are extinguished. The PROPER OPERATION LED is lighted.

(19) The set is now carrying the load and the following LEDs are lighted.

- AUTO (OPERATION SELECTOR SWITCH)
  - FUEL ON
  - LIGHT OFF TEMP
  - PROPER OPERATION
  - ACB CLOSED
  - Possibly one or more of the VIBRATION LEDs
  - POWER FAILURE (if commercial power has not been restored)
  - SIMULATED POWER FAILURE (if test is a simulated power failure).
- (20) Procedure for reclosing the NCB depends on one of the two conditions listed below.
- TRANSFER SWITCH RESTORE SELECT switch in MANUAL position
  - TRANSFER SWITCH RESTORE SELECT switch in AUTO position.

**3.24 Transfer Switch Restore Select Switch in Manual Position:** To close the NCB when TRANSFER SWITCH RESTORE SELECT switch is in MANUAL position, proceed as follows:

**Caution:** *Commercial power should be restored before attempting restore operation, thus avoiding a recycling condition. Until the power failure term is cleared, normal power cannot be successfully restored.*

- (1) Power failure term is cancelled by one of the three listed methods:
- Commercial power returns and OPERATION SELECTOR SWITCH is in AUTO position.
  - Commercial power is present, OPERATION SELECTOR SWITCH is in AUTO position, system is in simulated power failure mode of operation.
  - Commercial power is present, OPERATION SELECTOR SWITCH is in AUTO position, system is in remote routine operation.

- (2) When power failure condition is cancelled, hold over timer (HOT) begins to time out. The READY TO RESTORE LED is lighted.
- (3) Depress the TRANSFER SWITCH RESTORE pushbutton (this must be accomplished after HOT times out).
- (4) The close ACB relay and the close ECB relay are de-energized. The close NCB relay is energized while switch is depressed. The TRANSFER TO NORMAL LED is lighted.
- (5) The NCB closes. The TRANSFER TO NORMAL, the PROPER OPERATION, and the ACB CLOSED LEDs are extinguished.
- (6) The open ACB relay is energized. The ACB OPEN and the READY TO LOAD LEDs are lighted.
- (7) The set is in a 2-minute cool-down period and the lighted LEDs are as follows:

- AUTO (OPERATION SELECTOR SWITCH)
- FUEL ON
- LIGHT OFF TEMP
- READY TO LOAD
- READY TO RESTORE
- ACB OPEN
- Possibly one or more of the VIBRATION LEDs
- SIMULATED POWER FAILURE (if test is a simulated power failure).

**Note:** If another commercial power failure occurs while the set is in the cool-down period, the POWER FAILURE LED is lighted and the READY TO RESTORE LED is extinguished. An automatic load transfer as described earlier in this section will then occur.

**3.25 Transfer Switch Restore Select Switch in Auto Position:** Closing of TRANSFER SWITCH RESTORE SELECT switch in AUTO position occurs as follows:

- (1) Power failure term is cancelled by one of the three listed methods:

- Commercial power returns and OPERATION SELECTOR SWITCH is in AUTO position.
  - Commercial power is present, OPERATION SELECTOR SWITCH is in AUTO position, system is in simulated power failure mode of operation.
  - Commercial power is present, OPERATION SELECTOR SWITCH is in AUTO position, system is in remote routine operation.
- (2) When power failure condition is cancelled, hold over timer (HOT) begins to time out. The READY TO RESTORE LED is lighted.
  - (3) The HOT times out.
  - (4) The close ACB relay and the close ECB relay are de-energized. The close NCB relay is energized. The TRANSFER TO NORMAL LED is lighted.
  - (5) The NCB closes. The TRANSFER TO NORMAL, the PROPER OPERATION, and the ACB CLOSED LEDs are extinguished.
  - (6) The open ACB relay is energized. The ACB OPEN and the READY TO LOAD LEDs are lighted.
  - (7) The set is in a 2-minute cool-down period and the lighted LEDs are as follows:
    - AUTO (OPERATION SELECTOR SWITCH)
    - FUEL ON
    - LIGHT OFF TEMP
    - READY TO LOAD
    - READY TO RESTORE
    - ACB OPEN
    - Possibly one or more of the VIBRATION LEDs
    - SIMULATED POWER FAILURE (if test is a simulated power failure).

**Note:** If another commercial power failure occurs while the set is in the cool-down period,

the POWER FAILURE LED is lighted and the READY TO RESTORE LED is extinguished. An automatic load transfer as described earlier in this section will then occur.

#### E. Automatic Shutdown Sequence

**3.26** To perform an automatic shutdown sequence operation, proceed as follows:

- (1) The TRANSFER SWITCH RESTORE SELECT switch is positioned in either the MANUAL or AUTO position.
- (2) The HOT times out and the cool down timer (CDT) begins to time out.

**Note:** The cool down timer is approximately 2 minutes.

- (3) The CDT times out, providing an engine stop signal.

**Note:** The engine can not be cranked in any operation mode while the set is in the coast down period. The coast down timer is enabled at 5 percent speed.

- (4) The main fuel shutoff valve relay is de-energized.
- (5) The voltage regulator relay de-energizes.
- (6) The READY TO LOAD LED is extinguished.
- (7) The LIGHT OFF TEMP LED may temporarily remain lighted until the engine exhaust area cools down.
- (8) If set is in a simulated power failure test operation, the SIMULATED POWER FAILURE LED is extinguished.
- (9) If TRANSFER SWITCH RESTORE SWITCH is in the AUTO position, close NCB relay de-energizes at this time.
- (10) The set is in the normal standby mode.

#### F. Purge Crank Sequence

**3.27** The purge crank mode of operation is used for maintenance purposes. To operate the set in the purge crank mode, proceed as follows:

- (1) Operate the OPERATION SELECTOR SWITCH to the OFF position.
- (2) Depress the PURGE CRANK pushbutton. The CRANKING LED is lighted.

**Note:** The PURGE CRANK pushbutton is ineffective if engine is in a start sequence, engine is running, or any engine shutdown malfunction exists.

- (3) The starter relay energizes and starter cranks engine to approximately 20 percent engine speed. The overcrank timer begins to time out.

**Note:** If PURGE CRANK pushbutton is not released to the OFF position before the OCT times out (70 seconds), a crank failure alarm will occur due to overcranking and will abort the purge crank sequence. The CRANK FAILURE LED is lighted.

- (4) Release the PURGE CRANK to the OFF position.
- (5) The starter relay de-energizes and the starter disengages.
- (6) The OCT is reset.
- (7) The engine coasts to a stop.

#### 4. ROUTINE CHECKS

##### ROUTINE RUN

**4.01** A 30-minute run at 100 percent speed under no-load condition every month and a 30-minute run with full or office load every 3 months should be made to maintain constant readiness for emergency use. These runs will provide an opportunity for routine checks of controls and engine performance that could not be made when the set is idle. A log should be kept of engine operating parameters.

**4.02** The operation of equipment and control circuitry should be checked every 3 months. These checks can be made while the set is shut down, using a CRT and test information on the microcomputer (see paragraph 4.05).

