CHAPTER

24

ELECTRICAL POWER

CHAPTER 24
ELECTRICAL POWER

Subject/Page	Date	COC	Subject/Page	Date	COC	Subject/Page	Date	COC
24-EFFECTIVE PAGES			24-00-00			24-10-00 (cont)		
1 thru 5	AUG 01/2016		501	Feb 01/2015		504	Feb 01/2015	
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			503	Feb 01/2015				

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CHAPTER 24
ELECTRICAL POWER

Subject/Page	Date	COC
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CHAPTER 24
ELECTRICAL POWER

Subject/Page	Date	COC	Subject/Page	Date	COC	Subject/Page	Date	COC
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CHAPTER 24
ELECTRICAL POWER

Subject/Page	Date	COC	Subject/Page	Date	COC	Subject/Page	Date	COC
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CHAPTER 24
ELECTRICAL POWER

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

CHAPTER 24
ELECTRICAL POWER

CHAPTER 24
ELECTRICAL POWER

CHAPTER 24
ELECTRICAL POWER

CHAPTER 24
ELECTRICAL POWER

GENERAL - DESCRIPTION AND OPERATION

1. **Description**

A. The AC and DC electrical power systems used on the airplane are similar in design. Referred to as a split-bus system, both the AC and DC electrical power systems are divided into two independent systems; the left side and the right side. Normally each side operates independently from the other, each having a power source and bus system supplying power to the various load demands throughout the airplane. In the event of a power loss on the load buses of either side, a crosstie relay is provided so that the dead buses can be connected to the buses of the opposite side. Two major differences between the AC system and the DC system are:

(1) Sensing and control relays are installed in the AC system to prevent any two power sources from operating in parallel to supply power to the AC load buses.

(2) If an AC generator bus should lose power, the AC crosstie relay is operated automatically to tie the two generator buses together if the AC bus crosstie switch is in the automatic position. When the airplane is on the ground, the control circuitry for the AC crosstie relay is interlocked with the ground control relays to prevent crosstying when the auxiliary power unit (APU) generator or external power is supplying power to the airplane. The DC crosstie relay is actuated to tie the two DC buses together only when the DC bus crosstie switch is manually placed in the closed position.

B. The engine-driven AC generators, one on each engine, are normally the primary source of power supplied to all AC load buses. Each generator is a brushless, air-cooled type, rated at 40 kva with a 120/208-volt, 3-phase, 400-cycle per second output. Generator speed is held at a constant 6000 rpm, with any variation of engine speeds between idle and takeoff, by a corresponding hydromechanical type constant-speed drive (CSD) transmission. Frequency is maintained at 400(±4) cps by a governor inside the CSD.

C. Transmission output rotation can be stopped under specific procedures by placing the corresponding generator CSD disconnect switch, located on the electrical power section of the flight compartment overhead switch panel, in the disconnect position. This will electrically energize the disconnect solenoid within the CSD, and the resultant action will disengage the rotating input shaft from the planetary differential of the CSD. Once a transmission is disengaged, it must not be reengaged until the engine is shut down and comes to a complete stop. Reengagement of the transmission is accomplished manually at the transmission by pulling downward on the T-handle, located at the bottom of the unit, until a stop is felt and then releasing the handle.

D. Auxiliary AC electrical power is provided by a generator of the same type as the engine-driven generators to supply AC power to the corresponding dead buses if an engine-driven generator fails during flight, or to supply power to the AC load buses when the airplane is on the ground and external power is not available. The generator is driven by a constant-speed, gas turbine auxiliary power unit (APU) installed in the aft accessory compartment of the airplane. Through the use of control switches and relays, auxiliary power can be supplied to all AC load buses at the same time, or to only the left or right AC buses, or ground service AC bus, provided the bus selected is not receiving power from an engine-driven generator. If external power is supplying power to the bus selected, the APU generator will take over, and external power will be disconnected from the bus.

E. An external power receptacle, mounted on the left side of the fuselage nose section, enables the connection of a 115/200- volt, 3-phase, 400-cycle, external power source to supply power to the AC load buses of the airplane when the engine-driven or APU generators are not operating. External power distribution to the load buses can be selected in the same manner as the APU generator output. External power will not be supplied to a load bus that is already receiving power from an engine-driven generator or the APU generator.

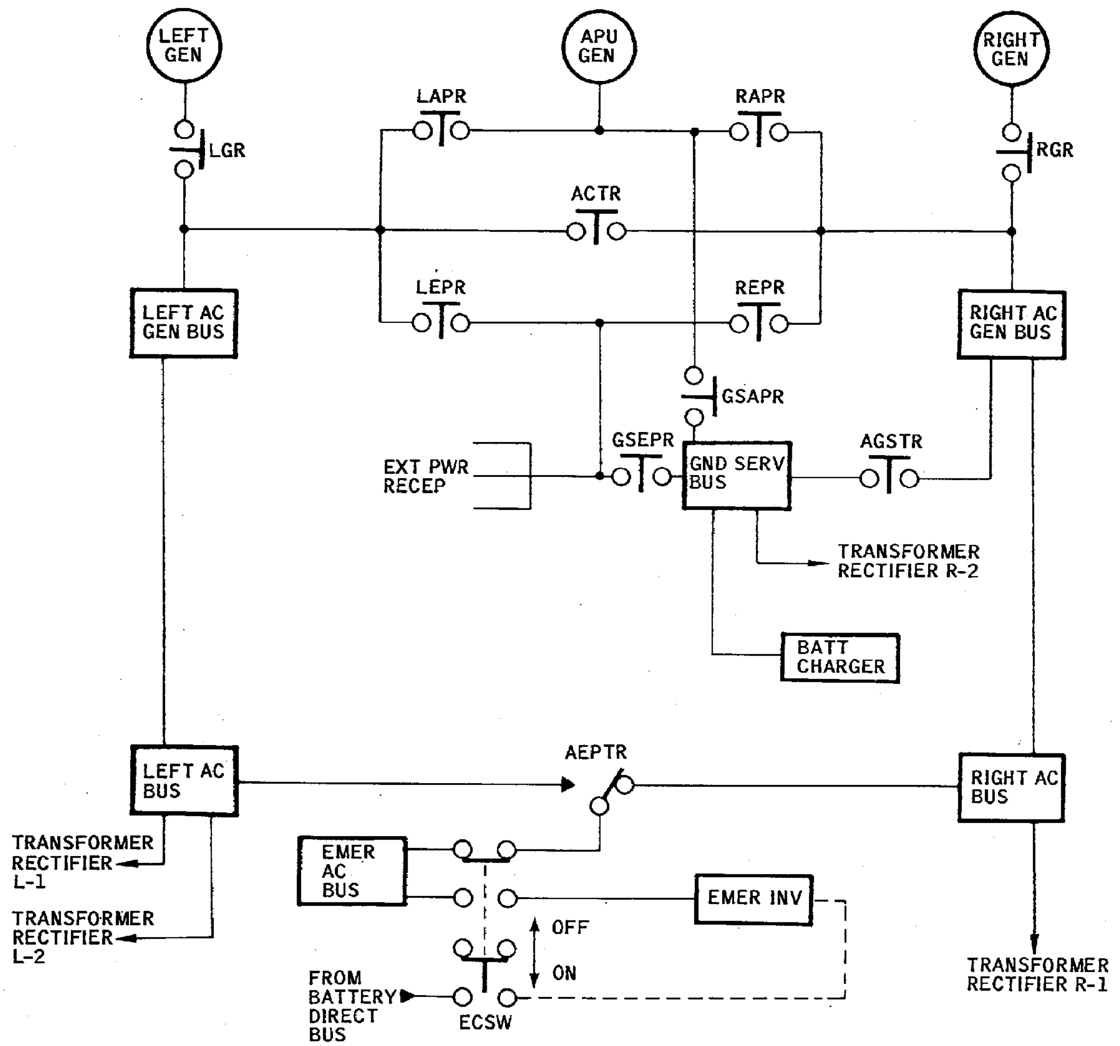
F. A 410-va or 600-va, solid-state inverter is installed in the forward accessory compartment to provide 115-volt, single-phase, AC power to fulfill certain operational requirements. The inverter supplies AC power for ground refueling when only battery power is available. The inverter also supplies power to the AC emergency bus when the emergency power switch is placed in the on position. DC power necessary for operation of the inverter is taken from the battery direct bus.

G. The 28-volt DC electrical power is normally supplied by four 50-ampere, unregulated transformer-rectifiers (TR), installed in the forward accessory compartment. These units are powered from a 115-volt, 3-phase, AC power source. The 28-volt outputs from two of the TR's are connected in parallel to the left DC bus. The output of the third TR is connected directly to the right DC bus. The output of the forth TR is connected to one of the two buses as determined by electrical power requirements. During normal operation, with the right AC bus powered, the DC ground service tie relay is energized. With the relay energized, output of the TR is supplied to the right DC bus. When power for only ground servicing is required, the right AC bus is not powered, the DC ground service tie relay is deenergized and the rectifier output is supplied to the DC transfer bus.

H. A diode is connected in series with the output of each TR unit as an extra precaution in the event of an internal failure of the TR which would allow DC current to flow back into the unit.

I. Two 14-volt batteries, installed in the electrical/electronics compartment, are connected in series to provide 28-volt DC power to the starter control relay of the auxiliary power unit and through an 80-ampere circuit breaker directly to the battery direct bus. The battery direct bus circuit breaker, located in the electrical/electronics compartment, can be manually reset from the flight compartment. A hinged handle is provided on the lower portion of the control pedestal shroud, cable-connected to the circuit breaker reset actuator. Battery power is utilized to start the APU or for refueling operations when no other electrical power source is available. Also, with a proper air supply connected to the engine starter, the batteries can supply the necessary electrical power for starting an engine. If AC power is not available during flight, the batteries are capable of supplying DC power to operate the single-phase inverter, and to the most important DC operated equipment.

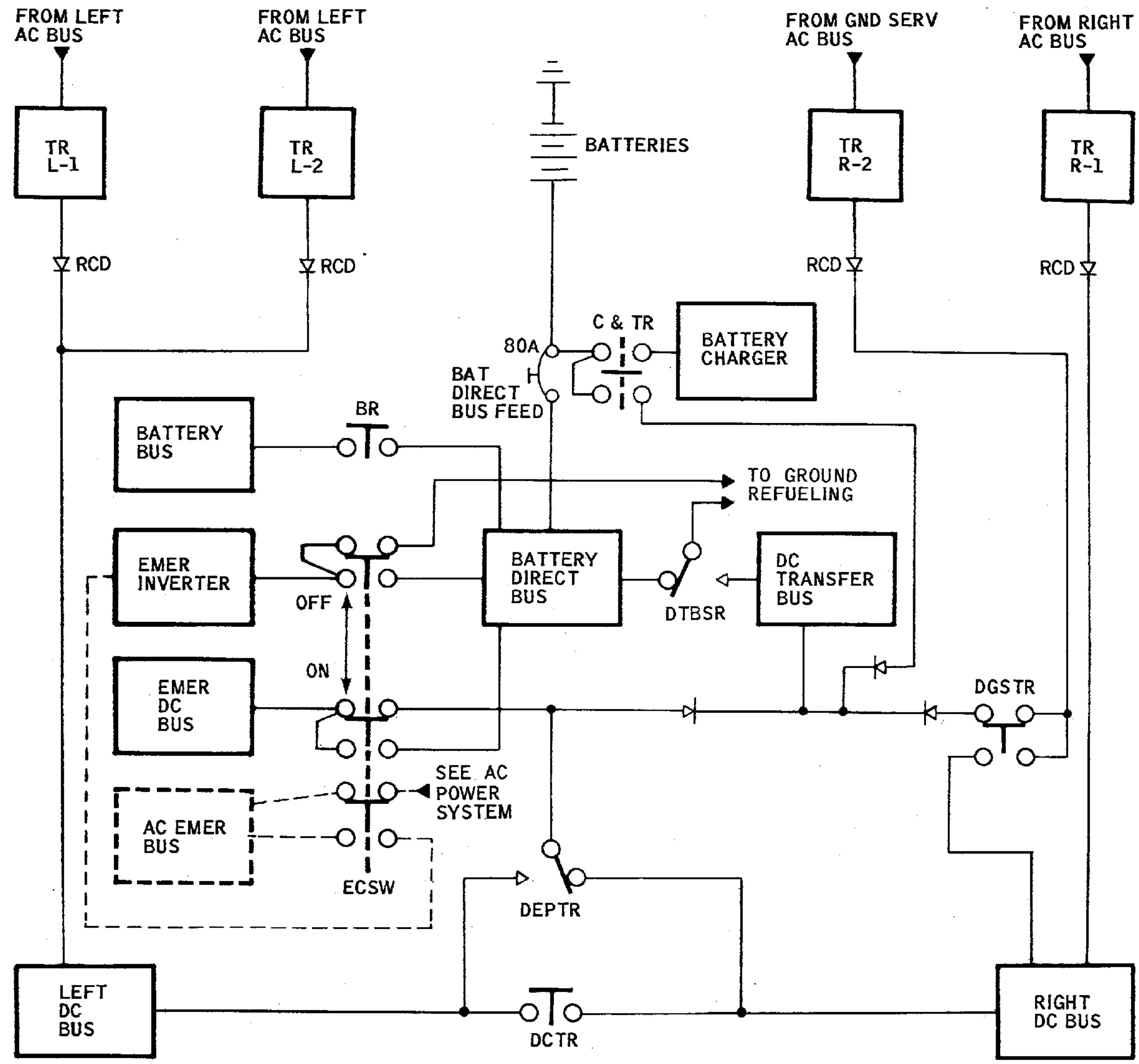
J. Recharging the batteries is accomplished by a high charge rate battery charger installed adjacent to the batteries. The battery charger operates when the ground service AC bus is energized and the battery switch is in the on position. During operation the charger is supplied power from the right AC bus, through the AC ground service tie relay and ground service bus. During ground service operations, the battery charger will operate directly from the ground service bus. In addition to supplying power for recharging the batteries, the battery charger supplies DC power to the battery direct bus and the battery bus during normal operation. When the battery charger is operating, battery voltage indications can vary between 26 and 39 volts, depending on the temperature and state of charge of the batteries.



TR	TRANSFORMER RECTIFIER
LGR	LEFT GENERATOR RELAY
RGR	RIGHT GENERATOR RELAY
ACTR	AC CROSS TIE RELAY
ECSW	EMERGENCY CONTROL SWITCH
LAPR	LEFT AUXILIARY POWER RELAY
RAPR	RIGHT AUXILIARY POWER RELAY
LEPR	LEFT EXTERNAL POWER RELAY
REPR	RIGHT EXTERNAL POWER RELAY
AEPTR	AC EMERGENCY POWER TRANSFER RELAY
AGSTR	AC GROUND SERVICE TIE RELAY
GSAPR	GROUND SERVICE AUXILIARY POWER RELAY
GSEPR	GROUND SERVICE EXTERNAL POWER RELAY

BBB2-24- 1

AC Power System -- Block Diagram
Figure 1/24-00-00-990-803



NOTE: SOME CIRCUIT BREAKERS ARE NOT SHOWN

BR	BATTERY RELAY
TR	TRANSFORMER RECTIFIER
RCD	REVERSE CURRENT DIODE
C & TR	BATTERY CHARGER & DC TRANSFER BUS RELAY
DCTR	DC CROSS TIE RELAY
ECSW	EMERGENCY POWER SWITCH
DEPTR	DC EMERGENCY POWER TRANSFER RELAY
DGSTR	DC GROUND SERVICE TIE RELAY
DTBSR	DC TRANSFER BUS SENSING RELAY

BBB2-24- 2

DC Power System -- Block Diagram
Figure 2/24-00-00-990-804

2. Control and Indication

A. The flight compartment overhead switch panel is divided into sections and/or subpanels containing the controls and indications for individual systems used on the airplane. Controls and indications used for the electrical power system are located on three portions of the overhead panel: the electrical power section, the ground service electrical power panel, and the annunciator panel.

B. Electrical Power Section

(1) Switches

(a) Left and right constant-speed drive disconnect (L CSD and R CSD) switches -- guarded and normally in normal (NORM) position. When placed in the disconnect (DISC) position, an electric solenoid is energized in the CSD, allowing the CSD input shaft to be disconnected from the remaining portion of the CSD gear train. The CSD must be rotating for the actual disconnect operation. This switch will not reengage the CSD when returned to normal position.

(b) Left and right generator control (L GEN and R GEN) switches -- normally in ON position which allows automatic system operation. OFF position trips the generator relay if the relay is closed. RESET position is momentary and resets the generator control relay if the relay is tripped. If the control relay is closed, no action occurs.

(c) APU generator (APU GEN) reset switch -- normally in NORM position. RESET position is momentary and resets the APU generator control relay if the relay is tripped. If the relay is closed, no action occurs.

(d) APU left and right bus (APU L BUS and APU R BUS) switches -- normally in OFF position which removes APU power from the associated bus. The ON position places APU generator on the associated bus if APU power is available and an engine-driven generator is not connected to the bus.

(e) External power left and right bus (EXT PWR L BUS and EXT PWR R BUS) switches -- normally in OFF position which removes external power from the associated bus. The ON position places external power on the associated bus if external power is available and no other power is on the bus.

(f) AC bus crosstie (AC BUS X TIE) switch -- normally in AUTO position. For ground operation with either the APU sup-plying power or with an external power source supplying power, AUTO position has no function as the AC crosstie relay cannot close due to interlocking action of ground control relays. For flight operation, the AC crosstie relay will close automatically if either of the two generators being used should disconnect from the associated AC bus, unless a bus fault lockout occurs. This applies to any combination of the left, right, or APU generation operation. The OPEN position trips the AC crosstie relay if the relay is closed. If the relay is open, no action occurs. With the switch in OPEN position, the AC crosstie relay cannot be closed.

(g) DC bus crosstie (DC BUS X TIE) switch -- normally in OPEN position. With switch in OPEN position, the left and right DC buses are not connected. The CLOSE position closes the DC crosstie relay and connects the left and right DC buses.

(h) Emergency power (EMER PWR) switch -- normally in OFF position which allows AC and DC emergency buses to receive power from the main distributing systems. The OFF position allows the ground refueling AC circuit be energized from the inverter and allows the battery charger to charge the batteries if AC power is on the buses and the battery switch is in ON position. When the emergency power switch is placed in the ON position, power for inverter operation is connected to the battery direct bus, and the AC and DC emergency buses are transferred to the inverter and batteries, respectively. The ON position turns on the emergency power in-use (EMER POWER IN USE) light, removes the batteries from the battery charger, and, if the battery (BATT) switch is in the ON position and the DC transfer bus is not receiving power from the ground service bus, connects the DC transfer bus to the batteries.

(i) Battery (BATT) switch -- normally in ON position. When the switch is placed in the ON position, the battery bus is connected to the battery direct bus. The battery switch also works in conjunction with the emergency power switch. The ON position also controls the DC transfer bus power feed. If the DC transfer bus has power from the main DC system or from the ground service bus, the battery switch does not affect power feed. If no DC power is available at the DC transfer bus, placing the switch in the ON position connects the DC transfer bus to the batteries. The battery switch will be in the ON position during flight. The OFF position disconnects the battery bus from the battery direct bus, prevents the battery charger from being connected to the batteries, and disconnects the DC transfer bus from the batteries, if the bus is receiving power from the batteries.

(j) Indicator selector switch -- a 6-position rotary selector switch with no off position. Starting from the extreme counterclockwise position and moving clockwise, the positions and associated indications are:

APU	APU generator AC voltage and frequency
EXT PWR	External power AC voltage and frequency
L	Left generator AC voltage and frequency; left DC bus voltage
R	Right generator AC voltage and frequency; right DC bus voltage
BATT VOLT	DC voltage at batteries
BATT AMP	DC current to or from batteries

(k) Constant-speed drive oil temperature rise (CSD TEMP) switch -- momentary pushbutton-type switch. Pressing on the switch will cause the CSD oil temperature indicators to show oil temperature rise. When the switch is released, the indicators again show oil outlet temperature.

(2) Indicators

(a) Left and right constant speed drive temperature indicators -- double scale indicators. One scale used during normal operation indicates oil outlet temperature. The second scale, if selected, indicates oil temperature rise which is the proportional difference between oil inlet and oil outlet temperature of the CSD. The scales are calibrated in degrees centigrade with limitation markings provided.

(b) Left, right, and APU AC loadmeters -- indicate generator current as sensed from phase A of the associated generator. Indication is proportional to generator rating (0.5 is 50 percent of rating, 1.0 is 100 percent). Maximum allowable continuous reading during all operations is 1.0.

(c) Left and right DC loadmeters -- dual scale instruments. One scale for each of the four transformer-rectifiers indicates output current proportional to the TR rating (0.5 is 50 percent of rating, 1.0 is 100 percent). Maximum allowable continuous reading during all operations is 1.0.

(d) AC voltmeter (AC VOLTS) -- indicates phase A to neutral voltage of the selected source.

(e) AC frequency meter (FREQUENCY CPS) -- indicates frequency as sensed from phase A of the selected source.

(f) DC voltmeter/ammeter -- a combination voltmeter-ammeter indicates the voltage of the selected source in volts or the battery current in amperes. The meter is zero centered and indicates both charge and discharge currents.

(3) Indicating Lights

(a) APU power available (APU PWR AVAIL)(blue) light -- when on, indicates that the APU generator is ready to be put on a bus.

(b) Left and right APU power in-use (APU L BUS and APU R BUS) (blue) light -- when on, indicates APU power is on the associated bus.

(c) External power available (EXT PWR AVAIL)(blue) light -- when on, indicates that external power with the current phase sequence is connected to the airplane.

(d) Left and right external power in-use (EXT PWR L BUS and EXT PWR R BUS)(blue) light -- when on, indicates that external power is supplying power to the associated bus.

(e) Emergency power in-use (EMER POWER IN USE)(blue) light -- when on, indicates that the emergency power switch is on and the batteries are supplying power to the emergency loads.

C. Ground Service Electrical Power Panel

(1) External Power Ground Service Bus and APU Ground Service Bus Switches

(a) Both APU ground service bus (APU PWR) switch and external power ground service bus (EXT PWR) switch -- normally in the OFF position. Both must be placed in OFF position prior to any main engine startup and remain OFF during flight. When power is required for ground servicing, placing the APU ground service bus (APU PWR) switch in the ON position will supply power to the ground service bus, provided the external power ground service bus switch is in the OFF position.

(b) Ground service bus switching must only be accomplished when appropriate APU power or external power sources are available and correct indication is provided. In all cases switching must be accomplished with external power ground service bus (EXT PWR) switch OFF or APU ground service bus (APU PWR) switch OFF. Ground service electrical power is not governed by sequential control as the main bus network. External power ground service bus (EXT PWR) switch -- normally in the OFF position. When power is required for ground servicing, placing the switch in the ON position will supply external power to the ground service bus, provided the APU ground service bus switch is in the OFF position.

(2) Indicating Lights

(a) APU power available (APU PWR AVAIL)(blue) light -- when on, indicates that the APU generator is ready to be put on a bus.

(b) APU PWR and GROUND SERVICE BUS (blue) lights -- when on, indicate that the ground service bus is receiving power through the ground service auxiliary power relay.

(c) External power available (EXT PWR AVAIL)(blue) light -- when on, indicates that external power with correct phase sequence is connected to the aircraft.

(d) External power (EXT PWR) and GROUND SERVICE (blue) lights -- when on, indicate that the ground service bus is receiving power through the ground service external power relay.

D. Annunciator Panel

NOTE: The lights for the electrical power systems located on the annunciator panel are also a portion of the master warning and caution circuit. When either a warning or a caution light on the annunciator panel comes on, the applicable master lights, located on the glareshield, will also come on.

(1) Caution (Amber) Lights

(a) DC TRANSFER BUS OFF -- when on, indicates that battery power is available but the DC transfer bus has no power.

(b) L AC BUS OFF and R AC BUS OFF -- when on, indicates that the left or right AC bus has no power.

(c) L GEN OFF and R GEN OFF -- when on, indicates that the associated generator relay is open (tripped).

(d) APU GEN OFF -- when on, indicates that APU generator power is available and that the left and right auxiliary power relays are open (tripped).

WJE 873, 874

(e) L GEN FEEDER FAULT, R GEN FEEDER FAULT and APU GEN FEEDER FAULT -- when on, indicates that the associated generator distribution system has a fault. (Distribution system fault is also annunciated on the maintenance annunciator panel.)

WJE ALL

(f) L CSD OIL PRESS LOW and R CSD OIL PRESS LOW -- when on, indicates that the oil pressure of the associated CSD is below a predetermined value, or that the CSD oil temperature is above a predetermined value.

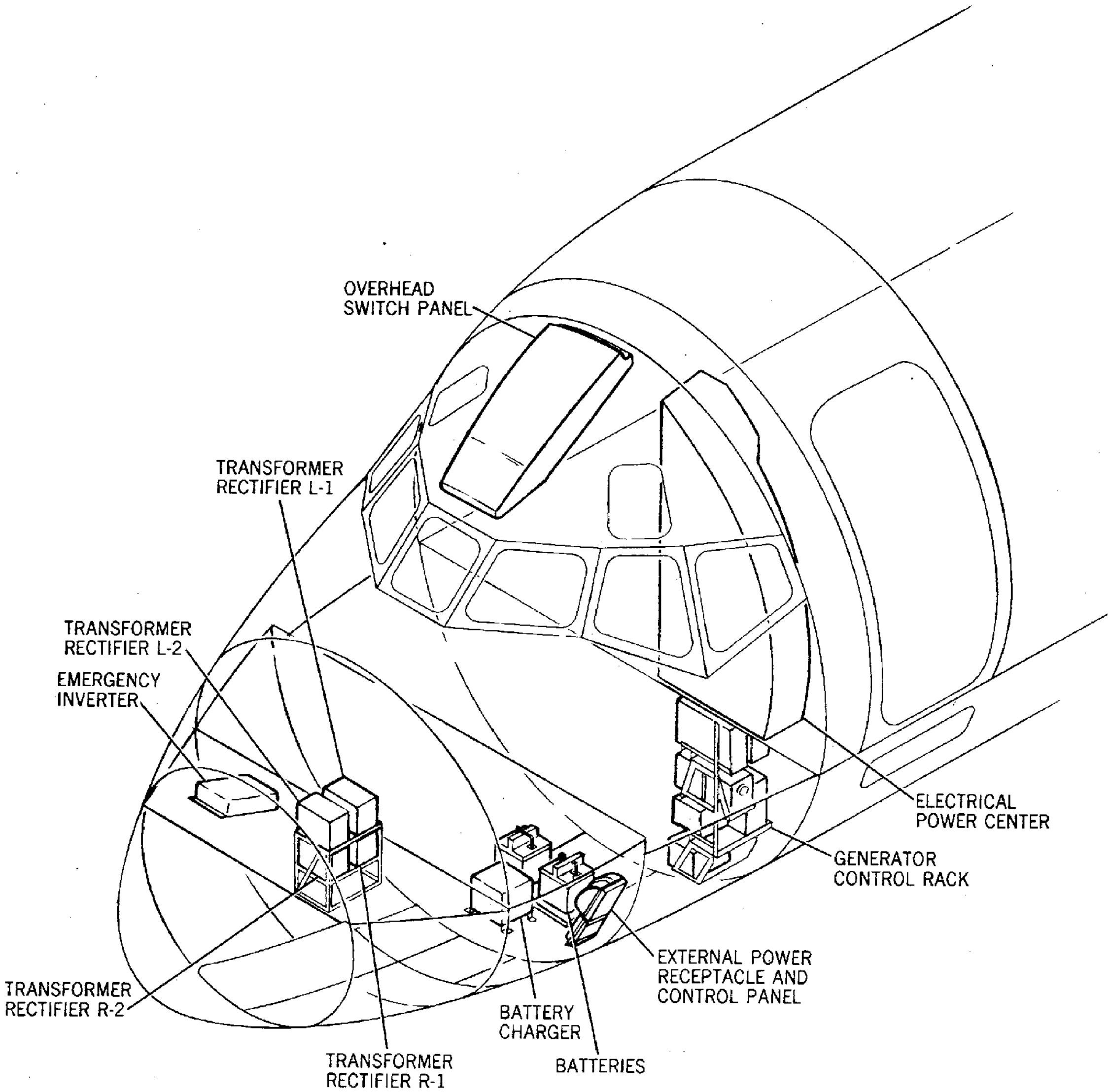
(g) DC BUS OFF -- when on, indicates that either the left or right DC bus has no power.

(h) AC CROSSTIE LOCKOUT -- when on, indicates that the left and right AC generator buses cannot be tied together due to the AC crosstie lockout relay being closed.

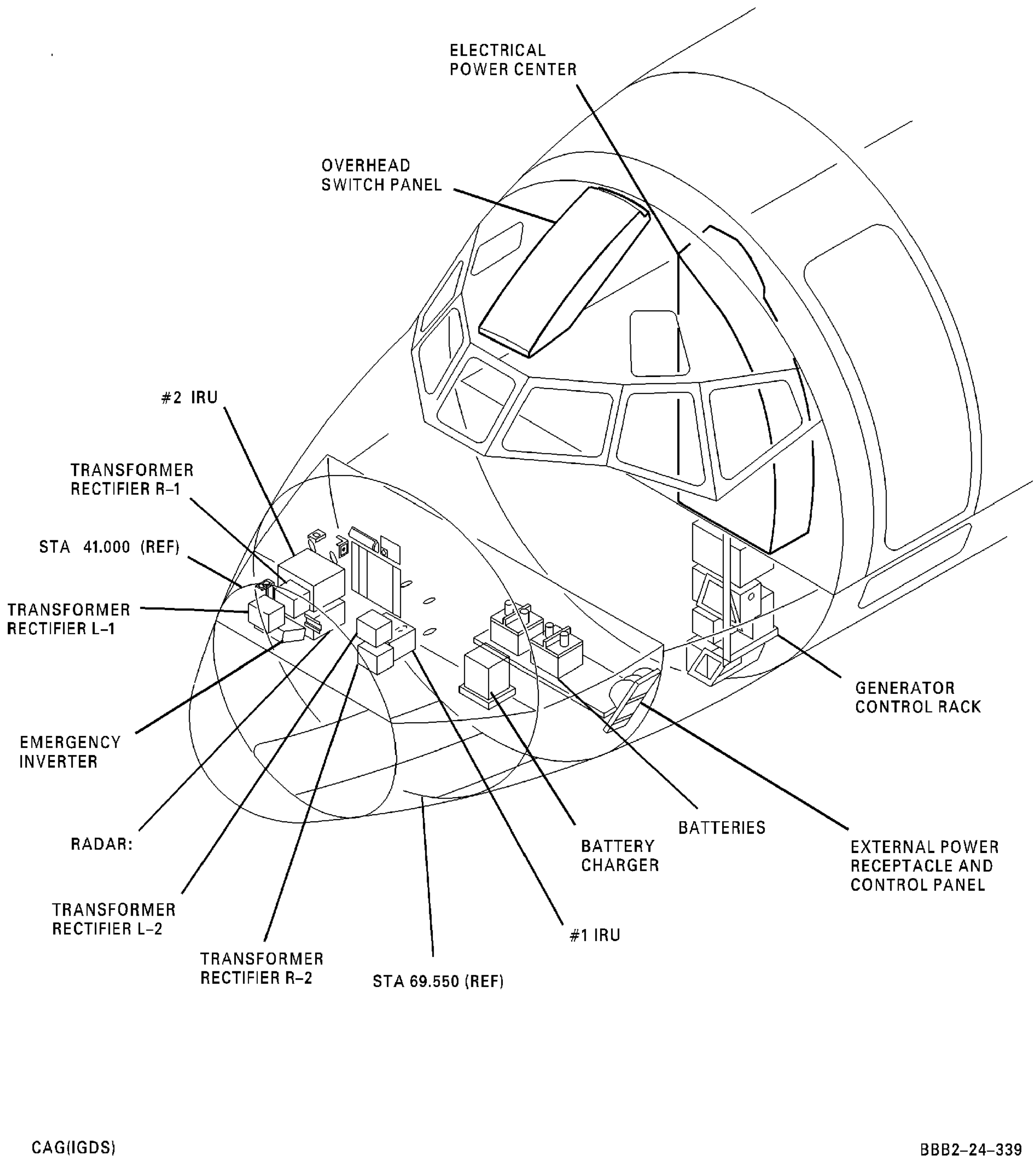
(2) Warning (Red) Lights

(a) AC EMER BUS OFF -- when on, indicates that the AC emergency bus has no power.

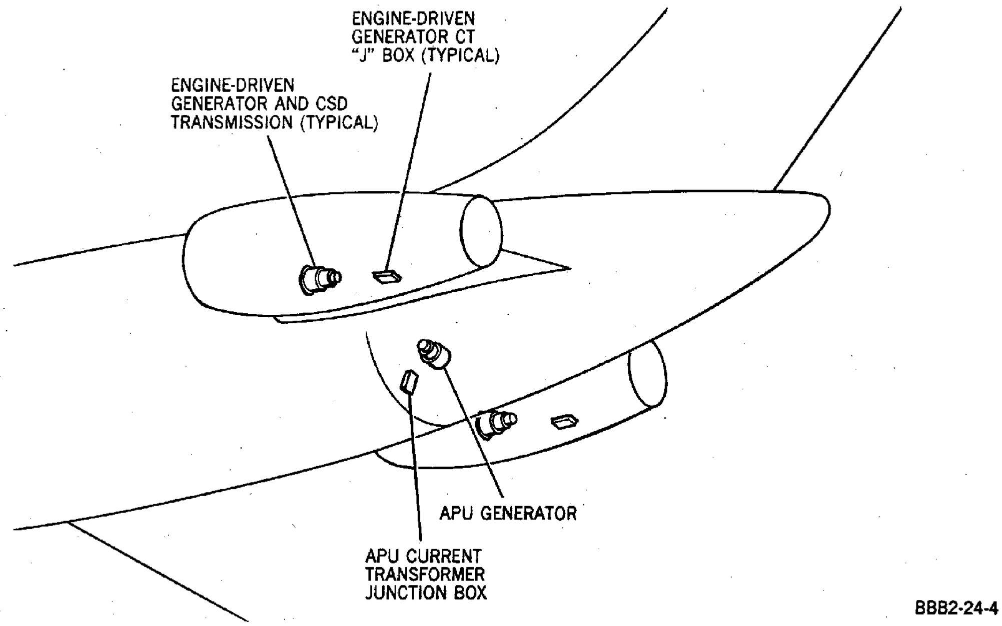
(b) DC EMER BUS OFF -- when on, indicates that the DC emergency bus has no power.



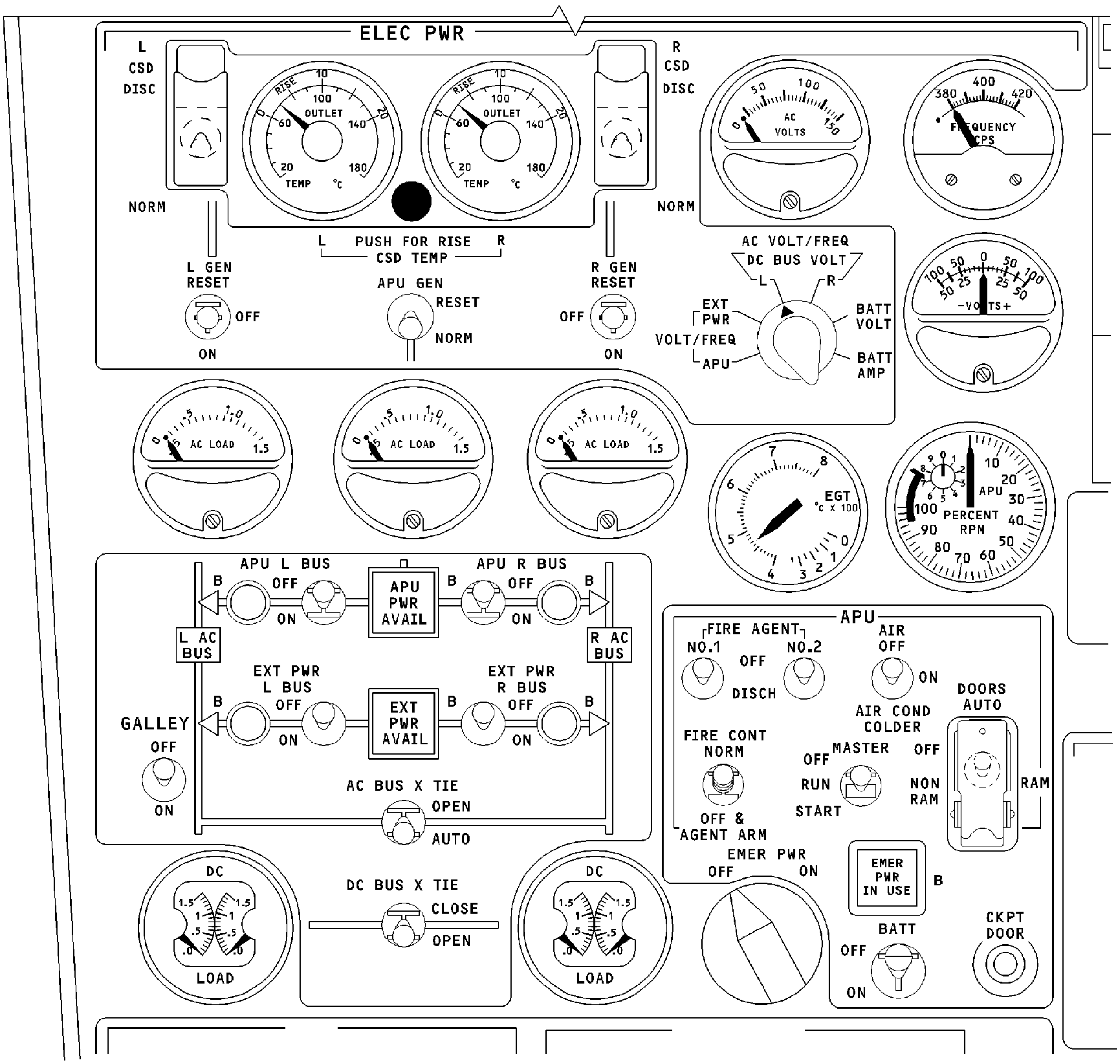
Electrical Power System Installation -- Forward Fuselage
Figure 3/24-00-00-990-805 (Sheet 1 of 2)



Electrical Power System Installation -- Forward Fuselage
Figure 3/24-00-00-990-805 (Sheet 2 of 2)



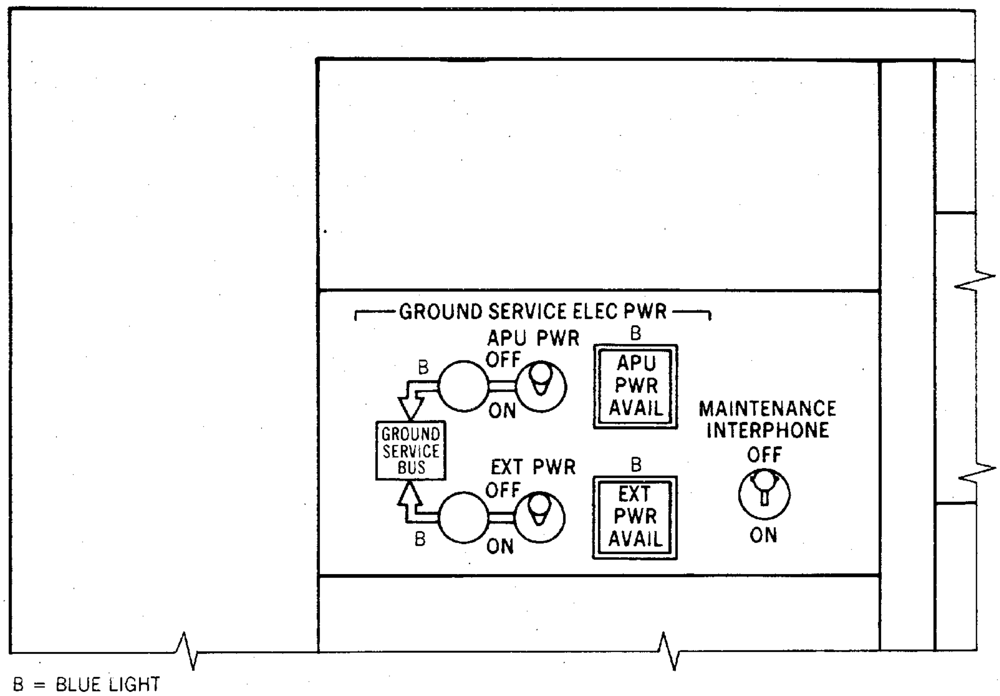
Electrical Power System Installation -- Aft Fuselage
Figure 4/24-00-00-990-806



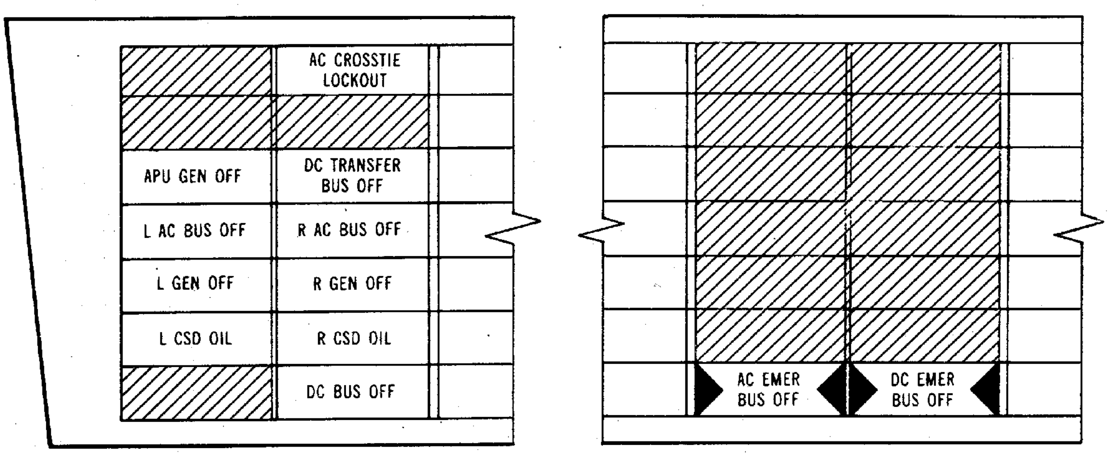
B = BLUE LIGHT

CAG(IGDS) BBB2-24-5B

Overhead Switch Panel Electrical System Controls and Indications
Figure 5/24-00-00-990-807 (Sheet 1 of 6)



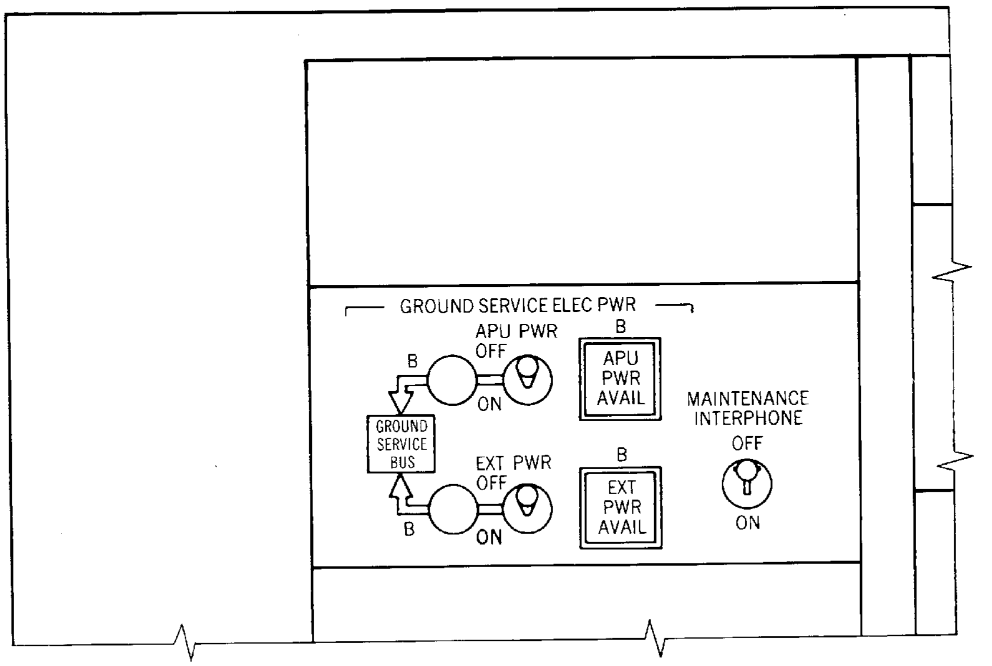
AFT OVERHEAD SWITCH PANEL



ANNUNCIATOR PANEL

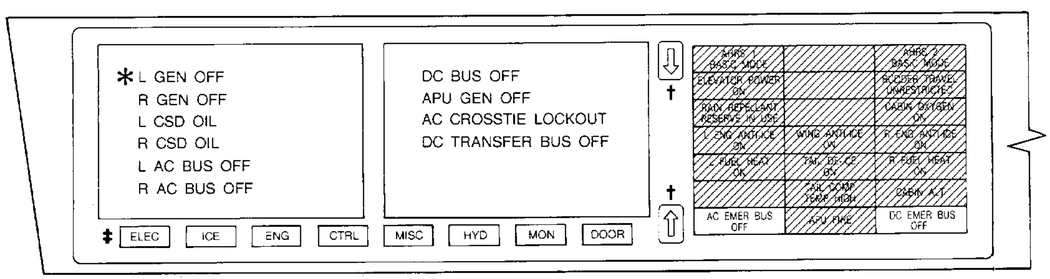
BBB2-24-74A

Overhead Switch Panel Electrical System Controls and Indications
Figure 5/24-00-00-990-807 (Sheet 2 of 6)



B = BLUE LIGHT

AFT OVERHEAD SWITCH PANEL



ANNUNCIATOR PANEL

✱ ANNUNCIATIONS NOT NECESSARILY IN THIS SEQUENCE.
ANNUNCIATIONS APPEAR ONLY IF PROBLEM EXISTS.
ONLY ANNUNCIATIONS IMPORTANT TO CHAPTER 24 ARE SHOWN.

† USE SCROLL BUTTONS, IF ILLUMINATED, FOR ANNUNCIATIONS STORED OFF SCREEN.

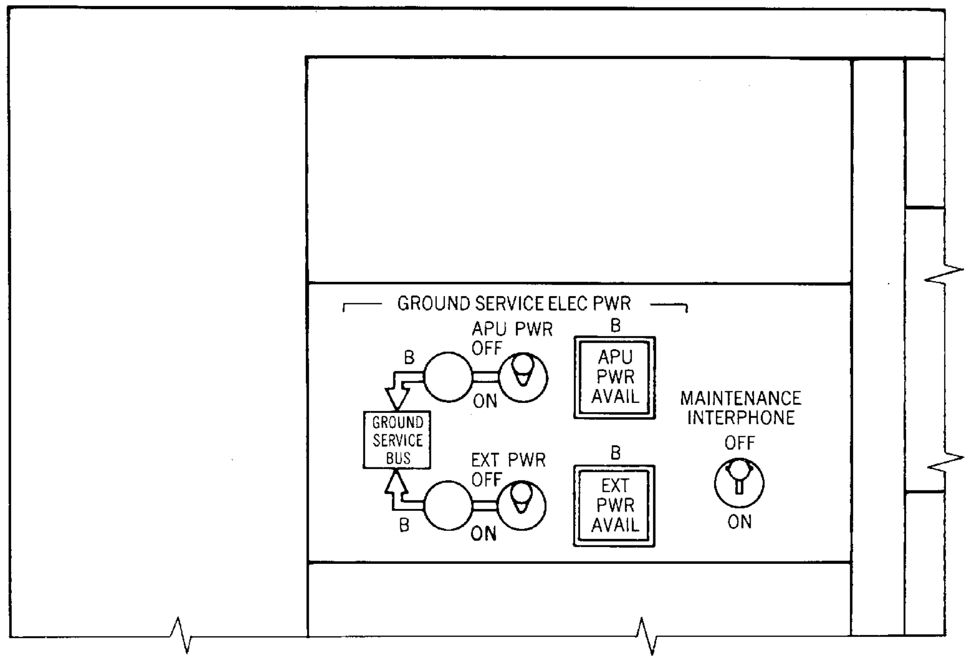
‡ ELEC CUE LIGHT FLASHES FOUR TIMES AND GOES OUT EACH TIME A NEW ELECTRIC ANNUNCIATION IS DISPLAYED ON SCREEN.

ELEC CUE LIGHT ON STEADY INDICATES ELECTRIC ANNUNCIATION STORED OFF SCREEN

PUSH ELEC CUE LIGHT TO DISPLAY ONLY ELECTRIC FAULT ANNUNCIATIONS. IF THERE ARE NO ELECTRIC FAULTS, NO ELEC FAULTS WILL BE DISPLAYED.

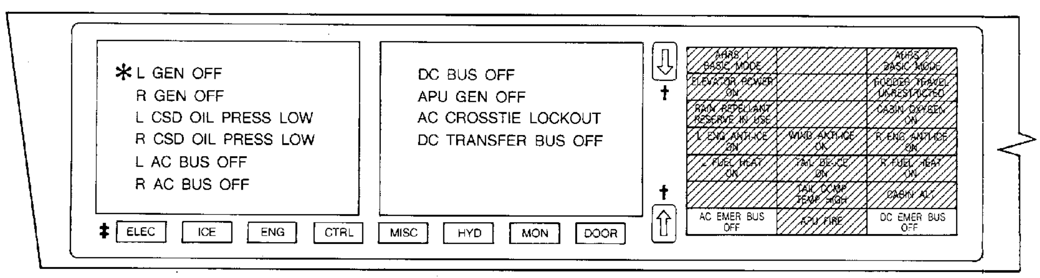
BBB2-24-254

Overhead Switch Panel Electrical System Controls and Indications
Figure 5/24-00-00-990-807 (Sheet 3 of 6)



B = BLUE LIGHT

AFT OVERHEAD SWITCH PANEL



ANNUNCIATOR PANEL

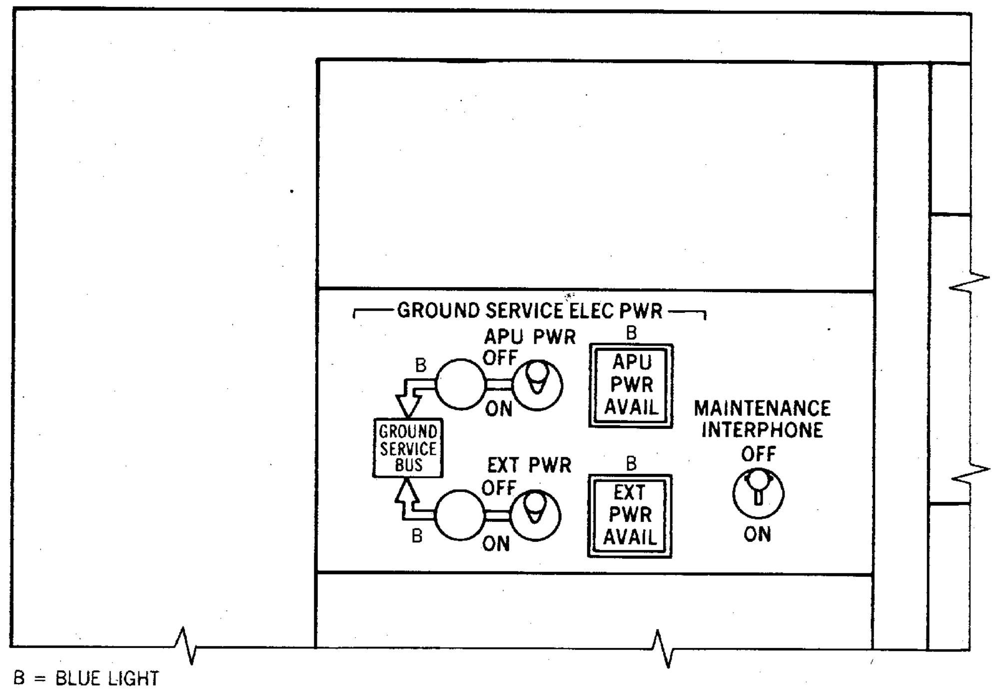
* ANNUNCIATIONS NOT NECESSARILY IN THIS SEQUENCE.
ANNUNCIATIONS APPEAR ONLY IF PROBLEM EXISTS.
ONLY ANNUNCIATIONS IMPORTANT TO CHAPTER 24 ARE SHOWN.

† USE SCROLL BUTTONS, IF ILLUMINATED, FOR ANNUNCIATIONS STORED OFF SCREEN.

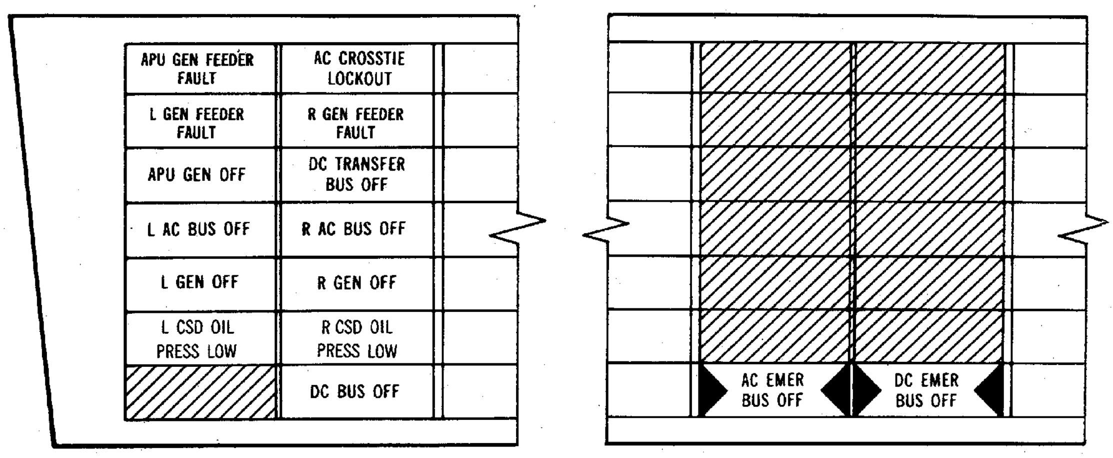
‡ ELEC CUE LIGHT FLASHES FOUR TIMES AND GOES OUT EACH TIME A NEW ELECTRIC ANNUNCIATION IS DISPLAYED ON SCREEN.
ELEC CUE LIGHT ON STEADY INDICATES ELECTRIC ANNUNCIATION STORED OFF SCREEN
PUSH ELEC CUE LIGHT TO DISPLAY ONLY ELECTRIC FAULT ANNUNCIATIONS. IF THERE ARE NO ELECTRIC FAULTS, NO ELEC FAULTS WILL BE DISPLAYED.

BBB2-24-253

Overhead Switch Panel Electrical System Controls and Indications
Figure 5/24-00-00-990-807 (Sheet 4 of 6)



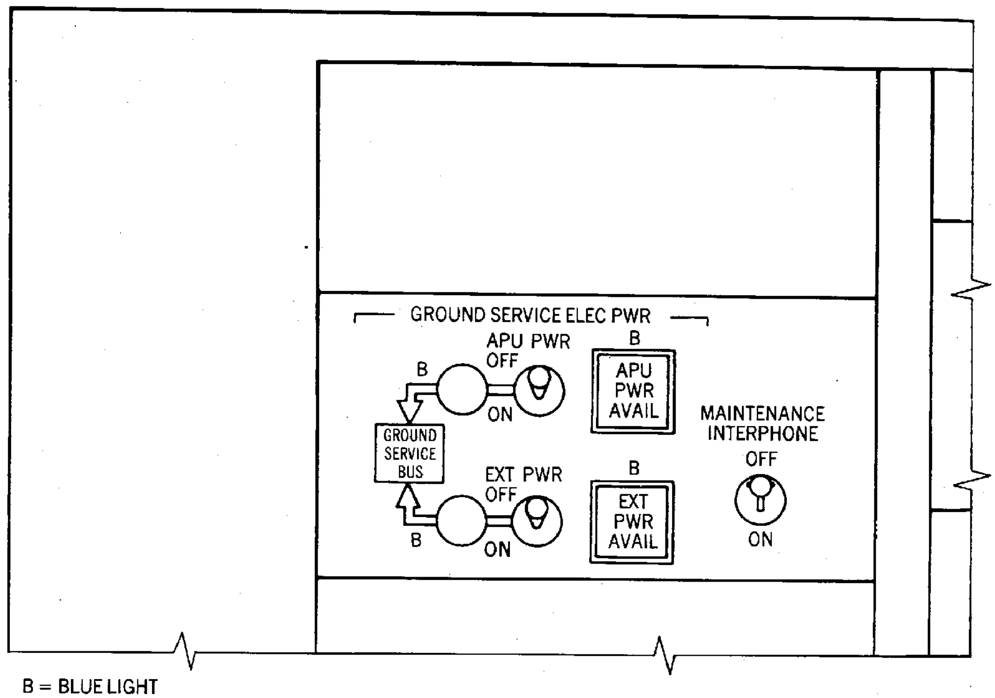
AFT OVERHEAD SWITCH PANEL



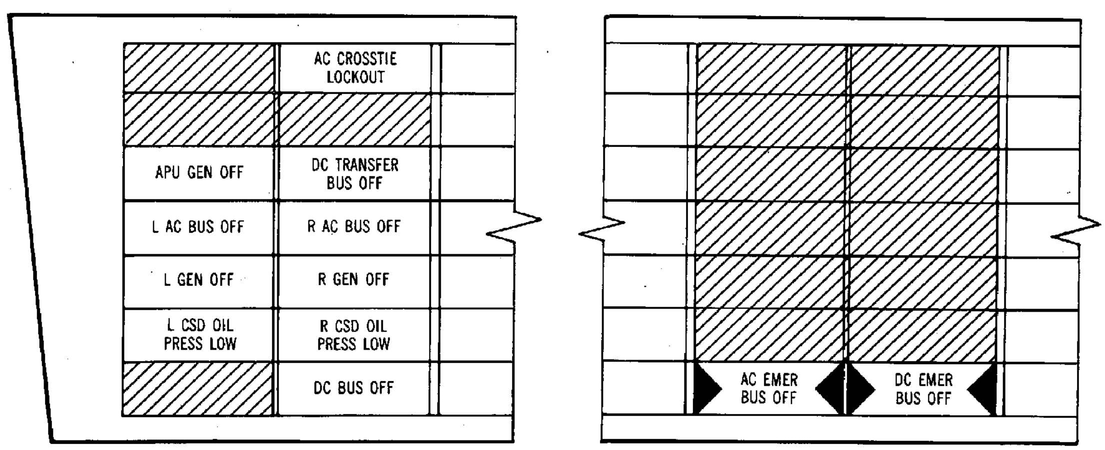
ANNUNCIATOR PANEL

BBB2-24-75A

Overhead Switch Panel Electrical System Controls and Indications
Figure 5/24-00-00-990-807 (Sheet 5 of 6)



AFT OVERHEAD SWITCH PANEL



ANNUNCIATOR PANEL

BBB2-24-135

Overhead Switch Panel Electrical System Controls and Indications
Figure 5/24-00-00-990-807 (Sheet 6 of 6)

3. Electrical Power Limitation

A. The values shown in the normal column are normal operating ranges. Indications outside the normal range indicate possible system abnormalities.

CAUTION: ANY CONDITION WHICH CAUSES ANY INDICATION IN THE ALLOWABLE COLUMN, OTHER THAN WITHIN THE NORMAL RANGE, SHOULD BE CORRECTED AT THE EARLIEST OPPORTUNITY.

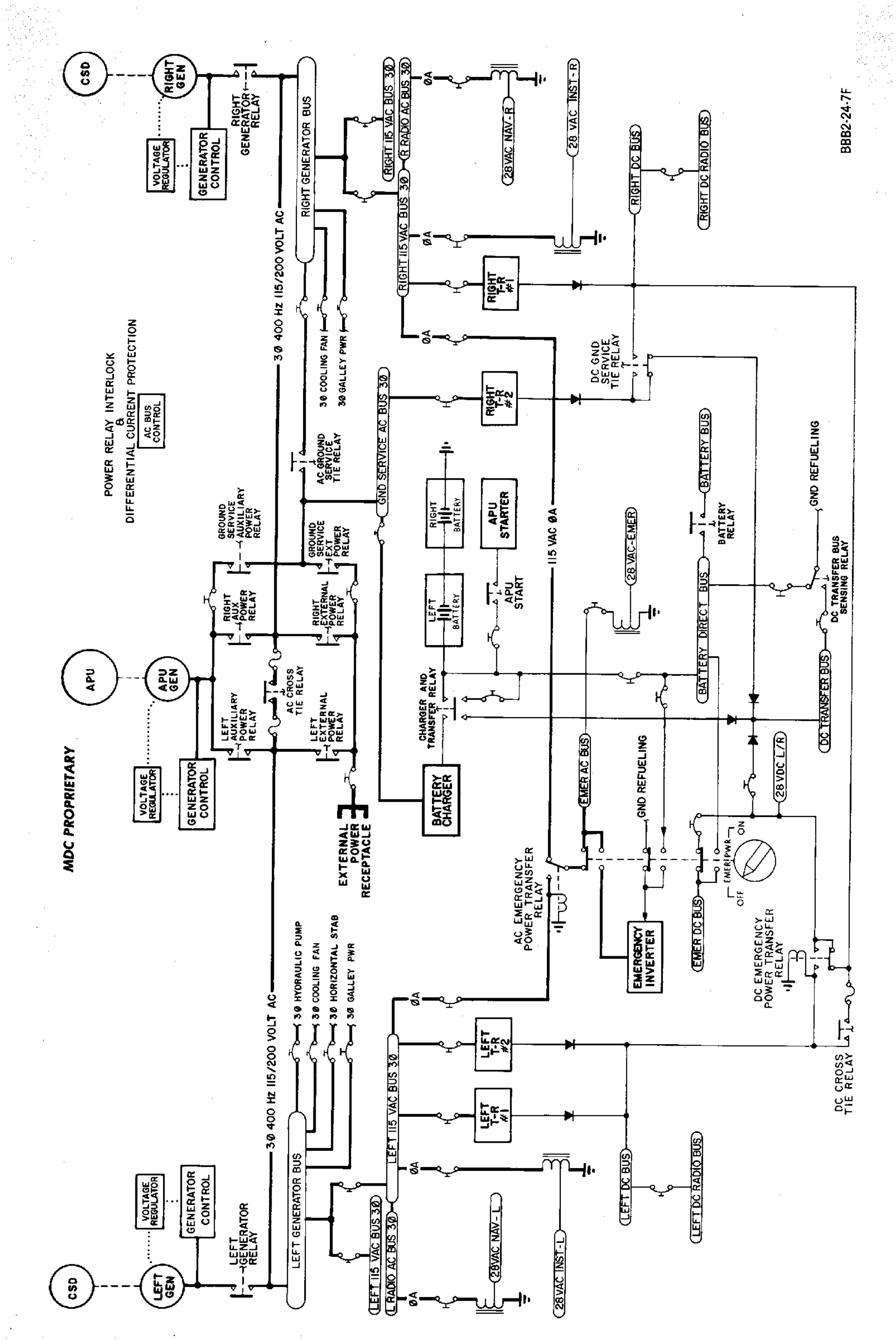
B. Limits shown in the allowable column should not be exceeded, and sustained operation at these limits is not recommended.

Table 1

	Normal Min or Max		Allowable	
			Min	Max
Left DC loadmeter	Maximum difference between the two indications should not exceed 0.3 and both units should indicate some load.		Zero	1.0
Right DC loadmeter	Same as left.			
Right or left DC bus	24 to 28 volts		22 volts	30 volts
Engine generator	Voltage	112 to 118 volts	107 volts	123 volts
	Frequency:	396 to 404 cps	380 cps	420 cps
APU generator	Voltage:	112 to 118 volts	107 volts	123 volts
	Frequency: (Ground)	390 to 415 cps	380 cps	420 cps
	Frequency: (Flight) up to 35,000 ft.	395 to 420 cps	380 cps	420 cps
External power (Ref. NOTE 1)	Voltage:	112 to 118 volts	107 volts	123 volts
	Frequency:	396 to 404 cps	380 cps	420 cps
AC load- meters of operating generators (Ref. NOTE 2)	ENGINE GENERATORS			
	Over zero and under 1.0		Zero	1.0
	APU GENERATOR			
	Over zero and under 1.0		Zero	1.0 below 25,000 ft 0.7 above 25,000 ft
Ground operation	Over zero and under 1.25		Zero	1.25
Battery voltage:				
a. No other power on airplane. No load on battery.	28 to 29 volts		Not less than 27 volts	
b. Battery charging	30 to 33 volts		Ref. NOTE 3)	

Table 1 (Continued)

	Normal Min or Max	Allowable Min	Allowable Max
c. Emergency power switch in on position.	Not less than 26 volts	Not less than 24 volts	
Battery amperes:			
a. Battery charging	Zero to 65 amperes (Sundstrand charger) or 45 amperes (Utah R.D.C. charger, SB 24-93) to the left (Ref. NOTE 4)		
b. Emergency switch in on position	10 to 35 amperes to the right		
Generator drive trans mission oil temperature rise (with temperature rise switch in pressed position)	Zero to 11.2°C		11.2°C
Generator drive trans mission out let oil temperature	40°C to 146°C		163°C
NOTE: #1 If external power is not within normal limits, it should be corrected as soon as possible.			
NOTE: #2 Generator ratings for operation are: (a) 1.0 continuous (equivalent to 40KVA). (b) 1.5 for 5 minutes. (c) Over 1.5 for 5 seconds (the overload rating of the generator is 2.0 for 5 seconds).			
NOTE: #3 Battery voltage may be steady or may be fluctuating, depending on mode of operation of the battery charger. The allowable limits may be noted when battery temperature sensor resistance is indicating temperature extremes of 0°F or 165°F. Trouble Shooting, Battery Temperature Sensing Chart.(DC GENERATION - TROUBLE SHOOTING, PAGEBLOCK 24-30-00/101)			
NOTE: #4 Battery current will vary depending on battery condition. A severely discharged battery may cause current limit action which appears as an oscillation between 40 and 65 amperes (Sundstrand charger) or 45 amperes (Utah R.D.C. charger, S.B. 24-93). Subsequently continuous current from 65 amperes decreasing to approximately 40 amperes, and then into a pulse mode of operation at intervals of approximately 5 seconds to 20 minutes or longer.			



Electrical Power System -- Schematic
Figure 6/24-00-00-990-808

GENERAL - REMOVAL/INSTALLATION

1. General

A. Removal and installation instructions for components of the electrical system requiring special attention are outlined in procedural steps, to enable the job to be done easily and efficiently.

B. Removal and installation instructions are not given for components that are secured in position with standard bolts or screws, or secured in a mount assembly with knurled nuts, as removal/installation is obvious. Some components have electrical connectors and/or terminals that need to be disconnected before removal, while other components have an electrical connector that is an integral part of the component. This type connector is usually found on components that are installed on a mount assembly, and are mated to a receptacle installed on the mount when the component is properly seated in the mount. Whenever electrical equipment is removed, the receptacle and the plug of the connector should be protected from the entrance of material that may cause damage to the pins or shorting when power is applied to the circuit.

C. When replacing defective equipment, use equipment that has an identical part number unless the use of substitute equipment has been authorized. After installation of serviceable equipment, adjustment/tests should be conducted to ensure that the applicable system is operating properly.

D. Paragraph 2. describes typical removal and installation of a rack-mounted component and of a relay. Procedures may vary slightly with each individual component or relay.

2. Removal/Installation

A. Remove Rack-mounted Components

(1) Remove electrical power from unit by Paragraph 2.A.(1)(a) or Paragraph 2.A.(1)(b).

(a) Open applicable circuit breaker(s).

1) Install clamp under open circuit breaker(s). Suitable clamps are HPV-5N (Burndy) or P4-5WS (Nylon Molding Corporation).

WARNING: DO NOT CLOSE THIS CIRCUIT BREAKER(S). THIS CIRCUIT BREAKER(S) MUST REMAIN OPEN UNTIL COMPLETION OF MAINTENANCE WORK.

2) Tag circuit breaker(s) with warning sign.

WARNING: DO NOT APPLY EXTERNAL POWER.

(b) Disconnect external power. Tag external power receptacle with warning sign.

(2) Gain access to unit.

NOTE: The following step is not applicable to units having an integral electrical connector.

(3) Disconnect electrical connectors; cap connectors and receptacles.

(4) Loosen knurled nuts on holddown assemblies.

(5) Disengage holddown assemblies from mounting brackets.

CAUTION: TO PREVENT DAMAGE TO ENGAGING PINS AND ELECTRICAL CONNECTOR, DO NOT RAISE PANEL WHILE IT IS BEING PULLED OUT.

(6) Pull unit from mount.

B. Install Rack-mounted Components

(1) Make certain that power is removed, as called out in Paragraph 2.A.(1).

CAUTION: IF UNIT BEING INSTALLED HAS AN INTEGRAL ELECTRICAL CONNECTOR, MAKE CERTAIN THAT CONNECTOR IS PROPERLY MATED WITH RECEPTACLE TO PREVENT DAMAGE TO PINS OF CONNECTOR.

