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SUPERVISED BY D. R. Duren D. R. Duren 7-1-62

APPROVED BY E. A. Waters E. A. Waters 7-1-62

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SAC-CEM-21-SM80A-2-21-2
(Formerly D2-13608-2 Volume I of IV)

LAUNCH FACILITIES
SYSTEM MANUAL
FIXED INSTALLED SUPPORT EQUIPMENT

HSM-80A
MALMSTROM AIR FORCE BASE

POWER GENERATION AND DISTRIBUTION

THIS PUBLICATION SAC-CEM-21-SM80A-2-21-2 REPLACES D2-13608-2 VOLUME I OF IV DATED 1 JULY 1962.

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Figure 2-6	21 September 1962	5 December 1962
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INTRODUCTION

This manual is one of a set of four manuals providing detailed information for operation and maintenance of Launch Facilities Fixed Installed Support Equipment Systems of the WS133A Weapon System installed at Malmstrom Air Force Base. Fixed Installed Support Equipment is generally defined as that equipment supplied and/or installed by contractors during the construction phase of weapon system facilities. Launch Facilities are defined as those directly supporting launch operations.

The four manuals comprising the complete set are:

SAC-CEM-21-SM80A-2-21-2	Power Generation and Distribution
SAC-CEM-21-SM80A-2-24-2	Water Supply and Waste Disposal
SAC-CEM-21-SM80A-2-20-2	Air Conditioning, Heating, and Ventilating
SAC-CEM-21-SM80A-2-26-2	Miscellaneous Systems

Each of the four manuals is supported by a separate Equipment Manual. The Equipment Manuals consist of manufacturers' data and contain operation and maintenance information on specific items of equipment. Reference is made to Equipment Manuals where applicable. Information may be located in Equipment Manuals by using item nomenclature, sequence number, name of manufacturer, or manufacturer's identification as called out in component lists.

The appropriate Equipment Manuals for Malmstrom Air Force Base are:

SAC-CEM-35R-1-451-2	Power Generation and Distribution
SAC-CEM-35R-1-461-2	Water Supply and Waste Disposal
SAC-CEM-35R-1-441-2	Air Conditioning, Heating, and Ventilating
SAC-CEM-35R-1-481-2	Miscellaneous Systems

Unless stated otherwise a reference to an Equipment Manual in any of the System Manuals will mean the Equipment Manual with corresponding title.

Similar information for Strategic Missile Support Base Facilities (SMSB) at Malmstrom Air Force Base are included in SAC-CEM-21-SM80A-2-27-2 and the supporting manual SAC-CEM-35R-1-491-2. Support Facilities are generally defined as those facilities such as handling, maintenance, and storage that are not directly involved in launch operations.

Information pertaining to operation and maintenance of Fixed Installed Support Equipment Systems contained in other weapon system manuals is referenced in this manual. Information will not be duplicated in this manual except where overlapping is necessary for clarity. Interface information necessary to provide logistic system information will be included in AGE Technical Manuals.

The standby power diesel engine-generator set is covered in this manual on a systems level. For detailed information on any of the components comprising the LF diesel engine-generator set, refer to "Generator Set, Diesel Engine, Model PU-361/FPS, and Switching Unit, Power Transfer, Model C-1931/FPS", T.O 35C2-3-228-1, -3, -4, -3-1, and -4-1.

SAFETY PRECAUTIONS

EQUIPMENT OR MATERIAL	SAFETY ACTION REQUIRED	REASON
All electrical	Two people within easy access of each other will be required while testing or performing maintenance on equipment that is energized.	To assist in case of an emergency
All cooling or dehumidifying systems	Refrigerants should not be allowed to contact skin or eyes.	Toxic effects and freezing of tissue can result.
All boilers	Shut off power to circulating pump and boiler controls and allow hot water to cool down prior to disconnecting hot water lines.	To prevent hot water burns to personnel
All cooling or dehumidifying systems.	Shut off power to refrigerant compressors and relieve pressure in lines prior to making repairs on refrigerant lines whenever possible.	To prevent discharge of refrigerant on personnel

SECTION I

DESCRIPTION

1-1. LCF POWER GENERATION AND DISTRIBUTION SYSTEM.

1-2. GENERAL DESCRIPTION.

1-3. The LCF power generation and distribution system performs two major functions: (1) distributes a-c power supplied by a commercial source to the electrical equipment within the LCF, and (2) generates and distributes standby a-c power in the event of a commercial power failure. The major power generation and distribution system components are listed in figure 1-1. Component locations are shown in figure 1-2. Under normal conditions, all electrical equipment at the LCF uses commercial power. Standby power is provided by a manually controlled diesel engine-generator set located in the LCF Support Building. When neither commercial nor standby power is available to the LCC, a battery set within the capsule is used as an emergency power supply (see figure 1-3). Hence, the electrical equipment within the capsule is never without a source of power. Refer to T.O. 21-SM80A-2-11, "Aero-Space Ground Equipment Power and Miscellaneous Systems", for information on the LCC emergency power supply.

1-4. Each distribution, power, and lighting panel has a letter designation signifying the function of the panel as follows:

PANEL	FUNCTION
LCDA, Standby Section	Launch Control Support Building Power Distribution Panel A - Standby Bus
LCDA, Normal Section	Launch Control Support Building Power Distribution Panel A - Normal Bus
LCDB	Launch Control Power Distribution Panel B
PP	Power Distribution Panel PP
LCA	Launch Control Lighting Panel A
LCB	Launch Control Lighting Panel B
LP	Lighting Panel LP

1-5. DESCRIPTION OF SYSTEM FUNCTIONS.

1-6. Under normal conditions, the electrical equipment at the LCF uses commercial power. All power is distributed from the two sections of panel LCDA (see figures 1-4 and 4-1). The main circuit breaker in the standby section of panel LCDA is key interlocked with the standby bus circuit breaker in the generator

control panel (see figure 1-5). Likewise the main circuit breaker in the normal bus section of panel LCDA is key interlocked with the normal bus circuit breaker in the generator control panel. This arrangement renders it impossible to connect both the commercial and standby power supplies to panel LCDA simultaneously.

1-7. If commercial power fails, a transfer to standby power must be made manually. An operator must enter room 102 and start up the standby diesel. The standby generator is connected to the load by opening the main circuit breakers in panel LCDA, removing the two keys, and transferring them to the standby bus breakers in the generator control panel. Closing the standby breakers places the LCF on the standby system.

1-8. When commercial power is restored to the support building, a buzzer sounds automatically in the commercial power supervisory panel (room 105). The buzzer continues to sound until it is acknowledged by pressing the RESET pushbutton on the panel. The load can then be retransferred to commercial power and the standby system shut down.

1-9. A shock contactor is located in the line supplying power to the LCC. The shock contactor is a normally closed switch-like device attached to the inner wall of the capsule. The contactor will open under severe shock conditions, cutting off all power supplied to the LCC. It can also be operated manually by means of pushbuttons on the contactor itself. When neither commercial nor standby power is available to the LCC at the required voltage and frequency, a battery set within the capsule provides emergency power. A solenoid in the LCC motor-generator set senses the voltage and frequency of the incoming power (commercial or standby) and automatically switches to the emergency battery set when necessary. The motor-generator set includes an a-c motor, d-c motor, 400 cps generator, and 60 cps generator. Refer to T.O. 21-SM80A-2-11, "Aero-Space Ground Equipment Power and Miscellaneous Systems", for detailed information on the LCC electrical system.

1-10. Filters are located at various points in the power distribution system to prevent stray radio-frequency interference with the electronic gear in the capsule. A grounded steel liner, completely enveloping the inner surface of the capsule, forms an electromagnetic interference shield for the capsule equipment.

1-11. The LCF grounding system consists of a network of buried steel rods, all of which meet at one central ground tie box in the capsule. A single pair of steel rods carries all ground current from the tie box to the water well casing. There are three types of ground runs in the system: equipment ground, instrument ground, and neutral bus ground. The equipment ground is connected to the noncurrent carrying parts of electrical equipment such as motor enclosures, circuit breaker panels, and conduits. Communication, telephone and other electronic equipment is grounded through the instrument ground. Neutral conductors in the power distribution system are insulated and grounded via the neutral buses of panel LCDA to prevent an unbalance in the load from affecting the electrical phase relationships in the power supply.

1-12. LCF STANDBY POWER GENERATION SYSTEM.

1-13. The standby diesel engine-generator set delivers up to 150 kw of 120/208-volt, 3-phase, 60 cps power. The diesel engine is a six-cylinder, two-cycle, liquid-cooled unit using lead-acid storage batteries for starting power. Diesel fuel is obtained from a day tank located in the support building (room 102) which, in turn, is fed from an underground storage tank outside the building. Refer to SAC-CEM-21-SM80A-2-26-2 for detailed information on the LCF fuel system.

1-14. Two types of output voltage control are possible with the standby generator: manual and automatic. Control in both cases is accomplished by varying the field current to produce the desired change in output voltage. Manual voltage control requires an operator in room 102 at all times to maintain the generator output voltage constant following any load changes. With automatic control no operator is needed once the system has been started up and adjusted, as explained in section II of this manual. Control circuitry for the diesel engine-generator is contained in the engine-generator control panel (figure 1-5) and the engine cranking panel (location shown in figure 1-2).

1-15. The engine cranking cycle is timed to prevent needless drainage of the batteries. A timer in the engine cranking panel limits engine cranking to four ten-second periods, each separated by ten seconds. If the engine fails to start after the four cranking periods have elapsed, the cranking circuit is locked out and the OVERCRANK light on the engine-generator control panel indicates the failure. No starting cycle can be reattempted until an operator presses the EMERGENCY STOP RESET button on the engine-generator control panel.

1-16. Engine operating speed is 1800 rpm, which corresponds to a generator output frequency of 60 cps. A governor (different from the overspeed governor) maintains engine speed at 1800 rpm when the throttle control is in the maximum run position. No tachometer is provided; however, when the frequency meter on the engine-generator control panel indicates 60 cps, engine speed is necessarily 1800 rpm.

1-17. While the engine is running, the coolant is maintained at 180°F nominal by controlling air flow through the radiator. Air is drawn into the room through a roof damper which opens automatically during engine startup. The engine fan forces the air through the radiator and out of the building via a damper located directly in front of the radiator. A thermally controlled motor positions the damper vanes such that the opening is proportional to engine coolant temperature. When the engine is not running, an immersion heater in the engine cooling system maintains the coolant temperature at 120°F minimum. The heater facilitates engine startup and minimizes engine wear during the initial part of the run.

1-18. The engine has four safety devices which cause automatic engine shutdown if their prescribed safety limits are exceeded:

a. High coolant temperature switch: Initiates shutdown when coolant temperature reaches 205°F.

b. Low oil pressure switch: Initiates shutdown when oil pressure drops to 27 psi.

c. High oil temperature switch: Initiates shutdown when oil temperature reaches 260°F.

d. Overspeed governor: Initiates shutdown when speed reaches 1975 (±25) rpm.

When a safety device operates, it also causes a light on the engine-generator control panel to illuminate, indicating the nature of the fault. The light remains on until the fault is acknowledged and corrected. The security monitor panel in room 105 indicates an emergency shutdown of the standby diesel by sounding a buzzer and illuminating the GEN RM light on the panel. The buzzer and light will remain on until someone enters room 102 and presses the ALARM ACKNOWLEDGE pushbutton on the engine-generator control panel. An overcrank condition for the standby diesel, or a low fuel main tank or low fuel day tank condition will also cause the buzzer to sound and GEN RM light to illuminate on the security monitor panel. Refer to SAC-CEM-21-SM80A-2-26-2 for details on the security monitor panel.

1-19. A battery charger (location shown in figure 1-2) maintains a constant floating charge on the engine cranking batteries except during engine startup.

1-20. OPERATION OF ENGINE STARTING AND ALARM CIRCUITS. A schematic of the engine starting and alarm circuits is provided in figure 4-8. Engine startup is initiated when an operator presses the START pushbutton on the engine cranking panel. Relay 2CW is energized through the START pushbutton and contacts 4CWb. Contacts 2CWa are closed, locking in relay 2CW through contacts OT, W, O, OSa and the STOP pushbutton. The engine shutdown valve solenoid is energized. When the solenoid is energized, it holds the shutdown valve for the air inlet housing in the open position, allowing combustion air to enter the engine. When the solenoid is de-energized by pressing the STOP or EMERGENCY STOP pushbuttons or by the operation of any of the engine safety devices, the shutdown valve closes and the engine is stopped.

1-21. The clutch coil in the engine cranking panel is energized, closing a switch in the circuit to the cranking timer motor. The timer motor drives a cam which controls two microswitches, M1 and M2, according to the time schedule shown on the drawing. When switch M1 is closed, relay 7CW operates, contacts 7CW are closed, and the starting motor contactor operates. If the engine starts during any of the four 10-second cranking attempts, the crank cutoff switch will be closed. Relay 3CW operates, opening contacts 3CWb and disconnecting power from the cranking timer motor. A spring return device on the clutch coil returns the microswitch cam

to its initial position, ready for the next starting operation. This also prevents the starting motor pinion from engaging the engine flywheel during the run.

1-22. If the engine fails to start after the four 10-second cranking attempts, the cam in the engine cranking panel closes switch M2, operating relay 4CW. Contacts 4CWb are opened, de-energizing relay 2CW. Contacts 4CWa and 2CWb are closed and the OVERCRANK light is illuminated on the engine-generator control panel.

1-23. If an overspeed condition occurs during a run, the overspeed switch closes and relay OS operates. Contacts OSa open and the shutdown valve solenoid is de-energized, stopping the engine. Contacts OSb close, illuminating the OVER-SPEED light. Contacts OSc are also closed, energizing relay R1 and closing contacts R1. The GEN RM light on the security monitor panel in room 105 is illuminated and a buzzer sounds. The buzzer and light will remain on until an operator enters room 102 and presses the ALARM ACKNOWLEDGE button on the engine-generator control panel.

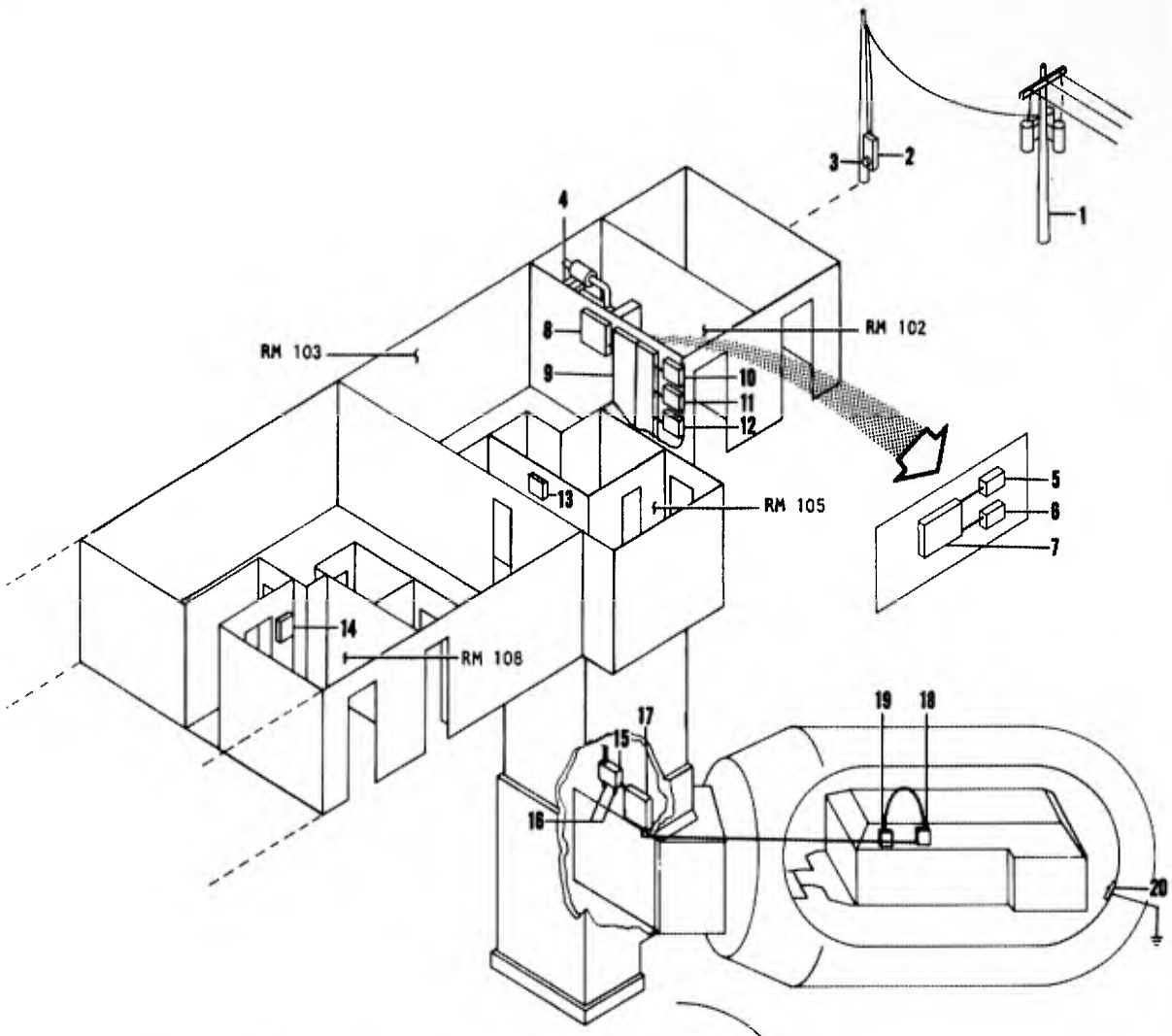
1-24. The alarm circuitry for low oil pressure, high water temperature, and high oil temperature conditions operate similar to that of the overspeed circuit. The TD0 time delay relay and variable resistor in series with the lube oil pressure switch prevent operation of the low oil pressure relay during engine startup.

COMPONENT	SEQ. NO.	LOCATION	FIGURE REF.	IDENTIFICATION AND MANUFACTURER	DESCRIPTION
		LCF POWER GENERATION SYSTEM			
Diesel Engine-Generator	1201-01	Rm 102	1-2	Model DASE-418150 Anderson-O'Brien	Engine, generator, and generator control panel mounted on common skid.
Diesel Engine	1201-02 01A-1	Rm 102	1-2	Model 62306RD Detroit Diesel	2-cycle, 6-cylinder
Governor	1201-02A 01A-1A	Part of diesel engine	1-2	Type 370776 Woodward Governor	Hydraulic type; adjusted for 1800 rpm with throttle in maximum run position.
Immersion Heater	1201-02B 01A-10	Part of diesel engine	1-2 and 1-7	Cat. No. MT-110 Wiegand, Edwin	Thermosiphon type engine coolant heater
Thermoswitch, Immersion Heater	1201-02C	Part of diesel engine	1-2 and 1-7	Cat. No. 17100 Fenwal	Controls immersion heater operation
Starting Battery	1201-02D 01A-1R	Rm 102	1-2	Type HYCAP-8D Electric Stor Battery	Two 12-volt batteries; series connected; 200 ampere-hours total
Engine Control Panel	1201-02E 01A-1X	Part of generator control panel	1-2 and 1-5	Dwg. 70766 Salyers Equipment	Engine alarm relays, warning lights, and shutdown pushbuttons
Overspeed Governor	1201-02G	Part of diesel engine	1-2 and 1-7	Model GW-2 Synchro Start Prod.	Mechanical-centrifugal type with microswitches for starting motor disconnect and overspeed.
Generator	1201-03 01A-2	Rm 102	1-2	Model Y1-4844 Delco	150 kw, 120/208-volt, 3-phase, 4 wire, synchronous
Voltage Regulator	1201-03B	Part of generator	1-2	Dwg. No. 3167291 Delco	Magnetic amplifier type
Generator control panel	1201-03C 01A-2B	Diesel engine-generator skid	1-2 and 1-5	Dwg. No. 70754 Salyers Equipment	Control and monitoring instrumentation for generator and engine; standby system circuit breakers.
Engine Cranking Panel	1201-04 01A-3	Rm 102	1-2	Dwg. No. 70850 Salyers Equipment	Wall-mounted, pushbutton starting control with timed cranking cycle.
Battery Charger	1201-05 01A-5	Rm 102	1-2	Type 24LT6RO Lester Equipment Mfg.	Maintains regulated charge on engine cranking batteries

Figure 1-1. LCF Power Generation and Distribution System Components (Sheet 1 of 2)

COMPONENT	SEQ. NO.	LOCATION	FIGURE REF.	IDENTIFICATION AND MANUFACTURER	DESCRIPTION
Commercial Power Monitor Panel	1201-07 01A-4	Rm 105	1-2	Dwg. #2LA9239-1 Cutler-Hammer	Monitors commercial power restoration after an outage.
		LCF POWER DISTRIBUTION SYSTEM			
Standby Circuit Breaker #1	1201-10	Generator control panel	1-5	Cat. #ET9670 I-T-E Circuit Breaker w/Mech.-Interlock	120/208-volt, 3-phase, 500 amp trip, 800 amp frame
Standby Circuit Breaker #2	1201-11	Generator control panel	1-5	Cat. #ET4742 I-T-E Circuit Breaker w/Mech.-Interlock	120/208-volt, 3-phase, 100 amp trip, 225 amp frame
Distribution Panel LCDA, Standby Section	1202-01 01B-1	Rm 103	1-2 and 1-4	Type CDPR Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 500 amp trip, 600 amp frame
Distribution Panel LCDA, Normal Section	1202-02 01B-2	Rm 103	1-2 and 1-4	Type CDPR Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 300 amp trip, 400 amp frame
Power Panel LCDB	1202-03 01B-5	LCC	1-2	Type NAIB Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 150 amp trip, 225 amp frame
Power Panel PP	1202-04 01B-4	Water Well Pump House	1-2	Type CDPR Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 175 amp trip, 225 amp frame
Shock Contactor	1202-09 01B-16	LCC	1-2	Bul. 6956ED77-2 Cutler-Hammer	200 amp, 4-pole
RFI Filter	1202-15 01B-9	Access Shaft	1-2	Cat. No. CDF-1002 Cornell-Dubilier	200 amp, 3-phase and neutral, 60 cps radio frequency interference filter
Lighting Panel LCA	1203-01 01C-28	Rm 108	1-2	Type NAIB Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 200 amp trip, 225 amp frame
Lighting Panel LCB	1203-02 01C-27	Rm 103	1-2	Type NAIB Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 70 amp trip, 100 amp frame
Lighting Panel LP	1203-03 01C-36	Water Well Pump House	1-2	Type NAIB Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 50 amp trip, 100 amp frame
Exit Light Circuit	1203-23 01C-30	Rm 103	1-2	Cat. No. NEF212020 Federal Pacific Elect. w/NEMA-1 encl.	Single-pole, 20 amp trip, 100 amp frame
Fire Alarm Circuit Breaker	1202-11 01C-32	Rm 103	1-2	Cat. No. NEF212020 Federal Pacific Elect. w/NEMA-1 Encl.	Single-pole, 20 amp trip, 100 amp frame
Power-On Circuit Breaker	1201-08 01A-6	Rm 103	1-2	Cat. No. NEF212020 Federal Pacific Elect.	Single-pole, 20 amp trip, 100 amp frame

Figure 1-1. LCF Power Generation and Distribution System Components (Sheet 2 of 2)



1 COMMERCIAL POWER POLE AND TRANSFORMERS
2 CURRENT TRANSFORMER CABINET
3 POWER METER
4 DIESEL ENGINE-GENERATOR
5 BATTERY CHARGER
6 ENGINE CRANKING PANEL
7 PULL BOX
8 LIGHTING PANEL LCB
9 DISTRIBUTION PANEL LCDA
10 POWER-ON CIRCUIT BREAKER
11 EXIT LIGHT CIRCUIT BREAKER
12 FIRE ALARM CIRCUIT BREAKER
13 COMMERCIAL POWER SUPERVISORY PANEL
14 LIGHTING PANEL LCA
15 JUNCTION BOX
16 LIGHTNING ARRESTERS
17 POWER FILTER
18 SHOCK CONTACTOR
19 DISTRIBUTION PANEL LCDB
20 GROUND TIE BOX
21 POWER PANEL PP
22 LIGHTING PANEL LP