##### TESTING SET

**4.03 No-Load Test Run:** To perform a no-load test run, proceed as follows:

(1) **Starting:** Perform the inspection procedures given in paragraph 3.04. To start the set and operate it at no load; operate OPERATION SELECTOR SWITCH to the OFF position, verify REDUCED SPEED switch is in NORMAL position, operate OPERATION SELECTOR SWITCH to the MANUAL position, operate the TRANSFER SWITCH RESTORE SELECT switch to the MANUAL position, and depress the MANUAL START pushbutton and hold momentarily. When the engine starts, the set operates at no load. If commercial power should fail while operating the set with the OPERATION SELECTOR SWITCH in the MANUAL position, the operator should perform subparagraphs 3.10(5) through (8).

(2) **Stopping:** Operate the OPERATION SELECTOR SWITCH to the OFF position. The engine will shut down and coast to a stop. Move the OPERATION SELECTOR SWITCH to the desired position for next start.

**Note:** Do not stop set if commercial power has failed during a no-load test run and transfer of power has taken place. When commercial power has been restored, shut down set as in Step (2).

**4.04 Final Check:** Before leaving set unattended, verify the set is in operating condition for the next start. Perform a walk-around inspection.

**Danger:** Avoid creation of sparks, including those from static electricity or the use of an open flame near batteries, since the gas given off by the battery is explosive.

**Warning:** Ensure batteries are properly connected. Reverse polarity will cause damage to the control circuitry.

**4.05 Battery Data:** Batteries should be checked and maintained in accordance with manufacturer's requirements and specifications for the Delco Dry Catalog No. 349 and 771 lead-acid type batteries.

**Danger:** The power pack of the precipitator supplies the high-voltage direct current to the ionizer and collector sections. Exercise normal precautions when working with high voltage.

**4.06** The List 15 precipitator should be checked for operation when the turbine is running. A

steady glow of the pilot light on the unit is an indication that the ionizer and collector sections are correctly powered.

## 5. GENERAL TROUBLES

**Danger:** Avoid the use of an open flame or portable lamp without a suitable guard while working near the engine, particularly near any part of the fuel system.

**5.01** This section provides the necessary information for verification of system parameters and isolation of malfunctions up to the microcomputers boards. An ADM 5 CRT will be used during these test procedures.

**5.02** When observing indicator LEDs for information, bear in mind that a possibility exists that a LED could be defective, although the LEDs used are long life types.

**5.03** This system incorporates safety circuits and associated alarms to indicate particular malfunctions which have occurred during operation of the system. The operation of any alarm channel causes an indicator LED to light which will identify the malfunction.

**5.04** In order to prevent induced problems, follow the procedures systematically. Do not attempt to correct more than one problem at a time. After a corrective action, repeat the procedure used and observe the operational changes. If corrective actions were unjustified, restore the system before attempting other corrective action.

### 5.05 Self-Testing of Microcomputer Control

**Unit:** The following test allows testing of both microcomputer boards used in the control unit and the turbine engine alternator set. The test is self-testing and is done with the use of a CRT terminal and a RS-232 adapter cable (used for interfacing between the CRT and J85529 controller). There are two tests performed on the control unit with the set "OFF" and one test performed on the control unit with the set "ON". The two test performed on the control unit with the set "OFF" are "Inputs" and "Outputs". There are currently 40 inputs and 60 outputs being tested on the control board. The CRT will check each one, or the user may check any input or output at random.

### 5.06 Setting up the CRT for Test of Control

**Boards:** To test each input or output, set up CRT as follows:

- (1) Obtain a ADM5 CRT terminal.

**Note:** If using an ADM 3A CRT, switches may be in various locations, but switches must be set as in the following steps to allow for proper interfacing with the J85529 controller.

- (2) Set microswitches on SW1, located on the back panel of the CRT, as indicated in Table D.

**Note:** The SW1 is the switch for setting Baud Rate on the CRT. The Baud Rate for this test is 1200.

TABLE D

PROPER POSITION FOR SWITCHES ON SW1 ON CRT FOR 1200 BAUD OPERATION

SWITCH ON SW1		POSITION	
NUMBER	BAUD RATE	ON	OFF
1	75		X
2	110		X
3	150		X
4	300		X
5	600		X
6	1200	X	
7	2400		X
8	4800		X
9	9600		X
10	19.2K		X

- (3) Set microswitches on SW2, located on the back panel of the CRT, as indicated in Table E.

**Note:** The SW2 is the switch for setting up the options on the CRT.

- (4) Set microswitches on SW3, located internally in the CRT, as indicated in Table F.

TABLE E

## PROPER POSITION FOR SWITCHES ON SW2 ON CRT

SWITCH ON SW2	SET UP OPTION
1	OFF
2	AUTO New Line OFF
3	60 HZ
4	RS 232
5	FULL DUPLEX
6	BIT 8 = 0
7	PARITY INHIBIT
8	2 STOP BIT
9	EVEN PARITY
10	8-BIT WORD LENGTH

TABLE F

## PROPER POSITION FOR SWITCHES ON SW3 ON CRT

SWITCH ON SW3		POSITION	
NUMBER	ACCESS	ON	OFF
1	LOCAL		X
2	103	X	
3	202		X
4	CODE		X
5	EXT		X
6	EOT		X

**Note:** To gain access to SW3 switch, remove the two screws underneath the front of the CRT and hinge the upper panel to the rear. The SW3 switch is located on the back of the circuit board inside the CRT.

- (5) Connect the RS-232 adapter cable (supplied with the set) between the MODEM connection of the CRT and the P2 plug of the ZZ211 board (J85529 Controller) located behind the control panel.

## OPERATION

**5.07 Input:** To perform the self-test on the engine-alternator set, proceed as follows:

- (1) Verify that the CRT is correctly set per paragraph 5.06.
- (2) Operate the OPERATION SELECTOR SWITCH to the OFF position.
- (3) Operate the CB203 circuit breaker to the OFF position.
- (4) Operate the rocker switch on the back of the CRT to the ON position.
- (5) Select the test program by closing SW3 on the ZZ210 board (J85520 controller board).
- (6) Operate CB203 circuit breaker to the ON position.

**Note:** Closing the CB203 circuit applies power to the control boards.

- (7) Depress the "i" key on the CRT.

**Note:** The CRT will display a list of all inputs as indicated on Table G.

- (8) A sequence of operating events from the CRT screen are as follows:

- A 2-digit number appears in upper left side of screen.
- The 2-digit number indicates which input is currently being tested.
- Advancement of input is done by depressing the space bar on the CRT.

- Decrement of input is done by depressing the “-” (minus) key.
- Random selection or direct entry of an input can be selected by typing in the desired input number.
- An asterisk “\*” appears next to the selected input.
- If selective input is active, a pulsating beep is heard from CRT.
- If selective input is inactive, no beep is heard from CRT.

(9) Depress the space bar on CRT.

**Note:** The 01 code number will appear at the top of the CRT screen and an \* (asterisk) will appear at the left of the code number. See Table G for identification of what is to appear on the CRT screen.

(10) Each code number with identification of input will have a test result which appears in Table H. If these results are not met, proceed to Table I to locate and correct trouble.