(2) Place unit on mount and slide in as far as it will go. Do not raise unit.

(3) Engage holddown assemblies with mounting brackets.

(4) Tighten knurled nuts on holdown assemblies.

NOTE: The following step is not applicable to units having an integral electrical connector.

(5) Uncap and connect electrical connectors to receptacles on unit.

(6) Install parts removed to gain access to unit.

(7) Remove warning tag. Apply external power or close circuit breaker(s), as applicable.

(8) Follow applicable system adjustment/test procedures to determine that unit is functioning properly.

C. Remove Relay

(1) Remove electrical power from relay by either Paragraph 2.C.(1)(a) or Paragraph 2.C.(1)(b).

(a) Open applicable circuit breaker(s).

1) Install clamp under open circuit breaker(s). Suitable clamps are HPV-5N (Burndy) or P4-5WS (Nylon Molding Corporation).

WARNING: DO NOT CLOSE THIS CIRCUIT BREAKER(S). THIS CIRCUIT BREAKER(S) MUST REMAIN OPEN UNTIL COMPLETION OF MAINTENANCE WORK.

2) Tag circuit breaker(s) with warning sign.

WARNING: DO NOT APPLY EXTERNAL POWER.

(b) Disconnect external power. Tag external power receptacle with warning sign.

(2) Gain access to relay.

(3) Tag and disconnect wires.

(4) Support relay and remove mounting screws.

(5) Remove relay.

D. Install Relay

(1) Make certain that power is removed, as called out in Paragraph 2.C.(1).

NOTE: Before installation, make certain that paint is removed from relay mounting flange so that a good electrical bond between relay and structure of airplane is provided.

(2) Position relay.

(3) Install and tighten mounting screws.

(4) Connect wires, making certain that leads are connected correctly.

(5) Torque terminals to value listed in SWPM 20–20–03, General Installations Hardware - Maintenance Practices.

(6) Remove tags from wires.

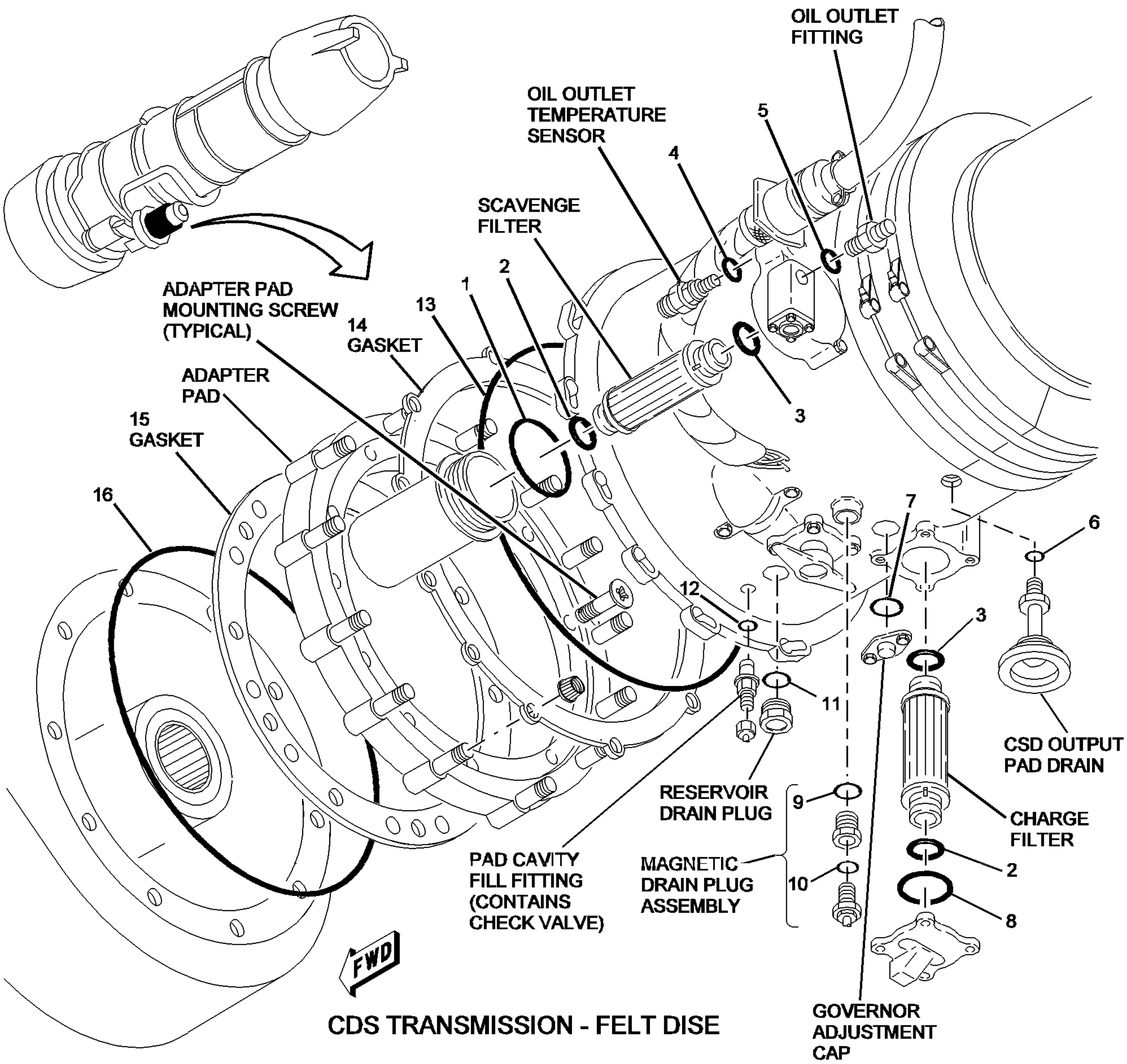
(7) Install parts removed to gain access to relay.

(8) Remove warning tag. Apply external power or close circuit breaker(s) as applicable.

(9) Follow applicable system Adjustment/Test procedures to determine that relay is functioning properly.

3. **Electrical Power System O-rings**

A. O-rings, used when installing the CSD transmission and various components on the CSD transmission, are shown and listed by part number (Figure 401)



CDS TRANSMISSION - FELT DISE

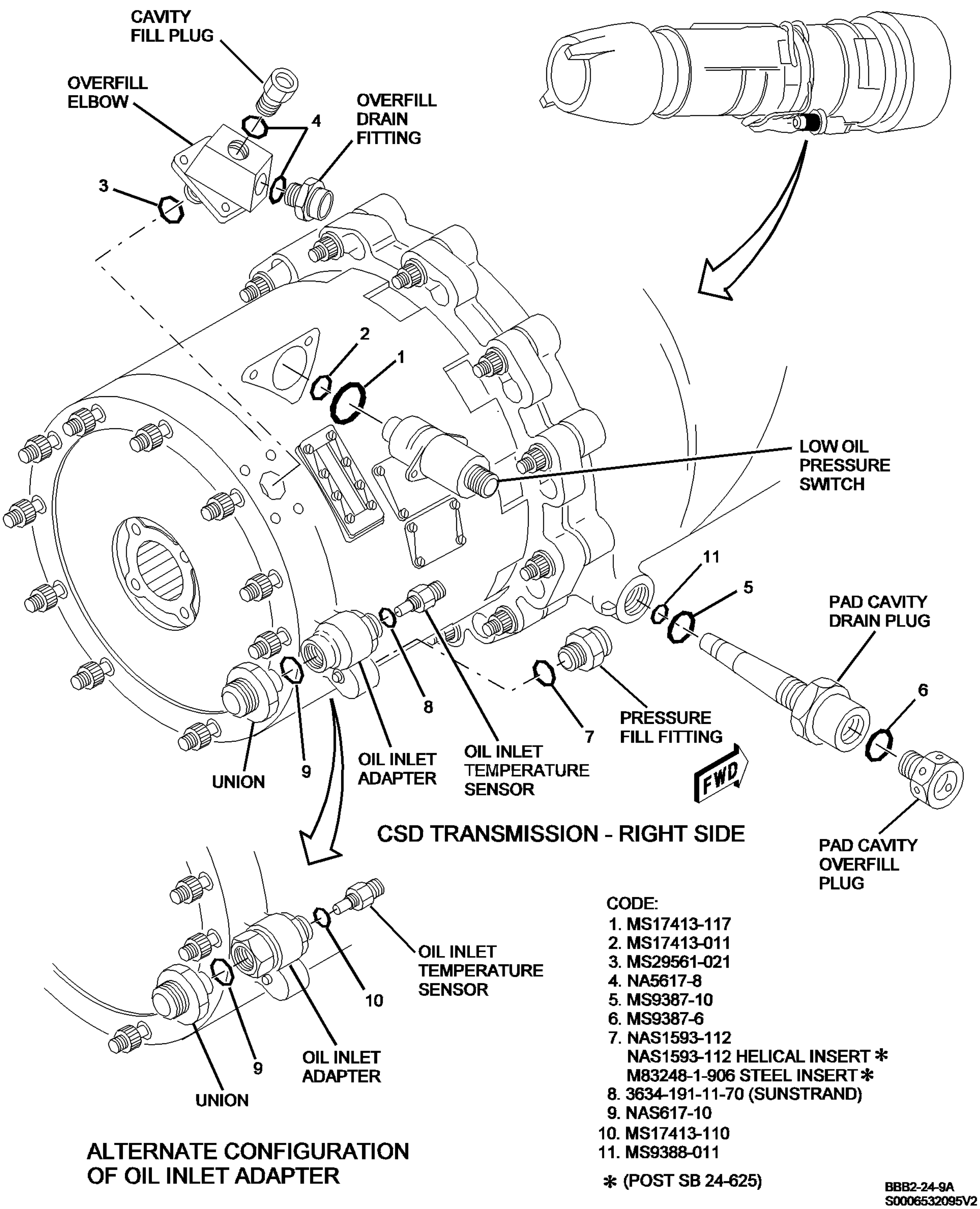
CODE:

1. MS17413-225
2. MS17413-018
3. MS17413-014
4. MS17413-110
   M83248-1-110 HELICAL INSERT*
   M83248-1-904 STEEL INSERT*
5. NAS1593-114
   NAS1593-114 HELICAL INSERT*
   M83248-1-908 STEEL INSERT*
6. NAS1593-110
   NAS1593-110 HELICAL INSERT*
   M83248-1-904 STEEL INSERT*
7. MS17413-016
8. MS17413-128
9. MS17413-111
   M83248-1-111 HELICAL INSERT*
   M83248-1-905 STEEL INSERT*
10. 3634-202-11-70 (SUNSTRAND)
11. MS17413-112
    M83248-1-112 HELICAL INSERT*
    M83248-1-906 STEEL INSERT*
12. 1611-0716C (SUNSTRAND)
13. MS17413-270
14. 696944 (SUNSTRAND)
15. 693206 (SUNSTRAND)
16. 28904-3 (SUNSTRAND)

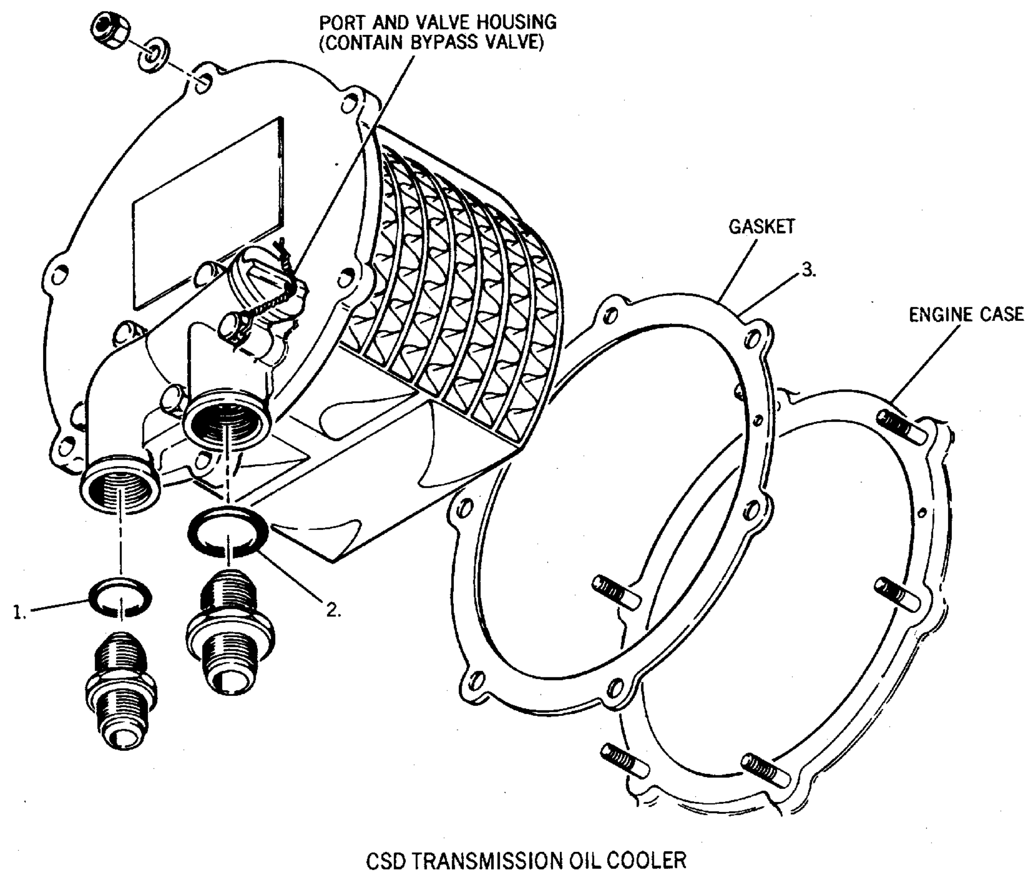
* (POST SB 24-625)

BBB2-24-76A
S0006532093V1

Electrical Power System Components -- O-rings Installation
Figure 401/24-00-00-990-801 (Sheet 1 of 3)



Electrical Power System Components -- O-rings Installation
Figure 401/24-00-00-990-801 (Sheet 2 of 3)



CODE:

1. NAS617-10
2. NAS617-12
3. 22D36 (JANITROL AERO DIVISION)

BBB2-24-10

Electrical Power System Components -- O-rings Installation
Figure 401/24-00-00-990-801 (Sheet 3 of 3)

GENERAL - ADJUSTMENT/TEST

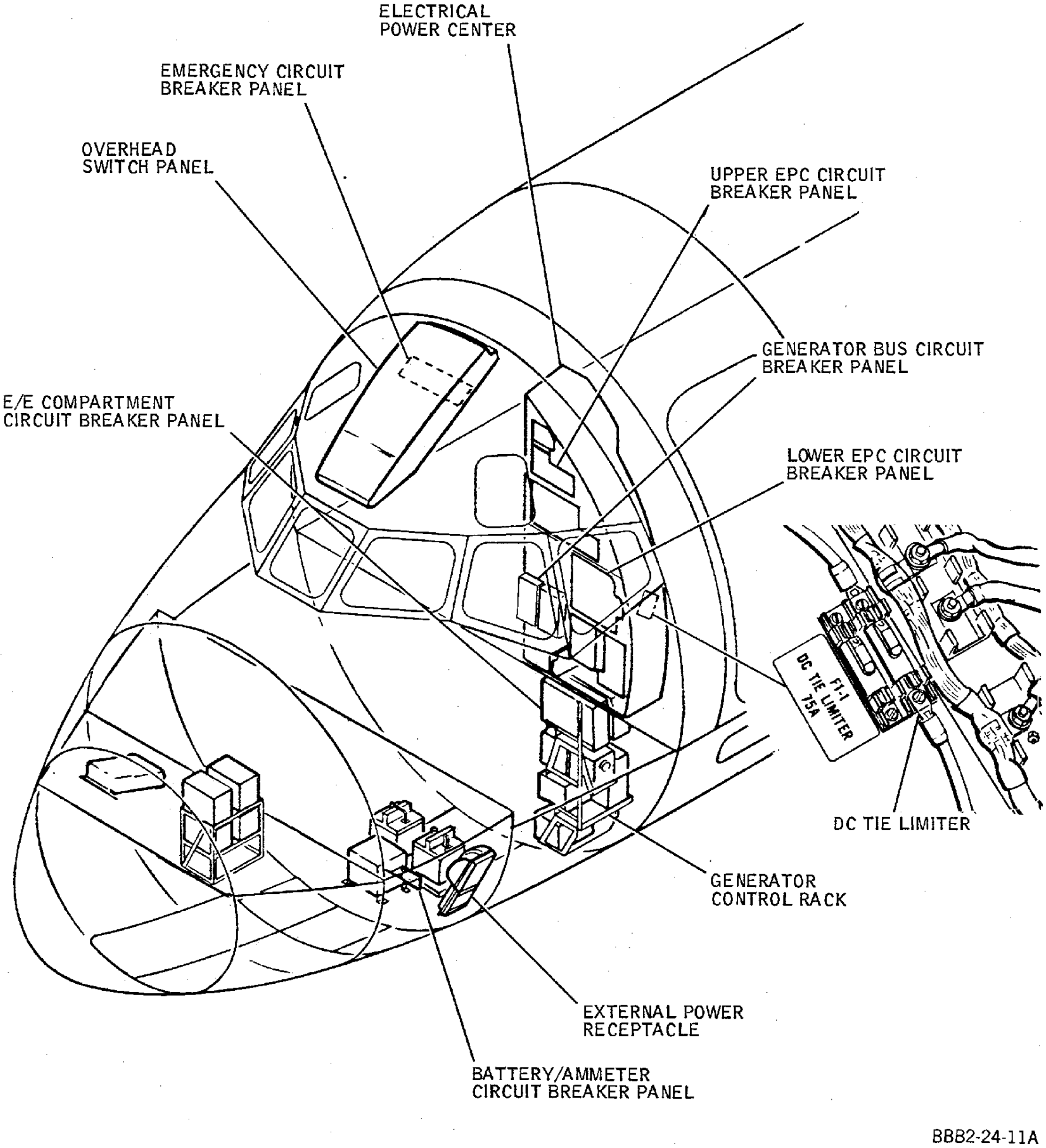
1. General

A. Adjustment/test procedures are given as an aid for adjustment and/or test of a complete system or a particular component.

Detailed adjustment/test procedures are given in the sections that cover a complete system; i.e., dc generation, generator drive, etc. In sections covering component removal and installation, a simple adjustment/test is given following the installation of the component.

B. Before applying power to the electrical system to be tested, check that all associated switches located on the electrical power and ground service electrical power panels are in the off, normal, or open position as applicable.

C. Before starting the test procedures, make certain that all circuit breakers associated with electrical power supply and distribution are closed. Throughout this chapter it will be assumed that all breakers associated with electrical power are closed at all times, except as noted. Locations of circuit breakers used in circuits of the ac or dc electrical power system. (Figure 501)



Electrical Power System Circuit Breakers Location -- Forward Fuselage
Figure 501/24-00-00-990-802

GENERAL - INSPECTION/CHECK

1. **General**

   A. This section provides instructions for performing a preventive maintenance check and a damage evaluation check of the electrical system components and associated areas.

   B. The preventive maintenance check should be performed in addition to scheduled inspection requirements in order to increase the safety and efficiency of the aircraft. All readily accessible areas should be checked for discrepancies. Whenever a closed area is opened for maintenance, a check of the area should be accomplished before the area is closed. Discrepancies to be checked and corrected are described in paragraph 2.

   C. The damage evaluation check should be performed when it has been determined that the aircraft electrical system has been subjected to one or more of the following improper external power applications:

   WARNING: IF ANY OF THE BELOW CONDITIONS HAVE OCCURRED, PARAGRAPH 3. MUST BE ACCOMPLISHED PRIOR TO NEXT FLIGHT.

   (1) Voltage above 130 volts AC or below 100 volts AC.

   (2) Frequency above 425 Hz or below 375 Hz.

   (3) Incorrect phase rotation.

   D. If aircraft has been exposed to an external power overvoltage exceeding 134 VAC, for any duration, do a Return-To-Service check of the following components (if installed) before aircraft is returned to service:

Table 601

COMPONENT	MAINTENANCE MANUAL REFERENCE
Digital Flight Guidance Computer	DIGITAL FLIGHT GUIDANCE COMPUTER, SUBJECT 22-01-01
Lateral Accelerometers	DUAL LATERAL ACCELEROMETER, SUBJECT 22-19-02
3 Axis Accelerometers	DUAL 3-AXIS ACCELEROMETER, SUBJECT 22-19-01
WJE 401-404, 407, 408, 410-412, 414, 875-879, 881, 883, 892	
High Frequency Receiver/Transmitters	HF TRANSCEIVER, SUBJECT 23-10-01
WJE ALL	
Very High Frequency Receiver/Transmitters	VHF COMMUNICATIONS TRANSCEIVER, SUBJECT 23-20-01
Cockpit Voice Recorder	MICROPHONE VOICE RECORDER MONITOR, SUBJECT 23-70-01
EPR Indicators	INSTRUMENTS - GENERAL, SUBJECT 31-00-01
Flight Data Acquisition Unit	DATA ACQUISITION SYSTEM, SUBJECT 31-31-02
Central Aural Warning Unit	CENTRAL AURAL WARNING UNIT, SUBJECT 31-51-02
WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
Systems Display Panel	ELECTRONIC SYSTEMS DISPLAY PANEL, SUBJECT 31-61-01
WJE ALL	
Altimeter (Electric)	ALTIMETER, SUBJECT 34-12-01

Table 601 (Continued)

COMPONENT	MAINTENANCE MANUAL REFERENCE
Mach Airspeed Indicator	MACH AIRSPEED INDICATOR, SUBJECT 34-13-01
Central Air Data Computer	CENTRAL AIR DATA COMPUTER, SUBJECT 34-16-01
Stall Warning Computer	COMPUTER STALL WARNING, SUBJECT 34-19-02
WJE 405, 409, 410, 415, 416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873, 874, 880, 881, 883, 884, 891-893	
Directional Gyro	DIRECTIONAL GYRO, SUBJECT 34-21-04
WJE 406-408, 411, 877	
Radio Magnetic Indicator	RADIO MAGNETIC INDICATOR, SUBJECT 34-21-05
WJE 405, 409, 410, 415, 416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873, 874, 880, 881, 883, 884, 891-893	
Compass Indicator	COMPASS INDICATOR, SUBJECT 34-21-07
WJE 406-408, 411, 886, 887	
Attitude Heading Reference Unit	(ATTITUDE/HEADING REFERENCE UNIT, SUBJECT 34-21-10)
WJE 401-404, 412, 414, 417, 419, 421, 423, 865, 869, 871, 872, 875-879, 886, 887	
Radio Distance Magnetic Indicator	RADIO DISTANCE MAGNETIC INDICATOR, SUBJECT 34-21-12
WJE 405, 409, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893	
Horizontal Situation Indicator	HORIZONTAL SITUATION INDICATOR, SUBJECT 34-22-03
WJE 401-404, 406-408, 410-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
Navigation Display Unit	EFIS NAVIGATION DISPLAY UNIT, SUBJECT 34-22-06
Symbol Generator	EFIS SYMBOL GENERATOR, SUBJECT 34-22-10
WJE 405, 409, 410, 880, 884	
Vertical Gyro	VERTICAL GYRO, SUBJECT 34-23-01
WJE 405, 409, 416, 420, 422, 424-427, 429, 861, 862, 868, 874, 880, 881, 883, 884, 891-893	
Attitude Director Indicator	ATTITUDE DIRECTOR INDICATOR, SUBJECT 34-23-02
WJE 401-404, 406-408, 410-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
Primary Flight Display	PRIMARY FLIGHT DISPLAY (PFD), SUBJECT 34-23-06
WJE ALL	
Standby Horizon Indicator	STANDBY HORIZON INDICATOR, SUBJECT 34-28-01
Standby Horizon Static Inverter	STANDBY HORIZON STATIC INVERTER, SUBJECT 34-28-02
VOR/ILS Receiver	VOR/ILS RECEIVER, SUBJECT 34-32-02
VHF NAV Control Panel	VHF NAV CONTROL PANEL, SUBJECT 34-32-03
Radio Altimeter Transceiver	RADIO ALTIMETER TRANSCEIVER, SUBJECT 34-42-03
WJE 401-404, 412, 414, 417, 419, 421, 423, 865, 869, 871, 872, 875-879	
Inertial Reference Unit	INERTIAL REFERENCE UNIT, SUBJECT 34-43-01

WJE 401-404, 412, 414, 417, 419, 421, 423, 865, 869, 871, 872, 875-879 (Continued)

Table 601 (Continued)

COMPONENT	MAINTENANCE MANUAL REFERENCE
WJE ALL	
Ground Proximity Warning Computer	ENHANCED GROUND PROXIMITY WARNING COMPUTER, SUBJECT 34-45-01
WJE 410, 412, 414, 875-879	
Traffic Collision Avoidance Computer	TCAS COMPUTER, SUBJECT 34-46-01
WJE 401-404, 406-412, 414, 417, 419, 421, 423, 864, 865, 869, 871-879, 884, 886, 887, 892, 893	
Windshear Computer	WINDSHEAR COMPUTER, SUBJECT 34-47-01
WJE ALL	
ADF Receiver	ADF RECEIVER, SUBJECT 34-53-05
WJE 405, 409, 410, 874, 881, 883, 884, 886, 887, 892	
Omega Receiver Processor Unit	OMEGA RECEIVER PROCESSOR UNIT, SUBJECT 34-55-01
Omega Control Display Unit	ANTENNA COUPLER UNIT, SUBJECT 34-55-03
WJE 405-411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 886, 887, 891-893	
Performance Management Control Display Unit	PERFORMANCE MANAGEMENT CONTROL DISPLAY UNIT, SUBJECT 34-63-01
Performance Management Computer Unit	PERFORMANCE MANAGEMENT COMPUTER, SUBJECT 34-63-02
WJE 401-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-881, 883, 884	
Flight Management Computer	ADVANCED FLIGHT MANAGEMENT COMPUTER, SUBJECT 34-63-03
Multipurpose Control Display Unit	MULTIPURPOSE CONTROL DISPLAY UNIT, SUBJECT 34-63-04
WJE 401-406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
Electronic Engine Display Panel	ENGINE DISPLAY PANEL, SUBJECT 77-42-00
WJE ALL	

2. Inspection/Check - Preventive Maintenance

A. Check all readily accessible areas, and closed areas that are open for maintenance, for discrepancies as follows:

(1) Check electrical wiring for physical damage such as chafing, fraying, and cut or mashed insulation.

(2) Check wire clamps and supports for security.

(3) Check that all wiring is supported clear of sharp edges.

(4) Check wiring for liquid impregnation.

(5) Check that terminal connections are secure and that lugs are not cracked or touching adjacent terminals or structure.

(6) Check that no foreign or metallic objects are lying between terminals.

(7) Check electrical bonding jumpers for security and for frayed or broken condition.

(8) Check electrical equipment for proper installation, security of mounting, physical damage, and evidence of overheating.

(9) Check shock-mounted racks and equipment for physical damage and deterioration of rubber mounts.

(10) Check security of lockwire on electrical equipment and electrical connectors, where applicable. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(11) Check interior of electrical junction boxes for cleanness.

3. Inspection/Check - Damage Evaluation

A. Check for evidence of burned or charred insulation; abnormal discoloration of bus bar or terminals; overheated motors; burned out lamps; damage to transformers, instruments, amplifiers, relays, power supplies, controllers, circuit breakers, batteries, and rectifiers; blown fuses; and tripped circuit breakers in the following areas:

(1) Electrical power and distribution centers.

(2) Circuit breaker and fuse panels.

(3) External power protection panel and receptacles.

(4) Junction boxes and equipment panels.

(5) Instrument and switch panels.

(6) Radio racks and distribution centers.

(7) General flight, passenger, under floor, and tail compartments.

NOTE: The above is not intended to cover all areas that may be affected. Conditions found will dictate if further detailed inspection is necessary.

B. Determine if external power unit, aircraft external power circuits, or both, were responsible for improper external power being supplied to electrical buses.

C. Connect external power and perform Return-To-Service check of all systems known to be operating or energized during period of improper power application.

GENERATOR DRIVE - DESCRIPTION AND OPERATION

1. General

A. A constant speed drive (CSD) transmission is located on each engine to provide a means of driving the AC generator at a constant speed regardless of variation in engine operating speeds and applied electrical loads. The transmission is installed on an adapter pad at the lower aft centerline of the engine accessory case.

2. Operation

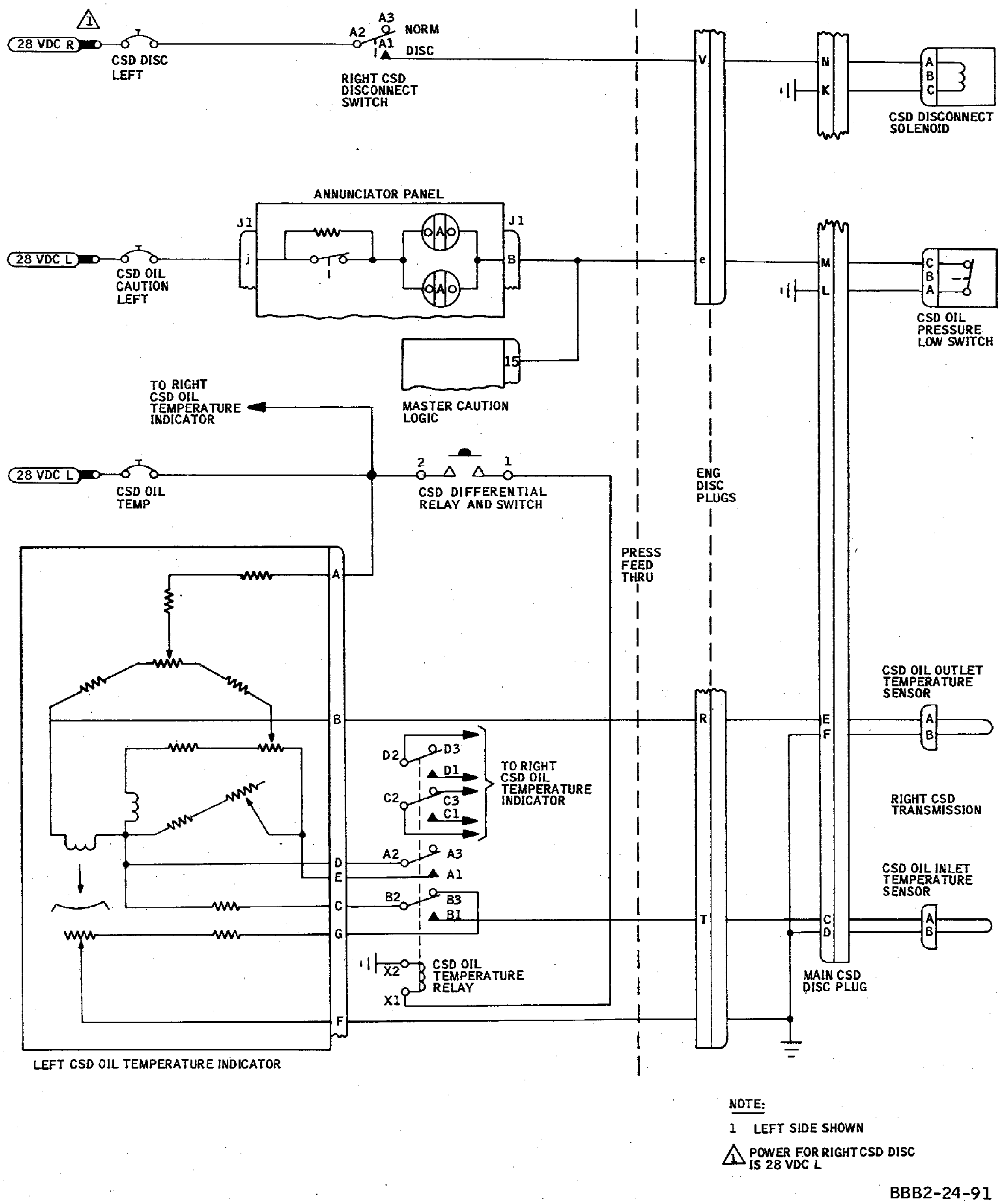
A. The CSD transmission is a gear-differential type unit, which includes a hydraulic system, a power unit, and a governor. The hydraulic system charge pump moves the oil from the integral reservoir through the charge filter to the power unit and governor. The governor is a spring-biased, flyweight-operated hydraulic control valve, which ports charge pressure oil to the control cylinder. As transmission input speed varies, oil flow ported to the control cylinder varies, and the control cylinder is positioned accordingly. Movement of the control cylinder controls operation of the variable hydraulic unit, which is a portion of the power unit. The power unit is capable of adding to, or subtracting from, input speed to maintain a constant output speed of 6000 rpm, within narrow limits. Return oil and drain oil from the transmission sump is pumped through the scavenge filter, the transmission oil cooling system, and back to the reservoir by the scavenge pump. The oil is cooled by engine bypass air flowing across a plate and fin-type oil cooler, which is installed on a mounting pad on the bottom side of the engine.

B. The oil cooler contains a normally closed bypass valve in the port and valve housing, directing the oil through the cooling passages. If during engine start the oil is cold, or if the oil cooler passages become clogged the bypass valve will open. Oil pressure against the poppet valve overcomes spring pressure and the flow of oil is directed from the oil-in port to the oil-out port, bypassing the oil cooling passages.

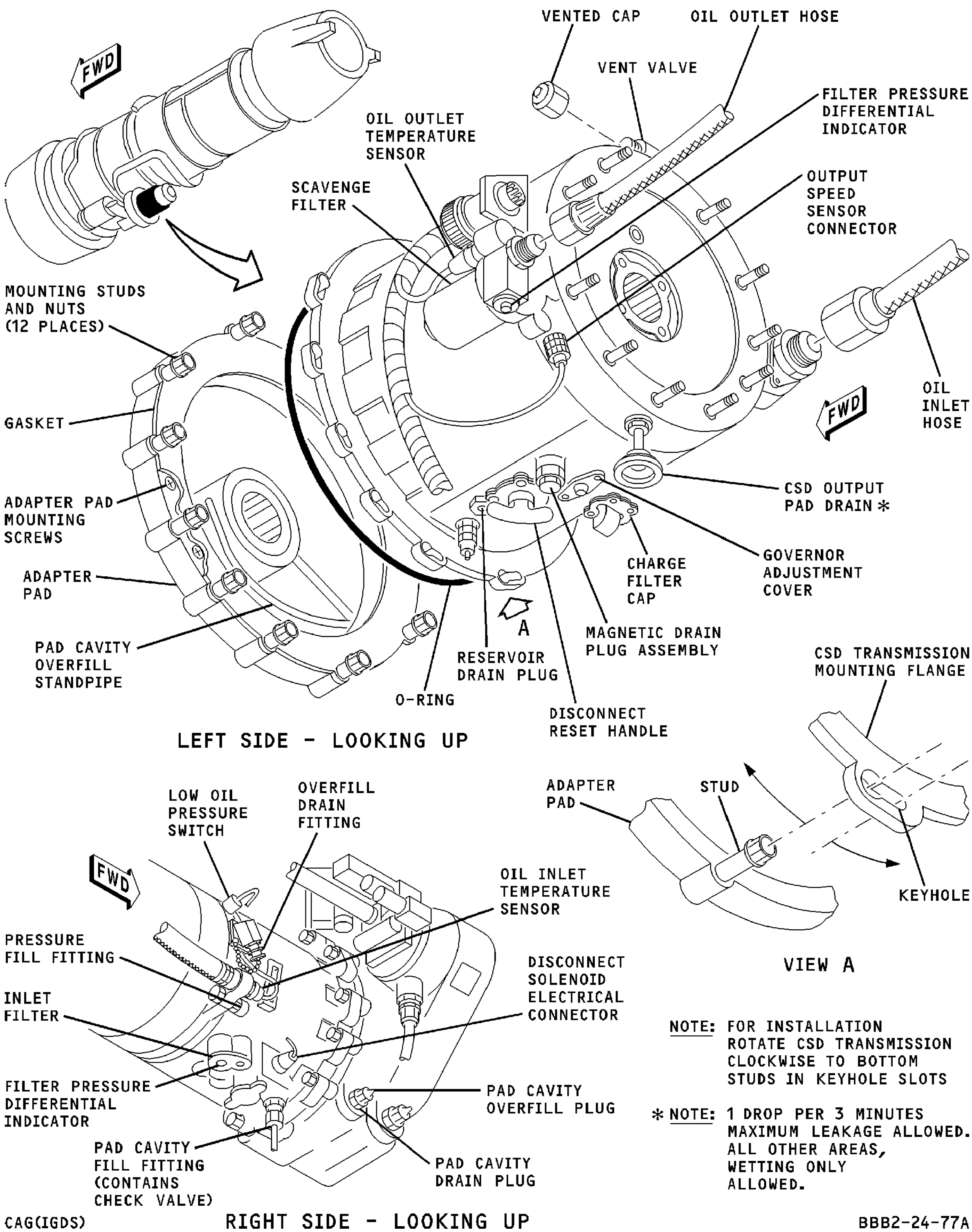
C. To ensure lubrication for the CSD input spline shaft, the cavity formed between the drive end of the transmission and the engine gearbox mounting pad is filled with a sufficient quantity of oil to cover the spline. Filling or adding oil to the CSD transmission or pad cavity is accomplished by connecting a pressure fill stand capable of delivering lubricating oil to fill fittings provided. Overfill drain ports are provided on both the CSD transmission and pad cavity to prevent overfilling.

D. The CSD transmission vent valve is a two-way valve that maintains case air pressure equal to or greater than atmospheric pressure at all altitudes. In the event case air pressure becomes less than atmospheric pressure, the vent valve opens at a 0-2 psi differential and case air pressure is increased to equalize atmospheric pressure. As case air pressure increases and reaches 18-23 psi differential, the vent valve opens and excess case air pressure is vented overboard.

E. Transmission output rotation can be stopped, under specific procedures, by placing the corresponding CSD disconnect switch in the disconnect position. This will electrically energize the disconnect solenoid, releasing a spring-loaded pawl, and the resultant action will disengage the rotating input shaft from the planetary differential of the CSD transmission. When disengaged, a transmission must not be reengaged until the engine is shut down and comes to a complete stop. Reengagement of the transmission is accomplished by pulling downward on the T-handle until a stop is felt, and then releasing the handle.



Constant Speed Drive Indications and Disconnect Circuits -- Simplified
Figure 1/24-10-00-990-801



Constant Speed Drive Transmission -- Installation
Figure 2/24-10-00-990-802

3. **Indications**

A. A pressure-sensing switch, located at the top of the transmission, and a caution light on the overhead switch panel annunciator panel are used in the CSD oil light circuitry. When the charge oil pressure is below a minimum safe value (100 to 150 psi) (689 to 1033 kPa), the switch closes and completes the light ground circuit, which causes the light to come on. Whenever the CSD oil light comes on, the master caution lights also come on. During normal operation, charge pressure opens the contacts of the pressure switch and the caution light goes off.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

B. The temperature of the oil in each transmission is sensed by identical temperature sensors installed in the oil outlet and oil inlet ports of the transmission. During operation, temperature indication is shown on a dual-scale indicator, located on the overhead switch panel. Normally the indicator shows oil outlet temperature. By pressing a button-type switch, located adjacent to the oil temperature indicators, temperature rise of the oil can be read. Temperature rise is the difference between oil outlet and oil inlet temperatures.

WJE ALL

C. The output speed sensor is provided for ease of trouble shooting the electrical power system. During normal operation, signals from the transmission (CSD) output speed sensor and from an engine tachometer generator are applied to the applicable generator control panel/unit. Circuitry within the generator control panel/unit is such that when the engine is operating and no signal is received from the transmission output speed sensor, the drive light on the maintenance annunciator will come on, indicating that the transmission is not operating. Once a light on the maintenance annunciator comes on, it will remain on until the system recovers or the reset switch is operated manually.

4. **CSD Oil Leakage**

A. Check CSD transmission oil system for oil leakage.

(1) With engine running at idle, check CSD Output Pad Drain (cowl door drain mast with cowl doors closed) - 1 drop per 3 minutes maximum allowable leakage. (Figure 2)

(2) Check CSD system static seals (CSD/fwd adapter pad, CSD case split, service plugs, CSD and CSD oil line connections, B-nuts, etc.) - no leakage allowed, seal wetting only allowed.

NOTE: If the leak source is not apparent, perform leak test in Paragraph 4.B..

B. Constant Speed Drive (CSD) Leak Test

WARNING: DO NOT PERFORM LEAK TEST WITH ENGINES OPERATING. THIS WILL PREVENT INJURY TO PERSONNEL.

(1) Place shut-off valve in OFF position, and back out regulator valve to prevent pressure from going to CSD fitting. (Figure 3)

(2) Snap flex hose end with appropriate mating fitting on to oil servicing fitting (pressure fill fitting).

(3) Install other end to clean, dry compressed air supply, or regulated nitrogen source with maximum pressure of 100 PSI.

NOTE: The compressed air source port on the tester must be plugged if a regulated nitrogen source is used.

(4) Turn valve to ON position. Adjust regulator to system pressure of 25 PSIG.

CAUTION: DO NOT EXCEED 50 PSIG. IF 50 PSIG IS EXCEEDED, CONSTANT SPEED DRIVE MAY BE DAMAGED.

(5) Turn valve to OFF position to trap air in system.

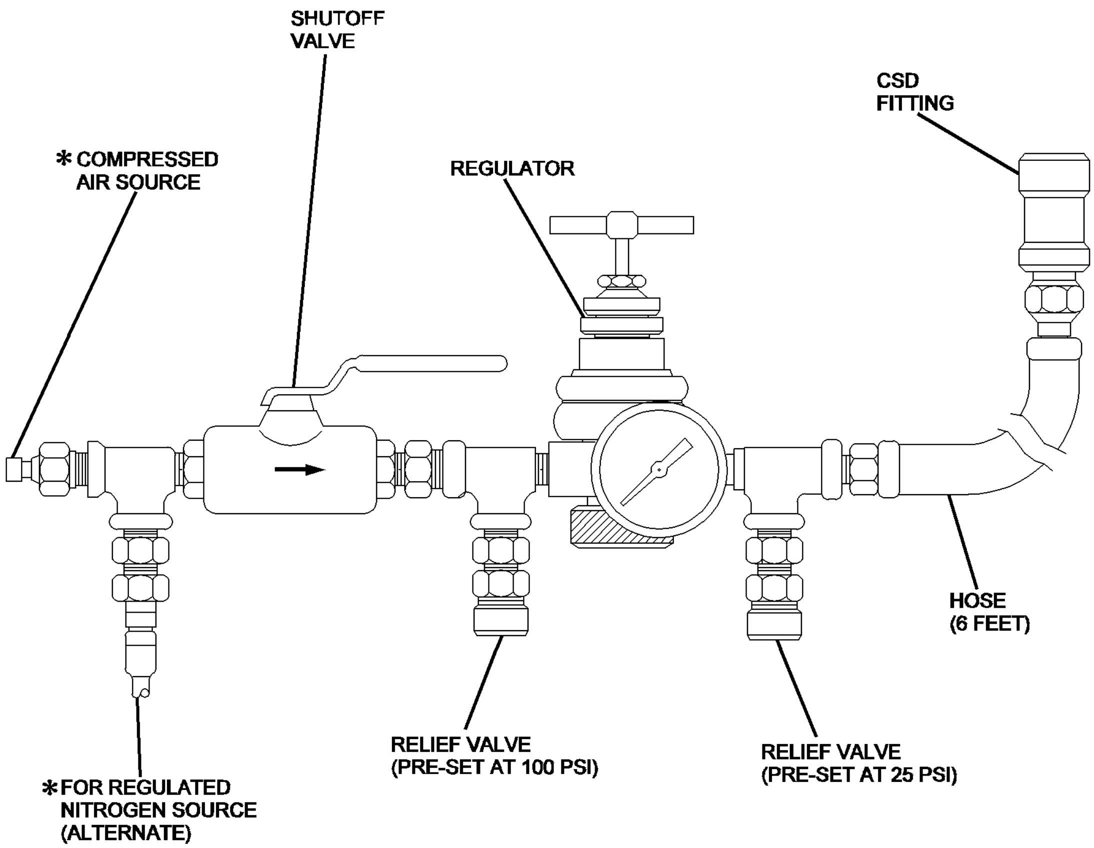
NOTE: Pressure will remain fixed in systems with no leakage.

(6) If visual check does not locate leak source, check system for leaks using soap suds of equivalent leak detector fluid.

(7) Make necessary corrections and restore system to operational configuration.

NOTE: When pressure is applied oil from CSD oil cooler will enter CSD leaving a high oil level. Do not drain oil, correct oil level by cranking the engine.

(8) Depressurize CSD system and remove tester.



✻ NOTE:
IF REGULATED NITROGEN SOURCE IS TO BE USED, COMPRESSED AIR SOURCE PORT MUST BE PLUGGED.

BBB2-24-232A
S0006532110V2

Constant Speed Drive Leak Tester
Figure 3/24-10-00-990-805

GENERATOR DRIVE - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures are identical for the left and right engine-driven constant speed drive (CSD) systems. Maintenance annunciator lights, as noted in the following procedures, are located on the face of the applicable generator control panel for the left or right AC generator system.

2. Trouble Shooting

Table 101

Possible Causes		Isolation Procedure	Correction
A.	CSD OIL LIGHT REMAINS ON OR COMES ON AFTER STARTING ENGINE; FREQUENCY AND VOLTAGE FAIL TO BUILD UP.		
(1)	CSD drive disconnected	Reset CSD.	Start engine; check that CSD oil light goes off by approximately 47% N_2 rpm and frequency and voltage are normal. If CSD oil light remains on, replace CSD.
(2)	CSD input shaft sheared	Check maintenance annunciator panel for drive light on.	Replace CSD.
(3)	No oil in CSD	Check CSD for proper oil level.	If no oil in CSD, replace unit.
(4)	Internal failure	Check magnetic plug and filters for evidence of large amounts of fuzz or large chips.	Replace CSD.
(5)	CSD or oil cooling system leaking	Check CSD oil cooler, and lines for evidence of leaking.	Replace CSD or oil cooler as necessary. Tighten fittings or replace lines as necessary.
B.	ENGINE RUNNING; CSD OIL LIGHT OFF; NO VOLTAGE OR FREQUENCY INDICATIONS. MOMENTARILY PLACING GENERATOR SWITCH IN RESET POSITION HAS NO EFFECT.		
(1)	Failure of AC generator system component or open in system wiring	Check maintenance annunciator panel for light on to isolate failure.	Generator light on; replace generator. Voltage regulator/GCU light on; replace voltage regulator/generator control unit.
			AC bus control light on; replace AC bus control panel/unit.
			Distribution system light on; check AC electrical system wiring.
C.	OUTLET TEMPERATURE READS IN YELLOW BAND ON CSD TRANSMISSION OIL TEMPERATURE INDICATOR. CSD OIL LIGHT COMES ON.		
(1)	Oil quantity low or high	Check CSD for proper oil level.	Service CSD.
(2)	Obstructions in CSD oil cooling system	Check oil cooler, and CSD oil inlet and oil outlet lines.	Replace oil cooler; clean oil lines.
(3)	Scavenge or charge filter clogged	Check filter pressure differential indicators for popped-out button.	If button is popped, replace filters and clean magnetic plug; check after first engine run.
	(4) Defective temperature sensor	Refer to Step D.	Replace temperature sensor.

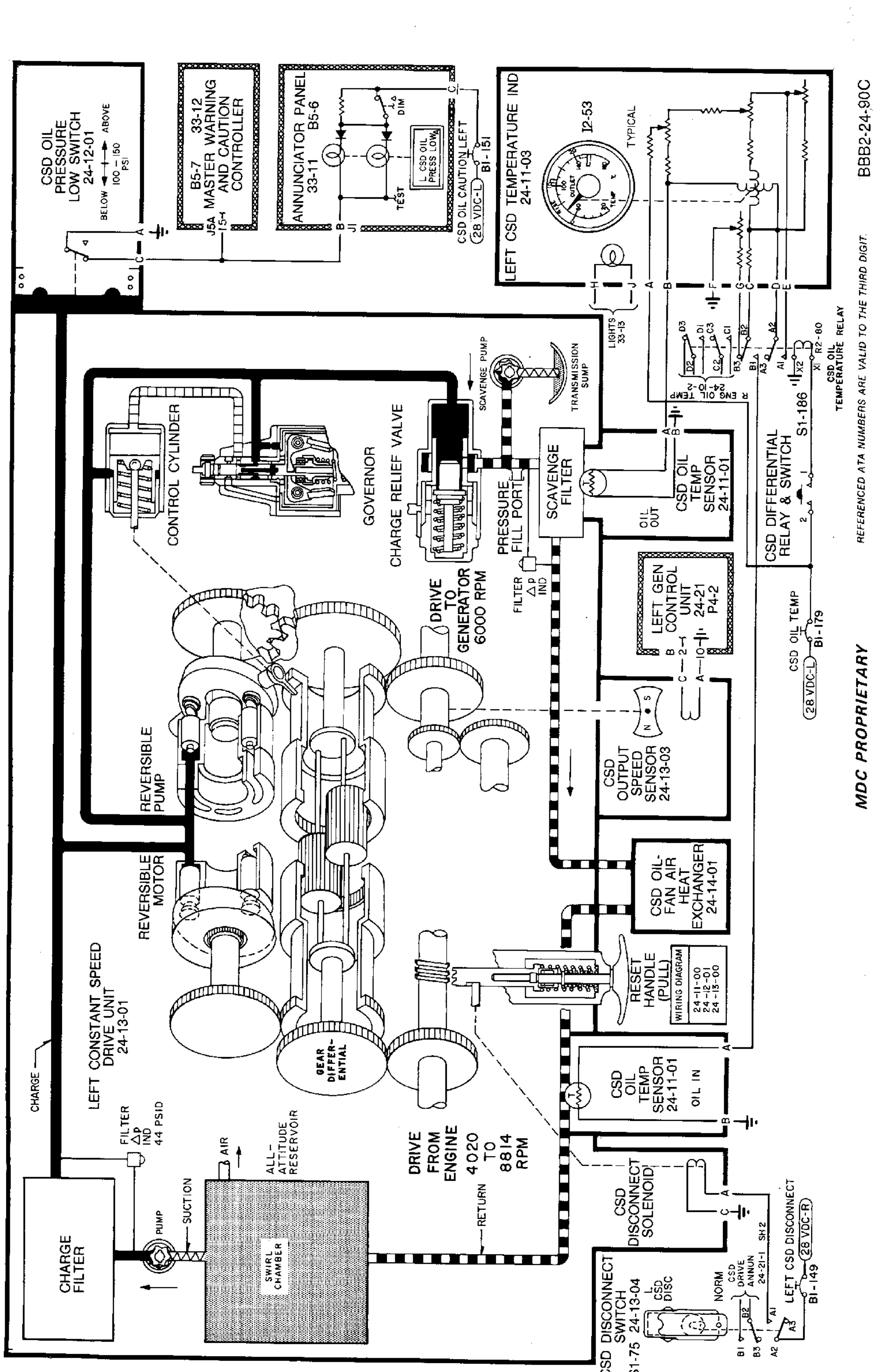
Table 101 (Continued)

Possible Causes		Isolation Procedure	Correction
D.	OIL TEMPERATURE INDICATOR POINTER DEFLECTS TO BOTTOM OR TOP OF SCALE WHEN READING RISE TEMPERATURE.		
(1)	Defective indicator	Read outlet temperature. Pointer remains at bottom or top of scale.	Replace indicator.
(2)	Defective temperature sensor	Table 102	Replace temperature sensor.

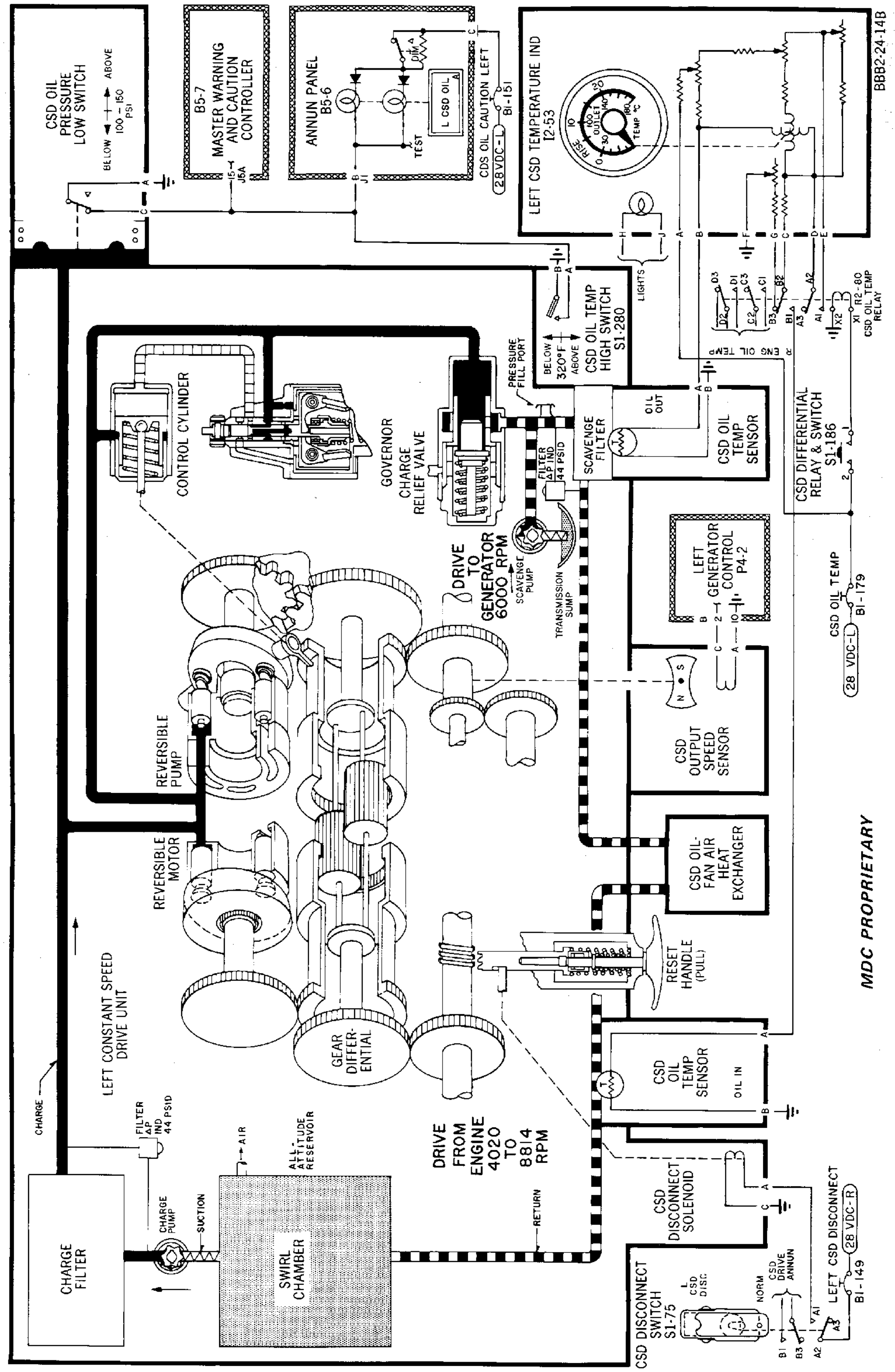
Table 102 Temperature Sensor Failure Versus Temperature Indication

Temperature Sensors and Type of Failure		Rise Temperature Indication	Oil Outlet Temperature Indication
Inlet	Outlet		
Shorted	Normal	Top of scale	Normal
Open	Normal	Bottom of scale	Normal
Normal	Shorted	Bottom of scale	Bottom of scale
Normal	Open	Top of scale	Top of scale

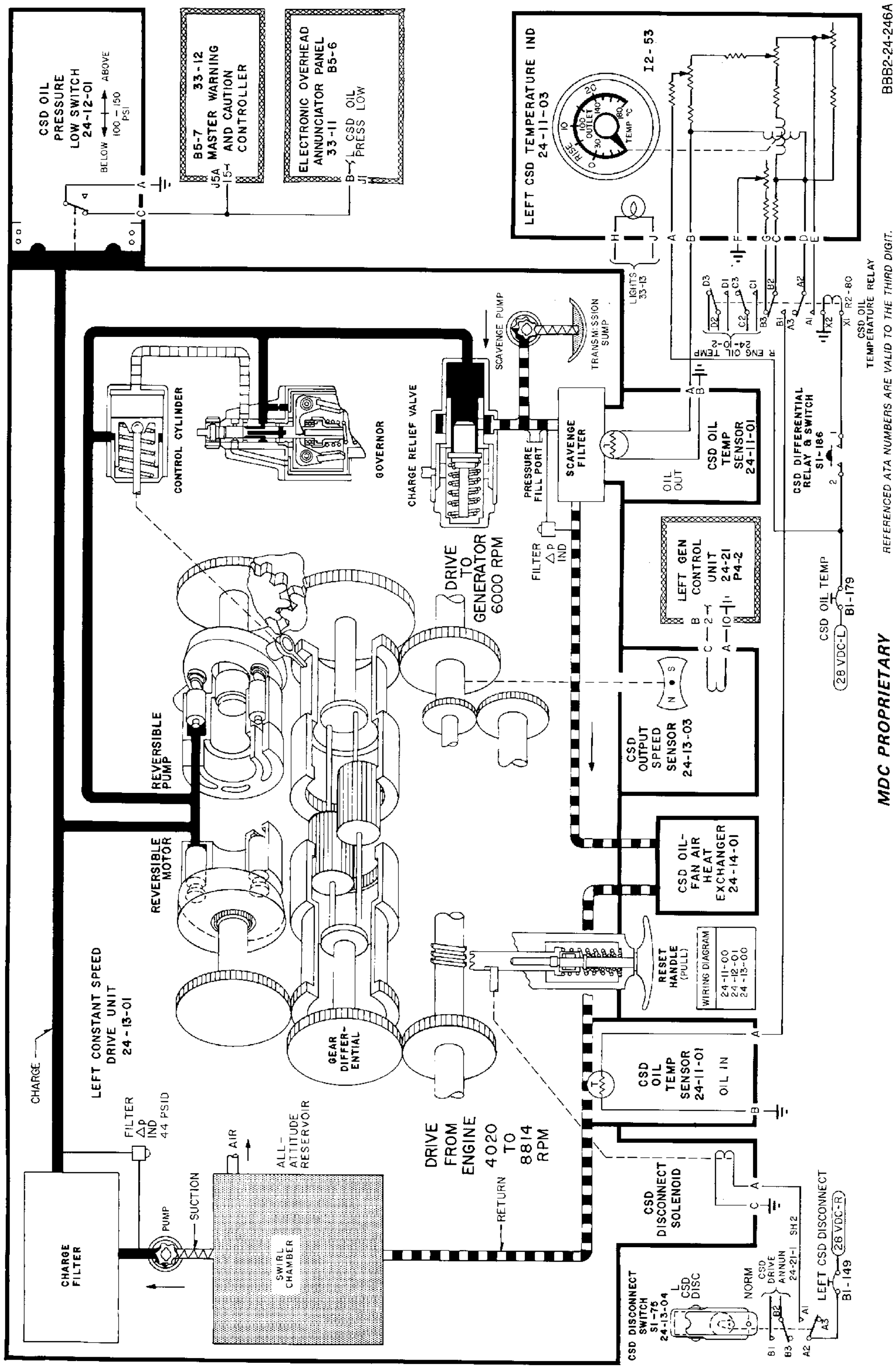
NOTE: 11.2° C on the rise temp scale (yellow radial if applicable) indicates an operating point which, when exceeded, may indicate a system malfunction.