Figure 1-2. LCF Power Generation and Distribution System Component Locations

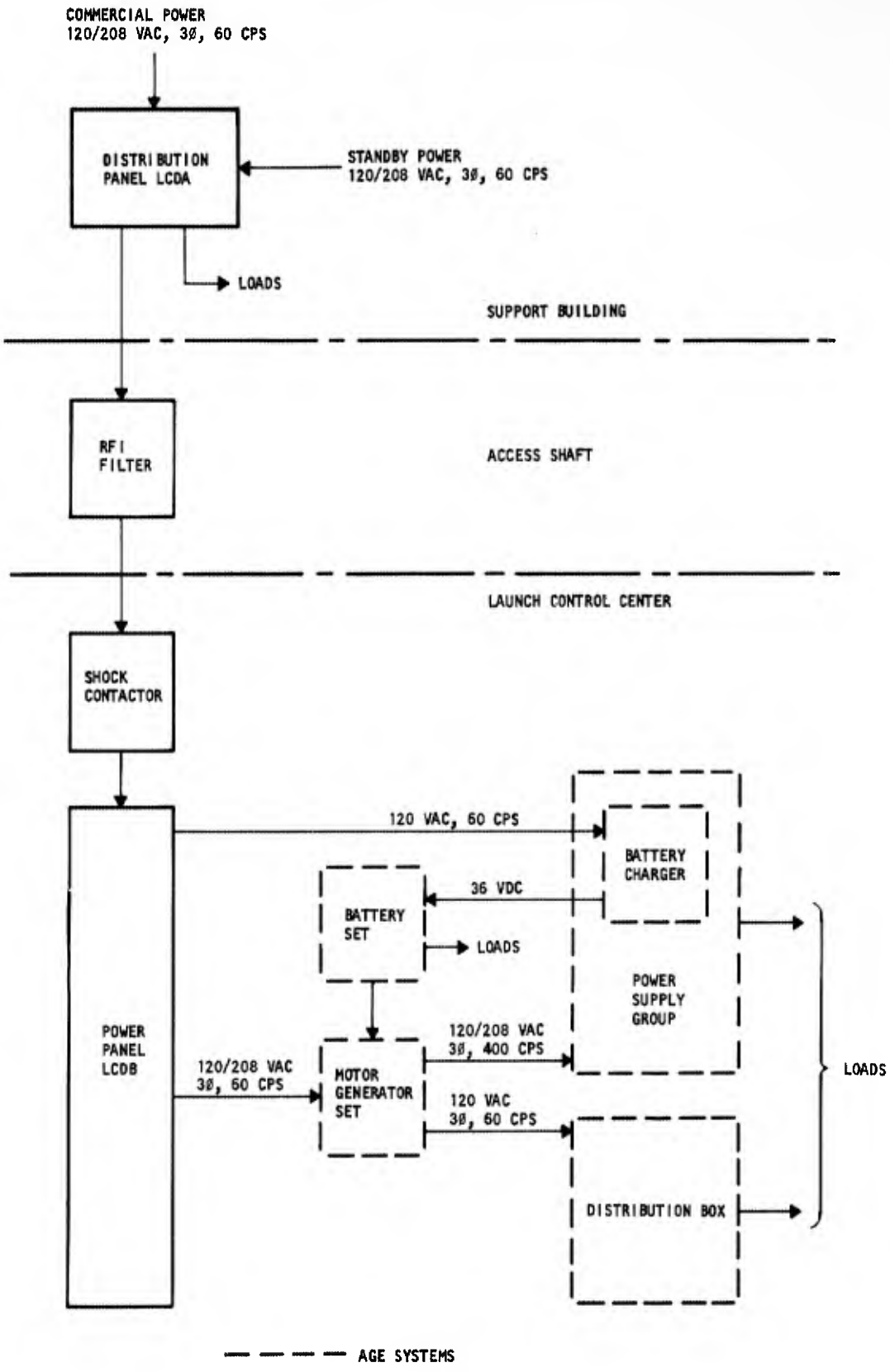


Figure 1-3. LCF Power Distribution System Block Diagram

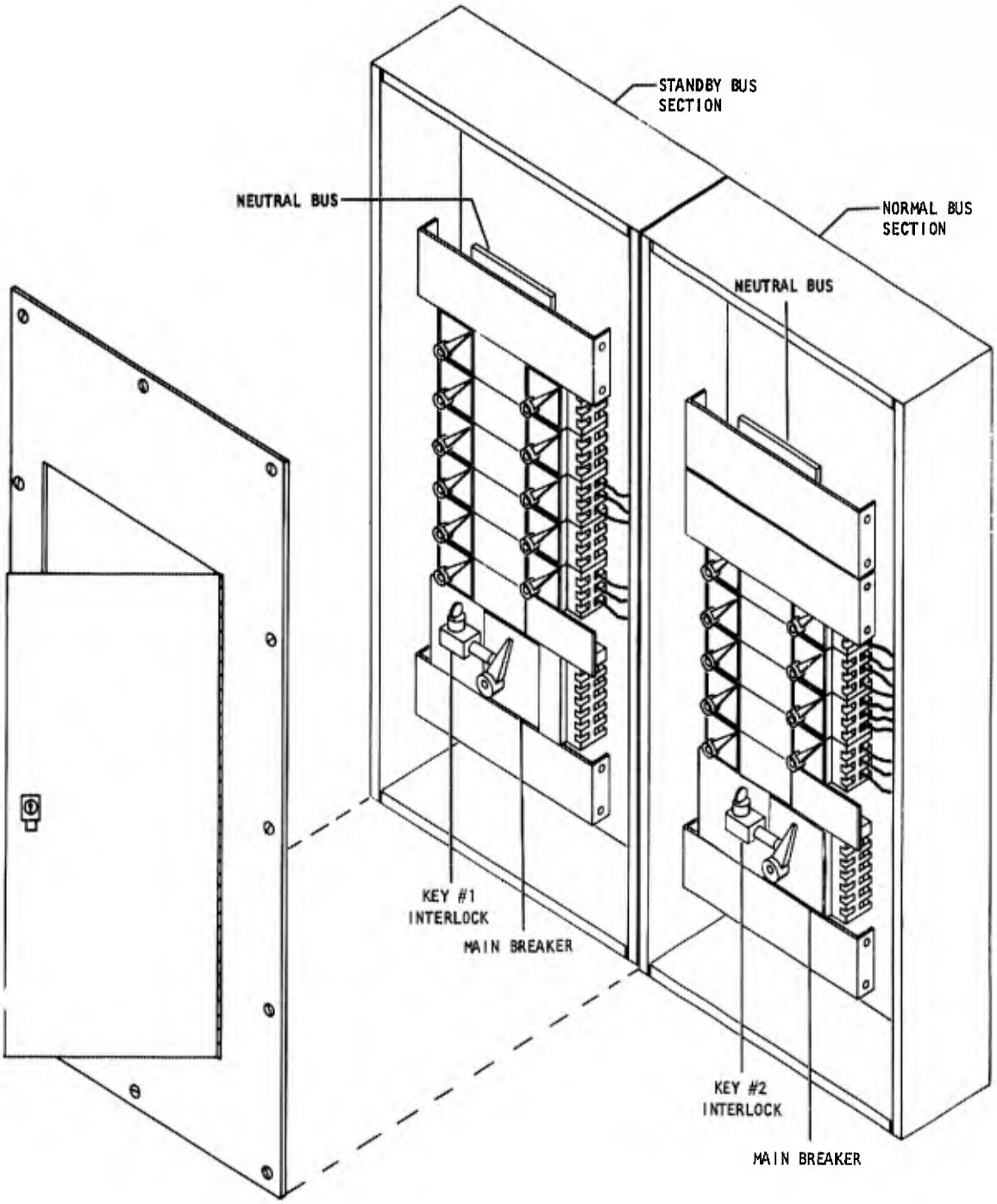
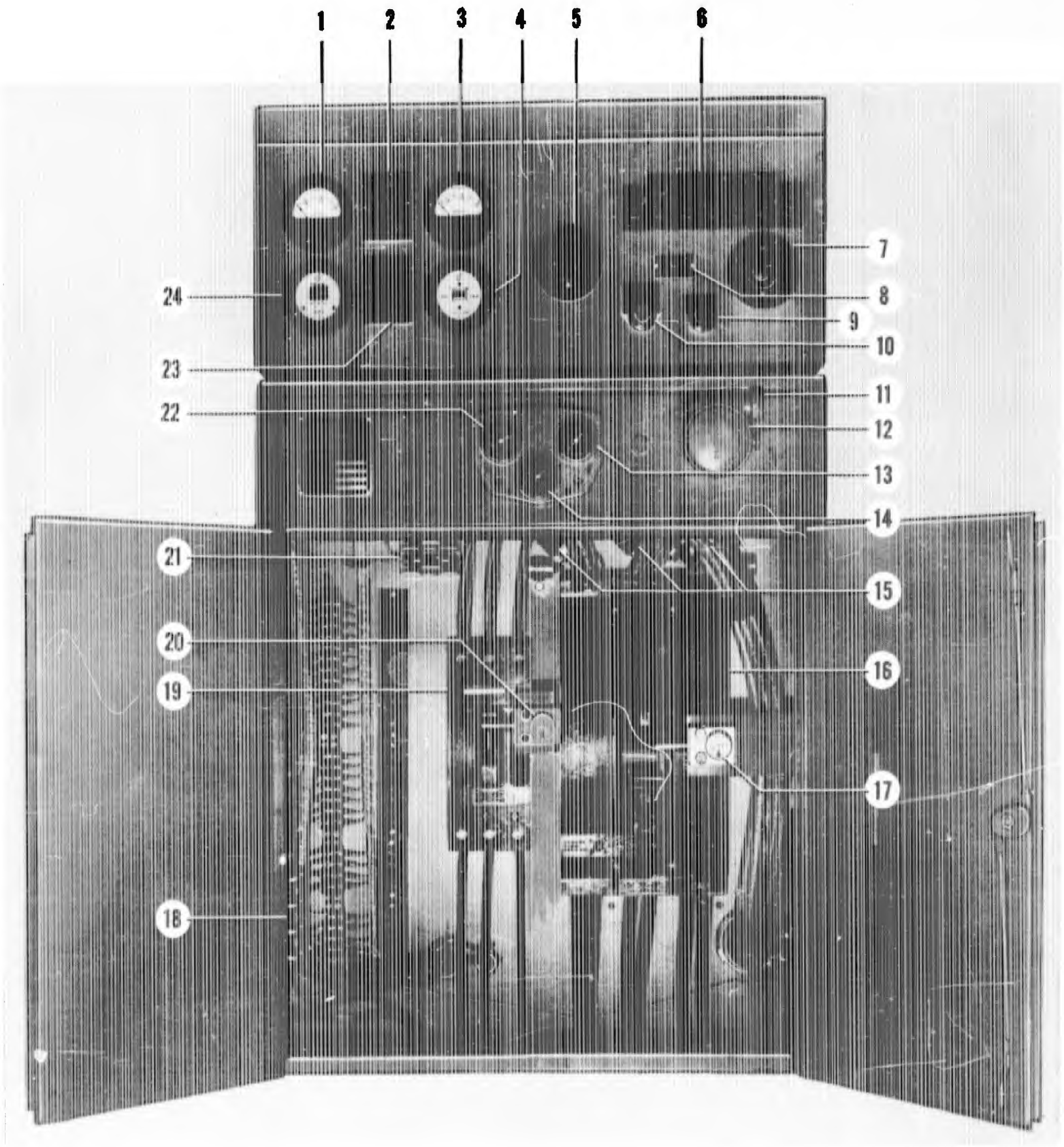
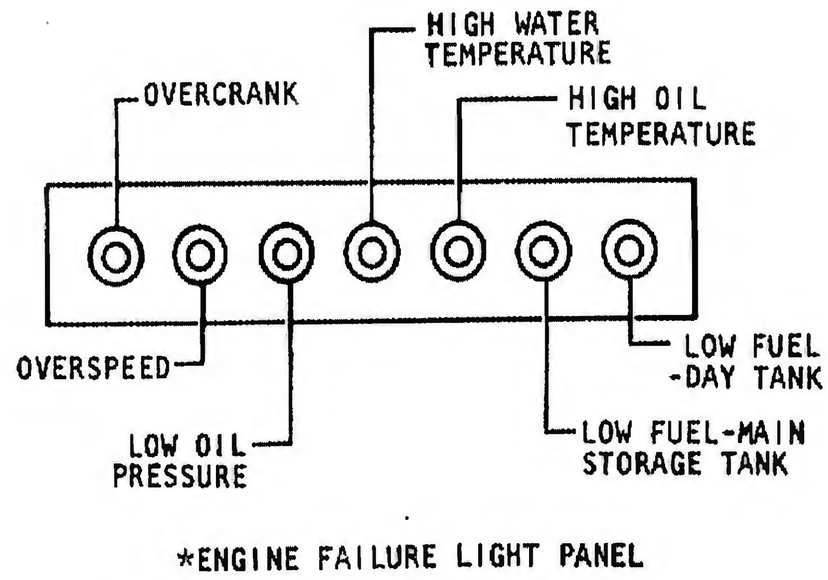


Figure 1-4. LCF Distribution Panel LCDA



1 AC VOLTMETER
2 VOLTMETER PHASE-SELECTOR SWITCH
3 AC AMMETER
4 RUNNING TIME METER
5 EXCITER FIELD RHEOSTAT KNOB
*6 ENGINE FAILURE LIGHT PANEL
7 VOLTAGE REGULATOR RHEOSTAT KNOB
8 VOLTAGE REGULATOR SWITCH
9 ALARM ACKNOWLEDGE PUSHBUTTON
10 EMERGENCY STOP RESET PUSHBUTTON
11 THROTTLE CONTROL VERNIER
12 THROTTLE CONTROL KNOB
13 OIL PRESSURE GAGE
14 OIL TEMPERATURE GAGE
15 AMMETER CURRENT TRANSFORMERS
16 STANDBY BUS CIRCUIT BREAKER
17 KEY INTERLOCK #1
18 FUSE HOLDER
19 NORMAL BUS CIRCUIT BREAKER
20 KEY INTERLOCK #2
21 FUSE HOLDER
22 WATER TEMPERATURE GAGE
23 AMMETER PHASE-SELECTOR SWITCH
24 FREQUENCY METER



*ENGINE FAILURE LIGHT PANEL

Figure 1-5. LCF Diesel Engine-Generator Control Panel

FIGURE REFERENCE	MARKING OR NAME	FUNCTION
(1, figure 1-6)	A-C Voltmeter	Indicates voltage across any two phases of commercial or generated voltage as selected by the VOLTMETER phase-selector switch (2).
(2)	Voltmeter phase-selector switch	Selects phase of commercial or generated voltage for voltage reading.
(3)	A-C Ammeter	Indicates the current in any phase of the generated output as selected by the AMMETER phase-selector switch.
(4)	Running time meter	Displays total number of hours that the generator set has been in operation
(5)	Exciter field rheostat knob	Used to make adjustment of generator output voltage, when voltage regulator is out of operation circuit.
(6)	Engine failure light panel	When the engine-generator set is shut down by the action of any of the safety devices, the red-colored engine failure lamp, associated with the safety device lockout relay, illuminates to retain an indication of the cause of generator-set failure.
(7)	Voltage regulator rheostat knob	Used to make adjustment of generated voltage, when voltage regulator is in operation
(8)	Voltage regulator switch	Switches the voltage regulator in service in the AUTO position and out of service in the MANUAL position
(9)	Alarm acknowledge pushbutton	Cancels the remote alarm buzzer and light at the security monitor panel in room 105.
(10)	Emergency stop reset push-button	Used to stop engine in case of hazardous operation and to reset the engine failure lights circuit after an engine shutdown.
(11)	Throttle control vernier	Fine adjustment for THROTTLE control knob
(12)	Throttle control knob	Used to adjust diesel engine-generator speed and hence the frequency of the generated output
(13)	Oil pressure gage	Indicates the pressure in the engine (lubricating) oil system
(14)	Oil temperature	Indicates the temperature of the engine lubricating oil
(15)	Current transformers	Transform generated current to range of ammeter. Ammeter is 5 amperes full range and has 600 amperes full range dial face.
(16)	Standby bus circuit breaker	Overload protection for the standby bus in Distribution Panel LCDA.
(18)	Fuse holder	Twenty-ampere fuses protect voltmeter phase-selector switch, in commercial power leads.
(19)	Normal bus circuit breaker	Overload protection for the normal bus in Distribution Panel LCDA.
(21)	Fuse holder	Twenty-ampere fuses protect ammeter phase-selector switch, in generator leads.

Figure 1-6. LCF Diesel Engine-Generator Operationg Controls and Indicators (Sheet 1 of 2)

FIGURE REFERENCE	MARKING OR NAME	FUNCTION
(22)	Water temperature gage	Indicates temperature of the engine coolant
(23)	Ammeter phase-selector switch	Selects phase of generator output to be metered for ammeter reading
(24)	Frequency meter	Displays visual indication of the generated output frequency

Figure 1-6. LCF Diesel Engine-Generator Operationg Controls and Indicators (Sheet 2 of 2)

1-25. LF POWER GENERATION AND DISTRIBUTION SYSTEM.

1-26. GENERAL DESCRIPTION.

1-27. The LF power generation and distribution system performs two major functions: (1) distributes a-c power supplied by a commercial source to the electrical equipment within the LF, and (2) generates and distributes standby power in the event of a commercial power failure. The major power generation and distribution system components are listed in figure 1-7. Component locations are shown in figure 1-8. Under normal conditions, all electrical equipment at the LF uses commercial power. Standby power is provided by a diesel engine-generator set in the support building that operates automatically when a commercial power failure occurs. When neither commercial nor standby power is available, a battery set within the launcher is used as an emergency power supply (see figure 1-9). Hence, the launcher is never without a source of power. Refer to T.O. 21-SM80A-2-11, "Aero-Space Ground Equipment Power and Miscellaneous Systems", for information on the launcher emergency power supply.

1-28. Each distribution, power and lighting panel at the LF has a letter designation signifying the function of the panel, as follows:

PANEL DESIGNATION	FUNCTION
LDA	Launch Support Building Distribution Panel - Standby and Normal Bus
LA	Launch Support Building Lighting Panel
LDB/LWS	Launcher Distribution Panel

1-29. DESCRIPTION OF SYSTEM FUNCTIONS.

1-30. Under normal conditions the system uses commercial power. Refer to the block diagram of the power distribution system, figure 1-9, and the line diagram, figure 4-9. If a commercial power failure occurs, the automatic switching unit will sense the condition and initiate standby diesel engine startup. Once the standby generator is developing rated voltage and frequency, the automatic switching unit will automatically transfer the load to the standby power system. The normal bus of panel LDA is dead during standby operation. When commercial power is restored, the automatic switching unit will automatically retransfer the load to commercial power and shut down the standby diesel. The standby system is also automatically exercised (under load) once every two weeks for a period of two hours.

1-31. A shock contactor is located in the line supplying power to the Launcher. The shock contactor is a normally closed switch-like device located in the Launcher (lower-level). The contactor opens under severe shock conditions, cutting off all power supplied to the Launcher. It can also be operated manually by means of push-buttons on the contactor itself. When neither commercial nor standby power is

available at the required voltage and frequency, a battery set within the Launcher supplies emergency power. A solenoid in the launcher motor-generator set senses the voltage and frequency of the incoming power (commercial or standby) and automatically switches to the emergency battery set when necessary. The batteries supply power to a motor-generator set consisting of an a-c motor, d-c motor, and 400 cps generator. Refer to T.O. 21-SM80A-2-11, "Aero-Space Ground Equipment Power and Miscellaneous Systems", for detailed information on the launcher electrical system. When neither commercial nor standby power is available to the Launcher, a channel of the VRSA system will indicate the condition when interrogated. There is no way of determing the cause of standby power failure without entering the support building itself and checking the alarm lights on the generator set control switchboard.

1-32. Filters are located at various points in the power distribution system to prevent stray radio-frequency interference with the electronic gear in the Launcher. A grounded steel liner completely envelops the first and second levels of the Launcher and another steel liner surrounds the missile silo itself, forming an electromagnetic shield for the launcher equipment.

1-33. There are three types of grounds in the system: Equipment ground, instrument ground, and neutral bus ground. The equipment ground is connected to the non-current carrying parts of electrical equipment such as motor enclosures, circuit breaker panels, and conduits. The instrument ground is connected to electronic equipment. The neutral conductors in the power distribution system are insulated and grounded via the neutral bus of panel LDA to prevent an unbalance in the load from affecting the electrical phase relationships in the power supply. The several grounding circuits all meet at a steel-rod counterpoise, located just inside the security fence. An array of steel ground rods is brazed to the counterpoise and directed vertically downward to form the final conductor earth contact.

1-34. LF STANDBY POWER GENERATION SYSTEM.

1-35. The standby diesel engine-generator set delivers up to 60 kw of 120/208-volt, 3-phase, 60 cps power to loads in the support building and Launcher. The diesel engine is a six-cylinder, four-cycle, liquid-cooled unit using lead-acid storage batteries for starting power. Diesel fuel is obtained from a day tank located in the support building which, in turn, is fed from an underground storage tank outside the building. Control circuitry for the diesel engine-generator is contained in the generator set control switchboard, (part of the diesel-generator skid), and the automatic switching unit. The operation and maintenance of the diesel engine-generator and its control circuitry are explained fully in the following publications:

T.O. 35C2-3-288-1, "Generator Set, Diesel Engine, Model PU-361/FPS and Switching Unit, Power Transfer, Model C-1931/FPS", Operation and Maintenance Instructions

T.O. 35C2-3-288-3, Overhaul Instructions

T.O. 35C2-3-288-4, Illustrated Parts Breakdown

T.O. 35C2-3-288-3-1, Supplemental Handbook for the Minuteman Installations

T.O. 35C2-3-288-4-1, Supplemental Handbook for the Minuteman Installations

COMPONENT	SEQ. NO.	LOCATION	FIGURE REF.	IDENTIFICATION AND MANUFACTURER	DESCRIPTION
Distribution Panel LDA	1205-01 05B-1	Support Bldg.	1-8	Type CDPR Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 300 amp trip, 400 amp frame
Lighting Panel LA	1206-02 05B-1	Support Bldg.	1-8	Type NAIB Federal Pacific Elect.	120/208-volt, 2-phase, 4-wire, 50 amp trip, 100 amp frame
Shock Contactor	1205-03 05B-18	Launcher, Level 2	1-8	Cutler-Hammer Bul. 6956FD76	200 amp, 4-pole
RFI Filter	1205-07 05B-8	Launcher, Level 2	1-8	Cat. No. CDF-1001 Cornell-Dubilier	200 amp, 250-volt, radio frequency interference filter
Lighting Panel LDS/LWS	1206-01 05C-1	Launcher, Level 2	1-8	Type NAIB Federal Pacific Elect.	120/208-volt, 3-phase, 4-wire, 150 amp trip, 225 amp frame