**TABLE G**  
**IDENTIFICATION OF INPUTS ON CRT SCREEN**  
**AND LOGIC DEFINITION**

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 CHARG 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

**LOGIC DEFINITION**

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PB = Push Button  
 SW = Switch  
 E = Engine or Set Transducer  
 I = Internal to Microcomputer  
 C = Customer Connection Board-Remote from Set  
 M = Master Board-(J85520) ZZ210  
 S = Slave Board-(J85529) ZZ211  
 B = Pertains to Both Boards--Master and Slave Boards

TABLE H

## INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CODE NUMBER	CRT IDENTIFICATION	ACTUAL IDENTIFICATION	TEST RESULTS ACTION TO BE TAKEN TO MAKE DEVICE ACTIVE (SEE NOTE 1 AND NOTE 2)	RESULTS
<b>PUSHBUTTONS</b>				
01	ACO-PB	ALARM CUTOFF	Depress PB	CRT beeps
02	CL-ACB-PB	CLOSE ALTERNATOR CIRCUIT BREAKER	Depress PB	CRT beeps
03	MAN-RST	MANUAL RESTORE	Depress PB	CRT beeps
04	OP-ACB	OPEN ALTERNATOR CIRCUIT BREAKER	Depress PB	CRT beeps
05	PURG	PURGE CRANK	Depress PB	CRT beeps
06	RED-SPD	REDUCED SPEED	Depress PB	CRT beeps
07	REM-STRT	REMOTE START (Customer Located)	Depress PB	CRT beeps
08	STRT	START	Depress PB	CRT beeps
09	TST-RUN	TEST RUN	Depress PB	CRT beeps
<b>SWITCHES</b>				
10	AM-SEL1	AMMETER SELECT 1	Operate to 1 Position	CRT beeps
11	AM-SEL2	AMMETER SELECT 2	Operate to 2 Position	CRT beeps
12	AUTO-TRNS	AUTO TRANSFER	Operate to AUTO	CRT beeps
13	OSS-LA	OPERATION SELECTOR SWITCH LOCAL AUTO	Operate to AUTO	CRT beeps
14	OSS-LM	OPERATION SELECTOR SWITCH LOCAL MANUAL	Operate to MANUAL	CRT beeps
15	OSS-RA	OPERATION SELECTOR SWITCH REMOTE AUTO	Operate to AUTO	CRT beeps

TABLE H (Contd)

## INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CODE NUMBER	CRT IDENTIFICATION	ACTUAL IDENTIFICATION	TEST RESULTS ACTION TO BE TAKEN TO MAKE DEVICE ACTIVE (SEE NOTE 1 AND NOTE 2)	RESULTS
<b>SWITCHES (Contd)</b>				
16	OSS-RM	OPERATOR SELECTOR SWITCH REMOTE MANUAL	Operate to MANUAL	CRT beeps
17	RUN-TIM	RUN TIMER	Operate To ON	CRT beeps
18	SW1-CL	SW1 Close (MASTER BOARD ZZ210)	Close SW1	CRT beeps
19	SW2-CL	SW2 Close (MASTER BOARD ZZ210)	Close SW2	CRT beeps
20	SW3-CL	SW3 Close (MASTER BOARD ZZ210)	Close SW3	CRT beeps
21	SW3-CL	SW3 Close (SLAVE BOARD ZZ211)	Close SW3	CRT beeps
22	SW4-CL	SW4 Close (SLAVE BOARD ZZ211)	Close SW4	CRT beeps
23	SW5-CL	SW5 Close (SLAVE BOARD ZZ211)	Close SW5	CRT beeps
<b>TRANSDUCER</b>				
24	ALT-CB	ALTERNATOR CIRCUIT BREAKER	Short pin 2-7 to 2-8 on ACB	CRT beeps
25	HI-OIL-TMP	HIGH OIL TEMPERATURE	SIMULATE—TB301-6 to ground	CRT beeps
26	LO-CRK-BAT	LOW CRANK BATTERY	(1) NORMAL INACTIVE— (2) SIMULATE— Manually close the K-217 relay to the on state	No beep CRT beeps
27	LO-OIL-PRS	LOW OIL PRESSURE	(1) NORMAL INACTIVE— (2) SIMULATE—TB301-7 to Ground	No beep CRT beeps

TABLE H (Contd)

## INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CODE NUMBER	CRT IDENTIFICATION	ACTUAL IDENTIFICATION	TEST RESULTS ACTION TO BE TAKEN TO MAKE DEVICE ACTIVE (SEE NOTE 1 AND NOTE 2)	RESULTS
<b>TRANSDUCER (Contd)</b>				
28	MAJ-CB	MAJOR CIRCUIT BREAKER	(1) Close all MAJOR CIRCUIT BREAKERS — CB104, CB202, CB203, CB207, or CB310  (2) Open each CB one at a time  (3) Open EMERGENCY STOP Circuit breaker	CRT beeps  CRT beeps  CRT beeps
29	MIN-CAB	MINOR CIRCUIT BREAKER	(1) Close all MINOR CIRCUIT BREAKERS — CB205, CB206, CB309, or CB311,  (2) Open each CB one at a time except CB205 which supplies power to microcomputer	No beep  CRT beeps
30	OV-CUR	OVER CURRENT CONTACT	SIMULATE—Short TB5-25 to TB5-26 on ALTERNATOR CIRCUIT BREAKER	CRT beeps
<b>INTERNAL TO MICROCOMPUTER</b>				
31	ALT-OV	ALTERNATOR OVER VOLTAGE	(1) NORMAL INACTIVE  (2) Use AC SIMULATOR	No beep  CRT beeps
32	ALT-UN	ALTERNATOR UNDER VOLTAGE	(1) NORMAL ACTIVE  (2) Use AC SIMULATOR	CRT beeps  No beep
33	PWR-FAIL	POWER FAILURE	Open CB205	CRT beeps
34	RECT-FAIL	RECTIFIER FAILURE	Turn BATTERY CHARGER OFF to allow batteries to discharge to 24 volts	CRT beeps
35	ACB-INTER	ACB INTERLOCK	(TEST ONLY IF ANOTHER SET IS IN PARALLEL)  Open and close parallel sets ALTERNATOR CIRCUIT BREAKER	CRT beeps

TABLE H (Contd)

## INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CODE NUMBER	CRT IDENTIFICATION	ACTUAL IDENTIFICATION	TEST RESULTS ACTION TO BE TAKEN TO MAKE DEVICE ACTIVE (SEE NOTE 1 AND NOTE 2)	RESULTS
<b>CUSTOMER CONNECTIONS</b>				
36	CHARG-FAIL	CHARGER FAILURE CONTACT	TB 308-12 to Ground	CRT beeps
37	EMG-CB	EMERGENCY CIRCUIT BREAKER	SIMULATE—Apply +24 volts to TB307-8 (+) and TB307-7 (-)	CRT beeps
38	LOUV-OP	LOUVER OPEN CONTACT	SIMULATE—Apply +24 volts to TB306-13 (+) and TB306-14 (-)	CRT beeps
39	NORM-CB	NORMAL CIRCUIT BREAKER	SIMULATE—Apply +24 volts to TB307-24 (+) and TB307-25 (-)	CRT beeps
40	STRT-INTR	START INTERLOCK CONTACT	(TEST ONLY IF ANOTHER SET IS IN PARALLEL) SIMULATE—Apply +24 volts to TB307-11 (+) and TB307-12 (-)	CRT beeps

**Note 1:** Each device should be tested in both positions, inactive and active.

**Note 2:** In any other position the device will be in the inactive state and CRT will not beep. If CRT beeps in the inactive state or if CRT does not beep in the active state, a trouble situation exists and user should use Table I to clear the trouble.