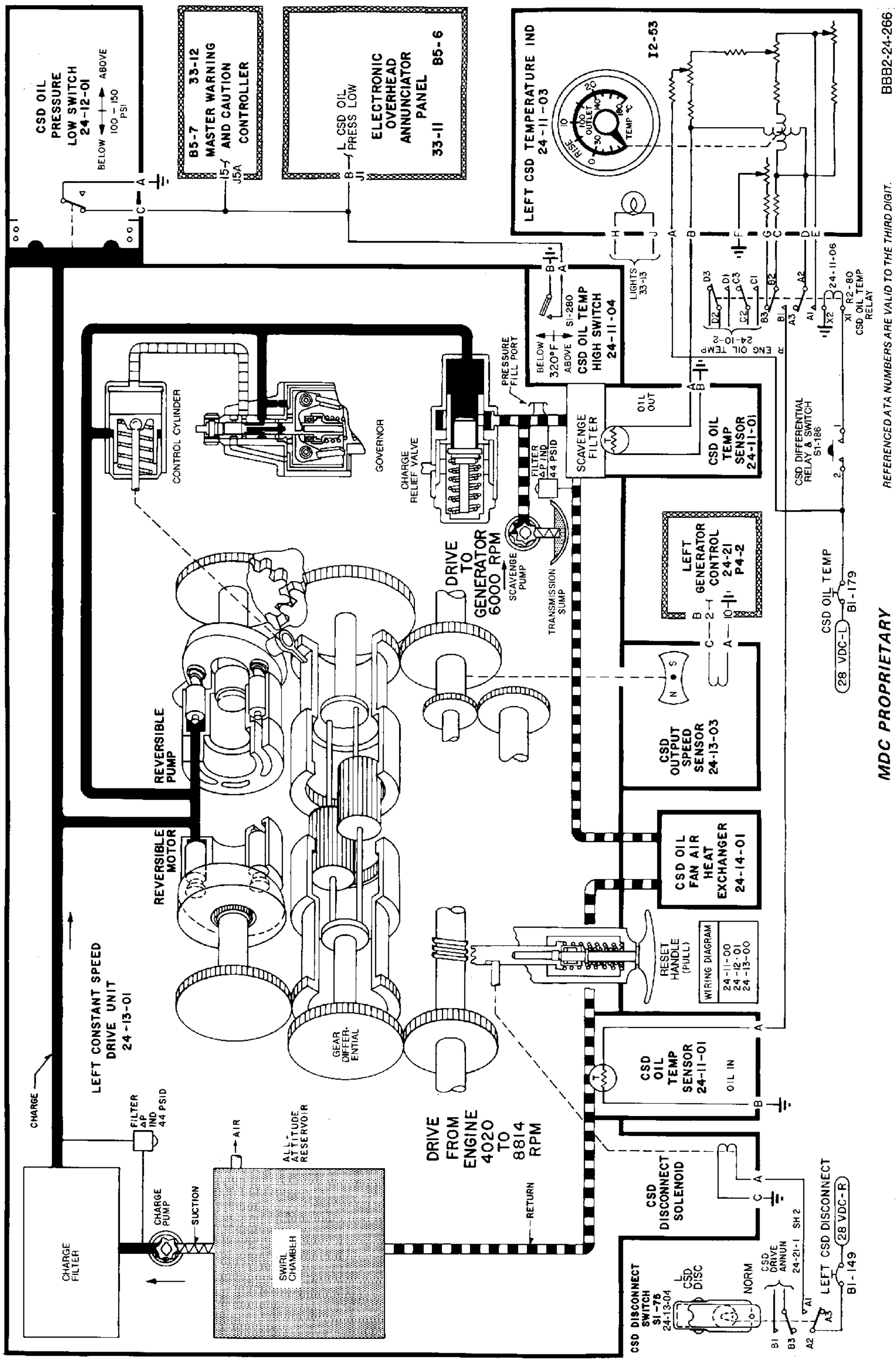
Constant Speed Drive (Left Engine) -- Schematic
Figure 101/24-10-00-990-810



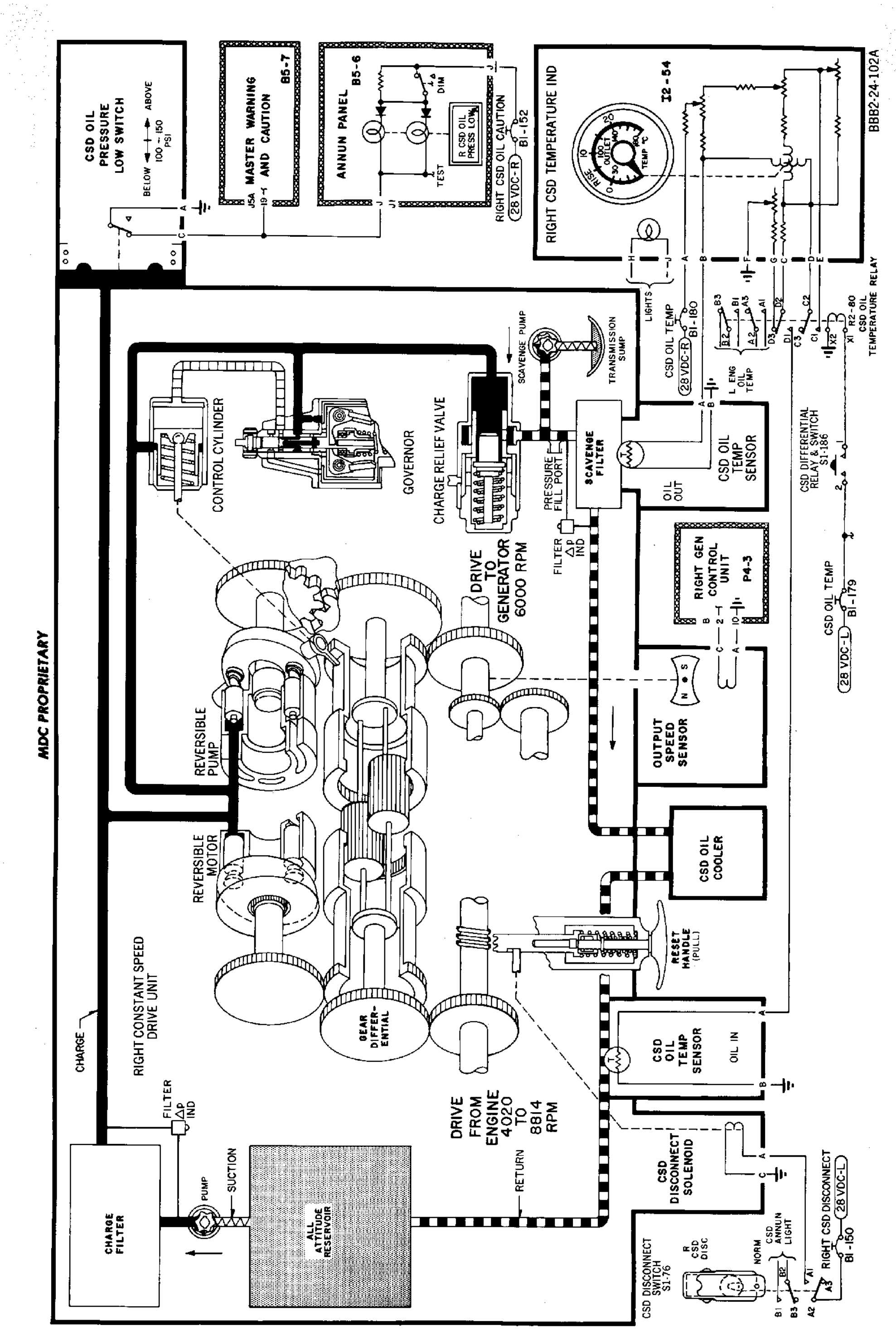
Constant Speed Drive (Left Engine) -- Schematic
Figure 102/24-10-00-990-811



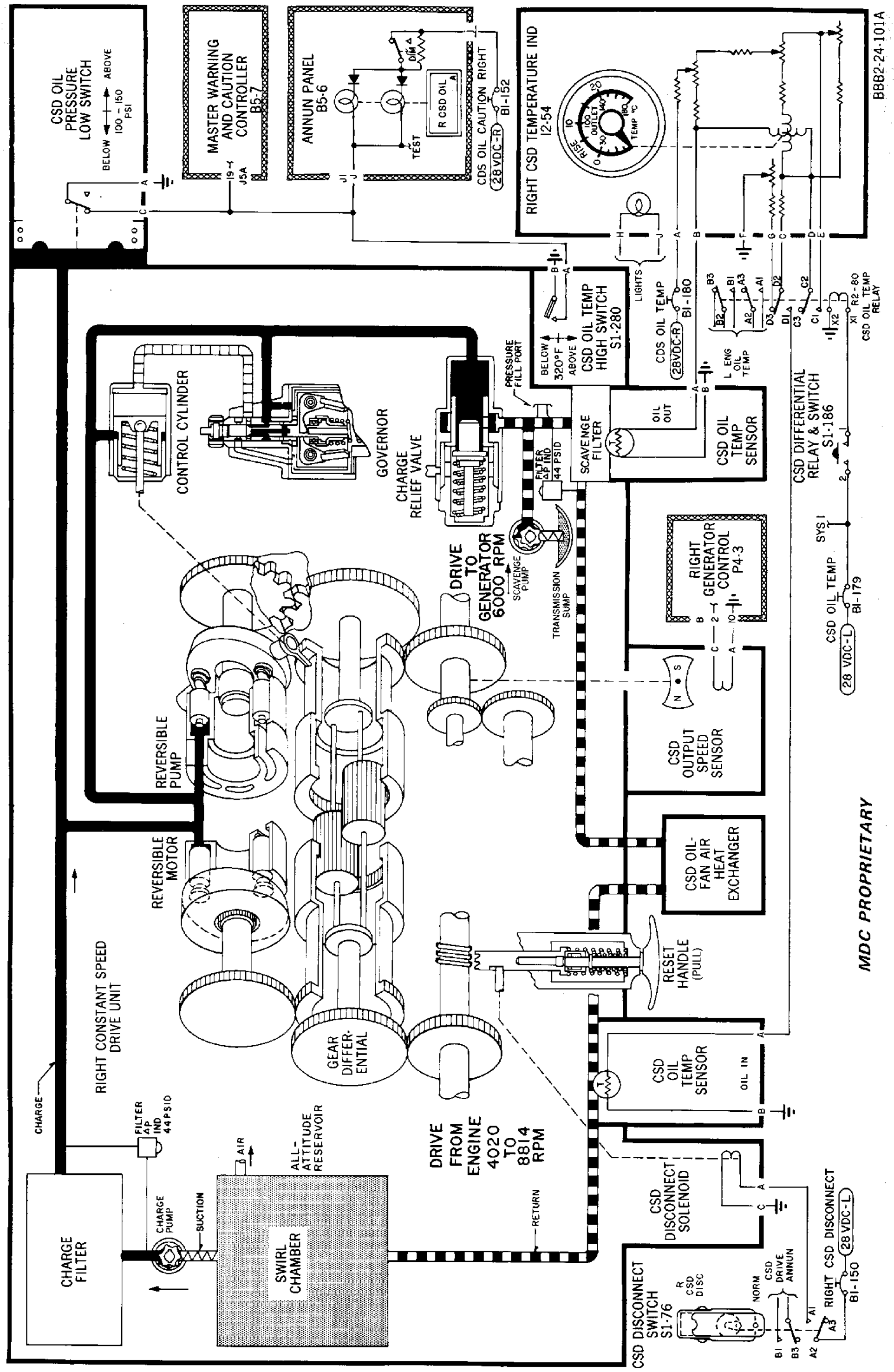
Constant Speed Drive (Left Engine) -- Schematic
Figure 103/24-10-00-990-812



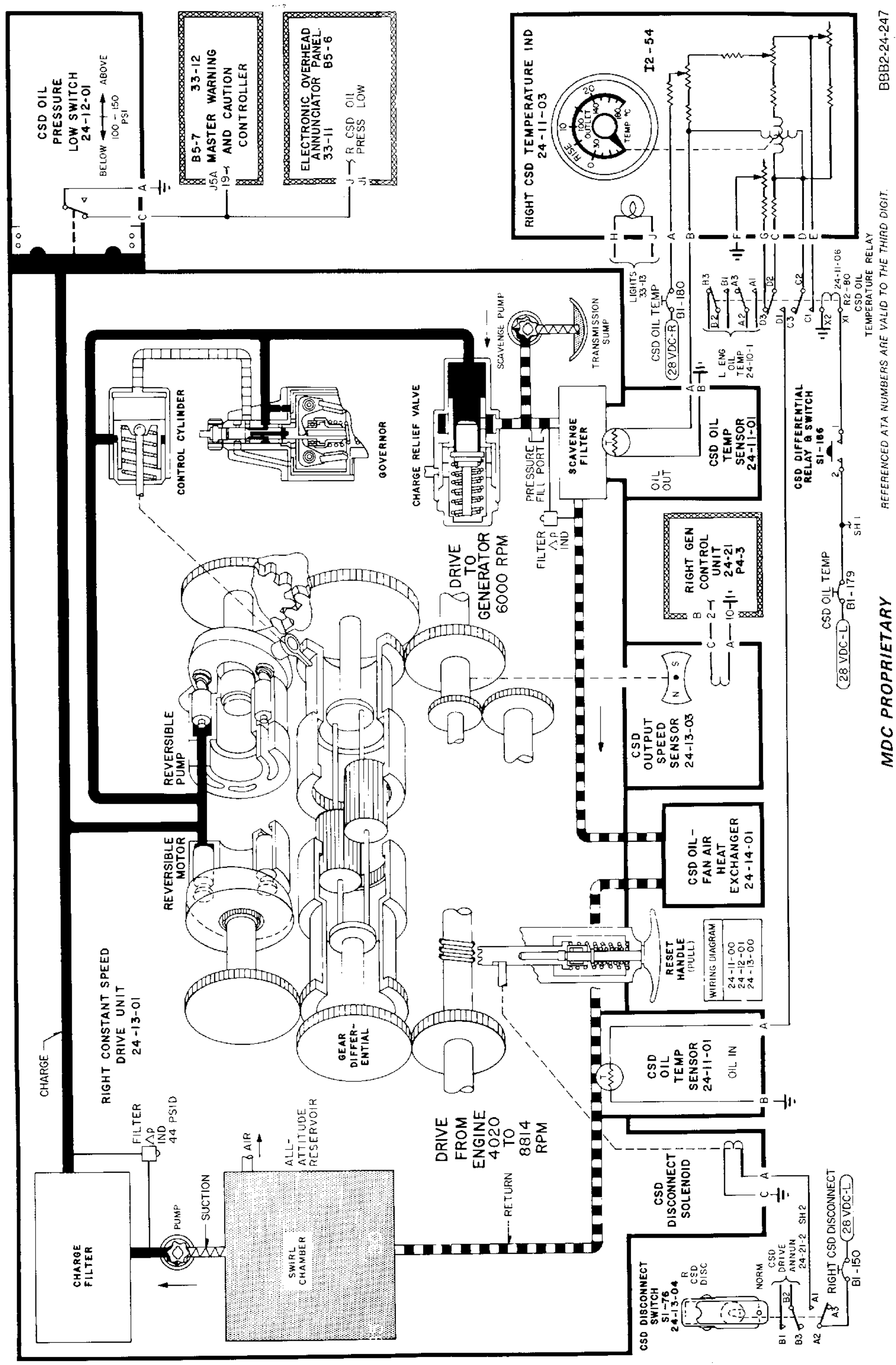
Constant Speed Drive (Left Engine) -- Schematic
Figure 104/24-10-00-990-815



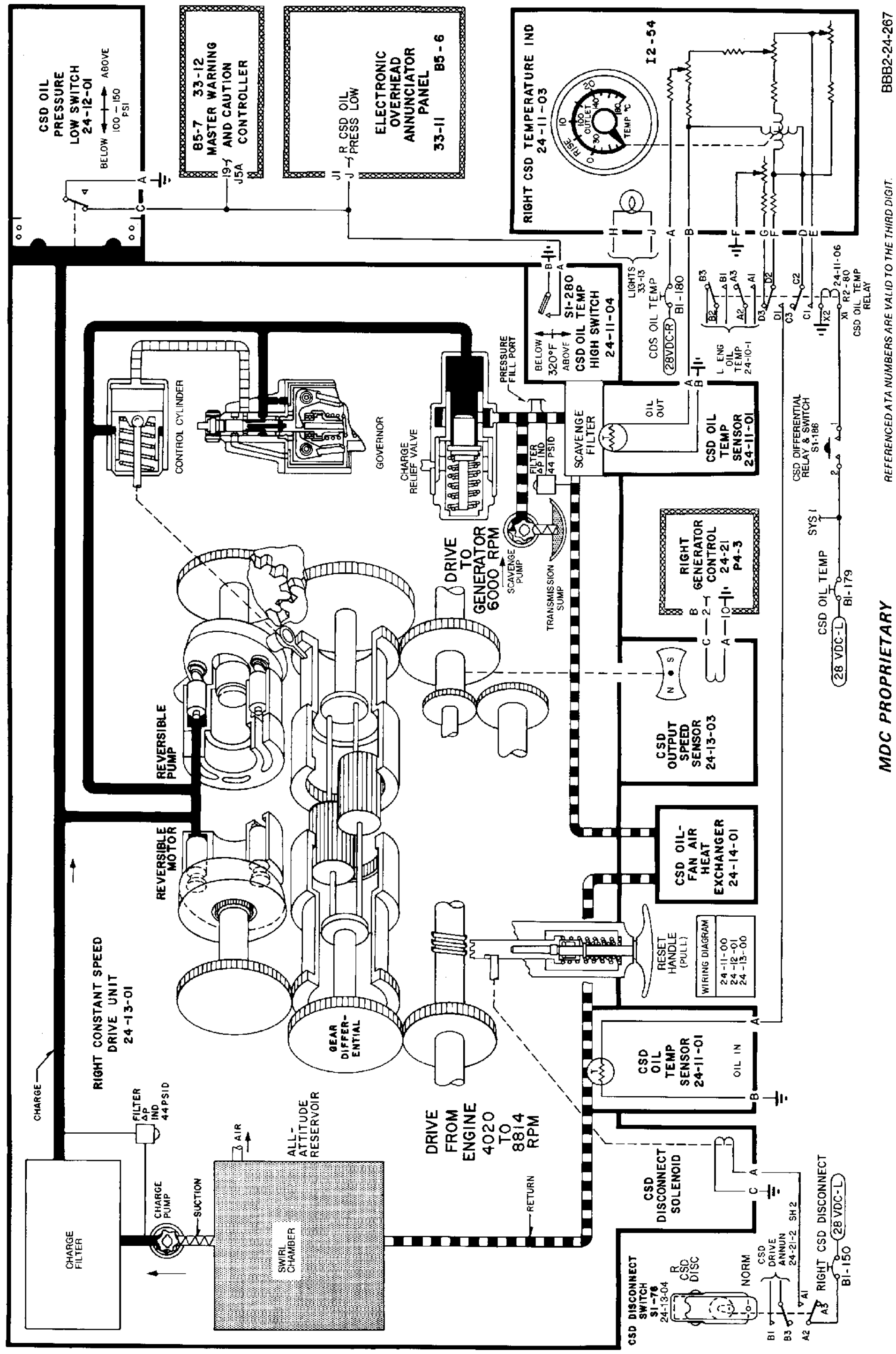
Constant Speed Drive (Right Engine) -- Schematic
Figure 105/24-10-00-990-817



Constant Speed Drive (Right Engine) -- Schematic
Figure 106/24-10-00-990-819



Constant Speed Drive (Right Engine) -- Schematic
Figure 107/24-10-00-990-820



Constant Speed Drive (Right Engine) -- Schematic
Figure 108/24-10-00-990-821

GENERATOR DRIVE - SERVICING

1. General

A. Servicing of the engine-driven constant speed drive (CSD) system includes procedures for draining and filling the CSD transmission and CSD transmission pad cavity. Before removing a CSD transmission, the CSD transmission and CSD transmission pad cavity must be drained, and following installation must be serviced.

B. CSD pressure filling can be accomplished through an access door located on the lower right side of each engine lower cowl door. (POWER PLANT ZONES - DESCRIPTION AND OPERATION, PAGEBLOCK 06-26-00/001)

C. CSD gravity filling and pad cavity servicing is accomplished by opening the forward lower cowl door.

D. Oil changes are accomplished periodically or at any time it is suspected that the oil temperature has exceeded 150°C (302°F). Excessive oil temperature can change the acid content of the oil, leading to possible failure of the CSD transmission.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items.

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 301

Name and Number	Manufacturer
Coupling half fitted to suitable hose (OMP 2506-3)	
Coupling half fitted to suitable hose (OMP 2505-3)	
Female connector (MS 24587-3) to mate with MS33656 fitting and fitted to suitable hose	
Inconel Lockwire 0.020 in NASM20995N20, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.020 in NASM20995C20, DPM 5865	Not specified
Inconel Lockwire 0.032 in NASM20995N32, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.032 in NASM20995C32, DPM 5865	Not specified
Torque wrench (capable of 0 to 800 inch-pounds) (0 to 90.4 N·m)	

Table 301 (Continued)

Name and Number	Manufacturer
Lubricating oil, MIL-PRF-7808 conforms to Sundstrand Standard No. MS 02.40: Mobil Jet Oil 254 Aero Shell Turbine Oil 500 Mobil Jet Oil II Aero Shell Turbine Oil 555 Royco Turbine Oil 500 Royco Turbine Oil 555 Exxon Turbo Oil 2380 Exxon Turbo Oil 25	
Pressure fill stand capable of delivering lubricating oil at a pressure of at least 25 psi (172 kPa)	
Small capacity pans (containers) as noted or one pan having a capacity of at least 2 gallons (7.57 liters)	
Clean container with provision for proper filtering	

3. **Servicing CSD Transmission**

A. Draining

(1) Connect overflow hose to relieve case pressure.

(2) Obtain suitable container for oil to be drained from CSD transmission.

NOTE: Container should have capacity of at least 5 quarts (4.73 liters).

(3) Remove reservoir drain plug; drain CSD transmission oil into container.

(4) Remove magnetic drain plug assembly; drain CSD transmission oil into container.

NOTE: Outer hex fitting is used when removing magnetic drain plug as an assembly.

(5) Install reservoir drain plug with new O-ring. Tighten plug to torque of 75 to 100 inch-pounds (8.47 to 11.30 N·m); safety with lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

CAUTION: DO NOT APPLY TORQUE VALUE SHOWN FOR INNER/OUTER HEX FITTINGS WHEN INSTALLING MAGNETIC DRAIN PLUG. DAMAGE TO MAGNETIC DRAIN PLUG CAN OCCUR IF TORQUE VALUES ARE EXCEEDED.

(6) Install magnetic drain plug assembly with new O-ring. Tighten assembly to torque of 30 to 40 inch-pounds (3.39 to 4.52 N·m). (Figure 302)

(7) Safety both plugs (inner and outer hex fittings) with lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(a) Use corrosion-resistant steel safety wire, G60845 or .032 inconel lockwire, G60169 except on small fasteners that have a hole diameter less than .045 inch. In these fasteners, use .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

B. Pressure Filling

(1) Check that overflow hose is connected.

(2) Connect service pressure hose coupling to CSD pressure fill connector.

(3) Slowly fill CSD transmission oil system until oil flows from overflow drain hose.

(4) Stop pressure filling; allow approximately 3 minutes for oil level in CSD transmission to stabilize.

CAUTION: DO NOT OVERFILL. OVERFILLING CAN CAUSE OVERHEATING AND OIL SLUDGING, RESULTING IN DRIVE DAMAGE.

(5) Visually check oil level sight gage and add additional oil as required.

NOTE: Oil level should stabilize near upper limit of green area on gage.

(6) Remove service pressure hose, then service overflow hose.

(7) Install protection caps on CSD pressure fill fitting and on overflow fitting.

(8) Check CSD transmission oil system for oil leakage.

(a) With engine running at idle, check CSD Output Pad Drain (cowl door drain mast with cowl doors closed) - 1 drop per 3 minutes maximum allowable leakage.

(b) Check CSD system static seals (CSD/fwd adapter pad, CSD case split, service plugs, CSD and CSD oil line connections, B-nuts, etc.) - no leakage allowed, seal wetting only allowed.

C. Gravity filling

(1) Remove gravity fill plug. Check that overflow hose is removed.

CAUTION: WHEN GRAVITY FILLING THE UNIT, BE EXTRA CAREFUL TO KEEP THE OIL CLEAN. THE OIL SHOULD BE FILTERED (33 MICRONS) JUST BEFORE IT ENTERS THE TRANSMISSION. FAILURE TO KEEP CONTAMINATION OUT OF THE OIL WILL REDUCE THE LIFE OF THE TRANSMISSION.

CAUTION: DO NOT OVERFILL. OVERFILLING CAN CAUSE OVERHEATING AND OIL SLUDGING, RESULTING IN CSD TRANSMISSION DAMAGE.

(2) Using container as specified, add oil until level is near upper limit of green area on sight gage.

NOTE: Oil level after filling, should stabilize near upper limit of green area on sight gage.

(3) Install gravity fill plug with new O-ring. Tighten to torque of 150 to 170 inch-pounds (17 to 19 N·m); safety with lockwire. (Figure 302)(LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(4) Check CSD transmission oil system for oil leakage.

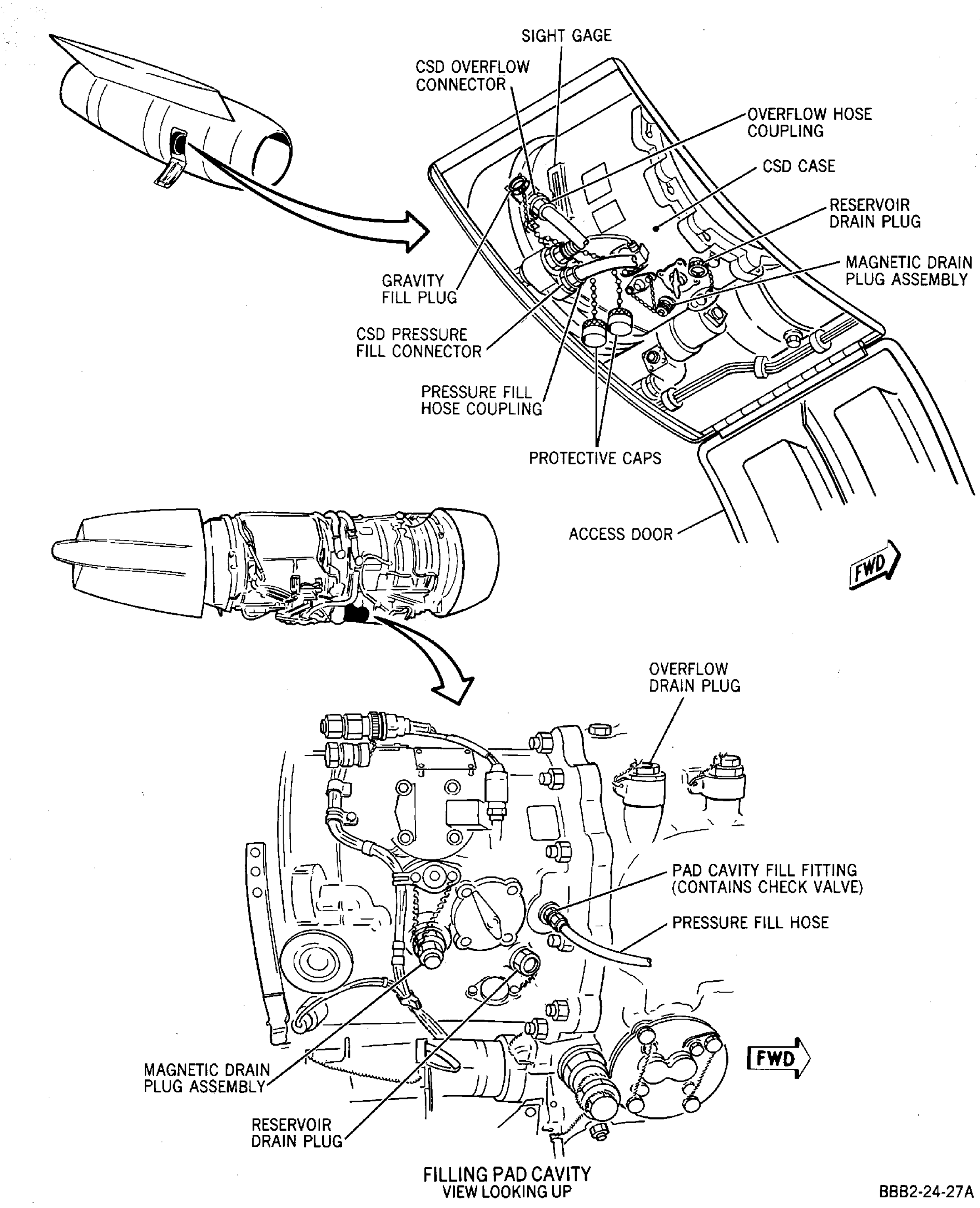
(a) With engine running at idle, check CSD Output Pad Drain (cowl door drain mast with cowl doors closed) - 1 drop per 3 minutes maximum allowable leakage.

(b) Check CSD system static seals (CSD/fwd adapter pad, CSD case split, service plugs, CSD and CSD oil line connections, B-nuts, etc.) - no leakage allowed, seal wetting only allowed.

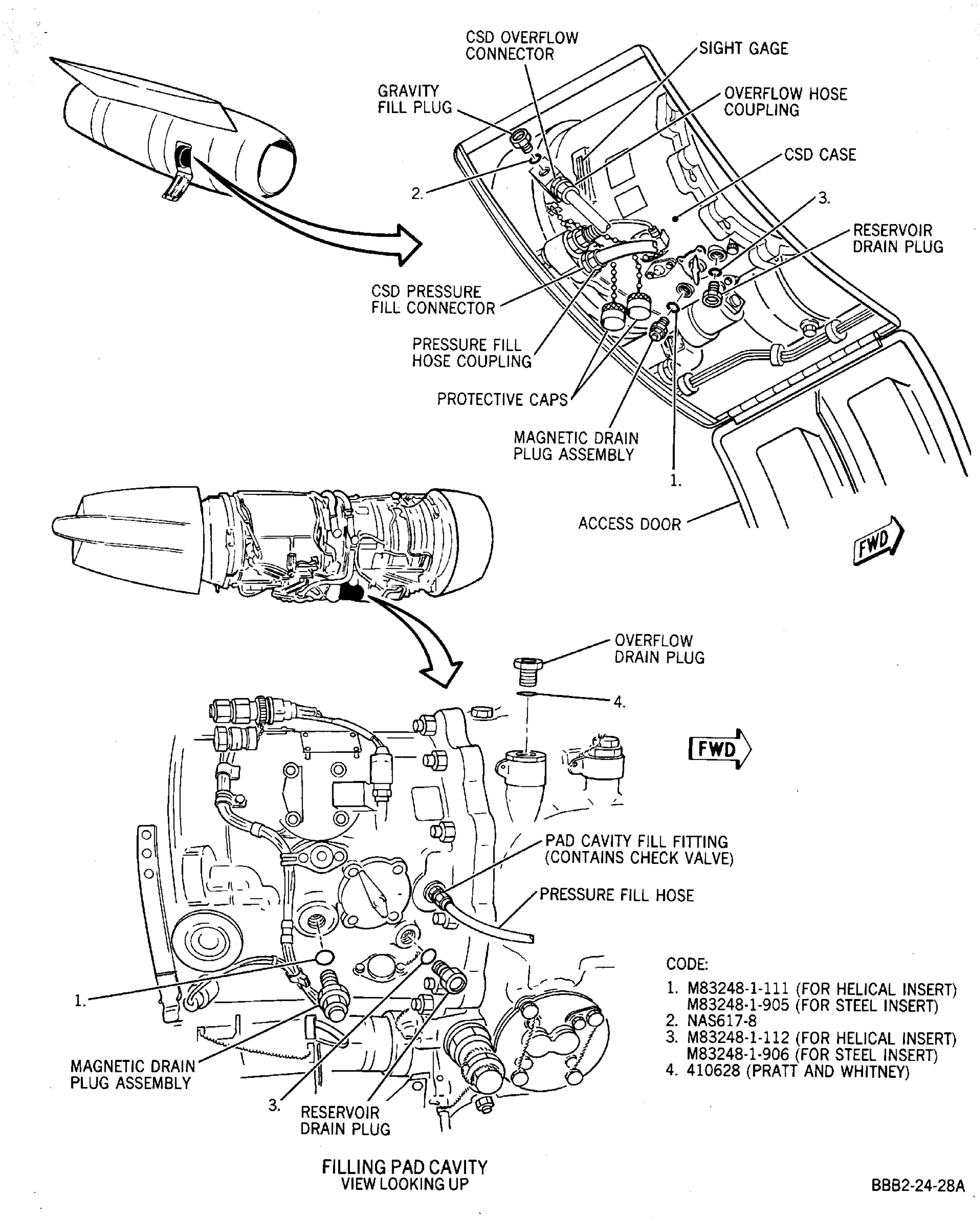
D. Special Filling Instructions for Disconnected CSD Transmission

CAUTION: DO NOT RECONNECT TRANSMISSION AFTER PERFORMING SPECIAL FILLING OR FURTHER DAMAGE MAY RESULT.

(1) If it is necessary to continue a flight with the transmission disconnected, it is recommended that the transmission be serviced to the normal oil fill level. Disconnected transmissions should be replaced at the first convenient location.



Constant Speed Drive (CSD) Transmission -- Servicing
Figure 301/24-10-00-990-807



CODE:
1. M83248-1-111 (FOR HELICAL INSERT)
   M83248-1-905 (FOR STEEL INSERT)
2. NAS617-8
3. M83248-1-112 (FOR HELICAL INSERT)
   M83248-1-906 (FOR STEEL INSERT)
4. 410628 (PRATT AND WHITNEY)

Constant Speed Drive (CSD) Transmission -- Servicing
Figure 302/24-10-00-990-808

4. Servicing CSD Transmission Pad Cavity

A. Draining

(1) Obtain suitable container for oil drained from CSD transmission pad cavity.

NOTE: Container should have capacity of at least 3 quarts (2.84 liters).

(2) Remove drain plug assembly; drain oil into container.

NOTE: Outer hex fitting is used when removing drain plug as an assembly.

(3) Install drain plug assembly with new O-ring. Tighten plug assembly to torque of 150 inch-pounds (16.95 N·m). (Figure 302)

B. Pressure Filling

(1) Connect pressure fill hose.

NOTE: The pressure fill fitting contains a check valve. Check valve should open between 20 to 25 psi (138 to 172 kPa).

(2) Remove overflow drain plug.

NOTE: Inner hex fitting is used when removing overflow drain plug from drain plug assembly.

(3) Slowly pressure fill CSD transmission pad cavity until oil flows from overflow drain; catch oil in pan.

(4) Stop pressure filling; allow oil in CSD transmission pad cavity to stabilize.

(5) Remove pressure fill hose.

(6) Install overflow drain plug with new O-ring. Tighten plug to torque of 75 inch-pounds (8.48 N·m); safety overflow drain plug with lockwire. (Figure 302)(LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(7) Install cap on CSD transmission pad cavity fill fitting. Tighten cap to torque of 30 to 40 inch-pounds (3.39 to 4.52 N·m).

(8) Check CSD transmission oil system for oil leakage.

(a) With engine running at idle, check CSD Output Pad Drain (cowl door drain mast with cowl doors closed) - 1 drop per 3 minutes maximum allowable leakage.

(b) Check CSD system static seals (CSD/fwd adapter pad, CSD case split, service plugs, CSD and CSD oil line connections, B-nuts, etc.) - no leakage allowed, seal wetting only allowed.

GENERATOR DRIVE - ADJUSTMENT/TEST

1. General

A. Adjustment/test procedures for the generator drive system are basically the same as for an engine driven AC generator system, due to the close operating relationship between the two systems. Adjustment/test procedures are identical for the left and right generator drive systems.

NOTE: The following adjustment/test procedures must be accomplished with external or APU power being supplied to the AC buses, to ensure having power available for engine instruments during adjustment of voltage and frequency.

NOTE: For applying external power or APU power to AC buses. Refer to: EXTERNAL POWER - DESCRIPTION AND OPERATION, PAGEBLOCK 24-40-00/001 or AUXILIARY POWER UNIT AC GENERATOR - ADJUSTMENT/TEST, PAGEBLOCK 24-20-02/501.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 501

Name and Number	Manufacturer
Lockwire, NASM20995N32, DPM684	Not specified
Portable precision voltmeter with 0 to 150 volt scale, calibrated at 115 (±.4) volts.	
Portable precision frequency meter with 380 to 420 Hz range, calibrated at 400(±0.5) Hz.	

3. Adjustment/Test Generator Drive

A. Test Generator Drive

(1) Place GEN control switch of system to be functioned in OFF position.

(2) Place AC BUS X TIE switch in OPEN position.

(3) Check that DC BUS X TIE switch is in OPEN position.

(4) Place AC VOLT/FREQ DC BUS VOLT selector switch in applicable position (L or R); AC voltmeter and frequency meter should read zero.

(5) Check that BATT switch is in ON position.

(6) Check following corresponding lights for operation for system (left or right) to be tested.

(a) AC BUS OFF.......................................OFF

(b) GEN OFF...ON

(c) CSD OFF...ON

(d) APU or EXT PWR BUS in-use light.......ON

(7) Motor engine of system being checked. Check that CSD OIL PRESS LOW light indicates OFF. (GENERAL, SUBJECT 71-00-00, Page 501)

NOTE: When CSD OIL PRESS LOW light indicates OFF, it indicates that CSD transmission charge pump has pressurized CSD transmission hydraulic system.

CAUTION: BEFORE STARTING ENGINE, BE CERTAIN ENGINE HAS STOPPED ROTATING.

(8) Start engine, as engine comes up to operating rpm, check the following: (GENERAL, SUBJECT 71-00-00, Page 501)

(a) CSD OIL PRESS LOW light indicates OFF.

(b) AC voltmeter and frequency meter indications should increase. AC voltmeter should stabilize at approximately 115(±3) volts, frequency meter should stabilize at approximately 400(±4) Hz.

CAUTION: SHUT DOWN ENGINE IMMEDIATELY IF VOLTAGE AND FREQUENCY DO NOT REGISTER.

(c) If voltmeter and frequency meter indications are at zero, momentarily place GEN control switch in RESET position and then to OFF position.

(d) Applicable CSD oil temperature indicator should show an increase in temperature and remain in normal operating range (below yellow band).

(9) Set engine at idle rpm.

WARNING: USE EXTREME CAUTION WHEN WORKING IN THE EPC AREA AS VOLTAGES ENCOUNTERED CAN BE FATAL. WHEN MEASURING VOLTAGE, OBSERVE THE SAFETY PRECAUTIONS NORMALLY FOLLOWED WHEN WORKING WITH HIGH VOLTAGES.

(10) Check and adjust voltage and frequency as follows:

(a) Connect portable precision voltmeter and frequency meter between the GR side of the airplane AC voltmeter resistor and ground. If the voltage is not 115 volts, adjust voltage as follows:

NOTE: Resistor is located in lower aft side of the EPC, adjacent to the corresponding power relay.

WJE 886, 887

1) Loosen cover plate at upper left corner on face of voltage regulator to gain access to voltage adjustment potentiometer.

WJE 401-412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 891-893

2) Hole labeled VOLT ADJ at lower right of face plate of generator control unit is for potentiometer adjustment.

WJE ALL

3) Adjust potentiometer to obtain, as nearly as possible, 115 volts on precision voltmeter.

NOTE: Turn voltage adjustment potentiometer clockwise to increase voltage, and counterclockwise to decrease voltage.

4) Check AC voltmeter indication on overhead switch panel for system adjusted. If indication is not within tolerance of 115 (±3) volts, replace AC voltmeter.

5) Install cover plate on voltage regulator.

WARNING: ALWAYS APPROACH AN OPERATING JET ENGINE FROM THE SIDE, MAKING CERTAIN TO AVOID THE INTAKE AND THE PRIMARY EXHAUST AREAS. WEAR SUITABLE CUP-TYPE EAR PROTECTION TO PREVENT DAMAGE TO THE EARS RESULTING FROM THE HIGH NOISE LEVEL OF AN OPERATING JET ENGINE.

(b) Remove cover at bottom of CSD transmission to gain access to governor adjustment.

(c) Insert screwdriver in adjustment screw slot, press inward and turn screwdriver until adjustment screw engages governor adjustment screw.

(d) Adjust governor to position that brings generator frequency nearest to 400 Hz.

NOTE: Turn adjustment screw clockwise to increase frequency, and counterclockwise to decrease frequency. (One full 360 degree turn is equal to approximately 18 Hz.)

(11) Check frequency indication on overhead switch panel for system adjusted. If indication is not within tolerance of 400(±4) Hz, replace frequency meter.

(12) Place generator control switch of operating engine in on position. Check applicable lights as follows:

(a) AC BUS OFF...OFF

(b) GEN OFF...OFF

(c) APU or EXT PWR BUS in-use light.......OFF

(13) Place corresponding air-conditioning SUPPLY switch in the AUTO position.

(14) Check that applicable AC loadmeter indicates some load.

(15) Place APU or EXT PWR BUS switches in OFF position; AC BUS OFF light for non-operating generator system should come on.

CAUTION: IF AC LOADMETER INDICATES MORE THAN 1.0, REDUCE LOADS TO PREVENT DAMAGE.

(16) Place AC BUS X TIE switch in AUTO position. AC loadmeter for operating generator system should show an increase in load; AC BUS OFF light for opposite bus should go off.

(17) Check precision frequency meter to be certain that frequency remains at reading obtained in (Paragraph 3.A.(10)(d)).

NOTE: If frequency is unstable or erratic, or if frequency goes out and stays out of limits for more than one second on application or removal of load, replace transmission.

(18) Remove precision voltmeter and frequency meter.

(19) Place APU or EXT PWR BUS switches in ON position. AC loadmeter for operating generator should show decrease in load; applicable in-use light for opposite bus should come on.

(20) Place air conditioning SUPPLY switch in OFF position.

(21) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(22) As engine rpm drops, AC voltmeter and frequency meter readings should decrease; check following corresponding lights on system tested:

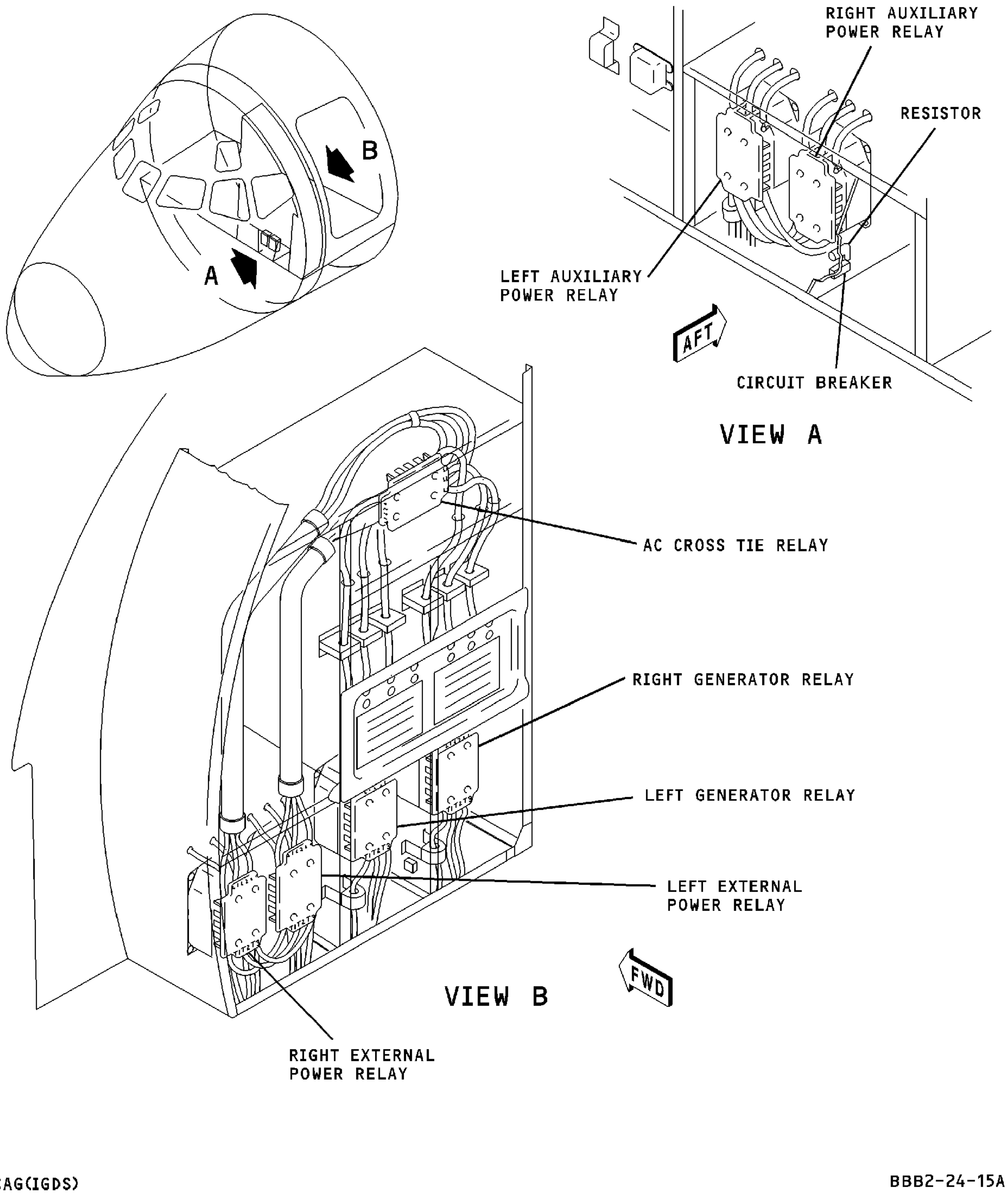
(a) GEN OFF...ON

(b) CSD OIL...ON

(c) APU or EXT PWR BUS in-use light......ON

(23) Install CSD governor adjustment plate with new O-ring; tighten screws to torque of 20 in-lb (2.26 N·m) to 22 in-lb (2.49 N·m). Safety the screws with lockwire. (PAGEBLOCK 24-00-00/401)

(24) Test completed, position electrical power control switches as required.



AC Voltmeter Resistors -- Location
Figure 501/24-10-00-990-828

CONSTANT SPEED DRIVE (CSD) TRANSMISSION - DESCRIPTION AND OPERATION

1. General

A. The constant speed drive (CSD) transmission is a hydromechanical transmission located on the aft side of the engine accessory drive section, at the bottom center line of the engine. The CSD transmission is used to drive a 40-kva AC generator at a constant speed of 6000 rpm, within narrow limits, through the varying normal operating speeds of the engine. In effect the constant speed of the AC generator produces current at approximately 400 cps. There is one CSD transmission AC generator combination for each engine. Each CSD transmission consists essentially of a hydraulic transmission with mechanical controls governing the output rotation speed. The CSD transmission is capable of either adding to or subtracting from the speed received from the engine gearbox to provide constant output speed to keep the AC generator on frequency. Mechanical (flyweight) governor action keeps the AC generator output at approximately 400 cps. A constant output speed of the CSD transmission is maintained due to overdrive, straight-through drive, and underdrive phases of operation.

B. Overdrive

(1) If the input speed supplied to the CSD transmission is lower than that needed to produce the required output speed, the CSD transmission hydraulically adds the necessary speed to the speed of the engine gearbox through the differential, thus maintaining constant output speed. The CSD transmission when adding speed hydraulically is operating in overdrive.

C. Straight-through Drive

(1) If the input speed supplied to the CSD transmission is sufficient to produce the required output speed, the CSD transmission drives the AC generator directly through the differential. The CSD transmission when neither adding nor subtracting speed hydraulically is operating in straight-through drive.

D. Underdrive

(1) If the input speed supplied to the CSD transmission exceeds that needed to produce the required output speed, the CSD transmission hydraulically subtracts the necessary speed from the speed of the engine gearbox through the differential, thus maintaining constant output speed. The CSD transmission when subtracting speed hydraulically is operating in underdrive.

2. Operation

A. Power Unit

(1) The power used to drive the AC generator is controlled and transmitted from the engine through the combined effects of the differential, the variable hydraulic unit, and the fixed hydraulic unit. (Figure 1)

(a) Geared Differential

1) The geared differential consists of a carrier shaft, two planet gears, an input ring gear, and an output ring gear. The ratio between the ring gears and the carrier shaft is 2:1.

2) At any speed and load condition, a torque load is imposed on the output ring gear by the output gear. Input torque is supplied by the input gear turning the carrier shaft. If there were no torque on the input ring gear, it would run freely at whatever speed would allow the output ring gear to stop. Because the carrier shaft to ring gear ratio is 2:1, the speed of the input ring gear at this condition would be double that of the carrier shaft. Since a given output speed is desired, the input ring gear must be constrained.

3) If the input ring gear is constrained to zero speed, the output ring gear will run at double the carrier shaft speed. If the input ring gear is forced to rotate in a direction opposite to that of the carrier shaft, the output ring gear will run at a speed more than double that of the carrier shaft. If the input ring gear is allowed to rotate in the same direction as the carrier shaft, the output ring gear will run at a speed less than twice that of the carrier shaft. Thus, the differential is a "speed summer" or "adding" device which is controlled through the input ring gear to add to, or subtract from, the speed of the engine gearbox to achieve the desired output.

(b) Variable Hydraulic Unit

1) The variable hydraulic unit consists of a cylinder block, reciprocating pistons, a variable angle wobbler, and a control piston. The variable unit is connected to the engine accessory pad by direct gearing; consequently, the speed of the cylinder block is always proportional to the input speed and the direction of rotation is always the same.

2) When the CSD transmission is operating in overdrive, the variable hydraulic unit functions as a hydraulic pump. To enable the variable unit to pump oil, the governor ports charge oil to the control piston which positions the wobbler so oil is compressed as the pistons are forced into the rotating cylinder block. This high-pressure (working pressure) oil is ported to the fixed hydraulic unit. (Figure 1)

3) As the input speed increases and the need to add speed decreases, the governor ports less oil to the control cylinder until the variable wobbler is in a position approximately perpendicular to the pistons; and no oil, except that required for power losses due to friction and leakage, is pumped or received by the variable unit. At this time, the CSD transmission is operating in straight-through drive.

4) When the CSD transmission is operating in underdrive, the variable hydraulic unit functions as a motor. To enable the variable unit to operate as a motor (receive oil from the pumping unit), the governor ports oil away from the control cylinder causing the wobbler to be positioned so that the volume for accommodating oil in the piston bores on the high-pressure side is increased; consequently, oil flows from the fixed hydraulic unit to the variable unit.

(c) Fixed Hydraulic Unit

1) The fixed hydraulic unit consists of a cylinder block, reciprocating pistons, and a fixed angle wobbler. The direction of rotation and speed of the fixed hydraulic unit is determined by the volume of oil pumped or received by the variable hydraulic unit. This volume of oil is determined by the angular position of the variable wobbler and the speed of the variable block.

2) When the CSD transmission is operating in overdrive, the fixed hydraulic unit functions as a hydraulic motor. High-pressure oil pumped from the variable unit forces the fixed unit pistons to slide down the inclined wobbler face, causing the cylinder block to rotate. The block's rotation forces the input ring gear on the differential to turn in a direction opposite to the carrier shaft rotation and adds to the speed of the engine gearbox through the differential, maintaining constant output speed. (Paragraph 2.A.(1)(a))

3) As the input speed increases and the need to add speed to the output decreases, the variable hydraulic unit pumps less oil to the fixed hydraulic unit until the cylinder block stops rotating. At this time, the CSD transmission is operating in straight-through drive.

4) When the CSD transmission is operating in underdrive, the fixed hydraulic unit functions as a pump. The variable wobbler in the variable hydraulic unit is positioned so the variable hydraulic unit can receive oil from the fixed hydraulic unit. The fixed hydraulic unit pistons are forced into the cylinder block as they slide up the inclined wobbler face, pumping high-pressure oil to the variable hydraulic unit and allowing the cylinder block to rotate in the direction opposite to that of overdrive operation. Opposite rotation of the cylinder block allows the input ring gear to turn in the same direction as the carrier shaft rotation and subtracts speed from the speed of the engine gearbox through the differential, maintaining constant output speed.

B. Governing System

(1) The basic governor is a spring-biased, flyweight-operated, hydraulic control valve. The governor functions to control porting of CSD transmission charge oil to the control cylinder . The rotating sleeve in the governor is driven by the output gear and hence is responsive to CSD transmission output speed. Flyweights pivoted on this sleeve move a valve stem, located within the sleeve, against the bias of a spring. The inlet port directs charge oil to the valve stem groove between two lands. Depending on valve stem position, oil is either ported to the control piston or drained to the CSD transmission case.(Figure 5)

C. Hydraulic System

(1) The hydraulic system consists of the charge pump, the scavenge pump, and the charge relief valve. Each component is described in the following paragraphs.

(a) Charge Pump

1) The charge pump is located in the hydraulic system between the all-attitude reservoir and the CSD transmission. The charge pump supplies oil to the cylinder blocks, governor, control piston, and the lubricating system.

(b) Scavenge Pump

1) The scavenge pump is located in the hydraulic system between the CSD transmission sump and the oil cooler. The scavenge pump picks up lube oil and internal leakage and pumps it through the oil cooler into the all-attitude reservoir.

(c) Charge Relief Valve

1) The purpose of the charge relief valve is to regulate the operating pressure of the charge oil system. The valve accomplishes this function by metering the discharge of oil from the charge oil system to maintain the preset charge pressure. This principle is illustrated in Figure 2. A simple hydraulic system is shown in view A. The pump draws oil from the reservoir and delivers a constant volume of oil to the cylinder. The oil emerges from the right side of the cylinder without raising the load and flows back to the reservoir. The working pressure developed in this hydraulic system is negligible. In view B, resistance has been added, in the form of a relief valve, at a point below the area where work is to be done. Pressure is now developed between the pump and relief valve which depends on the relief pressure setting of the valve, assuming that the capacity of the pump is adequate. This working pressure is used to raise the load. The same hydraulic system is used in the CSD transmission. (Figure 5)

D. All-attitude Reservoir

(1) General

(a) The all-attitude reservoir is designed to separate entrained air from the system oil and provide a supply of deaerated oil to the CSD transmission through a wide range of acceleration loadings and airplane attitudes.

(b) The reservoir contains no moving parts and performs its functions automatically, utilizing the energy of the CSD transmission scavenge oil.

(2) Swirl Chamber

(a) Scavenge oil pumped through the oil cooler returns to the CSD transmission reservoir via the swirl chamber. This return oil, which is highly aerated, enters the swirl chamber at high velocity through a tangential inlet, causing a swirling action which creates a vortex within the swirl chamber. Air entrained in the entering oil, having a lower density than the oil, moves to the center of the vortex and escapes to the upper chamber of the reservoir. The oil, relieved of the entrained air, moves along the wall of the swirl chamber and out into the lower chamber of the reservoir. (Figure 3)

(3) Reservoir

(a) As noted in paragraph (2), return oil is always deaerated and ported to the lower reservoir chamber regardless of CSD transmission attitude. The inlet suction port is located approximately in the middle of the lower chamber; and the volume of oil delivered to the chamber is such that, regardless of CSD transmission attitude, the inlet port will always be surrounded by oil. Static pressure in the chamber is relatively low due to the constant removal of oil through the inlet suction port. (Figure 3)

(b) Regardless of CSD transmission attitude, the upper reservoir chamber will always receive a mixture of air and oil, or foam, or mist. As the air settles out of this mixture, the oil drains back into the lower reservoir chamber through small holes in the baffle between the upper and lower reservoir chambers. Residual air in the oil in the lower chamber also settles and enters the upper chamber through these same holes. A vent between the upper chamber and the CSD transmission case equalizes reservoir and case pressures.

E. Filters -- Pressure Differential Indicators

(1) Each filter (charge and scavenge) has a pop-out button which actuates when the pressure drop across the filter is 44 psi (303 kPa), indicating that the filter is becoming clogged. The charge filter is also equipped with a bypass around the filter element to ensure a flow of oil if the element becomes completely clogged.

F. Electrical Disconnect

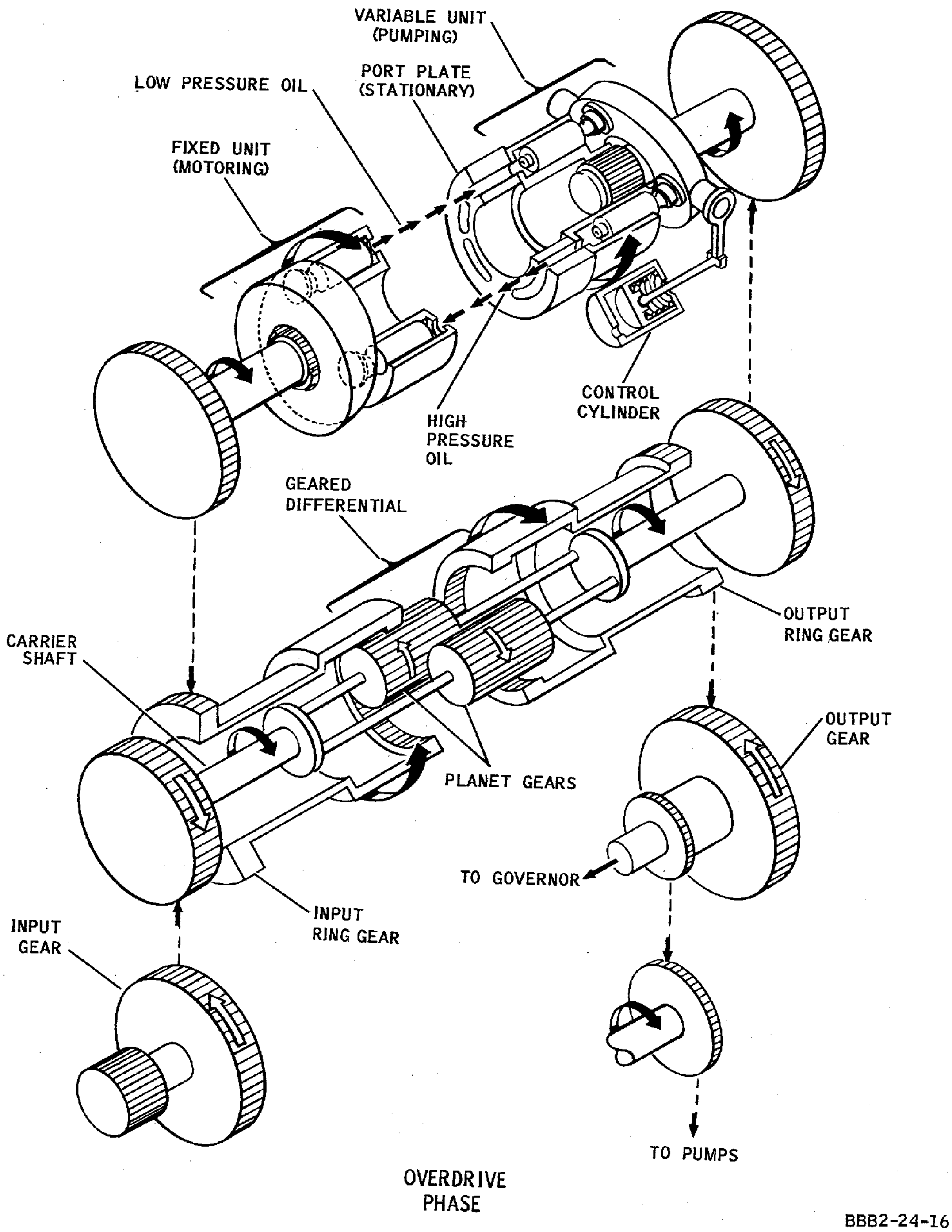
CAUTION: DO NOT ACTUATE DISCONNECT SWITCH UNLESS ENGINE IS AT OR ABOVE IDLE SPEED. DISCONNECT MAY BE ACTUATED WITH ENGINE SHUT DOWN, BUT IT MUST BE RESET BEFORE ENGINE IS STARTED. DISCONNECTING BELOW IDLE SPEED OR WITH ENGINE SHUT DOWN DOES NOT RESULT IN COMPLETE SEPARATION OF DISCONNECT DOG TEETH. STARTING ENGINE WITHOUT RESETTING DISCONNECT, OR DISCONNECTION WITH ENGINE BELOW IDLE SPEED COULD RESULT IN DAMAGE TO DOG TEETH.

CAUTION: DO NOT ATTEMPT TO RESET CSD DISCONNECT UNLESS HIGH SPEED ROTOR (N_2) IS STATIONARY.

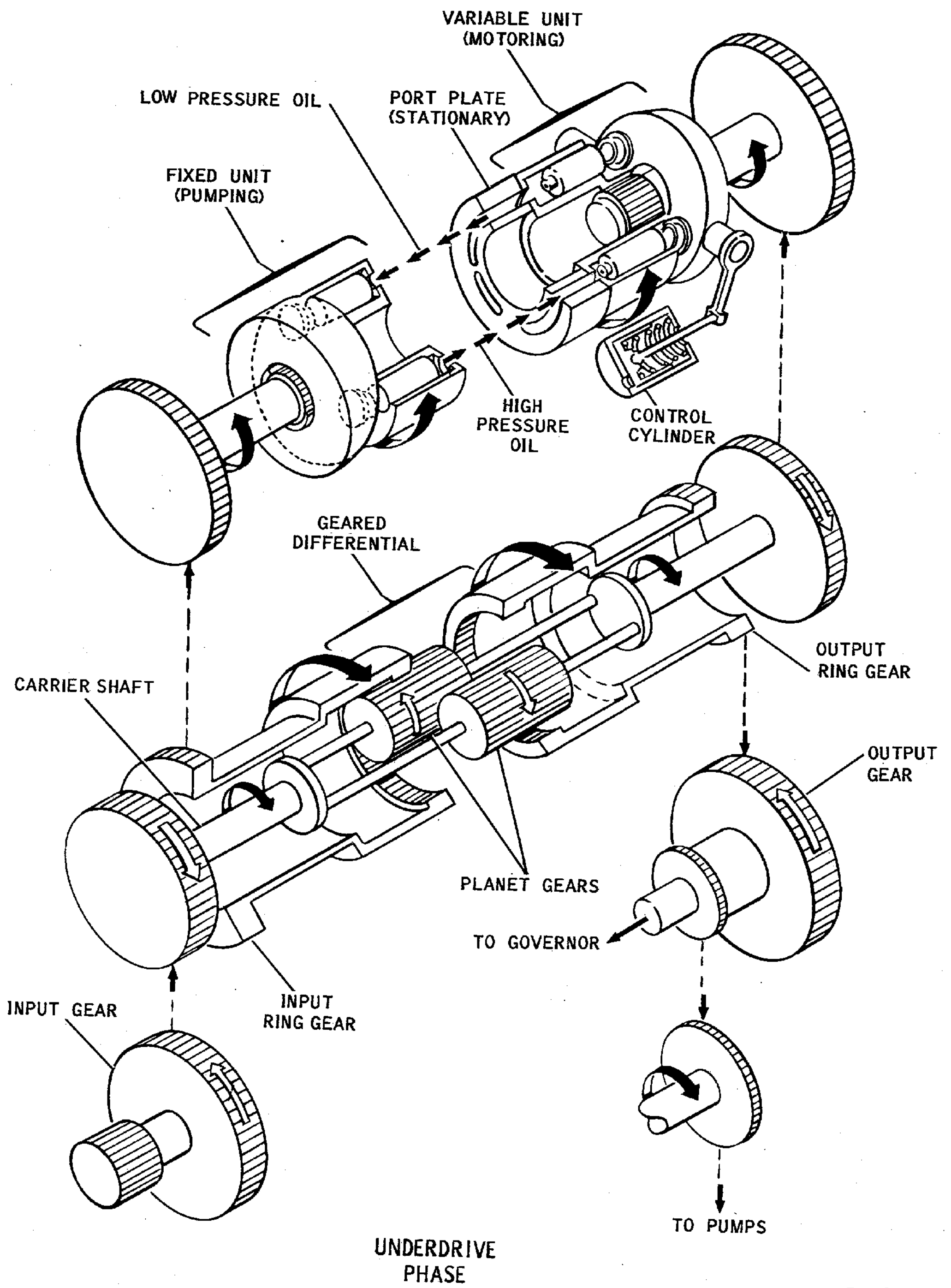
(1) The CSD transmission disconnect is an electrically actuated device which uncouples the input shaft from the spline shaft in the event of a CSD transmission malfunction. When the disconnect solenoid is energized by operation of the CSD disconnect switch, a spring-loaded pawl moves into contact with threads on the input shaft. The input shaft becomes as a screw in a threaded hole, and input rotation causes the input shaft to move away from the input spline shaft, separating the driving dogs on the two shafts. When the driving dogs have been separated, the input spline shaft, which is still being driven by the airplane engine, spins freely in the CSD transmission without causing transmission rotation. Reset may be accomplished, following engine shutdown, by pulling down on the disconnect reset handle until the solenoid nose pin snaps into position. (Figure 4)

NOTE: If the CSD was disconnected during the last flight, and a replacement CSD is not available, it is allowable to leave the disconnected CSD (per MEL) installed on the aircraft and replace it at the next station that has a spare unit.

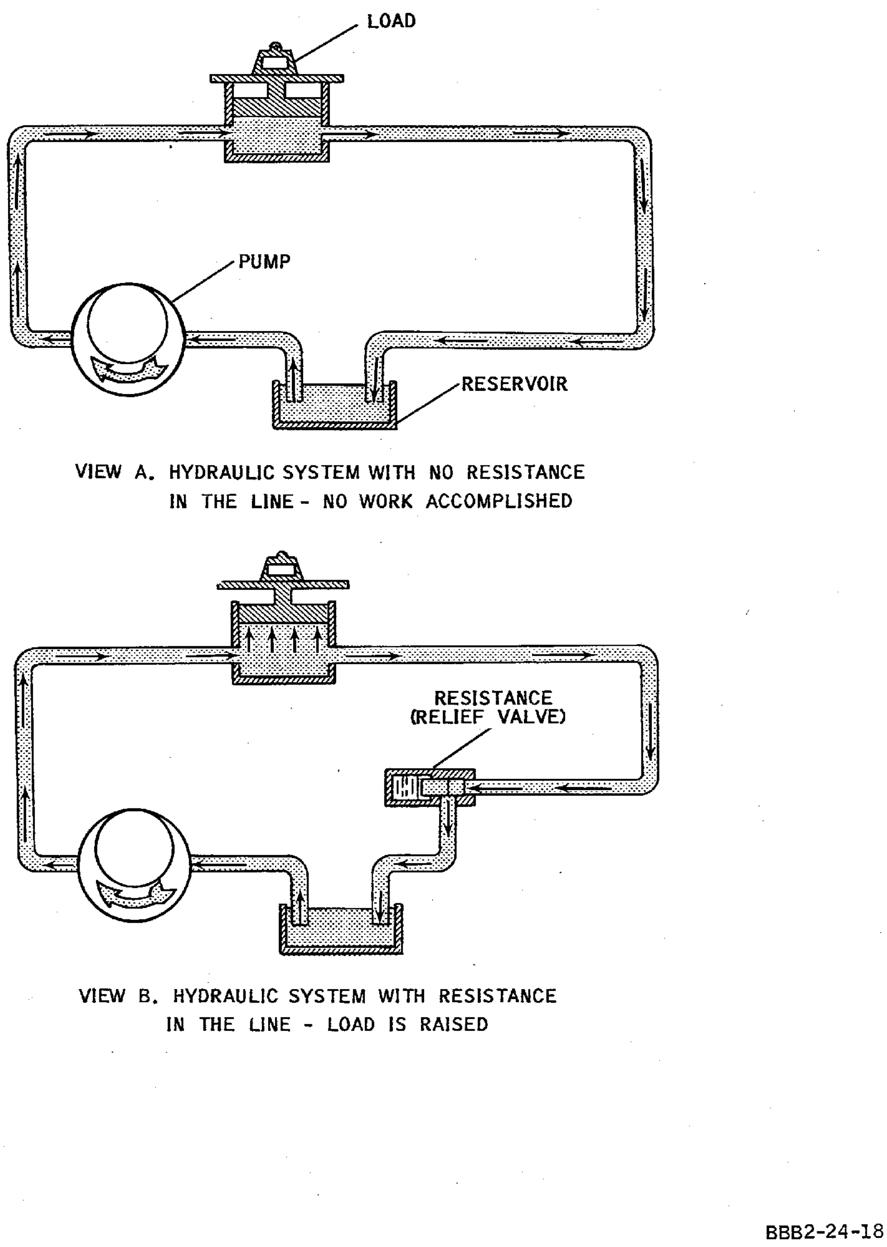
NOTE: Be sure the disconnected CSD is properly filled with oil so that the disconnect bearing in the CSD input shaft is lubricated. (GENERATOR DRIVE - SERVICING, PAGEBLOCK 24-10-00/301), paragraph 3., step D



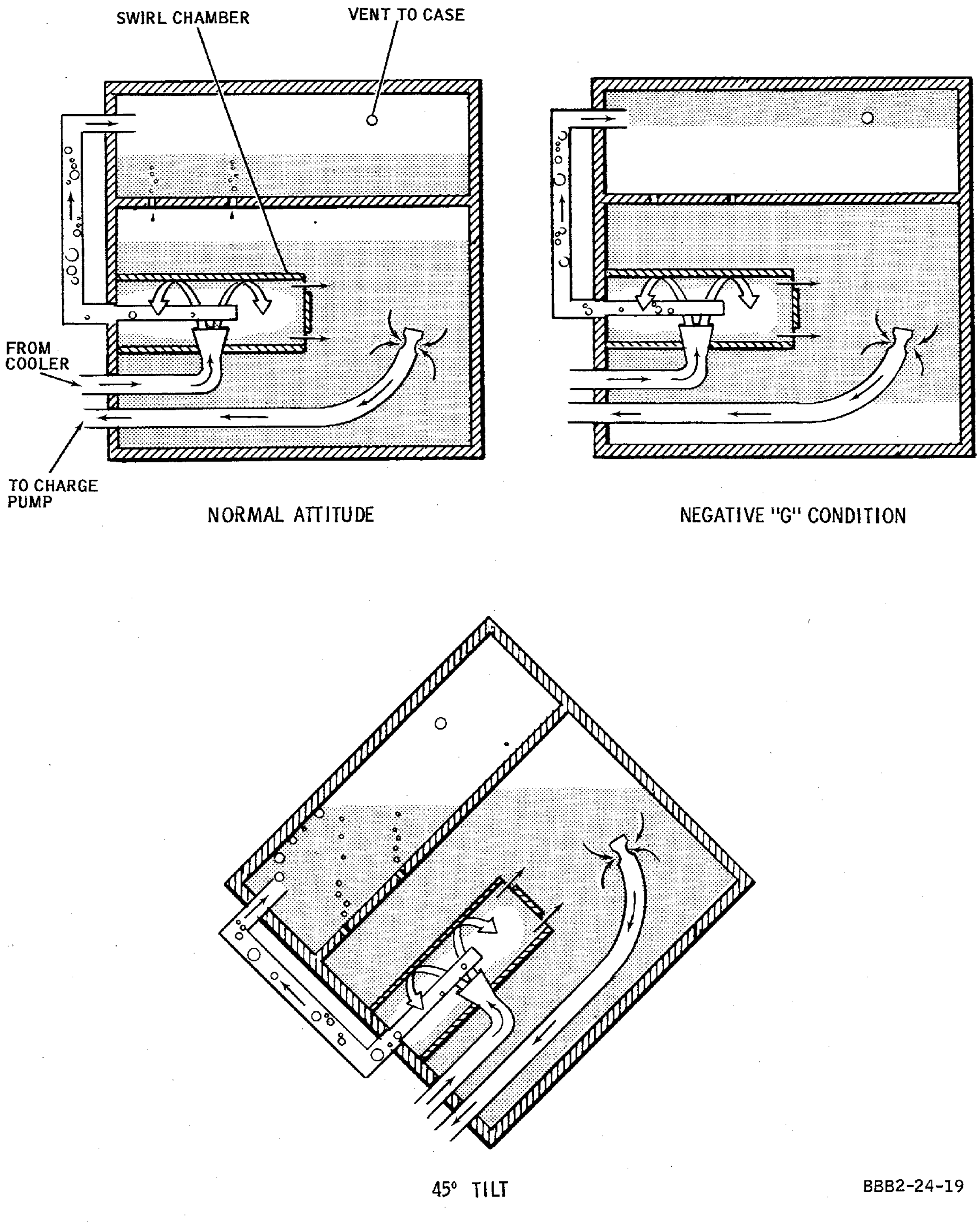
CSD Transmission Power Unit -- Functional Operation
Figure 1/24-10-01-990-803 (Sheet 1 of 2)



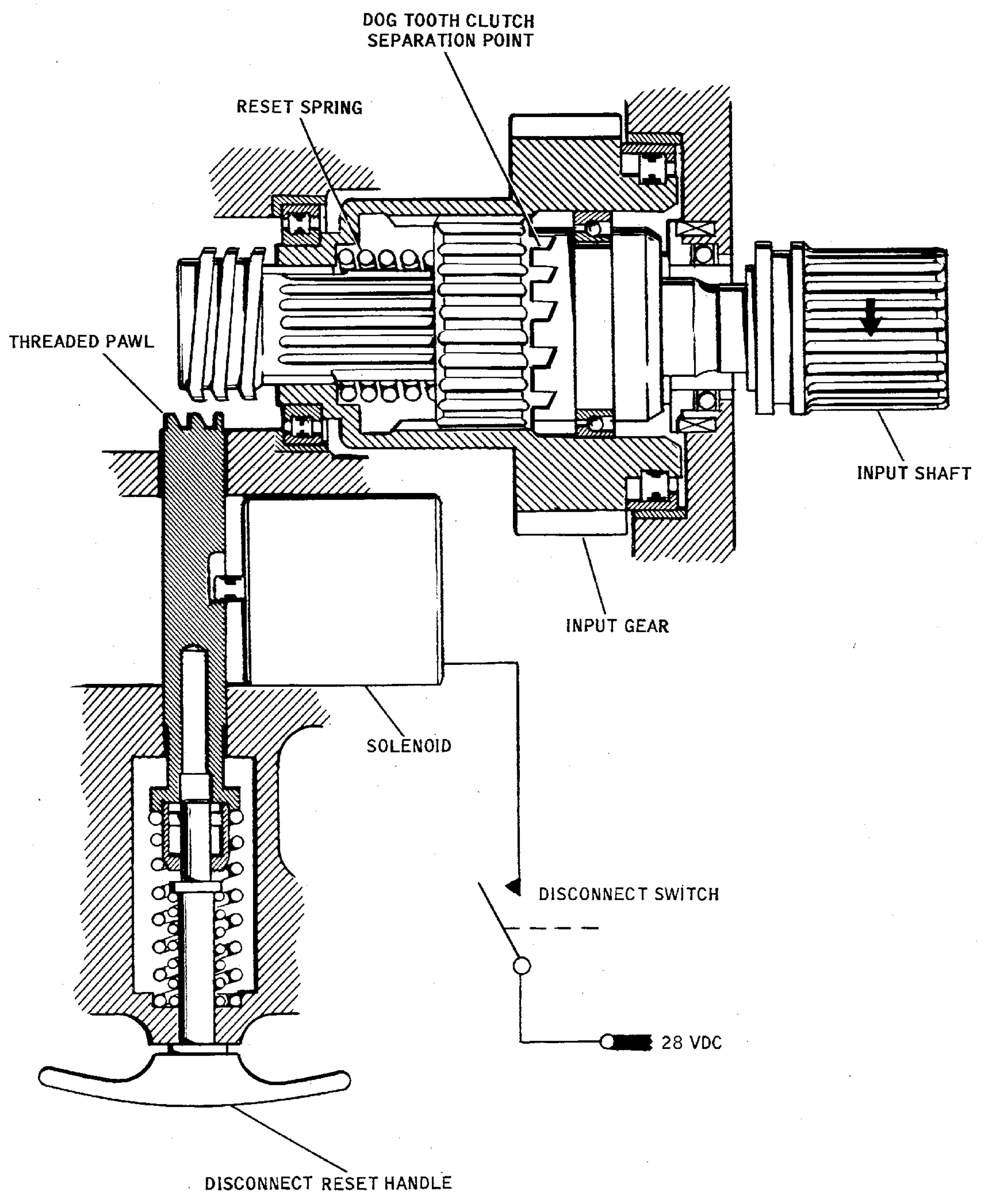
CSD Transmission Power Unit -- Functional Operation
Figure 1/24-10-01-990-803 (Sheet 2 of 2)



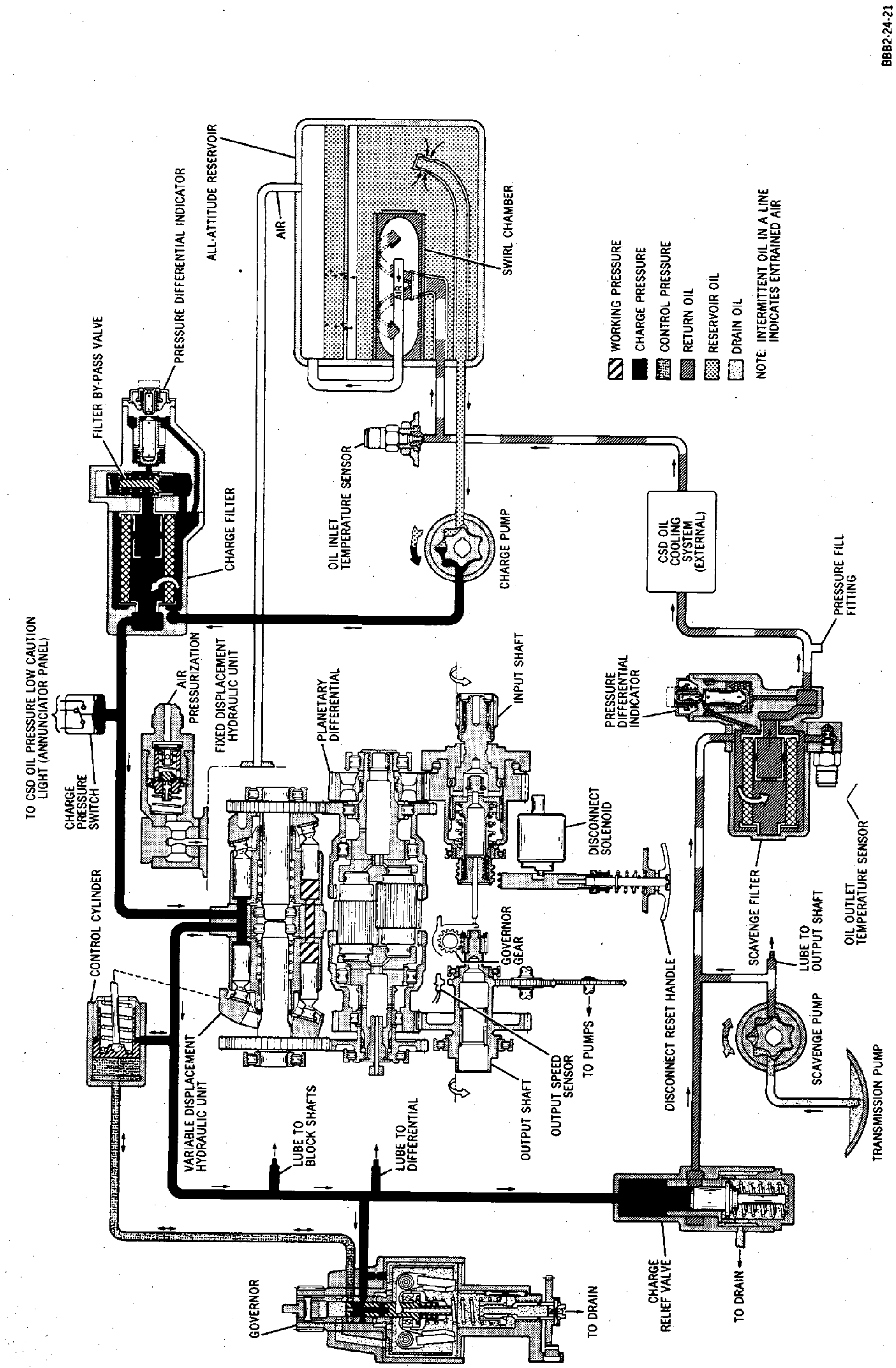
Charge Relief Valve -- Functional Diagram
Figure 2/24-10-01-990-804



All-Attitude Reservoir Operation
Figure 3/24-10-01-990-805



CSD Transmission Disconnect Mechanism
Figure 4/24-10-01-990-806



CSD Transmission Oil System -- Schematic
Figure 5/24-10-01-990-807

CONSTANT SPEED DRIVE TRANSMISSION - REMOVAL/INSTALLATION

1. General

A. A constant speed drive (CSD) transmission is installed on a mounting pad provided on the aft side of the accessory drive case of each engine. The engine-driven AC generator is mounted to the aft end of the CSD transmission. Access to the CSD transmission is through the nacelle lower door. Removal and installation procedures are identical for the left and right CSD transmissions.