Figure 1-7. LF Power Generation and Distribution System Components

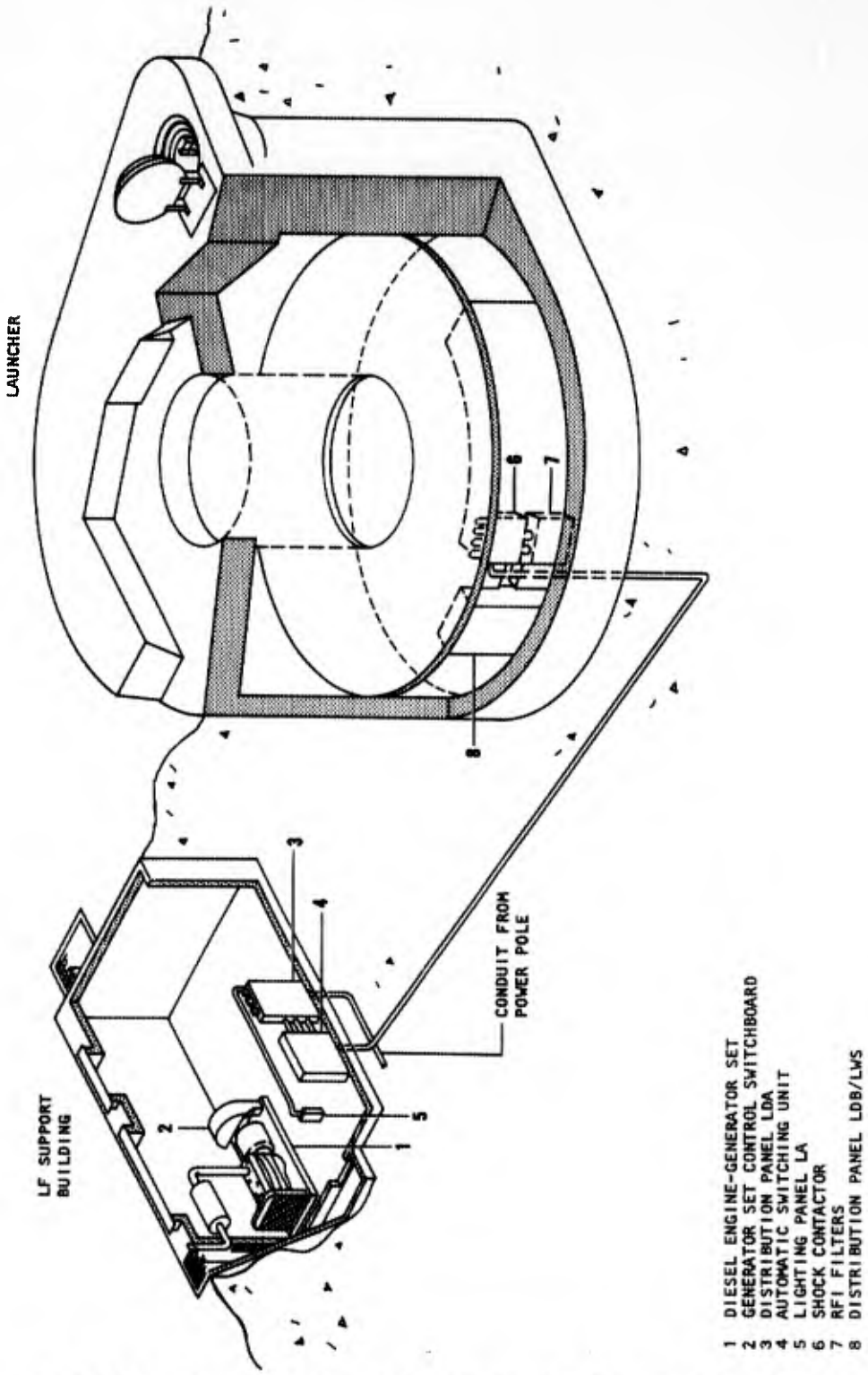


Figure 1-8. LF Power Generation and Distribution System Component Locations

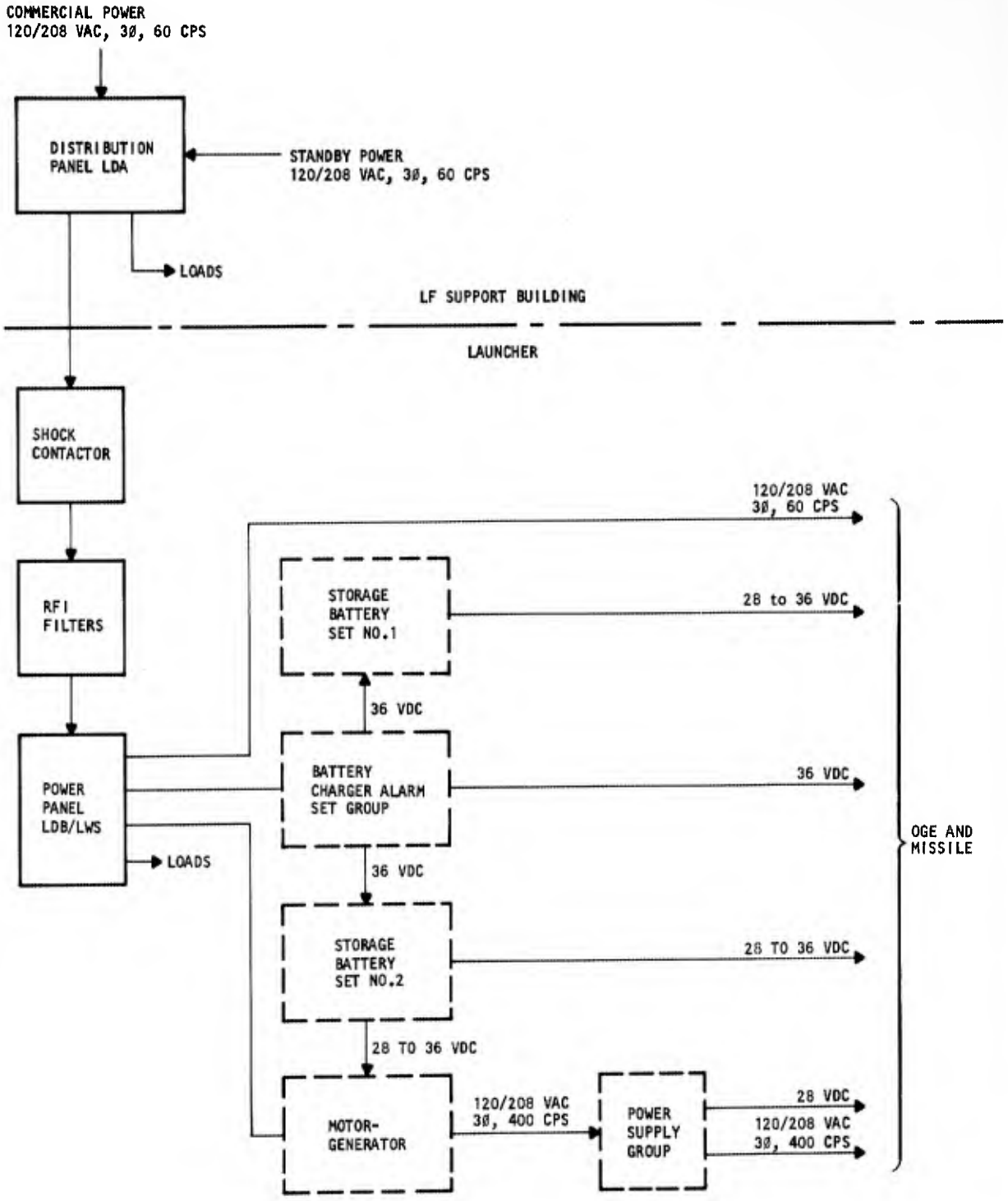


Figure 1-9. LF Power Generation and Distribution System Block Diagram

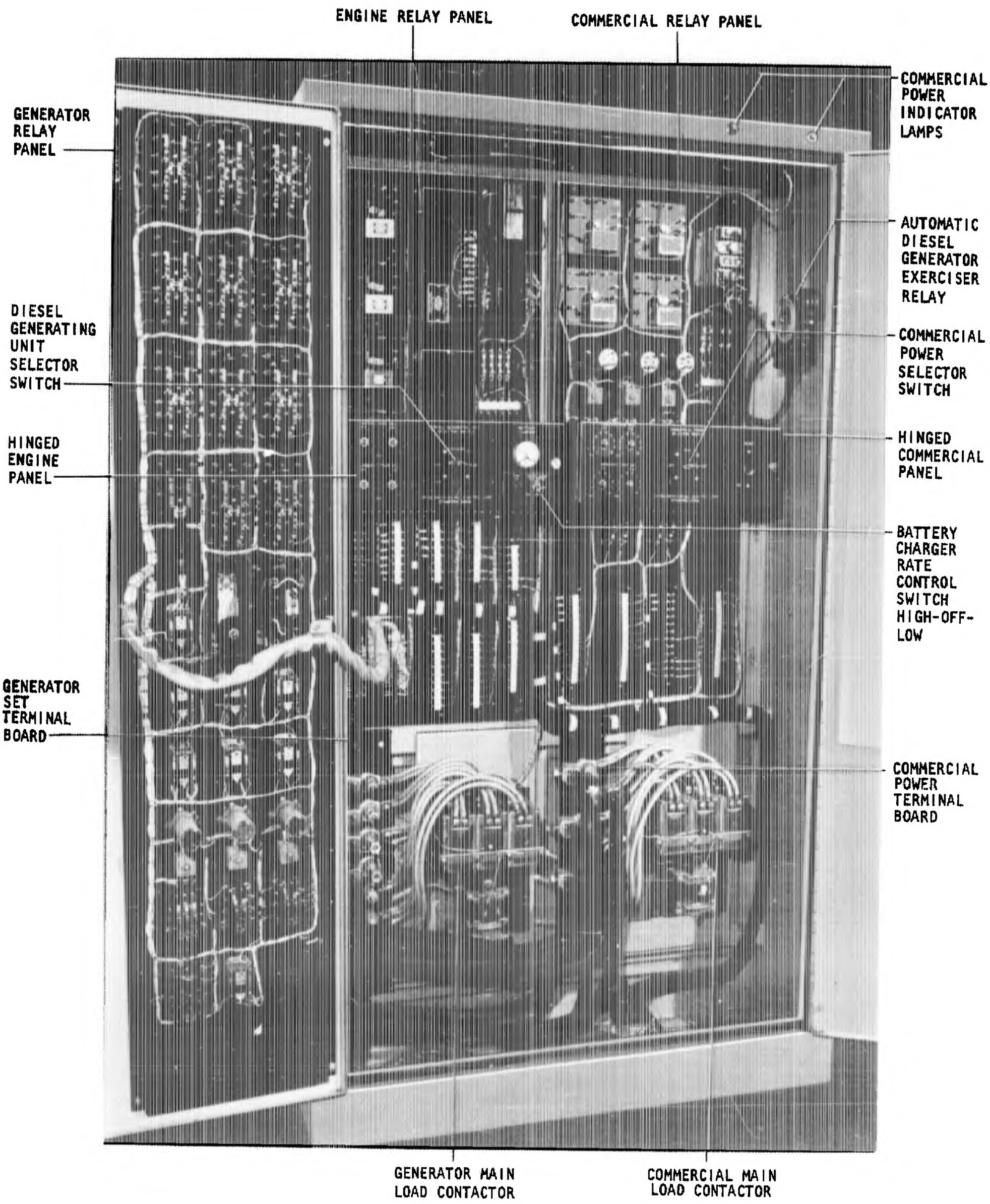


Figure 1-10. LF Automatic Switching Unit

NOMENCLATURE	FEDERAL STOCK NUMBER OR PART NUMBER	USE
Multimeter	AN/PSM-6 [2]	To perform continuity, resistance and voltage checks
AC Voltmeter	Model 904 [3]	To perform voltage checkout
AC Ammeter	Model 370 [3]	To perform current checkout
Ohmmeter (Megger)	Model 7679 [6]	To check insulation resistance of generator windings
Phase Sequence Indicator	Model 40 [4]	To perform phase sequence rotation checkout of diesel engine-generator
Frequency Meter	Model 339USM [3]	For comparison check with diesel engine-generator frequency meter
Electric Lantern	FSN 6230-672-2541 [5]	To perform procedures when power must be off
Anti-freeze Hydrometer		To check specific gravity of diesel engine coolant
Battery Hydrometer	FSN 6630-526-9242 [5]	To check specific gravity of diesel battery acid
Demineralized Water Container	25-27425 [1]	To store and add water to batteries
Hydraulic Jack		To lift diesel engine-generator

[1] The Boeing Company
[2] Bruno-New York Industries Corporation
[3] Weston Instrument Company
[4] Associated Research Corporation
[5] Federal Stock Number
[6] James G. Biddle Co.

Figure 1-11. LCF and LF Power Generation and Distribution System Tools and Test Equipment

SECTION II

OPERATION

2-1. LCF POWER GENERATION SYSTEM.

2-2 Operation procedures for the LCF power generation system consist of initial prepration, startup, shutdown and emergency shutdown procedures. The initial preparation procedures are used after the diesel engine-generator set has been shut down for maintenance or an extended period.

2-3. DIESEL ENGINE-GENERATOR PRESTART CHECK. (See figure 2-1.)

2-4. DIESEL ENGINE-GENERATOR STARTUP. (See figure 2-2.)

2-5. DIESEL ENGINE-GENERATOR SHUTDOWN. (See figure 2-3.)

2-6. DIESEL ENGINE-GENERATOR EMERGENCY SHUTDOWN. (See figure 2-4.)

STEP	PROCEDURE	NORMAL INDICATION
a.	Check and clear reason for any warning tags on diesel engine or control panel and remove tags.	None.
b.	Check that keys No. 1 and 2 are installed in main circuit breakers of distribution panel LCDA. (See figure 1-4.)	None.
c.	Check required points of lubrication as outlined in Power Generation and Distribution Equipment Manual.	None.
d.	Remove all tools, rags, and loose equipment from diesel engine-generator skid.	None.

Figure 2-1. LCF Diesel Engine-Generator Pre-start Check

STEP	PROCEDURE	NORMAL INDICATION
a.	Perform pre-start checkout listed in figure 2-1 when diesel engine-generator has been shut down for maintenance or service for an extended period of time.	None.
b.	If diesel engine-generator has been shut down for maintenance or service for an extended period of time. Remove sediment collected in fuel strainer by draining 1/4 pint of fuel oil from engine fuel strainer. Turn fitting at bottom of strainer counterclockwise to open. NOTE Engine must be stopped a minimum of five minutes before checking oil level to permit oil in various parts of the engine to drain back into the crankcase.	None.
c.	Check engine crankcase oil level with oil level dipstick and add MIL-L-2104A lubricating oil as required.	Oil level on dipstick shall read between the full and low marks.
d.	Place air door reset lever in vertical position (figure 3-11).	Air door is open when reset lever is in vertical position.
e.	Check that immersion heater is operating.	Generator control panel WATER TEMPERATURE gage (figure 1-5) will indicate 120 (+20/-5)°F and cooling system components will feel warm.
f.	Check coolant level and add makeup coolant as necessary.	Coolant level is within 2 or 3 inches from top of radiator reservoir.
g.	Place VOLTAGE REGULATOR SWITCH (8, figure 1-5) in MANUAL position.	None.
h	Place VOLTAGE REGULATOR RHEOSTAT (7) in middle of range on plaque.	None.
i.	Place EXCITER FIELD RHEOSTAT (5) in extreme counterclockwise position.	None.
j.	Place THROTTLE (12) in RUN position. CAUTION Generator must not be loaded before it is adjusted for voltage and frequency.	None.

Figure 2-2. LCF Diesel Engine-Generator Startup (Sheet 1 of 3)

STEP	PROCEDURE	NORMAL INDICATION
	CAUTION If diesel engine-generator starts, but fails to come up to speed, depress EMERGENCY STOP RESET pushbutton. Refer to trouble analysis table in Power Generator and Distribution Equipment Manual.	
l.	Press START pushbutton on engine cranking panel (6, figure 1-2).	Diesel engine will start. If engine fails to start after four 10-second cranking cycles OVER-CRANK light (6, figure 1-5) on generator control panel will light. Refer to figure 4-8 and figure 3-6.
m.	Check the following engine failure lights (6, figure 1-5).	
	LOW FUEL DAY TANK	Indicating light will be off. If illuminated, day tank servicing required.
	LOW FUEL MAIN TANK	Indicating light will be off. If illuminated, main storage tank servicing required.
n.	If the engine stops after starting, check the following engine failure warning lights (6, figure 1-5). If any of the lights are illuminated, refer to figures 4-8 and 3-6.	None.
	OVERSPEED light	Engine locked out because speed exceeded 1975 (±25) rpm.
	LOW OIL PRESSURE light	Engine locked out because engine oil pressure was below 27 (±2) psig.
	HIGH WATER TEMPERATURE light	Engine locked out because water (coolant) temperature exceeded 205 (±5)°F.
	HIGH OIL TEMPERATURE light	Engine locked out because engine oil temperature exceeded 250 (±10)°F.
o.	Check WATER TEMPerature gage (22) after about 5 minutes of operation.	Gage should indicate between 160 to 185°F.
p.	Check OIL PRESSURE gage (13).	Gage should indicate at least 30 psi.
q.	Check OIL TEMPerature gage (14).	Gage should indicate between 200 to 225°F.
r.	Check frequency meter (24) and adjust THROTTLE control vernier (11) if necessary.	Maximum vertical vibration of frequency meter 60-CYCLE reed.
s.	Place VOLTMETER phase-selector switch (2) in L2L1 GEN position and adjust FIELD EXCITER RHEOSTAT (5) as required to obtain correct voltage indication.	Voltmeter (1) indicates 208 (±2) volts.
t.	Place VOLTMETER phase-selector switch (2) in L2L3 GEN position and then in L1L3 GEN position.	Voltmeter (1) indicates 208 (±2) volts.

Figure 2-2. LCF Diesel Engine-Generator Startup (Sheet 2 of 3)

STEP	PROCEDURE	NORMAL INDICATION
u.	Place VOLTAGE REGULATOR SWITCH (8) in AUTO position.	None.
v.	Place VOLTMETER phase-selector switch (2) in L2L1 GEN position and adjust VOLTAGE REGULATOR RHEOSTAT (7) as required to obtain correct voltage indication.	Voltmeter (1) indicates 208 (±2) volts.
w.	Place VOLTMETER phase-selector switch (2) in L2L3 GEN position and then in L1L3 GEN position.	Voltmeter indicates 208 (±2) volts.
x.	Place AMMETER phase-selector switch (23) in 1, 2 and 3 positions.	Zero indication on ammeter (3) in each position.
y.	Check RUNNING TIME meter (4).	Totals number of hours engine has operated.
	NOTE To transfer power from the commercial power supply to the standby power supply system use the following steps.	
z.	Trip all branch circuit breakers in the normal and standby sections of distribution panel LCDA (figure 1-4).	All lights and electrical equipment in the Support Building are off.
	NOTE The critical loads in the LCC are now being supplied by the LCC power supply system (figure 1-3) while the commercial and standby power supply systems are inoperative.	
aa.	Trip main circuit breakers in normal and standby sections of distribution panel LCDA (figure 1-4) and remove keys No. 1 and 2.	None.
ab.	Insert keys No. 1 and 2 in the normal bus circuit breaker (19, figure 1-5) and the standby bus circuit breaker (16) in the generator control panel and close circuit breakers.	Generator is connected to buses in panel LCDA.
ac.	Close branch circuit breakers in the normal and standby sections of distribution panel LCDA. Observe ampere reading on ammeter (3).	All lights and electrical equipment in the LCF Support Building will return to normal.

Figure 2-2. LCF Diesel Engine-Generator Startup (Sheet 3 of 3)

STEP	PROCEDURE	NORMAL INDICATION
a.	Place VOLTMETER phase-selector switch (2) in the BUS position to indicate when commercial power supply system has returned to normal.	VOLTMETER (1) will indicate 208 VOLTS in all three positions of the VOLTMETER phase-selector switch.
b.	Trip all branch circuit breakers in the normal and standby sections of distribution panel LCDA. NOTE The critical loads in the LCC are now being supplied by the launch control power supply system (figure 1-3) while the commercial and standby power supply systems are inoperative.	All lights and electrical equipment in the LCF Support Building are off.
c.	Trip the normal bus circuit breaker (19, figure 1-5) and the standby bus circuit breaker (16) in the generator control panel and remove keys No. 1 and 2.	None.
d.	Insert keys No. 1 and 2 in the main circuit breakers in the normal and standby section of distribution panel LCDA, (figure 1-4) and close circuit breakers.	None.
e.	Close branch circuit breakers in the normal and standby section of distribution panel LCDA one at a time.	All lights and electrical equipment in the LCF Support Building will return to normal operation.
f.	Press STOP pushbutton on engine cranking panel, (figure 1-2).	Engine will stop.
g.	Check ammeter and white indicating light on the battery charging panel (figure 3-13) to determine if starting batteries are being charged. NOTE To perform an emergency shutdown when the diesel engine-generator is supplying the load to the LCF, perform the procedure in figure 2-4.	Ammeter will indicate charging rate and indicating light will be illuminated. If the battery charger fails to operate refer to figure 3-8.

Figure 2-3. LCF Diesel Engine-Generator Shutdown

STEP	PROCEDURE	NORMAL INDICATION
a.	Trip the normal bus circuit breaker (19, figure 1-5) and the standby bus circuit breaker (16) in the generator control panel. NOTE The critical loads in the LCC are now being supplied by the launch control power supply system, (figure 1-3).	All lights and electrical equipment in the LCF Support Building are off.
b.	Press the EMERGENCY STOP RESET push-button (10, figure 1-5), on the generator control panel. NOTE If the emergency shutdown is of the type that will not prevent operating on commercial power, if available, follow the procedure outlined in steps a. to e. in figure 2-3.	Engine will stop.

Figure 2-4. LCF Diesel Engine-Generator Emergency Shutdown

2-7. LF POWER GENERATION SYSTEM.

2-8. Operation procedures for the LF power generation system consist of normal preparation, startup, and automatic operation procedures. The normal preparation procedures are used to prepare the diesel engine-generator set (1, figure 1-8) for manual startup. Startup procedures are used to prepare the set for automatic operation.

CAUTION

Operating instructions for the diesel engine-generator set in this manual are to be used instead of operating procedures in Generator Set, Diesel Engine, Model PU-261/FPS and Switching Unit, Power Transfer, Model C-1939/FPS, T.O. 35C2-288-1, because the T.O. was written for parallel operation of two sets and is not applicable to this installation.

If the normal indications cannot be obtained refer to trouble analysis charts.

2-9. DIESEL ENGINE-GENERATOR PRESTART CHECK AND NORMAL PREPARATION. (See figure 2-5.)

2-10. DIESEL ENGINE-GENERATOR STARTUP AND AUTOMATIC OPERATION. (See figure 2-6.)

STEP	PROCEDURE	NORMAL INDICATION
a.	Turn DIESEL GENERATING UNIT SELECTOR switch in automatic switching unit (figure 1-8 and 1-10), to OFF position.	None.
b.	Check and clear reason for any warning tags on diesel engine or control panel and remove tags.	None.
c.	Remove all tools, rags and loose equipment from diesel engine-generator skid.	None.
d.	Check required points of lubrication as outlined in Generator Set, Diesel Engine, Model PU-361/FPS and Switching Unit, Power Transfer, Model C-1931/FPS, T.O. 35C2-3-288-1.	None.
e.	Check diesel engine crankcase oil level. Add MIL-L-2104A lubricating oil as required. Refer to T.O. listed in step c. for viscosity of oil required.	Oil level on dipstick shall read between the full and low marks.
f.	Check that immersion heater is operating.	Engine control panel WATER TEMPERATURE gage will indicate 120 (+15/-10)°F and engine cooling components will feel warm.
g.	Check coolant level and add makeup coolant as necessary.	Coolant level within 2 or 3 inches from top of radiator reservoir.
h.	If diesel engine-generator has been shut down for maintenance or service for an extended period of time, drain about 1/4 pint of fuel oil from primary fuel oil filter located on left side of engine to remove sediment from filter. A drain fitting is provided at bottom of filter.	None.
i.	Place CROSS CURRENT COMPENSATION SWITCH and SYNCHRONIZING SWITCH on generator control panel in OFF positions. These switches are to remain in the OFF position at all times.	None.
j.	Place VOLTAGE REGULATOR switch in OFF position.	None.
k.	Turn EXCITER FIELD RHEOSTAT control knob to extreme counterclockwise position (only if maintenance has been performed.) NOTE The THROTTLE CONTROL knob is equipped with a locking device to prevent it from shifting position during operation. Unlock this device before making any adjustment of throttle setting. Turn knob counterclockwise to increase speed of the engine and clockwise to decrease the speed.	None.
l.	Place THROTTLE CONTROL knob at midpoint of its travel (only if maintenance has been performed).	None.

Figure 2-5. LF Diesel Engine-Generator Prestart Check and Normal Preparation

STEP	PROCEDURE	NORMAL INDICATION
a.	Perform normal preparation procedures listed in figure 2-5.	None.
b.	Check that the BATTERY CHARGER RATE CONTROL toggle switch is in LOW position (located on engine panel in automatic switching unit).	Battery charger ammeter indicated between 0.2 and 0.3 amps.
c.	Press ENGINE CONTROL STOP pushbutton, MEMORY LAMP RESET pushbutton, and ENGINE CONTROL START pushbutton (2, figure 1-8) in that order.	None.
d.	Check that COMMERCIAL POWER SELECTOR SWITCH is in the RUN position.	None.
e.	Place CIRCUIT BREAKER control panel in the OFF position.	None.
	NOTE Steps g. and h. must be accomplished within two minutes of starting the diesel engine-generator (step f.). If not, the diesel engine-generator will stop due to an overcrank condition. If diesel engine-generator stops, press MEMORY RESET pushbutton and the diesel engine-generator will restart.	
f.	Turn DIESEL GENERATING UNIT SELECTOR SWITCH in automatic switching unit (figure 1-10) clockwise to RUN position.	Engine starts but will not pick up the load with both selector switches in the RUN position.
g.	Adjust speed of engine with THROTTLE CONTROL knob (if required).	Frequency meter indication of 61 cps.
h.	Adjust EXCITER FIELD RHEOSTAT CONTROL knob (if required).	Voltmeter indication of 210 volts.
i.	Place CIRCUIT BREAKER control in the ON position.	None.
j.	Place VOLTAGE REGULATOR toggle switch in ON position. (Adjustment of voltage regulator rheostat control knob for 210 volts may be required.)	FREQUENCY meter indication of 61 cps, and voltmeter indication of 210 volts.
k.	Turn DIESEL GENERATING UNIT SELECTOR SWITCH counterclockwise to STANDBY position.	Diesel engine stops.
	NOTE Doors of automatic switching unit must be kept closed at all times when not performing operations inside unit due to extreme air flow and dust conditions during running of diesel engine.	

Figure 2-6. LF Diesel Engine-Generator Startup and Automatic Operation (Sheet 1 of 2)

STEP	PROCEDURE	NORMAL INDICATION
l.	Trip AUTO TRANS SW circuit breaker in panel LDA.	Generator starts and assumes the load in approximately 6 seconds and ammeter will indicate load.
m.	Close AUTO TRANS SW circuit breaker in panel LDA.	The diesel engine is shut down and the load transferred automatically to commercial power after a period of 30 minutes to 2 hours (depending upon setting of timer relay K43).

Figure 2-6. LF Diesel Engine-Generator Startup and Automatic Operation (Sheet 2 of 2)

SECTION III

MAINTENANCE

3-1. LCF POWER GENERATION AND DISTRIBUTION SYSTEM.

3-2. CHECKOUT. (See figures 3-1 through 3-4.) The diesel engine-generator is checked out by running the unit through a complete start-to stop cycle as instructed in section II.

3-3. TROUBLE ANALYSIS. (See figures 3-5 through 3-8.) Use the Power Generation and Distribution Equipment Manual to perform trouble analysis on the standby diesel engine and generator.