**TABLE I**  
**TROUBLE CHART 1**  
**INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
01	(1) Defective ALARM CUTOFF pushbutton	Replace pushbutton
	(2) Defective wiring in alarm cutoff circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
02	(1) Defective CLOSE ALTERNATOR CIRCUIT BREAKER pushbutton	Replace pushbutton
	(2) Defective wiring in closed alternator circuit breaker circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
03	(1) Defective MANUAL RESTORE pushbutton	Replace pushbutton.
	(2) Defective wiring in manual restore circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
04	(1) Defective OPEN ALTERNATOR CIRCUIT BREAKER pushbutton	Replace pushbutton.
	(2) Defective wiring in open alternator breaker circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
05	(1) Defective PURGE CRANK pushbutton	Replace pushbutton.
	(2) Defective wiring in purge circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
(3)	Defective microcomputer	Replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 1**  
**INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
06	(1) Defective REDUCE SPEED pushbutton	Replace pushbutton.
	(2) Defective wiring in reduce speed circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer	Replace Master Board ZZ210.
07	(1) Defective remote start pushbutton (customer located)	Replace pushbutton.
	(2) Defective wiring in remote start circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer	Replace Master Board ZZ210.
08	(1) Defective START pushbutton	Replace pushbutton.
	(2) Defective wiring in start circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(30) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
09	(1) Defective TEST RUN pushbutton	Replace pushbutton.
	(2) Defective wiring in test run circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
10	(1) Defective AMMETER SELECT 1 switch	Replace switch.
	(2) Defective wiring in ammeter select circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211.
11	(1) Defective AMMETER SELECT 2 switch	Replace switch.
	(2) Defective wiring in ammeter select circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Slave Board ZZ211.

TABLE I (Contd)

**TROUBLE CHART 1**  
**INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
12	(1) Defective AUTO TRANSFER switch	Replace switch.
	(2) Defective wiring in AUTO transfer circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
13	(1) Defective OPERATION SELECTION SWITCH LOCAL AUTO switch	Replace switch.
	(2) Defective wiring in operation selection switch circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.
14	(1) Defective OPERATION SELECTION SWITCH LOCAL MANUAL switch	Replace switch.
	(2) Defective wiring in operation selection switch circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.
15	(1) Defective OPERATION SELECTION SWITCH REMOTE AUTO switch	Replace switch.
	(2) Defective wiring in operation selection switch circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
16	(1) Defective OPERATION SELECTION SWITCH REMOTE MANUAL switch	Replace switch.
	(2) Defective wiring in operation selection switch circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 1**  
**INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
17	(1) Defective RUN TIMER switch	Replace switch.
	(2) Defective wiring in ammeter select circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Slave Board ZZ211.
18	(1) Defective SW1 switch (Master Board)	Replace Master Board ZZ210.
19	(1) Defective SW2 switch (Master Board)	Replace Master Board ZZ210.
20	(1) Defective SW3 switch (Master Board)	Replace Master Board ZZ210.
21	(1) Defective SW3 switch (Slave Board)	Replace Slave Board ZZ211.
22	(1) Defective SW4 switch (Slave Board)	Replace Slave Board ZZ211.
23	(1) Defective SW5 switch (Slave Board)	Replace Slave Board ZZ211.
24	(1) Defective ALTERNATOR CIRCUIT BREAKER auxiliary relay	Replace relay.
	(2) Defective wiring in alternator circuit breaker circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.
25	(1) Defective HIGH OIL TEMPERATURE transducer.	Replace transducer.
	(2) Defective wiring in high oil temperature circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.
26	(1) Defective LOW CRANK BATTERY transducer	Replace transducer.
	(2) Defective wiring in low crank battery circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 1**  
**INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
27	(1) Defective LOW OIL PRESSURE transducer.	Replace transducer.
	(2) Defective wiring in low oil pressure circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Bord ZZ210.
28	(1) Defective MAJOR CIRCUIT BREAKER circuit breaker(s)	Replace circuit breaker(s).
	(2) Defective wiring in major circuit breaker circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.
29	(1) Defective MINOR CIRCUIT BREAKER circuit breaker(s)	Replace circuit breaker(s).
	(2) Defective wiring in minor circuit breaker circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.
30	(1) Defective OVER CURRENT CONTACT transducer.	Replace transducer.
	(2) Defective wiring in over current contact circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board	Replace Master Board ZZ210.
31	(1) Defective wiring in alternator over voltage circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Master Board ZZ210.
32	(1) Defective wiring in alternator under voltage circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 1**  
**INPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
33	(1) Defective wiring in power failure circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Master Board ZZ210.
34	(1) Defective wiring in rectifier failure circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Master Board ZZ210.
35	(1) Defective wiring in ACB interlock circuit	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
36	(1) Defective wiring in charger failure contact circuit (customer connection)	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Master Board ZZ210.
37	(1) Defective wiring in emergency circuit breaker circuit (customer connection)	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Master Board ZZ210.
38	(1) Defective wiring in louver open contact circuit (customer connection)	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Slave Board ZZ211.
39	(1) Defective wiring in norm circuit breaker circuit (customer connection)	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(2) Defective microcomputer board	Replace Slave Board ZZ211.
40	(1) Defective wiring in start interlock contact circuit (customer connection)	Check and replace defective wiring per SD-82575-01 and SD-82531-01.
	(3) Defective microcomputer board(s)	Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.

**5.08 Output:** To perform the self-test on the engine-alternator set, proceed as follows:

- (1) Verify that the CRT is correctly set per paragraph 5.06.
- (2) Operate the OPERATION SELECTOR SWITCH to the OFF position.
- (3) Operate the CB203 circuit breaker to the OFF position.
- (4) Operate the rocker switch on the back of the CRT to the ON position.

(5) Select the test program by closing SW3 on the ZZ210 board (J85520 controller board).

- (6) Operate the CB203 circuit breaker to the ON position.

**Note:** Closing the CB203 circuit breaker applies power to the control boards.

- (7) Depress the "o" (letter) key on the CRT.

**Note:** The CRT will display a list of all outputs as indicated on Table J.

**TABLE J**

**IDENTIFICATION OF OUTPUTS ON CRT SCREEN  
AND LOGIC DEFINITION**

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 VS-OP-L	33 B 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 REV-SPD-R	60 S LOWR-HZ-R

**LOGIC DEFINITIONS**

L = Lamp

R = Relay

% = Remote Only

M = Master Board-(J85520) ZZ210

S = Slave Board-(J85529) ZZ211

B = Pertains to Both Boards—Master and Slave Boards

(8) A sequence of operating events from the CRT screen are as follows:

- A 2-digit number appears in the upper left side of the screen.
- The 2-digit number indicates which output is currently being tested.
- Advancement of output is done by depressing the space bar on the CRT.
- Decrement of output is done by depressing the “-” (minus) key on the CRT.
- Random selection or direct entry of an output can be selected by typing in the desired output number.

- An asterisk “\*” appears as the selected output.

- If selective output is active, either the LED being tested will blink or the relay being tested will operate on and off.

(9) Depress the space bar on the CRT.

**Note:** The 01 code number will appear at the top of the CRT screen and an \* (asterisk) will appear at the left of the code number. See Table J for identification of the code number.