B. The adapter kit, consisting of those parts required to mount the CSD transmission on an engine accessory pad, will usually remain on the engine accessory pad when the transmission is removed for servicing. Removal/Installation and Approved Repairs for the adapter pad are contained in paragraph 4.

CAUTION: FIRE DETECTOR SENSING ELEMENTS LOCATED WITHIN ENGINE AREA ARE VERY SENSITIVE. PHYSICAL CONTACT WITH THESE ELEMENTS CAN CAUSE HIDDEN DAMAGE. A CONSTANT DIMENSION MUST BE MAINTAINED BETWEEN ELEMENTS AND SUPPORT TUBE.

C. When removing or installing components of the oil inlet adapter (oil inlet hose, union, and temperature sensor), care should be exercised not to exceed the recommended torque values, to prevent damage to the CSD housing and/or the adapter. A later CSD improvement (modification) provides a steel oil inlet adapter with hex-type wrench flats. The adapter should always be securely wrench-held when removing or installing the oil inlet hose, union or temperature sensor.

NOTE: Due to combined weight of CSD transmission and engine-driven generator, it is necessary to first remove the generator. Procedures given in this section include generator removal/installation.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

Table 401

Name and Number	Manufacturer
Lubricant HF-825 DPM 5068	Royal Lubricants Co. Hanover, NJ
Antifretting compound No. No. 688272	Sundstrand Aviation Div., Rockford, Ill.
WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893	
or	
730691	
WJE ALL	
or	
E/M 76	E/M Lubricant, Inc. North Hollywood, CA.

Table 401 (Continued)

Name and Number	Manufacturer
WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893	
Cleaning solvent P-D-680, Type 1 DPM 518	Commercially available
WJE ALL	
Inconel Lockwire 0.020 in NASM20995N20, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.020 in NASM20995C20, DPM 5865	Not Specified
Safety wire 0.014 inch copper FED-J-W 001177/9	Commercially available
Torque wrench (0 to 800 inch pounds) (0 to 90.4 N·m)	
Small capacity pans (containers) as noted or one pan having a capacity of at least 2 gallons (7.57 liters)	

3. Removal/Installation

A. Remove CSD Transmission

WARNING: GENERATOR WEIGHS APPROXIMATELY 86 POUNDS (39.04 KG). CSD TRANSMISSION WEIGHS APPROXIMATELY 70 POUNDS (31.78 KG). DUE TO WEIGHT OF UNITS AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR REMOVAL.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(1) Open these circuit breakers:

LOWER EPC, ENGINE - LEFT DC BUS

Row	Col	Number	Name
WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893			
S	24	B1-151	LEFT CSD OIL PRESS LOW CAUTION
WJE ALL			
S	25	B1-179	LEFT CSD OIL TEMP
S	26	B1-150	RIGHT CSD DISC

LOWER EPC, ENGINE - RIGHT DC BUS

Row	Col	Number	Name
WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893			
T	24	B1-152	RIGHT CSD OIL PRESS LOW CAUTION

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893 (Continued)

(Continued)

LOWER EPC, ENGINE - RIGHT DC BUS

Row	Col	Number	Name
WJE ALL			
T	25	B1-180	RIGHT CSD OIL TEMP
T	26	B1-149	LEFT CSD DISC

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893

NOTE: Circuit breaker, CSD OIL PRESSURE LOW CAUTION, is not applicable on aircraft with Electronic Overhead Annunciator Panel.

WJE ALL

(2) Remove clamp to disconnect generator cooling air inlet duct from generator blast cap.

(3) Disconnect electrical connector from right side of generator.

(4) Remove terminal block cover from generator terminal block; tag and disconnect power leads.

NOTE: It is not necessary to remove guide block from generator power leads. Guide block aids in proper installation of generator wiring by keeping power leads separated.

(5) Remove screws securing air exit duct to generator exhaust air shroud; remove duct and discard gasket.

(6) Loosen T-bolts nuts sufficiently to separate and remove two halves of shroud as follows:

(a) Remove left shroud section.

(b) Lift right shroud section to clear generator mounting flange and move aft approximately 2 inches (50 mm) to clear angle locator.

(c) Rotate right shroud section 180 degrees counterclockwise on generator.

(d) Remove right shroud section.

(7) Loosen nuts that attach generator to CSD transmission.

NOTE: The keyhole-type generator mounting holes are larger at one end than the attaching nuts. This permits removing generator without removing nuts from CSD transmission studs. Attaching nuts must be loosened enough to rotate generator and center studs in large end of generator mounting holes.

CAUTION: BE CERTAIN TO SUPPORT AFT END OF GENERATOR TO PREVENT GENERATOR FROM FALLING.

(8) Rotate generator until CSD transmission studs are in large end of generator mounting holes.

CAUTION: AVOID SUPPORTING OR LIFTING GENERATOR BY DRIVE SHAFT TO PREVENT POSSIBLE DAMAGE TO SHAFT OR INTERNAL DAMAGE TO GENERATOR.

(9) Slowly move generator aft until splined drive shaft of generator disengages CSD transmission.

(10) Cover generator drive pad opening on CSD transmission to prevent entrance of foreign material.

(11) Obtain suitable container for oil to be drained from CSD transmission pad cavity and CSD transmission.

NOTE: In order to drain CSD transmission pad cavity and CSD transmission, container should have capacity of at least 2 gallons (7.57 liters).

(12) Remove drain plug assembly from CSD transmission pad cavity; drain oil into container.

NOTE: Outer hex fitting is used when removing overfill and drain plug as an assembly.

(13) Install drain plug assembly in CSD transmission pad cavity; tighten plug to torque of 150 inch-pounds (16.95 N·m).

(14) Relieve case pressure by opening the overfill drain fitting.

CAUTION: USE TWO WRENCHES WHEN REMOVING OIL INLET LINE, ONE ON LINE FITTING AND ONE ON UNION. OTHERWISE, DAMAGE CAN RESULT TO ADAPTER AS WELL AS ADAPTER RETAINING SCREW AND CSD HOUSING.

(15) Disconnect CSD transmission oil inlet and oil outlet supply hoses and allow oil to drain into container.

(16) Cap hoses and fittings to prevent entrance of foreign material.

(17) Remove reservoir drain plug; drain oil into container.

(18) Remove magnetic drain plug assembly; drain oil into container.

NOTE: Outer hex fitting is used when removing magnetic drain plug as an assembly.

(19) Install reservoir drain plug; tighten plug to torque of 75 to 100 inch-pounds (8.47 to 11.30 N·m); safety with .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(20) Install magnetic drain plug assembly; tighten plug to torque of 30 to 40 inch-pounds (3.39 to 4.52 N·m); safety with .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(21) Remove and retain vented cap.

(22) Disconnect and cap CSD transmission main electrical connector.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(23) Disconnect and cap electrical connector at oil temperature high switch in oil outlet T-fitting.

WJE ALL

WARNING: CSD TRANSMISSION WEIGHS APPROXIMATELY 70 POUNDS (31.78 KG). DUE TO WEIGHT OF UNIT AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR REMOVAL.

(24) Loosen nuts that attach CSD transmission to adapter pad.

NOTE: The keyhole-type CSD transmission mounting holes are larger at one end than the attaching nuts. This permits removing CSD transmission without removing nuts from adapter pad studs. Attaching nuts must be loosened enough to rotate CSD transmission and center studs in larger end of CSD transmission mounting holes.

CAUTION: BE CERTAIN TO SUPPORT AFT END OF CSD TRANSMISSION TO PREVENT UNIT FROM FALLING.

(25) Rotate CSD transmission until adapter pad studs are centered in large end of CSD transmission mounting holes.

CAUTION: AVOID SUPPORTING OR LIFTING CSD TRANSMISSION BY INPUT SHAFT, TO PREVENT POSSIBLE DAMAGE TO SHAFT OR INTERNAL DAMAGE TO UNIT.

(26) Slowly move CSD transmission aft until splined drive shaft of CSD transmission disengages accessory drive.

(27) Remove gasket from adapter pad; discard gasket.

(28) Perform main gear box CSD drive gear movement check. (MAIN ACCESSORY GEARBOX SECTION - INSPECTION/CHECK-01, PAGEBLOCK 72-61-00/601)

(29) Cover CSD transmission pad cavity to prevent entrance of foreign material.

(30) Remove O-ring from CSD transmission mounting flange; discard O-ring.

(31) If original CSD transmission is not to be installed, proceed as follows:

(a) Remove oil outlet fitting from oil outlet boss; discard O-ring.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(b) Remove fitting from oil inlet boss; discard O-ring.

WJE ALL

(c) Remove CSD transmission output pad seal drain and fitting; discard O-ring.

(d) Do not remove the pressure fill and overfill couplings from the CSD transmission.

NOTE: The pressure fill and overfill couplings should remain on the CSD transmission for the static leak test.

NOTE: If the pressure fill and overfill couplings are known good, they can be removed and reinstalled on the next CSD.

(e) Remove generator attaching nuts from CSD transmission studs.

CAUTION: TRANSMISSION PORTS SHOULD NOT BE LEFT OPEN LONGER THAN ABSOLUTELY NECESSARY. TO PREVENT FOREIGN MATERIAL FROM ENTERING REPLACEMENT TRANSMISSION, LEAVE SHIPPING PLUGS AND COVERS ON OPENINGS UNTIL FITTINGS ARE TO BE INSTALLED. TO PREVENT FURTHER DAMAGE TO TRANSMISSION BEING REPLACED, INSTALL SHIPPING PARTS REMOVED FROM REPLACEMENT TRANSMISSION AS SOON AS POSSIBLE.

(f) Remove shipping plugs, caps, and plate from new or overhauled CSD transmission; install on unit removed from aircraft.

B. Install CSD Transmission

NOTE: Paragraph 3.B.(2) does not apply if original CSD transmission is to be installed; proceed to Paragraph 3.B.(3)

NOTE: Lubricate O-rings with HF-825 lubricant, or equivalent, before installing.

WARNING: CSD TRANSMISSION WEIGHS APPROXIMATELY 70 POUNDS (31.78 KG). GENERATOR WEIGHS APPROXIMATELY 86 POUNDS (39.04 KG). DUE TO WEIGHT OF UNITS AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR INSTALLATION.

WARNING: LUBRICANT IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN LUBRICANT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET LUBRICANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

(WARNING PRECEDES)

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:
- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Make sure that these circuit breakers are open:

LOWER EPC, ENGINE - LEFT DC BUS

Row	Col	Number	Name
WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893			
S	24	B1-151	LEFT CSD OIL PRESS LOW CAUTION
WJE ALL			
S	25	B1-179	LEFT CSD OIL TEMP
S	26	B1-150	RIGHT CSD DISC

LOWER EPC, ENGINE - RIGHT DC BUS

Row	Col	Number	Name
WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893			
T	24	B1-152	RIGHT CSD OIL PRESS LOW CAUTION
WJE ALL			
T	25	B1-180	RIGHT CSD OIL TEMP
T	26	B1-149	LEFT CSD DISC

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893

NOTE: Circuit breaker, CSD OIL PRESSURE LOW CAUTION, is not applicable on aircraft with Electronic Overhead Annunciator Panel.

WJE ALL

(2) If new or overhauled CSD transmission is to be installed, proceed as follows: (Figure 403)

(a) Install generator attaching nuts on CSD transmission studs.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(b) If the pressure fill coupling is not installed or needs to be replaced on the CSD transmission, install the coupling with a new O-ring.

1) Tighten the pressure fill coupling to 200 in-lb (22.6 N·m) to 250 in-lb (28.2 N·m).

WJE ALL

(c) If the overfill coupling is not installed or needs to be replaced on the CSD transmission, install the coupling with a new O-ring.

1) Tighten the overfill coupling to 200 in-lb (22.6 N·m) to 225 in-lb (25.4 N·m).

2) Safety the attaching screws with .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(d) Torque gravity fill plug 150 to 170 inch-pounds (16.9 to 19.2 N·m). Safety gravity fill plug with lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

CAUTION: DO NOT OVER-TORQUE TO PREVENT DAMAGE TO CSD HOUSING OR DAMAGE TO ADAPTER HELICOIL INSERTS. IF STEEL ADAPTER IS INSTALLED, USE WRENCH FLATS TO HOLD ADAPTER WHILE APPLYING TORQUE.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(e) Install fitting with new O-ring, and CSD transmission pad seal drain; tighten fitting to torque of 40 to 65 inch-pounds (4.52 to 7.34 N·m).

(f) Install fitting with new O-ring in oil outlet boss; tighten nut to torque of 70 to 110 inch-pounds (7.91 to 12.43 N·m).

WJE ALL

(g) Install fitting with new O-ring in oil inlet boss; tighten to torque of 120 to 150 inch-pounds (13.56 to 16.95 N·m).

(3) Remove protective covering from CSD transmission pad cavity.

(4) If necessary remove the generator attach nuts from the studs of the CSD. Install a new gasket on the CSD adapter pad.

(5) Loosely install the generator attach nuts on the studs of the CSD.

WARNING: LUBRICANT IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN LUBRICANT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET LUBRICANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(6) Lubricate new O-ring with HF-825 lubricant, or equivalent, and install on CSD transmission mounting flange.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

WARNING: DRY CLEANING SOLVENT IS AN AGENT THAT IS FLAMMABLE, POISONOUS, AND AN IRRITANT. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN DRY CLEANING SOLVENT IS USED.

- GAS/AIR MIXTURES MORE THAN THE LOWER EXPLOSIVE LIMIT (LEL) CAN CAUSE AN EXPLOSION IF HIGH HEAT, SPARKS, OR FLAMES SUPPLY IGNITION.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET DRY CLEANING SOLVENT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WJE ALL

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

CAUTION: TO PREVENT EXCESSIVE SPLINE WEAR AND CONTAMINATION OF OIL IN TRANSMISSION PAD CAVITY, DO NOT APPLY GREASE OR ANTI-FRETTING COMPOUND TO SPLINE. ANTI-FRETTING COMPOUND HARDENS AND BECOMES BRITTLE WHEN COMBINED WITH TRANSMISSION OIL.

(7) Remove any grease or anti-fretting compound from CSD transmission input shaft spline with Cleaning solvent (P-D-680).

(8) Lubricate CSD transmission input shaft spline, mounting screws, and adapter pad studs with approved lubricating oil. (PAGEBLOCK 24-10-00/301)

CAUTION: AVOID SUPPORTING OR LIFTING CSD TRANSMISSION BY INPUT SHAFT, TO PREVENT POSSIBLE DAMAGE TO SHAFT OR INTERNAL DAMAGE TO UNIT.

(9) Center large end of holes in CSD transmission mounting flange over attaching nuts on adapter pad.

NOTE: Position CSD transmission so that reset T-handle is at bottom of unit.

(10) Slowly move CSD transmission forward until spline input shaft of CSD transmission engages engine accessory drive; continue forward until CSD transmission mates with adapter pad.

CAUTION: CSD TRANSMISSION ATTACHING NUTS ARE WET TORQUED, (ADAPTER PAD STUDS LUBRICATED).

(11) Rotate CSD transmission to bottom adapter pad studs in small end of CSD transmission mounting holes; tighten attaching nuts evenly to torque of 216 to 240 inch-pounds (24.41 to 27.12 N·m).

(12) Connect CSD transmission main electrical connector.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(13) Connect oil temperature high switch electrical connector.

WJE ALL

(14) Install vented cap.

CAUTION: UNION IN OIL INLET BOSS AND IN OIL OUTLET BOSS, MUST BE HELD SECURE WHILE TORQUE IS BEING APPLIED TO RESPECTIVE HOSE CONNECTIONS, TO PREVENT CRACKING OF CSD HOUSING OR DAMAGE TO HELICOIL INSERTS.

(15) Connect CSD transmission oil inlet and oil outlet supply hoses; tighten hose connections to standard hose torque values.

(16) If generator is to be replaced, perform the following:

(a) Remove blast cap from removed generator.

(b) Install blast cap on new generator; safety screws with .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

NOTE: Outlet must face to right hand bottom of terminal block.

(c) Provide electrical bond at three places on generator mounting flange. (Figure 401)

WARNING: ANTI-FRETTING COMPOUND IS AN AGENT THAT IS POISONOUS AND AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN ANTI-FRETTING COMPOUND IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET ANTI-FRETTING COMPOUND IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(17) Apply film of anti-fretting compound No. 688272, or E/M 76, or equivalent, onto generator drive shaft splines.

Apply film of anti-fretting compound No. 730691, or No. 688272, or E/M 76, or equivalent, onto generator drive shaft splines.

WJE ALL

(18) Remove protective covering from generator drive pad opening.

WARNING: GENERATOR WEIGHS APPROXIMATELY 86 POUNDS (39.04 KG). DUE TO WEIGHT OF UNIT AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR INSTALLATION.

CAUTION: AVOID TILTING, DUMPING, OR ROUGH HANDLING WHICH MIGHT DAMAGE CSD TRANSMISSION OUTPUT SEAL.

(19) Center large end of holes in generator mounting flange over attaching nuts on CSD transmission studs.

NOTE: Position generator so that power leads terminal strip is on upper right side of generator and with bottom terminal approximately horizontal to generator.

(20) Slowly move generator forward until splined drive shaft of generator engages CSD transmission.

CAUTION: CHECK GENERATOR INSTALLATION TO MAKE CERTAIN THAT CAPTIVE WASHERS ON MOUNTING NUTS ARE WITHIN SPOT-FACED AREA AROUND EACH MOUNTING HOLE OF GENERATOR MOUNTING FLANGE. IF WASHERS RIDE OUTSIDE EDGE OF SPOT-FACE, INSTALLATION WILL BE INSECURE AND GENERATOR MAY BECOME LOOSE.

(21) Rotate generator clockwise to bottom CSD transmission studs in small end of generator mounting holes; tighten attaching nuts to torque of 144 to 168 inch-pounds (16.27 to 18.98 N·m).

(22) Position right shroud section at left side of generator and rotate shroud 180 degrees (3.14 rad) clockwise.

NOTE: Air exit opening should be positioned on horizontal centerline, right side of generator, at completion of rotation.

(23) Move right shroud section forward approximately 2 inches (50.8 mm), lift to engage generator mounting flange, and align with angle locator.

(24) Install left shroud section, making certain left and right shroud sections mate properly.

(25) Connect clamp T-bolts and tighten to torque of 25 to 30 inch-pounds (2.8 to 3.4 N·m).

(26) Install air exit duct with new gasket on shroud. (Figure 401)

(27) Connect power leads to generator terminal strip, making certain that all wires are connected properly. Tighten terminal nuts to torque of 160 to 190 inch-pounds (18.1 to 21.5 N·m). (Refer to Wiring Diagram Manual)

(28) Install terminal block cover on terminal block.

(29) Connect generator electrical connector; safety with .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(30) Install clamp securing cooling air inlet duct to generator blast cap, tighten to torque value specified on clamp.

NOTE: Position clamp so that when tightening, there will be no interference with fire detector connector.

(31) Pressure fill CSD transmission pad cavity and CSD transmission with approved lubricating oil. (PAGEBLOCK 24-10-00/301)

(32) Close these circuit breakers:

LOWER EPC, ENGINE - LEFT DC BUS

Row	Col	Number	Name
WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893			
S	24	B1-151	LEFT CSD OIL PRESS LOW CAUTION
WJE ALL			
S	25	B1-179	LEFT CSD OIL TEMP
S	26	B1-150	RIGHT CSD DISC

LOWER EPC, ENGINE - RIGHT DC BUS

Row	Col	Number	Name
WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893			
T	24	B1-152	RIGHT CSD OIL PRESS LOW CAUTION
WJE ALL			
T	25	B1-180	RIGHT CSD OIL TEMP
T	26	B1-149	LEFT CSD DISC

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893

NOTE: Circuit breaker, CSD OIL PRESSURE LOW CAUTION, is not applicable on aircraft with Electronic Overhead Annunciator Panel.

WJE ALL

CAUTION: IF ENGINE IS RUNNING, DO NOT ACTUATE DISCONNECT SWITCH UNLESS ENGINE IS AT OR ABOVE IDLE SPEED. DISCONNECT MAY BE ACTUATED WITH ENGINE SHUT DOWN BUT IT MUST BE RESET BEFORE ENGINE IS STARTED. DISCONNECTING BELOW IDLE SPEED OR WITH ENGINE SHUT DOWN DOES NOT RESULT IN COMPLETE SEPARATION OF DISCONNECT DOG TEETH. STARTING ENGINE WITHOUT RESETTING DISCONNECT, OR DISCONNECTING WITH ENGINE BELOW IDLE SPEED COULD RESULT IN DAMAGE TO DOG TEETH.

CAUTION: DO NOT HOLD SWITCH IN DISCONNECT POSITION LONGER THAN IS NECESSARY TO ACTUATE DISCONNECT SOLENOID. ALLOW 60 SECOND COOLING PERIOD BETWEEN ACTUATION PERIODS.

(33) Test CSD disconnect circuitry and actuation mechanism.

NOTE: Actuation of disconnect solenoid can be detected by listening for an audible "clank" in area of disconnect reset handle on CSD.

(a) Momentarily place applicable CSD disconnect switch, located on overhead switch panel, in disconnect position.

CAUTION: DO NOT ATTEMPT TO RESET CSD DISCONNECT UNLESS HIGH SPEED ROTOR (N_2) IS STATIONARY.

(b) Slowly pull disconnect reset handle to outward limit of travel noting amount of force required. Operation of handle should require moderate force and be smooth with no indication of binding.

NOTE: When resetting, solenoid actuating pin should produce an audible "click" as reset handle approaches outward limit of travel.

(c) Allow reset handle to return slowly to inward position.

(d) Slowly pull reset handle to outward limit of travel noting amount of force required. Force required should be less than in Paragraph 3.B.(33)(b) and there should be no indication of disconnect actuating pin resetting.

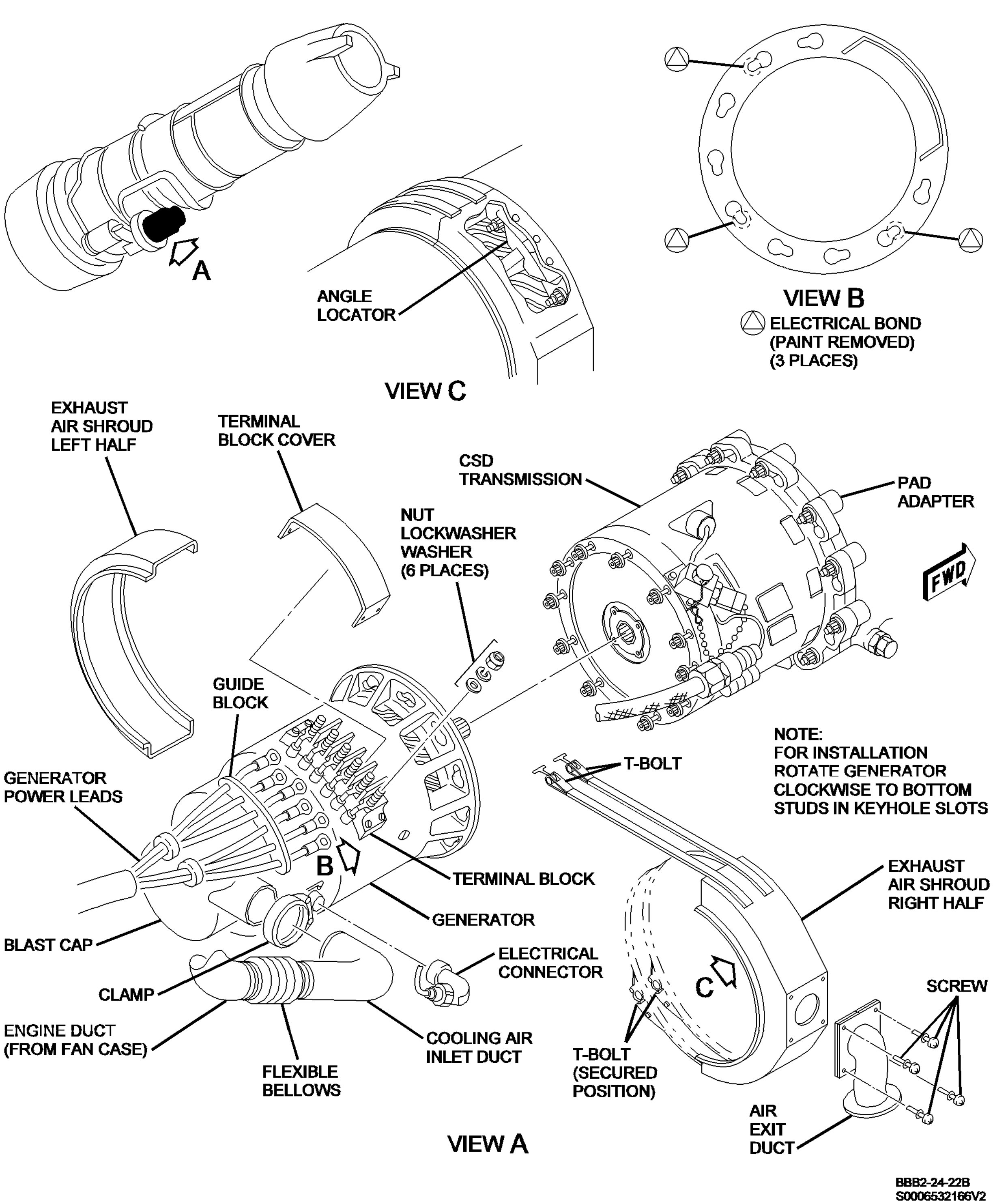
(e) Disconnect test complete. Allow reset handle to return to inward position.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

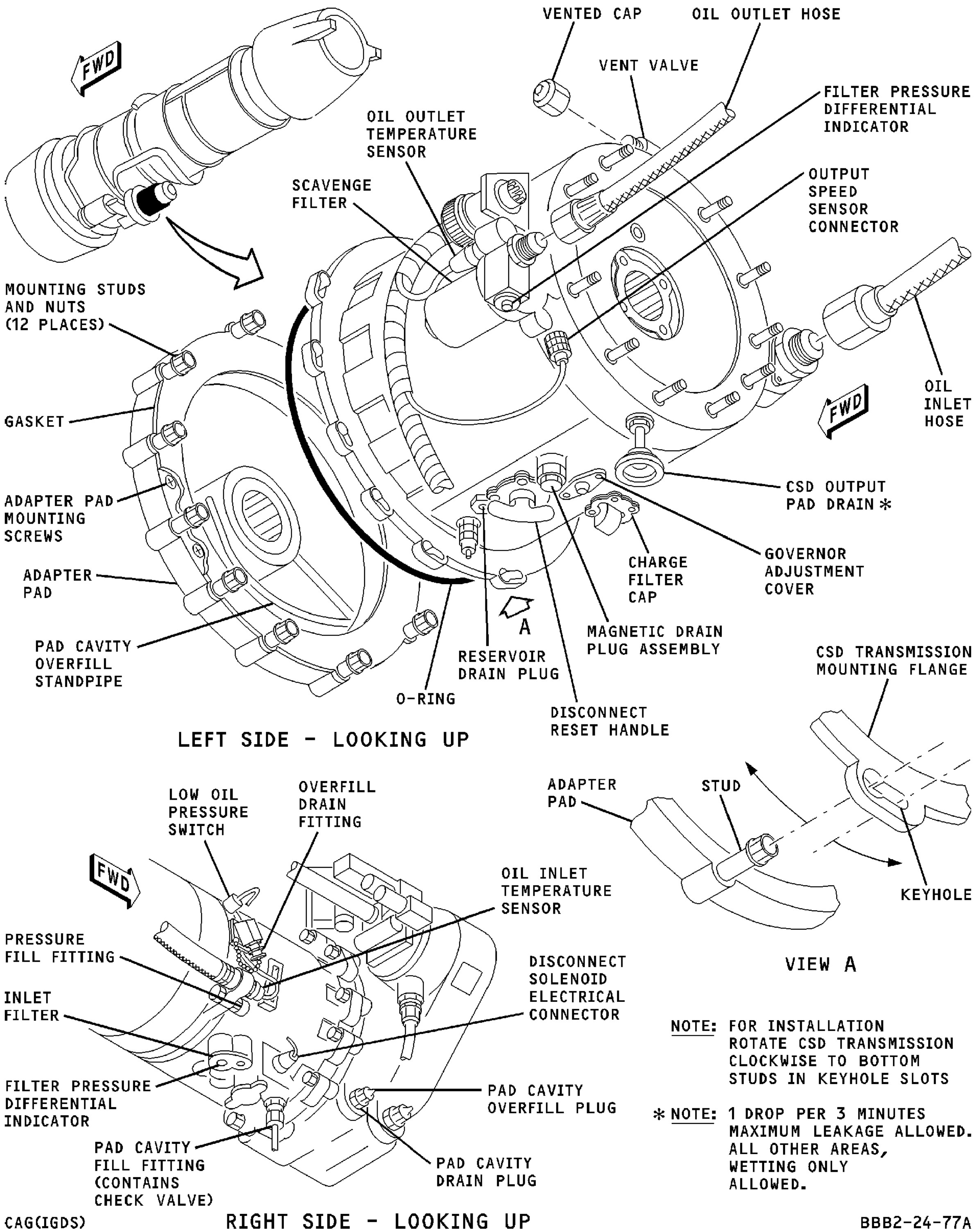
(34) Safety CSD disconnect switch in normal position with single strand (0.014 inch) emergency type copper safety wire.

WJE ALL

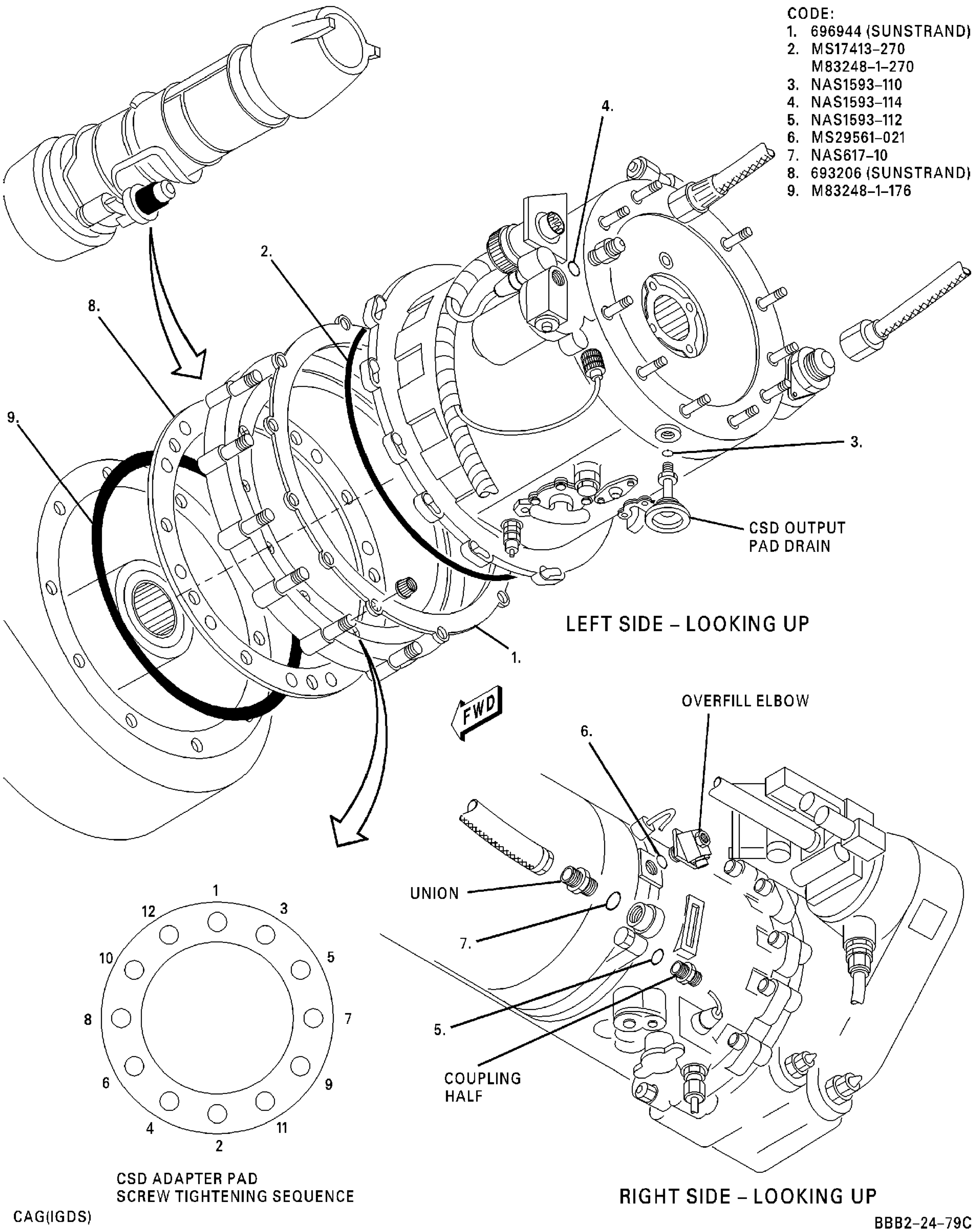
(35) Perform adjustment/test of generator drive. (PAGEBLOCK 24-10-00/501)



AC Generator -- Installation
Figure 401/24-10-01-990-802



Constant Speed Drive Transmission -- Installation
Figure 402/24-10-01-990-809



Constant Speed Drive Transmission -- Installation
Figure 403/24-10-01-990-810

4. Removal/Installation and Approved Repairs for Adapter Pad

A. Removal/Installation

(1) Remove adapter pad.

(a) Using Allen wrench, remove screws securing adapter pad to engine accessory pad.

(b) Remove adapter pad; discard gasket and O-ring.

(2) Install adapter pad.

(a) Check engine accessory pad and O-ring groove in adapter pad to ensure that they are clean and free of burrs.

WARNING: LUBRICANT IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN LUBRICANT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET LUBRICANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: P-D-680 TYPE 1 SOLVENT IS AN AGENT THAT IS FLAMMABLE AND POISONOUS. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN P-D-680 TYPE 1 SOLVENT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET P-D-680 TYPE 1 SOLVENT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THESE HAZARDOUS AGENTS.

(b) Remove any grease or rust inhibitor with Cleaning solvent (P-D-680).

(c) Install new O-ring in groove on forward face of adapter pad. Use HF-825 lubricant or equivalent. (Figure 403)

NOTE: Lubricant is used to hold O-ring in the groove and to reduce crimping.

(d) Lubricate attaching screws with approved lubricating oil. (PAGEBLOCK 24-10-00/301)

(e) Using new gasket, install adapter pad on engine accessory pad. Tighten all screws in sequence as shown in Figure 403. Tighten screws evenly to torque of 50 inch-pounds (5.65 N·m), then finally tighten all screws evenly to torque of 180 to 210 inch-pounds (20.34 to 23.73 N·m).

NOTE: The adapter pad is marked TOP. Install with this marking in the 12 o'clock position (up), away from the engine accessory pad.

B. Approved Repairs

(1) Damaged studs may be replaced, if desired, as follows:

(a) Remove damaged stud from adapter pad.

CAUTION: STUDS MUST BE WET TORQUED AND VALUES MAINTAINED.

(b) Lubricate new stud with approved lubricating oil, and screw coarse thread into the adapter pad; tighten to torque of 162 to 180 inch-pounds (18.31 to 20.34 N·m), and to an installed height of 1.266 (+0.000 -0.020) inches (32.15 (+0.000, -0.508) millimeters). (PAGEBLOCK 24-10-00/301)

(c) If values cannot be met with standard stud, use oversize stud (0.003 inch (0.076 millimeter) oversize).

CONSTANT SPEED DRIVE (CSD) TRANSMISSION - ADJUSTMENT/TEST

1. **General**

   A. This procedure contains MSG-3 task card data.

TASK 24-10-01-710-801

2. **Operational Check of the CSD Disconnect System**

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
24-00-00 P/B 001	GENERAL - DESCRIPTION AND OPERATION

B. Prepare for the Operational Check of the CSD Disconnect System

SUBTASK 24-10-01-861-001

(1) Energize the electrical system. (GENERAL - DESCRIPTION AND OPERATION, PAGEBLOCK 24-00-00/001)

C. Operational Check of the CSD Disconnect System

SUBTASK 24-10-01-710-001

CAUTION: IF ENGINE IS RUNNING, DO NOT ACTUATE DISCONNECT SWITCH UNLESS ENGINE IS AT OR ABOVE IDLE SPEED. DISCONNECT MAY BE ACTUATED WITH ENGINE SHUT DOWN BUT IT MUST BE RESET BEFORE ENGINE IS STARTED. DISCONNECTING BELOW IDLE SPEED OR WITH ENGINE SHUT DOWN DOES NOT RESULT IN COMPLETE SEPARATION OF DISCONNECT DOG TEETH. STARTING ENGINE WITHOUT RESETTING DISCONNECT, OR DISCONNECTING WITH ENGINE BELOW IDLE SPEED COULD RESULT IN DAMAGE TO DOG TEETH.

(1) Do an operational check of the CSD disconnect system.

NOTE: Actuation of disconnect solenoid can be detected by listening for an audible "clank" in area of disconnect reset handle on CSD.

CAUTION: DO NOT HOLD SWITCH IN DISCONNECT POSITION LONGER THAN IS NECESSARY TO ACTUATE DISCONNECT SOLENOID. ALLOW 60 SECOND COOLING PERIOD BETWEEN ACTUATION PERIODS.

(a) Momentarily place applicable CSD disconnect switch, located on overhead switch panel, in disconnect position.

CAUTION: DO NOT ATTEMPT TO RESET DISCONNECT WITH ENGINE ROTATING.

(b) Slowly pull disconnect reset handle to outward limit of travel noting amount of force required. Operation of handle should require moderate force and be smooth with no indication of binding.

NOTE: When resetting, solenoid actuating pin should produce an audible "click" as reset handle approaches outward limit of travel.

(c) Allow reset handle to return slowly to inward position.

(d) Slowly pull reset handle to outward limit of travel noting amount of force required. Force required should be less than in step (b) and there should be no indication of disconnect actuating pin resetting.

(e) Disconnect test complete. Allow reset handle to return to inward position.

D. Job Close-up

SUBTASK 24-10-01-862-001

(1) De-energize the electrical system. (GENERAL - DESCRIPTION AND OPERATION, PAGEBLOCK 24-00-00/001)

SUBTASK 24-10-01-430-001

(2) Safety CSD disconnect switch in normal position with single strand emergency type copper safety wire.

SUBTASK 24-10-01-942-001

(3) Remove all the tools and equipment from the work area. Make sure the area is clean.

END OF TASK

CONSTANT SPEED DRIVE TRANSMISSION - CHECK

1. General

A. This section contains check procedures for the magnetic plug and filters installed on the CSD transmission. Following the first runup of a newly installed CSD transmission, and at specified time intervals as recommended by the manufacturer, the magnetic plug and filters should be removed for check.

B. The magnetic plug is a portion (inner hex fitting) of the magnetic drain plug assembly. Periodic checks of the magnetic plug can be accomplished by removal and check of the plug.

CAUTION: FIRE DETECTOR SENSING ELEMENTS LOCATED WITHIN ENGINE AREA ARE VERY SENSITIVE. PHYSICAL CONTACT WITH THESE ELEMENTS CAN CAUSE HIDDEN DAMAGE. CONSTANT DIMENSION MUST BE MAINTAINED BETWEEN ELEMENTS AND SUPPORT TUBE.

C. Periodic checks should be made of the differential pressure indicators of both the charge filter and scavenge filter. A pop-out button will actuate when the pressure across the filter is 44 psi (303 kPa), indicating the filter is becoming clogged.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 601

Name and Number	Manufacturer
Lockwire, NASM20995N32, DPM684	Not specified
Lockwire, NASM20995N20, DPM684	Not specified
Torque wrench 0 in-lb (0 N·m) to 25 in-lb (2.8 N·m)	

3. Check Constant Speed Drive Transmission

A. Check Magnetic Plug (Figure 601).

(1) Applicable for electric type, magnetic plug only.

Using ohmmeter, check continuity between small prong extending from plug and ground. If no continuity exists, no further check is required. If continuity exists, proceed as described in the following steps.

(2) Remove magnetic plug.

NOTE: A self-closing valve on magnetic drain plug assembly permits magnetic plug to be removed without loss of CSD transmission oil.

(3) Small amount of fine granular material, or fuzz, is normal. If magnetic plug appears normal, clean plug.

(a) Install plug with new O-ring. Tighten plug to torque of 15 in-lb (1.7 N·m) to 20 in-lb (2.3 N·m); safety with lockwire.

NOTE: Use .032 inch lockwire except on small fasteners that have a hole diameter less than .045 inch. In these fasteners, use .020 inch lockwire.

(4) If heavy deposits of fuzz are present on plug and if CSD transmission has been operating normally, examine filters for evidence of nonmagnetic metal chunks (deposits clearly definable as being caused by breakage, in contrast to non-magnetic flakes and slivers, caused by normal CSD transmission wear).

(a) If chunks of metal (breakage) are found on either filter, remove and replace CSD transmission.

(b) If filters are free of chunks of metal, clean and install magnetic plug and filters. Check after next engine run. Accumulation of fuzz equal to or greater than original is indication of possible internal failure. Remove and replace CSD transmission.

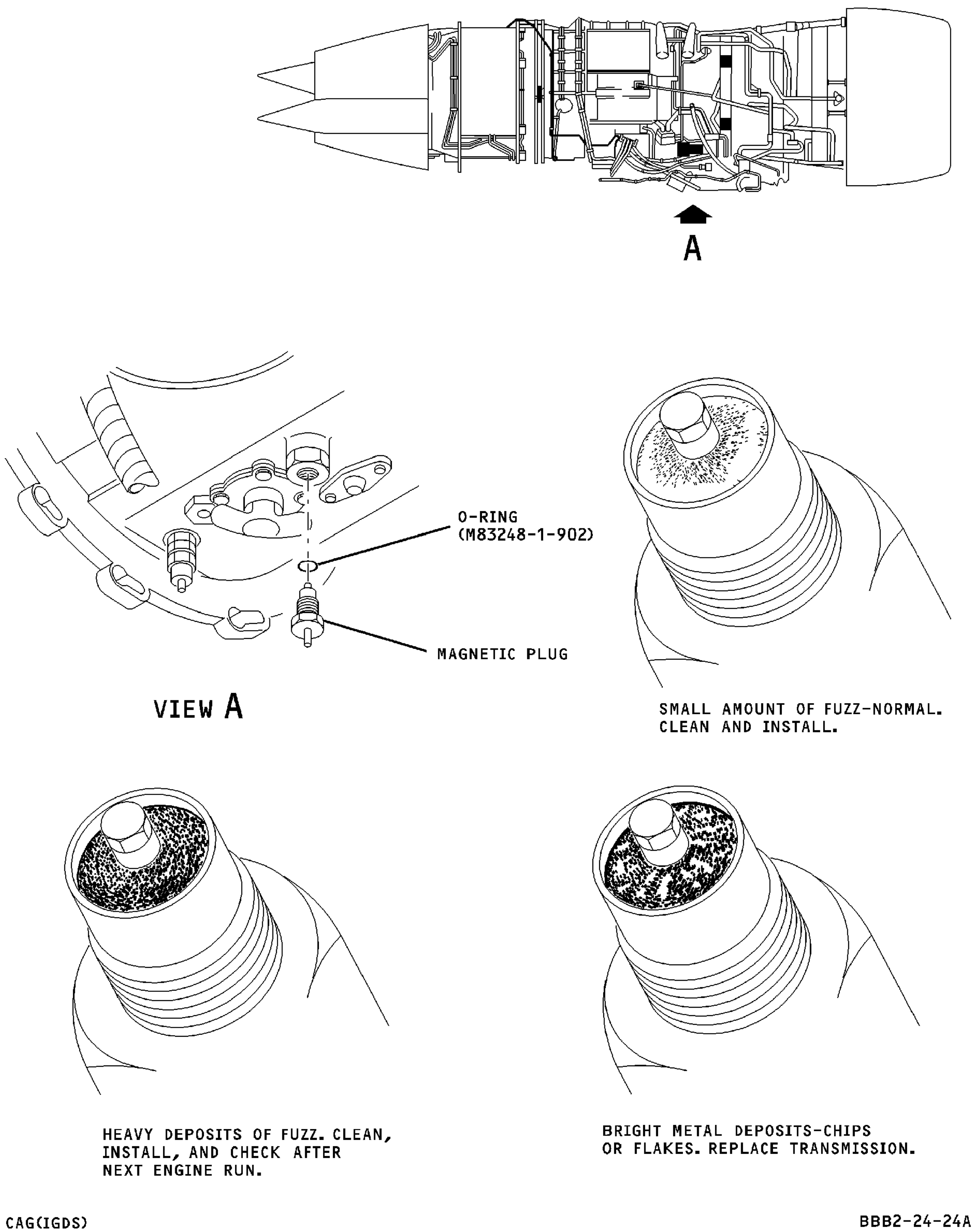
(5) If bright metal deposits (chips or flakes) are found on magnetic plug, remove and replace CSD transmission.

B. Check Filters

(1) If either charge or scavenge filter shows bright metal deposits, and if magnetic plug also has bright metal deposits (chips, flakes, or slivers), remove and replace CSD transmission.

(2) If either filter shows bright metal deposits which can be clearly defined as chunks, or pieces caused by breakage (in contrast to nonmagnetic flakes or slivers caused by normal CSD transmission wear), remove and replace CSD transmission regardless of condition of magnetic plug.

(3) If either filter shows bright metal deposits (flakes or slivers), but magnetic plug is clean (small deposits of black metallic fuzz are normal), thoroughly clean magnetic plug and both filters; check plug and filters after next flight. If the accumulation of metal flakes, after one flight, is equal to or greater than the original accumulation, CSD transmission should be replaced.



Check of Magnetic Plug
Figure 601/24-10-01-990-801

CONSTANT SPEED DRIVE TRANSMISSION OIL FILTERS - MAINTENANCE PRACTICES

1. General

CAUTION: FIRE DETECTOR SENSING ELEMENTS LOCATED WITHIN ENGINE AREA ARE VERY SENSITIVE. PHYSICAL CONTACT WITH THESE ELEMENTS CAN CAUSE HIDDEN DAMAGE. CONSTANT DIMENSION MUST BE MAINTAINED BETWEEN ELEMENTS AND SUPPORT TUBE.

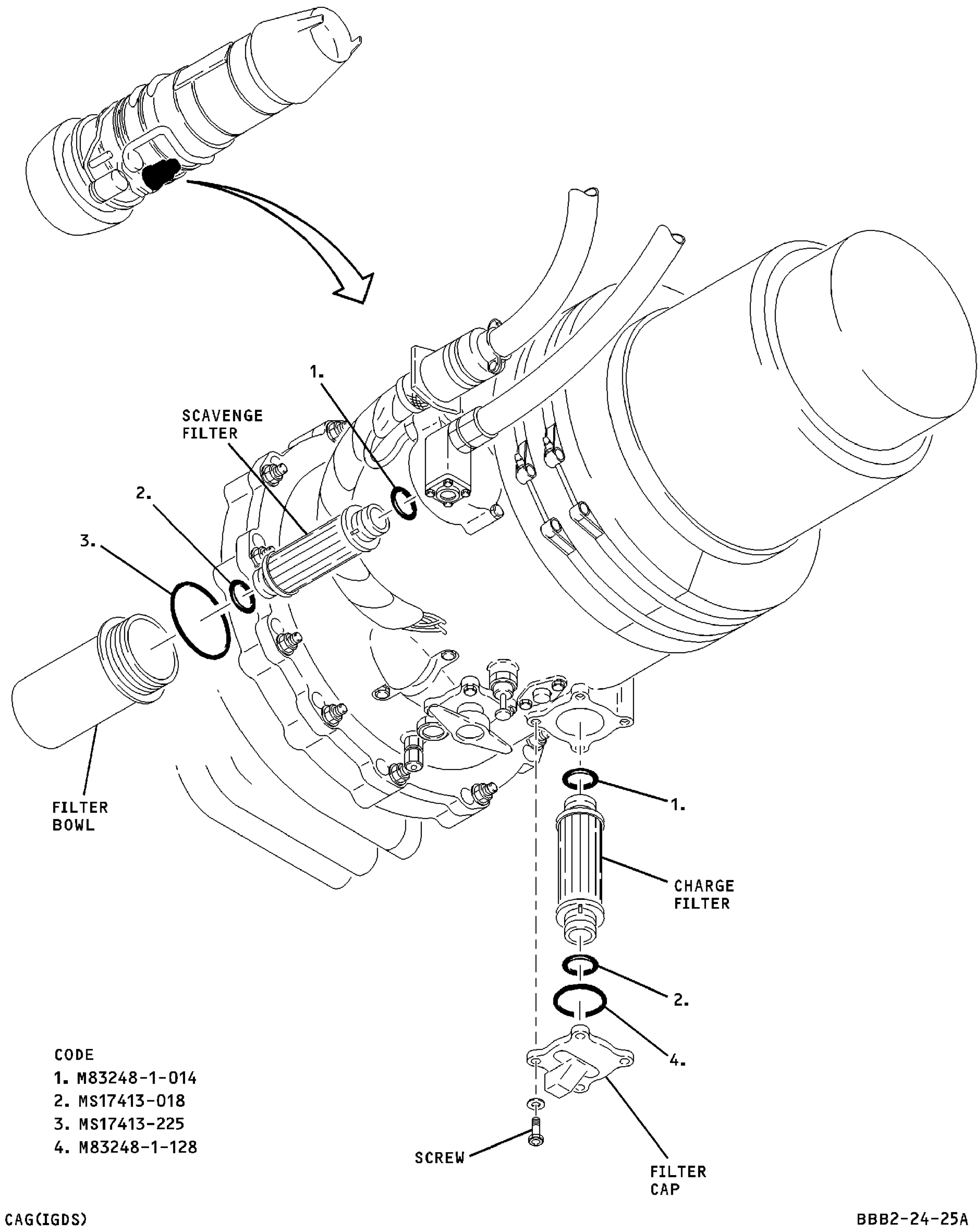
A. Each CSD transmission has two filters, the charge oil filter and scavenge oil filter. Removal/installation procedures for the corresponding filter are identical on each CSD transmission.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

Table 201

Name and Number	Manufacturer
Inconel Lockwire 0.032 in NASM20995N32, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.032 in NASM20995C32, DPM 5865	Not Specified
Inconel Lockwire 0.020 in NASM20995N20, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.020 in NASM20995C20, DPM 5865	Not Specified
Lubricant HF-825 DPM 5068	Royal Lubricants Co. Hanover, NJ
Torque wrench (capable of 0 to 150 inch-pounds range)	



CSD Transmission Oil Filters -- Installation
Figure 201/24-10-02-990-801

3. Removal/Installation

A. Remove Charge Oil Filter

CAUTION: CASE PRESSURE SHOULD BE RELIEVED BEFORE REMOVING FILTERS.

(1) Place container under charge filter port.

NOTE: Container used to catch oil when filters are removed should have a capacity of at least 1 quart (0.95 liter).

(2) Remove the filter cap attaching screws.

(3) Remove the filter cap and filter from the CSD transmission housing.

(4) Remove the filter from the filter cap.

(5) Discard the O-rings.

B. Install Charge Oil Filter

WARNING: LUBRICANT IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN LUBRICANT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET LUBRICANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(1) Lubricate new O-rings with HF-825 lubricant or equivalent.

(2) Install O-rings on filter and filter cap. (Figure 201)

(3) Plug filter into filter cap.

(4) Insert filter into CSD transmission housing until flange of filter cap is mated with filter mounting pad.

CAUTION: DO NOT ATTEMPT TO DRAW FILTER INTO TRANSMISSION HOUSING BY TIGHTENING SCREWS. MAKE CERTAIN THAT FILTER CAP FLANGE IS IN CONTACT WITH FILTER MOUNTING PAD BEFORE TIGHTENING SCREWS.

(5) Install attaching screws.

- Tighten screws to torque of 48 to 53 inch-pounds (5.42 to 5.99 N·m).

(6) Push indicator button to be certain that pressure differential indicator is reset.

C. Remove Scavenge Oil Filter

(1) Place container under scavenge filter port.

(2) Unscrew filter bowl.

(3) Remove filter bowl and filter from cavity.

(4) Remove filter from bowl; discard O-rings.

D. Install Scavenge Oil Filter

WARNING: LUBRICANT IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN LUBRICANT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET LUBRICANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(1) Lubricate new O-rings with HF-825 lubricant or equivalent.

(2) Install O-rings on filter and filter bowl. (Figure 201)

(3) Plug filter into filter bowl.

CAUTION: APPLY ONLY CORRECT TORQUE. OVERTORQUING CAN RESULT IN CRACKED FILTER CAP. CORRECT OIL LEAKAGE WITH NEW SEALS, NOT BY TIGHTENING ABOVE SPECIFIED TORQUE.

(4) Install filter and filter bowl.

- Tighten filter bowl to torque of 84 to 108 inch-pounds (9.49 to 12.20 N·m); safety with lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

NOTE: Use corrosion-resistant steel safety wire, G60845 or .032 inconel lockwire, G60169 except on small fasteners that have a hole diameter less than .045 inch. In these fasteners, use .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(5) Push indicator button to be certain that pressure differential indicator is reset.

CONSTANT SPEED DRIVE TRANSMISSION OIL FILTERS - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 24-10-02-212-801

2. Inspect CSD Charge and Scavenge Filter Differential Pressure Indicators

A. Prepare for the CSD Charge and Scavenge Filter Differential Pressure Indicators Inspection

SUBTASK 24-10-02-010-001

(1) Open access panels.

B. Inspect CSD Charge and Scavenge Filter Differential Pressure Indicators

SUBTASK 24-10-02-212-001

(1) Check that the differential pressure indicators are not extended (popped out). (Figure 601)

C. Job Close-up

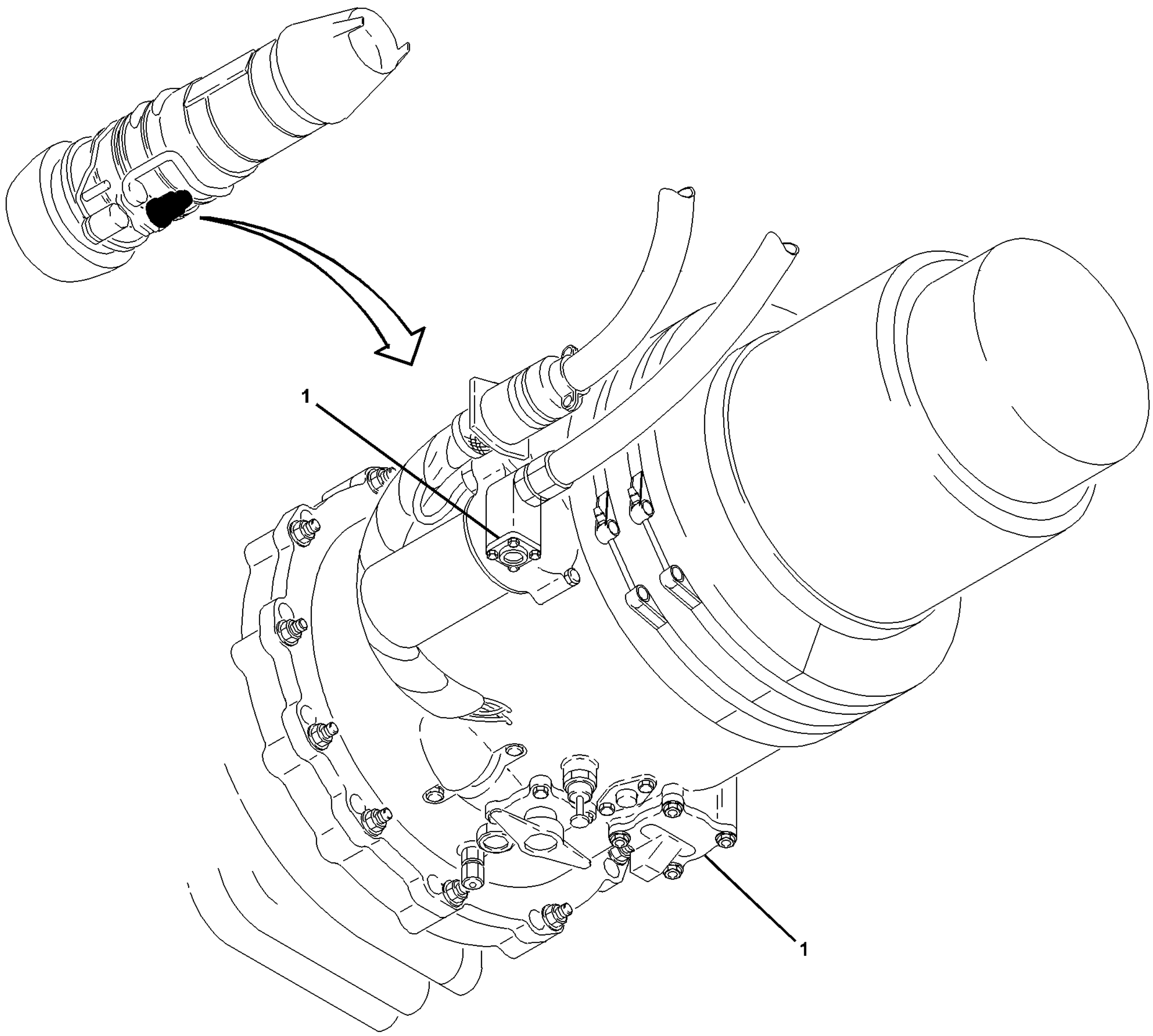
SUBTASK 24-10-02-410-001

(1) Close access panels.

SUBTASK 24-10-02-942-001

(2) Remove all the tools and equipment from the work area. Make sure the area is clean.

——— END OF TASK ———



LEGEND:
1. DIFFERENTIAL PRESSURE INDICATOR

BBB2-24-403
S0000293570V1

CSD - Transmission Differential Pressure Indicator
Figure 601/24-10-02-990-804

CONSTANT SPEED DRIVE TRANSMISSION OIL COOLER - MAINTENANCE PRACTICES

1. General

CAUTION: FIRE DETECTOR SENSING ELEMENTS LOCATED WITHIN ENGINE AREA ARE VERY SENSITIVE. PHYSICAL CONTACT WITH THESE ELEMENTS CAN CAUSE HIDDEN DAMAGE. CONSTANT DIMENSION MUST BE MAINTAINED BETWEEN ELEMENTS AND SUPPORT TUBE.

A. The CSD transmission oil coolers, one for each CSD transmission, are located on the bottom side of the engine, below the horizontal centerline. Access is through the lower nacelle door. Removal and installation procedures for the left and right CSD transmission oil coolers are identical.

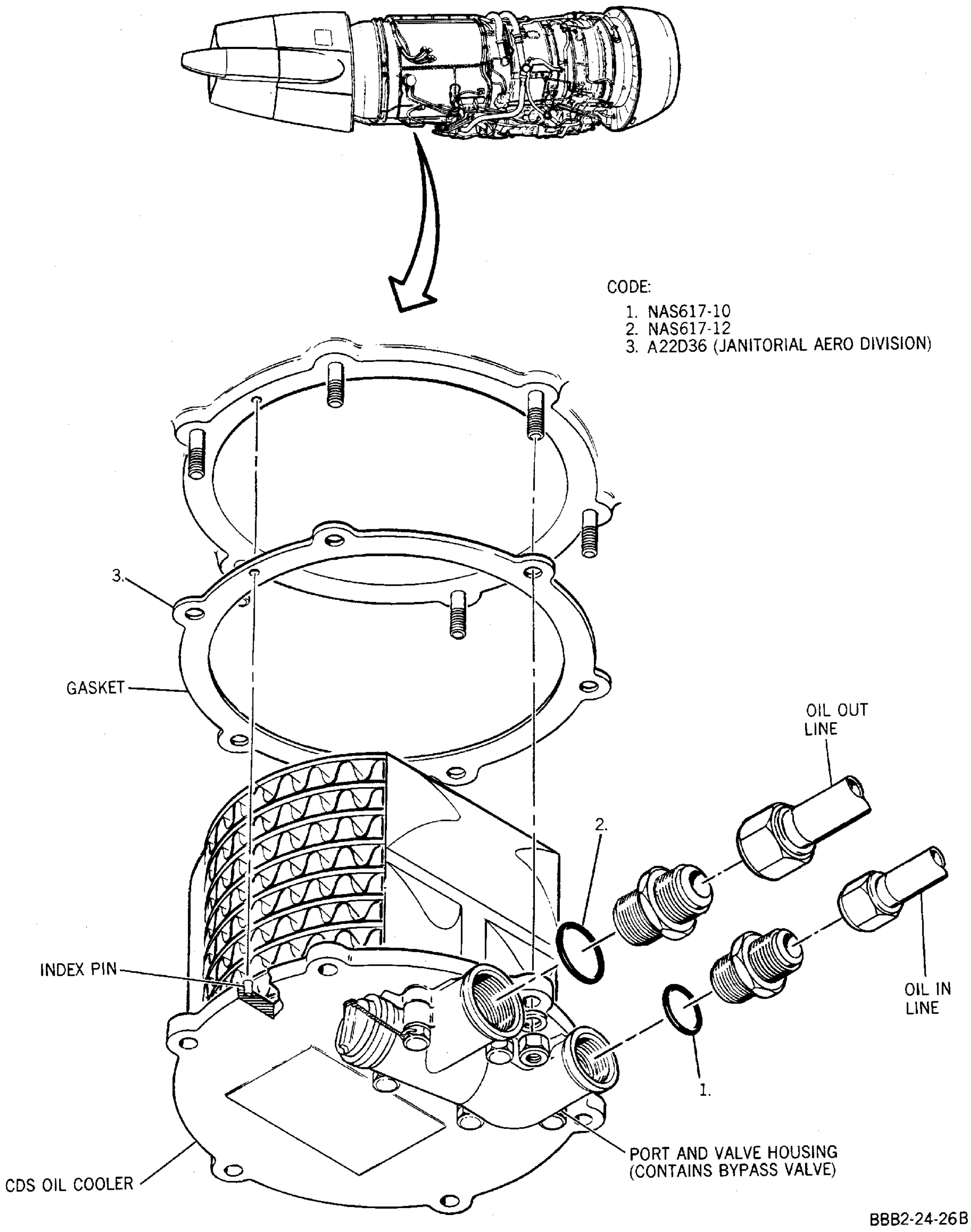
2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

Table 201

Name and Number	Manufacturer
Lubricant HF-825 DPM 5068	Royal Lubricants Co. Hanover, NJ
Solvent, Cleaning P-D-680, Type 1 DPM 518	Commercially available
NOTE: For additional equipment and material required for servicing CSD transmission, reference. (GENERATOR DRIVE - SERVICING, PAGEBLOCK 24-10-00/301)	



CSD Transmission Oil Cooler -- Installation
Figure 201/24-10-03-990-801

3. **Removal/Installation**

A. Remove CSD Transmission Oil Cooler

(1) Disconnect oil lines from oil cooler as follows.

(a) Disconnect and tag inlet and outlet oil lines from CSD transmission and oil cooler. (Figure 202)

NOTE: It is not necessary to separate the rigid from the flexible oil lines.

(b) Remove oil line clamps.

(c) Remove oil lines from aircraft.

WARNING: P-D-680 TYPE 1 SOLVENT IS AN AGENT THAT IS FLAMMABLE AND POISONOUS. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN P-D-680 TYPE 1 SOLVENT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET P-D-680 TYPE 1 SOLVENT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(d) Clean oil lines by flushing with cleaning solvent P-D-680, Type 1.

NOTE: On aircraft flushing is not recommended.

(e) Allow cleaning solvent to drain from oil lines.

(f) Allow oil lines to completely dry.

(2) Remove attaching nuts.

CAUTION: PULL OIL COOLER STRAIGHT OUT FROM ENGINE, KEEPING OIL COOLER MOUNTING FLANGE PARALLEL WITH MOUNTING PAD UNTIL INDEX PIN IS DISENGAGED. AVOID CONTACT OF OIL COOLER WITH MOUNTING PAD OR NACELLE STRUCTURE WHEN REMOVING, TO PREVENT POSSIBLE DAMAGE TO OIL COOLER.

(3) Remove oil cooler from engine; discard gasket.

(4) Cover oil cooler mounting pad opening to prevent entrance of foreign material.

(5) Remove reducers from oil ports of oil cooler; discard O-rings.

B. Install CSD Transmission Oil Cooler

NOTE: Lubricate O-rings with HF-825 lubricant, or equivalent, before installation.

WARNING: LUBRICANT IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN LUBRICANT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET LUBRICANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(1) Install reducers with new O-rings in oil ports of oil cooler. (Figure 201)

(2) Install new gasket on oil cooler mounting pad. (Figure 201)

CAUTION: AVOID CONTACT OF OIL COOLER WITH NACELLE STRUCTURE OR MOUNTING PAD WHEN INSTALLING, TO PREVENT POSSIBLE DAMAGE TO OIL COOLER.

(3) Install oil cooler making certain that index pin aligns with mating hole on mounting pad.

(4) Install attaching nuts.

(5) Connect inlet and outlet oil lines to CSD transmission and to oil cooler.

(6) Install oil line clamps.

(7) Motor engine to ensure that CSD transmission oil cooler and oil lines are filled with oil. (GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 71-00-00/201) (GENERAL, SUBJECT 71-00-00, Page 501)

(8) Visually check CSD transmission oil level sight gage.

NOTE: Oil level should be in green area of gage.

(9) If CSD transmission oil level is low, add approved lubricating oil as follows: (PAGEBLOCK 24-10-00/301)

(a) Connect pressure fill hose from fill stand.

(b) Connect overfill drain hose.

(c) Obtain suitable container to catch overfill oil.

CAUTION: DO NOT OVERFILL. OVERFILLING CAN CAUSE OVER-HEATING AND OIL SLUDGING, RESULTING IN DRIVE DAMAGE.

(d) Slowly fill CSD transmission oil system until oil flows from overfill drain hose.

(e) Stop pressure filling; allow approximately 3 minutes for oil level in CSD transmission to stabilize.

(f) Visually check that oil level is in green area of sight gage.