3-4. SERVICING. Refer to the Power Generation and Distribution system Equipment Manual and to AFM-17, "Maintenance and Operation of Electric Plants and Systems", or to AFM 18-19, "Maintenance and Operation of Electric Power Generating Plants".

3-5. COMPONENT REPLACEMENT. (See paragraphs 3-6 through 3-20.)

STEP	PROCEDURE	NORMAL INDICATION
a.	Trip and close POWER-ON circuit breaker (10, figure 1-2).	Buzzer in COMMERCIAL POWER SUPERVISORY PANEL (figure 3-9) sounds.
b.	Press BUZZER RESET pushbutton on front of COMMERCIAL POWER SUPERVISORY PANEL.	Buzzer is silenced.
c.	Perform trouble analysis (figure 3-5) if buzzer does not sound on completion of step a., or is not silenced on completion of step b.	

Figure 3-1. LCF Commercial Power Supervisory Panel Checkout

STEP	PROCEDURE	NORMAL INDICATION
a.	Remove top cover from diesel engine-generator instrument panel (figure 1-5).	None.
b.	Connect Weston Model 904 or equivalent voltmeter across instrument panel voltmeter terminals.	None.
c.	Connect 5 amp. AC ammeter in series with instrument panel ammeter.	None.
d.	Connect Weston Model 399 USM2 or equivalent frequency meter across instrument panel frequency meter terminals.	None.
e.	Perform procedures stated in operation tables in Section II to start up and place diesel engine-generator set on the line.	None.
f.	Place AMMETER phase-selector switch (23) in 1 position. NOTE The ammeter should have a minimum of a 100 amp load when performing this check out.	
g.	Read instrument panel and test ammeters.	Reading on test meter should be multiplied by 120 and the result should be within (+10) amperes of the reading on the instrument panel ammeter.
h.	Place VOLTMETER phase-selector switch (2) in L2L1 GEN position.	
i.	Read instrument panel and test voltmeters.	Test voltmeter should be indicating within (±2) volts of instrument panel voltmeter.
j.	Read instrument panel and test frequency meters.	Test frequency meter should be indicating within 1/2 cycle of instrument panel frequency meter.

Figure 3-2. LCF Diesel Engine-Generator Control Panel Checkout (Sheet 1 of 2)

STEP	PROCEDURE	NORMAL INDICATION
k.	Place AMMETER phase-selector switch in 2, 3 and OFF positions.	Instrument panel ammeter reading in the 2 and 3 positions and zero indication in the OFF position.
l.	Place VOLTMETER phase-selector switch in L2L3 BUS, L1L3 BUS, and OFF positions.	Instrument panel voltmeter indication of approximately 208 volts in the L2L3 BUS and L1L3 BUS positions and zero volts indication in OFF positions.
m.	Check WATER TEMPERATURE gage (22).	Gage reads 180 (+5/-20)° F.
n.	Check OIL TEMPERATURE gage (14).	Gage reads 200 (+35/-20)° F.
o.	Check OIL PRESSURE gage (13).	Gage reads 50 (+10/-5) psig.
p.	Perform procedures stated in operation tables in Section II to take set off the line and shut down diesel engine.	
q.	Remove test meter leads and replace top cover on instrument panel.	None

Figure 3-2. LCF Diesel Engine-Generator Control Panel Checkout (Sheet 2 of 2)

STEP	PROCEDURE	NORMAL INDICATION
a.	Disconnect wire from starting motor contactor coil.	None
b.	Press START pushbutton on engine cranking panel (6, figure 1-2).	There should be four approximately 10-second, cranking cycles as observed on timing cam in engine cranking panel. At end of fourth cranking cycle timing cam returns to starting position automatically. (See figure 3-10.) After completion of the cranking cycles the OVERCRANK light on the engine failure light panel (6, figure 1-5) will illuminate.
c.	Connect wire on starting motor contactor coil.	None.
d.	Depress EMERGENCY STOP RESET push button.	OVERCRANK light extinguishes.

Figure 3-3. LCF Engine Cranking Panel Checkout

STEP	PROCEDURE	NORMAL
a.	Observe battery charger (figure 3-13) charging indicator light and ammeter after diesel engine has been operated.	Charging indicator light illuminated and ammeter indicating. NOTE If indications are not observed see trouble analysis (figure 3-8).

Figure 3-4. LCF Battery Charger Checkout

TROUBLE	PROBABLE CAUSE	REMEDY
When testing the COMMERCIAL POWER SUPERVISORY PANEL by operating the POWER-ON circuit breaker the alarm buzzer fails to silence when RESET pushbutton is pressed.	Defective relay R1	Replace relay.
	Defective RESET pushbutton	Replace pushbutton.
When testing the commercial power supervisory panel by operating the POWER-ON circuit breaker, the alarm buzzer fails to sound.	Defective alarm buzzer	Replace alarm buzzer.
	Open circuit in wiring to alarm buzzer	Check wiring to alarm buzzer and repair.
	Open contact R1b to alarm buzzer	Replace relay R1.
	Defective POWER-ON circuit breaker	Replace power-on circuit breaker.

Figure 3-5. LCF Commercial Power Supervisory Panel Trouble Analysis

TROUBLE	PROBABLE CAUSE	REMEDY
Diesel engine fails to crank-over when START pushbutton in engine cranking panel is pressed and all indicating lights are normal.	No or low voltage from starting batteries	Check wiring to batteries engine cranking panel, and generator control panel and repair. Refer to figure 3-8, battery charger trouble analysis.
	Defective EMERGENCY STOP RESET pushbutton switch in generator control panel	Replace pushbutton switch.
	Defective STOP pushbutton switch in engine cranking panel	
	Defective START pushbutton switch in engine cranking panel	Replace pushbutton switch.
	Defective interval timer in engine cranking panel	Replace interval timer.
	Defective relay 7CW	Replace relay.
	Defective diesel engine starting motor	Replace starting motor. Refer to Power Generation and Distribution Equipment Manual.
Diesel engine fails to start when START pushbutton in engine cranking panel has been pressed and diesel engine has completed four 10-second cranking cycles.	Mechanical failure of diesel engine	Refer to Equipment Manual.
Diesel engine starts but engine cranking panel does not cut out when diesel engine speed reaches 600 rpm.	Defective crank cut-off switch (part of overspeed governor)	Replace crank cutoff switch. Refer to Equipment Manual.
	Defective relay 3CW	Replace relay.
	Defective relay 2CW	Replace relay.
Diesel engine fails to stop when any of the following safety devices operate.		
Overspeed 1975 (±25) rpm	Defective overspeed switch (part of overspeed governor)	Replace overspeed switch. Refer to Equipment Manual.
	Defective overspeed relay OS	Replace relay.
Low lube oil pressure	Defective low lubricating oil pressure switch	Replace switch. Refer to Equipment Manual.
	Defective time delay relay TDO	Replace relay.
	Defective oil pressure failure relay O	Replace relay.
High jacket water temperature (above 205 (±3)°F.)	Defective water temperature switch	Replace switch. Refer to Equipment Manual.
	Defective water temperature relay W	Replace relay.

Figure 3-6. LCF Diesel Engine Starting and Control Circuit Trouble Analysis (Sheet 1 of 2)

TROUBLE	PROBABLE CAUSE	REMEDY
High lubricating oil temperature (above 260°F).	Defective high lubricating oil temperature switch	Replace switch. Refer to Equipment Manual.
	Defective high oil temperature relay OT	Replace relay.
Diesel engine fails to stop when EMERGENCY STOP pushbutton on generator control panel is pressed.	Defective EMERGENCY STOP switch	Replace switch.
Diesel engine fails to stop when STOP pushbutton on engine cranking panel is pressed.	Defective STOP switch	Replace switch.

Figure 3-6. LCF Diesel Engine Starting and Control Circuit Trouble Analysis (Sheet 2 of 2)

TROUBLE	PROBABLE CAUSE	REMEDY
When LCF is being supplied from the commercial power supply, with the VOLTMETER phase-selector switch in the BUS position, the voltmeter indicates low or no voltage in any of the three positions.	Fault on commercial power supply	Transfer LCF to the stand-by power supply. Notify local commercial power company.
	Defective voltmeter; refer to Section II, operational checkout of this manual.	
	Defective voltmeter phase selector switch	Replace switch.
	Blown fuse in voltmeter circuit	Replace fuse.
When diesel engine is running, with the VOLTMETER phase-selector switch in the GEN position, the voltmeter indicates low or no voltage in any of the three positions.	Setting on EXCITER FIELD RHEOSTAT too low	Adjust EXCITER FIELD RHEOSTAT.
	Setting on VOLTAGE REGULATOR RHEOSTAT too low	Adjust VOLTAGE FIELD RHEOSTAT
	Blown fuse in voltmeter circuit	Replace fuse.
	Defective EXCITER FIELD RHEOSTAT	Replace EXCITER FIELD RHEOSTAT.
	Defective VOLTAGE REGULATOR RHEOSTAT	Replace VOLTAGE REGULATOR RHEOSTAT.
	Open circuit in wiring from generator or to voltmeter	
	Defective voltmeter	Replace voltmeter.
	Defective VOLTMETER phase-selector switch	Replace switch.
When diesel engine is running, frequency meter indicates low frequency (below 60 cycles).	Diesel engine speed too low	Adjust engine throttle.
		Faulty operation of diesel engine; refer to Power Generation and Distribution Equipment Manual.

Figure 3-7. LCF Generator Control Panel Trouble Analysis (Sheet 1 of 2)

TROUBLE	PROBABLE CAUSE	REMEDY
	Defective frequency meter; refer to Section II, operational checkout, of this manual.	Replace frequency meter.
When diesel engine is running, frequency meter indicates high frequency (above 60 cycles).	Diesel engine speed too high	Adjust engine throttle.
	Faulty operation of diesel engine	Refer to Equipment Manual.
	Defective frequency meter	Replace frequency meter.
When diesel engine is running and supplying power to the LCF, voltage indication on voltmeter is not constant.	VOLTAGE REGULATOR witch in MANUAL position	Turn VOLTAGE REGULATOR switch to AUTO position.
	Defective voltage regulator	Replace voltage regulator.
	Defective VOLTAGE REGULATOR switch	Replace VOLTAGE REGULATOR switch.
When diesel engine is running, RUNNING TIME meter fails to indicate.	Defective RUNNING TIME meter	Replace RUNNING TIME meter.
When diesel engine is shut down, WATER TEMPERATURE gage indicates zero degrees.	Circuit breaker to immersion heaters open.	Close circuit breaker.
	Defective immersion heater	Replace immersion heater.
	Defective WATER TEMPERATURE gage	Replace WATER TEMPERATURE gage.
When diesel engine is running, WATER TEMPERATURE gage indicates high water temperature; high water temperature warning light indicates normal conditions.	Defective WATER TEMPERATURE gage	Replace WATER TEMPERATURE gage.
When diesel engine is running, OIL TEMPERATURE gage indicates high lubricating oil temperature; high oil temperature warning light indicates normal conditions.	Defective OIL TEMPERATURE gage	Replace OIL TEMPERATURE gage.
When diesel engine is running, OIL PRESSURE gage indicates low lubricating oil pressure; LOW OIL PRESSURE light indicates normal conditions.	Defective OIL PRESSURE gage	Replace OIL PRESSURE gage.

Figure 3-7. LCF Generator Control Panel Trouble Analysis (Sheet 2 of 2)

TROUBLE	PROBABLE CAUSE	REMEDY
Battery charger fails to operate when diesel engine starting batteries are not at full charge.	Circuit breaker in panel LCB open	Close circuit breaker.
	ON-OFF switch in battery charging panel in OFF position	Turn switch to ON position.
	Open circuit in wiring to battery charger or to diesel engine starting batteries	Check wiring and repair.
	Charging rate of diesel engine starting batteries too high	Check batteries for open or shorted cell; replace battery and press RESET pushbutton.
	Defective a-c timer TS1	Replace timer.
	Defective voltage sensitive relay K2	Replace relay.
	Defective relay K1	Replace relay.
	Defective relay K3	Replace relay.
	Defective transformer or silicon rectifier	Replace transformer and rectifier.
Diesel engine starting batteries overcharge.	Defective voltage sensitive relay K2	Replace relay and press RESET pushbutton.
Battery charger operates, white indicating light is on; ammeter shows no indication.	Defective ammeter	Replace ammeter.
Battery charger operates and ammeter indicates charging rate; white indicating light fails to light.	Defective indicating light	Replace indicating light.

Figure 3-8. LCF Battery Charger Trouble Analysis

3-6. DIESEL ENGINE ELECTRICAL COMPONENT REPLACEMENT. (See figure 3-11.)

3-7. SAFETY DEVICES.

a. Disconnect positive lead from starting battery to de-energize engine starting and control circuit.

b. Disconnect all mechanical linkage between safety device and diesel engine.

c. Disconnect and remove all wiring.

d. Remove safety device from engine.

e. Install in reverse order of removal.

3-8. STARTING MOTOR.

a. Disconnect positive lead from starting battery to de-energize engine starting and control circuit.

b. Disconnect and remove all wiring.

c. Remove three mounting bolts and lift starting motor straight away from flywheel housing.

d. Install in reverse order of removal.

3-9. STARTING MOTOR SOLENOID.

a. Disconnect positive lead from starting battery to de-energize engine starting and control circuit.

b. Disconnect and remove all wiring.

c. Remove four nuts from mounting studs.

d. Remove starting solenoid from engine.

e. Install in reverse order of removal.

3-10. ENGINE HEATER AND THERMOSTAT.

a. Open branch circuit breaker in distribution panel LCDA and physically lock out circuit breaker with cylinder lock in breaker handle and a padlock through the retractable locking ring.

b. Disconnect and remove all wiring from heater and thermostat assembly.

c. Unscrew heater and thermostat assembly from cast housing at water pump. Either heater or thermostat may be replaced as a separate unit.

d. Install in reverse order of removal.

3-11. GENERATOR CONTROL PANEL ELECTRICAL COMPONENT REPLACEMENT. (See figures 1-5 and 3-12.)

WARNING

All Electrical power to the generator panel must be interrupted when replacing electrical components in panel. When removing components on the generator control panel, one man must be stationed at the power company pole to prevent accidental closing of any of the fused cutouts until work has been completed.

a. Notify local commercial power company to have a lineman open the three fused cutouts on the power company pole feeding the primary of the power transformers.

NOTE

The critical loads of the LCC are now being supplied by the launch control power supply. Illumination for performing this work will be supplied by a portable hand lantern.

3-12. MAIN CIRCUIT BREAKERS.

a. Repeat steps outlined in paragraph 3-11.

b. Remove two bolts securing the key-interlocks to the panel.

c. Disconnect and remove power leads from the line and load side of the circuit breaker.

d. Remove four mounting bolts securing breaker to panel and remove circuit breaker.

e. Install in reverse order from removal.

3-13. VOLTMETER, AMMETER, FREQUENCY METER AND RUNNING TIME METER.

a. Repeat steps outlined in paragraph 3-11.

b. Disconnect and remove wiring in rear of meter.

c. Remove three mounting bolts from face of meter.

d. Remove meter from panel.

e. Install in reverse order from removal.

3-14. VOLTMETER AND AMMETER PHASE-SELECTOR SWITCHES.

a. Repeat steps outlined in paragraph 3-11.

b. Disconnect and remove wiring from switches.

c. Remove screw holding the switch knob to the switch.

d. Remove four mounting bolts from face of switch.

e. Remove switch from panel.

f. Install in reverse order of removal.

3-15. EXCITER FIELD RHEOSTAT AND VOLTAGE REGULATOR RHEOSTAT.

a. Repeat steps outlined in paragraph 3-11.

b. Disconnect and remove wiring from rheostat.

c. Remove operating knob from rheostat.

d. Remove two mounting bolts from face of rheostat.

e. Remove rheostat from panel.

f. Install in reverse order of removal.

3-16. ENGINE CRANKING PANEL REPLACEMENT.

a. Disconnect positive lead from starting battery to de-energize engine starting and control circuit.

b. Disconnect all wiring to component being replace. (See figure 3-10.)

c. Remove mounting screws securing component to panel.

d. Remove component from panel.

e. Install in reverse order of removal.

3-17. BATTERY CHARGER REPLACEMENT.

a. Open circuit breaker in lighting panel LCB.

b. Disconnect positive lead from battery to de-energize engine starting and control circuit.

c. Disconnect and remove all wiring from terminal boards. (See figure 3-13.)

d. Remove four mounting bolts holding entire interior panel in battery charger.

e. Individual components of the battery charger may be replaced. Refer to the Power Generation and Distribution Equipment Manual.

f. Install in reverse order of removal.

3-18. COMMERCIAL POWER SUPERVISORY PANEL REPLACEMENT.

a. Open POWER-ON circuit breaker in room 103.

b. Disconnect wiring to component being replaced. (See figure 3-9.)

c. Remove mounting bolts securing component to panel.

d. Remove component from panel.

e. Install in reverse order of removal.

3-19. DIESEL ENGINE-GENERATOR SET REMOVAL.

NOTE

Replacement diesel engine-generator must be available for installation to keep the time that the standby power system is inoperative to a minimum.

a. Open circuit breaker in lighting panel LCB supplying the battery charger.

b. Place battery charger switch in the OFF position.

c. Disconnect and remove cables from diesel engine starting batteries and remove batteries from rack.

d. Remove battery cables from starting motor and solenoid.

e. Close valve in fuel-in line on right hand side of engine. Disconnect coupling and remove tee, drain valve, and pipe from foundation.

f. Disconnect coupling in fuel-out line and remove elbow and pipe from foundation.

g. Cap diesel engine fuel-in and fuel-out lines on foundation.

h. Remove mounting nuts from studs at base of foundation.

i. Remove section of engine exhaust pipe between exhaust manifold and silencer.

j. Notify local commercial power company to have a lineman open the three fused cutouts on the power company pole feeding the primaries of the power transformers.

WARNING

When working on panel LCDA, one man must be stationed at the power company pole to prevent accidental closing of any of the fused cutouts until work has been completed and the front cover has been installed on panel LCDA.

NOTE

The critical loads in the Launch Control Center are now being supplied by the launch control center power supply. Illumination for performing this work will be supplied by a portable hand lantern.

k. Remove front cover from both sections of panel LCDA.

l. Remove bottom pan section from both sections of panel LCDA.

m. Disconnect the power feeders from the standby power system and from the phase and neutral bus bars in both sections of the panel, tape the cable lugs, and secure cables in bottom gutter of panel to prevent accidental contact with any of the live conductors in the panel.

n. Disconnect the voltmeter leads from the terminals of the main circuit breaker in the standby section of the panel, tape the ends of the voltmeter leads, and secure leads in the side gutter of the panel to prevent accidental contact with any of the live conductors in the panel.

o. Replace bottom pan section and front cover on both sections of panel LCDA.

p. Notify local commercial power company to close the fused cutouts on the power company pole and restore the Launch Control Facility to commercial power.

q. Disconnect ground wire from diesel engine foundation.

r. Remove covers from sheet metal pull box in front of generator control panel and junction box on wall of room 102.

s. Disconnect external wiring between the generator control panel and the junction box, and pull wires back into junction box.

t. Remove locknuts and bushing from conduits securing sheet metal pull box in front of diesel engine foundation, remove pull box, and cap conduits to prevent damage to threads or entrance of foreign material into conduits.

u. Disconnect wiring between generator control panel and gravity ventilator motor. Remove locknuts and bushing from conduit and remove conduit from top of control panel.

v. Disconnect wiring between generator control panel and fuel-oil day tank alarm switch, remove locknuts and bushing from conduit, and remove conduit from top of control panel.

w. Open branch circuit breaker in distribution panel LCDA feeding engine heaters and physically lock out circuit breaker with cylinder type lock in breaker handle and a padlock through the retractable locking ring.

x. Disconnect wires to engine heaters and secure flexible conduit to concrete base of engine to prevent physical damage to conduit and wire while removing diesel engine.

y. Seal all openings on diesel engine with a waterproof material.

z. Jack up diesel engine-generator with hydraulic jacks and place 2-inch, steel rollers under foundation.

aa. Shore path level with concrete base of engine to outside of building with timbers and remove diesel engine-generator set from building.

3-20. DIESEL ENGINE-GENERATOR SET INSTALLATION.

a. Move diesel engine-generator set over shoring and steel rollers into room 102 and position over mounting studs.

b. Jack up foundation with hydraulic jacks and remove steel rollers.

c. Replace nuts on mounting studs at base of foundation and tighten.

d. Remove seals from all engine openings.

e. Replace section of engine exhaust pipe between exhaust manifold and silencer

f. Replace all pipe and fittings for fuel-in and fuel-out lines and reconnect to diesel engine.

g. Close all fuel-oil drains on engine and open valve in fuel-in line.

h. Drain about 1/4 pint of fuel from valve on left side of engine to bleed air from line.

i. Check diesel engine crank case oil level.

NOTE

The rust preventive oil in diesel engine crankcase can be used for ten operating hours. Check records for previous operating time. If oil must be changed refer to the Power Generation and Distribution Equipment Manual.

j. Close cooling system drains in engine block and radiator.

k. Fill radiator with proper coolant until level is within 2 or 3 inches of top.

l. Adjust fan belt to the proper tension by adjusting the fan bracket. Refer to the Power Generation and Distribution Equipment Manual.

m. Install conduits in top of generator control panel between the gravity ventilator motor and the fuel-oil day tank alarm switch and connect wiring to terminal boards in panel.

n. Install conduit and connect wires to engine heater.

o. Remove caps from conduit in floor and install sheet metal pull box in front of generator control panel.

p. Pull all wire and power cables into conduits between junction box on wall and sheet metal pull box in front of generator control panel.

q. Reconnect all control wiring to terminal boards in generator control panel.

r. Perform all procedures for checking generator, before starting, as outlined in the Power Generation and Distribution Equipment Manual.

s. Check all wiring for proper connections as given in the Power Generation and Distribution Equipment Manual.

t. Replace diesel engine starting batteries in battery rack and reconnect cables to batteries, starting motor, and solenoid.

u. Check and replenish water to electrolyte in batteries.

v. Replace ground wire on diesel engine foundation.

w. Perform resistance check of ground wire using a multimeter. The resistance from the diesel engine foundation and generator control panel must not exceed 5 ohms.

x. Unlock circuit breaker in distribution panel LCDA feeding engine heaters and close circuit breaker.

y. Close circuit breaker in lighting panel LCB feeding battery charger.

z. Place battery charger switch in ON position.

aa. Perform procedures outlined in figures 2-1 and 2-2, for starting diesel engine and adjusting voltage.

ab. Check and adjust diesel engine safety devices as outlined in the Power Generation and Distribution Equipment Manual.

ac. Notify local commercial power company to have a lineman open the three fused cutouts on the power company pole feeding the primary of the power transformers.

WARNING

When working on panel LCDA, one man must be stationed at the power company pole to prevent accidental closing of any of the fused cutouts until work has been completed.

NOTE

The critical loads in the Launch Control Center are now being supplied by the launch control center power supply.

ad. Open all circuit breakers in both sections of panel LCDA.

ae. Remove front cover of both sections of panel LCDA.

af. Remove bottom pan section from both sections of panel LCDA.

ag. Connect voltmeter wires to line side of main circuit breaker in the standby section of panel LCDA.

ah. Connect power feeders from diesel engine-generator to the bus bars and neutral in both sections of panel LCDA.

w. Perform resistance check of ground wire using a multimeter. The resistance from the diesel engine foundation and generator control panel must not exceed 5 ohms.

x. Unlock circuit breaker in distribution panel LCDA feeding engine heaters and close circuit breaker.

y. Close circuit breaker in lighting panel LCB feeding battery charger.

z. Place battery charger switch in ON position.

aa. Perform procedures outlined in figures 2-1 and 2-2, for starting diesel engine and adjusting voltage.

ab. Check and adjust diesel engine safety devices as outlined in the Power Generation and Distribution Equipment Manual.

ac. Notify local commercial power company to have a lineman open the three fused cutouts on the power company pole feeding the primary of the power transformers.

WARNING

When working on panel LCDA, one man must be stationed at the power company pole to prevent accidental closing of any of the fused cutouts until work has been completed.

NOTE

The critical loads in the Launch Control Center are now being supplied by the launch control center power supply.

ad. Open all circuit breakers in both sections of panel LCDA.

ae. Remove front cover of both sections of panel LCDA.

af. Remove bottom pan section from both sections of panel LCDA.

ag. Connect voltmeter wires to line side of main circuit breaker in the standby section of panel LCDA.

ah. Connect power feeders from diesel engine-generator to the bus bars and neutral in both sections of panel LCDA.

ai. Connect power leads to the normal and standby bus circuit breakers of the generator control panel.

aj. Follow the procedures outlined in figure 2-2 for transferring power from the commercial power supply to the standby power supply.

ak. Notify the local power company to close the three fused cutouts on the power company pole.