(10) Each code number with identification of output will have a test result which appears in Table K. If these results are not met, proceed to Table L to locate and correct trouble.

TABLE K

## OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CRT SCREEN		ACTUAL IDENTIFICATION	TEST RESULTS
CODE NUMBER	CRT IDENTIFICATION	PANEL STAMPING FOR LEADS — RELAY DEFINED THAT IS ACTIVATED	
01	COAST-DN-L%	COAST DOWN LED (REMOTE PANEL ONLY)	LED Blinking
02	RF-FF-L	RECTIFIER FAIL LED	LED Blinking
03	COAST-DN-L	COAST DOWN LED	LED Blinking
04	OVER-CUR-L	OVER CURRENT LED	LED Blinking
05	MIN-CB-L	MINOR CIRCUIT BREAKER LED	LED Blinking
06	SIM-PWR-FAIL-L	SIMULATED POWER FAILURE LED	LED Blinking
07	OS-RVP-L	OVER SPEED/REV POWER LED	LED Blinking
08	RUN-TMR-L	RUN TIMER LED	LED Blinking
09	HI-OIL-TMP-L	HIGH LUBE OIL TEMP LED	LED Blinking
10	LO-OIL-PRS-L	LOW OIL PRESSURE LED	LED Blinking
11	OS-RVP-L%	OVER SPEED OPEN PROBE LED (REMOTE PANEL ONLY)	LED Blinking
12	MAJ-CB-L	MAJOR ALARM LED	LED Blinking
13	OV-UV-L	OVER/UNDER VOLTAGE LED	LED Blinking
14	US-OP-L%	UNDER SPEED/OPEN PROBE LED (REMOTE PANEL ONLY)	LED Blinking
15	AUTO-L	AUTO LED (OPERATION SELECTION SWITCH)	LED Blinking
16	MAN-L	MANUAL LED (OPERATION SELECTOR SWITCH)	LED Blinking
17	OFF-L	OFF LED (OPERATION SELECTOR SWITCH)	LED Blinking
18	US-OP-L	UNDER SPEED/OPEN PROBE LED	LED Blinking
19	AUTO-L%	AUTO LED (OPERATION SELECTOR SWITCH REMOTE PANEL ONLY)	LED Blinking
20	MAN-L%	MANUAL LED (OPERATION SELECTOR SWITCH REMOTE PANEL ONLY)	LED Blinking
21	OFF-L%	OFF LED (OPERATION SELECTOR SWITCH-REMOTE PANEL ONLY)	LED Blinking
22	MAJ-ALM-VIS-R	MAJOR ALARM VISUAL RELAY (K-302)	Relay Operating On And Off

TABLE K (Contd)

## OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CRT SCREEN		ACTUAL IDENTIFICATION	TEST RESULTS
CODE NUMBER	CRT IDENTIFICATION	PANEL STAMPING FOR LEADS — RELAY DEFINED THAT IS ACTIVATED	
23	MAJ-ALM-AUD-R	MAJOR ALARM AUDIBLE RELAY (K-312)	Relay Operating On And Off
24	PWR-FAIL-R	POWER FAIL RELAY (K-388)	Relay Operating On And Off
25	RTL-R	READY TO LOAD RELAY (K-311)	Relay Operating On And Off
26	PROP-OP-R	PROPER OPERATION RELAY (K-310)	Relay Operating On And Off
27	MIN-ALM-AUD-R	MINOR ALARM AUDIBLE RELAY (K-307)	Relay Operating On And Off
28	MIN-ALM-VIS-R	MINOR ALARM VISUAL RELAY (K-308)	Relay Operating On And Off
29	LOUV-OP-R	LOUVER OPEN RELAY (K-303)	Relay Operating On And Off
30	AUTO-R	AUTO RELAY (K-306)	Relay Operating On And Off
31	PWR-RET-R	POWER RETURN RELAY (K-305)	Relay Operating On And Off
32	FIELD-FLASH-R	FIELD FLASH RELAY (K-360)	Relay Operating On And Off
33	CF-NOLGT-L	CRANK FAIL NO LIGHT LED	LED Blinking
34	RTL-L	READY TO LOAD LED	LED Blinking

TABLE K (Contd)

## OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CRT SCREEN		ACTUAL IDENTIFICATION	TEST RESULTS
CODE NUMBER	CRT IDENTIFICATION	PANEL STAMPING FOR LEADS — RELAY DEFINED THAT IS ACTIVATED	
35	OP-ECB-R	OPEN ECB RELAY (K-327)	Relay Operating On And Off*
36	OP-NCB-R	OPEN NCB RELAY (K-325)	Relay Operating On And Off†
37	CL-ECB-R	CLOSE ECB RELAY AND LED (K-328)	Relay Operating On And Off‡ LED Blinking
38	CL NCB-R	CLOSE NCB RELAY AND LED (K-326)	Relay Operating On And Off§ LED Blinking
39	VOLT-REG-R	VOLTAGE REGULATOR RELAY (K-313)	Relay Operating On And Off¶
40	CL-ACB-R	CLOSE ACB RELAY (K-316)	Relay Operating On And Off¶
41	OP-ACB-R	OPEN ACB RELAY (K-201)	Relay Operating On And Off¶
<b>WARNING:</b> Before selecting code number 42, the starter motor should be disabled. To disable, remove a lead from the start battery at TB-502.			
42	CRANK-R	CRANK RELAY (K-243)	Relay Operating On And Off
43	IGN-R	IGNITION RELAY (K-245)	Relay Operating On And Off¶
44	FUEL-R	FUEL RELAY (K-249)	Relay Operating On And Off¶

\* This is a solid-state relay, therefore, no clicking will be heard. To test, connect a DMM to TB203-21 (+) and ground (-). A pulsating voltage will be indicated of 0 to 23 volts.

† This is a solid-state relay, therefore, no clicking will be heard. To test, connect a DMM to TB-203-19 (+) and ground (-). A pulsating voltage will be indicated of 0 to 23 volts.

‡ This is a solid-state relay, therefore, no clicking will be heard. To test, connect a DMM to TB-203-22 (+) and ground (-). A pulsating voltage will be indicated of 0 to 23 volts.

§ This is a solid-state relay, therefore, no clicking will be heard. To test, connect a DMM to TB-203-20 (+) and ground (-). A pulsating voltage will be indicated of 0 to 23 volts.

¶ Circuit breaker CB104 must be closed, or the A and B contacts on CB104 shorted.