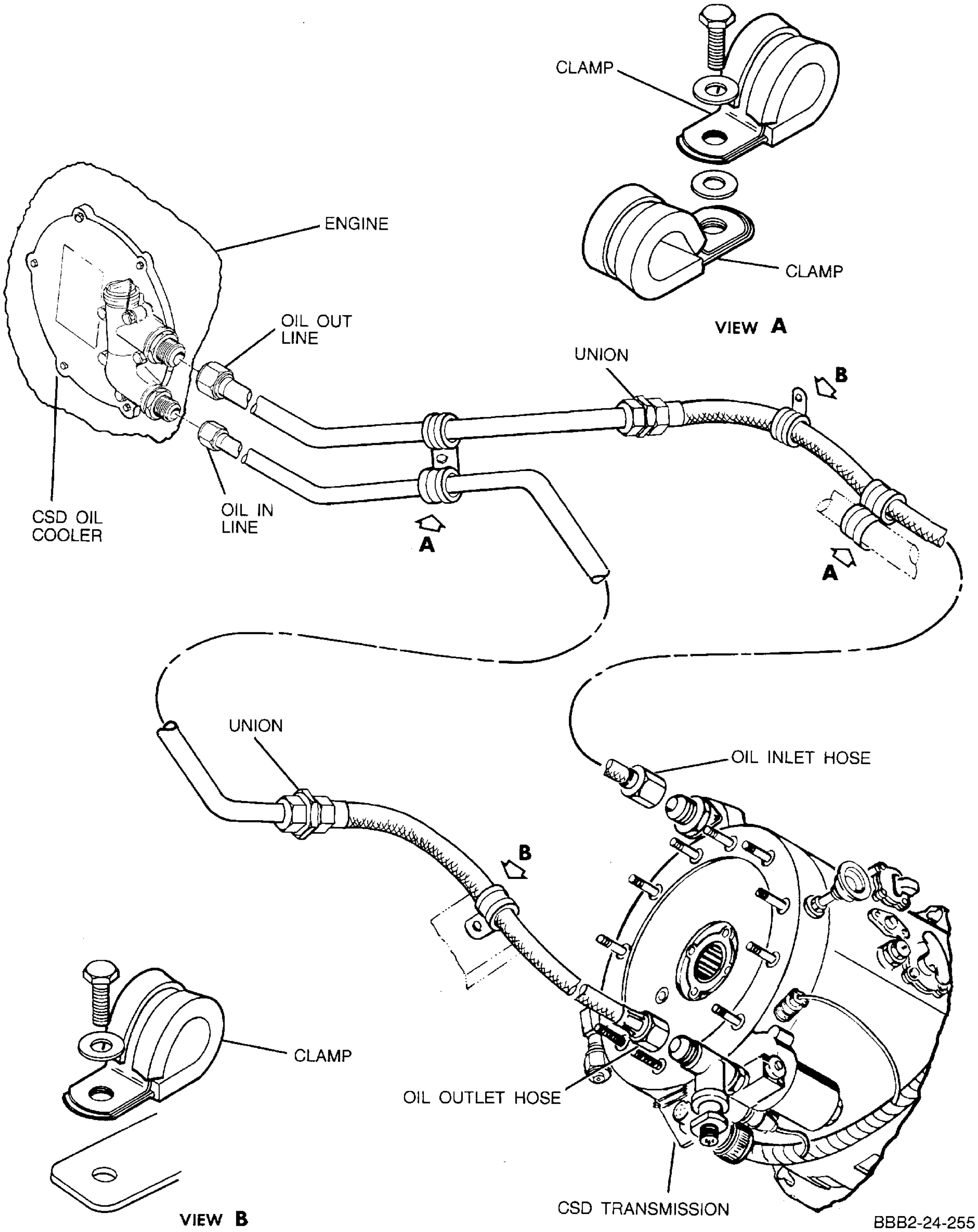
(g) Remove service hoses.

(h) Install protective caps on CSD pressure fill fitting and on overflow fitting.

4. **Check**

   A. Check CSD Transmission Oil Cooler

      (1) Check oil cooler fittings for leakage, after first engine run.



CSD Transmission Oil Lines -- Installation
Figure 202/24-10-03-990-802

CSD TRANSMISSION OIL TEMPERATURE SENSOR - MAINTENANCE PRACTICES

1. General

A. The oil inlet temperature sensor is installed into a fluid line adapter which in turn is secured to the transmission housing with a pressure seal washer and a special nut. A machine screw through the adapter flange helps secure and prevent rotation of the adapter. The special nut has one side counterbored which must go against the washer. Incorrect nut installation will possibly destroy the seal on the washer and cause a leak.

B. All torque values relating to the aluminum oil inlet adapter or components should be carefully applied to avoid damage to the CSD housing or adapter.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 201

Name and Number	Manufacturer
Inconel Lockwire 0.032 in NASM20995N32, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.032 in NASM20995C32, DPM 5865	Not Specified
Inconel Lockwire 0.020 in NASM20995N20, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.020 in NASM20995C20, DPM 5865	Not Specified
Torque wrench (capable of 0 to 175 inch-pounds, 0 to 19.78 N·m)	

3. Removal/Installation

CAUTION: USE TWO WRENCHES TO AVOID DAMAGE TO THE OIL INLET ADAPTER IN WHICH THE TEMPERATURE SENSOR IS INSTALLED.

A. Remove Sensor

(1) Using one wrench on adapter and one on temperature sensor, remove sensor and discard O-ring.

B. Install Sensor

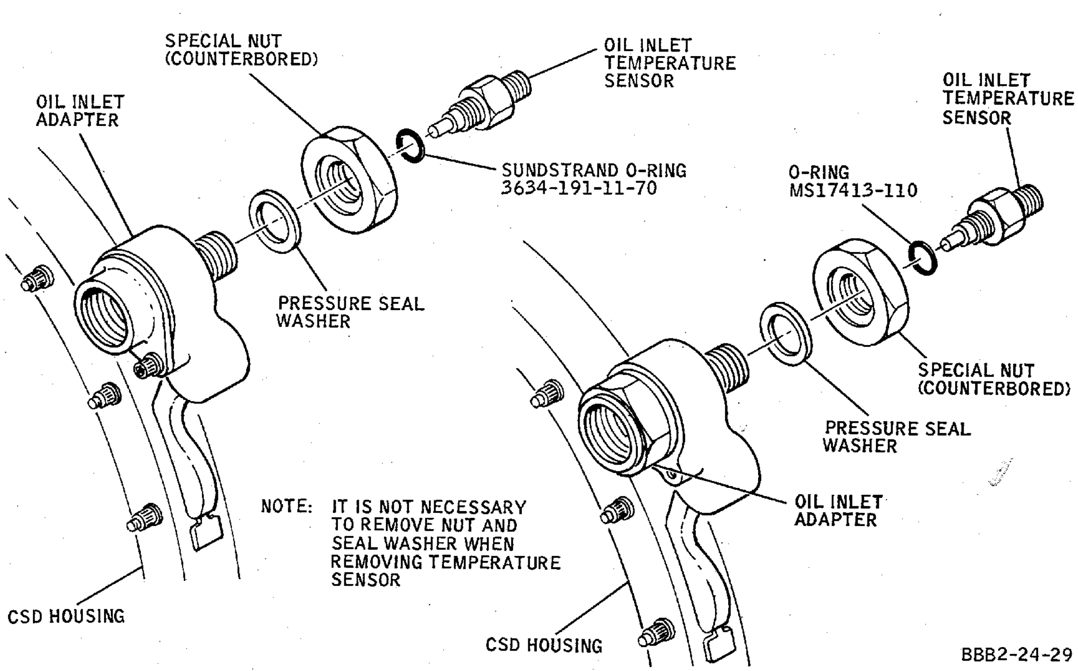
CAUTION: EXCESSIVE TORQUE CAN RESULT IN STRIPPED THREADS OR SENSOR ELEMENT DAMAGE.

(1) Using two wrenches, one on adapter and one on sensor, care-fully install sensor with new O-ring into adapter, tighten to torque of 55 to 75 inch-pounds (6.21 to 8.47 N·m).

CAUTION: DO NOT OVER TORQUE FITTINGS TO STOP OIL LEAKS. REPLACE GASKETS OR SEALS.

(2) If oil leak develops at oil inlet adapter, install new pressure seal washer and special nut with counterbored side against washer, carefully tighten nut to torque of 110 to 150 inch-pounds (12.53 to 16.95 N·m) and safety with lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

NOTE: Use corrosion-resistant steel safety wire, G60845 or .032 inconel lockwire, G60169 except on small fasteners that have a hole diameter less than .045 inch. In these fasteners, use .020 corrosion resistant steel (CRES) lockwire, G60794 or .020 inconel lockwire, G60166. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)



CSD Oil Inlet Temperature Sensor -- Removal/Installation
Figure 201/24-10-04-990-801

AC GENERATION - DESCRIPTION AND OPERATION

1. General

A. The ac generation system is the airplane's primary source of electrical power. In addition to supplying all ac loads, the ac system provides power for the dc system through transformer rectifier units.

B. The ac generation system is a split bus system referred as left side and right side, designed for isolated operation. Primarily, the system utilizes two 40-kva ac generators that are engine mounted and driven through hydromechanical constant speed drives.

C. Each engine-driven generator is connected through a corresponding generator relay (LGR and RGR) to a corresponding generator bus and ac bus. The generator buses are used as load distribution buses for heavy 3-phase loads including the ac buses. The two generator buses may be connected through an ac crosstie relay (ACTR) so either the left or right generator can supply power to all ac buses.

D. An additional source of ac power, for either flight or ground operation, is provided by a third 40-kva generator driven by the auxiliary power unit (APU). The APU driven generator can be connected to either or both generator ac buses through the auxiliary power relays (LAPR and RAPR). During ground operation, the APU generator can also be connected directly to the ground service ac bus through the ground service auxiliary power relay (GSAPR). During ground operations only and for airfields up to 8000 feet altitude at NASA starting temperature of 40°F and below, 50 kva power is available from the 40 kva rated APU generator (except during engine starts).

E. Ac Generator

(1) The ac brushless-type generators are rated at 40-kva, 0.75 power factor, and have an output at the generator terminals of 120/208 volts, 3-phase, 400 cps at 6000 rpm. A fan, located within the generator case, on the antidrive end of the generator shaft, provides cooling air for the generator during operation.

(2) Each engine-driven generator is mounted to and driven at a constant speed, within narrow limits, by a constant speed (CSD) transmission. The CSD is located at the forward bottom centerline of the engine on the aft side of the accessory drive gearbox. Cooling air is taken from the fan bleed air section of the engine through a duct connected to the blast cap mounted on the aft (antidrive) end of the generator. The cooling air passes through the generator, is collected in a shroud assembly mounted around the forward (drive) end of the generator and ducted overboard.

(3) The APU generator is driven directly by the APU and is installed on a mounting pad provided on the unit. A constant operating speed of the APU is maintained and controlled, within narrow limits, by the APU speed control (governor). Through an accessory drive gear train, the turbine high rpm is reduced to 6000 rpm required to drive the generator. Cooling air for the generator is supplied to the blast cap, mounted on the outboard (antidrive) end of the generator, through a duct connected to the turbine oil cooler inlet duct. The air passing through the generator is collected in the shroud assembly mounted around the inboard (drive) end of the generator and ducted into the turbine exhaust duct.

(4) The 3-phase windings of the ac generator stator are wye-wound with each end of each phase connected to a terminal of the 6-post terminal block mounted on the generator externally. Terminals T1, T2, and T3 are the power terminals of each phase; terminals T4, T5, and T6 are the neutral terminals. Terminals T1 and T4 are phase A, T2 and T5 are phase B, and T3 and T6 are phase C. An electrical receptacle is used to connect the self-excitation circuits of the generator to the generator control panel and the voltage regulator. Pins C and D are connected to the permanent magnet generator (PMG) circuit. Pins A and F are connected to the exciter circuit.

(5) The ac brushless-type generator does not require any type of electrical connection (brushes) between the rotating and nonrotating portion of the generator. Actually the brush-less generator consists of three ac-generators, the permanent magnet generator (PMG), exciter, and the main ac generator, enclosed in a single housing. The rotor of the PMG, exciter armature, rotating rectifiers, and ac generator field are mounted on the generator shaft. The PMG stator armature, exciter field windings, and ac generator stator armature are secured to, and insulated from the generator frame.

(6) The permanent magnet generator is a 90 volt single-phase, 2800 cps, flux switch inductor generator, utilizing stationary permanent magnets for excitation. The output is not regulated and varies as the load varies. The PMG produces initial excitation, and supplies power to the voltage regulator circuit of the ac generator control unit.

(7) The exciter, which provides power for the rotating ac generator field, uses a stationary dc exciter field and a rotating ac armature. The stationary field has two windings in parallel. A thermistor (negative temperature coefficient resistor) is placed in series with one of the windings to provide an almost constant exciter field resistance over the temperature range encountered by the generator. Six silicon power diodes, connected in a 3-phase full-wave bridge, are mounted inside a hollow portion of the generator shaft. Regulated dc power from the ac voltage regulator, is fed to the stationary dc exciter field. An ac voltage is produced in the rotating armature, rectified by the rotating rectifiers, and fed to the rotating generator field. The rotating generator field induces 3-phase power in the generator output windings.

WJE 405-411, 880, 881, 883, 884

F. Ac Voltage Regulator (VR)

(1) The ac voltage regulator is transistorized, completely static in operation, and uses no relays or moving parts. The regulator provides and regulates excitation to the ac generator.

(2) The regulator obtains power from the PMG portion of the ac generator and rectifies the power to provide dc excitation to the exciter portion of the ac generator. The regulator senses line voltage (at the power relay terminals) and controls the flow of excitation to the generator, thereby regulating ac line voltage.

(3) The voltage regulators are located in the generator control rack in the electrical/electronics compartment.

WJE ALL

G. Ac Generator Control Unit (GC)

CAUTION: NORMALLY, A GENERATOR WOULD BE RESET ONLY ONCE FOR A GIVEN FAULT. IF A FAULT TRIPS THE GENERATOR AFTER RESET, THE FAULT MUST BE LOCATED AND CORRECTED BEFORE ATTEMPTING TO PLACE THE GENERATOR ON ITS BUS AGAIN.

(1) Most automatic control and protective functions and maintenance annunciator functions for each individual generator system are incorporated in the corresponding generator control unit. The GC units (left, right and APU) are located in the generator control rack in the electrical/electronics compartment. (Figure 3)

(2) A power ready relay (PRR) senses when power of correct phase sequence, voltage, and frequency is available at the GR terminals.

(3) The generator control relay (GCR) is contained within the generator control unit. Input to the regulator circuit passes through the main contacts of this relay and, thus, generator field control is provided.

(4) The various protective functions are coordinated with supervisory control functions through static time delays (TD's) actuating slave relays and logic circuits.

(5) The ac voltage regulator circuit is transistorized, completely static in operation, and uses no relays or moving parts. The regulator circuit provides and regulates excitation to the ac generator.

(6) The regulator circuit is a pulse width modulated amplifier for supply of DC field current to the generator exciter field. For sensing, it compares a half-wave rectified line voltage signal taken from the point of regulation and a preset reference using the half-wave rectifier ripple for switching frequency.

(7) One LRU jumper for each generator control unit is also located in the generator control rack. (Figure 3)

(8) Five protection functions are involved in the generator control unit: differential current, overvoltage, undervoltage, under frequency, and phase sequence.

H. Ac Bus Control Unit

(1) The bus control panel contains control and protection circuitry for the ac crosstie relay (ACTR) and for the external power relays (LEPR and REPR). The panel also includes interlocking circuitry which prevents paralleling of any two power sources.

(2) Basic circuits of the BC are the dead bus sensing circuits, ACTR control circuits, external power control circuits and auxiliary power differential protection circuit connections.

(3) The BC panel is located in the generator control rack in the electrical/electronics compartment. (Figure 3)

I. Ac System Power Relays

(1) The ac system power relays provide 3-phase power source switching. These relays are operated electrically, held magnetically, and rated at 175 amperes, 200 volts. In addition to the close and trip coil, each relay has three sets of main power contacts, one for each power phase, and seven sets of auxiliary contacts. Five sets of auxiliary contacts are provided for use in the protective, control, and indicating circuits of the ac system. The remaining two sets of auxiliary contacts are used for controlling the close and trip coils of the relay. The close and trip coil is dc operated.

(2) The seven power relays used in the ac system are:

(a) Left generator relay -- LGR

(b) Right generator relay -- RGR

(c) Left external power relay -- LEPR

(d) Right external power relay -- REPR

(e) Left auxiliary power relay -- LAPR

(f) Right auxiliary power relay -- RAPR

(g) Ac crosstie relay -- ACTR.

J. Supplementary Relays -- Left and Right Auxiliary Power Relay Control Relay (LAPCR and RAPCR)

(1) Two sets of two each, 4-pole double-throw, single coil relays (LAPCR-1, LAPCR-2, RAPCR-1 and RAPCR-2) serve as control relays for the LAPR and RAPR. Each set (left and right) has the coils connected in parallel and, therefore, acts as an 8-pole relay. The four relays are located on the forward side of the electrical power center.

K. Differential Protection Current Transformers (CT)

(1) Differential current protection is used to sense line-to-line or line-to-neutral faults on each ac power source (left, right, and APU). Sensing is accomplished by means of one current sensing transformer per phase on the neutral side of each ac generator, and one current sensing transformer per phase on the load side of each respective power relay. This requires six CT's for each engine-driven generator and nine for the APU generator.

(2) Six CT's for the engine-driven generators and six CT's for the APU generator are located in the aft side of the electrical power center. Paragraph 2.F.(6) for operation of switching circuits for APU load side transformers).

(3) Three junction boxes, each containing three CT's are located, one in each engine nacelle and one in the APU compartment. (Figure 5)

L. Indicating Lights and Indicating Light Controls

(1) Six amber (caution) ac power indicating lights are located on the overhead annunciator panel. These are the left and right generator off lights, controlled by contacts of LGR and RGR, respectively; the left and right ac bus off lights, controlled by the dead bus circuits LDBC and RDBC in the ac bus control (BC) unit; the APU generator off light, controlled by series-connected contacts of the LAPR, RAPR, and APU master switch slave relay; and the ac crosstie lockout light controlled by the signals that actuate the ac crosstie lockout circuit (ACTL). (Figure 6)

(2) One red ac emergency bus off warning light is located on the overhead annunciator panel and is controlled by emergency ac bus sensing relay contacts. (Figure 6)

(3) Six blue ac power indicating lights are located on the electrical power section of the overhead switch panel and consist of: the external power available light controlled by the EPPSR in the BC; the external power on left bus and external power on right bus lights, controlled by contacts in the LEPR and REPR, respectively; the APU power available light controlled by the power ready (PRR) relay in the APGC; and the APU power on left bus and APU power on right bus lights controlled by contacts in the LAPR and RAPR, respectively. (Figure 6)

(4) Four blue ac power indicating lights are located on the ground service electrical power section of the overhead switch panel and consist of: the external power available light controlled by contacts of the EPPS circuit in the BC; external power on ground service bus light controlled by the ground service external power relay No. 2 (GSEPR2); the APU power available light controlled by contacts of the power ready relay in the APU GC; APU power on ground service bus light controlled by contacts of the ground service auxiliary power relay (GSAPR). (Figure 6)

M. Overhead Switch Panel

(1) Figure 6 illustrates the forward overhead switch panel. The left side of the panel includes all controls, indicators, and loadmeters for the ac power and main dc power systems. The upper right portion contains an ac power frequency meter, voltmeters and a dc voltmeter/ammeter, all controlled by a single selector switch. The battery and emergency power switches and a indicating light are in the bottom portion.

(2) The left side of the panel is arranged to simulate the basic ac and dc bus arrangement. Starting with CSD controls at the top, power flow is shown through the generator control switches, ac load meters, and ac buses to the dc loads (TR output) at the bottom. APU and external power source indicating lights and controls are located in the center. Ac and dc bus crosstie controls are located at the bottom center.

N. Maintenance Annunciator

(1) One of the most outstanding and unique features of the ac electrical generating system is the fault locating maintenance annunciator. In case of system malfunction, logic circuits determine which component or area of the system is the most probable source of the fault. The annunciator maintains memory of its findings, even with all electrical power removed from the airplane. At a later time, with the dc transfer bus energized, annunciator indicating lights come on to aid in determining corrective action.

(2) Maintenance annunciator circuitry for each ac generator system is located in the related generator control (GC) unit. Four annunciator indicating lights and an annunciator reset switch are located on the front of each GC panel.

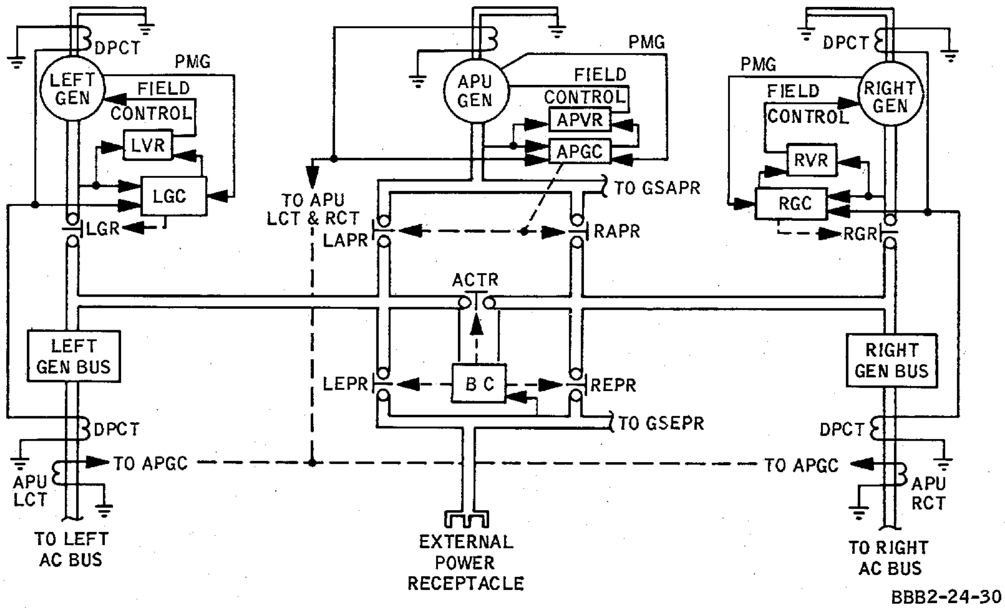
(3) The maintenance annunciator segregates possible fault sources into one of four areas: the constant speed drive transmission, ac generator, ac generator control unit, and distribution system. The corresponding indicating lights are labeled: DRIVE, GEN, GCU, and DISTR SYS.

(4) Each indicating light is controlled by a 2-coil latching relay, thereby providing the memory feature. The latching relays are designated as the drive annunciator relay (DAR), generator annunciator relay (GAR), generator control unit annunciator relay (GCUAR), and distribution system annunciator relay (DSAR). Each indicating light comes on when its corresponding relay is in tripped position, provided dc voltage is available. Dc voltage for the annunciator indicating lights and logic circuits is supplied from the GC unit 28-volt dc bus through a 7.5 ampere circuit breaker. The GC unit source supply, in turn, is supplied by the panel PMG TR unit or by the system dc transfer bus. (Figure 17)

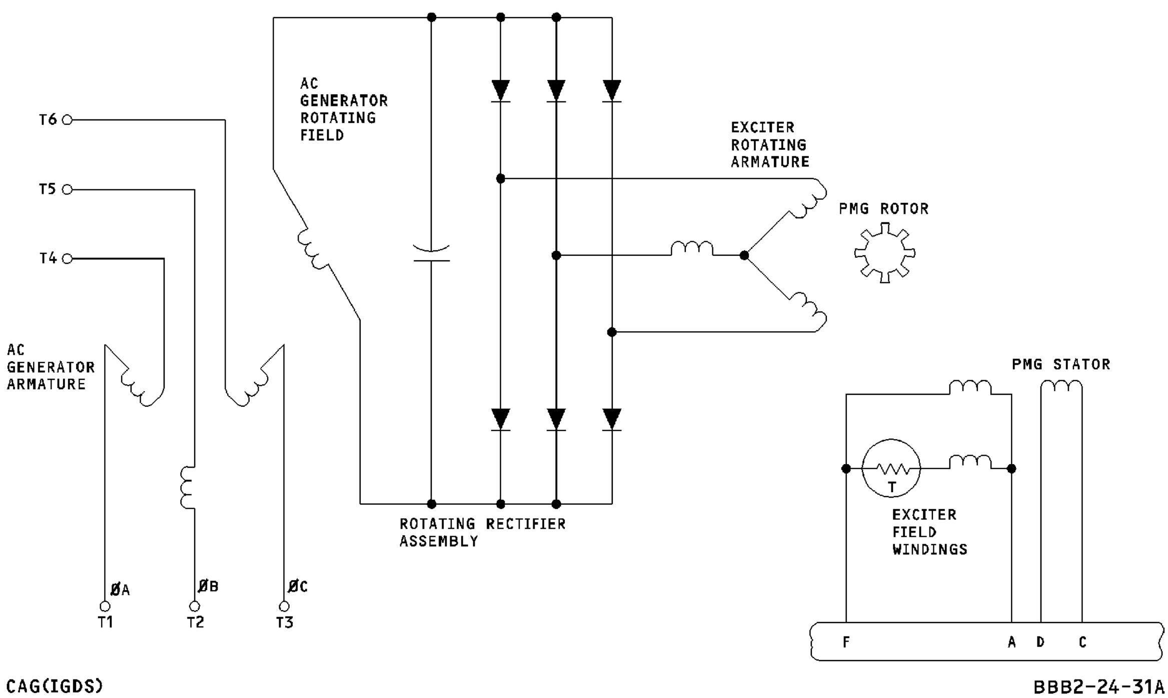
(5) Trip signals to the annunciator relays are provided through logic circuits from GC protective functions (i.e. under-voltage time delay (UVTD), overvoltage time delay (OVTD) voltage regulator OK (VROK) and differential protection (DP)), from other annunciator relays (i.e. DOR, GCUAR), and from system monitoring circuits. System monitoring circuits include an engine running circuit which receives excitation from the engine tachometer generator sensing engine N_2 rotor speed, a drive running circuit actuated by the CSD output speed sensor on the drive (CSD) output gear, a drive disconnect relay (DDR) actuated by the drive disconnect switch, and a generator PMG sensing circuit actuated by output of the GC panel PMG TR.

(6) Close (reset) signals to the annunciator relays are provided by the manual annunciator reset switch, automatic reset circuitry, and, in one case, on other annunciator relay. The automatic reset circuitry is energized (to reset annunciators) whenever the system PRR is energized (power available), fault selector time delay (FSTD) is deenergized (no UV fault), and the ac generator bus is dead. Thus, the annunciator resets itself if the fault is cleared and the system comes back on the line.

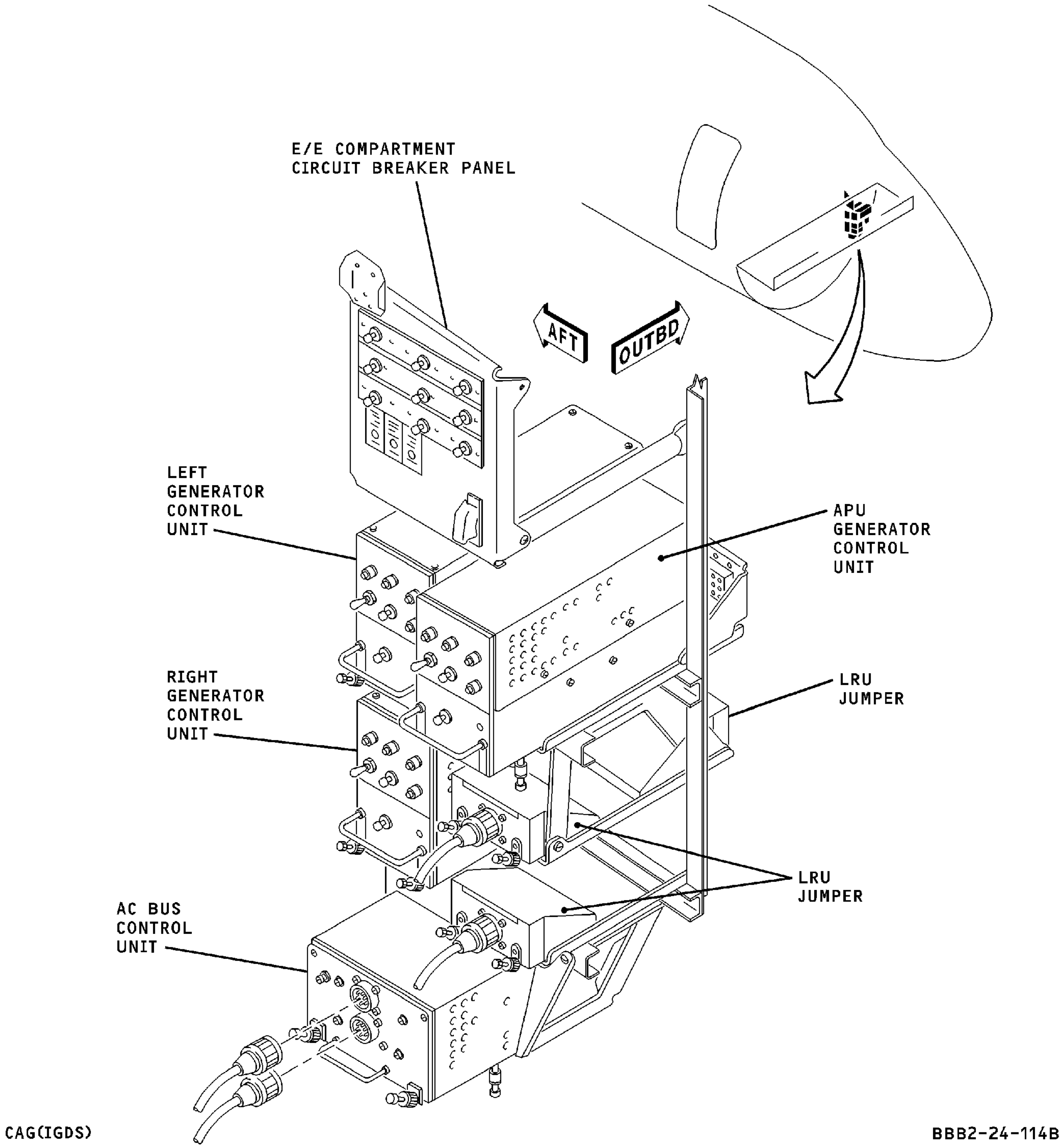
(7) When the GC unit is maintained properly through periodic functional tests, the maintenance annunciator normally provides initial trouble shooting information; however, the annunciator is subject to interpretation. A thorough understanding of maintenance annunciator operation should enable maintenance personnel to achieve accurate trouble shooting and component replacement greater than 95 percent of the time. (Paragraph 3.)



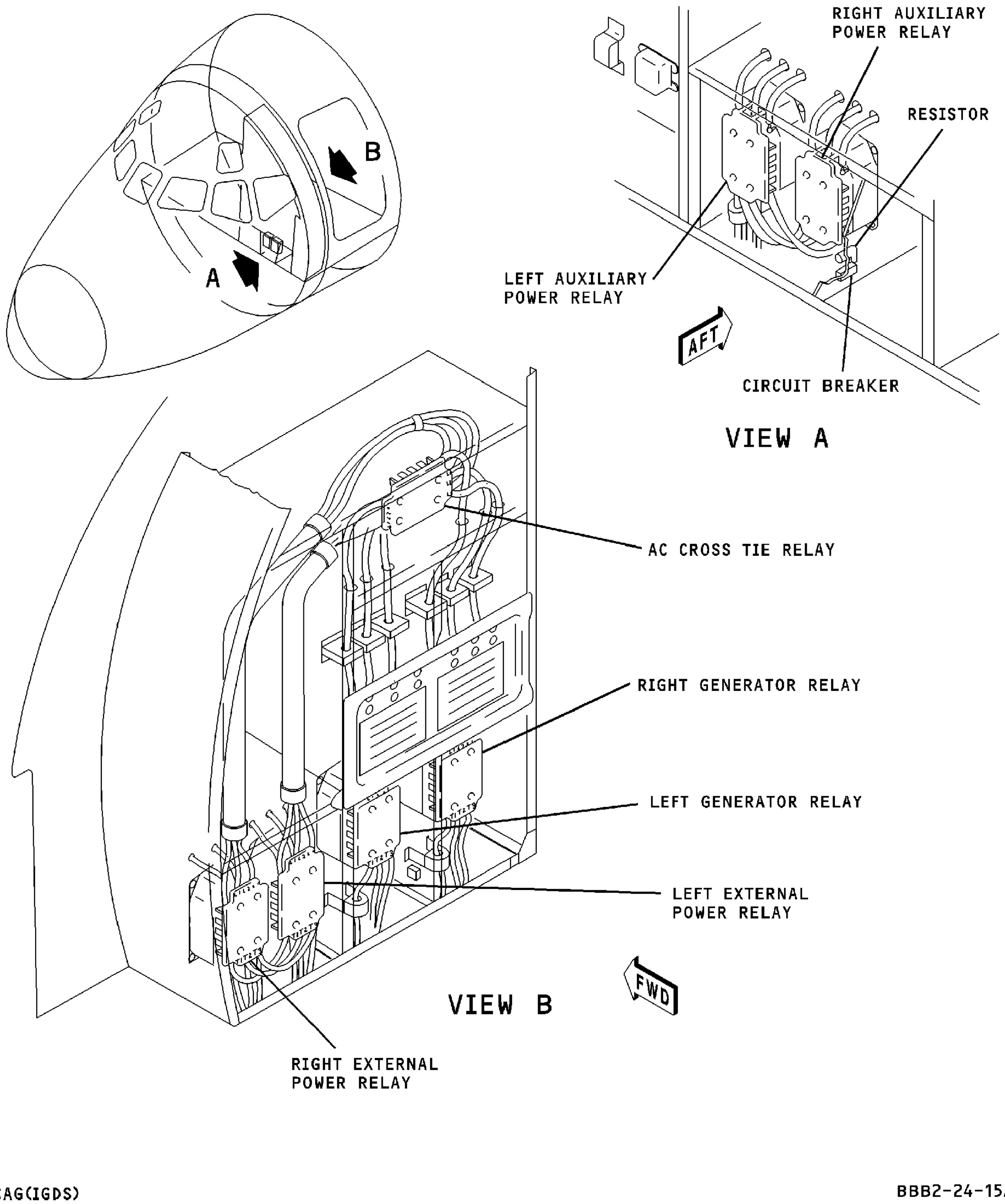
Ac Bus System -- Block Diagram
Figure 1/24-20-00-990-801



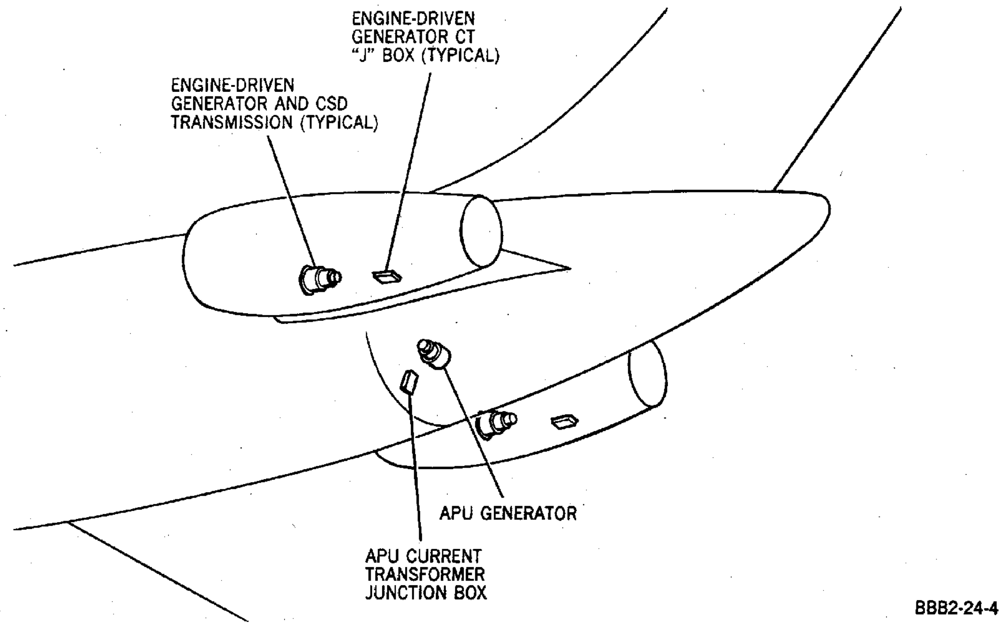
Ac Generator Internal Wiring -- Schematic
Figure 2/24-20-00-990-802



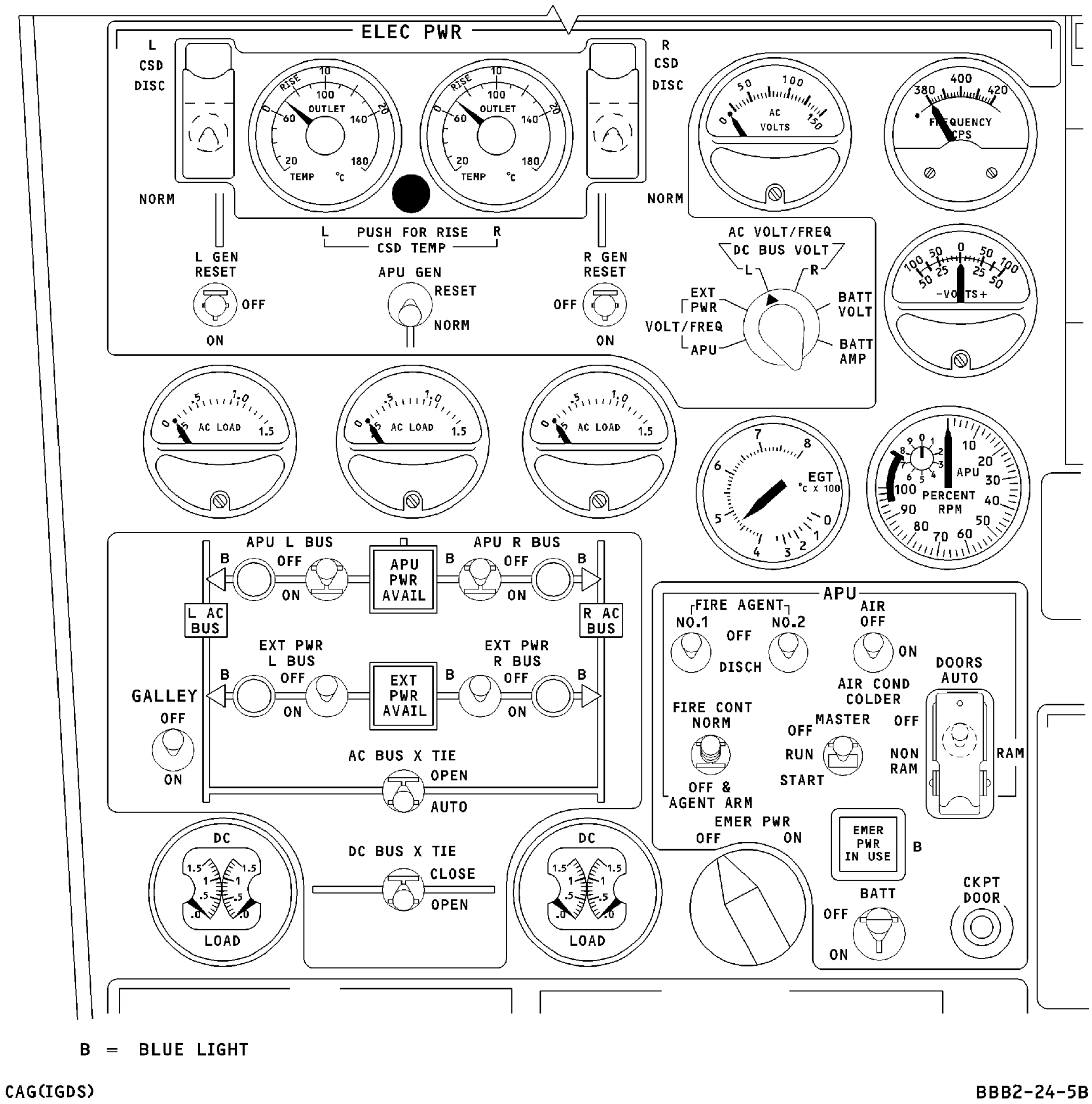
Generator Control Rack Installations
Figure 3/24-20-00-990-803



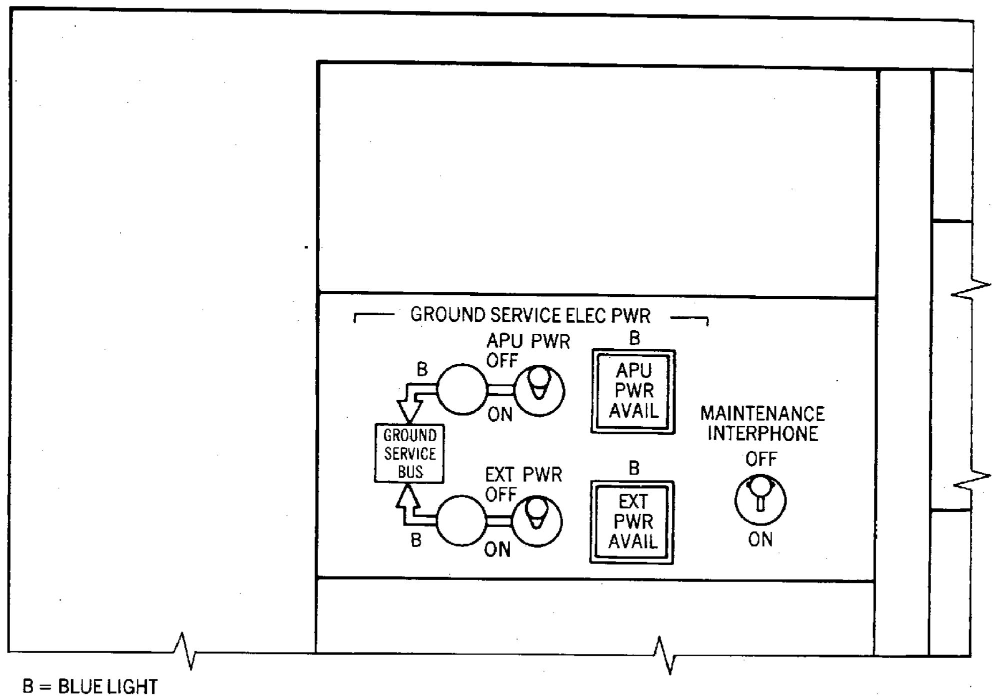
Power Relays -- Location
Figure 4/24-20-00-990-804



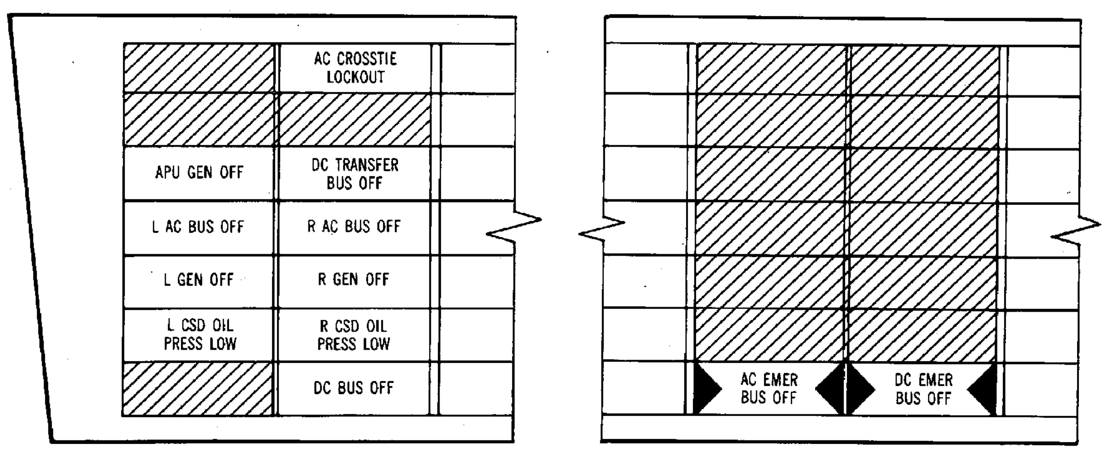
Electrical Power System Installation -- Aft Fuselage
Figure 5/24-20-00-990-805



Overhead Switch Panel Electrical System Controls and Indications
Figure 6/24-20-00-990-806 (Sheet 1 of 6)



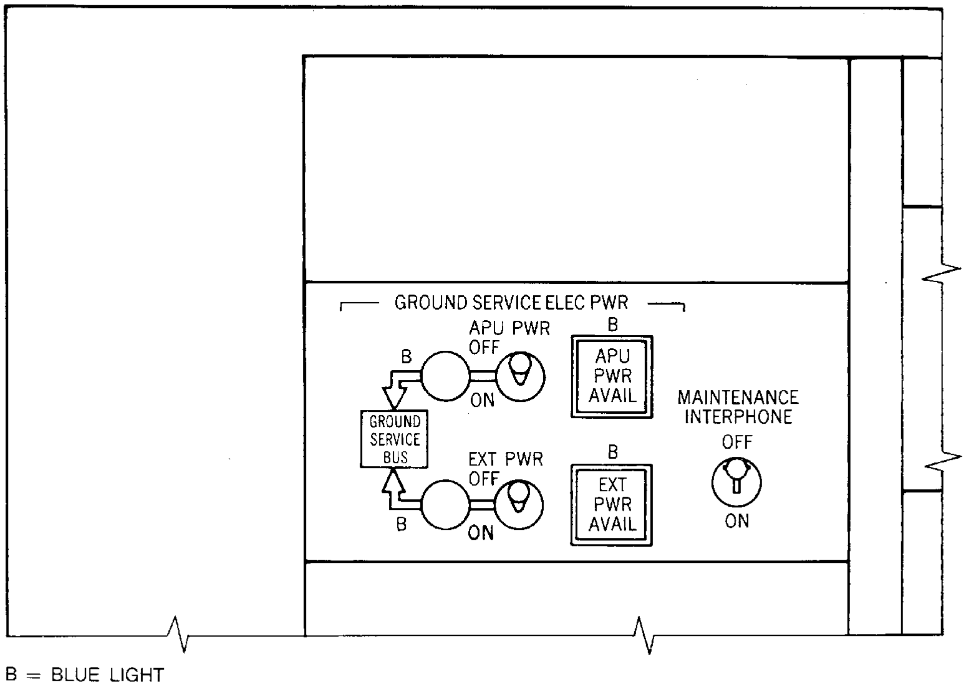
AFT OVERHEAD SWITCH PANEL



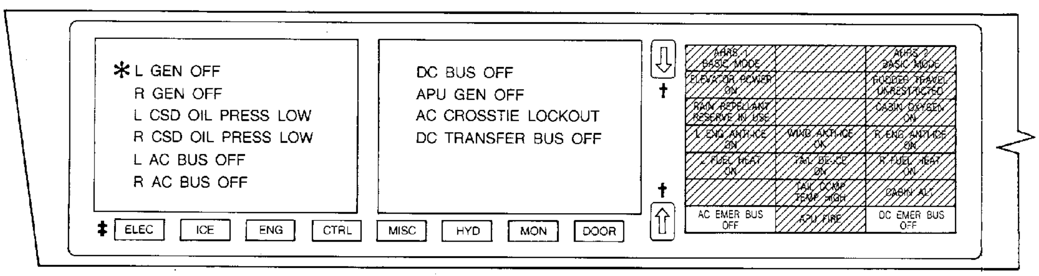
ANNUNCIATOR PANEL

BBB2-24-135

Overhead Switch Panel Electrical System Controls and Indications
Figure 6/24-20-00-990-806 (Sheet 2 of 6)



AFT OVERHEAD SWITCH PANEL



ANNUNCIATOR PANEL

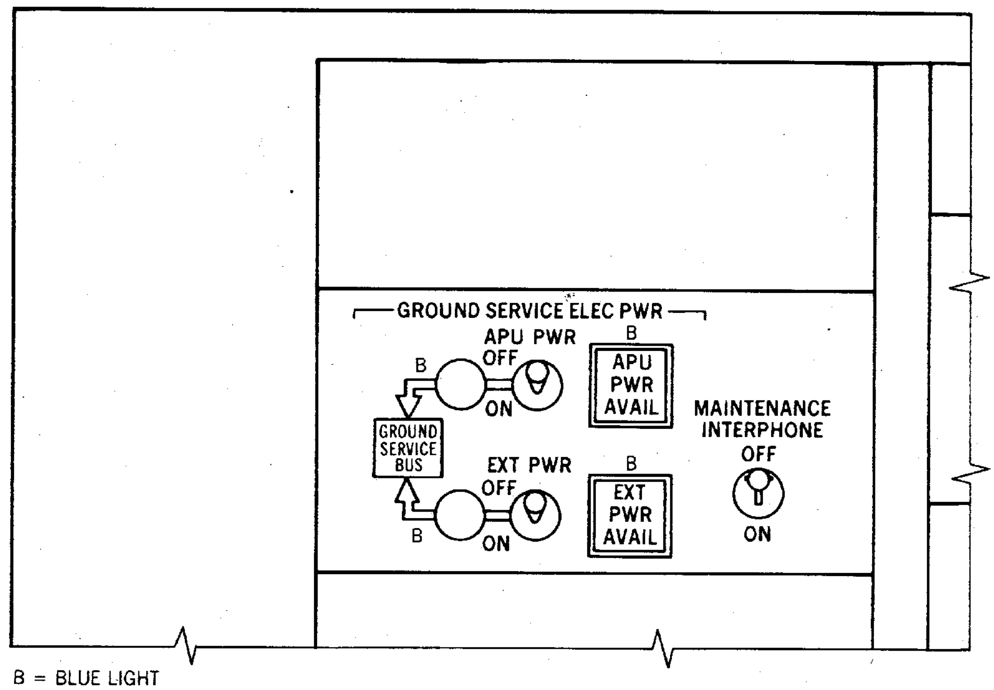
* ANNUNCIATIONS NOT NECESSARILY IN THIS SEQUENCE.
ANNUNCIATIONS APPEAR ONLY IF PROBLEM EXISTS.
ONLY ANNUNCIATIONS IMPORTANT TO CHAPTER 24 ARE SHOWN.

† USE SCROLL BUTTONS, IF ILLUMINATED, FOR ANNUNCIATIONS STORED OFF SCREEN.

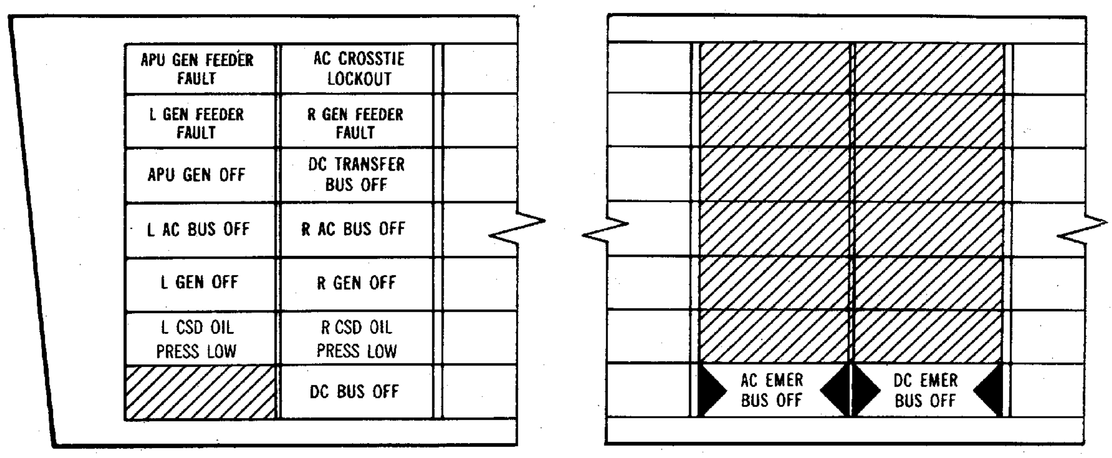
‡ ELEC CUE LIGHT FLASHES FOUR TIMES AND GOES OUT EACH TIME A NEW ELECTRIC ANNUNCIATION IS DISPLAYED ON SCREEN.
ELEC CUE LIGHT ON STEADY INDICATES ELECTRIC ANNUNCIATION STORED OFF SCREEN
PUSH ELEC CUE LIGHT TO DISPLAY ONLY ELECTRIC FAULT ANNUNCIATIONS. IF THERE ARE NO ELECTRIC FAULTS, NO ELEC FAULTS WILL BE DISPLAYED.

BBB2-24-253

Overhead Switch Panel Electrical System Controls and Indications
Figure 6/24-20-00-990-806 (Sheet 3 of 6)



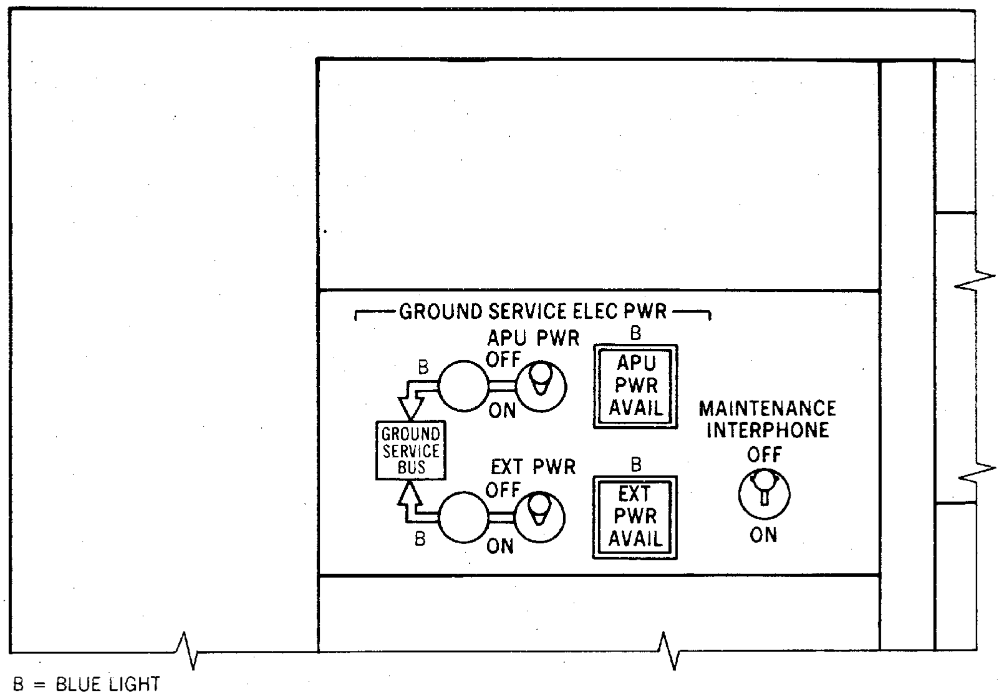
AFT OVERHEAD SWITCH PANEL



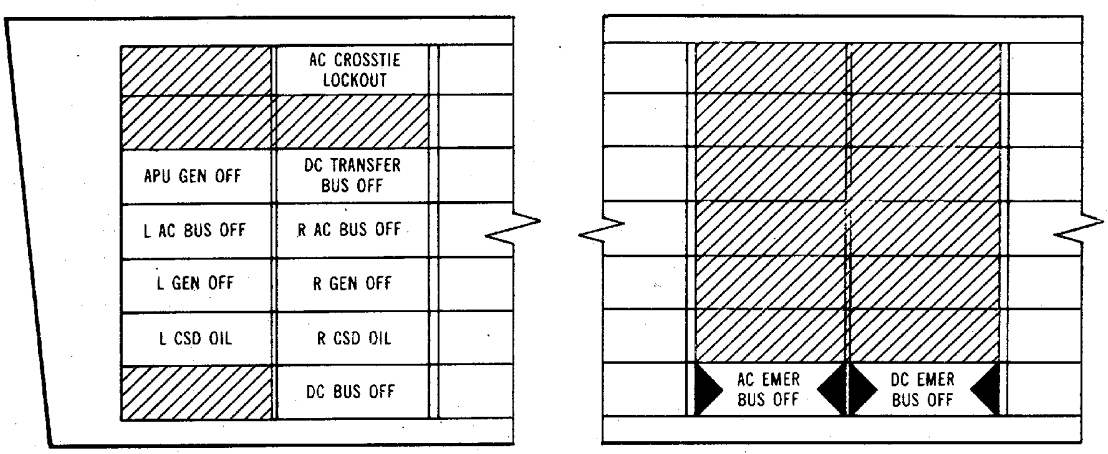
ANNUNCIATOR PANEL

BBB2-24-75A

Overhead Switch Panel Electrical System Controls and Indications
Figure 6/24-20-00-990-806 (Sheet 4 of 6)



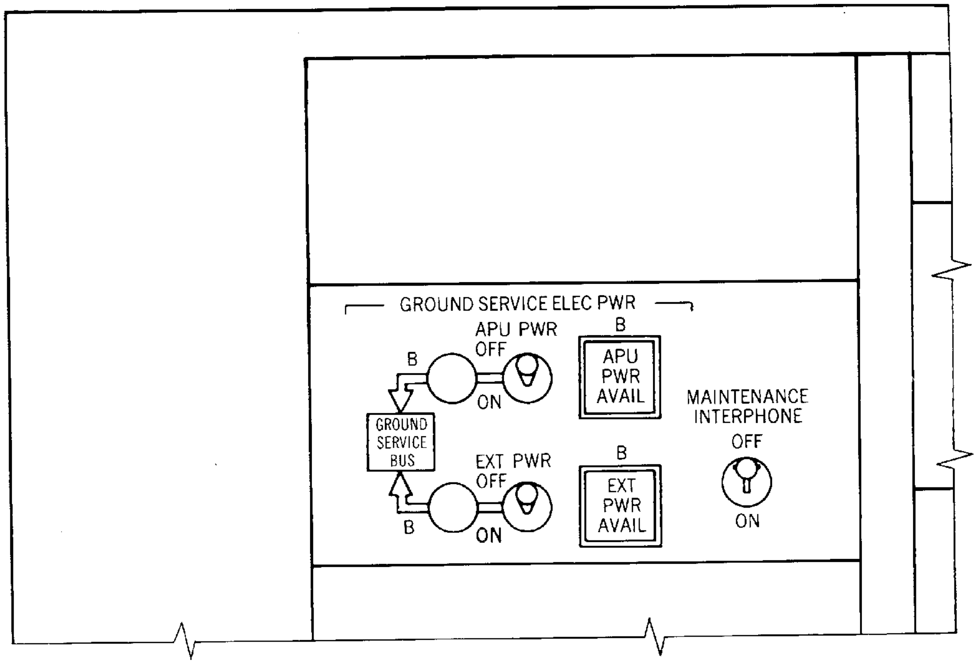
AFT OVERHEAD SWITCH PANEL



ANNUNCIATOR PANEL

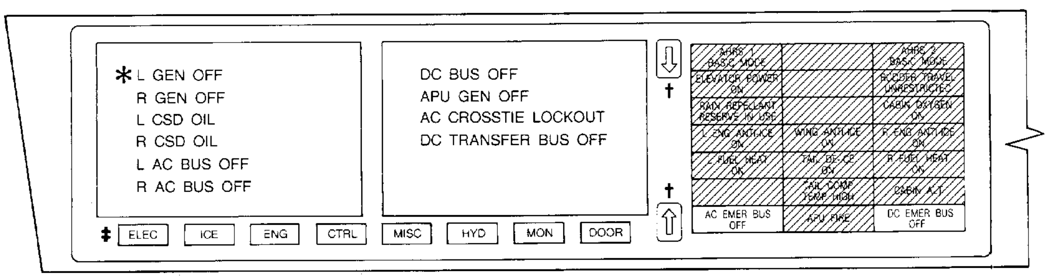
BBB2-24-74A

Overhead Switch Panel Electrical System Controls and Indications
Figure 6/24-20-00-990-806 (Sheet 5 of 6)



B = BLUE LIGHT

AFT OVERHEAD SWITCH PANEL



ANNUNCIATOR PANEL

✱ ANNUNCIATIONS NOT NECESSARILY IN THIS SEQUENCE. ANNUNCIATIONS APPEAR ONLY IF PROBLEM EXISTS. ONLY ANNUNCIATIONS IMPORTANT TO CHAPTER 24 ARE SHOWN.

† USE SCROLL BUTTONS, IF ILLUMINATED, FOR ANNUNCIATIONS STORED OFF SCREEN.

‡ ELEC CUE LIGHT FLASHES FOUR TIMES AND GOES OUT EACH TIME A NEW ELECTRIC ANNUNCIATION IS DISPLAYED ON SCREEN.

ELEC CUE LIGHT ON STEADY INDICATES ELECTRIC ANNUNCIATION STORED OFF SCREEN

PUSH ELEC CUE LIGHT TO DISPLAY ONLY ELECTRIC FAULT ANNUNCIATIONS. IF THERE ARE NO ELECTRIC FAULTS, NO ELEC FAULTS WILL BE DISPLAYED.

BBB2-24-254

Overhead Switch Panel Electrical System Controls and Indications
Figure 6/24-20-00-990-806 (Sheet 6 of 6)

2. Operation

A. Under normal operating conditions, the left and right generator control switches on the overhead switch panel should remain in the on position at all times (except for system checkout). The APU generator reset switch has no off position and is spring-loaded to the normal position. The GCR's (generator field circuits) remain closed at all times. The GR's normally are closed with engines operating but trip out due to under-frequency when engines are shut down. The ac bus crosstie switch is normally in auto position.

B. Engine Start-Up Conditions

(1) Starting from engine shutdown condition the necessary electrical requirements for engine starting can be obtained from external power, the APU, or from the airplane nickel-cadmium battery. Normally, either the external power or the APU is used, either one supplying both ac buses prior to engine start (that is, either APU or external power left or right bus switches, are on).

(2) If external power is used, no action is necessary. As each engine speed increases and generator frequency approaches 400 cps, the respective external power relay trips out and the GR closes, transferring that load bus to the engine-driven generator.

(3) If the APU is used on the ground, it is necessary prior to initiating engine start-up that both air conditioner and galley power electrical switches be in OFF position. This provides maximum electrical capability from the APU for engine starting. After the engines are started and the generators are feeding the appropriate electrical buses, the air conditioner and galley power switches may then be turned to ON position.

C. In-Flight Conditions

(1) Normally, no action is required in flight. Should one generator disconnect from the associated ac bus, or be shut down manually (generator control switch to off), the ACTR will close automatically unless a bus fault exists. If the generator is then placed back on the line (generator control switch to reset then on), the ACTR trips open and the applicable GR closes automatically.

D. Shutdown Conditions

(1) Normally, before engine shutdown after landing, external power is connected and the left and right external power bus switches placed to on position; or, the APU is started and APU bus switches placed to on.

(2) As the engines are shut down, the GR's trip due to underfrequency and the respective EPR's or APR's close automatically. The ACTR cannot close while external power or APU power is in use on the ground, if the nosegear is compressed sufficiently to actuate the ground sensing mechanism.

E. Ac System Control

(1) In each generating system, basic control functions affected are the generator control relay (GCR) and the power relay (GR or APR). The ac crosstie relay (ACTR) is common to all ac systems. Supplementary control functions are the dead bus circuits and, for APU only, the left and right auxiliary power control relays (LAPCR and RAPCR).

(2) Generator Control Relay (GCR)

(a) The main function of the GCR is to control the generator PMG power that is fed to the voltage regulator circuit and thereby control generator excitation and ac output. Figure 8 illustrates all circuitry related to GCR operation. That portion, including the GCR, shown inside the dash line is contained within the ac generator control (GC) unit.

(b) Power source for GCR op eration is the 28-volt dc bus in the GC unit. DC power is normally supplied by the generator control unit TR unit but has a secondary supply from the dc transfer bus. The GCR reset circuit of the generator control switch is at ground potential. Manual closure of the GCR is accomplished by momentarily placing the generator control switch to reset position. No means for manual tripping is provided except by pulling the fire control handle, which closes the generator cutoff switch, providing a ground to the GCR trip coil. The GCR remains closed throughout all normal operating conditions.

(c) Moving the generator control switch to reset energizes the GCR close coil, providing the anticycling logic is not energized. The anticycling logic and the GCR trip coils are actuated simultaneously from four sources: the fire control handle, differential current protection (DP), overvoltage protection (OV), or undervoltage time delay (UVTD).

(d) If an attempt is made to reset while a trip signal is present, the anticycling logic disables the GCR close coil circuit and provides a trip signal to the GCR trip coil, the GCR locks out and prevents cycling on the double signal. The GCR remains locked out as long as the generator control switch remains in reset position, even though the trip signal is removed.

(e) The following fault signal sources can remove a generator from a bus by tripping the generator control relay (GCR).

1) DP trips the GCR whenever a line-to-line or line-to-neutral fault occurs in the differential zone.

2) OV trips the GCR after an inverse time delay, depending on the magnitude of the overvoltage condition.

3) The undervoltage time delay (UVTD) and associated logic are energized by FSTD. The fault selector time delay (FSTD) and associated logic are energized by undervoltage protection solid state switch.

4) In order for the FSTD to energize, an undervoltage must be present while the GCR is closed and the underfrequency logic is not energized. Once energized the FSTD is latched on until the GCR opens.

5) During normal engine shutdown, UF is deenergized before UV. Therefore, underfrequency blocks undervoltage actuation of FSTD.

6) If underfrequency is normal and an undervoltage condition occurs, FSTD is actuated. After 5.0 to 7.0 seconds, FSTD energizes and locks in, tripping the GR. At the same time, UVTD is actuated and, after a 0.4 to 1.0 second time delay, UVTD operates and the GCR trips.

(3) Ac System Power Relay (Figure 9)

(a) General

1) The generator relays, ac crosstie relay, external power relays, and auxiliary power relays are identical units which are located at the electrical power electronic compartment (Figure 9). Each engine ac generator can be connected to, or removed from, the corresponding ac generator bus or the ac tie bus by an associated generator relay or ac crosstie relay, respectively. The APU ac generator can be connected to any one, or both, of the generator buses by an associated auxiliary power relay.

a) Each power relay is electrically operated, magnetically held, and rated at 115/200 vac, 400 Hertz, with a continuous contact current rating of 175 amperes. In addition to two coil switches and five auxiliary switches that have both normally open and normally closed contacts wired to the relay, the relay has three sets of main power contacts, one for each power phase. Ac input power is connected to terminals T1, T2, and T3, with output power connected to terminals L1, L2, and L3 (except in crosstie relay position which is reversible).

b) The relay coil transfer switch is connected in series with the trip and close coil to coordinate trip and close action and to remove power from the trip or close coil after operation. Normal dc power operation of the coil is between 12 and 30 volts. Two back to back zener diodes are connected across the coil to limit the effects of coil inductance (spike voltage) on the transfer switch when the switch interrupts the coil circuit.

(b) Generator Relay (GR)

1) All ac power from each generator flows through the main contacts of a GR to the corresponding generator bus. Thus, each GR with associated circuitry must be capable of conducting or interrupting power flow from either manual or automatic control under all normal and fault conditions. Figure 10 illustrates all circuitry in the GC unit and in the systems related to GR operation.

2) The power source for GR operation is the ac generator control (GC) unit 28-volt dc bus supplied by either the unit PMG TR or, when necessary, by the system dc transfer bus.

3) The GR trip circuit operates directly from the GC unit 28-volt dc bus while the GR close circuit and the unit power ready relay (PRR) circuit operate through a 7.5-ampere circuit breaker (GCCB-1).

4) GR tripping is accomplished either manually by moving the generator control switch to off, or automatically by opening of the PRR (due to an underfrequency fault or GCR trip on overvoltage or differential protection (DP)) or by closing of the fault selector time delay (FSTD) (due to an undervoltage fault).

5) GR closing requires that the generator control switch be in on position, thus activating the PRR circuit. With the generator control switch in the on position, the GR closes whenever the PRR is energized and FSTD is not actuated, provided the related EPR, APR, and the ACTR are tripped and the dead bus circuit (DBC) (in bus control (BC) unit) senses a dead bus.

6) Initial closing of the PRR requires that the generator control switch be in the on position, the phase sequence (PS), voltage (UV), and frequency (UF) of the generator output be correct, and the GCR be closed. Once closed, PS and UV do not affect the PRR circuit (due to bypass contact).

7) The PRR deenergizes immediately after the GCR trips, or following an underfrequency condition, after operation of the underfrequency time delay (UFTD) in 0.75 to 1.25 seconds. The UFTD overrides underfrequency transients and provides the normal mode of deenergizing PRR and tripping the GR on engine shutdown.

(c) APU Power Relay (LAPR and RAPR)

1) Function and circuitry of the (L and R) APR's is similar to that of the (L and R) GR's in that all power flow from the APU generator passes through the main contacts of the LAPR and RAPR to feed the left and right generator ac buses, respectively. Figure 11 illustrates all circuitry related to the operation of the LAPR and RAPR.

2) Additional interlocking is provided to ensure that APU power is connected to a bus only when the related engine-driven generator system is not available and the ACTR is not closed.

3) The major difference in the control of the APR's from that of the GR's is the use of single-coil auxiliary power control relays (LAPCR and RAPCR) to control the LAPR and RAPR, respectively.

4) Two main contacts of each (L or R) APCR controls the close and trip coils of the related (L or R) APR. A normally open contact in series with the (L or R) APR close coil permits (L or R) APR closure only when the related (L or R) APCR is energized. A normally closed contact provides a trip signal to the (L or R) APR when the related (L or R) APCR is deenergized.

5) The following conditions are necessary for APCR actuation.

   a) The PRR in the APGC must be energized indicating availability of APU power of correct phase sequence, voltage, and frequency.

   b) The PRR in the related (L or R) GC must be deenergized indicating engine-driven generator power is not available.

   c) The respective APU left or right bus switch be placed in on position.