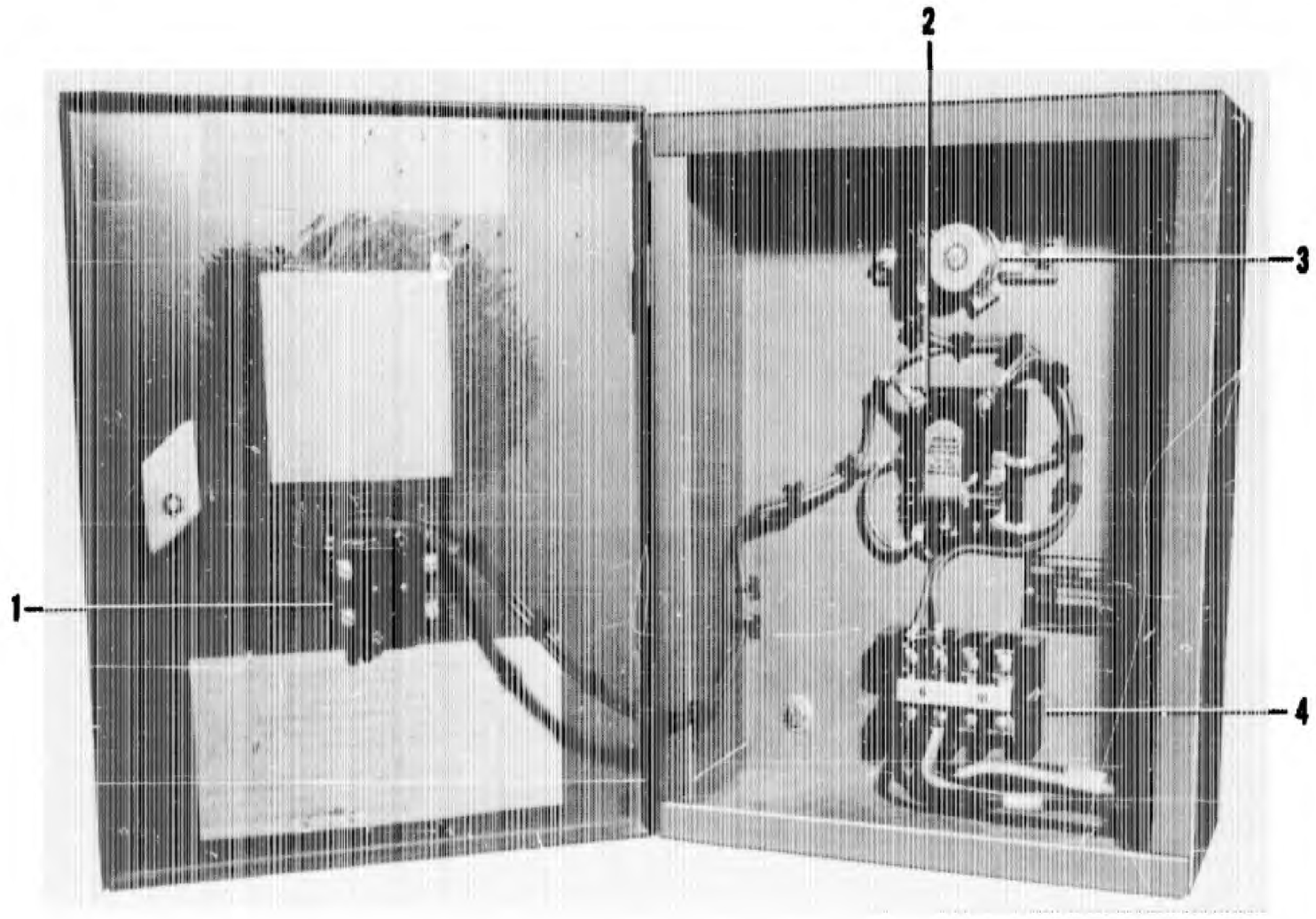
al. With a phase sequence indicator, check phase sequence rotation of output of diesel engine generator at the bus bar of each section of panel with the phase sequence rotation of the commercial power supply at the line side of the main circuit breakers. Phase indication should be ABC; if not, open circuit breakers in generator control panel and change leads at the load side of the circuit breakers until phase indication is the same as commercial power supply.

am. Replace bottom pan section on both sections of panel LCDA.

an. Replace front cover on both sections of panel LCDA.

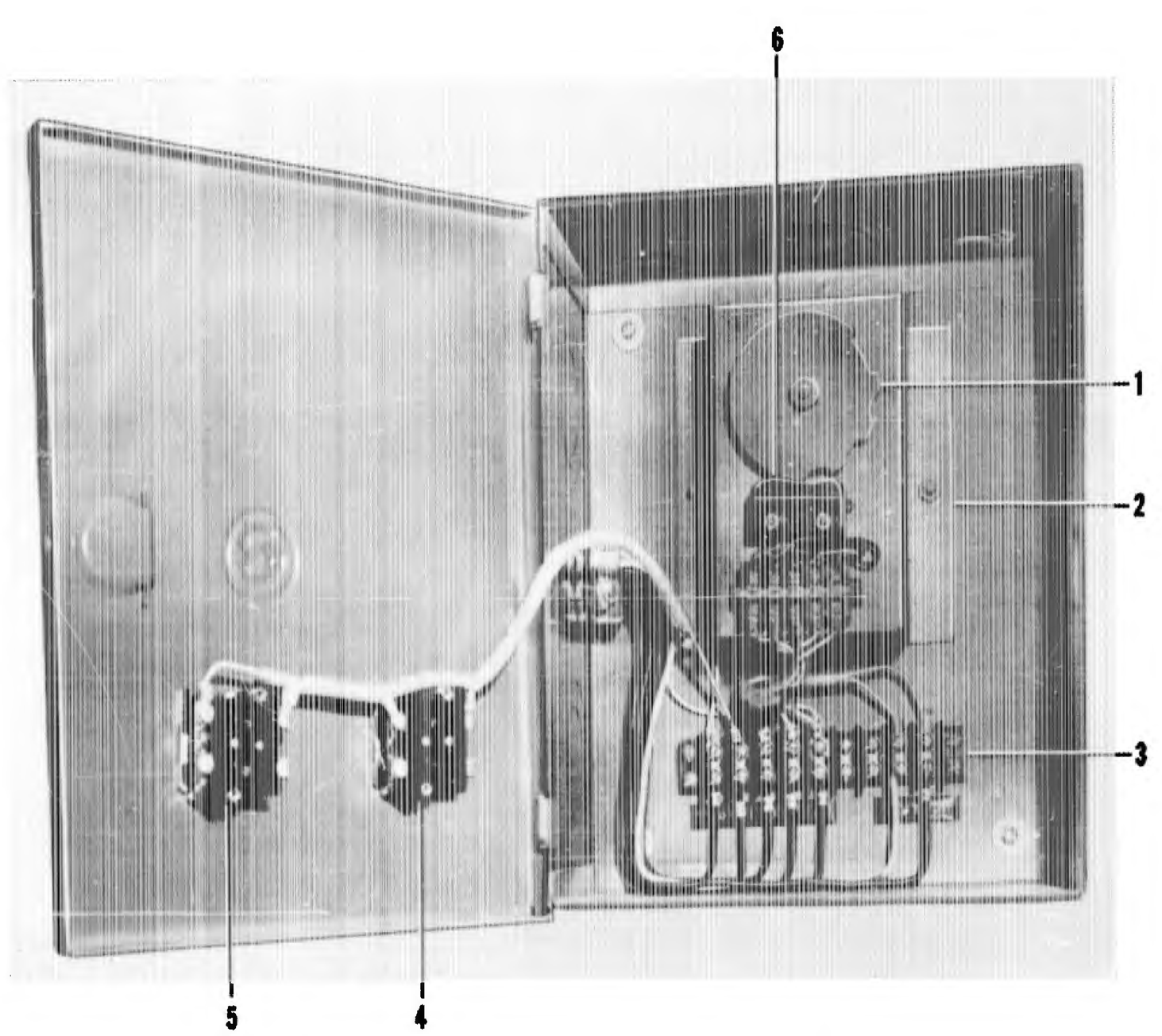
ao. Follow procedures outlined in figure 2-3 for transferring power from the standby power supply to the commercial power supply.

ap. Close all branch circuit breakers in both sections of panel LCDA. The LCF is now being supplied from the commercial power supply.



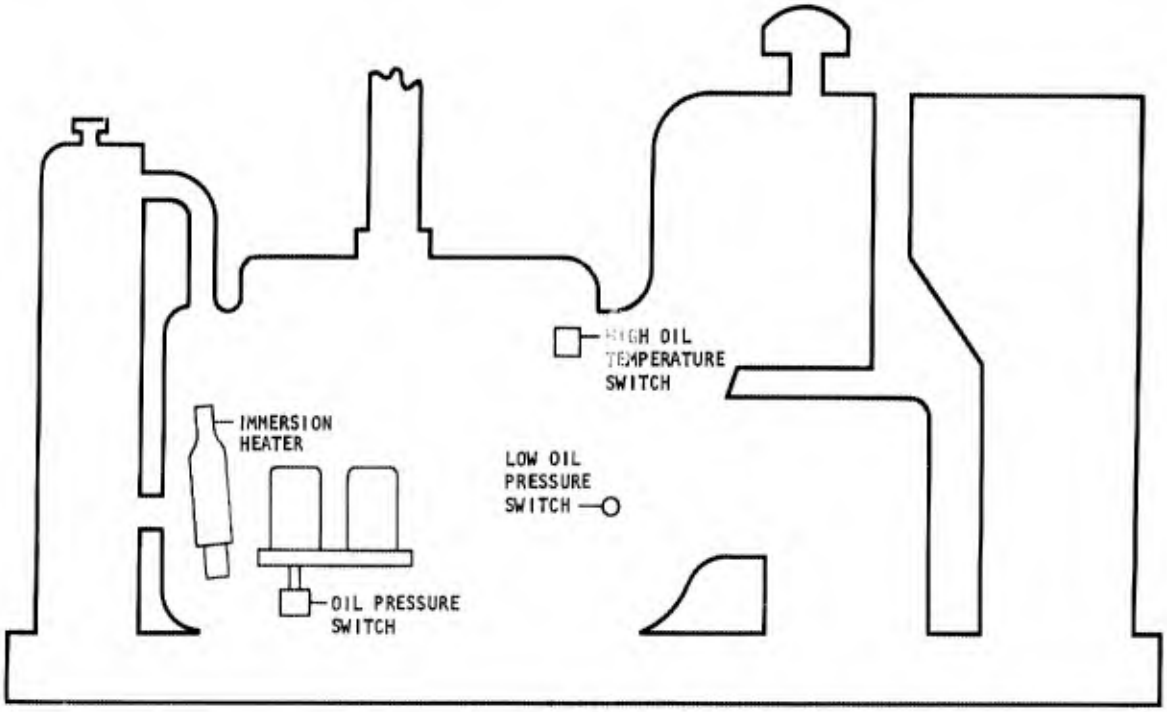
1 BUZZER RESET PUSHBUTTON
2 RELAY R1
3 BUZZER
4 TERMINAL BLOCK

Figure 3-9. LCF Commercial Power Supervisory Panel Component Locations

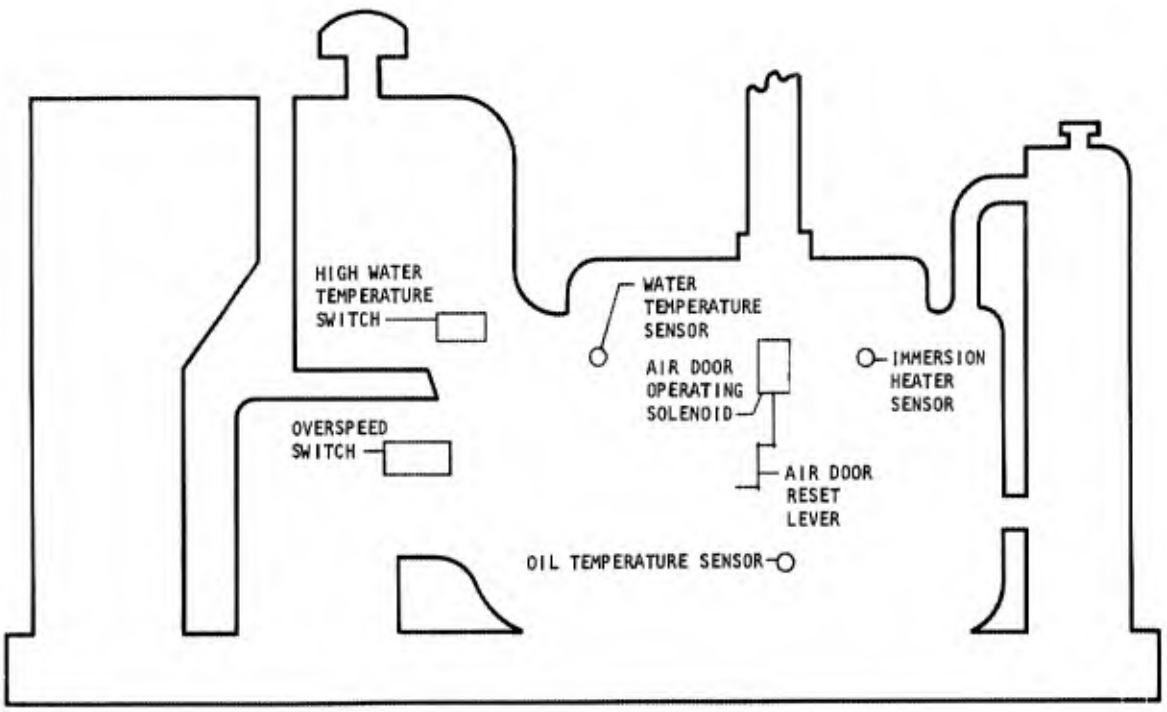


1 CAM
2 TIME DELAY UNIT
3 TERMINAL BLOCK
4 START PUSHBUTTON
5 STOP PUSHBUTTON
6 MICROSWITCH

Figure 3-10. LCF Engine Cranking Panel Component Locations



LEFT SIDE



RIGHT SIDE

Figure 3-11. LCF Diesel Engine-Generator Set Safety Device Locations

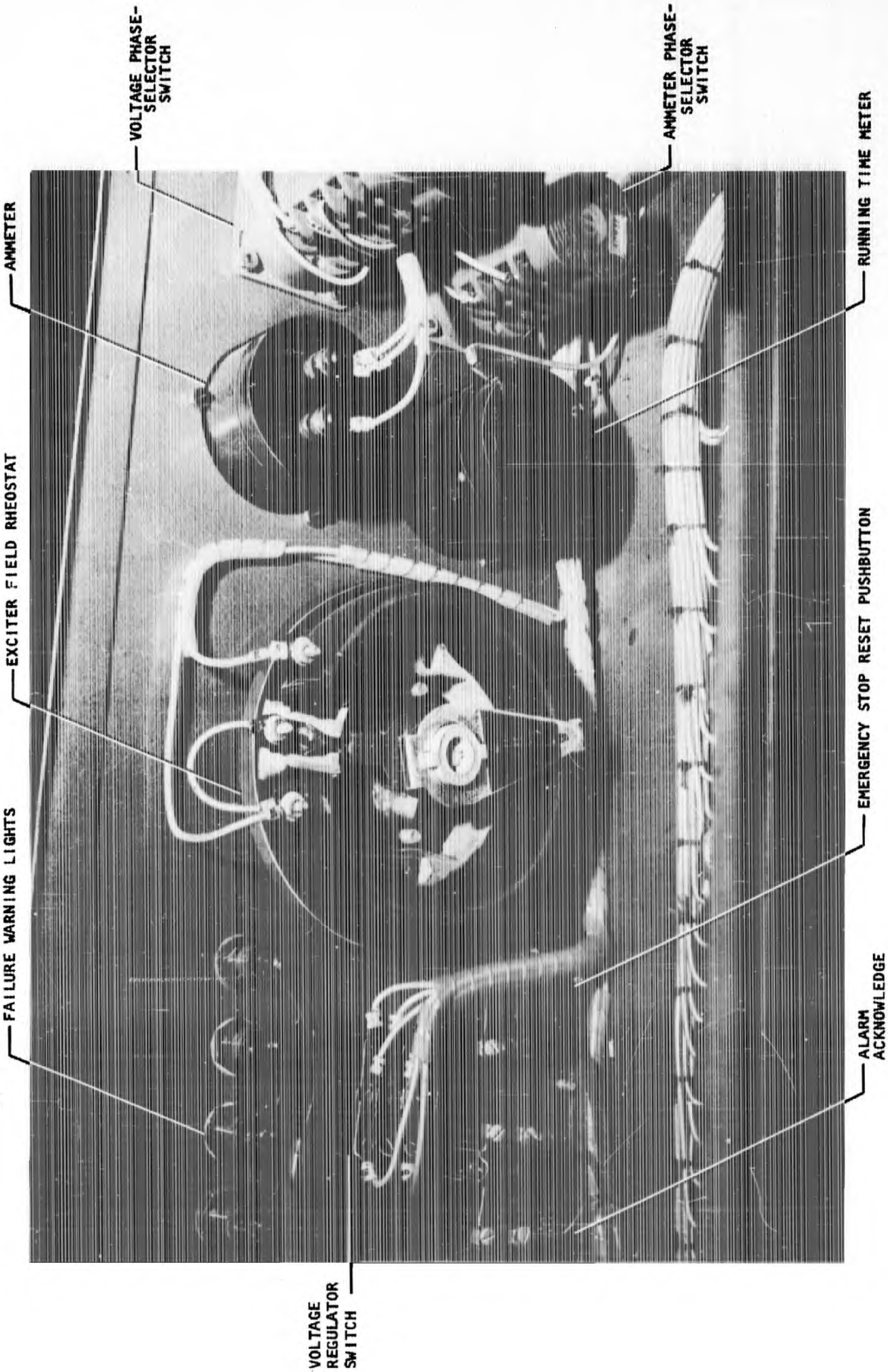


Figure 3-12. LCF Generator Control Panel Component Locations

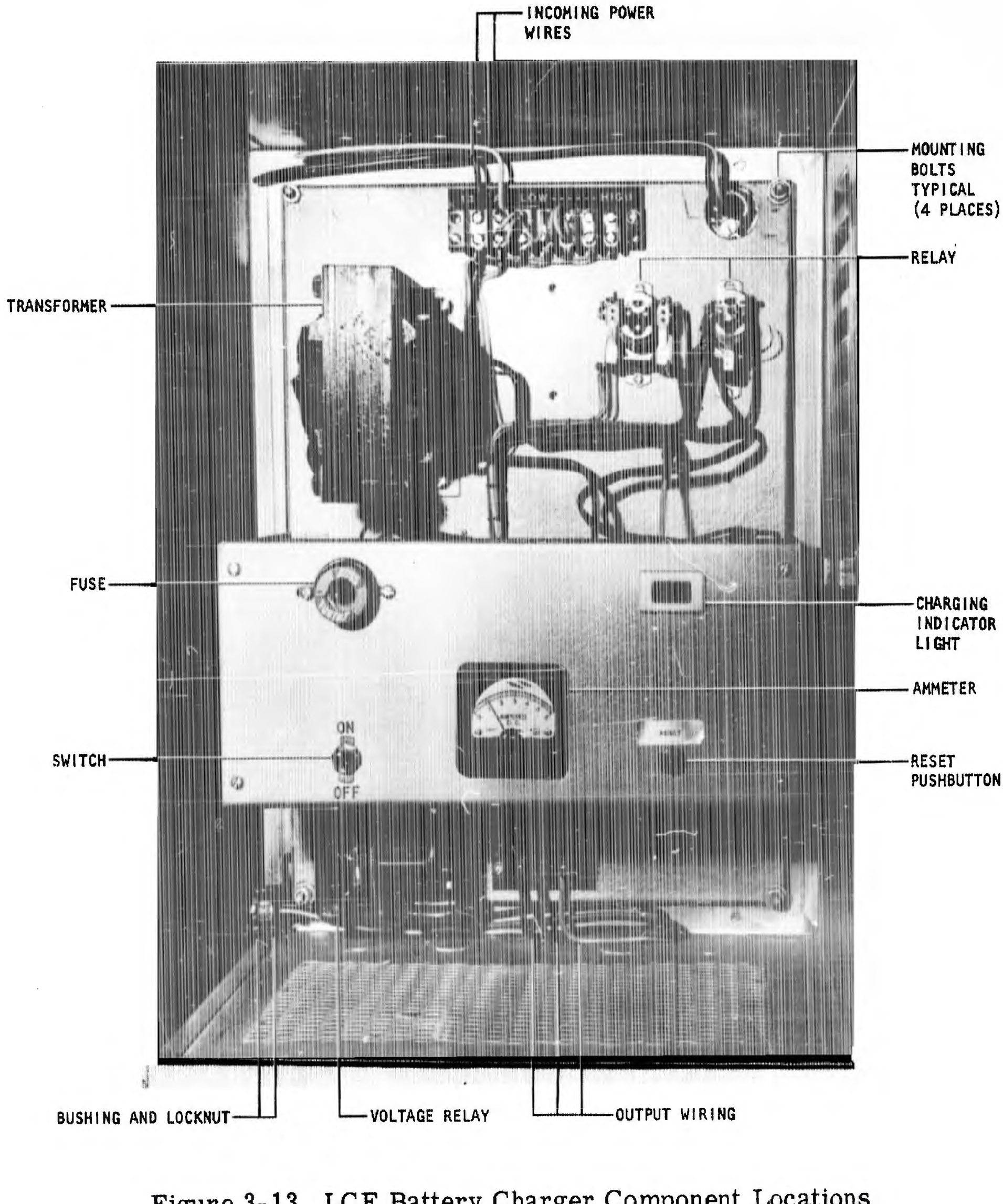


Figure 3-13. LCF Battery Charger Component Locations

3-21. LF POWER GENERATION AND DISTRIBUTION SYSTEM.

3-22. Refer to the applicable section of the Power Generation and Distribution System Equipment Manual for maintenance instructions on any part of the power distribution system. Maintenance instructions for the standby diesel engine-generator set and automatic transfer switch are covered in the following publications:

T.O. 35C2-3-288-1, "Generator Set, Diesel Engine, Model PU-361/FPS and Switching Unit, Power Transfer Model C-1931/FPS", Operation and Maintenance Instructions

T.O. 35C2-3-288-3, Overhaul Instructions

T.O. 35C2-3-288-4, Illustrated Parts Breakdown

T.O. 35C2-3-288-3-1, Supplemental Handbook for the Minuteman Installations

T.O. 35C2-3-288-4-1, Supplemental Handbook for the Minuteman Installations

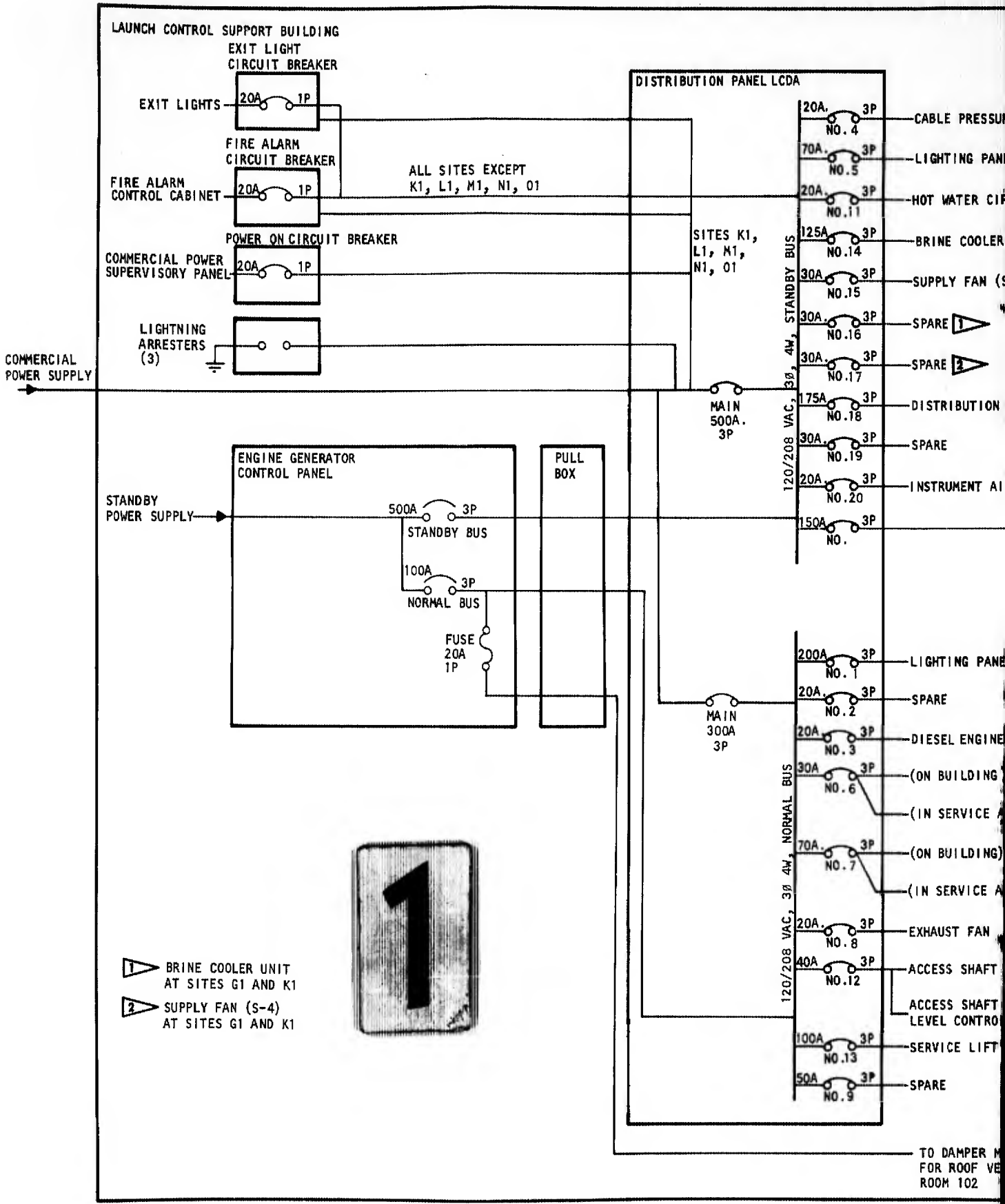
SECTION IV

DIAGRAMS

4-1. GENERAL.