TABLE K (Contd)

## OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM

CRT SCREEN		ACTUAL IDENTIFICATION	TEST RESULTS
CODE NUMBER	CRT IDENTIFICATION	PANEL STAMPING FOR LEADS — RELAY DEFINED THAT IS ACTIVATED	
45	RED-SPD-R	REDUCE SPEED RELAY (K-294)	Relay Operating On And Off
46	VIB1-L	VIBRATION 1G LED	LED Blinking
47	VIB2-L	VIBRATION 2G LED	LED Blinking
48	VIB3-L	VIBRATION 3G LED	LED Blinking
49	VIB4-L	VIBRATION 4G LED	LED Blinking
50	VIB-FAULT-L%	VIBRATION 5G LED (REMOTE PANEL ONLY)	LED Blinking
51	VIB-FAULT-L	VIBRATION 5G LED	LED Blinking
52	LIT-OFF-TMP-L%	LIGHT OFF TEMP LED (REMOTE PANEL ONLY)	LED Blinking
53	LIT-OFF-TMP-L	LIGHT OFF TEMP LED	LED Blinking
54	PRE-HI-TMP-L	PRE HIGH EXHAUST TEMP LED	LED Blinking
55	HI-TMP-L%	HIGH EXHAUST TEMP LED (REMOTE PANEL ONLY)	
56	HI-TMP-L	HIGH EXHAUST TEMP LED	LED Blinking
57	TMP-PROB-L	OPEN TEMPERATURE PROBE LED	LED Blinking
58	GND-FAULT-L	GROUND FAULT LED	LED Blinking
59	TOP-LIMIT-R	TOP LIMIT RELAY (K-244)	Relay Operating On And Off
60	LOWR-HZ-R	LOWER HERTZ	

**TABLE I**  
**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
01	(1) Defective COAST DOWN LED (remote panel only). (2) Defective wiring in coast down circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82575-01 and SD-82531-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
02	(1) Defective RECTIFIER FAIL LED (2) Defective wiring in rectifier fail circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82575-01 and SD-82531-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
03	(1) Defective COAST DOWN LED (Local panel) (2) Defective wiring in coast down circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
04	(1) Defective OVER CURRENT LED (2) Defective wiring in over current circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
05	(1) Defective MINOR CIRCUIT BREAKER LED (2) Defective wiring in minor circuit breaker circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
06	(1) Defective SIMULATED POWER FAILURE LED (2) Defective wiring in simulated power failure circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and 82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
07	(1) Defective OVER SPEED/REV POWER LED (2) Defective wiring in over speed or reverse power circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
08	(1) Defective RUN TIMER LED (2) Defective wiring in run timer circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
09	(1) Defective HIGH LUBE OIL TEMP LED (2) Defective wiring in high lube oil temperature circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Master Board ZZ210.
10	(1) Defective LOW OIL PRESSURE LED (2) Defective wiring in low oil pressure circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
11	(1) Defective OVER SPEED OPEN PROBE LED (2) Defective wiring in over speed open probe circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Master Board ZZ210.
12	(1) Defective MAJOR ALARM LED (2) Defective wiring in major alarm circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Master Board ZZ210.
13	(1) Defective OVER/UNDER VOLTAGE LED. (2) Defective wiring in over or under voltage circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Master Board ZZ210.
14	(1) Defective UNDER SPEED/OPEN PROBE LED (2) Defective wiring in under speed or open probe circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
15	(1) Defective AUTO LED (OPERATION SELECTOR SWITCH) (2) Defective wiring in AUTO circuit of operation selector switch circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
16	(1) Defective MAN LED (OPERATION SELECTOR SWITCH) (2) Defective wiring in manual circuit of operation selector switch circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
17	(1) Defective OFF LED (OPERATION SELECTOR SWITCH) (2) Defective wiring in off circuit of operation selector switch circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
18	(1) Defective UNDER SPEED/OPEN PROBE LED (2) Defective wiring in under speed and open probe circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
19	(1) Defective AUTO LED (OPERATION SELECTOR SWITCH – Remote panel only) (2) Defective wiring in AUTO circuit of operation selector switch circuit (Remote) (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
20	(1) Defective MAN LED (OPERATION SELECTOR SWITCH – Remote panel only) (2) Defective wiring in manual circuit of operation selector switch circuit (3) Defective microcomputer board(s)	Replace LED.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
21	(1) Defective OFF LED (OPERATION SELECTOR SWITCH — Remote panel only) (2) Defective wiring in off circuit of operation selector switch circuit (3) Defective microcomputer board(s)	Replace LED. Check and replace defective wiring per SD-82531-01 and SD-82575-01. Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
22	(1) Defective major alarm visual relay. (2) Defective wiring in major alarm visual circuit (3) Defective microcomputer board	Replace K-302 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
23	(1) Defective major alarm audible relay (2) Defective wiring in major alarm audible circuit (3) Defective microcomputer board	Replace K-312 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
24	(1) Defective power failure relay (2) Defective wiring in power failure circuit (3) Defective microcomputer board	Replace K-388 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
25	(1) Defective ready to load relay (2) Defective wiring in ready to load circuit (3) Defective microcomputer board	Replace K-311 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
26	(1) Defective proper operation relay. (2) Defective wiring in proper operation circuit (3) Defective microcomputer board	Replace K-310 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
27	(1) Defective minor alarm audible relay. (2) Defective wiring in minor alarm audible circuit (3) Defective microcomputer board	Replace K-307.  Check and replace defective wiring per SD-82531-01.  Replace Master Board ZZ210.
28	(1) Defective minor alarm visual relay (2) Defective wiring in minor alarm visual circuit (3) Defective microcomputer board	Replace K-308 relay.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Master Board ZZ210.
29	(1) Defective lower open relay (2) Defective wiring in lower open circuit (3) Defective microcomputer board(s)	Replace K-303 relay.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
30	(1) Defective AUTO relay (2) Defective wiring in AUTO circuit of operation selector switch circuit (3) Defective microcomputer board(s)	Replace K-306 relay.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
31	(1) Defective power return relay (2) Defective wiring in power return circuit (3) Defective microcomputer board(s)	Replace K-305 relay.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
32	(1) Defective field flash relay (2) Defective wiring in field flash circuit (3) Defective microcomputer board(s)	Replace K-360 relay.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.

TABLE L (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
33	(1) Defective CRANK FAIL NO LIGHT LED (2) Defective wiring in crank failure circuit (3) Defective microcomputer board(s)	Replace LED. Check and replace defective wiring per SD-82531-01 and SD-82575-01. Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
34	(1) Defective READY TO LOAD LED (2) Defective wiring in ready to load circuit (3) Defective microcomputer board	Replace LED. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
35	(1) Defective open ECB relay (2) Defective wiring in ECB circuit (3) Defective microcomputer board	Replace K-327 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
36	(1) Defective open NCB relay (2) Defective wiring in NCB circuit (3) Defective microcomputer board	Replace K-325 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
37	(1) Defective CLOSE ECB LED or relay (2) Defective wiring in ECB circuit (3) Defective microcomputer board	Replace LED. Replace K-328 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.
38	(1) Defective CLOSE NCB LED or relay (2) Defective wiring in NCB circuit (3) Defective microcomputer board	Replace LED. Replace K-326 relay. Check and replace defective wiring per SD-82531-01. Replace Master Board ZZ210.

TABLE L (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
39	(1) Defective voltage regulator relay (2) Defective wiring in voltage regulator circuit (3) Defective microcomputer board	Replace K-313 relay.  Check and replace defective wiring per SD-82531-01.  Replace Master Board ZZ210.
40	(1) Defective close ACB relay (2) Defective wiring in ACB circuit (3) Defective microcomputer board	Replace K-353-1 relay.  Check and replace defective wiring per SD-82531-01.  Replace Master Board ZZ210.
41	(1) Defective open ACB relay (2) Defective wiring in ACB circuit (3) Defective microcomputer board	Replace K-353-2 relay.  Check and replace defective wiring per SD-82531-01.  Replace Master Board ZZ210.
42	(1) Defective crank relay (2) Defective wiring in cranking circuit (3) Defective microcomputer board	Replace K-243 relay.  Check and replace defective wiring per SD-82531-01.  Replace Master Board ZZ210.
43	(1) Defective ignition relay (2) Defective wiring in ignition circuit (3) Defective microcomputer board	Replace K-245 relay.  Check and replace defective wiring per SD-82531-01.  Replace Master Board ZZ210.
44	(1) Defective fuel relay (2) Defective wiring in fuel circuit (3) Defective microcomputer board	Replace K-249 relay.  Check and replace defective wiring per SD-82531-01.  Replace Master Board ZZ210.