6) In addition to APCR actuation, APR closure also requires that other power relays be tripped and that the (L or R) ac bus is dead (LDBC or RDBC deenergized).

7) FSTD and PRR operation within the APGC is the same as in the LGC or RGC. The PRR relay is energized directly from the APGC 28-volt dc bus through circuit breaker GCCB-1 and a jumper from pins B27 to B36. The circuit does not pass through a control switch as in the engine-driven generator system.

(d) Ac Crosstie Relay (ACTR)

1) The function of the ACTR is to connect the left and right ac generator buses together under certain conditions, thereby permitting both buses to be fed by a single generator. Figure 12 illustrates all circuitry in the BC (below dash line), in the LGC, RGC, and APGC, and in the system, related to ACTR operation.

2) During normal operation, each generator supplies its own load bus and the ACTR switch is in automatic (AUTO) position. The ACTR is prevented from closing by the presence of voltage on both buses.

3) If power is lost on one bus, the associated dead bus sensing circuit output will change to a high state. This output is inverted in a logic control module which provides a current path to close the ACTR. At the same time, the affected generator control circuit is grounded through the PRR contacts, the DC voltage of the unaffected GCU will be dropped across parallel resistors in the affected GCU and a resistor in the BCU. The voltage dropped will not be enough to balance the comparator circuit and its output will go high.

4) If the ACTR is closed, it can be tripped by several means:

   a) If each generator is capable of supplying its bus, there is a DC signal from both GCU's to the BCU through the input of a comparator which puts the output in a low state and tripping the ACTR.

   b) If TD1 (CTTD) in the GCU is picked up, a 28VDC signal is applied to the BCU through directional control diodes. The higher voltage is applied to the logic to provide switching power to trip the ACTR.

c) A 28VDC signal is applied to the BCU under the following conditions: either EPR closed, or RAPR and right ground control relay is closed, or LAPR and left ground control relay is closed.

d) With no AC power connected to either bus all GR's open and a 28VDC signal is applied through LAPCR #2 and RAPCR #2. In the condition where the ACTR is closed and none of the following is closed LGR, RGR, LEPR and REPR, control logic disables the 28VDC power to the ACTR to prevent closure which subsequently turns on the ACTR trip coil circuit and trips the ACTR.

e) If the ACTR switch is placed in the OPEN position, the ACTR will trip.

5) The ACTR can be locked out by applying a 28VDC signal to the BCU by two sources:

a) One method consists of the series parallel network of normally open power relay contacts connected between the BCU and pins J1A and J1K. Anytime the ACTR switch is in the AUTO position and any combination of left and right power relays are closed simultaneously, the 28 volt signal will be applied to BCU pin J1K and the ACTR will be locked out.

When an ACTR trip signal occurs before any of the series parallel network of power relay contacts close, the ACTR must be tripped but not locked out. When this happens, the ACTR (Q105) trip output transistor is turned on grounding the transistor base. When the ACTR trip transistor turns on, this provides a positive voltage to the base of switching transistor Q502. When Q502 turns off, 28VDC is removed from pin J1A of the BCU. Without 28VDC to J1A the network of power relay contacts will not supply a lockout signal to J1A of the BCU and the ACTR will trip but not be locked out.

If the PR contacts in the ladder (series-parallel) network close simultaneously before any other ACTR trip signal has occured, (Q105) ACTR transistor will be off and the base of transistor (Q501) will have a positive voltage and the base of transistor (Q502) will be held to ground potential. When transistor (Q502) is turned on and a positive 28 volts is applied to BCU pin J1A, this signal is now available to lock out ACTR when any combination of L and R relays are closed simultaneously.

b) The second group of lockout signals is supplied by the GCU pin B17. The signal is supplied by a normally open DP circuit or by a normally open UV circuit. Thus any fault sensed by DP or a bus fault sensed by UV will lock out the ACTR. Each GCU is connected to the BCU supplying 28VDC power from each PMTR in the GCU and the DC transfer bus to the BCU. The unregulated DC voltage is regulated down to 15VDC and provides control power for ACTR control through the BCU and is also used as supply for the various integrated and transistor circuits in the BCU.

c) If either left or right ac bus loses related generator power and the ACTR closes due to a fault, an UV condition might appear on the remaining bus, causing the CTTD to operate, opening the ACTR. If the voltage then recovers (GCR contact closes), the fault is apparently on the first bus and the ACTR is locked out by a signal through CTTD and UVR contacts to the ACTLR relay in the BC.

d) If the voltage recovers after the GR trips but before UVTD times out, the UV signal passes through the UV and CTTD to ACTL in the BC, ACTL energizes and is held in, locking out the ACTR.

e) If the voltage does not recover after GR trip, UVTD times out in 0.4 to 1.0 second and trips GCR. When GCR trips, PRR deenergizes and FSTD and CTTD reset. When CTTD resets, the open signal is removed from the ACTLS circuit in the BC. When PRR is deenergized, a close signal to the ACTLS circuit causes the ACTLS to close and ACTR is energized through contacts of ACTLS and the dead bus circuit (DBC).

F. System Protection

(1) System protection is provided by protective circuits, circuit breakers, and current limiters (Figure 9). The protective circuits are the generator phase sequence (GPS), underfrequency (UF), overvoltage (OV), undervoltage (UV), and differential protection (DP). Each protective circuit is actuated by a corresponding protective function (PS, UF, OV, UV, and DP). Time delay functions (CTTD, UVTD, FSTD, and UFTD) are initiated by protective functions and coordinate actuation of control functions.

(2) Phase Sequence (PS) Protection

(a) Phase sequence (PS) protection prevents power relay (LGR, LAPR, RAPR or RGR) closure unless 3-phase power of proper sequence (A-B-C) is available at the feeder side terminals (T1, T2 and T3) of the respective power relay.

(b) The phase sequence circuit (PS) senses 2-phase A and B line voltage at the feeder side (T1, T2) terminals of the power relay. The PS is actuated whenever all three phases are energized in the proper phase sequence. The PS is deenergized whenever the three phases are applied in reverse sequence or whenever Phase A or B are open.

(c) A PSR normally open contact is connected in series with the power ready relay (PRR) coil. Thus, the PRR cannot energize following a deenergized condition unless all phases are energized in power sequence. (Figure 14)

(d) A PRR contact, in series with the GR close coil, prevents GR closure unless PS is actuated. After the PRR has been actuated, a PRR normally open contact bypasses the PSR circuit; therefore, subsequent deactuation of the PS does not affect system operation.

(3) Underfrequency (UF) Protection

(a) The UF circuit is used to protect the system in the event of low CSD drive RPM output. When an underfrequency condition exists, underfrequency time delay (UFTD) starts and power ready relay drops out causing the generator relay to trip. When UFTD starts the UV is locked out if UF occurs first.

(b) The UF protection circuit senses UF on phase C at T3 terminal of the GR. UF is activated whenever the generator frequency reaches approximately 380 Hz (generator drive speed reaches approximately 5700 rpm). A UF in series with the PRR coil prevents PRR closure from a deenergized condition when the frequency is below 380 Hz. A PRR normally open contact in series with the GR close coil prevents GR closure until frequency is normal. As with the PS, the UF is bypassed after the PRR is energized.

(c) UF is connected through time delay UFTD to the PRR amplifier. UFTD is designed to provide an immediate close signal to the PRR amplifier when the UF signal is correct (frequency normal). Thus UF permits PRR and referenced GR closure immediately providing all other requirements are satisfied. However, under fault or shutdown conditions (generator frequency drops below 380 Hz), the PRR is opened after a time delay of 0.75 to 1.25 seconds, tripping the GR.

(4) Overvoltage (OV) Protection

(a) Overvoltage protection circuits examine the line to neutral phase voltage to protect the system from an overvoltage condition exceeding a nominal setting of 130 volts alternating current (VAC). The circuits use an inverse time delay of a magnitude and duration preestablished by design to trip the GCR, PRR, and GR of the generator feeding the bus. The GCUAR will be annunciated on the GCU if an overvoltage condition exists. The inverse time delay prevents nuisance tripping of the GR during transient overvoltage conditions.

(b) The OV protection circuits senses the average of the 3-phase voltages appearing at the line side of the GR terminals. The line voltage is half-waved through a bridge circuit. The DC voltage is then filtered and dropped across a variable resistor for the control of the OV circuit comparator. As long as the DC voltage remains low, the inverse time delay will not be activated.

(c) When an overvoltage is sensed, the comparator goes into a high state which initiates the inverse time delay. The higher the voltage the faster the time delay responds which removes the generator from the bus by opening the GCR, PRR and associated generator relay. A signal is transmitted to the GCUAR relay which latches the annunciator light when the OVTD times out.

(5) Undervoltage (UV) Protection

(a) Undervoltage (UV) protection initiates a series of control trip functions, coordinated by time delays, whenever the lowest phase voltage, sensed at the power relay (T1, T2, T3) terminals, drops below approximately 95 volts line-to-neutral. The UV protection first trips and/or blocks open the ACTR. Then, if the fault is not cleared, UV trips, in sequence, the power relay and the generator control field relay (GCR). If the fault is cleared by either the ACTR trip or the power relay trip, a bus fault is indicated and the ACTR is locked open to prevent transfer of the fault to a good system. The UV protection is not actuated as long as UF condition exists; therefore, it does not function during normal engine shutdown.

(b) The UV protection circuit senses all three phases of volt-age appearing at the feeder side (T1, T2, T3) terminals of the GR, and energizes the UV circuit whenever the lowest phase reaches approximately 95 volts, phase to neutral. A UV condition occurs normally on shutdown and may occur as a result of a bus fault or an excitation fault. A UVR trip condition can result from a balanced 3-phase bus fault which causes the total generator output to reach approximately 400 amperes per phase, a phase-to-ground fault causing a total output of approximately 300 amperes per phase, or a phase-to-phase fault causing a total output of approximately 200 amperes per phase. Also a UV condition can result from an excitation fault in the voltage regulator circuit, generator or exciter field wiring.

(c) During engine shutdown, a UF condition is reached before a UV condition and the UF circuitry is energized. The energized state of the UF circuit prevents the UV circuitry from starting the CTTD and FSTD and no UV action results when the UV circuit is energized. During startup when the lowest phase voltage exceeds 95 volts, the UV circuit is deenergized permitting PRR actuation if the UF circuit is also deenergized, the PS is proper, and the generator control switch is on. PRR closure permits GR closure if no other power source is connected to the bus. When the PRR closes, latching logic bypasses the PRR, UV, UF, and PS sensing circuitry so that the PRR is not directly affected by a subsequent UV condition.

(d) Whenever a UV condition occurs after the PRR has closed, a UV signal along with a GCR closed signal and a UF not energized signal starts the CTTD and FSTD. At the same time, a UV signal also latches out the UF signal preventing a UF condition from deactivating the CTTD and FSTD. If the UV condition continues for 2 to 4 seconds with the GCR closed, the CTTD times out and provides a holdoff signal to the ACTLS circuit which trips the ACTR. If the UV condition disappears before CTTD times out, CTTD and FSTD are reset and no further action occurs.

(e) If the UV condition continues for 5 to 7 seconds, FSTD times out and locks in through a logic circuit. At the same time a signal is sent through logic gates and transistor switches to trip and prevent reclosure of the GR effectively locking it out to prevent cycling. The same signal is also sent to start the UVTD. In 0.4 to 1.0 seconds the UVTD times out and sends a signal through logic circuits and transistor switches to trip and lockout the GCR. When the GCU trips, a contact opens and removes PMG power from the VR circuit to deexcite the generator. At the same time another GCR contact opens and sends a GCR open signal to reset the CTTD and FSTD. The UVTD is reset by the deenergized state of the FSTD by a signal sent from the CTTD and UV circuits to the ACTL circuit in the bus control unit. The GCU logic circuit sends the ACTR lockout signal any time the CTTD is energized after timing out and a no UV condition signal is present.

(f) If the UV condition disappears after CTTD times out (ACTR trips) and before FSTD times out (GR trips), a bus fault exists beyond the ACTR. If the UV condition disappears after FSTD times out (GR trips) and before UVTD times out(GCR trips), a bus fault exists on the generator ac bus (beyond the GR). In either case, the ACTR is locked out, to prevent transfer of the fault, by a signal sent from the CTTD and UV circuits to the ACTL circuit in the bus control unit. The GCU logic circuit sends the ACTR lockout signal any time the CTTD is energized after timing out and a no UV condition signal is present. If the UV condition persists until the GCR trips, deexciting the generator, an excitation-type fault exists. CTTD is deenergized and the ACTR is permitted to close, providing the ac bus crosstie switch is in auto position and no other power source is available.

(6) Differential Protection (DP)

(a) Differential protection (DP) detects the presence of a fault by sensing and comparing the current flow at two locations in a common series circuit (Figure 15). Any difference in current flow at the two locations indicates the presence of a fault within the DP zone. The DP zone for each generator system includes the generator out-put windings, feeders, and generator relay (GR).

(b) Whenever a feeder fault is sensed in the generator output windings, feeders, or generator relay, the DP trips open the generator control relay (GCR). Tripping of the (GCR) deenergizes the power ready relay (PRR) which trips the generator relay (GR). DP also locks open the ACTR. Normally a bus fault in the DP zone is sensed and removed by DP before UV protection is actuated.

(c) Each pair of differential protection current transformers (DPCT's) (on common phase) are connected in a series loop and the loop is connected to the DP sensing circuit in the related GC unit. When the LAPR and RAPR are used, shorting transistor switch the main generator DP loops out of the circuit and APU generator feeders are protected in the same manner as described for the engine generator system. The sensing control for the shorting switches are located in the BCU and are switched when the L or R generator system is activated. A line current difference (e.g., fault current) of 20 to 40 amperes between the two sensing points (neutral and load side) in any phase actuates the differential protection (DP) in that GC unit. (Figure 14)

(d) Sensing and operation of DP for the APU generator is the same as for left and right generator except for the load side connections of the DPCT loop circuits (Figure 15). The DP system senses 3 phase line to neutral current flow through 2300: 1 ratio current transformers. Three are located at the generator and three in the electrical power center for each system. A comparator signal is activated if the current difference between the CT network is sensed. Normally the current differential is zero and the circuit is in a low (passive) state. The 3 phase circuits feed into a differential amplifier in the GCU. A DP signal to an operational amplifier trips the GCR and deenergizes the PRR which trips the generator relay. At the same time a signal is sent to the ACTLS in the BCU and locks out the affected generator system and annunciates a crosstie lockout light on the annunciator panel. The GCU will annunciate a distribution light. The DP function operates within 15-50 milliseconds. Since the APU generator can feed either left or right generator bus, nine DPCT's are required, one per phase on the neutral leads and one per phase on each load bus. To avoid false signals resulting from normal power flow from other sources, it is necessary to short out and disconnect the three DPCT's on either load bus whenever a source of power other than the APU is connected to that bus.

(e) The DPCT's can be shorted out and disconnected by means of transistors located in the BC unit. When either the LGR or LEPR is closed, the left generator CT shorting circuit is actuated, shorting out and disconnecting the left load side DPCT. The right generator CT shorting circuit performs the same function for the right side DPCT's. Also, if the ACTR is closed and any left or right GR or EPR is closed, all APU load side DPCT's are shorted out and disconnected.

(7) Current Limiter Protection

(a) On the ac crosstie relay terminals T1, T2, T3, L1, L2, and L3 current limiters are installed (Figure 9). In the event of an ac crosstie relay shorting out internally, the current limiters will isolate the shorted relay from the airplane wiring assuring continued operation of at least one generator system.

(8) Figure 16 summarizes the operation of the ac electrical system protective functions. The nature of faults detected, trip levels, applicable time delays and corrective actions are listed in abbreviated form for each protective function.

(9) Note that the trip level for DP is given directly in fault current while that for UV bus faults is given as the total load plus fault current that causes line voltage to drop to the UV trip point. Note also on UV operation that time delays CTTD and FSTD are started simultaneously by a UV trip condition; however, UVTD does not start until FSTD times out.

ABBREV.	NAME
ACTL	AC CROSSTIE LOCKOUT
ACTLIR	AC CROSSTIE LOCKOUT INDICATION RELAY
ACTLS	AC CROSSTIE LOCKOUT RELAY SLAVE
ACTR	AC CROSSTIE RELAY
AEPTR	AC EMERGENCY POWER TRANSFER RELAY
AGSTR	AC GROUND SERVICE TIE RELAY
APCR	AUXILIARY POWER CONTROL RELAY
APGC	GEN CONTROL UNIT (AUXILIARY POWER)
APPRR	POWER READY RELAY (AUXILIARY POWER)
APR	AUXILIARY POWER RELAY
APSR	AUXILIARY POWER UNIT STARTER RELAY
APU	AUXILIARY POWER UNIT
ARSW	ANNUNCIATOR RESET SWITCH
BAT	BATTERY
BC	AC BUS CONTROL UNIT
BCHG	BATTERY CHARGER
BCTR	BATTERY CHARGER TRANSFER RELAY
BR	BATTERY RELAY
BS	BATTERY SWITCH
C&TGSI	BATTERY CHARGER & DC TRANSFER BUS GROUND SERVICE INTERLOCK
C&TR	BATTERY CHARGER & DC TRANSFER BUS RELAY
C&TRCR	BATTERY CHARGER & DC TRANSFER BUS RELAY CONTROL RELAY
CB	CIRCUIT BREAKER
CSD	CONSTANT SPEED DRIVE
CT	CURRENT TRANSFORMER
CTTD	AC CROSSTIE RELAY TIME DELAY CIRCUIT
DAR	DRIVE ANNUNCIATOR RELAY
DBC	DEAD BUS CIRCUIT
DCTR	DC CROSSTIE RELAY
DDR	DRIVE DISCONNECT RELAY
DEPTR	DC EMERGENCY POWER TRANSFER RELAY
DGSTR	DC GROUND SERVICE TIE RELAY
DP	DIFFERENTIAL PROTECTION
DPCT-A	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ΦA)
DPCT-B	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ΦB)
DPCT-C	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ΦC)
DPTD	DIFFERENTIAL PROTECTION TIME DELAY
DRSR	DRIVE RUNNING SIGNAL RELAY
DSAR	DISTRIBUTION SYSTEM ANNUNCIATOR RELAY
DTBSR	DC TRANSFER BUS SENSING RELAY
ECSW	EMERGENCY POWER CONTROL SWITCH
EDBSR	EMERGENCY DC BUS SENSING RELAY
EPM	EXTERNAL POWER MONITOR
EPPSC	EXTERNAL POWER PHASE SEQUENCE CIRCUIT
EPR	EXTERNAL POWER RELAY
ERSR	ENGINE RUNNING SIGNAL (SSR)
FSTD	FAULT SELECTOR TIME DELAY CIRCUIT
GAR	GENERATOR ANNUNCIATOR RELAY
GCR	GENERATOR CONTROL RELAY
GCU	AC GENERATOR CONTROL UNIT
GCUAR	GENERATOR CONTROL UNIT ANNUNCIATOR RELAY
GEN	GENERATOR
GFFW	GENERATOR FEEDER FAULT WARNING
GPS	GENERATOR PHASE SEQUENCE
GR	GENERATOR RELAY
GRR	GROUND REFUELING RELAY
GSAPR	GROUND SERVICE AUXILIARY POWER RELAY
GSEPR#1	GROUND SERVICE EXTERNAL POWER RELAY NO.1
GSEPR#2	GROUND SERVICE EXTERNAL POWER RELAY NO.2
INV	INVERTER
L	LEFT
LAPCR#1	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
LAPCR#2	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
LAPR	LEFT AUXILIARY POWER RELAY
LDBC	LEFT DEAD BUS CIRCUIT
LDBS	LEFT DEAD BUS SLAVE
LEPCR	LEFT EXTERNAL POWER RELAY CONTROL RELAY
LEPR	LEFT EXTERNAL POWER RELAY
LGC	LEFT GENERATOR CONTROL UNIT
LGR	LEFT GENERATOR RELAY
LGRS	LEFT GENERATOR RELAY SLAVE
LPRR	LEFT POWER READY RELAY
OV	OVER VOLTAGE
OVTD	OVER VOLTAGE TIME DELAY CIRCUIT
PMG	PERMANENT MAGNET GENERATOR
PR	POWER RELAY
PRR	POWER READY RELAY
PS	PHASE SEQUENCE
R	RIGHT
RAPCR#1	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
RAPCR#2	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
RAPR	RIGHT AUXILIARY POWER RELAY
RCD	REVERSE CURRENT (BLOCKING DIODE)
RDBC	RIGHT DEAD BUS CIRCUIT
RDBS	RIGHT DEAD BUS SLAVE
REPCR	RIGHT EXTERNAL POWER RELAY CONTROL RELAY
REPR	RIGHT EXTERNAL POWER RELAY
RGC	RIGHT GENERATOR CONTROL UNIT
RGR	RIGHT GENERATOR RELAY
RGRS	RIGHT GENERATOR RELAY SLAVE
RPRR	RIGHT POWER READY RELAY
SW	SWITCH
TD	TIME DELAY
TR	TRANSFORMER-RECTIFIER
UF	UNDER FREQUENCY
UFTD	UNDER FREQUENCY TIME DELAY CIRCUIT
UV	UNDER VOLTAGE
UVTD	UNDER VOLTAGE TIME DELAY CIRCUIT
VR	VOLTAGE REGULATOR CIRCUIT
VROK	VOLTAGE REGULATOR OK

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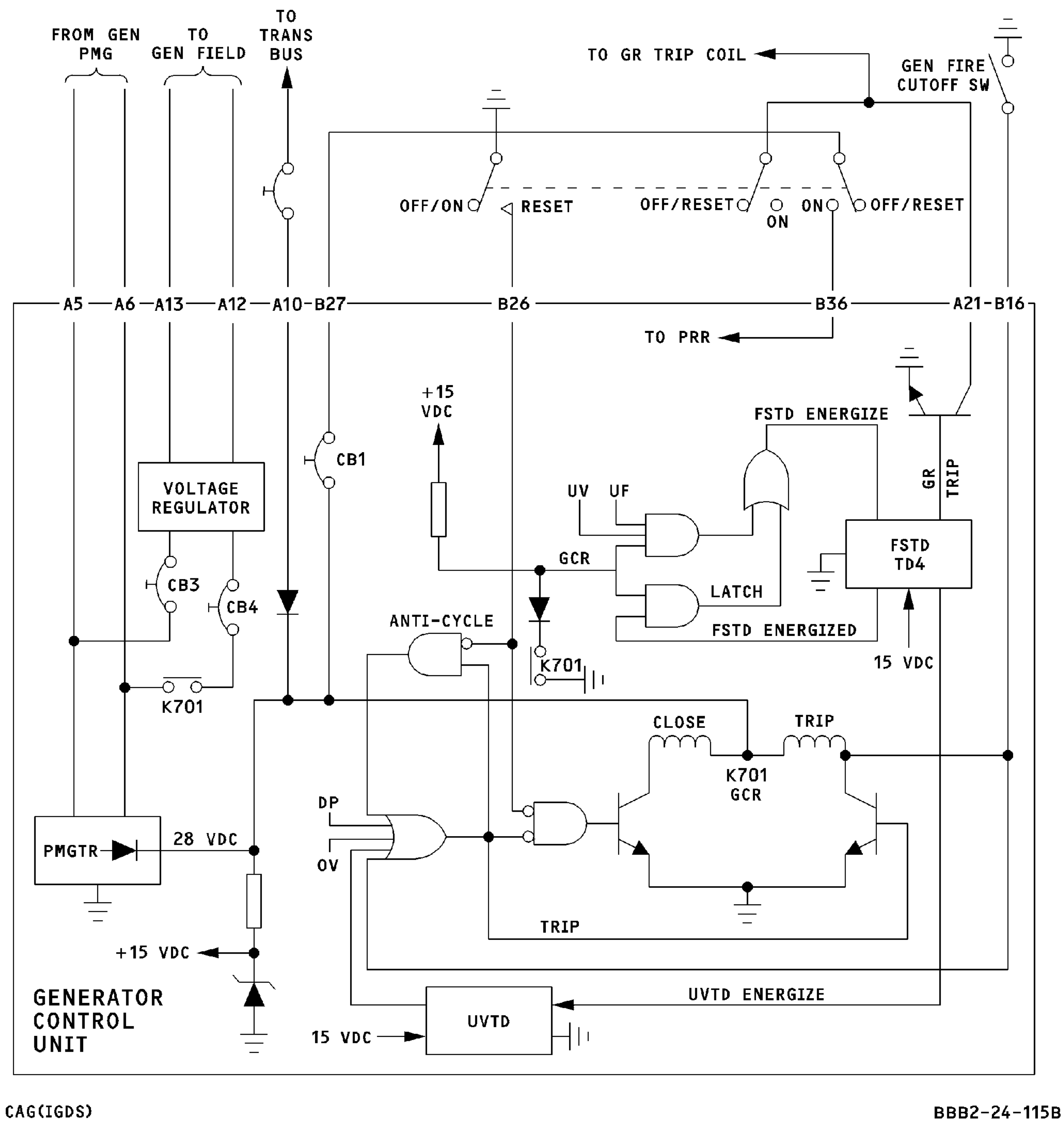
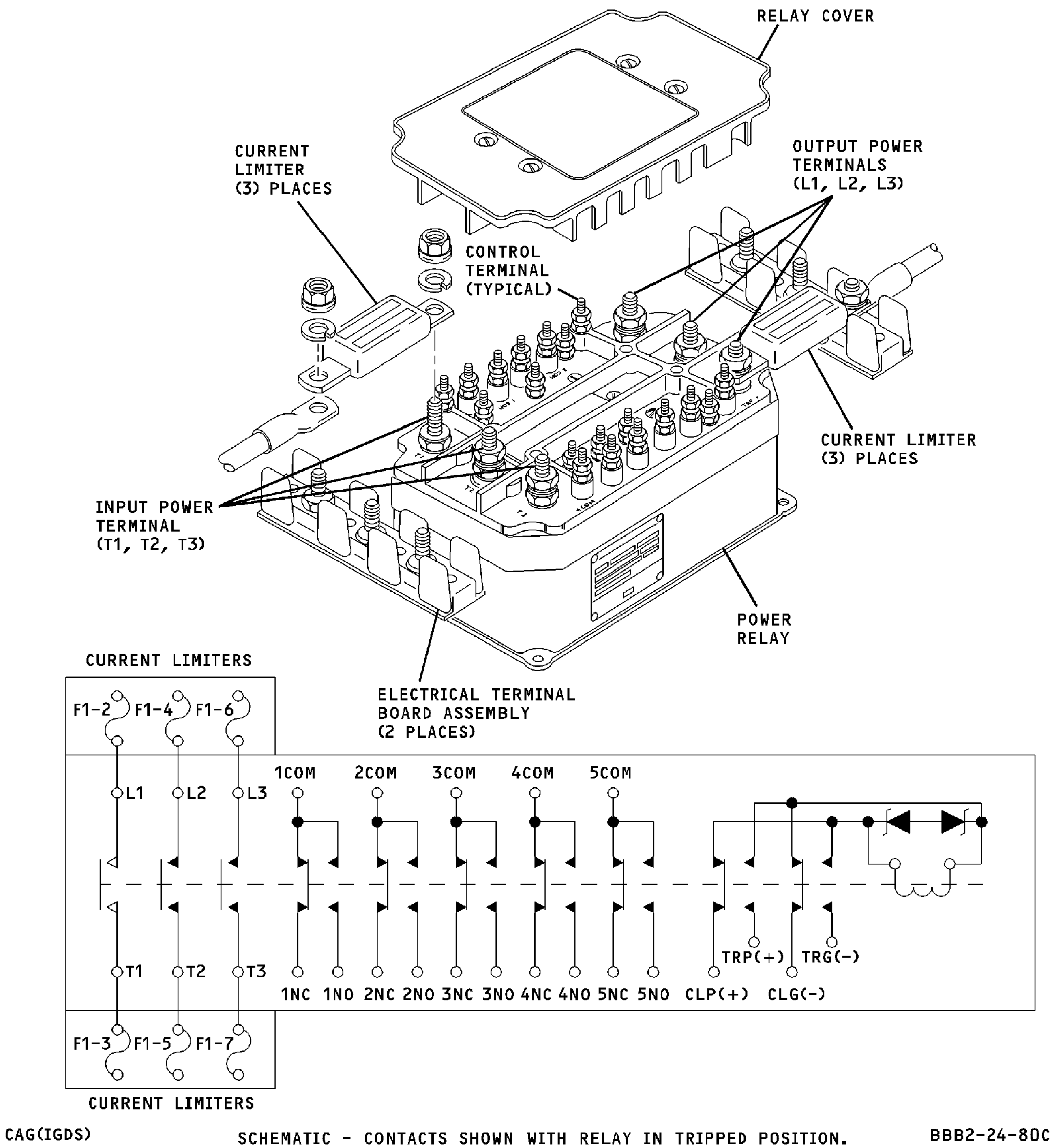
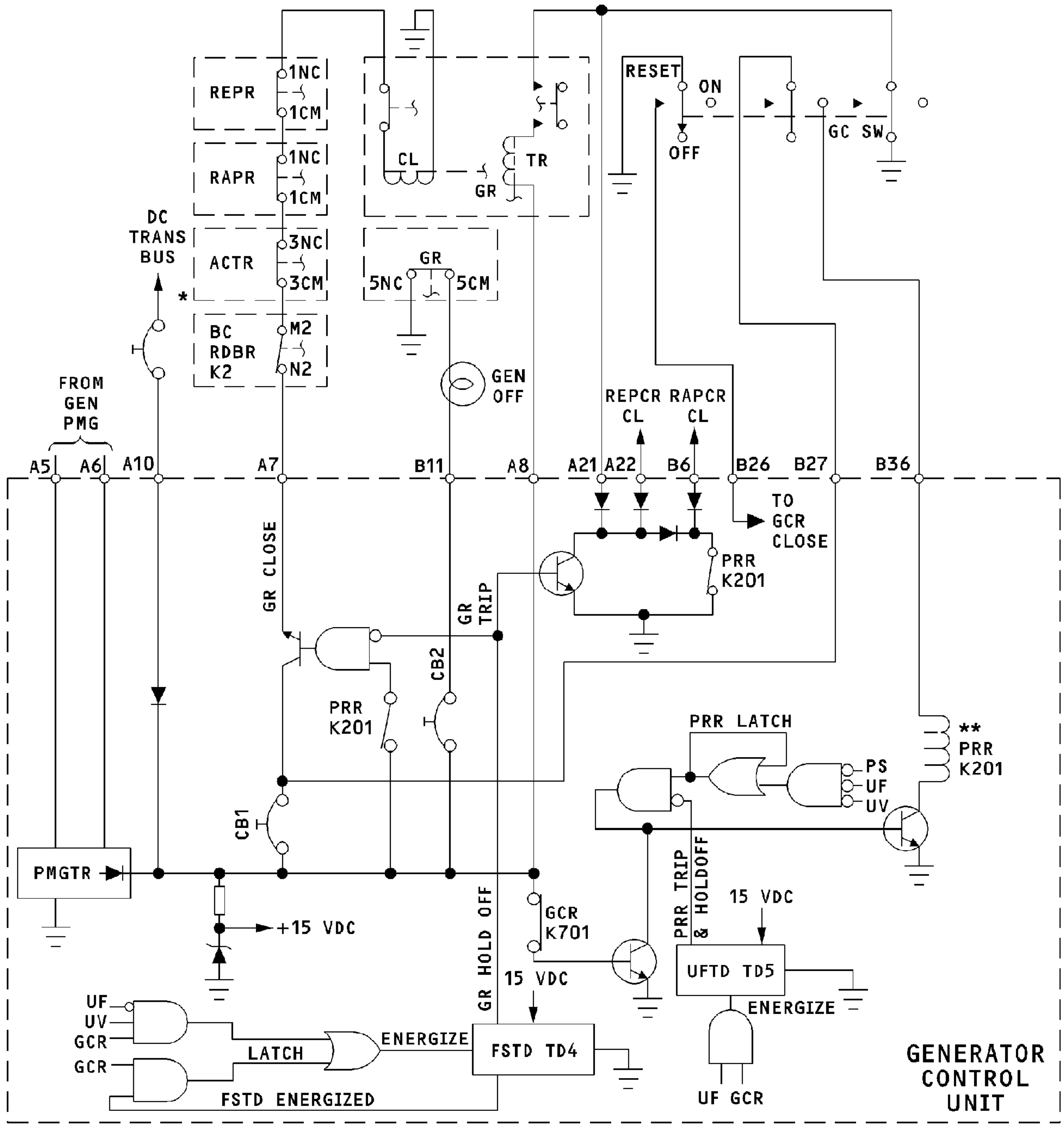
Electrical Power Abbreviations
Figure 7/24-20-00-990-807



Generator Control Relay (GCR) Control
Figure 8/24-20-00-990-808



Power Relay
Figure 9/24-20-00-990-809



*NOTE: ACTR CONTACT FOR LEFT GENERATOR GR CONTROL IS 1CM-1NC. ALL OTHER CONTACTS SAME FOR BOTH RIGHT AND LEFT SYSTEM.

**NOTE: PRR DEENERGIZES IMMEDIATELY ON GCR TRIP OR AFTER UFTD OF 0.75 TO 1.25 SECONDS.

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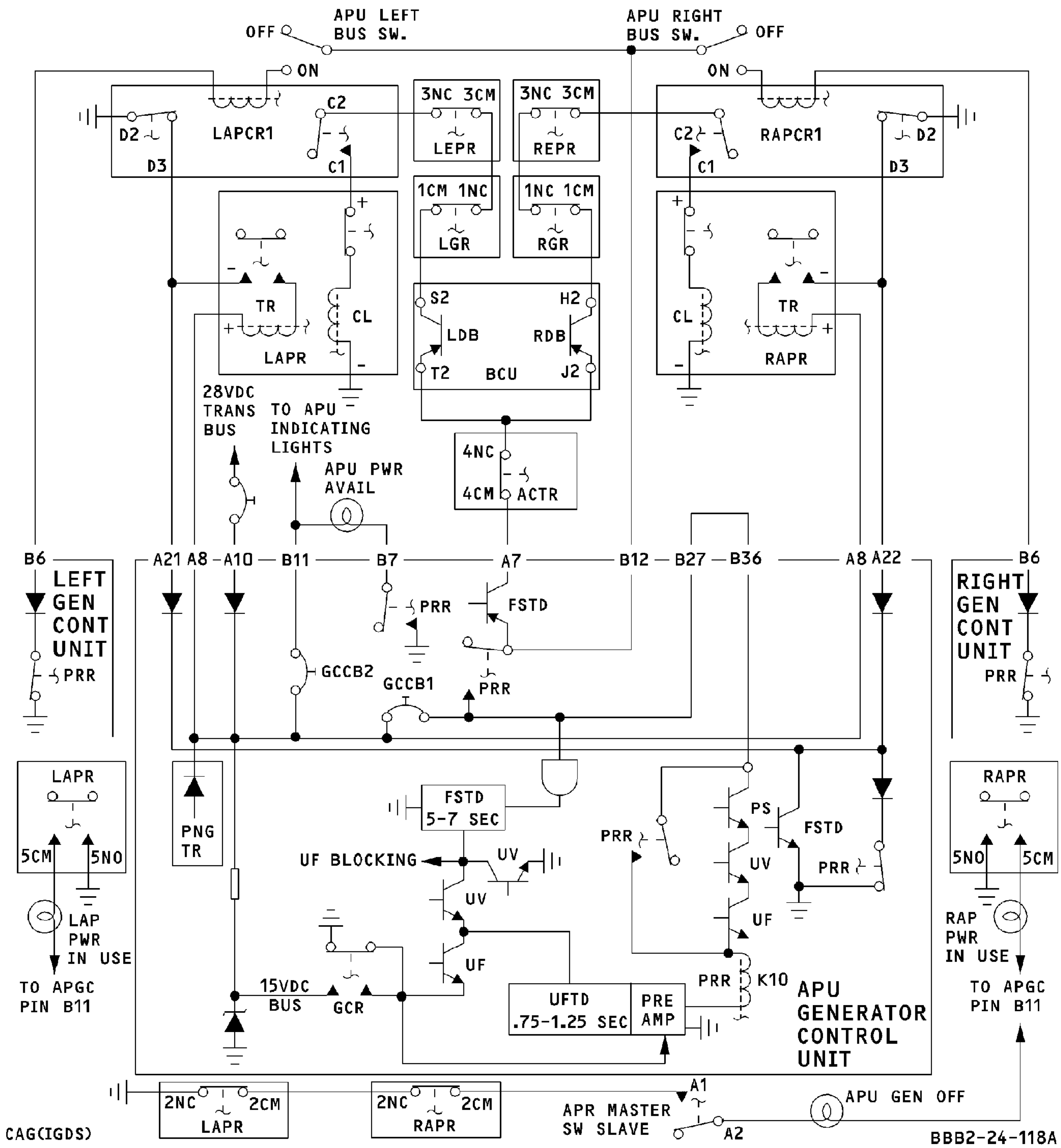
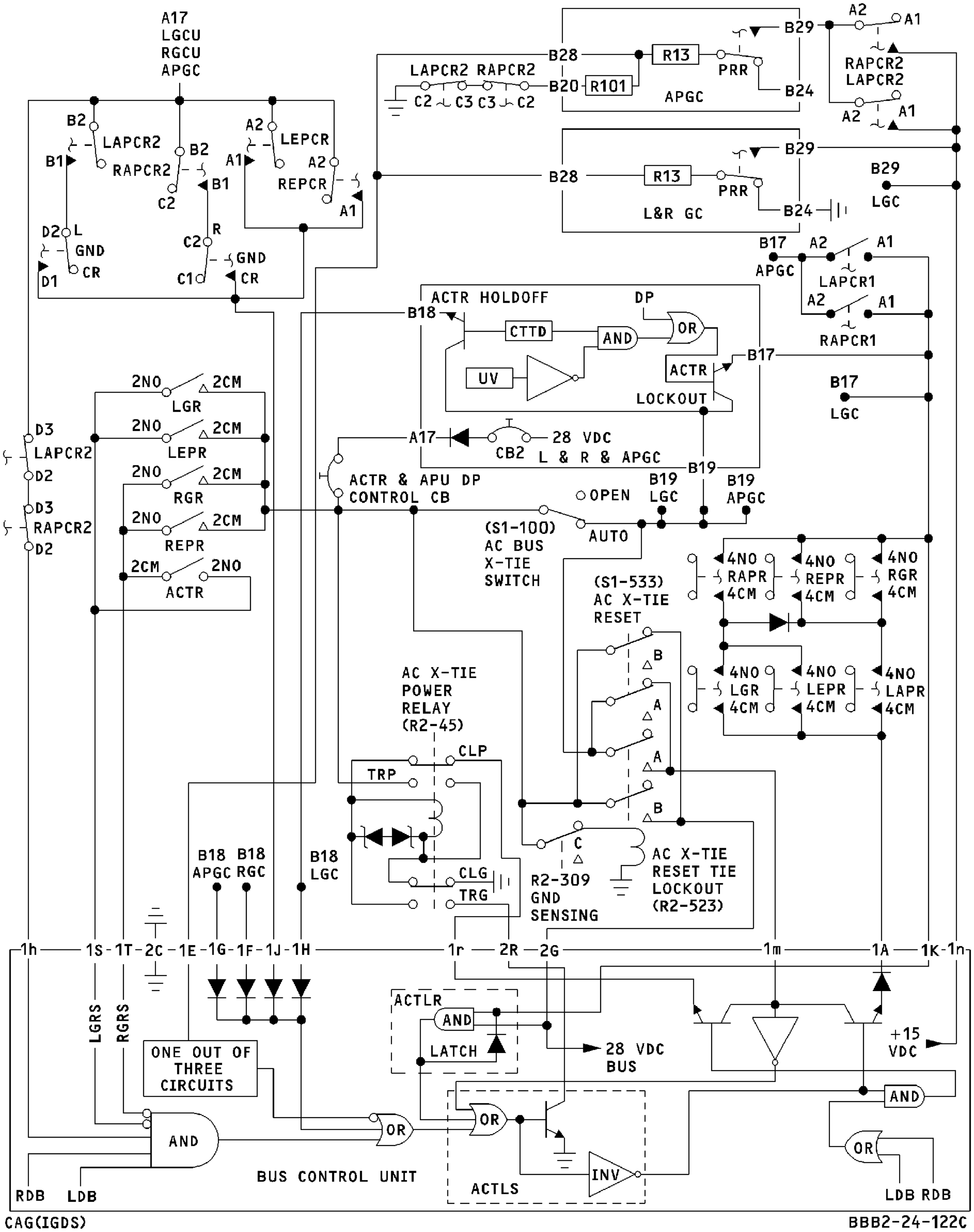
Generator Relay (GR) Control
Figure 10/24-20-00-990-810



Left and Right Auxiliary Power Relay (APR) Control
Figure 11/24-20-00-990-811



AC Crosstie Relay (ACTR) Control
Figure 12/24-20-00-990-812

CONTROL FUNCTION	CONDITIONS FOR CLOSURE	CONDITIONS FOR TRIPPING	CONDITIONS FOR LOCKOUT OR FAILURE TO CLOSE
Generator control (field) relay (GCR)	1. Generator control switch to reset momentarily. 2. Anti-cycling circuit is not latched.	1. Generator cutoff switch closed or 2. DP fault occurs or 3. OV fault occurs, or 4. UVTD actuated for 0.4 to 1.0 second (a) UV condition persists 5.0 to 7.0 seconds (FSTD) with frequency normal NOTE: GCR does not trip on shutdown.	1. Generator control switch held in reset, and 2. Presence of anti-cycle circuit latching signal NOTE: GCR will reclose, then trip and holdoff if fault exists. Release of generator control switch removes holdoff.
Generator (power) relay (GR)	1. Generator control switch in on position, and 2. PRR energized (a) GCR closed (b) Phase sequence normal (c) Line voltage normal (d) Line frequency normal 3. FSTD deenergized	1. Generator control switch to off/reset position, or 2. PRR deenergized (a) GCR tripped, or (b) UF condition persists 0.75 to 1.25 seconds (UFTD energized), or 3. FSTD energized (a) UV condition persists 5.0 to 7.0 seconds with frequency normal and GCR closed NOTE: GR normally trips on UF at shutdown	1. Generator control switch in off position, or 2. PRR fails to close (a) GCR tripped, or (b) UV condition, or (c) UF condition, or 3. FSTD times out (5.0-7.0) seconds and GCR has not tripped (UVTD - 0.4-1.0) second. NOTE: Lockout occurs only as long as above conditions persist.

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Summary of Ac Electrical System Control Functions
Figure 13/24-20-00-990-813 (Sheet 1 of 2)

CONTROL FUNCTION	CONDITIONS FOR CLOSURE	CONDITIONS FOR TRIPPING	CONDITIONS FOR LOCKOUT OR FAILURE TO CLOSE
Auxiliary power relay (L or R APR) NOTE: If LAPR, all (L) designations apply. If RAPR, all (R) designations apply.	1. APU L or R bus switch on, and 2. APU system conditions same as GR closure condition (2) above, and 3. L or R GR and ext. power relay tripped, and 4. L or R generator system PRR deenergized (engine-driven generator power not available)	1. APU L or R bus switch to off, or 2. Condition 2 above, or 3. Condition 3 above, or 4. L or R generator system PRR energized (power available)	1. APU L or R bus switch in off, or 2. Condition 2 above, or 3. Condition 3 above, or 4. L or R generator system PRR energized, or 5. L or R GR or EPR closed NOTE: Lockout occurs only as long as above condition persists.
Ac crosstie relay (ACTR)	1. Ac bus crosstie switch in auto position, and 2. APU or EPR, L and R bus switches off (affects closing only when airplane is on the ground) 3. CTTD circuit inactive, and 4. Two or more sources are not available (PPR's closed), and 5. A DBR indicates one bus is dead.	1. Ac bus crosstie switch in open position, or 2. Airplane is on ground and L or R APR is closed, or 3. CTTD active, or 4. Two or more sources become available, or 5. No ac source on the bus, or 6. L or R EPR is closed. 7. ACTL energized.	1. Any L & R power relays are closed simultaneously, and there is a signal to close the ACTR, or 2. A DP fault occurs, or 3. A bus fault which causes an UV condition occurs. NOTE: To release lockout, DC power must be removed from circuit by the lockout reset switch. Lockout release is automatic when all power is removed from BCU.

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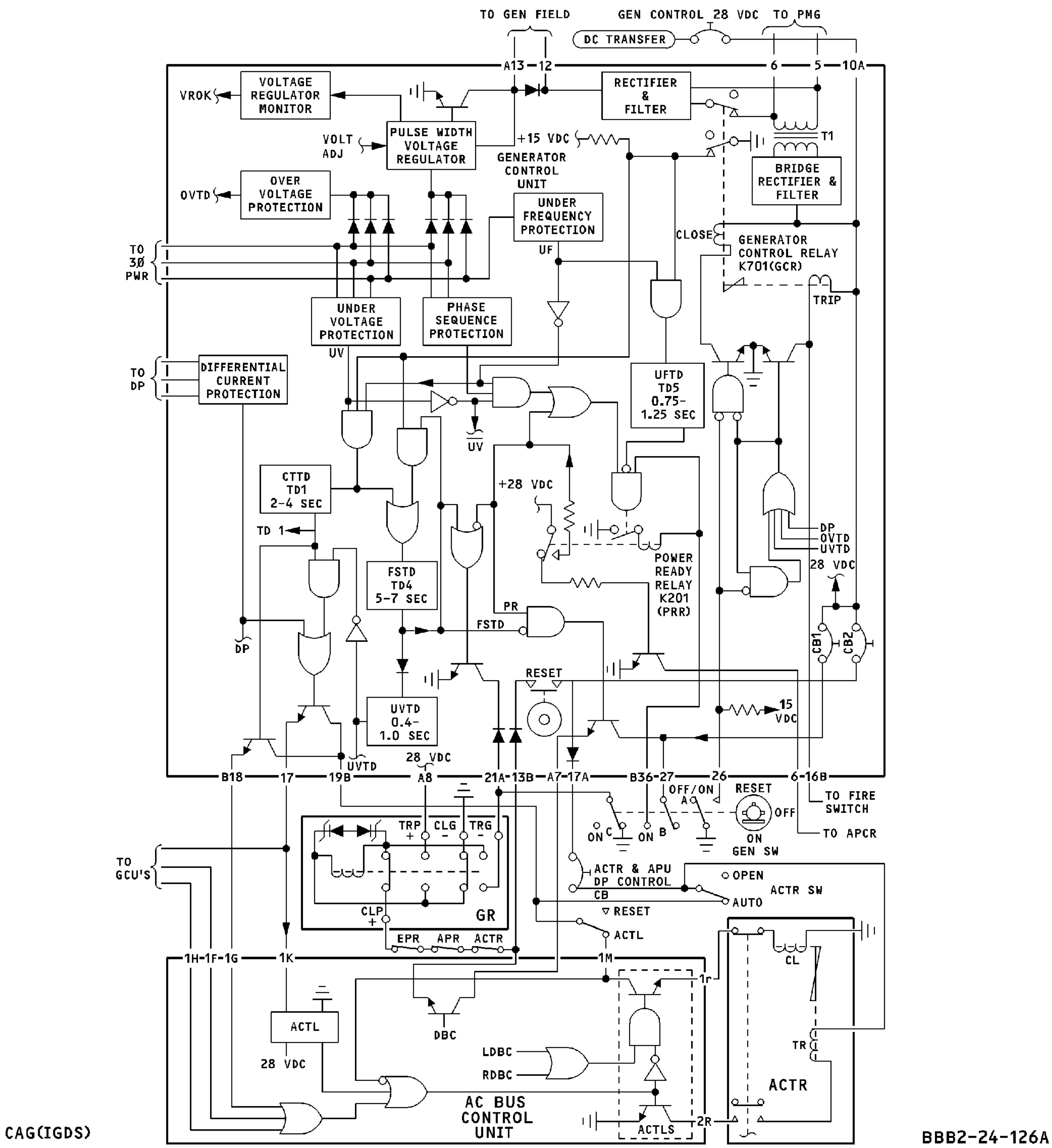
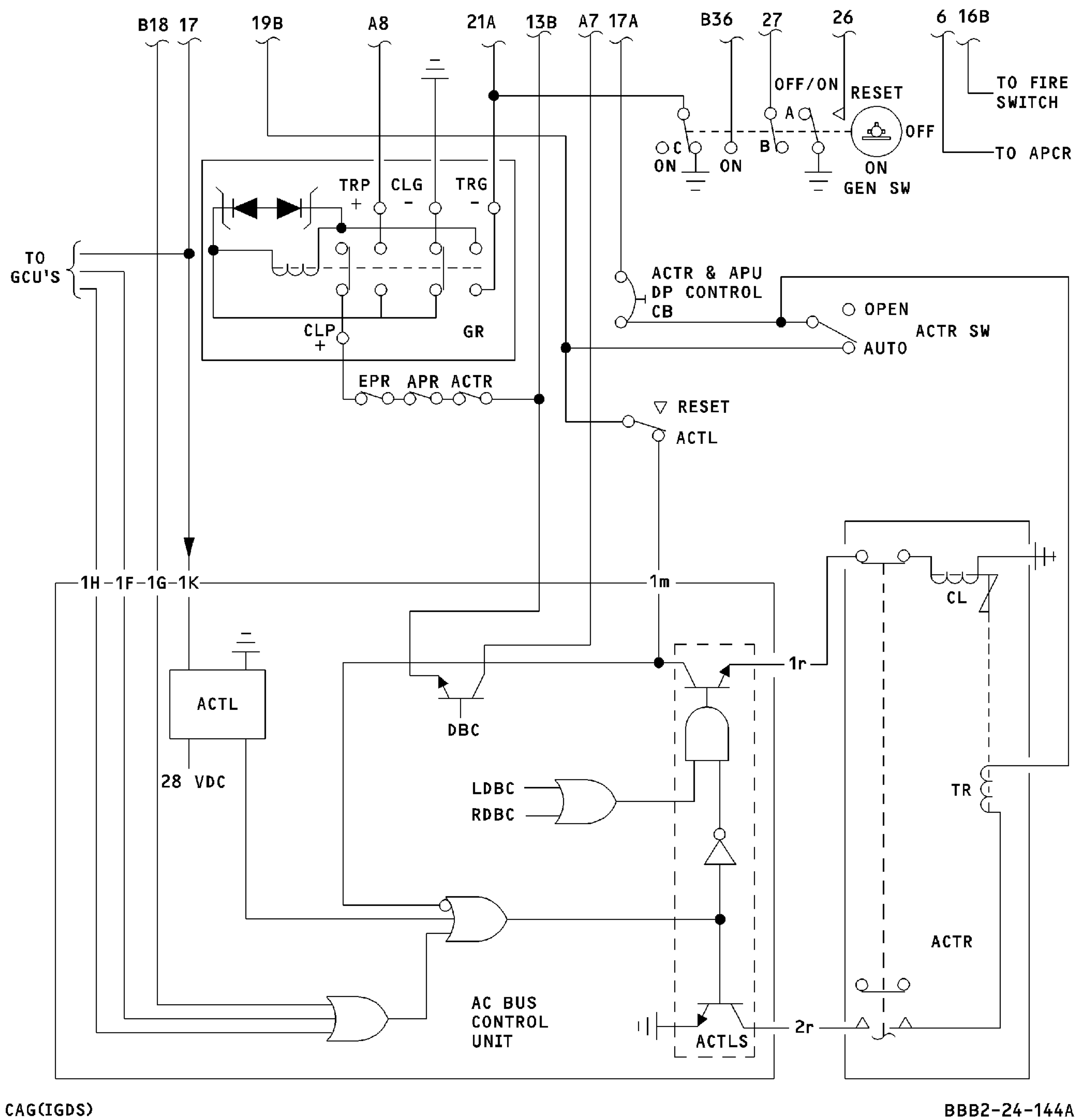
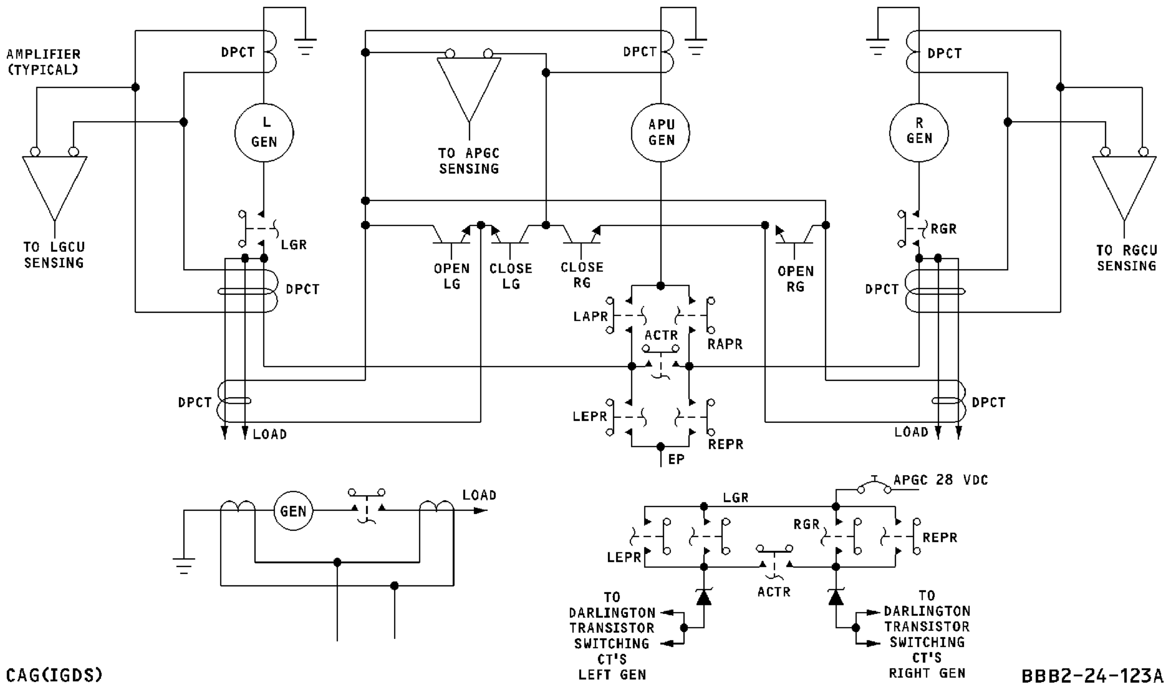
Summary of Ac Electrical System Control Functions
Figure 13/24-20-00-990-813 (Sheet 2 of 2)



AC System Protection
Figure 14/24-20-00-990-814 (Sheet 1 of 2)



AC System Protection
Figure 14/24-20-00-990-814 (Sheet 2 of 2)



Differential Protection (DP) Feeder Faults
Figure 15/24-20-00-990-815

PROTECTION	NATURE OF FAULT	TRIP LEVEL	TIME DELAY	CORRECTIVE ACTION
DP	Line to line, line to neutral, or 3-phase fault in differential zone (generator output windings, feeders or power relay)	20 to 40 amp ac fault current	0.015 to 0.050 second	Trips GCR, GCR deenergizes PRR, PRR trips GR. DP also actuates ACTL, ACTL locks out ACTR.
PS	Reverse phase sequence ϕA and ϕB.	120° out of phase or BAC	None	Prevents PRR actuation on startup, PRR prevents GR closure. Has no effect after PRR is actuated.
OV	OV condition caused by excitation fault (loss of sensing voltage to regulator circuit or fault in regulator circuit.)	130 vac minimum average phase to neutral volts	Inverse time with accelerated non-linear scale	Trips GCR, GCR deenergizes PRR, PRR trips GR
UF *	Generator drive speed below normal (due to engine shutdown, CSD disconnect or failure, or generator drive spindle failure)	Less than 380 Hz	UFTD (0.75 - 1.25) seconds on frequency decrease	Deenergizes PRR after time delay, PRR trips GR

BBB2-24-129

Summary of Ac Electrical System Protective Functions
Figure 16/24-20-00-990-816 (Sheet 1 of 2)

PROTECTION	NATURE OF FAULT	TRIP LEVEL	TIME DELAY	CORRECTIVE ACTION
UV *	UV condition caused by excitation fault in regulator circuit, in generator, or in PMG, or exciter field system wiring.	95 VAC lowest phase to neutral voltage	CTTD (2.0-4.0) seconds	Blocks ACTLS, ACTLS trips or prevents closure of ACTR
			FSTD (5.0-7.0) seconds	Trips and blocks closure of GR Locks in - starts UVTD
			UVTD (0.4-1.0) second	Trips GCR, GCR deenergizes PRR, CTTD, FSTD, and UVTD
	UV condition caused by bus fault beyond ACTR. Voltage recovers after ACTR trip	3-phase 400 amp, line to line 200 amp, line to neutral 300 amp (load plus fault current)	CTTD - FSTD	CTTD trips ACTLS, ACTLS trips ACTR, UV recovers, FSTD resets. CTTD & UV actuate ACTLR, ACTLR locks out ACTR
	UV condition caused by bus fault on generator ac bus. Voltage recovers after GR trip		CTTD-FSTD-UVTD	CTTD trips or blocks ACTR, FSTD trips GR, starts UVTD, CTTD & UV to actuate ACTL, ACTL locks out ACTR, UVTD trips GCR, GCR de-energizes PRR, CTTD, FSTD, and UVTD

NOTE: * UF and UV are interlocked in such a way that if UV occurs before UF, UF is latched out. If UF occurs before UV (normal shutdown), UV is blocked from actuating CTTD and FSTD.

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Summary of Ac Electrical System Protective Functions
Figure 16/24-20-00-990-816 (Sheet 2 of 2)

3. **Maintenance Annunciator Operation**

A. A drive fault is annunciated on the left or right ac generator control unit whenever the related constant speed drive (CSD) transmission output speed is below 3000(±1000) rpm while the engine is operating at or above idle speed. A malfunction may occur within the CSD transmission, in the CSD output speed sensor circuit, or related airplane wiring. (Figure 17)

(1) The engine running sensing relay (ERSR) is energized when engine speed is above 67 (-15) percent. The drive running sensing relay (DRSR) is energized when CSD transmission out-put speed is above 3000(±1000) rpm. The CSD normally provides a constant output speed of 6000(±60) rpm (generator frequency 400(±4) Hz). Underfrequency (UF) protection operates below 380 Hz.

(2) A CSD malfunction (such as a governor malfunction) in which CSD output speed drops below 5700 rpm (380 Hz generator frequency) but stays above 3000(±1000) rpm is not annunciated. Such a malfunction causes UF protection to trip and prevent reclosure of the GR.

(3) The drive annunciator relay (DAR) is tripped and a drive fault is annunciated whenever the following three conditions occur simultaneously:

(a) The engine running signal relay (ERSR) is energized (engine running speed normal).

(b) The drive disconnect relay (DDR) is closed (CSD disconnect is not actuated).

(c) The drive running signal relay (DRSR) is not energized (CSD output speed is below 3000(±1000) rpm).

(4) The annunciation is removed (DAR is reset) if the system recovers (annunciator reset relay ARR energized) or if the annunciator is reset manually. Following annunciator reset, a drive malfunction does not annunciate until engine speed increases above idle.

B. A generator fault is annunciated whenever input speed to the generator is normal and generator permanent magnet generator (PMG) output, as sensed through the PMG TR in the GC unit, is below normal. An annunciation is provided in case of generator spindle or PMG failure. An annunciator can also occur in case of PMG airplane wiring or GC unit PMG TR failure.

(1) The generator annunciator relay (GAR) is tripped and a generator fault is annunciated whenever the following two conditions occur simultaneously:

(a) The DRS circuit is energized (drive output speed is normal).

(b) The permanent magnet generator (PMG) is not energized (generator PMG output is below normal).

NOTE: On the APU system, the DRS circuit is not used. DRS circuit is bypassed by a circuit from the APU bleed air control switch; thereby providing generator annunciation in the APU system.

(2) A generator annunciation is not provided in case of failure of the generator excitation or output circuits. Refer to voltage regulator circuit annunciation concerning these conditions. (Paragraph 3.C.)

(3) The annunciation is removed (GAR is reset) if the system recovers or if the annunciator is reset manually.

C. A distribution system fault is annunciated when a line to line, line to neutral, or 3-phase fault occurs in the DP zone (generator output windings, feeders, or GR).

(1) The distribution system annunciator relay (DSAR) is tripped and a distribution system fault is annunciated whenever the following two conditions occur simultaneously:

(a) The differential protection amplifier (DP) goes high (generator, feeder DP fault exists).

(b) The GCUAR is not tripped (no GC unit fault exists).

(2) The annunciation is removed (DSUAR is reset) if the GCUAR trips (indicating GC fault causing false DP trip), if the generator control switch is placed in reset position and the system recovers (ARR energized), or if the annunciator is reset manually.

D. An ac generator control (GCU) unit fault is annunciated whenever a fault signal exists in the GC unit DP, OV, or UVTD circuits and the signal is not cleared by GCR tripping, indicating that the signal is false (from fault in GC unit) or that the GCR (in GC unit) failed to trip.

(1) The generator control annunciator relay (GCAR) is tripped and ac generator control unit fault is annunciated whenever any of the following apparent fault conditions occur and are not removed within 4.0 to 8.0 seconds by GCR trip.

(a) The DPR is energized (apparent DP fault exists), and the GAR is not tripped (fault is not in generator PMG).

(b) The OVR is energized (apparent OV fault exists), and the GAR is not tripped (fault is not in generator PMG).

(c) The UVTD is energized (apparent UV fault exists) and the GAR is not tripped (fault is not in generator PMG).

NOTE: Condition (a) first annunciates the distribution system. Conditions (b) or (c) first annunciate the generator control unit. Then, if any of the three apparent fault conditions are not removed within 4.0 to 8.0 seconds by GCR trip, the ac generator control unit fault is annunciated.

(2) A voltage regulator circuit fault is annunciated whenever an overvoltage (OV) or undervoltage (UV) fault exists which is not the result of generator PMG failure.

(3) The generator control circuit annunciator relay (GCAR) is tripped and a generator control unit fault is annunciated whenever the following two conditions occur simultaneously:

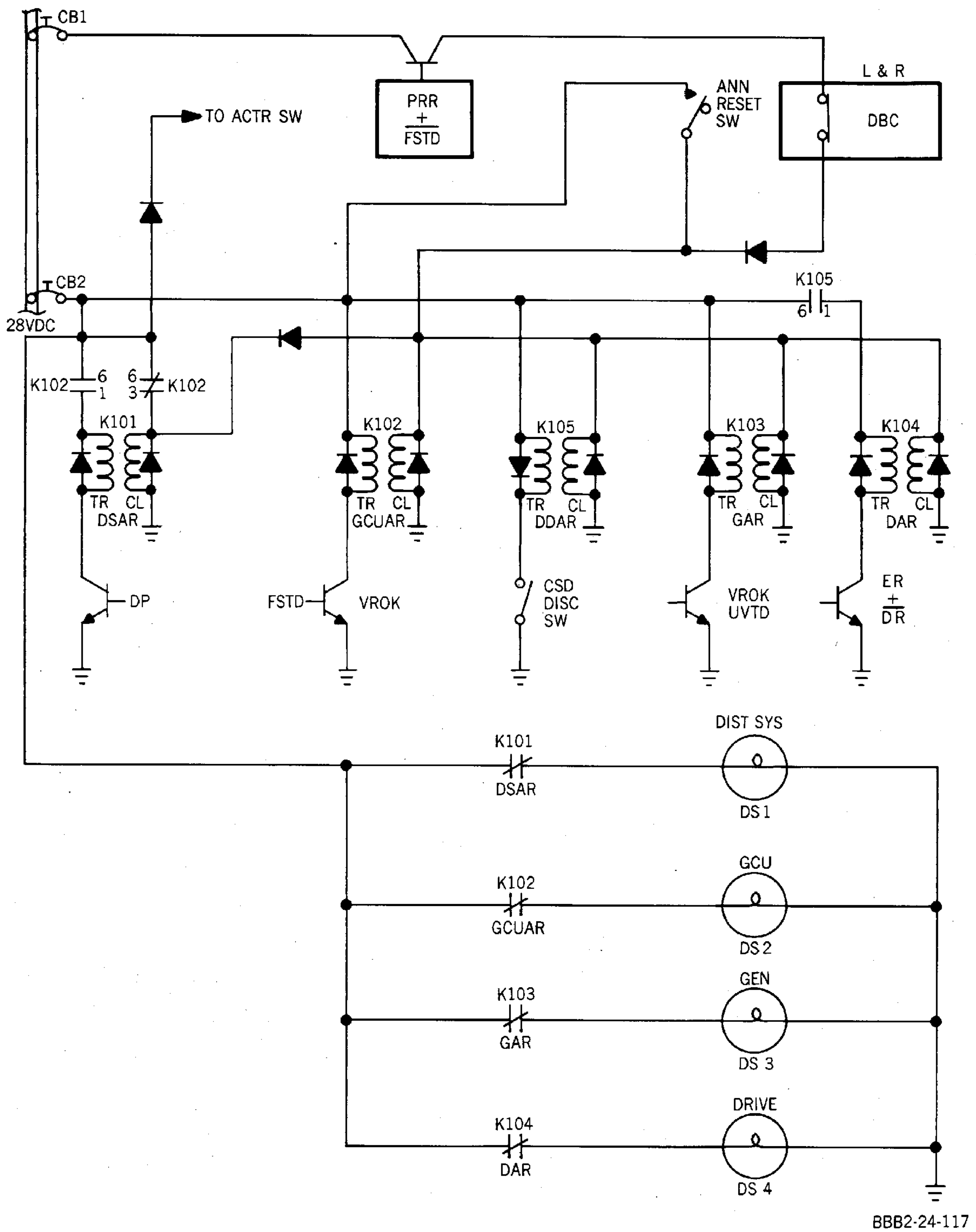
(a) The OV is energized (apparent OV fault exists) or the UVTD is energized (apparent UV fault exists) and the GAR is not tripped (generator PMG output normal).

(b) The generator control unit annunciator relay (GCUAR) is not tripped (no GC unit fault exists).

(4) The annunciation is removed if the GCAR trips (indicating GCU fault causing false OV or UV signal), if the system recovers (ARR energized), or if the annunciator is manually reset.

(5) Failure of GC unit annunciator circuits can either result in false annunciation or prevent annunciation in any component (area) indicator circuit. Therefore, periodic check-out of GC unit protective and annunciator circuits is recommended.

(6) The ac generator control unit annunciation is removed (GCUAR is reset) if the generator control switch is placed in reset position and the system recovers or if the annunciator is reset manually.



Maintenance Annunciator Operation -- Simplified Diagram
Figure 17/24-20-00-990-817

ANNUNCIATION	ANNUNCIATOR CONDITION	SIGNAL SOURCE	SYSTEM CONDITION	SOURCE OF FAULT
DRIVE (DAR)	1. Engine PMG signal and 2. DDR closed, and 3. No drive PMG signal	Engine tachometer generator N2 CSD disconnect switch CSD output speed sensor – deleted	Engine speed above 67 (–15) percent CSD disconnect not actuacted and	1. Normal indication with CSD output speed sensor deleted
GENERATOR (GAR)	1. Drive PMG signal, and 2. No PMG signal	CSD output speed sensor PMG–TR (GC unit)	CSD output speed above 3000 (+1000) RPM and PMG–TR output not above 5.0 vdc	1. AC generator 2. Generator PMG airplane wiring
AC GENERATOR CONTROL (GCAR)	1. DPTD energized, or 2. OVTD energized, or 3. UVTD energized, and 4. VROK deenergized	DP protection (GC unit) OV protection (GC unit) UV protection (GC unit) VR circuit (GC unit)	Apparent DP fault or Apparent overvoltage or Apparent undervoltage or Apparent VR circuit malfunction	1. AC generator control unit 2. AC generator 3. Bus fault
DISTRIBUTION SYSTEM (DSAR)	1. DP energized, and 2. GCAR not tripped	DP circuit (GC unit) GC unit failure annunciator	DP fault and GCR trips	1. Line to line, line to neutral, or three phase fault in generator output, feeders, or GR

CAG(IGDS) BBB2–24–131A

Summary of Maintenance Annunciator Operation
Figure 18/24-20-00-990-818

4. To Operate System

NOTE: Either the master caution lights or the master warning lights should come on at various points in the procedures. Lights should be reset immediately before proceeding with the next procedural step.

NOTE: The frequency meter does not have a zero indication marked on the scale. When a procedural step states that the frequency meter should indicate zero, the frequency meter pointer should be on the dot at the lower end of the scale.

NOTE: For applying external power or APU power to ac buses, refer to EXTERNAL POWER - TROUBLE SHOOTING, PAGEBLOCK 24-40-00/101, or AUXILIARY POWER UNIT AC GENERATOR - ADJUSTMENT/TEST, PAGEBLOCK 24-20-02/501 respectively.