4-2. Electrical control schematics and flow diagrams in support of system description, operation and checkout procedures, and trouble analysis are contained in this section. All diagrams supplement text or procedures and are not intended to be used alone.

4-3. All the diagrams included in this section are listed below.


LAUNCH CONTROL SUPPORT BUILDING
EXIT LIGHT CIRCUIT BREAKER
EXIT LIGHTS
20A 1P
FIRE ALARM CIRCUIT BREAKER
FIRE ALARM CONTROL CABINET
20A 1P
ALL SITES EXCEPT K1, L1, M1, N1, O1
POWER ON CIRCUIT BREAKER
COMMERCIAL POWER SUPERVISORY PANEL
20A 1P
LIGHTNING ARRESTERS (3)
COMMERCIAL POWER SUPPLY
DISTRIBUTION PANEL LCDA
SITES K1, L1, M1, N1, O1
MAIN 500A. 3P
120/208 VAC, 3Ø, 4W, STANDBY BUS
20A. 3P NO. 4
CABLE PRESSU
70A. 3P NO. 5
LIGHTING PANE
20A. 3P NO. 11
HOT WATER CI
125A 3P NO. 14
BRINE COOLER
30A 3P NO. 15
SUPPLY FAN (S
30A. 3P NO. 16
SPARE 1
30A. 3P NO. 17
SPARE 2
175A 3P NO. 18
DISTRIBUTION
30A. 3P NO. 19
SPARE
20A 3P NO. 20
INSTRUMENT AI
150A 3P NO.
ENGINE GENERATOR CONTROL PANEL
PULL BOX
STANDBY POWER SUPPLY
500A 3P STANDBY BUS
100A 3P NORMAL BUS
FUSE 20A 1P
MAIN 300A 3P
120/208 VAC, 3Ø 4W, NORMAL BUS
200A 3P NO. 1
LIGHTING PANE
20A. 3P NO. 2
SPARE
20A 3P NO. 3
DIESEL ENGINE
30A 3P NO. 6
(ON BUILDING
(IN SERVICE A
70A. 3P NO. 7
(ON BUILDING)
(IN SERVICE A
20A. 3P NO. 8
EXHAUST FAN
40A 3P NO. 12
ACCESS SHAFT
ACCESS SHAFT LEVEL CONTRO
100A 3P NO. 13
SERVICE LIFT
50A 3P NO. 9
SPARE
TO DAMPER M FOR ROOF VE ROOM 102
1 BRINE COOLER UNIT AT SITES G1 AND K1
2 SUPPLY FAN (S-4) AT SITES G1 AND K1
1

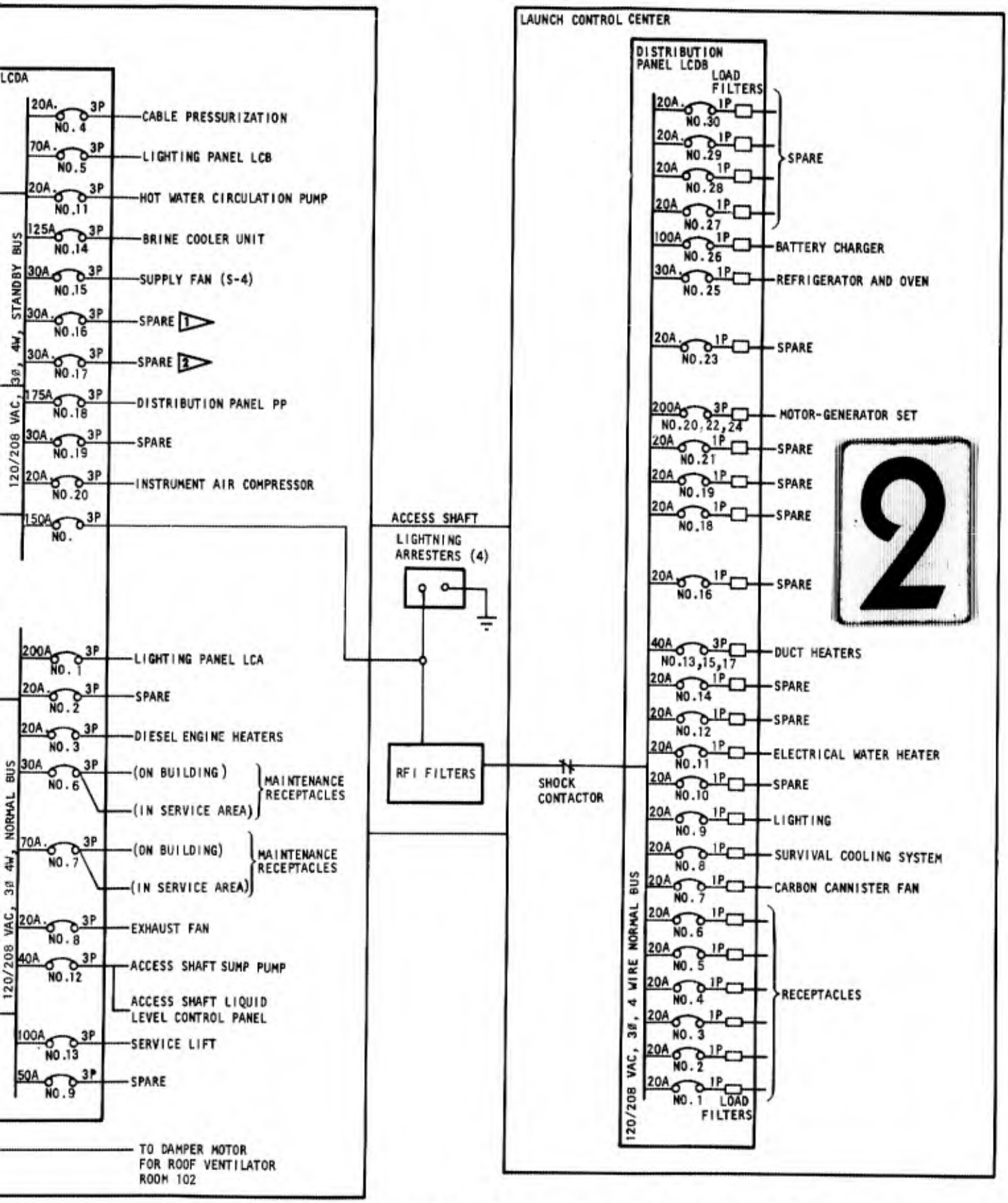


Figure 4-1. LCF Power Distribution Panel Diagrams

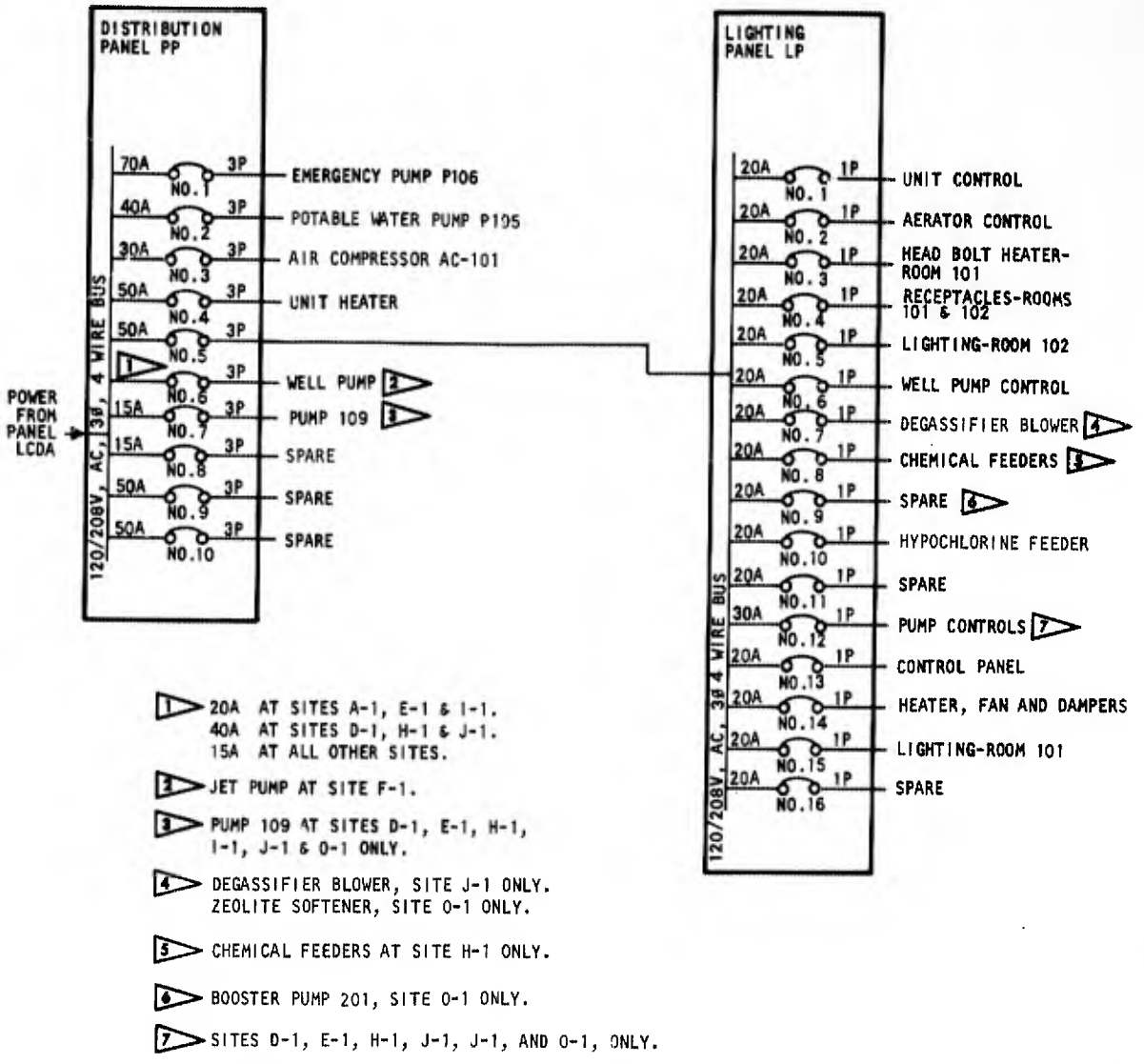


Figure 4-2. LCF Support Building Power Distribution and Lighting Panel Diagrams

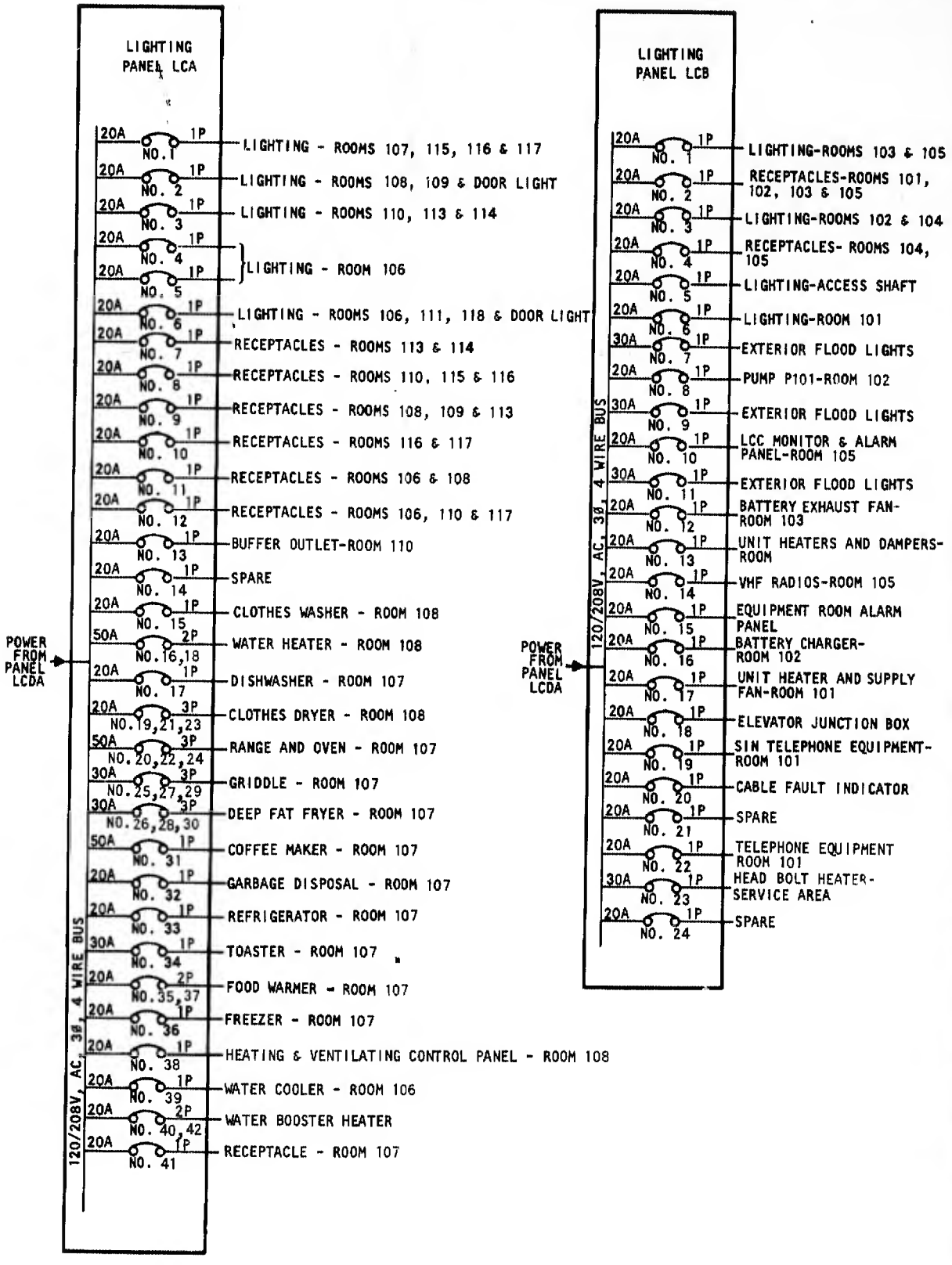
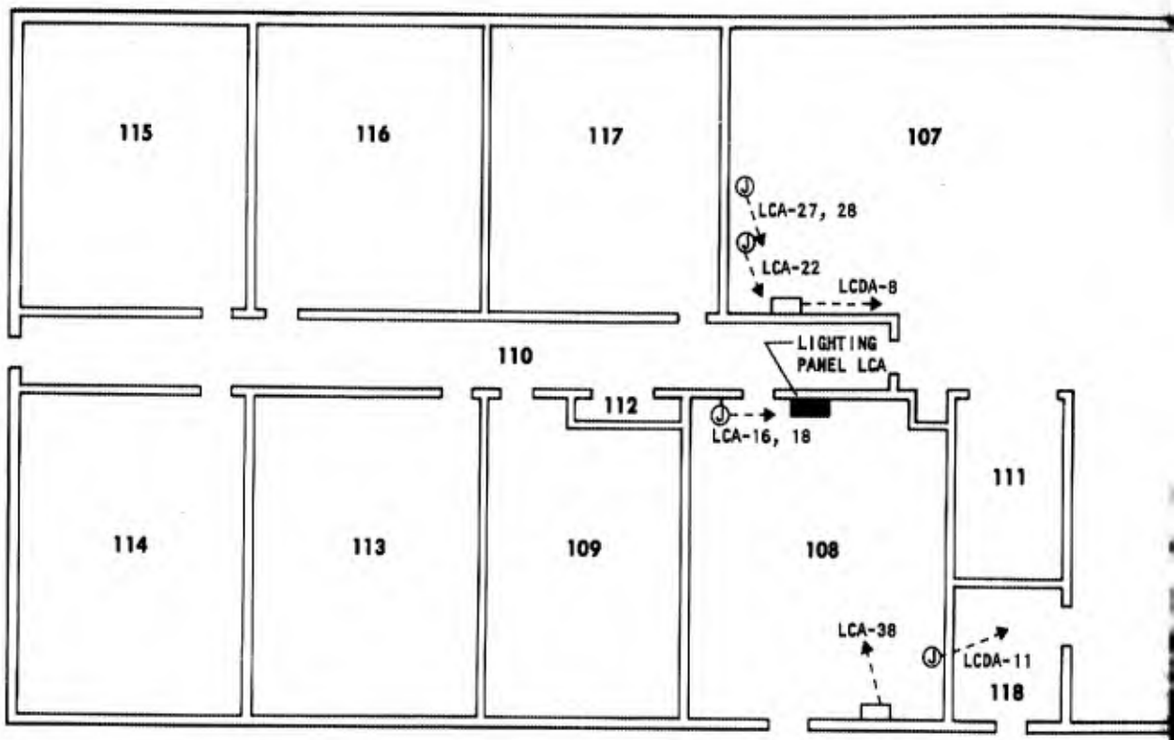


Figure 4-3. LCF Lighting Panel Diagrams


115
116
117
107
LCA-27, 28
LCA-22
LCDA-8
LIGHTING PANEL LCA
110
112
LCA-16, 18
111
114
113
109
108
LCA-38
LCDA-11
118

1

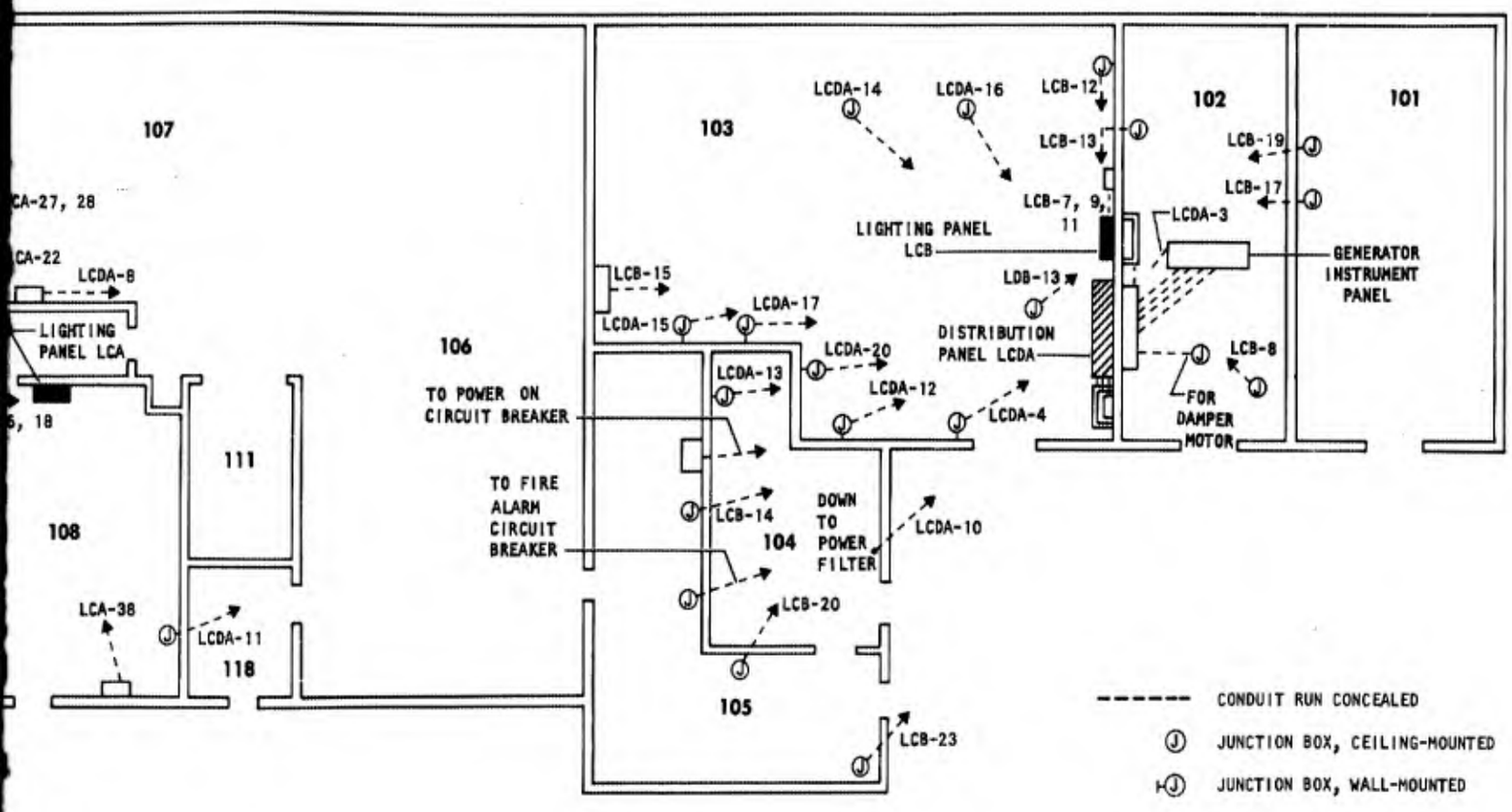
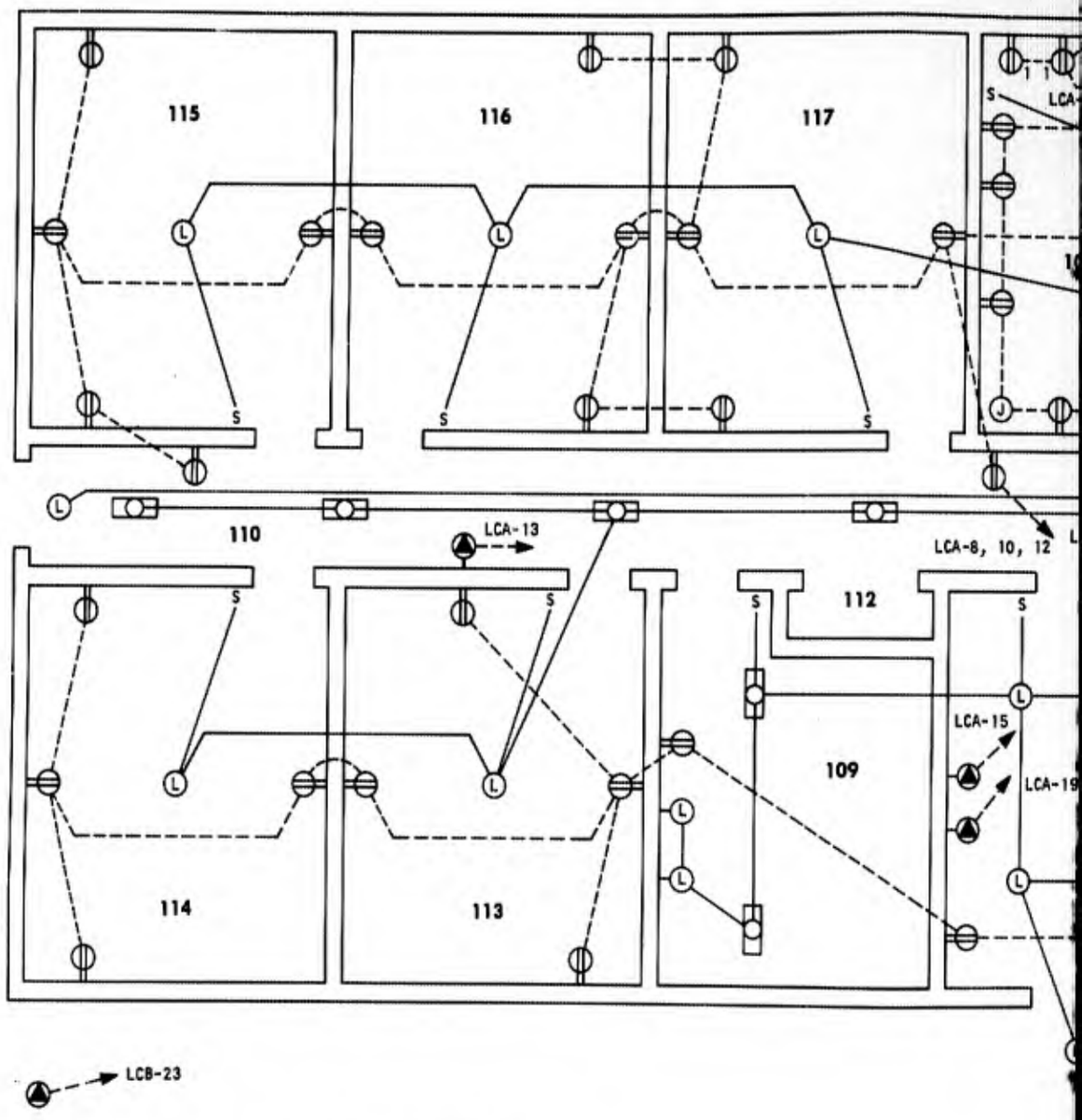
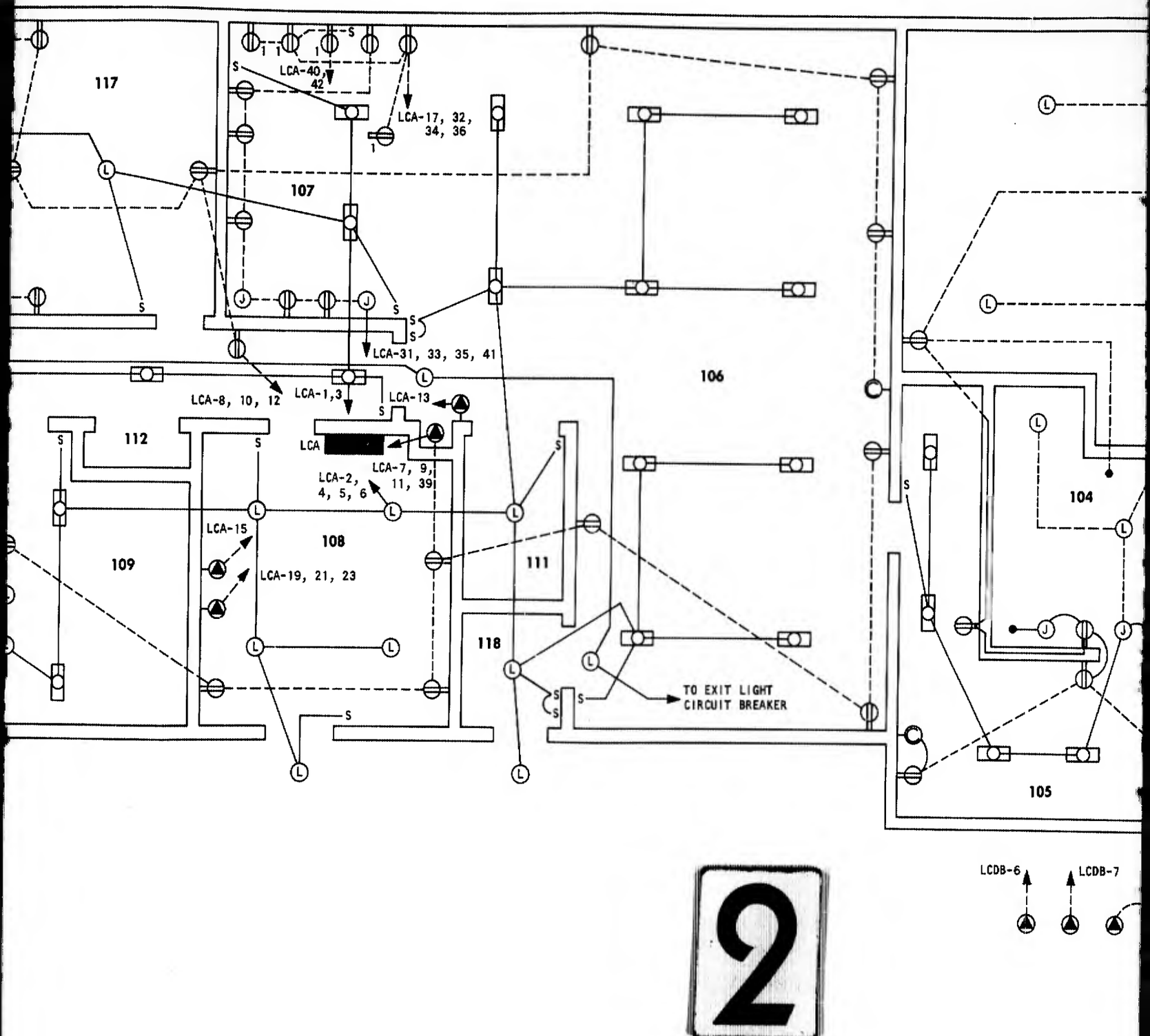