TABLE I (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
45	(1) Defective reduce speed relay (2) Defective wiring in reduce speed circuit (3) Defective microcomputer board(s)	Replace K-294 relay.  Check and replace defective wiring per SD-82531-01 and SD-82575-01.  Replace Slave Board ZZ211. If trouble still exists, replace Master Board ZZ210.
46	(1) Defective VIBRATION 1G LED (2) Defective wiring in vibration circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
47	(1) Defective VIBRATION 2G LED (2) Defective wiring in vibration circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
48	(1) Defective VIBRATION 3G LED (2) Defective wiring in vibration circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
49	(1) Defective VIBRATION 4G LED (2) Defective wiring in vibration circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
50	(1) Defective VIBRATION 5G LED (remote panel only) (2) Defective wiring in vibration circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.

TABLE I (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
51	(1) Defective VIBRATION 5G LED (2) Defective wiring in vibration circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
52	(1) Defective LIGHT OFF TEMP LED (remote panel only) (2) Defective wiring in temperature circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
53	(1) Defective LIGHT OFF TEMP LED (2) Defective wiring in temperature circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
54	(1) Defective PRE HIGH EXHAUST TEMP LED (2) Defective wiring in exhaust temperature circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
55	(1) Defective HIGH EXHAUST TEMP LED (remote panel only) (2) Defective wiring in exhaust temperature circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
56	(1) Defective HIGH EXHAUST TEMP LED (2) Defective wiring in exhaust temperature circuit (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.

TABLE L (Contd)

**TROUBLE CHART 2**  
**OUTPUT TESTING OF MICROCOMPUTER CONTROL SYSTEM**

CODE NUMBER	POSSIBLE TROUBLE	CORRECTIVE ACTION
57	(1) Defective OPEN TEMPERATURE PROBE LED  (2) Defective wiring in circuit  (3) Defective microcomputer board	Replace LED.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
58	(1) Defective GROUND FAULT LED  (2) Defective wiring in ground fault circuit  (3) Defective microcomputer board	Replace LED  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
59	(1) Defective TOP LIMIT relay  (2) Defective wiring in top limit circuit  (3) Defective microcomputer board	Replace K-244 relay.  Check and replace defective wiring per SD-82575-01.  Replace Slave Board ZZ211.
60	Not in use.	

**6. ACCESSORIES CLEANING**

**6.01** Following removal, each accessory should be cleaned (see Table M). The table lists accessories with recommended methods of cleaning and types of cleaning material to be used. New gaskets and O-rings must be used on reassembly.

**ENGINE COMPRESSOR CLEANING**

**6.02** An excessively contaminated compressor can be the cause of the engine failing to accelerate to full speed, a general lack of acceleration, compressor surge, or inability of the engine to pull full load. Whenever any of these symptoms become apparent, or when the troubleshooting procedures recommend compressor cleaning, follow the appropriate cleaning procedure.

(1) Contamination may be deposits of oil, salt, or other impurities on the compressor blades. Before cleaning the compressor, determine the source of contaminating materials and eliminate the condition if possible. Contamination can be caused by:

- (a) Drawing contaminated air into the compressor
- (b) Salt deposits resulting from operating in salt atmosphere
- (c) Oil leaking into the compressor air inlet.

(2) Compressor cleaning removes deposits from the compressor blades to restore engine performance. The cleaning medium (determined by the type and degree of contamination) is drawn in

**TABLE M**  
**CLEANING TABLE**

PART	CLEANING METHOD	CLEANING MATERIAL
Fuel Control Valve*	Wash and flush.	Stoddard Solvent or equivalent.
Fuel Filters (High-Pressure)		
Fuel Solenoid Valve*		
Fuel Pumps		
Oil Cooler		
Oil Filter Mount and Relief Valve		
Oil Pump		
Magnetic Pickup*	Wipe with clean, lintless cloth soaked in solvent.	Stoddard solvent or equivalent.
Oil Pressure Switch*		
Oil Temperature Switch*		
Ignition Exciter*	Wipe clean with lintless cloth.	No solvent to be used.
Instrument Panel Indicators		
Starter		
Switches and Relays		
Warning Lights		
Fuel and Oil Lines		
Ignitor Plug	Clean with soft-wire brush.	No solvent to be used.

\* Electrical components marked with asterisk; cap electrical receptacles before cleaning to prevent contamination.

through the air inlet. It is important that the cleaning medium reaches all parts of the compressor so that both the rotor and stator blades are cleaned. There are two approved methods of compressor cleaning:

(a) **Water Washing:** The water washing method is for periodic or daily washing when the engine has been operated in a dusty or salty atmosphere, but is not contaminated with oily deposits.

(b) **Abrasive Cleaning:** The abrasive cleaning method is for use when oil, dust, or chemical

deposits are such that cleaning method 1 is ineffective.

**Note:** Cleaning should not be attempted immediately after a prolonged full power run. Allow time for engine heat to stabilize at reduced speed.

**A. Water Washing**

**Warning 1:** *Ensure that all generator equipment is de-energized before operating the engine at reduced speeds.*

**Warning 2:** *Never use a solid stream of water while cleaning engine.*

**6.03** If the engine air supply is contaminated with foreign matter, such as salt water spray or dust, water washing prior to engine shutdown will help maintain the engine at peak performance. During prolonged periods of operation, wash the engine weekly or as operating experience dictates. The following procedure should be used.

- (1) Connect a pressurized 10-gallon source of distilled or deionized water to a hose with a fine spray nozzle (or water wash manifold); supply source should be pressurized at 15 to 60 psig.
- (2) Operate OPERATION SELECTOR SWITCH to the MANUAL position.
- (3) Depress the MANUAL START pushbutton.
- (4) After the READY TO LOAD and OPEN ACB LEDs are lighted, depress the REDUCED SPEED pushbutton.

**Note:** The engine must be operated to 100 percent speed before the REDUCED SPEED pushbutton is depressed. The engine will operate at about 50 percent speed at reduced speed.

- (5) Supply 10 gallons of water at the rate of 1 gallon per minute and approximately 60 psig.
- (6) After water washing is complete, operate OPERATION SELECTOR SWITCH to the OFF position.
- (7) After engine stops, restart engine and allow to run at rated speed (100 percent) and operate for 3 to 5 minutes.
- (8) Operate OPERATION SELECTOR SWITCH to the OFF position to stop engine.
- (9) Operate OPERATION SELECTOR SWITCH to the desired position.

#### **B. Abrasive Cleaning**

**Warning 1:** *Do not use this method of cleaning indiscriminately because repeated use could cause deterioration of turbine nozzles and blades.*

**Warning 2:** *The abrasive cleaner used in solar turbine engines must be clean,*

*dry, 35/60 mesh cleaning material, jet engine grade. Do not use material of coarser grade because the leading edges of the compressor rotor blades could be severely curled.*

**6.04** If the compressor is contaminated by salt water, oil vapors, oily dust, etc, and contamination has progressed to the point where washing the compressor does not restore performance; use an abrasive cleaning medium. The following materials and equipment must be used for abrasive cleaning.