A. Electrical Procedures - Starting Engine with External or APU Power Supplied to Buses

Table 1

Procedures		Indications
(1)	Check that BATT switch is in ON position.	(a) R GEN OFF light.........................ON
		(b) R CSD OIL..........................ON
		(c) L GEN OFF light.........................ON
		(d) L CSD OIL..........................ON
		(e) APU GEN OFF light........................OFF
		(f) EXT or APU PWR R BUS........................ON
		(g) EXT or APU PWR L BUS........................ON
(2)	Place AC VOLT/FREQ selector switch to R position.	(a) AC VOLTS should indicate zero.
		(b) FREQUENCY meter should indicate zero.
(3)	Check that AC BUS X TIE switch is in AUTO position.	There should be no changes.
(4)	Check that DC BUS X TIE switch is in OPEN position.	There should be no changes.
(5)	Check that L and R GEN RESET switches are in ON position.	There should be no changes.

Table 1 (Continued)

Procedures		Indications
(6)	Start right engine (GENERAL, SUBJECT 71-00-00, Page 501)	As engine comes up to operating rpm:
		(a) R GEN OFF light........................OFF
		(b) R CSD OIL.........................OFF
		(c) EXT or APU PWR R and L BUS......................OFF
		(d) AC VOLTS should stabilize at 115(±3) volts.
		(e) FREQUENCY meter should stabilize at 400(±4) Hz.
		(f) Right AC LOAD meter should indicate some load.
		(g) Right CSD oil temperature indicator should show increase in outlet temperature and stabilize in normal operating range (below yellow band) during engine operation.
NOTE: If indications (a), and (c) through (g) are not as noted, momentarily place GEN switch in RESET position then to ON position.		
(7)	Place AC VOLT/FREQ selector switch to L position.	(a) AC VOLTS should indicate zero.
		(b) FREQUENCY meter should indicate zero.
(8)	Start left engine (GENERAL, SUBJECT 71-00-00, Page 501)	(a) Corresponding indications (a) through (g) noted for right engine should be same for left engine.
		(b) If external power is connected to airplane, EXT PWR NOT IN USE light on external power control panel......................ON
		(c) If APU generator is used to supply power, APU GEN OFF light........................ON
(9)	Place external power or APU (as applicable) left and right bus switches in off position.	There should be no changes.
(10)	If external power is connected to airplane, shut down unit; disconnect.	(a) EXT PWR AVAIL light.......................OFF
		(b) EXT PWR NOT IN USE light......................OFF
(11)	Check that left and right air conditioning SUPPLY switches are in OFF position.	AC LOAD meters should show decrease in load if loads were using power.

Table 1 (Continued)

Procedures		Indications
CAUTION: IF AC LOAD METER INDICATES MORE THAN 1.25 CONTINUOUS LOAD, REDUCE LOADS TO PREVENT DAMAGE.		
(12)	Place L GEN switch in OFF position.	(a) L GEN OFF light.........................ON
		(b) Left AC LOAD meter should indicate zero.
		(c) Right AC LOAD meter indication should approximately double.
(13)	Place L GEN switch in ON position.	(a) L GEN OFF light........................OFF
		(b) Left AC LOAD meter should indicate some load.
		(c) Right AC LOAD meter indication should decrease.
(14)	Place R GEN switch in OFF position.	(a) R GEN OFF light.......................OFF
		(b) Right AC LOAD meter should indicate zero.
		(c) Left AC LOAD meter indication should approximately double.
(15)	Place R GEN switch in ON position.	(a) R GEN OFF light........................OFF
		(b) Right AC LOAD meter should indicate some load.
		(c) Left AC LOAD meter indication should decrease.
(16)	Place left and then after 10 seconds place right air conditioning SUPPLY switches, in desired position.	Both AC LOAD meters should show an increase if loads are turned on.
(17)	Place AC VOLT/FREQ selector switch in BATT VOLT position.	(a) If batteries are not charged fully, battery charger is operating in constant charging mode; DC AMPS meter indication should be steady and between 26 and 39 volts.
		(b) If batteries are fully charged, battery charger is operating in pulse charging mode; DC AMPS meter indication should vary due to battery charger pulses. Between pulses, indication should be approximately 30 volts.

Table 1 (Continued)

Procedures		Indications
(18)	Place AC VOLT/FREQ selector switch in BATT AMP position.	(a) If batteries are not fully charged, DC AMPS meter indication should be to left of zero, at approximately 65 amperes gradually reducing to 40 amperes.
		(b) If batteries are fully charged, DC AMPS meter indication should be pulsing to the left of zero with pulse interval ranging from 25 seconds to approximately 20 minutes. Between pulses, indication should be zero.
(19)	Place EMER PWR switch to ON position.	(a) EMER POWER IN USE light........................ON
		(b) DC AMPS meter should be to right of zero, between 10 and 35 amperes.
		(c) Indication on both left DC LOAD meters should decrease.
		(d) AC EMER BUS OFF light may flash on then off but should remain off.
(20)	Place AC VOLT/FREQ switch to BATT VOLT position.	DC AMPS meter should indicate not less than 26 volts.
(21)	Place EMER PWR switch to OFF position.	(a) EMER POWER IN USE light.......................OFF
		(b) Indication on both left DC LOAD meters should increase.
		(c) DC AMPS meter should indicate as noted in step (17).
(22)	Press CSD TEMP rise switch.	L and R CSD oil temperature indicators should indicate less than 11°C.
(23)	Release CSD TEMP rise switch.	L and R CSD oil temperature indicators should indicate normal outlet temperature.

B. Electrical Procedures - Starting Engine without External or APU Power Supplied to Buses

Table 2

Procedures		Indications
(1)	Check that left and right air conditioning SUPPLY switches are in OFF position.	There should be no changes.
(2)	Place AC BUS X TIE switch in OPEN position.	There should be no changes.
(3)	Place AC VOLT/FREQ switch to BATT VOLT position.	DC AMPS meter should indicate not less than 27 volts.

Table 2 (Continued)

Procedures		Indications
(4)	Place BATT switch in ON position.	(a) R AC BUS OFF light.........................ON
		(b) R GEN OFF light.........................ON
		(c) R CSD OIL light.......................OFF
		(d) L AC BUS OFF light.......................ON
		(e) L GEN OFF light.........................ON
		(f) L CSD OIL light.......................OFF
		(g) AC EMER BUS OFF light.........................ON
		(h) DC EMER BUS OFF light.........................ON
		(i) DC BUS OFF light.......................ON
		(j) DC TRANSFER BUS OFF light......................OFF
		(k) AC and DC LOAD meters should indicate zero.
(5)	Check that L and R GEN control switches are in ON position.	There should be no changes.
(6)	Place AC VOLT/FREQ selector switch to R position.	(a) AC VOLTS meter should indicate zero.
		(b) FREQUENCY meter should indicate zero.
		(c) DC AMPS meter should indicate zero.

Table 2 (Continued)

Procedures		Indications
(7)	Start right engine (GENERAL, SUBJECT 71-00-00, Page 501)	As engine comes up to operating rpm:
		(a) R AC BUS OFF light.......................OFF
		(b) R GEN OFF light.......................OFF
		(c) R CSD OIL light.......................OFF
		(d) AC EMER BUS OFF light.......................OFF
		(e) DC EMER BUS OFF light.......................OFF
		(f) AC VOLTS meter should stabilize at 115(±3) volts.
		(g) FREQUENCY meter should stabilize at 400(±4) Hz.
		(h) Right AC LOAD meter should indicate some load.
		(i) Both right DC LOAD meters should indicate some load.
		(j) DC AMPS meter should indicate 24 to 28 volts.
		(k) R CSD oil temperature indicator should show increase in outlet temperature and stabilize in normal operating range (below yellow band) during engine operation.
CAUTION: IF AC LOAD METER INDICATES MORE THAN 1.0 CONTINU OUS LOAD, REDUCE APPLICABLE LOADS TO PREVENT DAMAGE.		
(8)	Place AC BUS X TIE switch in AUTO position.	(a) L AC BUS OFF light.......................OFF
		(b) DC BUS OFF light......................OFF
		(c) L CSD OIL light........................ON
		(d) Right AC LOAD meter indication should approximately double.
		(e) Both left DC LOAD meters should indicate some load.

Table 2 (Continued)

Procedures		Indications
(9)	Place AC VOLT/FREQ selector switch to L position.	(a) AC VOLTS meter should indicate zero.
		(b) FREQUENCY meter should indicate zero.
		(c) DC AMPS meter should indicate 24 to 28 volts.
(10)	Start left engine (GENERAL, SUBJECT 71-00-00, Page 501)	(a) Corresponding indications noted for right engine should be same for left engine.
		(b) Right AC LOAD meter indication should decrease.
(11)	Place R GEN control switch in OFF position.	(a) R GEN OFF light........................ON
		(b) Right AC LOAD meter should indicate zero.
		(c) Left AC LOAD meter indication should approximately double.
(12)	Place R GEN control switch to ON position.	(a) R GEN OFF light.......................OFF
		(b) Right AC LOAD meter should indicate some load.
		(c) Left AC LOAD meter indication should decrease.
(13)	Place left and then after 10 seconds place right air conditioning SUPPLY switches in desired position.	Both AC LOAD meters should show an increase if loads are turned ON.
(14)	Place AC VOLT/FREQ selector switch to BATT VOLT position.	(a) If batteries are not fully charged, battery charger is operating in constant charging mode; DC AMPS meter indication should be steady and between 26 and 39 volts.
		(b) If batteries are fully charged, battery charger is operating in pulse charging mode; DC AMPS meter indication should vary due to battery charger pulses. Between pulses, indication should be approximately 30 volts.
(15)	Place AC VOLT/FREQ selector switch to BATT AMP position.	(a) If batteries are not fully charged, DC AMPS meter indication should be to left of zero, at approximately 65 amperes gradually reducing to 40 amperes.
		(b) If batteries are fully charged, DC AMPS meter indication should be pulsing to the left of zero with pulse interval ranging from 25 seconds to approximately 20 minutes. Between pulses, indication should be zero.

Table 2 (Continued)

Procedures		Indications
(16)	Place EMER PWR switch to ON position.	(a) EMER POWER IN USE light.......................ON
		(b) DC AMPS meter should be to right of zero, between 10 and 35 amperes.
		(c) Indication on both left DC LOAD meters should decrease.
		(d) AC EMER BUS OFF light may flash on then off but should remain off.
(17)	Place AC VOLT/FREQ selector switch to BATT VOLT position.	DC AMPS meter should indicate not less than 26 volts.
(18)	Place EMER PWR switch to OFF position.	(a) EMER POWER IN USE light.......................OFF
		(b) Indication on both left DC LOAD meters should increase.
		(c) DC AMPS meter should indicate as noted in step (14).
(19)	Press CSD TEMP rise switch.	L and R CSD oil temperature indicators should indicate less than 11°C.
(20)	Release CSD TEMP rise switch.	L and R CSD oil temperature indicators should indicate normal outlet temperature.

C. Electrical Procedures - Engine Shutdown with External or APU Power Available to Ac Buses

Table 3

Procedures		Indications
(1)	With external or APU power available	(a) Applicable power available light(s)..................ON
		(b) If external power is connected to airplane, EXT PWR NOT IN USE light......................ON
		(c) If APU power is available, APU GEN OFF light.......................ON
(2)	Place AC VOLT/FREQ selector switch to EXT PWR or APU (voltage/ frequency) position as applicable.	(a) AC VOLTS meter should indicate 115(±3) volts.
		(b) FREQUENCY meter should indicate 400(±4) Hz.
(3)	Place external or APU power (as applicable) left and right bus switches in ON position.	There should be no changes.

Table 3 (Continued)

Procedures		Indications
(4)	Shut down left engine. (GENERAL, SUBJECT 71-00-00, Page 501)	(a) L GEN OFF light.......................ON
		(b) Left EXT or APU PWR AVAIL light.............ON
		(c) L CSD OIL light........................ON
		(d) Left AC LOAD meter should indicate zero.
		(e) L CSD oil temperature indicator should slowly go to zero.
		(f) If external power is connected to airplane, EXT PWR NOT IS USE light......................OFF
		(g) If APU power is being used, APU GEN OFF light.....................OFF
(5)	Shut down right engine. (GENERAL, SUBJECT 71-00-00, Page 501)	Corresponding indications, (a) through (e), noted for left engine will be same for right engine.

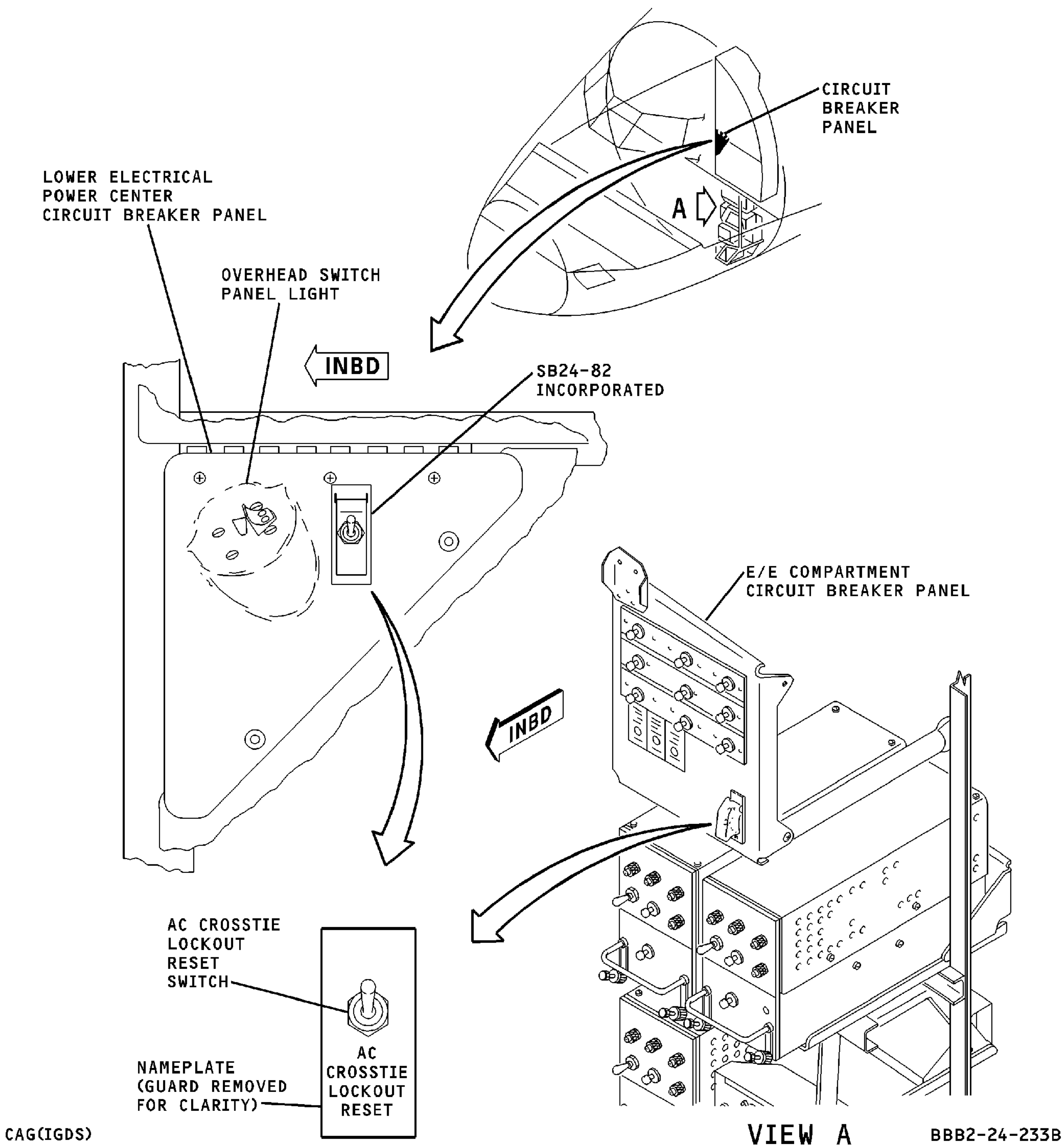
D. Electrical Procedures - Engine Shutdown without External or APU Power Available

Table 4

Procedures		Indications
(1)	Place AC BUS X TIE switch to OPEN position.	There should be no changes.
(2)	Shut down left engine. (GENERAL, SUBJECT 71-00-00, Page 501)	(a) DC BUS OFF light........................ON
		(b) L AC BUS OFF light........................ON
		(c) L GEN OFF light........................ON
		(d) L CSD OIL light......................OFF
		(e) Left AC LOAD meter should indicate zero.
		(f) Both left DC LOAD meters should indicate zero.
		(g) L CSD oil temperature indicator should slowly go to zero.
(3)	Shut down right engine. (GENERAL, SUBJECT 71-00-00, Page 501)	(a) Corresponding indications, (b) through (g), noted for left engine will be same for right engine.
		(b) AC EMER BUS OFF light.......................ON
		(c) DC EMER BUS OFF light......................ON

Table 4 (Continued)

Procedures		Indications
(4)	Place BATT switch to OFF position.	(a) All lights...........OFF
		(b) All indicators should cease operation.



AC Crosstie Lockout Reset Switch -- Location
Figure 19/24-20-00-990-819

AC GENERATION - TROUBLE SHOOTING

1. General

A. Trouble shooting the ac generation system is considerably modified and simplified in comparison with the task normally encountered in trouble shooting other modern airplane ac systems. A built-in maintenance annunciator readily identifies the fault location and permits immediate corrective action.

Although the maintenance annunciator will indicate the proper corrective action in most instances, maintenance personnel must be prepared to diagnose system malfunction conditions when required.

B. In the cases where initial maintenance annunciation is not provided or is not correct, an understanding of annunciator operation and limitations will facilitate rapid secondary trouble shooting procedures. Valuable information concerning system conditions before, during, and subsequent to a system malfunction is provided by the ac voltage and frequency meters; indicating lights located on the overhead switch panel, and the annunciator panel.

C. Trouble shooting procedures are based on the existence of a single system fault. In most cases, when more than one unrelated fault exists, the procedure will isolate one fault. A check of system operation will then indicate symptoms for further trouble shooting.

D. As an alternate to detailed trouble shooting procedures, Westinghouse Ac Generation System Test Set may be used to check out all circuits and components.

E. The system test set has the capability of performing functional tests on all major electrical components and checking most critical airplane circuits. The test set is intended primarily for use on external power, but may also be used to check dynamic (engine running) operating conditions of the generator (including rectifiers), regulator, and system control and sensing circuits. Rapid trouble shooting may be accomplished by utilizing abbreviated portions of the functional test procedure, as applicable, or by use of the test set system mounting capabilities. Test and trouble isolation procedures are provided with the test set.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 101

Name and Number	Manufacturer
Multimeter Model 2000A	Dana
AC Generator System Test Set 976J267-2 or 976J267-3 Airplane Adapter No. 909C477-1	Westinghouse

3. Trouble Shooting Ac Generation System

A. Preliminary Procedure

CAUTION: TO AVOID DAMAGE TO COMPONENTS AND CONNECTORS, SHUT DOWN ENGINES; PLACE APU AND EXTERNAL POWER SWITCHES TO OFF POSITION, AND OPEN AC AND DC BUS CROSSTIE AND GENERATION CONTROL CIRCUIT BREAKERS BEFORE DISCONNECTING OR RECONNECTING COMPONENTS.

ALSO AVOID VOLTAGE MEASUREMENTS AND USE OF METER PROBES ON CONNECTORS.

(1) Check all available reports and records pertaining to malfunction and conditions observed.

(2) Check and record indications on maintenance annunciator panel. Also observe indications on overhead annunciator panel and switch settings on overhead switch panel.

(3) Check availability of 28-volt control power and check that all applicable circuit breakers on electrical power center (EPC) and on components are closed. If any breakers have tripped, check related electrical control circuit and power relay wiring for shorts or ground.

4. Trouble Shooting

A. GENERATOR HAS TRIPPED OFF OR WILL NOT CONNECT TO BUS. PLACING GENERATOR CONTROL SWITCH TO RESET, THEN TO ON POSITION HAS NO EFFECT. LEFT OR RIGHT GENERATOR OFF LIGHT IS ON; OR (APU GENERATOR) APU GENERATOR OFF LIGHT IS ON WITH APU GENERATOR RESET SWITCH IN NORMAL POSITION. LEFT OR RIGHT AC BUS OFF LIGHT IS ON. MAINTENANCE ANNUNCIATOR INDICATES FAULT.

Table 102

Step	Possible Causes	Isolation Procedure	Correction
(1)	ACTR lockout, Bus fault on (L or R) Bus	Maintenance annunciator indicates generator control unit. Check for bus fault. (Paragraph 5.C.)	If fault exists in wiring, repair. If fault exists in generator relay (LAPR or RAPR for APU), replace.
(2)	ACTR lockout, DP fault in generator windings, feeders, or generator relay (power relay for APU)	Maintenance annunciator indicates distribution system. Check for DP fault. (Paragraph 5.B.)	If fault exists in feeders or DP wiring, repair or reroute. If fault exists in generator or associated power relay, replace.
(3)	ACTR lockout, DISTR SYS annunciator on, GCU failure	Maintenance annunciator indicates generator control unit.	If there is no DP fault, replace GCU.
(4)	No ACTR lockout, Drive failure	Maintenance annunciator indicates drive.	Replace CSD.
(5)	No ACTR lockout, generator drive shaft, PMG, or airplane wiring	Maintenance annunciator indicates generator. Check PMG and wiring. (Paragraph 5.D.)	Replace generator or repair wiring as indicated by check.
(6)	No ACTR lockout, generator excitation or associated wiring failure	Check excitation circuits. (Paragraph 5.E.)	If fault exists in excitation circuits, repair. If not, replace generator.
(7)	Generator control unit failure	Maintenance annunciator indicates generator control unit. Check inputs and circuit breakers on generator control unit.	Replace generator control unit.

B. GENERATOR HAS TRIPPED OFF OR WILL NOT CONNECT TO BUS. PLACING GENERATOR CONTROL SWITCH TO RESET, THEN TO ON POSITION HAS NO EFFECT. LEFT OR RIGHT GENERATOR OFF LIGHT IS ON; OR (APU GENERATOR) APU GENERATOR OFF LIGHT IS ON WITH APU GENERATOR RESET SWITCH IN NORMAL POSITION. LEFT OR RIGHT AC BUS OFF LIGHT IS ON. MAINTENANCE ANNUNCIATOR DOES NOT INDICATE FAULT.

Table 103

Step	Possible Causes	Isolation Procedure	Correction
(1)	(L or R system) CSD transmission governor adjustment or drive failure	AC frequency is below normal or at zero. Check governor adjustment. (GENERATOR DRIVE - ADJUSTMENT/TEST, PAGEBLOCK 24-10-00/501)	Adjust governor to limits or replace CSD.
(2)	(APU system), APU failure	AC frequency is below normal or at zero. Check APU operation. (GENERAL, SUBJECT 49-00-00, Page 501)	Adjust APU output speed or replace APU.
(3)	AC frequency normal. Phase sequence fault.	Check for phase sequence fault. (Paragraph 5.F.)	Repair wiring.
(4)	AC frequency normal. GCU failure.		If no phase sequence fault, replace GCU.
(5)	(L or R system) generator fire shutoff switch close circuit fault	Check for closed or shorted generator fire shutoff switch. (EXTINGUISHING SYSTEM - TROUBLE SHOOTING, PAGEBLOCK 26-20-00/101)	Replace generator fire shut off switch (left or right).
(5)	AC frequency normal. Generator relay (power relay for APU) close circuit fault.	Check generator power relay close circuit. (Paragraph 5.G.)	If fault exists in wiring, repair. If in BCU, generator, or power relay, replace.
(6)	AC frequency normal. Generator fire shut-off switch close circuit fault (left or right)	Check for closed or shorted generator fire shutoff switch. (EXTINGUISHING SYSTEM - TROUBLE SHOOTING, PAGEBLOCK 26-20-00/101)	Replace generator fire shutoff switch (left or right).

WARNING: NORMAL ELECTRICAL POWER SUPPLY TO VARIOUS SYSTEMS WILL BE INTERRUPTED WHEN GROUND CONTROL RELAY CIRCUIT BREAKERS ARE OPENED. MAKE CERTAIN THAT SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITIONS TO PREVENT INADVERTENT OPERATION OR SHUTDOWN OF EQUIPMENT.

WARNING: TO VERIFY FAULT, SHUT DOWN ENGINES. PLACE EXT PWR AVAIL L AND R BUS SWITCHES TO OFF POSITION. PLACE BATT SWITCH IN ON POSITION AND START APU. PLACE APU R BUS SWITCH TO ON POSITION AND L BUS SWITCH TO OFF. OPEN RIGHT GROUND CONTROL RELAY CIRCUIT BREAKER, LOCATED ON UPPER EPC CIRCUIT BREAKER PANEL. OBSERVE INDICATIONS AND FOLLOW INDICATED ISOLATION PROCEDURE.

C. AC CROSSTIE LOCKOUT LIGHT OFF (HOLDOFF)

Table 104

Step	Possible Causes	Isolation Procedure	Correction
NOTE: An ac crosstie lockout reset switch permits maintenance personnel to manually reset the ac crosstie relay in the event of a nuisance crosstie lockout during ground operation without engine shutdown. The switch is located on the generator control rack circuit breaker panel in the EE compartment, or upper electrical power center circuit breaker panel (SB 24-82 incorporated) in the flight compartment.			
(1)	28VDC present at ACTR terminal CLP (pos); ACTR fault	Verify ACTR terminal CLG (neg) is properly grounded.	If wiring fault exists, repair. If relay defective, replace.

Table 104 (Continued)

Step	Possible Causes	Isolation Procedure	Correction
(2)	28VDC present at ACTR terminal CLP (pos); BCU fault	Check high resistance between ACTR-TRG (ground) terminal and aircraft ground.	If continuity exists, replace BCU.
(3)	No 28VDC at ACTR terminal CLP (pos); no DC power source from GCU	Remove BCU connections and verify 28VDC at BCU connector J1 pin m.	If wiring fault exists, repair.
(4)	No 28VDC at ACTR terminal CLP (pos); ground control relay circuit shorted.	Check for zero DC voltage at BCU connector J1 pin J. If voltage is present, check circuit. (Paragraph 5.J.)	If wiring fault exists, repair. If relay defective, replace.
(5)	No 28VDC at ACTR terminal CLP (pos); "1 of 3" circuit fault	Check ACTR "1 of 3" circuit. (Paragraph 5.H.)	If wiring fault exists, repair. If GCU defective, replace.
(6)	No 28VDC at ACTR terminal CLP (pos); holdoff circuit fault	Check for zero VDC at BCU connector J1 pins G, F, H.	If voltage is present, replace GCU associated with pin.
(7)	No 28VDC at ACTR terminal CLP (pos); ACTR close circuit (airplane wiring)	Check continuity from BCU connector J1 pin r to ACTR terminal CLP (pos).	If wiring fault exists, repair.
(8)	No 28VDC at ACTR terminal CLP (pos); BCU fault	With BCU installed, momentarily place AC CROSSTIE LOCKOUT RESET in RESET position.	If voltage still not present at ACTR terminal CLP (pos), replace BCU.
(9)	R or L AC BUS OFF; lights off	None.	Normal ACTR operation.

D. AC CROSSTIE RELAY (ACTR) WILL NOT OPEN NORMALLY

Table 105

Step	Possible Causes	Isolation Procedure	Correction
(1)	Ground control relay circuit	With external power applied to one ac bus and then to the other, check for 28 vdc at bus control unit connector J1-J. If no voltage, check relay circuit.	If fault exists in wiring, repair; if in relay, replace.
(2)	Airplane wiring to ACTR	Check for 28 volts dc at ACTR terminal TRP (pos).	If there is no voltage, check and repair wiring.
(3)	ACTR, or airplane wiring, or bus control unit	Check for dc voltage at ACTR terminal TRG (neg). If voltage is present, open both circuit breakers on all 3 generator control units. Disconnect both connectors from BC units. Check continuity from connector J1-J to right ground control relay terminal C1, J2-R to ACTR terminal TRG (neg), and J2-C to ground.	If there is zero VDC, replace ACTR. If voltage is present and all continuity is acceptable, replace bus control unit. If only airplane circuit wiring is open, check and repair as necessary.

E. LEFT AC BUS LIGHT ON. AC CROSSTIE LOCKOUT LIGHT ON AND CANNOT BE RESET WITH AC CROSSTIE LOCKOUT RESET SWITCH.

Table 106

Step	Possible Causes	Isolation Procedure	Correction
(1)	Bus fault on L or R Bus	Maintenance annunciator indicates fault. Check for bus fault. (Paragraph 5.C.)	If fault exists in wiring, re pair. If fault exists in generator relay (LAPR or RAPR for APU), replace relay.
(2)	Power relay lockout circuit faulted	Maintenance annunciator does not indicate fault. Check power relay circuit connected to BCU terminals J1-A and J1-K. (Paragraph 5.I.)	If wiring fault exists, repair. If power relay defective, replace.
(3)	GCU failure	Maintenance annunciator does not indicate fault. Disconnect GC units one at a time. After disconnecting each GCU, momentarily place AC CROSSTIE LOCKOUT RESET switch in RESET position.	Replace GCU which turns off AC CROSSTIE LOCKOUT light.
NOTE: APU GCU must be installed to close ACTR.			

F. MAINTENANCE ANNUNCIATOR INDICATES DRIVE WITH NO APPARENT DRIVE MALFUNCTION; AC FREQUENCY IS NORMAL

Table 107

Step	Possible Causes	Isolation Procedure	Correction
(1)	CSD output speed sensor, airplane wiring, or annunciator circuit (GC unit)	Check CSD output speed sensor circuit. (Paragraph 5.K.)	If CSD output speed sensor fault exists, replace CSD. If airplane wiring is faulty, repair. If wiring is acceptable, replace ac generator control unit.

G. MAINTENANCE ANNUNCIATOR INDICATES GENERATOR, AC GENERATOR CONTROL UNIT, OR DISTRIBUTION SYSTEM WITH NO MALFUNCTION REPORTED OR EVIDENT. AC FREQUENCY IS NORMAL.

Table 108

Step	Possible Causes	Isolation Procedure	Correction
(1)	Various GCU circuits	None required	Replace ac generator control unit.

H. MAINTENANCE ANNUNCIATOR FAILS TO INDICATE DRIVE FAILURE; AC FREQUENCY BELOW NORMAL

Table 109

Step	Possible Causes	Isolation Procedure	Correction
(1)	Engine rpm too low	Increase N2 rpm above 10,000.	None; normal condition
(2)	Drive output 3,000 to 5,700 rpm	None	None; normal condition
(3)	Engine tachometer generator N1, airplane wiring, or annunciator circuit (GC unit)	Check engine tachometer generator N1 Check wiring to CSD disconnect switch. (Paragraph 5.L.)	If engine tachometer generator N1 is faulty, replace. If airplane wiring is faulty, repair. If wiring is accept able, replace ac generator control unit.

I. MAINTENANCE ANNUNCIATOR FAILS TO INDICATE ON, UV, DP FAULT CONDITIONS, GENERATOR PMG FAILURE, OR DRIVE ANNUNCIATION.

Table 110

Step	Possible Causes	Isolation Procedure	Correction
(1)	Various GC unit circuits	None required	Replace ac generator control unit.

5. **Fault Isolation Check Procedures**

A. General

(1) The following procedures supplement the general trouble shooting procedures of Paragraph 4.. The procedures may also be used to check specific circuits.

B. Check for DP Fault Condition (Generator System Trips Off Bus, and Maintenance Annunciator Indicates DISTR SYS)

(1) Power circuit fault (generator winding, feeder or power relay).

(a) Inspect feeders at all accessible locations for signs of rubbing or burning.

(b) Disconnect neutral leads from generator terminals T4, T5, and T6.

(c) With ohmmeter set to high scale, check continuity from T4 to T5, T4 to T6, T5 to T6, and from each terminal to ground. If continuity is indicated on any part of check, a fault exists.

1) Disconnect feeder leads from generator terminals T1, T2, and T3 and repeat (1) (c). If fault is in generator, replace.

2) If fault is not in generator, disconnect feeder leads from power relay terminals T1, T2, and T3 (both power relays of APU system). Check both ways to isolate fault.

(2) If no fault is found in power circuit, check DP sensing circuit.

CAUTION: HIGH VOLTAGE COULD EXIST ON DPCT TERMINALS.

(a) Inspect all connections at generator neutral leads (3 DPCT's) and in aft EPC (3 DPCT's for main system, 6 for APU system) for open circuit or mis-wiring (crossed leads).

(b) Remove all power from both ac buses and check dc resistance across terminals of one load side DPCT (aft EPC) in each phase. Resistance should be 12 to 20 ohms for left or right system or 8 to 15 ohms for APU system. If resistance is incorrect, disconnect leads and check each DPCT and wiring for fault. The resistance of each DPCT should be 25 to 35 ohms.

NOTE: The DPCT resistance will be different for Part Numbers as follows:

P/N 905D888-1 S/N 0001 thru 15846 is 25 to 35 ohms.

P/N 905D888-1 S/N 15847 and above is 15 to 25 ohms.

P/N 9002D14-1 S/N is 12 to 25 ohms.

(c) APU System only: If no fault is found in check (2) (b), apply external power to left ac bus. Check ac voltage across left bus load side DPCT terminals.

(d) If any voltage exists, replace bus control unit. If no voltage exists, check resistance across DPCT terminals. If resistance is not zero, replace bus control unit. Repeat check on right ac bus.

(3) If no fault is found in checks (1) and (2), and maintenance annunciator has indicated DISTR SYS, replace generator control unit. Reconnect and secure all generator and DPCT leads.

C. Check for Bus Fault Outside DP Zone (Generator System Trips Off Bus, Maintenance Annunciator Indicates GCU, and ACTR locks out)

(1) Left and right systems only.

(a) Visually check all 3-phase bus wiring from ACTR terminals to LEPR, LAPR, REPR, and RAPR terminals and to generator load side DPCT's for shorts or grounds.

(b) With engines shut down and all APU and external power switches placed in off position, using ohmmeter set to high scale, check continuity from ACTR terminals T1 to T2, T1 to T3, T2 to T3 (for left system), L1 to L2, L1 to L3, L2 to L3 (for right system), and all terminals to ground (for either system). If continuity is indicated in any part of check, a fault exists; disconnect bus leads as required to isolate fault.

(2) Left, right, and APU systems. (Figure 101, Figure 102 and Figure 103)

(a) Check for reports or evidence of faults in heavy motors or other load equipment. Combination of load fault and failure of protective load thermal circuit breaker to open will appear as a bus fault.

D. Check Generator PMG Circuit (Generator Trips Off Bus and Maintenance Annunciator Indicates GEN or DISTR SYS)

(1) With engine shut down, remove generator control unit.

(a) Check resistance between connector terminals A5 and A6 of generator control unit. Resistance should not exceed 3 ohms.

(b) Remove connector from generator and check resistance from generator terminals C to D. Resistance should not exceed 1.0 ohm.

(c) Check from generator terminals C to ground. Resistance should be a minimum of 1.0 megohm.

(d) If check (b) reads high or (c) reads low, replace generator. If check (a) reads high and check (b) and (c) is acceptable, check aircraft wiring for open circuit.

(e) If checks (a) through (c) are acceptable, check from generator system connector terminal C to D and from both terminals to ground (ac generator control unit disconnected). If any resistance is less than 1.0 megohm, check aircraft wiring for short or ground.

E. Check Generator Excitation Circuit (Generator Trips Off Bus Due to Low Voltage Condition, Maintenance Annunciator Indicates GCU, No ACTR Lockout Occurs, and GCU Replacement Did Not Correct Problem.)

(1) With generator shut down, remove GCU.

(a) Check for 12 to 18 ohms resistance between terminals A12 and A13 of GCU system connector.

(b) Check for minimum resistance of 1.0 megohm from terminal A13 to ground.

(c) If check (a) and (b) are both acceptable, replace GCU; if not acceptable, remove connector from generator and repeat resistance check on generator terminals F to A and A to ground.

(d) If checks are acceptable, check airplane wiring for open, short, or ground. If no fault exists in wiring, replace generator.

F. Check for Phase Sequence (PS) Fault (Engine (or APU) Running, Generator Voltage and Frequency Normal. No Maintenance Annunciator Indication. With APU and External Power Bus Switches in Off Position and Ac Bus Crosstie Switch in Open Position, Ac Bus Off and Generator Off Lights Stay On. APU Only, Power Available and Power-in-Use Lights Off.)

(1) Shut down engines and APU; visually check 3-phase feeder connections at generator and power relay terminals T1, T2, and T3 for open or crossed phases.

(2) Check generator neutral leads from terminals T4, T5, and T6 to ground.

(3) Check generator control unit sensing lead connections to power relay terminals T1, T2, and T3 for open or cross leads.

(4) With engines shut down, check for 0-ohm to 1-ohm maximum resistance from power relay terminals T1 to T2 to T3 to ground.

(5) If any fault found, repair as necessary. If no fault found, replace generator control unit.

G. Check Aircraft Power Relay Close Circuit (Engine (or APU) Running, Generator Voltage and Frequency Normal. No Maintenance Annunciator Indication. With APU and External Power Bus Switches in Off Position, and Ac Bus Crosstie Switch in Open Position; Ac Bus Off and Generator Off Lights Stay On. APU Only Power Available Light On, and APU Power-in-Use Light Off.)

(1) Left or right system only

(a) Shut down engines; place APU and external power bus switches in off position. Place ac bus crosstie switch in open position.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(b) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT

(c) Remove left or right GC unit as applicable for left or right system check.

(d) Place jumper between left or right GCU connector pin A10 and pin A7.

(e) Remove the safety tags and close these circuit breakers:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT

(f) Verify power relay is closed by checking for no continuity between power relay terminal 5CM and ground. If no continuity is present (power relay closed), replace left or right GC unit as applicable.

(g) If continuity is present (power relay open), check for O VDC at power relay terminal CLG (ground). If voltage is present, repair ground wire.

(h) If no voltage is present, verify 28VDC at the following locations:

Table 111

Left System	Right System
Terminal CLP of power relay	Terminal CLP of power relay
Terminal 1NC of LEPR	Terminal 1NC of REPR
Terminal 1CM of LEPR	Terminal 1CM of REPR
Terminal 1NC of LAPR	Terminal 1NC of RAPR
Terminal 1CM of LAPR	Terminal 1CM of RAPR
Terminal 1NC of ACTR	Terminal 3NC of ACTR
Terminal 1CM of ACTR	Terminal 3CM of ACTR

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(i) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT

(j) Remove GCU connector jumper.

(k) Reinstall G.C.U. and B.C.U.

(2) APU system only

(a) Shut down engines and APU. Place APU bus switch (left or right as applicable) in on position, and external power bus switches in off position. Place ac bus crosstie switch in open position.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(b) Open this circuit breaker and install safety tag:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU

(c) Remove APU generator control unit.

(d) Remove the safety tag and close this circuit breaker:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU

Place jumpers between APU GCU connector pins A10, B12, and A7.

(e) Verify left or right power relay is closed by checking for continuity between left or right power relay terminals 5CM and ground. If continuity does exist (power relay closed) replace APU GCU.

(f) If continuity does not exist, check for zero volts DC at left or right power relay CLG (ground) terminal. If voltage is present, repair power relay ground wire.

(g) If no voltage is present, check for 28VDC at left or right power relay CLP (pos) terminal. If voltage is present, replace left or right power relay.

(h) If no voltage is present, check for 28VDC at left or right #1 auxiliary power control relay terminal C1. If voltage is present, repair wiring.

(i) If no voltage is present, check for 28VDC at left or right #1 auxiliary power control relay terminal C2. If no voltage is present, go to step (n).

(j) If voltage is present, disconnect left or right GCU and check for 28VDC at left or right GCU connector pin B6. If voltage is present replace left or right GCU.

(k) If no voltage is present, check for 28VDC at left or right #1 APCR terminal X2. If voltage is present, repair wiring.

(l) If no voltage is present, check for 28VDC at left or right #1 APCR terminal X1. If voltage is present, replace left or right #1 APCR.

(m) If no voltage is present, check for 28VDC at APU L (or R) BUS switch terminal 3. If voltage is present, repair wiring.

(n) If no voltage is present, check for 28VDC at APU L (or R) BUS switch terminal 2. If voltage is present, repair wiring between APU BUS switch and APU GCU connector pin B12.

(o) Check for 28VDC at left or right EPR terminal 3NC. If voltage is present, repair wiring.

(p) If no voltage is present, check for 28VDC at left or right EPR terminal 3CM. If voltage is present, replace left or right EPR.

(q) If no voltage is present, check for 28VDC at left or right generator relay terminal 1NC. If voltage is present, repair wiring.

(r) If no voltage is present, check for 28VDC at left or right generator relay terminal 1CM. If voltage is present, replace left or right generator relay.

(s) If no voltage is present, disconnect BCU and check for 28VDC at BCU J2 connector pin T for left system or pin J for right system. If voltage is present, check continuity between BCU J2 connector pin S for left system or pin H for right system and left or right GR terminal 1CM. If continuity does exist, replace BCU. If no continuity, repair wiring.

(t) If no voltage is present, check for 28VDC at ACTR terminal 4NC. If voltage is present, repair wiring.

(u) If no voltage is present, check for 28VDC at ACTR terminal 4CM. If voltage is present, replace ACTR.

(v) If no voltage is present, repair wiring between APU GCU pin A7 and ACTR.

CAUTION: MAKE CERTAIN THAT TEMPORARY JUMPERS BETWEEN APU AND GCU CONNECTOR PINS HAVE BEEN REMOVED.

(w) Open this circuit breaker and install safety tag:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU

Remove jumpers from APU GCU.

(x) Install GCU and BCU.

H. Check Ac Crosstie "1 of 3" Circuit. (No Maintenance Annunciator Indication.)

(1) With all power removed from the ac bus, remove bus control unit. Using ohmmeter scale of R X 1000, check resistance between pin J2-C and J1-E of the BCU, with the positive ohm-meter probe on pin J1-E. If the meter indicates an open circuit or short circuit, replace the bus control unit.

NOTE: If the negative ohmmeter probe is placed on pin J1-E, a high resistance (open) circuit will be indicated.

(2) If bus control unit acceptable, remove each generator control unit and check for 1800 to 2200 ohms between pins B28 and B24. Check for no continuity from pin B28 to pin B29. If resistance is out of limits, replace generator control unit.

I. Power Relay Lockout Circuit (ACTR Locked Out. No Maintenance Annunciator Indication.)

(1) With all generator, external power, and APU bus switches in the off position, use ohmmeter set to high scale and check for no continuity between terminals 4NO and 4CM of the LGR and RGR. Use positive ohmmeter probe on terminal 4NO in each check.

NOTE: If negative ohmmeter probe is placed on terminal 4NO, a defective APR may not be indicated due to action of a blocking diode.

(2) If there is continuity on either side, check (L or R) GR, (L or R) APR and (L or R) EPR terminals 4NO to 4CM with wire(s) removed from one terminal on relay being checked. If there is no continuity, replace wire(s). If there is continuity, replace relay.

(3) To check for shorted blocking diode, place positive ohmmeter probe on LEPR terminal 4NO and negative ohmmeter probe on REPR terminal 4CM. There should be continuity (low resistance on the meter). Reverse the probe positions and there should be no continuity (high resistance on the meter). If these conditions are not met, replace the diode.

J. Ground Control Circuit (ACTR Locked Out. No Maintenance Annunciator Indication.)

(1) Place APU and external power bus switches in off position, and open generator control circuit breakers left, right, and APU (located on lower EPC circuit breaker panel). Check for no continuity at the following points:

(a) LEPCR -- terminal A1 to A2

(b) REPCR -- terminal A1 to A2

(c) LAPCR No. 2 -- terminal B1 to B2

(d) RAPCR No. 2 -- terminal B1 to B2

(e) Left ground control relay (R2-5) -- terminal D1 to D2

(f) Right ground control relay (R2-8) -- terminal C1 to C2.

(2) If continuity exists at any relay, remove wire(s) from one terminal and recheck relay to determine defective relay. Replace defective relay.

K. CSD Output Speed Sensor Circuit. (Maintenance Annunciator Indicates Drive Fault. Ac Frequency Normal.)

(1) With engine shut down, disconnect the CSD main electrical connector. Do the check of the speed sensor as follows:

(a) For speed sensor (P/N 69867A), use an ohmmeter to check for 110 to 150 ohms on system connector pin A to B . If low or zero, remove generator control panel and check resistance from pin B10 to pin B2 for 110 to 150 ohms. If low or zero, replace generator control panel. If acceptable, check aircraft wiring for short.

(b) For speed sensor (P/N 705291), use an ohmmeter to check for 34 to 51 ohms on system connector pin A to B. If low or zero, remove generator control panel and check resistance from pin B10 to pin B2 for 34 to 51 ohms. If low or zero, replace generator control panel. If acceptable, check aircraft wiring for short.

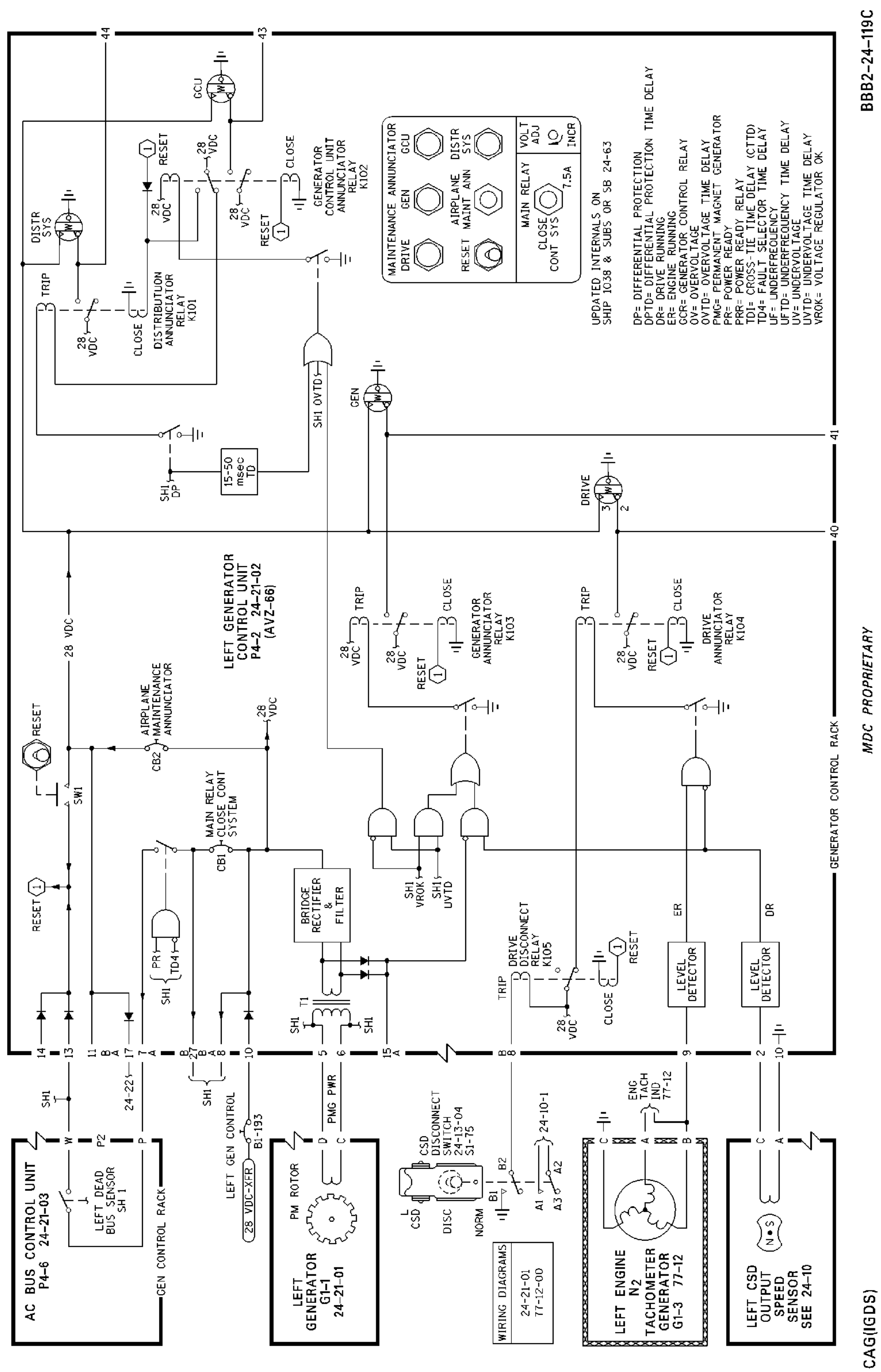
(2) Remove appropriate GCU connector and check continuity between CSD main electrical connector pin A and GCU connector pin B10 and between CSD connector pin C and GCU connector pin B2. If continuity is present, replace GCU.

L. Engine Tachometer Generator N2 Circuit (Maintenance Annunciator Fails to Indicate Drive Failure.)

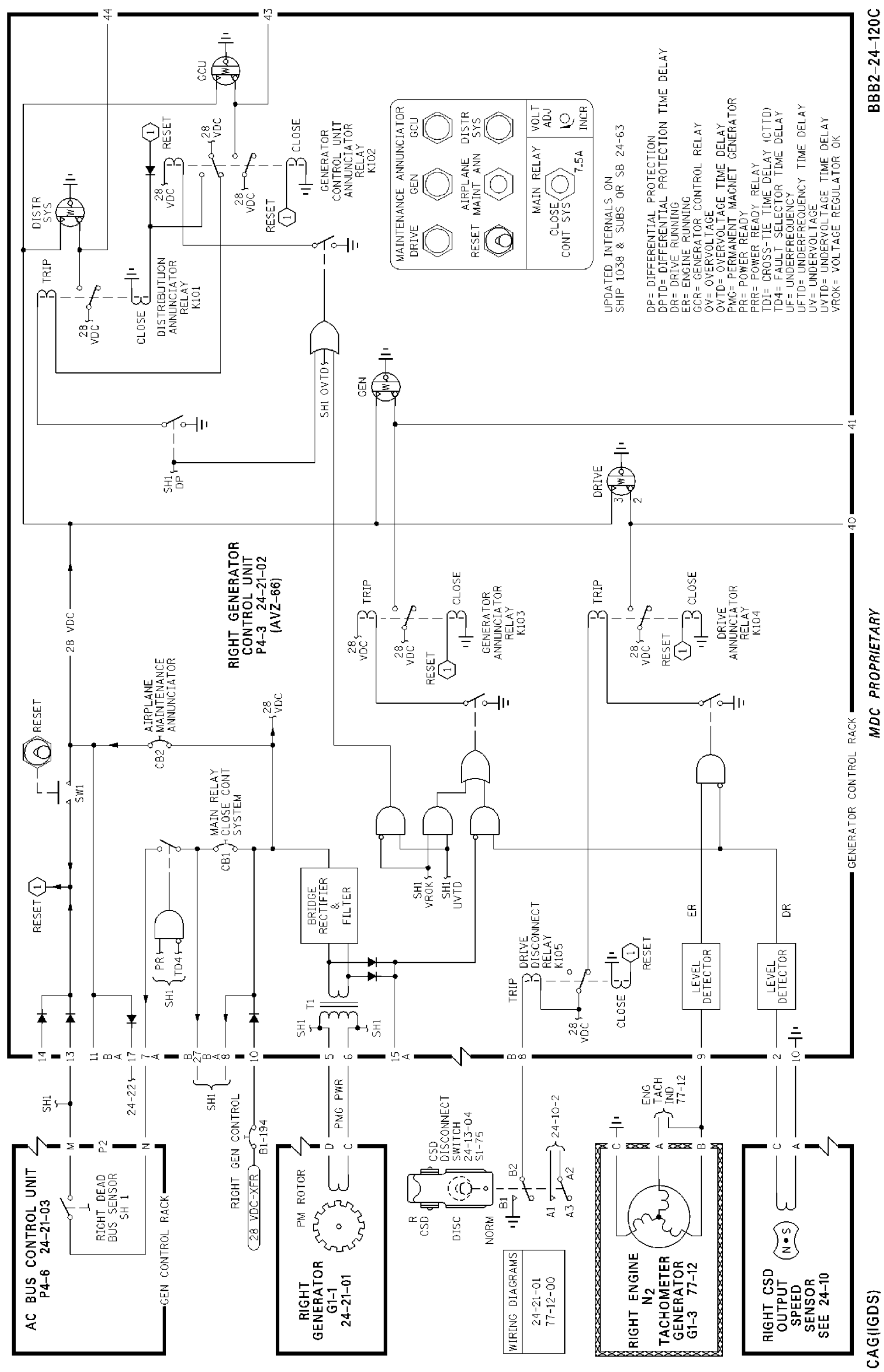
(1) Remove generator control unit and check continuity between GCU aircraft connector pin B9 and engine tachometer generator. If continuity does not exist, repair wiring.

(2) Check engine tachometer generator (N_2).

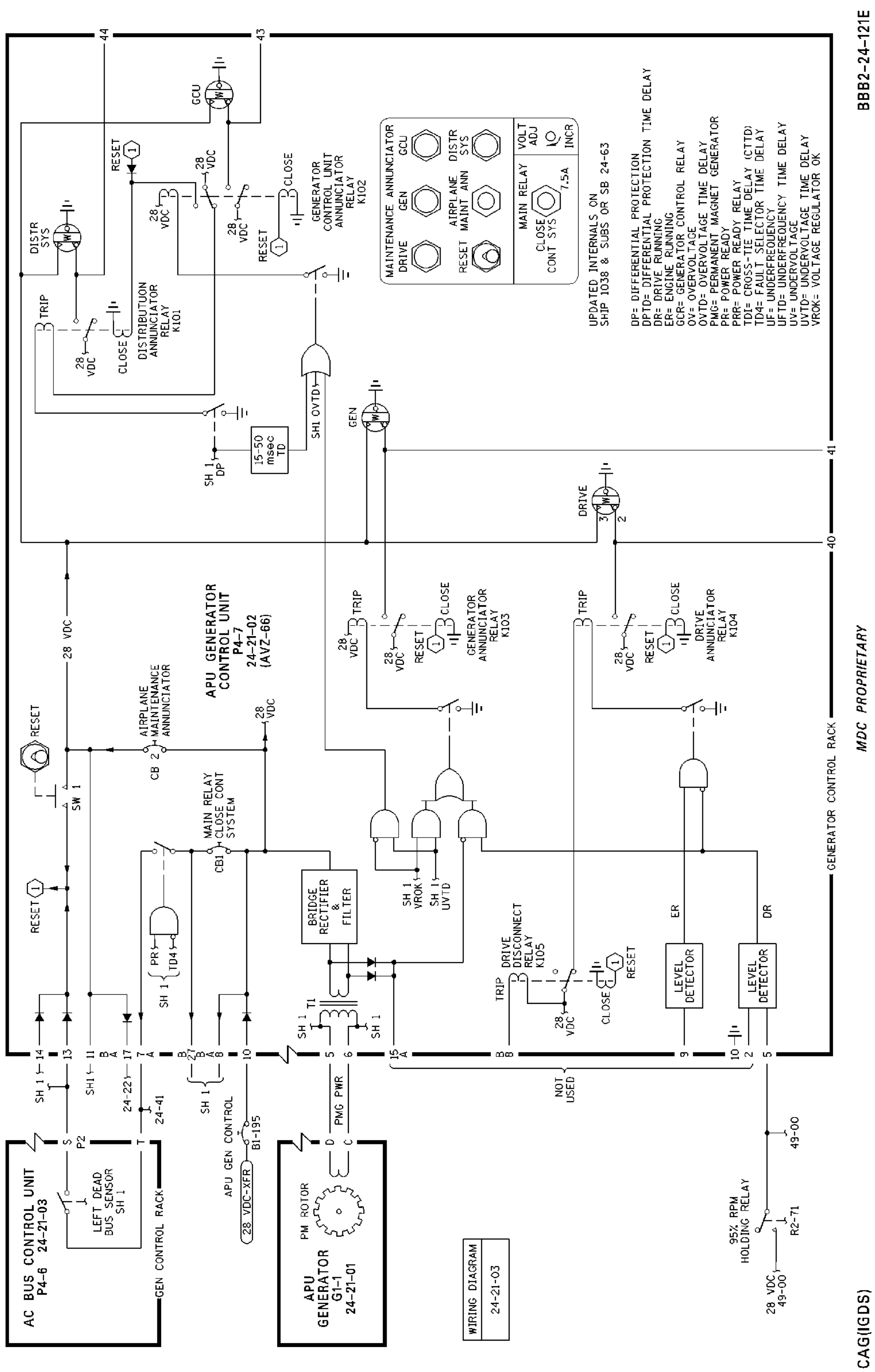
(3) If wiring and engine tachometer generator (N_2) checks good, replace GCU.



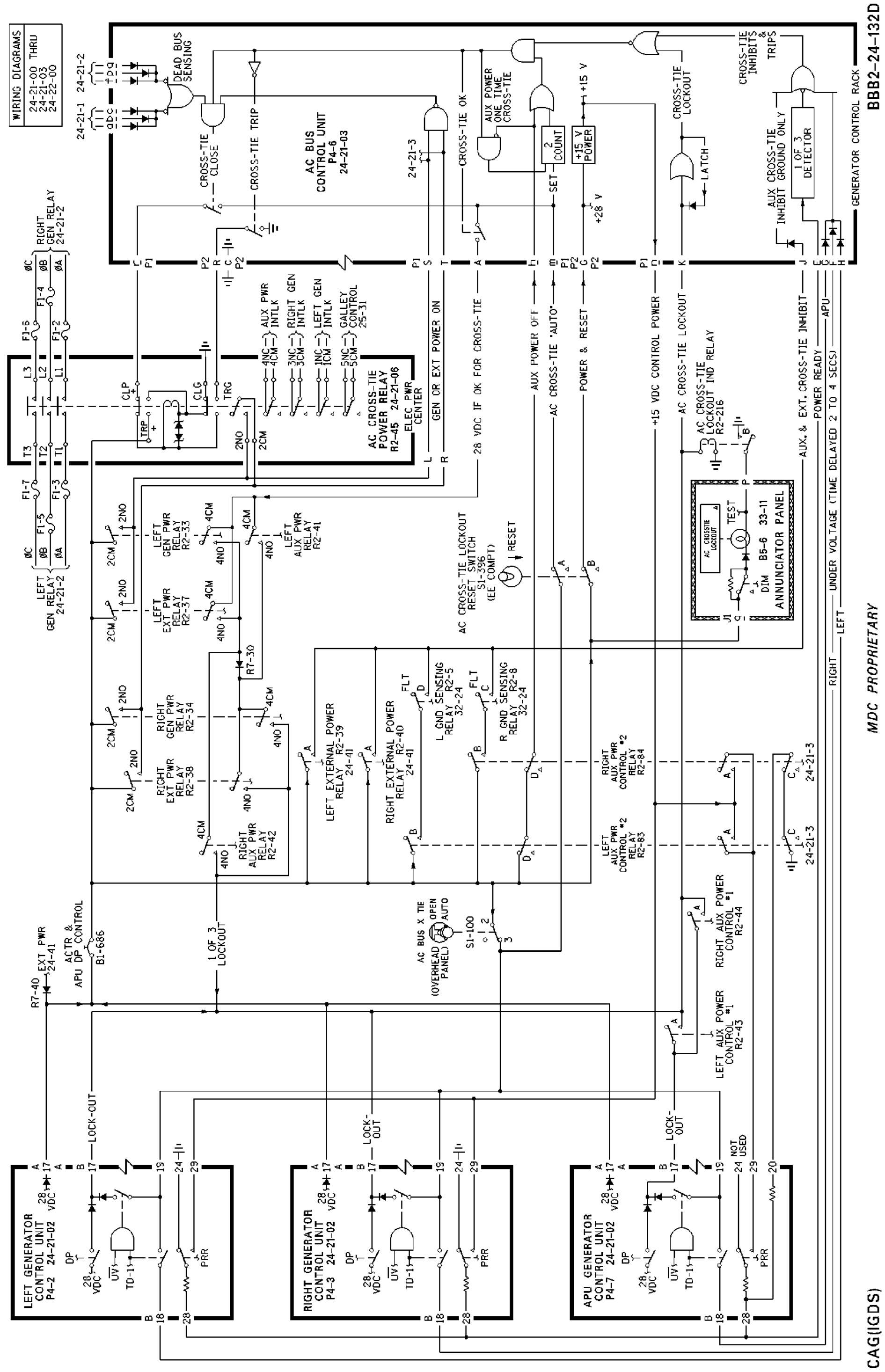
Left Generation and Control -- Schematic
Figure 101/24-20-00-990-820



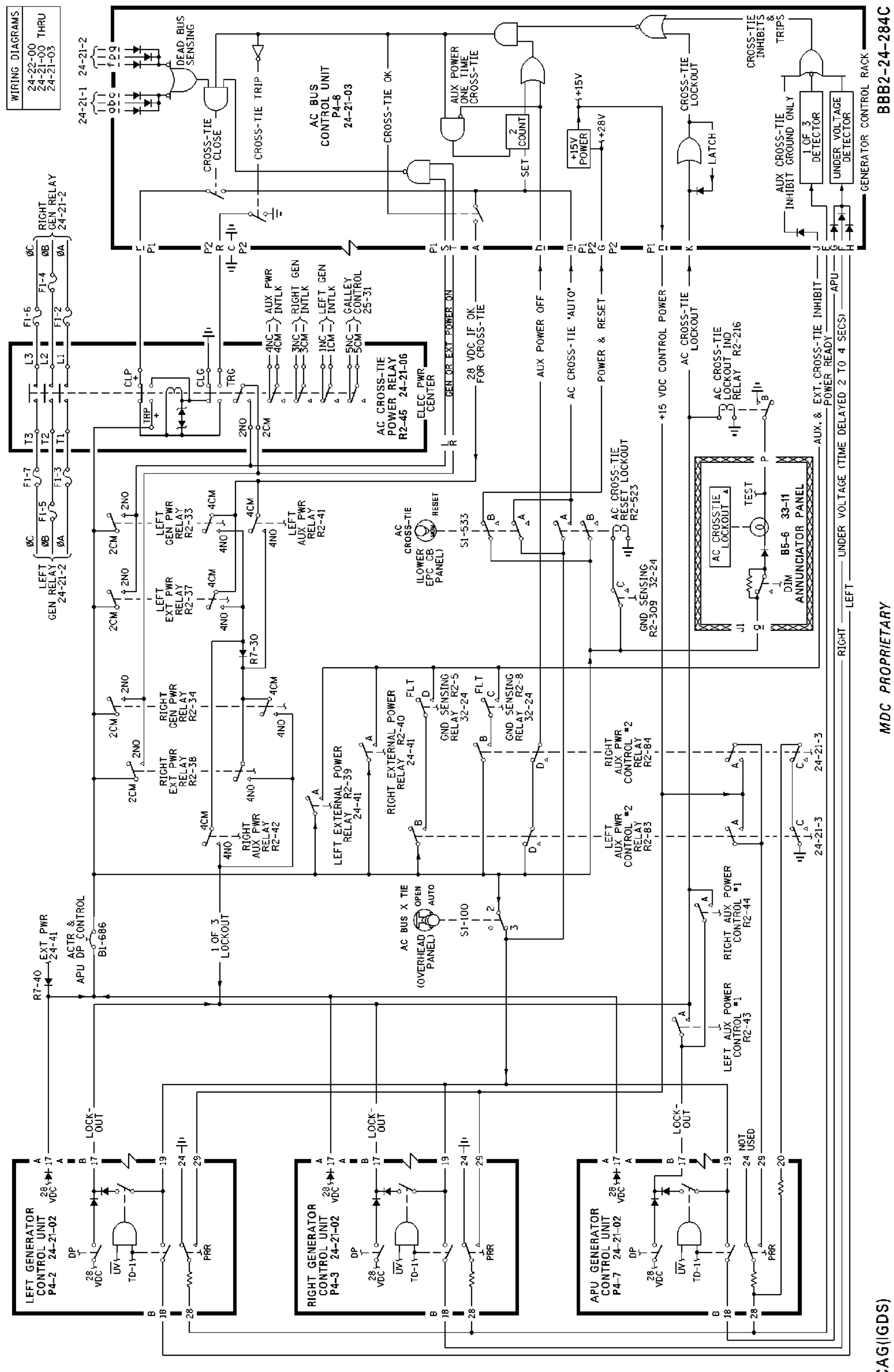
Right Generation and Control -- Schematic
Figure 102/24-20-00-990-821



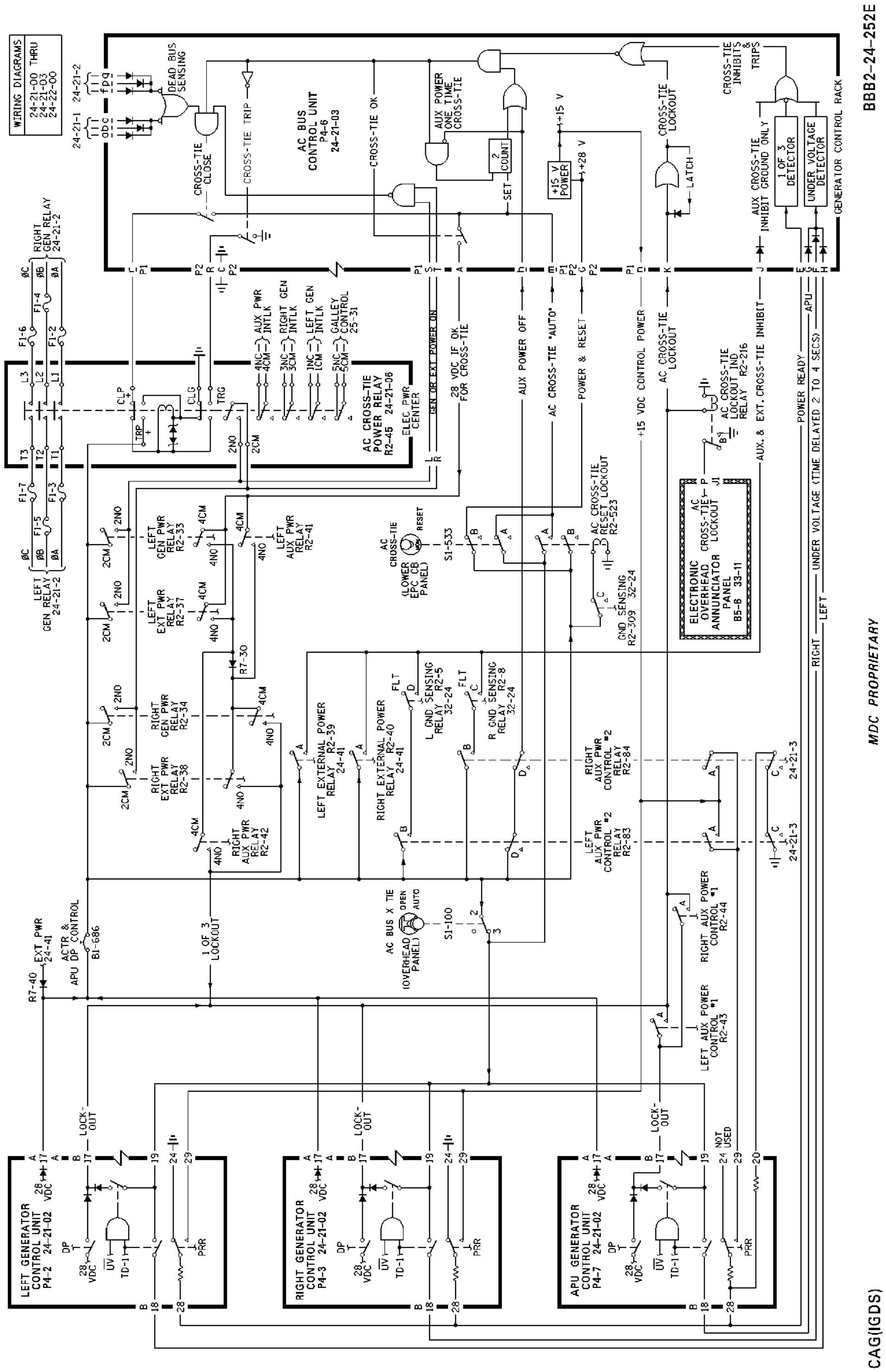
APU Generation and Control -- Schematic
Figure 103/24-20-00-990-822