Figure 4-4. LCF Support Building Power Distribution Plan


115
116
117
110
LCA-13
LCA-8, 10, 12
112
LCA-15
109
114
113
LCB-23


117
LCA-40, 42
LCA-17, 32, 34, 36
107
LCA-31, 33, 35, 41
106
LCA-8, 10, 12
LCA-1,3
LCA-13
LCA
112
LCA-2, 4, 5, 6
LCA-7, 9, 11, 39
104
LCA-15
108
109
LCA-19, 21, 23
111
118
TO EXIT LIGHT CIRCUIT BREAKER
105
LCDB-6
LCDB-7
2

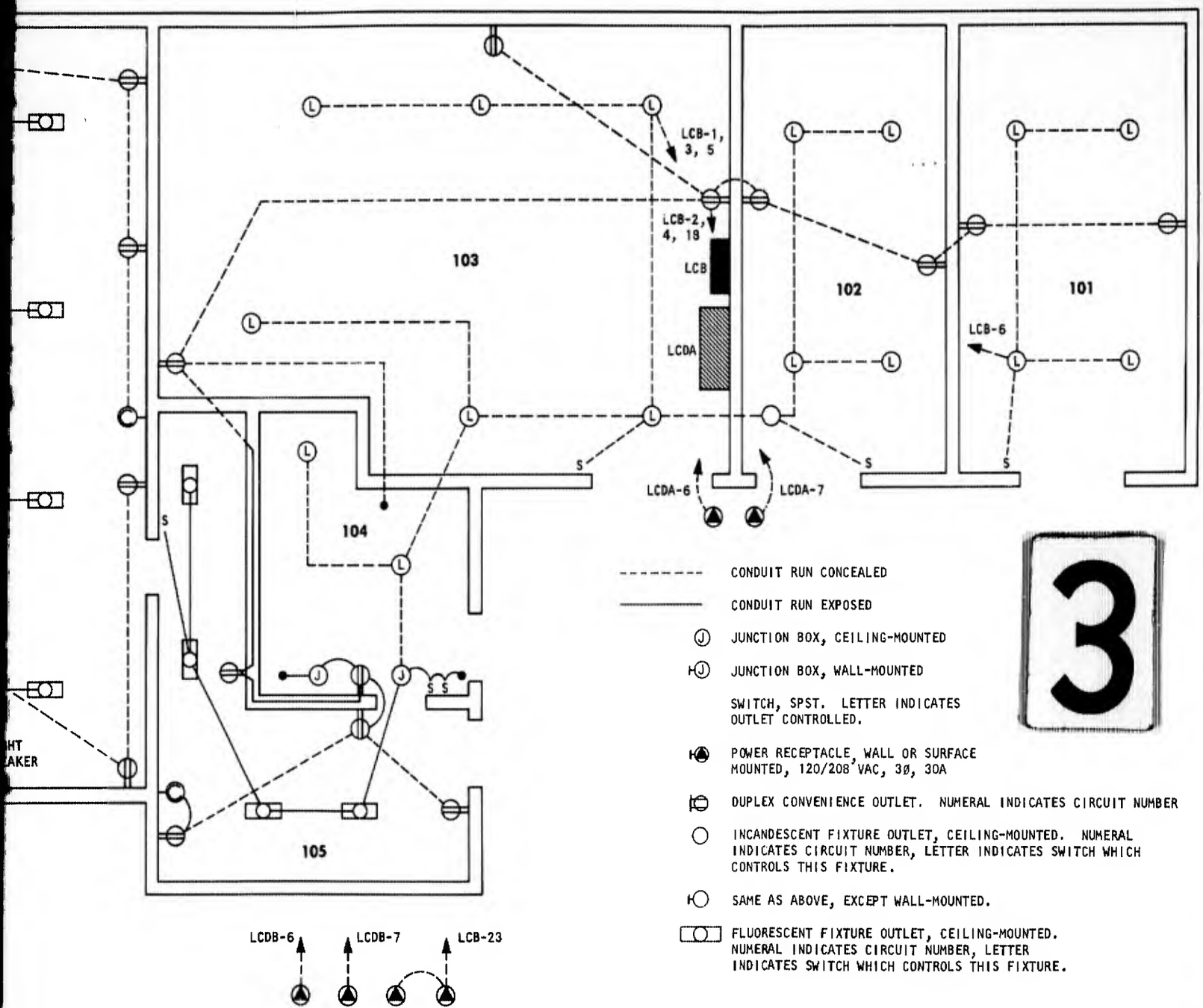


Figure 4-5. LCF Support Building Lighting and Receptacle Plan

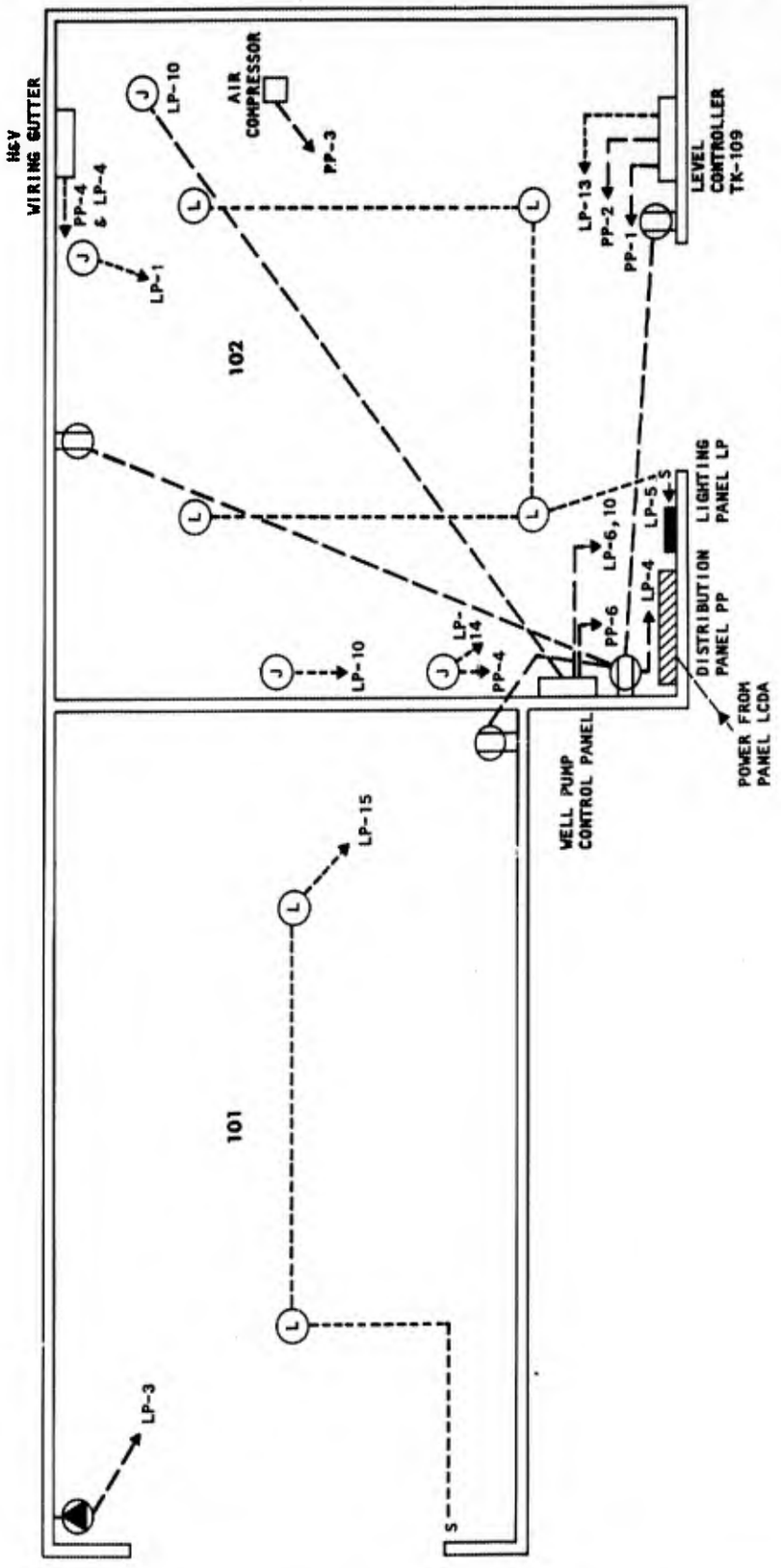


Figure 4-6. LCF Water Well Pump House Power, Lighting and Receptacle Plan

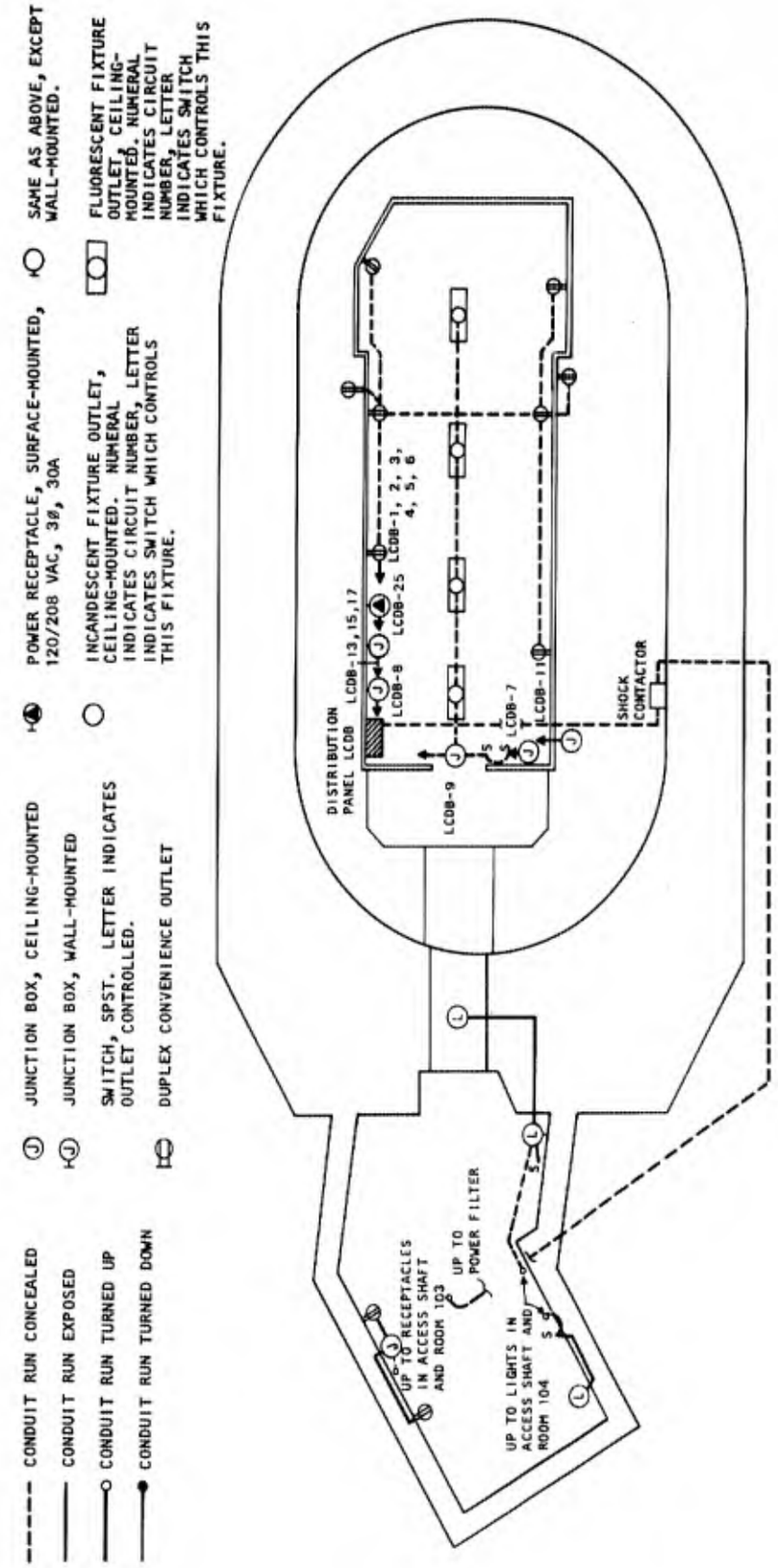
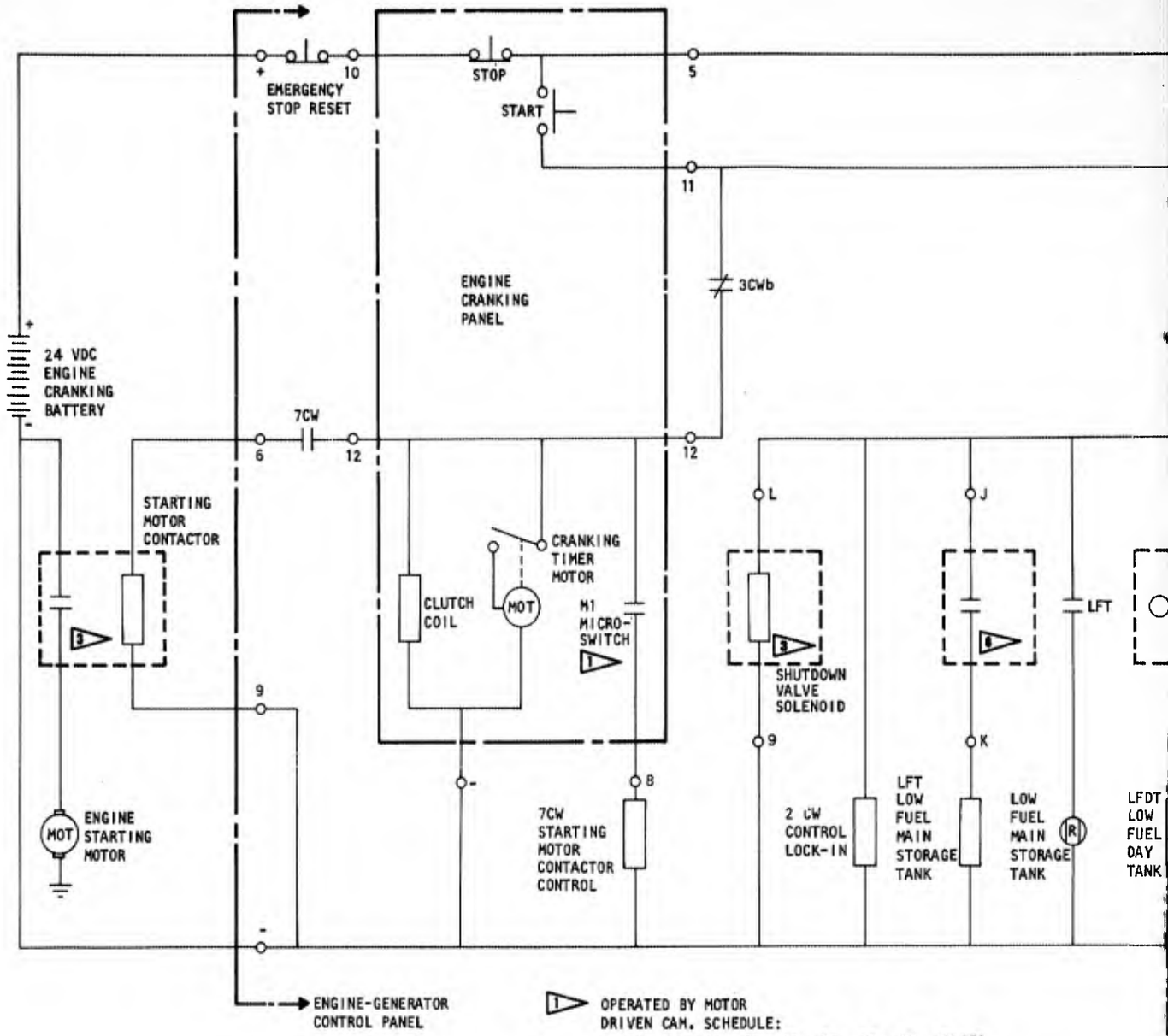
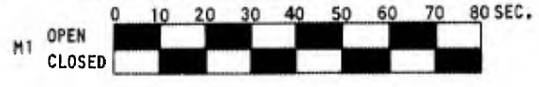


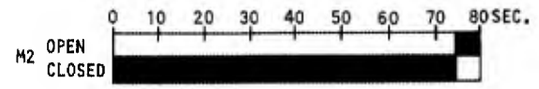
Figure 4-7. LCC Power, Lighting and Receptacle Plan

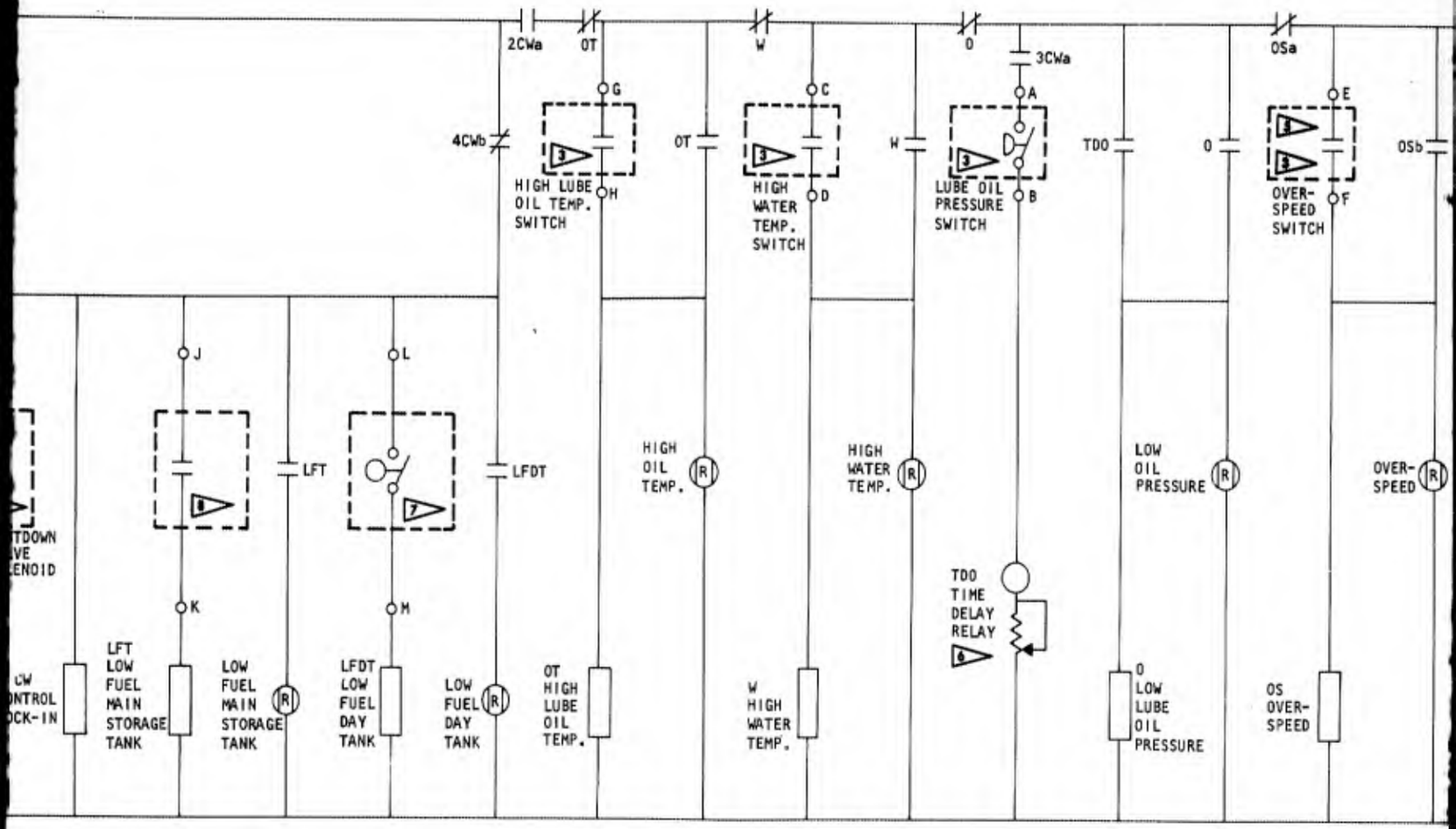


1 OPERATED BY MOTOR DRIVEN CAM. SCHEDULE:



2 LOCATED IN STARTING MOTOR CONTROL PANEL; OPERATED BY BY MOTOR DRIVEN CAM. SCHEDULE:





50 60 70 80 SEC.

TOR
D BY
CHEDULE:

50 60 70 80 SEC.