- Abrasive Cleaner — Solar Part Number 917426C1 (10-pound package)
- Abrasive Injector Kit (see Fig. 8) — Solar Part Number 39399-0
- 3/8-Inch AN flexible line — PCD (compressor discharge pressure) bleed boss to bottle
- 1/2-Inch AN flexible line — Bottle to engine (abrasive discharge line)
- Face shield or safety goggles.

**6.05** The following products are recommended with the cleaning of the engines:

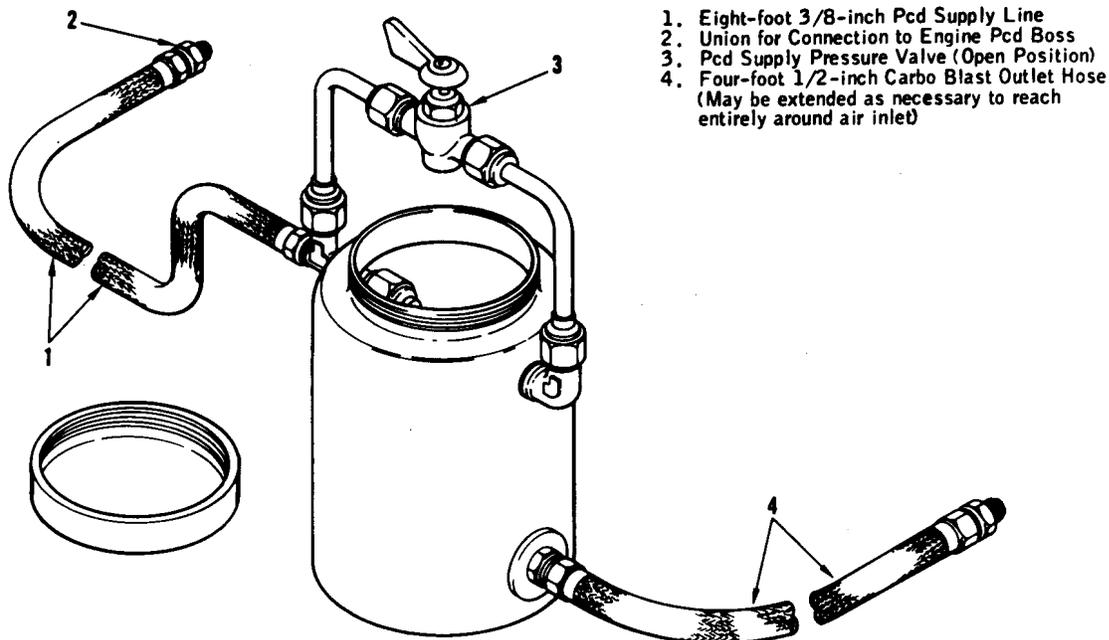
Jet Blast, 35/60 mesh jet engine grade,  
Jet Blast Company, Ft. Worth, Texas.

Shelblast, 35/60 mesh jet engine grade,  
Agrashell, Inc., Los Angeles, California.

**Note:** To prevent inadvertent use of contaminated and/or wet cleaning material which would be detrimental to the engine, it is recommended that each new batch come from a freshly opened package. This will preclude using cleaner which may have been contaminated from moisture, dust, floor sweepings, or trash.

**6.06** Before proceeding with the cleaning procedure operation, operate engine (if possible) and record the following engine no-load and load performance figures.

- Engine speed
- Ambient temperature
- Output power



1. Eight-foot 3/8-inch Pcd Supply Line
2. Union for Connection to Engine Pcd Boss
3. Pcd Supply Pressure Valve (Open Position)
4. Four-foot 1/2-inch Carbo Blast Outlet Hose (May be extended as necessary to reach entirely around air inlet)

Fig. 8—Abrasive Injector Kit and Lines

- Exhaust temperature
- Compressor discharge pressure.

**6.07 Procedure:** The following procedure should be followed for abrasive cleaning.

- (1) Operate OPERATION SELECTOR SWITCH to the OFF position.
- (2) Remove the air inlet access panels.
- (3) Remove inlet screen. Clean the screen, inlet casing flow paths, and inlet guide vanes with stoddard solvent, or equivalent. Reinstall inlet screen.
- (4) Disconnect the power turbine seal air line at the boss on the combustion chamber case. Recap the power turbine seal air line.
- (5) Disconnect the air line to the sixth-stage bleed air valve. Recap the air line.
- (6) Disconnect the combustion chamber drain lines. Recap the combustion chamber drain lines.
- (7) Place injector kit bottle in a convenient position over engine air inlet. Connect the 3/8-inch

line from the combustion chamber case boss [line removed in Step (4)] to the tee at the top of the bottle. Connect the 1/2-inch line to the connection at the base of the bottle. (The equipment must be positioned so that the free end of the 1/2-inch line can reach completely around the air inlet.)

- (8) Ensure that the injector bottle inlet line valve is closed. Fill the container with cleaning material. Leave the top off after filling.

**Warning 1:** Do not exceed 60 percent rated speed during cleaning procedure. Damage can result if compressor is cleaned at higher speeds.

**Warning 2:** Ensure that all generator equipment is de-energized before operating engine at reduced speeds.

- (9) Operate the OPERATION SELECTOR SWITCH to the MANUAL position.
- (10) Depress the MANUAL START pushbutton.
- (11) After the READY TO LOAD and OPEN ACB LEDs are lighted, depress the REDUCED SPEED pushbutton.

**Note:** The engine must be operated at 100 percent speed before the REDUCED SPEED

pushbutton is depressed. The engine will operate at about 50 percent speed at reduced speed.

***Danger: During the cleaning procedure, use safety goggles or a face shield and safety glasses to avoid any cleaning materials being blown in the eyes.***

- (12) Direct the discharge line at the engine air inlet with the end of line close to the inlet screen.
  - (13) Open the injector inlet line valve and move the discharge line around the engine air inlet so that all sections receive an equal quantity. The discharge rate should be approximately 1 pound per minute. The kit will provide this rate.
- Note:** The exhaust temperature will normally increase slightly as the material is injected.
- (14) Continue injection until all abrasive material has been discharged.
  - (15) Operate the OPERATION SELECTOR SWITCH to the OFF position.
  - (16) After engine has coasted to a complete stop, disconnect all cleaning equipment.

- (17) Blow out all control air lines and drain lines with clean, dry compressed air.
- (18) Reconnect all lines that were removed in Steps (4), (5), and (6) to their original configuration before cleaning.
- (19) Clean up any spilled blasting material in or around the inlet or inlet muff.
- (20) Reinstall the air inlet access panels.
- (21) Remove, disassemble, and clean sixth-stage bleed air valve. (See Section 155-211-701.)
- (22) Assemble and install sixth-stage bleed air valve.
- (23) Operate OPERATION SELECTOR SWITCH to the MANUAL position.
- (24) Restart engine by depressing the MANUAL START pushbutton and compare performance figures with those noted before cleaning.
- (25) After all test data is acquired, operate the OPERATION SELECTOR SWITCH to the OFF position, then reset switch to desired position after engine has coasted to a complete stop.