3 LOCATED ON ENGINE

4 MICROSWITCH IN OVERSPEED GOVERNOR; CLOSES WHEN ENGINE SPEED REACHES 600 RPM.

5 MICROSWITCH IN OVERSPEED GOVERNOR; CLOSES WHEN ENGINE SPEED REACHES 1975 (±25 RPM)

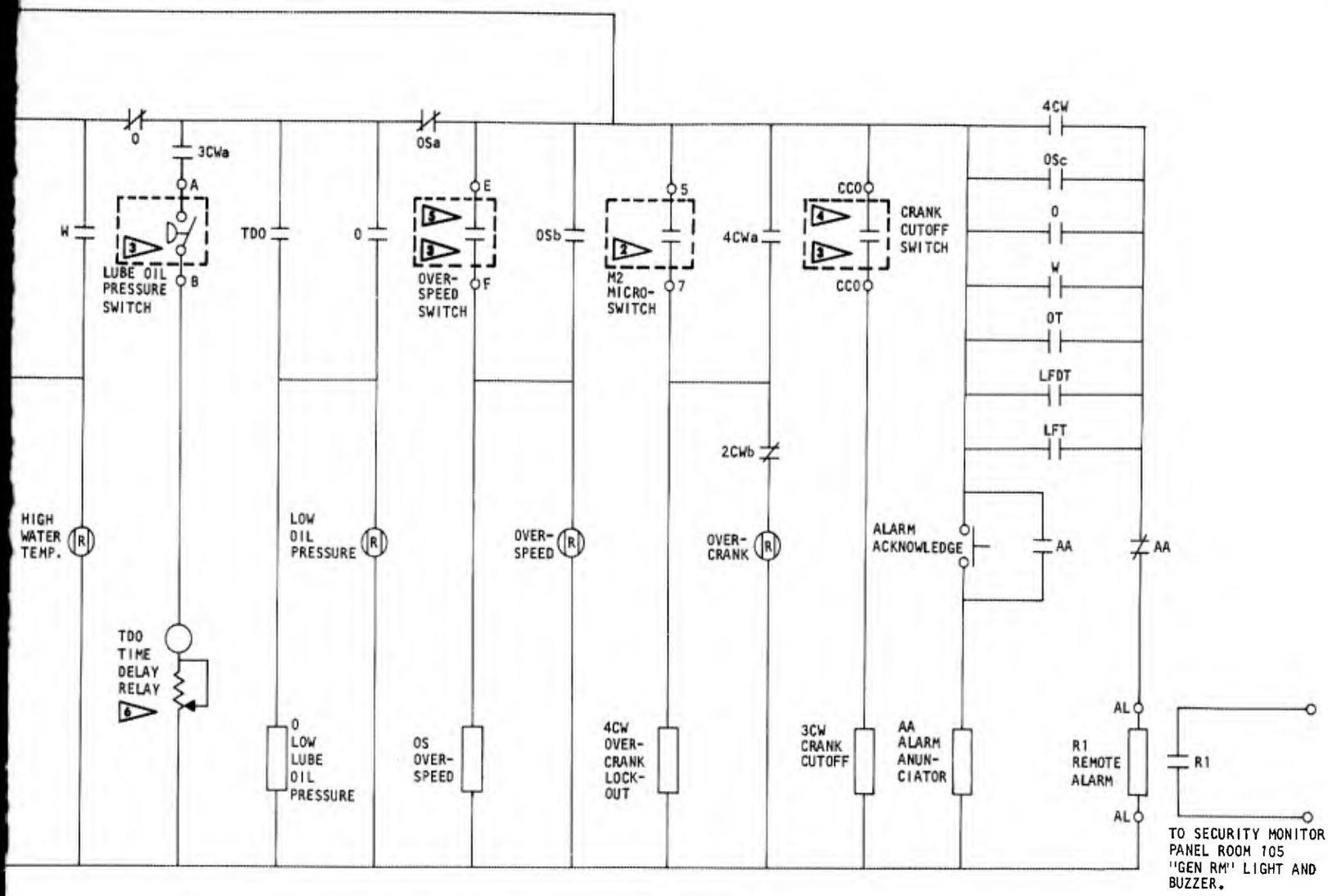
6 PREVENTS OPERATION OF LOW LUBE OIL PRESSURE RELAY DURING ENGINE STARTUP.

7 FLOAT SWITCH ON DAY TANK. CONTACTS CLOSE ON LOW LEVEL.

8 LOCATED IN MAIN TANK LIQUID LEVEL INDICATOR; ROOM 102.

2

Figure 4-



7 FLOAT SWITCH ON DAY TANK. CONTACTS CLOSE ON LOW LEVEL.

8 LOCATED IN MAIN TANK LIQUID LEVEL INDICATOR; ROOM 102.

3

Figure 4-8. LCF Standby System Engine Starting and Alarm Circuits

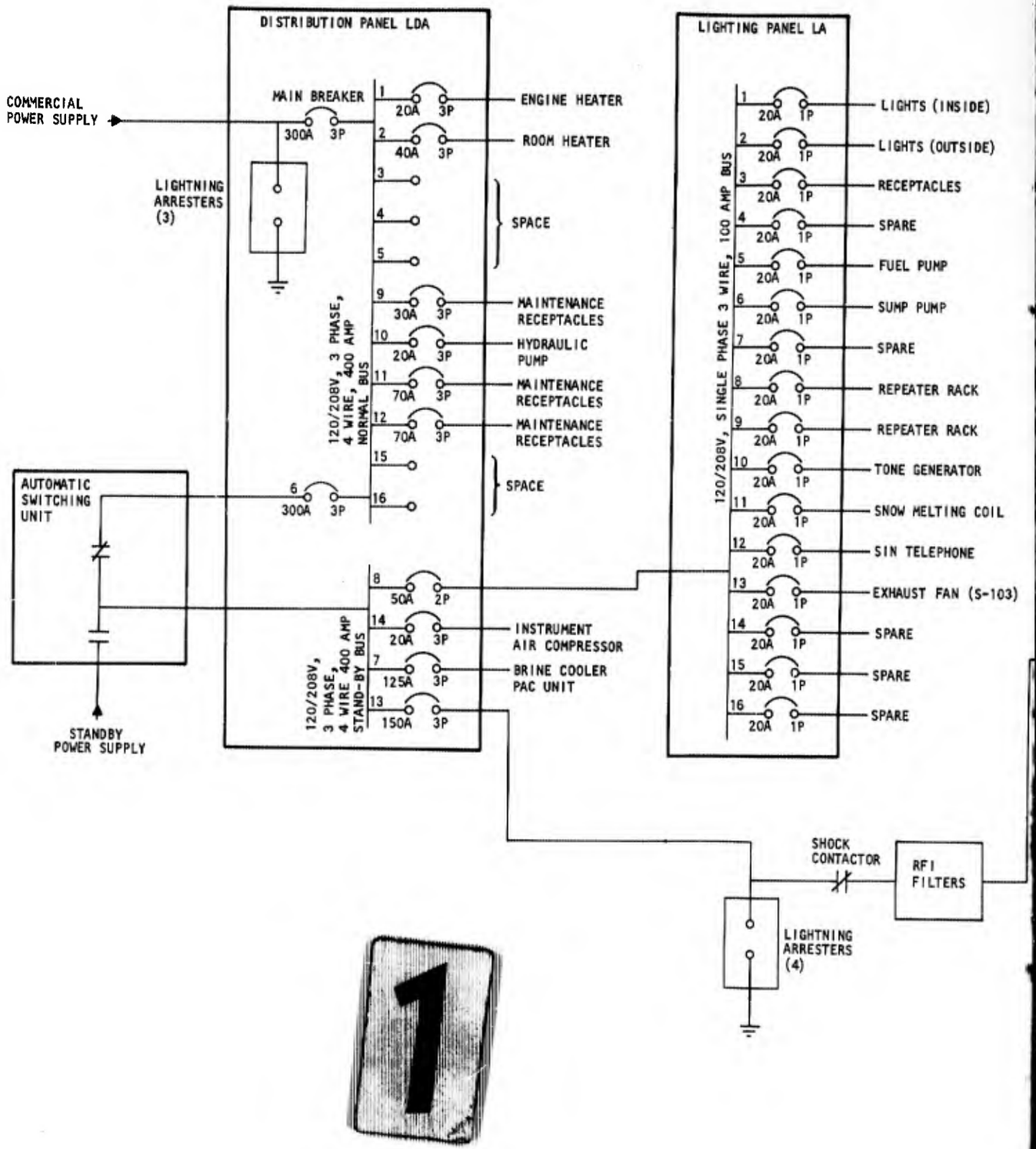


Figure 4-9. LF Power Distribu

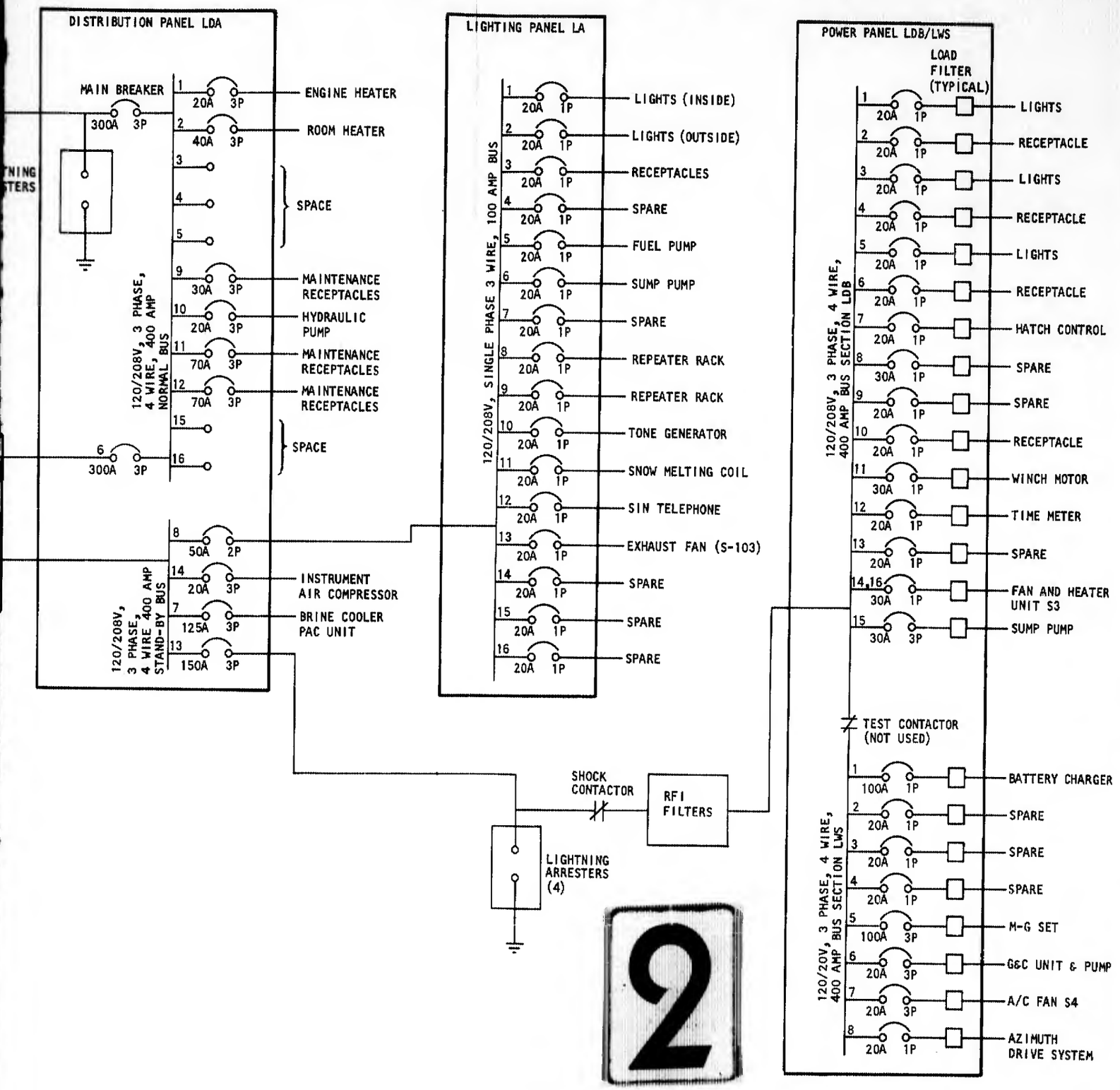


Figure 4-9. LF Power Distribution Panel Diagrams

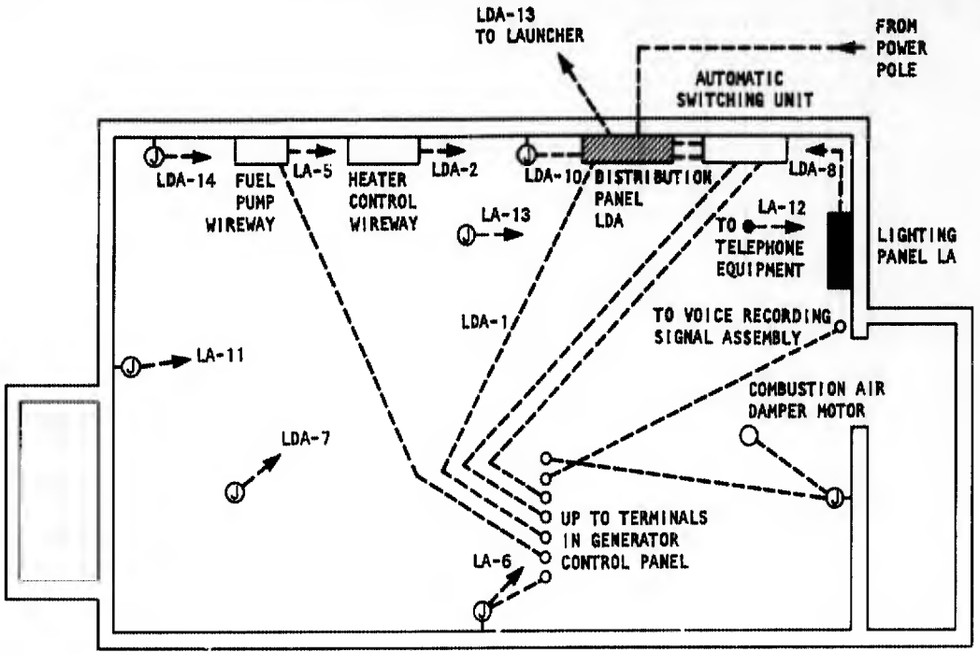


Figure 4-10. LF Support Building Power Distribution Plan

CONDUIT RUN CONCEALED
CONDUIT RUN EXPOSED
CONDUIT RUN TURNED DOWN
CONDUIT RUN TURNED UP
JUNCTION BOX, CEILING-MOUNTED
JUNCTION BOX, WALL-MOUNTED

S SWITCH, SPST. LETTER INDICATES OUTLET CONTROLLED.
POWER RECEPTACLE, SURFACE-MOUNTED, 120/208 VAC, 3ø, 30A
DUPLEX CONVENIENCE OUTLET. NUMERAL INDICATES CIRCUIT NUMBER

INCANDESCENT FIXTURE OUTLET, CEILING-MOUNTED. NUMERAL INDICATES CIRCUIT NUMBER, LETTER INDICATES SWITCH WHICH CONTROLS THIS FIXTURE.
SAME AS ABOVE, EXCEPT WALL-MOUNTED.

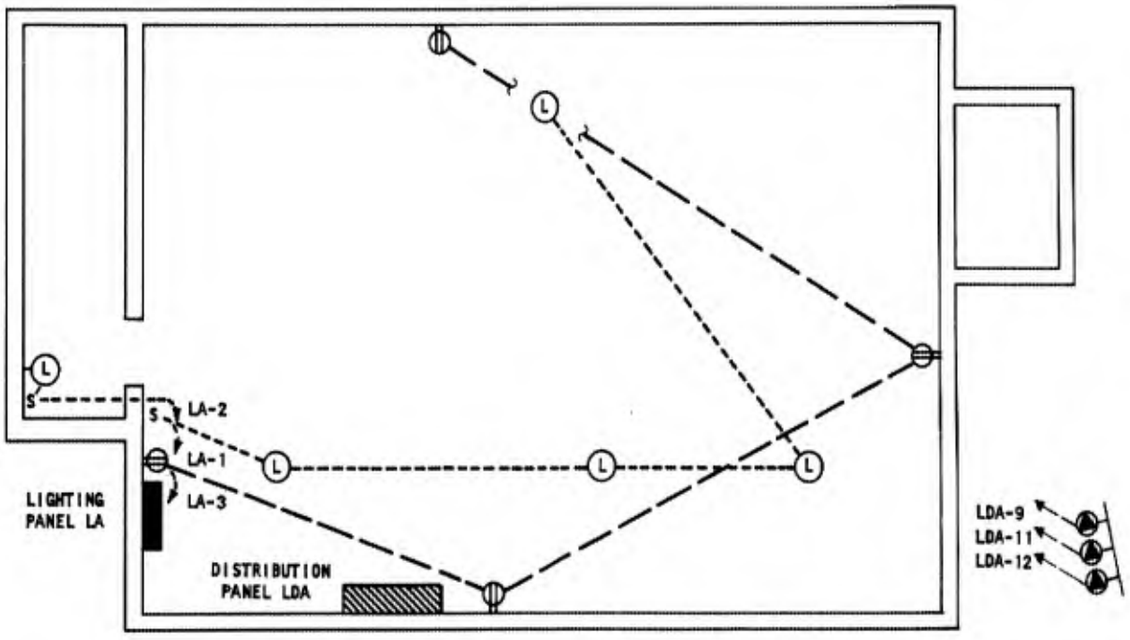


Figure 4-11. LF Support Building Lighting and Receptacle Plan

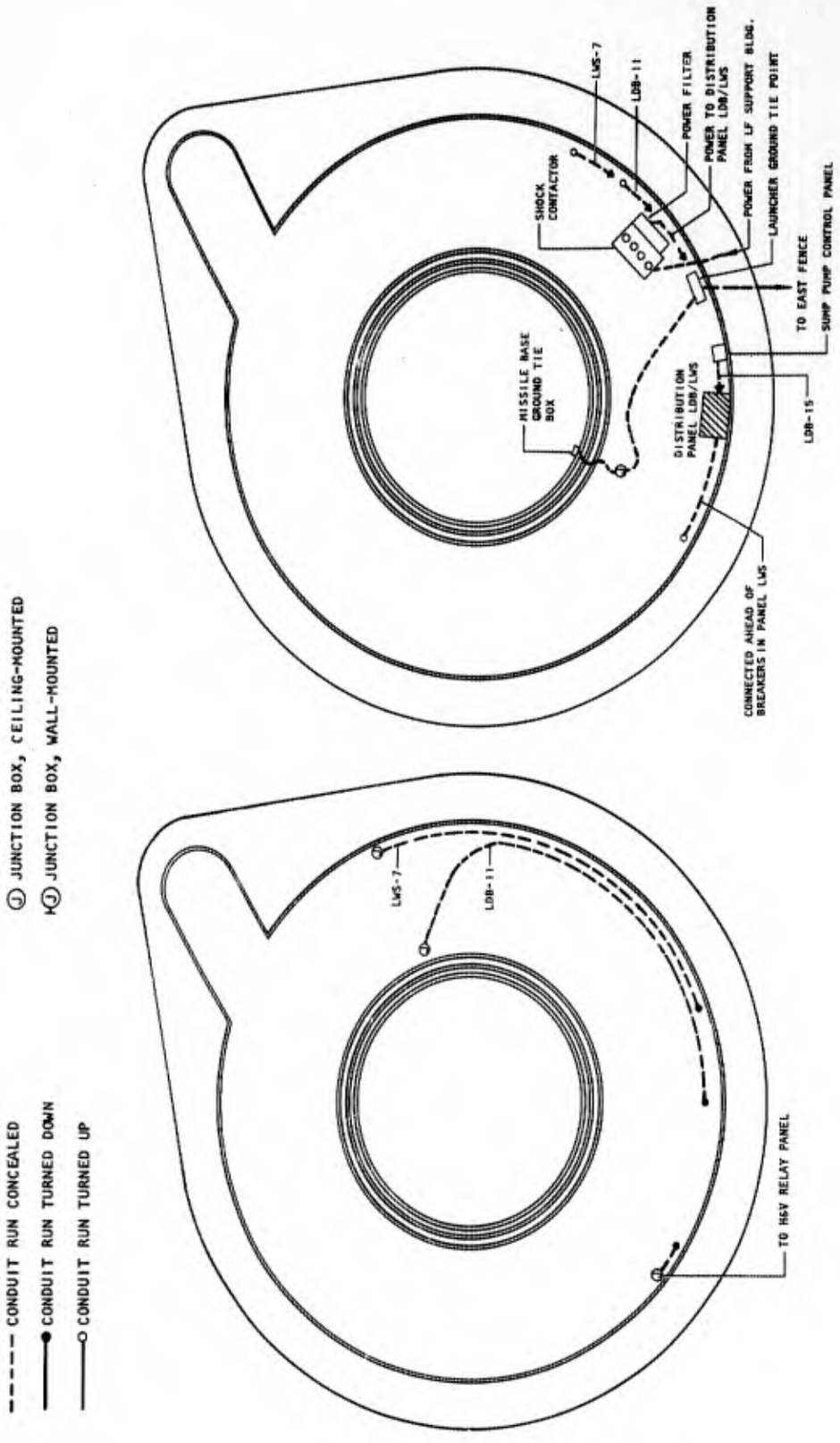


Figure 4-12. Launcher Power Plan

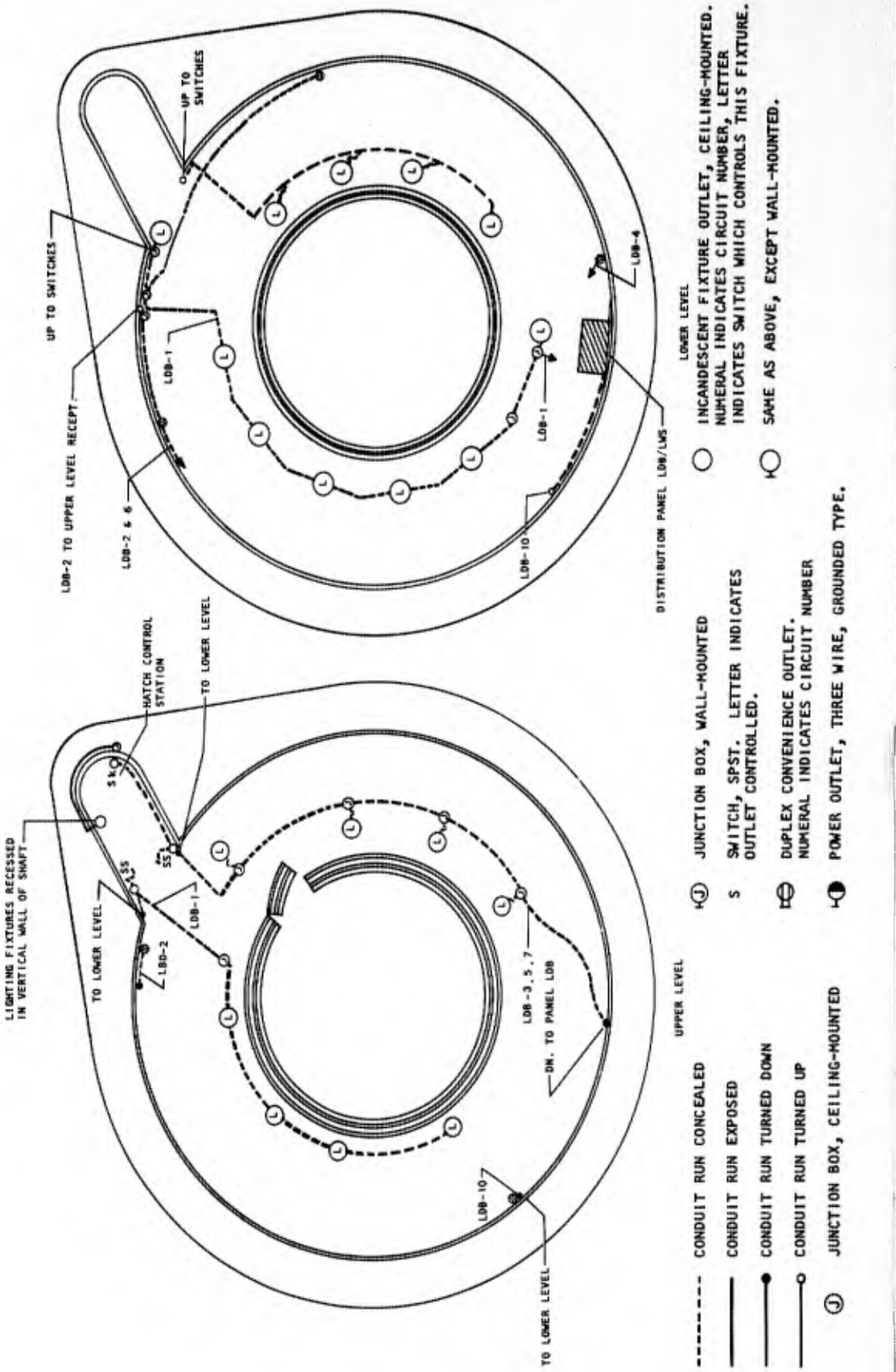


Figure 4-13. Launcher Lighting and Receptacle Plan

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