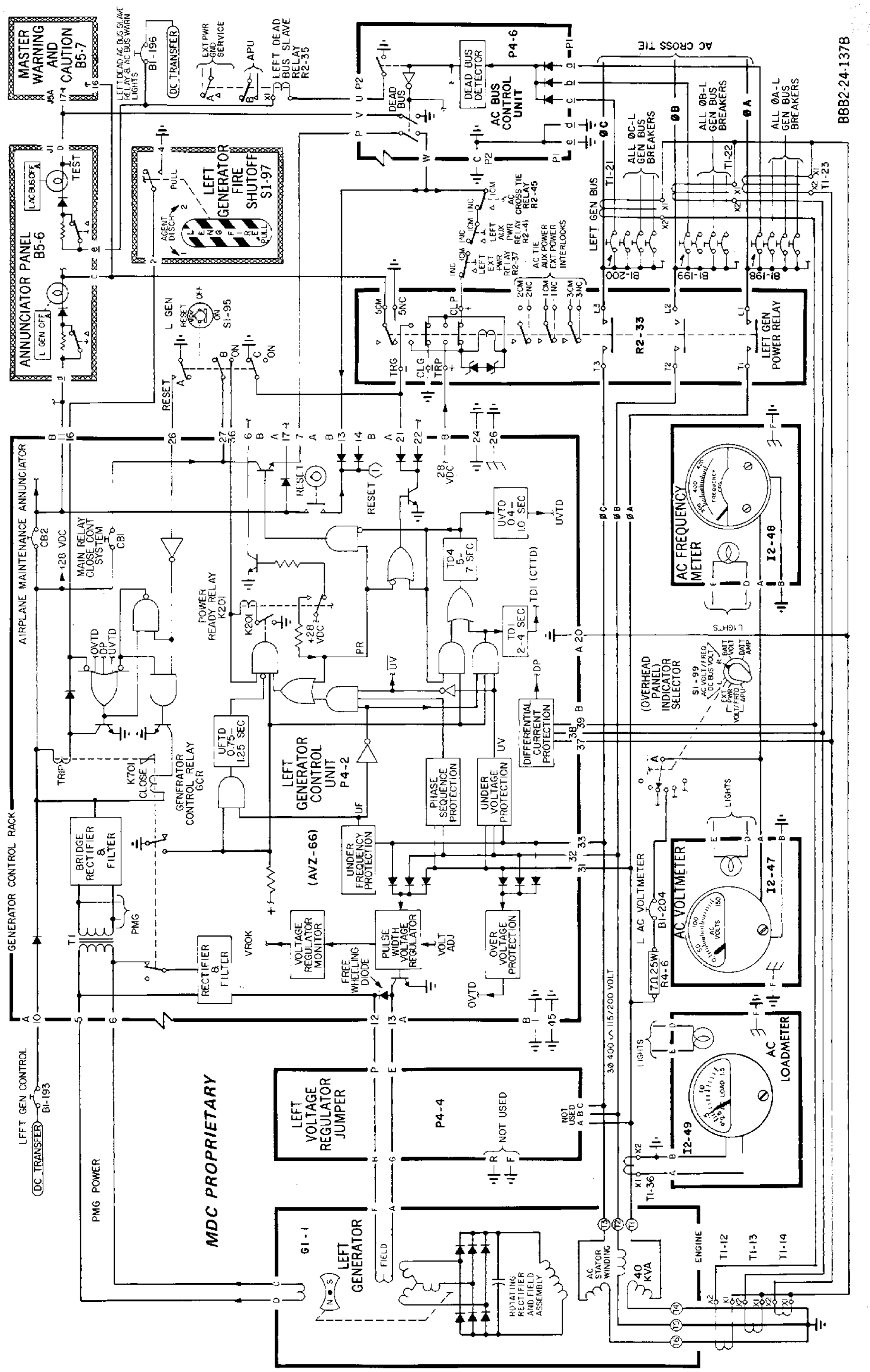
AC Crosstie -- Schematic
Figure 104/24-20-00-990-823 (Sheet 1 of 3)



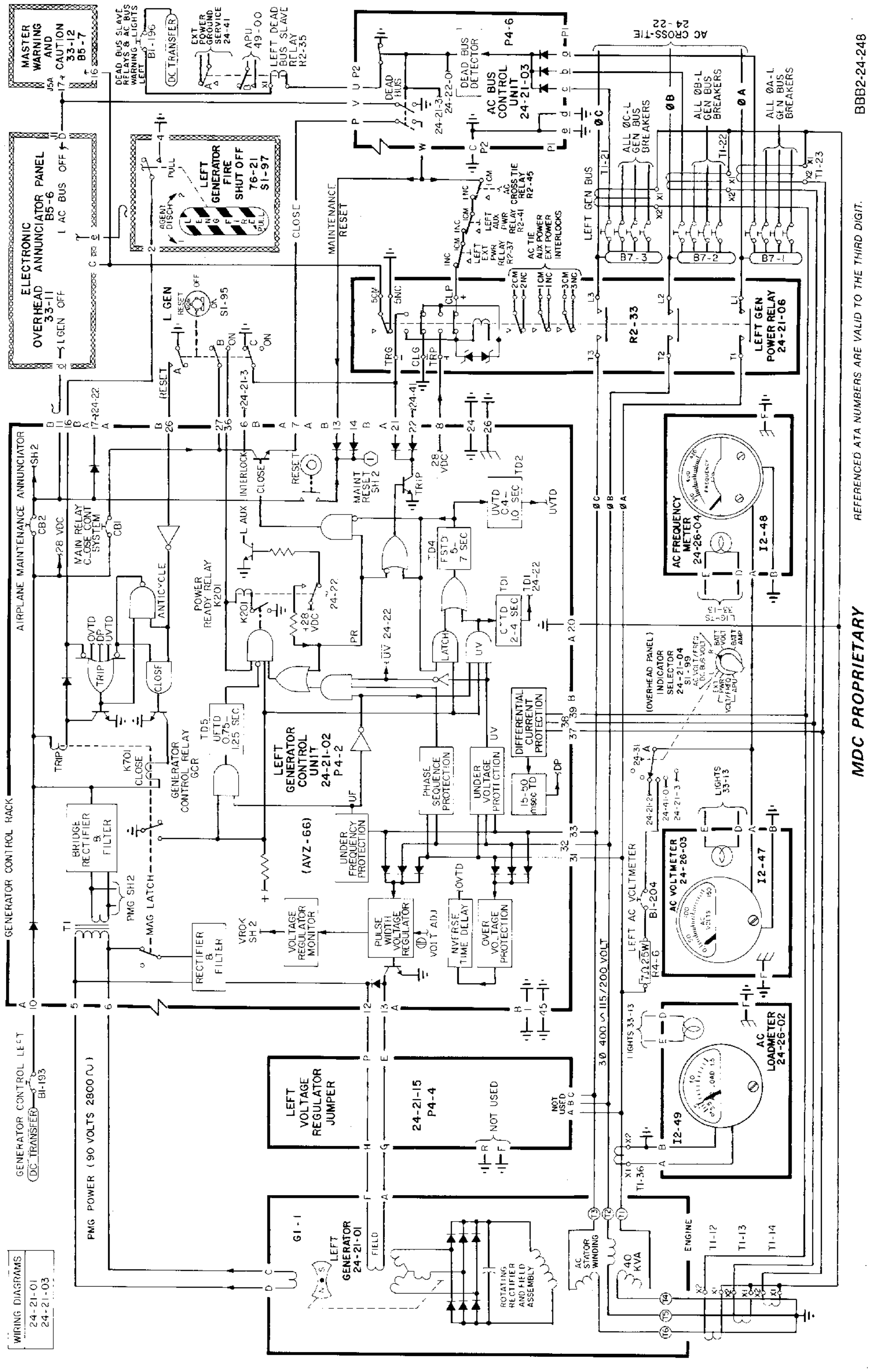
AC Crosstie -- Schematic
Figure 104/24-20-00-990-823 (Sheet 2 of 3)



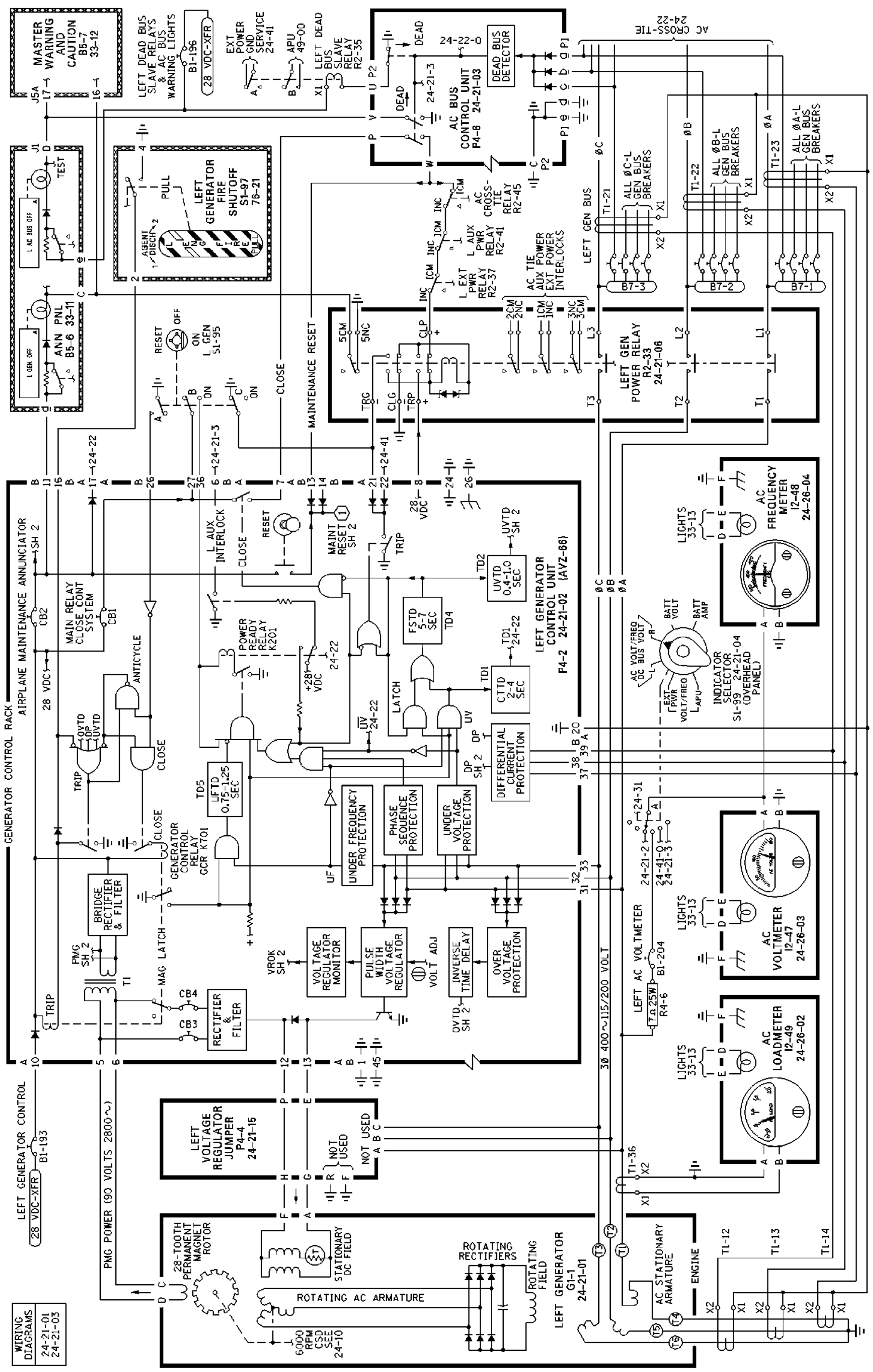
AC Crosstie -- Schematic
Figure 104/24-20-00-990-823 (Sheet 3 of 3)



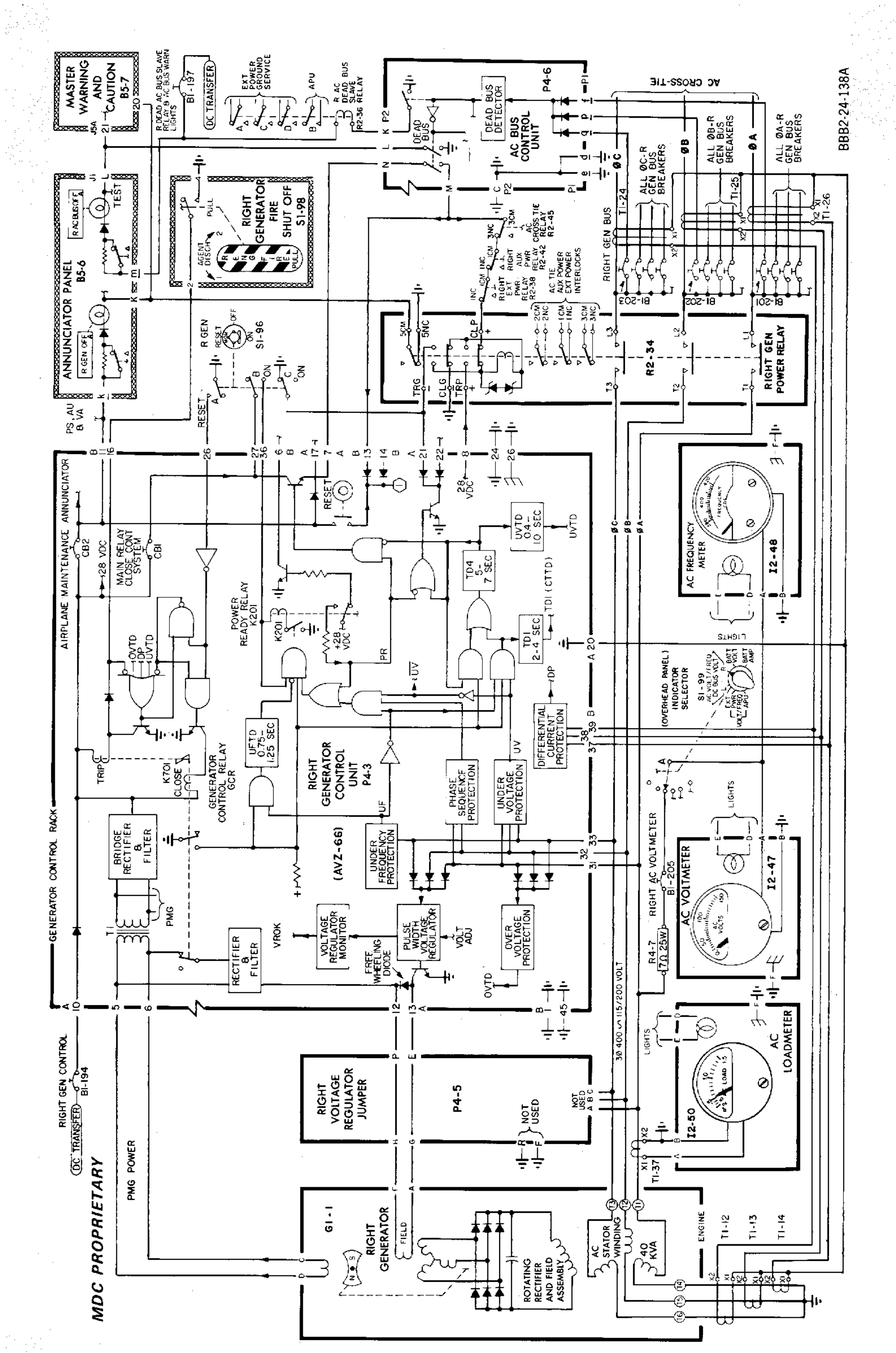
Left Generation and Control -- Schematic
Figure 105/24-20-00-990-824 (Sheet 1 of 3)



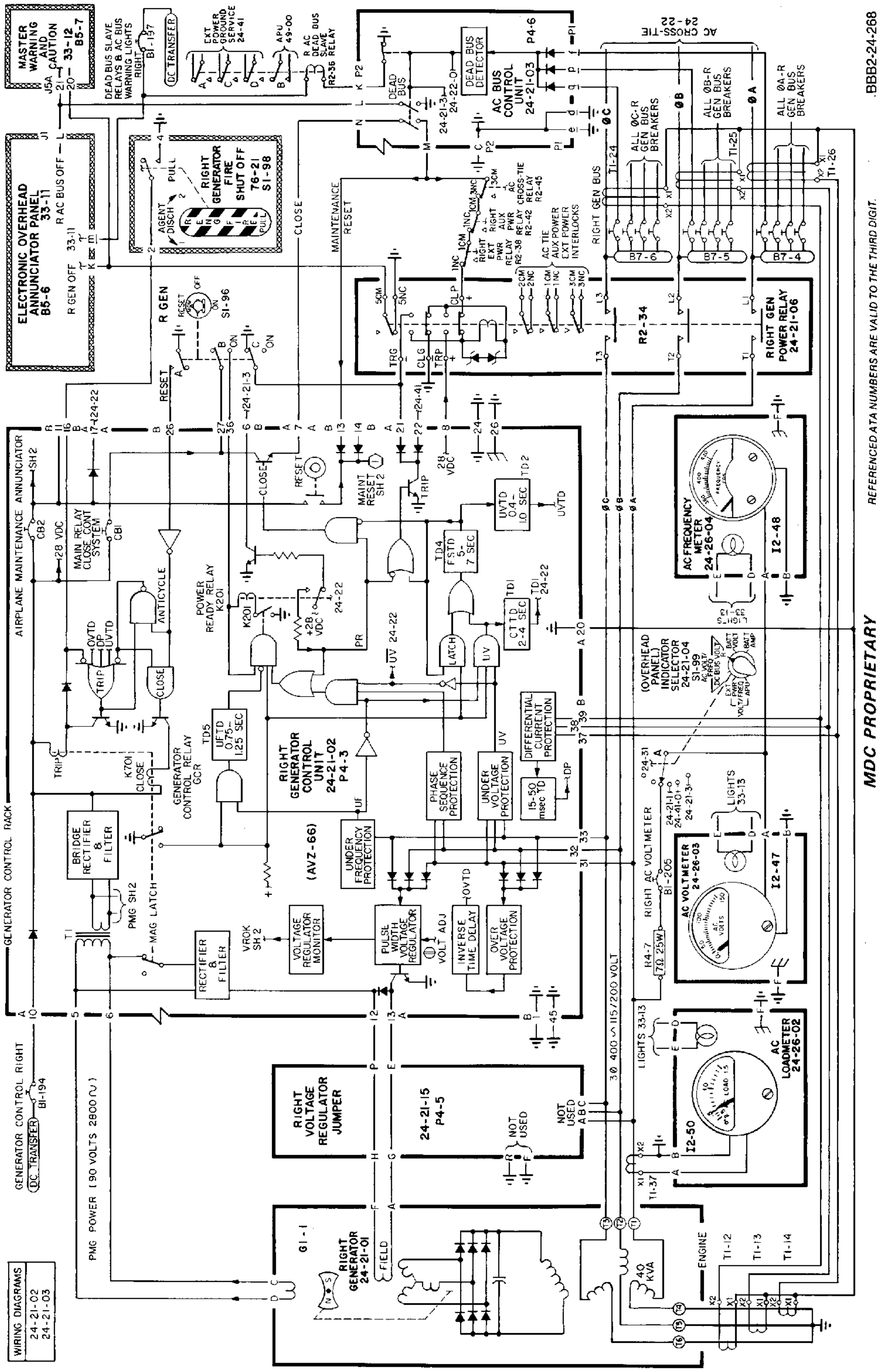
Left Generation and Control -- Schematic
Figure 105/24-20-00-990-824 (Sheet 2 of 3)



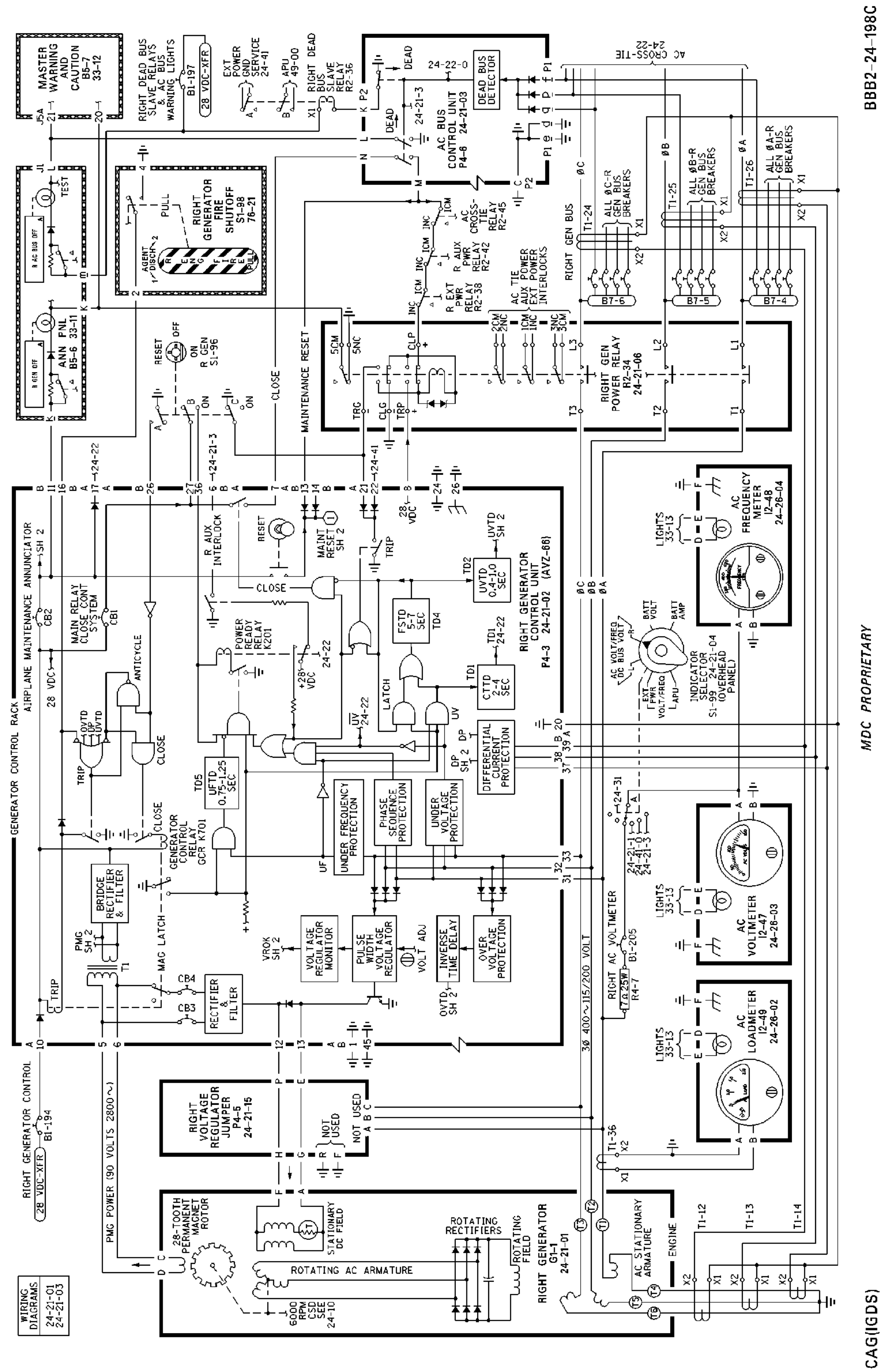
Left Generation and Control -- Schematic
Figure 105/24-20-00-990-824 (Sheet 3 of 3)



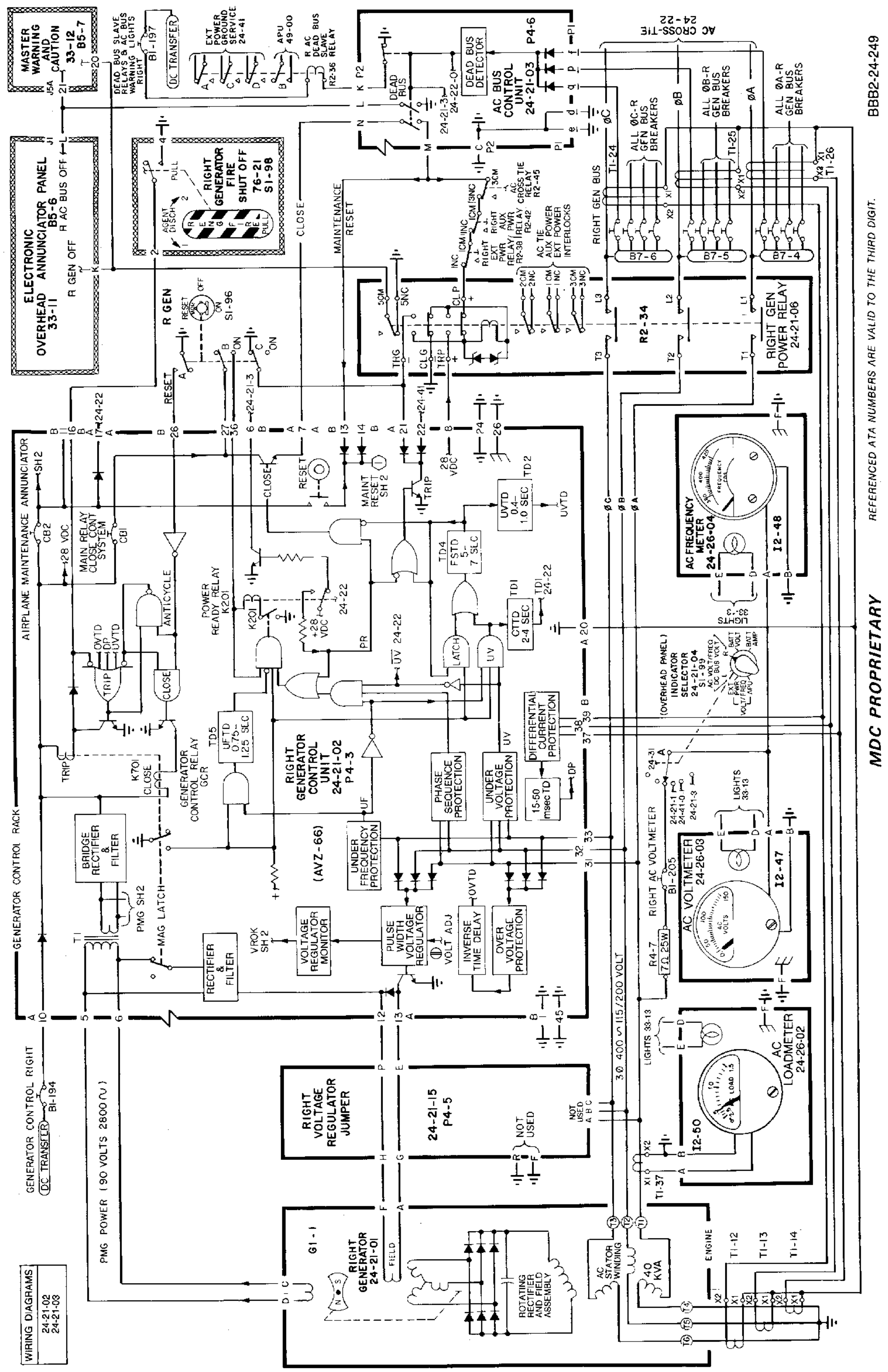
Right Generation and Control -- Schematic
Figure 106/24-20-00-990-825 (Sheet 1 of 4)



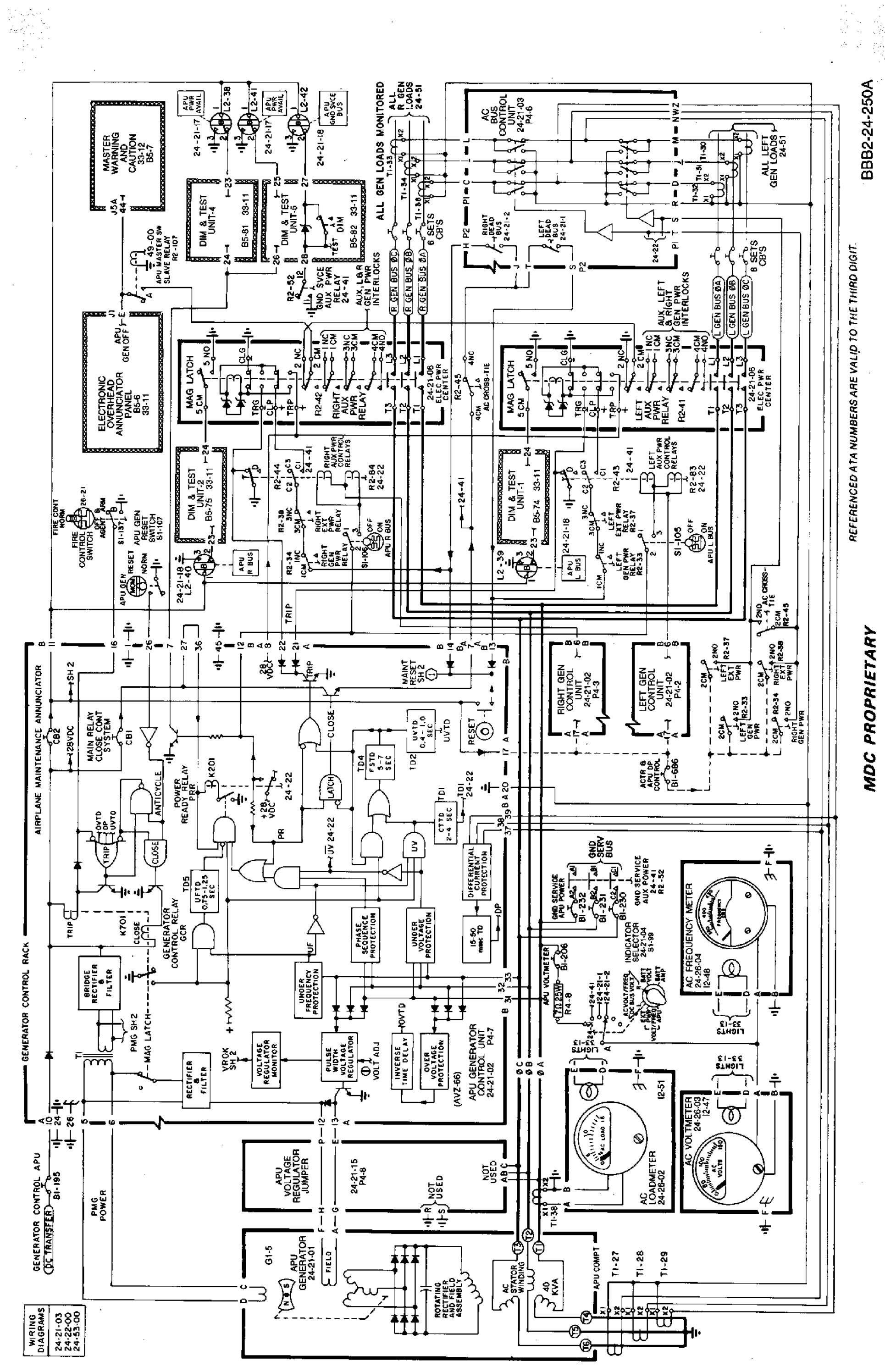
Right Generation and Control -- Schematic
Figure 106/24-20-00-990-825 (Sheet 2 of 4)



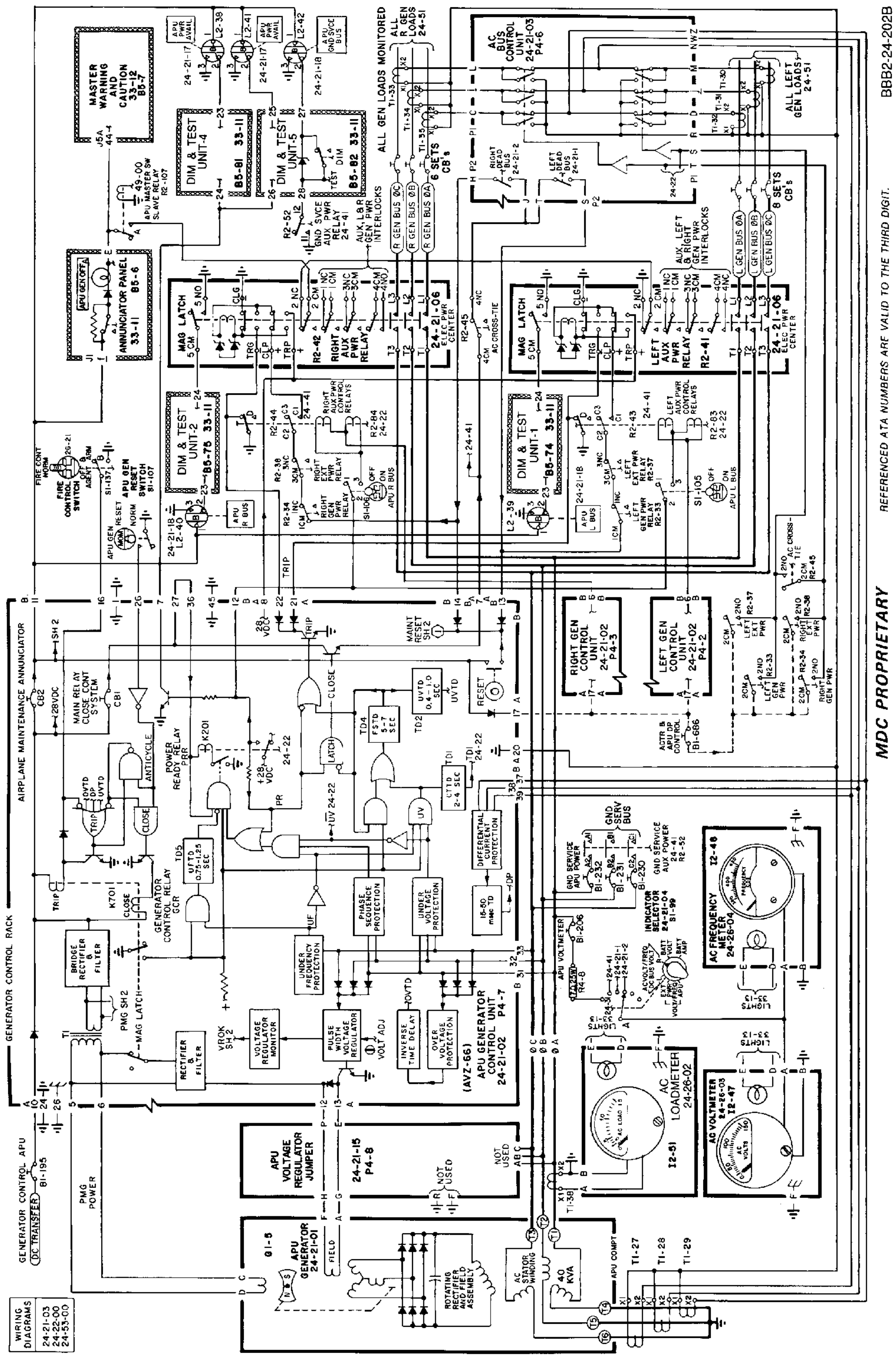
Right Generation and Control -- Schematic
Figure 106/24-20-00-990-825 (Sheet 3 of 4)



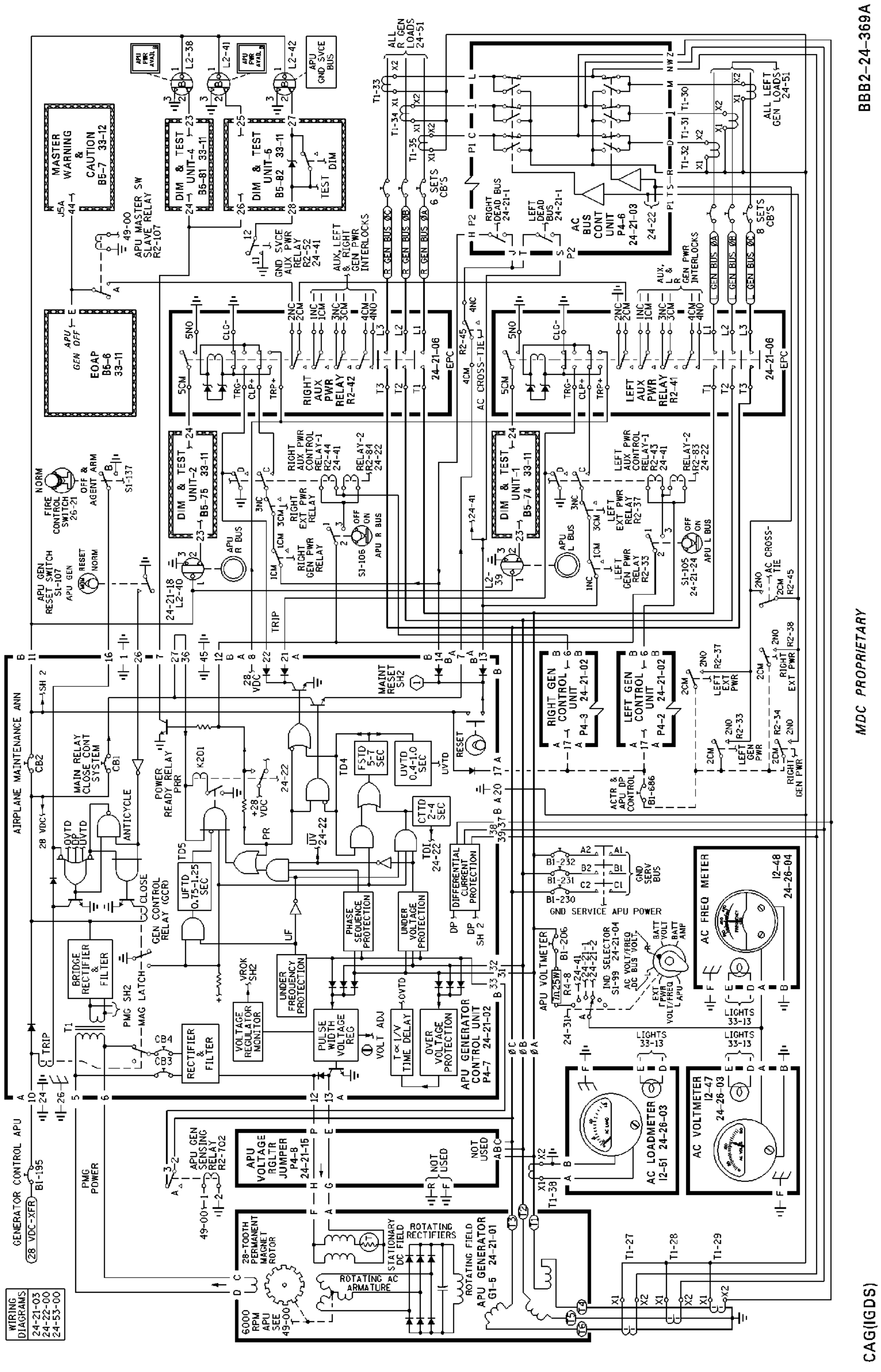
Right Generation and Control -- Schematic
Figure 106/24-20-00-990-825 (Sheet 4 of 4)



APU Generation and Control -- Schematic
Figure 107/24-20-00-990-826 (Sheet 1 of 3)



APU Generation and Control -- Schematic
Figure 107/24-20-00-990-826 (Sheet 2 of 3)



APU Generation and Control -- Schematic
Figure 107/24-20-00-990-826 (Sheet 3 of 3)

AC GENERATION - MAINTENANCE PRACTICES

1. General

A. The adjustment procedures given in this section provide procedural steps for adjusting voltage and frequency if either is found to be out of tolerance during normal operation of the system. Test procedures for checking the CSD or generator, following installation, are given in the applicable sections.

B. This section also provides test procedures for the emergency power systems and emergency AC inverter. Because of the close similarity, AC and DC emergency operation is included in one test.

CAUTION: NORMAL POWER SUPPLY TO VARIOUS LOAD DEMAND THROUGHOUT THE AIRCRAFT IS NOT ENSURED WHILE THE FOLLOWING ADJUSTMENT PROCEDURES ARE BEING PERFORMED. MAKE CERTAIN THAT SWITCHES FOR ALL OTHER SYSTEMS IN THE AIRCRAFT ARE IN OFF OR DISARMED POSITION BEFORE STARTING ADJUSTMENT PROCEDURES FOR THE ENGINE-DRIVEN OR APU GENERATOR SYSTEM.

C. The voltage and frequency adjustment procedures are to be accomplished during engine or APU operation (no frequency adjustment on APU system).

NOTE: If external or APU power is available on the aircraft, only the engine for the affected AC generator system need be operating. Both engines may be operated if desired. If external or APU power is not available, both engines must be operating.

NOTE: External power must be available when performing adjustment procedures for APU generator system.

NOTE: Engines are to be operated at idle rpm while performing adjustment procedures.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 201

Name and Number	Manufacturer
Portable precision AC voltmeter with 0 to 150 volt scale, calibrated at 115(±0.4) volts	
Portable precision frequency meter with 380 to 420 cps range, calibrated at 400 (±1.0) cps	
Inconel Lockwire 0.032 in NASM20995N32, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.032 in NASM20995C32, DPM 5865	Not Specified
Torque wrench (capable of 0 to 25 inch-pounds)	

3. Adjustment/Test AC Generation

A. Adjust AC Generation

(1) Engine-Driven Generator System

(a) With engines operating and L GEN and R GEN control switches in ON position, check that AC BUS X TIE switch is in AUTO position.

(b) Place GEN control switch of system to be adjusted in OFF position.

(2) APU Generator System

(a) Place L and R APU BUS switches and GRD SERVICE APU PWR switch in OFF position.

(b) With APU operating and external power available, place L and R EXT PWR BUS switches in ON position.

B. Adjust Voltage

WARNING: USE EXTREME CAUTION WHEN WORKING IN THE EPC AREA AS VOLTAGES ENCOUNTERED CAN BE FATAL. WHEN MEASURING VOLTAGE, OBSERVE THE SAFETY PRECAUTIONS NORMALLY FOLLOWED WHEN WORKING WITH HIGH VOLTAGES.

(1) Connect portable precision voltmeter between GR side of aircraft AC voltmeter resistor and ground.

NOTE: Resistor for engine-driven system is located in lower aft side of EPC, adjacent to corresponding relay. Resistor for APU system is located in lower forward section of EPC, adjacent to APU power relay.

(2) Hole labeled VOLT ADJ at lower right of face plate of applicable generator control unit is for potentiometer adjustment.

(3) Adjust potentiometer to obtain, as nearly as possible, 115 volts on precision voltmeter.

NOTE: Turn voltage adjustment potentiometer clockwise to increase voltage and counterclockwise to decrease voltage.

(4) Place GEN control switch or L or R APU BUS switch (as applicable) in ON position.

CAUTION: IF AC LOAD METER INDICATES MORE THAN 1.0 CONTINUOUS LOAD, REDUCE LOADS TO PREVENT DAMAGE.

(5) Place applicable left or right AIR CONDITIONING SUPPLY switch in AUTO position to ensure load on generator system.

(6) Check precision voltmeter reading to be certain that voltage remains at 115 volts.

NOTE: If voltage indication decreases when load is added to system, generator control unit may be defective.

(7) Check AC voltmeter indication on overhead switch panel for system adjusted. If indication is not within tolerance of 115(±3) volts, replace voltmeter.

(8) Place AIR CONDITIONING SUPPLY switch in OFF position.

(9) Remove precision voltmeter.

(10) Adjustment completed.

WARNING: IF FREQUENCY ADJUSTMENT IS REQUIRED, ALWAYS APPROACH AN OPERATING JET ENGINE FROM SIDE, MAKING CERTAIN TO AVOID INTAKE AND PRIMARY EXHAUST AREAS. WEAR SUITABLE CUP-TYPE EAR PROTECTION TO PREVENT DAMAGE TO EARS RESULTING FROM HIGH NOISE LEVEL OF AN OPERATING JET ENGINE.

C. Adjust Frequency

NOTE: This adjustment does not apply to APU generator.

(1) Place GEN control switch of system to be adjusted in off position.

WARNING: USE EXTREME CAUTION WHEN WORKING IN EPC AREA AS VOLTAGES ENCOUNTERED CAN BE FATAL. WHEN MEASURING VOLTAGE, OBSERVE SAFETY PRECAUTIONS NORMALLY FOLLOWED WHEN WORKING WITH HIGH VOLTAGES.

(2) Connect portable frequency meter between GR side of aircraft AC voltmeter resistor and ground.

NOTE: Resistor is located in lower aft side of the EPC, adjacent to corresponding power relay.

(3) Remove cover plate at bottom of CSD transmission to gain access to governor adjustment.

(4) Insert screwdriver in adjustment screw slot, press inward and turn screwdriver until adjustment screw engages governor adjustment screw.

(5) Adjust governor to position that brings generator frequency nearest to 400 cps.

NOTE: Turn adjustment screw clockwise to increase frequency and counterclockwise to decrease frequency. (One full 360 degree turn is equal to approximately 18 cps).

(6) Place GEN control switch of system adjusted in ON position.

CAUTION: IF AC LOAD METER INDICATES MORE THAN 1.0 CONTINUOUS LOAD, REDUCE LOADS TO PREVENT DAMAGE.

(7) Place applicable left or right AIR CONDITIONING SUPPLY switch in AUTO position to ensure load on generator system.

(8) Check precision frequency meter reading to be certain that frequency remains at previous setting (400 cps).

NOTE: If frequency is unstable or erratic, or if frequency goes out and stays out of limits (400(±20) cps) for more than 1 second on application or removal of load, replace transmission.

(9) Check frequency meter indication on overhead switch panel for system adjusted. If indication is not within tolerance of 400(±4) cps, replace frequency meter.

(10) Place AIR CONDITIONING SUPPLY switch in OFF position.

(11) Remove precision meter.

(12) Install cover plate with new O-ring; tighten screws to torque of 20 to 22 inch-pounds and safety screws with lockwire. (PAGEBLOCK 24-00-00/401)(LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(13) Adjustment completed; position electrical power control switches as required.

D. Test Emergency Power Systems

CAUTION: BOTH POT WATER HTR PLUG AND EXTERNAL POWER PLUG MUST BE DISCONNECTED FROM EXTERNAL POWER RECEPTACLES. APU AND BOTH ENGINES MUST NOT BE OPERATING DURING TEST OF EMERGENCY POWER SYSTEMS AND EMERGENCY AC INVERTER.

CAUTION: TEST MUST BE COMPLETED WITHIN TEN (10) MINUTES. BATTERY MUST NOT BE DISCHARGED TO POINT OF CELL REVERSAL.

WJE 405, 407-409, 411, 412, 414, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893

(1) Place BATT switch in ON position.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887

Place BATT switch in ON position. Only the far left screen of the Electronic Overhead Annunciator Panel (EOAP) is powered.

WJE ALL

(2) AC EMER BUS OFF, DC EMER BUS OFF, and DC BUS OFF lights come on in overhead panel.

(3) DC TRANSFER BUS OFF light goes off.

(4) Place AC VOLT/FREQ selector switch in BATT VOLT position.

(5) AMPS/VOLTS meter should read 26 to 28 volts.

(6) Place AC VOLT/FREQ selector switch in BATT AMP position.

(7) Read and note amps as indicated on AMPS/VOLTS meter.

(8) Open electrical and electronics compartment access door.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(9) Open this circuit breaker:

EE COMPARTMENT

Row	Col	Number	Name
		B1-172	DC TRANS BUS FEED (BAT)

WJE 405, 407-409, 411, 412, 414, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893

(10) Annunciator panel should show DC BUS OFF light off; DC TRANSFER BUS OFF, AC EMER BUS OFF, and DC EMER BUS OFF lights should be on.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887

(11) EOAP panel is de-energized. There is no DC BUS OFF indication. AC EMER BUS OFF and DC EMER BUS OFF indications are still illuminated.

WJE ALL

(12) Close this circuit breaker:

EE COMPARTMENT

Row	Col	Number	Name
		B1-172	DC TRANS BUS FEED (BAT)

WJE 405, 407-409, 411, 412, 414, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893

(13) Verify DC TRANSFER BUS OFF light is off; AC EMER BUS OFF and DC EMER BUS OFF lights are on.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887

(14) EOAP panel is re-energized. DC BUS OFF indication appears illuminated on the far left screen. AC EMER BUS OFF and DC EMER BUS OFF indications are still illuminated.

WJE ALL

(15) Place overhead switch panel EMER PWR switch ON.

(16) EMER POWER IN USE light comes on.

(17) Verify AC VOLT/FREQ selector switch is in BATT AMP position.

(18) Read and note amps as indicted on AMPS/VOLTS meter. Reading should show increase over reading in Paragraph 3.D.(7).

(19) Verify AC EMER BUS OFF and DC EMER BUS OFF lights are off.

(20) Verify no flags or other abnormal electrical indications show on captain's Attitude Director Indicator (Primary Flight Display on aircraft with EFIS (main instrument panel). (ATTITUDE SYSTEM, SUBJECT 34-23-00, Page 1)

NOTE: If no flags or other abnormal electrical indications on Attitude Director Indicator or Primary Flight Display, the Test Emergency AC Inverter need not be performed. (Paragraph 3.E.)

NOTE: Ignore any random and intermittent indications of the No. 1 VHF NAV control panel.

(21) Place overhead switch panel EMER PWR switch to OFF.

(22) EMER POWER in use light should go off.

(23) Overhead switch panel should show AC EMER BUS OFF and DC EMER BUS OFF lights on.

(24) Restore external power or APU power to aircraft.

(25) Place AC VOLT/FREQ selector switch in BATT AMP position.

(26) Verify battery charging at 40 to 65 amps on left side of AMPS/VOLTS meter.

(27) Close electrical and electronics compartment access door.

(28) Test completed; position electrical power control switches as required.

E. Test Emergency AC Inverter

(1) Remove forward accessory compartment door.

(2) Connect AC voltmeter and frequency meter to terminals D and C of inverter.

(3) Place overhead switch panel EMER PWR switch in ON position. Voltage reading should be 115(±4) VAC; frequency reading should be 380 to 420 Hz. If voltage or frequency is not within limits, replace inverter.

(4) Place EMER PWR switch in OFF position.

(5) Remove portable AC voltmeter and frequency meter.

(6) Install forward accessory compartment door.

(7) Test completed.

F. Test Generator Field (GCR) Disconnect Circuits (L. and R. Engines)

NOTE: This test requires running engine of system to be tested and should be made only at prescribed periods identified by appropriate maintenance schedule, engine change, or after repairs on engine wiring or field disconnect circuits.

(1) Verify BATT switch is ON. Energize aircraft electrical buses with external or APU electrical power. Place both AC BUS X TIE switch and DC BUS X TIE switch to OPEN.

(2) Place AC VOLT/FREQ selector switch to system being tested and start engine for that system. (POWER PLANT, CHAPTER 71)

NOTE: If necessary, reset generator by momentarily placing respective generator control switch in RESET position.

(3) Verify that meters show voltage of 115 VAC and frequency of 400 Hz. This indicates field circuit is complete and generator control relay (GCR) contacts are closed.

(4) Place respective generator control switch, located on forward overhead panel, in ON position and check that GEN OFF light (located on annunciator panel) goes off. Verify that some load appears on loadmeter to indicate generator relay has closed onto load.

CAUTION: DO NOT ROTATE ENGINE FIRE CONTROL HANDLE.

(5) Slowly pull applicable engine fire control handle, located on upper instrument panel, until GEN OFF light comes on.

NOTE: To avoid shutting the engine down during test, observe engine parameters when pulling fire control handle. If parameters decrease (engine shut down), immediately place fuel shutoff handle located on the pedestal to OFF position.

(6) Place engine fire control handle to full in position.

(7) Check that respective GEN OFF light remains on and verify that respective generator AC voltage is zero.

(8) Reset generator GCR by momentarily placing respective generator control switch in RESET position then to ON position. Verify GEN OFF light goes off and loadmeter, voltmeter, and frequency meter reads normal.

(9) Shut down engine. (POWER PLANT, CHAPTER 71)

G. Test Generator Field (GCR) Disconnect Circuit (APU Generator)

NOTE: This test requires running APU and should be made only at prescribed periods identified by appropriate maintenance schedule, APU change, or after repairs on APU wiring or field disconnect circuits.

(1) Verify BATT switch is ON. Energize aircraft electrical buses with external electrical power. Place both AC BUS X TIE switch and DC BUS X TIE switch to OPEN.

(2) Place AC VOLT/FREQ selector switch to APU and start APU. (GENERAL, SUBJECT 49-00-00)

NOTE: If necessary, reset generator by momentarily placing APU GEN control switch in RESET position.

(3) Verify that meters show voltage of 115 VAC and frequency of 400 Hz. This indicates field circuit is complete and generator control relay (GCR) contacts are closed.

(4) Place APU L BUS and APU R BUS switches, located on forward overhead panel, in ON position and check that APU GEN OFF light (located on annunciator panel) goes off. Verify that some load appears on loadmeter to indicate APU generator relays have closed onto load.

(5) Place APU FIRE CONT switch (located on overhead panel) in OFF & AGENT ARM position.

(6) The APU will shut down immediately. APU GEN OFF light comes on.

(7) Start APU. APU GEN OFF light will remain on and APU generator voltage will be zero.

(8) APU generator must be RESET prior to normal operation.

(9) Shut down APU. (GENERAL, SUBJECT 49-00-00)

H. Test AC Cross-tie with APU Generator

NOTE: This AC Cross-tie verification test is to be performed with APU running, left and right engines not operating and external power not connected to the aircraft.

(1) Place AC BUS X TIE switch in AUTO position.

(2) Place DC BUS X TIE switch in OPEN position.

(3) Place both air conditioning packs to AUTO.

(4) Place APU L BUS and APU R BUS switches in ON position. Make certain that APU Load meter indicates minimum of 0.5.

(5) Check that L AC BUS OFF, R AC BUS OFF, DC BUS OFF, AC EMER BUS OFF, and DC EMER BUS OFF lights go off.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(6) Open these circuit breakers:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

(7) Place APU R BUS switch in OFF position. Make certain AC Cross-tie relay operates, the R AC BUS OFF and DC BUS OFF lights remain OFF, the right blue APU POWER IN USE light goes off, and the four transformer rectifiers remain powered.

(8) Check AC EMER BUS OFF and DC EMER BUS OFF lights remain off.

(9) Place APU R BUS switch to ON, place AC BUS X TIE switch to OPEN and then back to AUTO. Make certain that AC Cross-tie relay opens, and the right blue APU POWER IN USE light comes on.

(10) Check that R AC BUS OFF and DC BUS OFF lights remain off.

(11) Place APU L BUS switch in OFF position. Make certain AC Cross-tie relay operates, the L AC BUS OFF and DC BUS OFF lights remain off, the left blue APU POWER IN USE light goes off and the four transformer rectifiers remain powered.

(12) Check that AC EMER BUS OFF and DC EMER BUS OFF lights remain off.

(13) Place APU L BUS switch to ON, place AC BUS X TIE switch to OPEN, and then back to AUTO. Make certain that AC Cross-tie relay opens, and the left blue APU POWER IN USE light comes on.

(14) Check that L AC BUS OFF and DC BUS OFF lights remain off.

(15) Close these circuit breakers:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			

WJE 417, 419, 421, 423, 865, 869, 871, 872 (Continued)

(Continued)

UPPER EPC, L AC BUS

Row	Col	Number	Name
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

(16) Place both air conditioning packs to OFF.

(17) Using proper procedures, shut down APU. (GENERAL, SUBJECT 49-00-00)

I. Test AC Cross-tie with Engine Generators

NOTE: This AC cross-tie verification test is to be performed with both engine generators operating.

(1) Make certain L GEN and R GEN switches are in ON position.

(2) Make certain following lights are off:

(a) R GEN OFF

(b) L GEN OFF

(c) R AC BUS OFF

(d) L AC BUS OFF

(e) DC BUS OFF

(f) AC EMER BUS OFF

(g) DC EMER BUS OFF

(3) Place CKPT TEMP AUTO/MANUAL selector switch on air conditioning panel in MANUAL position.

(4) Check if cabin pressure outflow valve on left side of aircraft is open.

(5) Place both SUPPLY switches on air conditioning panel in OFF position.

(6) Place HYD PUMPS AUX switch in ON position.

(7) Place EXT PWR L BUS, EXT PWR R BUS, APU L BUS, and APU R BUS switches in OFF position, and both External and APU Ground Service BUS Power switches are in OFF position.

(8) Place AC BUS X TIE switch and DC BUS X TIE switch in OPEN position.

(9) Place R GEN switch in OFF position. Check following lights for operation:

(a) R GEN OFF....................................on

(b) R AC BUS OFF..............................on

(c) DC BUS OFF.................................on

(d) AC EMER BUS OFF......................off

(e) DC EMER BUS OFF.....................off

(f) R AC Load meter should indicate zero.

(10) Place AC BUS X TIE switch in AUTO position. Check following lights for operation:

(a) R GEN OFF...................................on

(b) R AC BUS OFF..............................off

(c) DC BUS OFF.................................off

(d) L AC Load meter indication should increase minimum of 0.5.

NOTE: If L AC load meter shows more than 1.0, reduce load.

NOTE: If load meter indicates less than 0.5, increase aircraft electrical load to meet minimum requirement.

(11) Place R GEN switch in ON position. Check following lights for operation:

(a) R GEN OFF...................................off

(b) R AC BUS OFF..............................off

(c) DC BUS OFF.................................off

(d) R AC BUS Load meter should increase and L AC Load meter should decrease.

(12) Place L GEN switch in OFF position. Check following lights for operation:

(a) L GEN OFF....................................on

(b) L AC BUS OFF...............................off

(c) DC BUS OFF..................................off

NOTE: If R AC load meter shows more than 1.0, reduce load.

(13) Place AC BUS X TIE switch in OPEN position. Check following lights for operation:

(a) L GEN OFF....................................on

(b) L AC BUS OFF...............................on

(c) DC BUS OFF..................................on

(d) DC EMER BUS OFF.....................off

(e) AC EMER BUS OFF......................off

(14) Place AC BUS X TIE switch in AUTO position. Check following lights for operation:

(a) L GEN OFF....................................on

(b) L AC BUS OFF...............................off

(c) DC BUS OFF..................................off

(d) R AC load meter should increase.

(15) Place L GEN switch in ON position. Check following lights for operation:

(a) L GEN OFF....................................off

(b) L AC BUS OFF...............................off

(c) DC BUS OFF..................................off

(16) Place HYD PUMPS AUX switch in OFF position.

(17) Place AUTO/MANUAL selector switch in AUTO position.

(18) Using proper procedures, shut down engines. (GENERAL, SUBJECT 71-00-00, Page 501)

J. Check Generator Load Shed

(1) Start both engines. (GENERAL, SUBJECT 71-00-00, Page 501)

(2) Make certain that both generators come on line.

(3) Place APU GEN and EXT PWR L and R bus switches, located on overhead panel, in OFF position.

(4) Place GALLEY power switch, located on overhead panel, in ON position. Make certain that galley is powered.

(5) Place L GEN switch, located on overhead panel, in OFF position. Make certain that electrical power to the galley is shed.

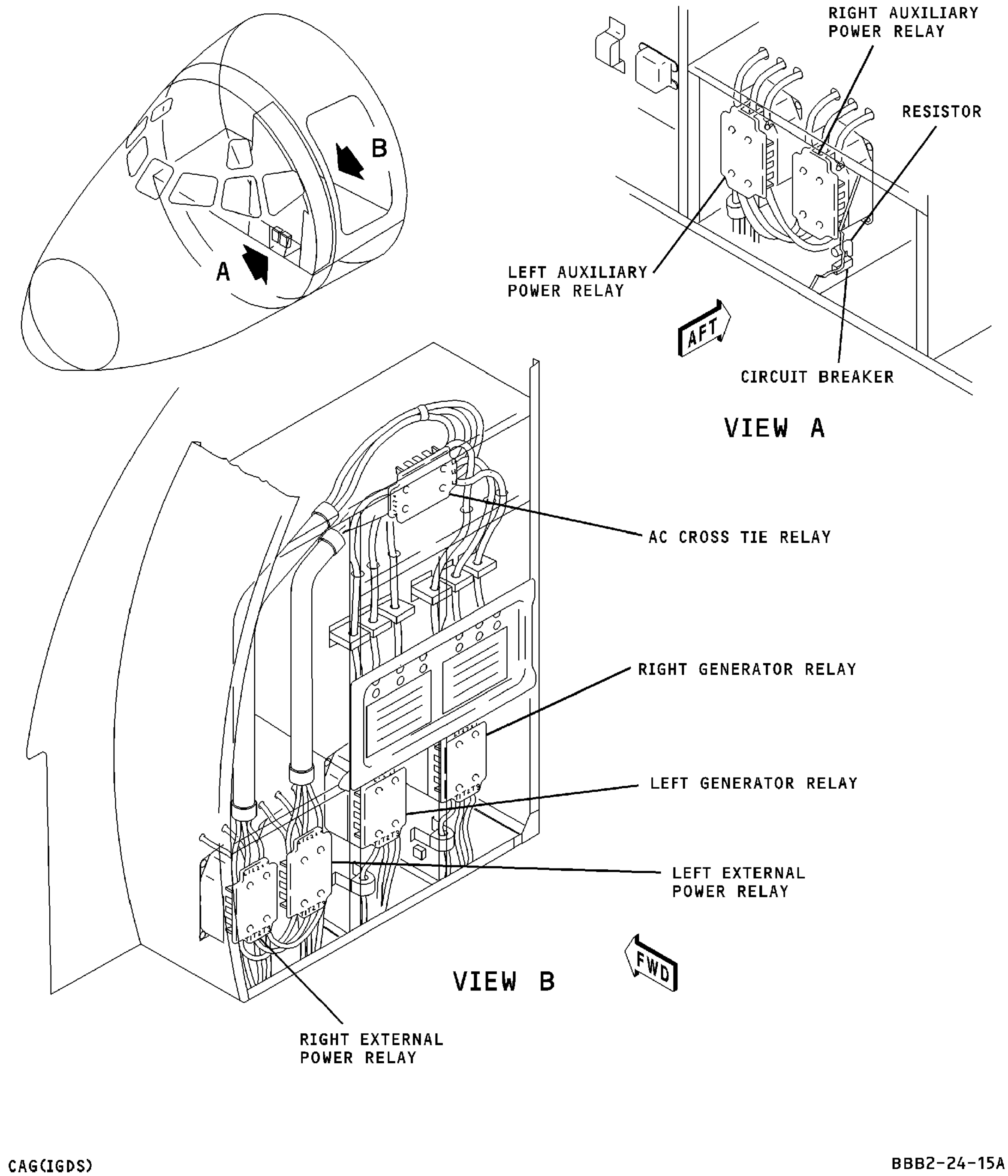
(6) Place L GEN switch in ON position. Check that power is restored to the galley.

(7) Place R GEN switch, located on overhead panel, in OFF position. Make certain that electrical power to the galley is shed.

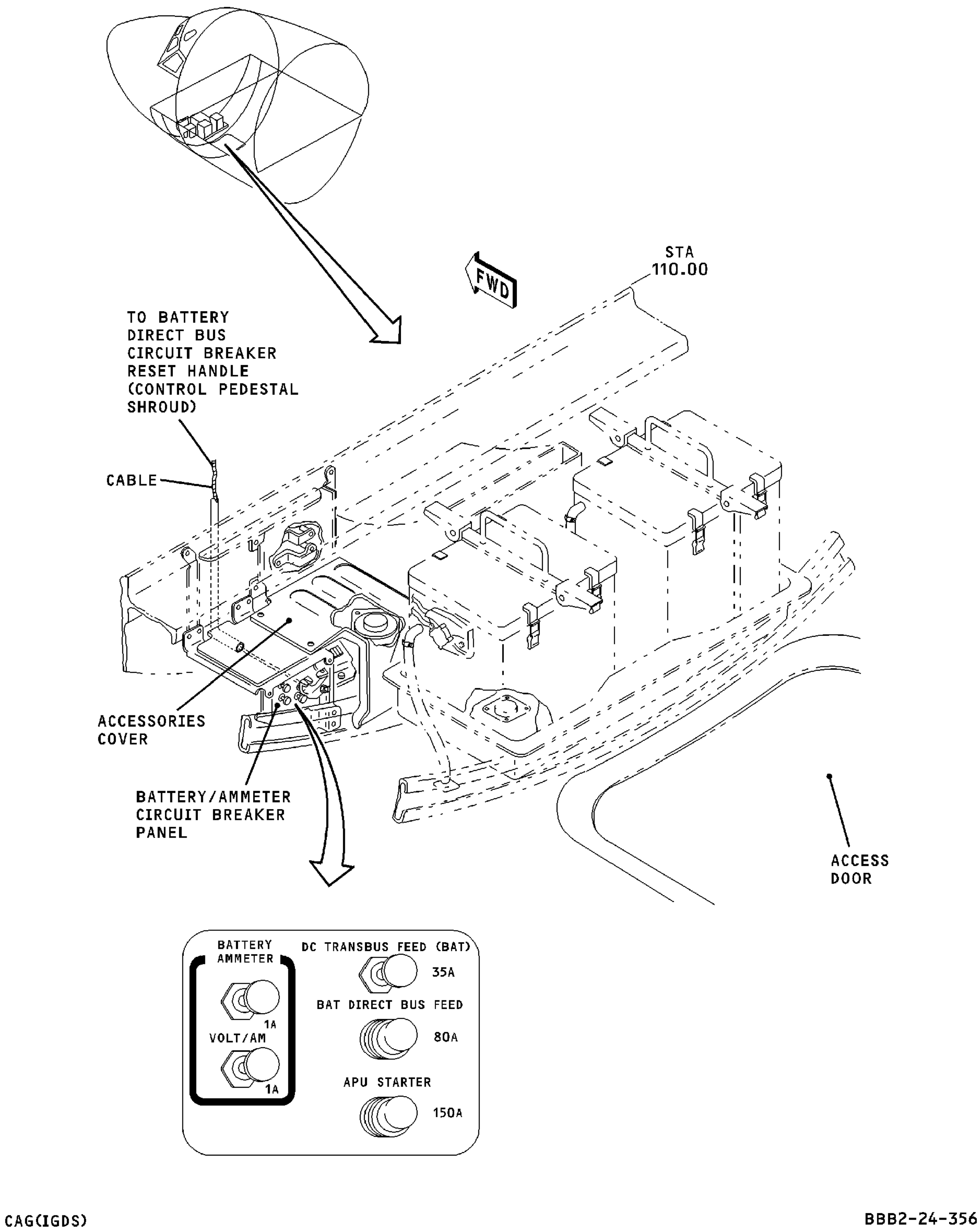
(8) Place R GEN switch in ON position. Check that power is restored to the galley.

(9) Place APU GEN and EXT PWR L and R bus switches in ON position.

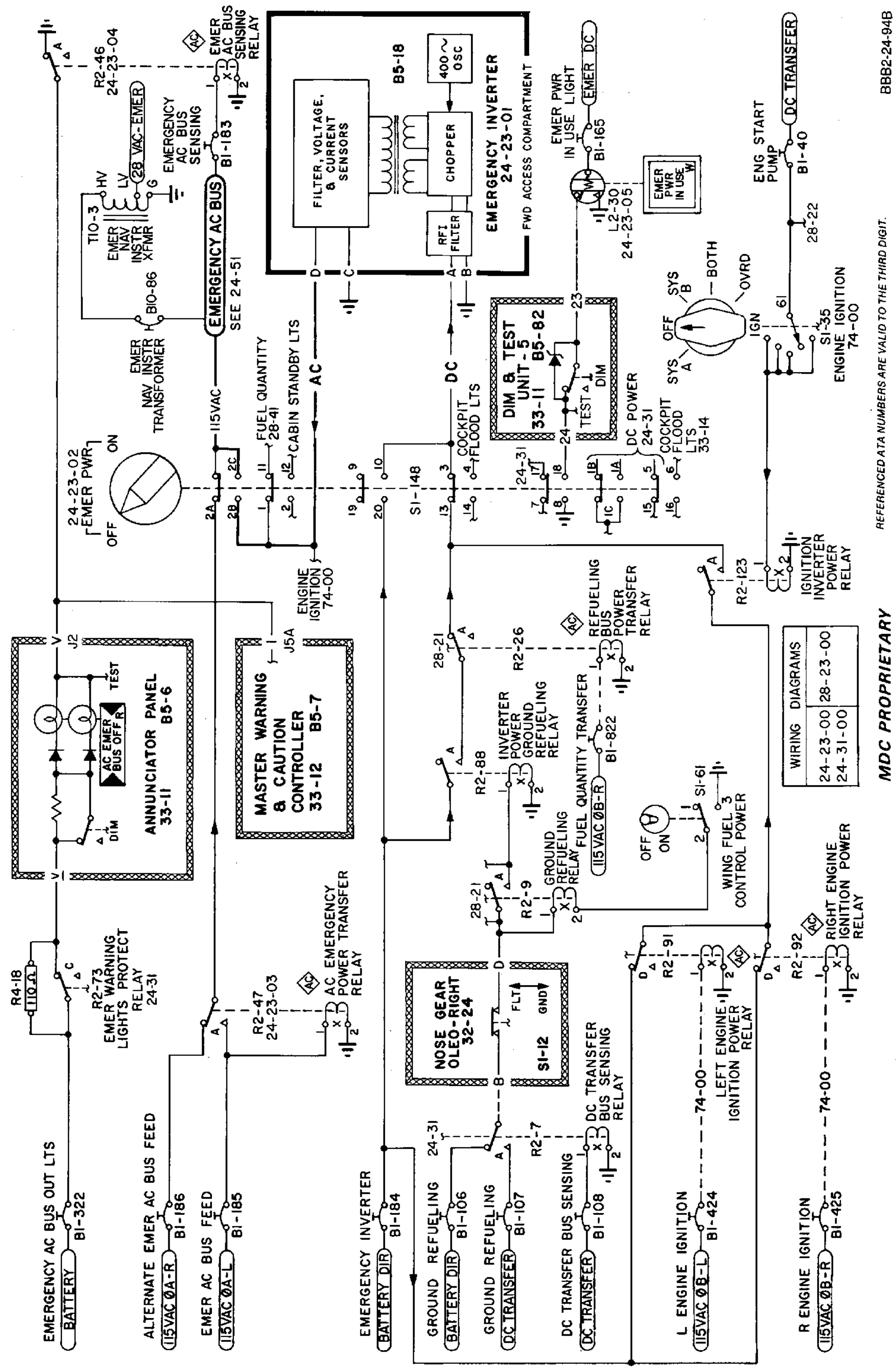
(10) Shut down engines. (GENERAL, SUBJECT 71-00-00, Page 501)



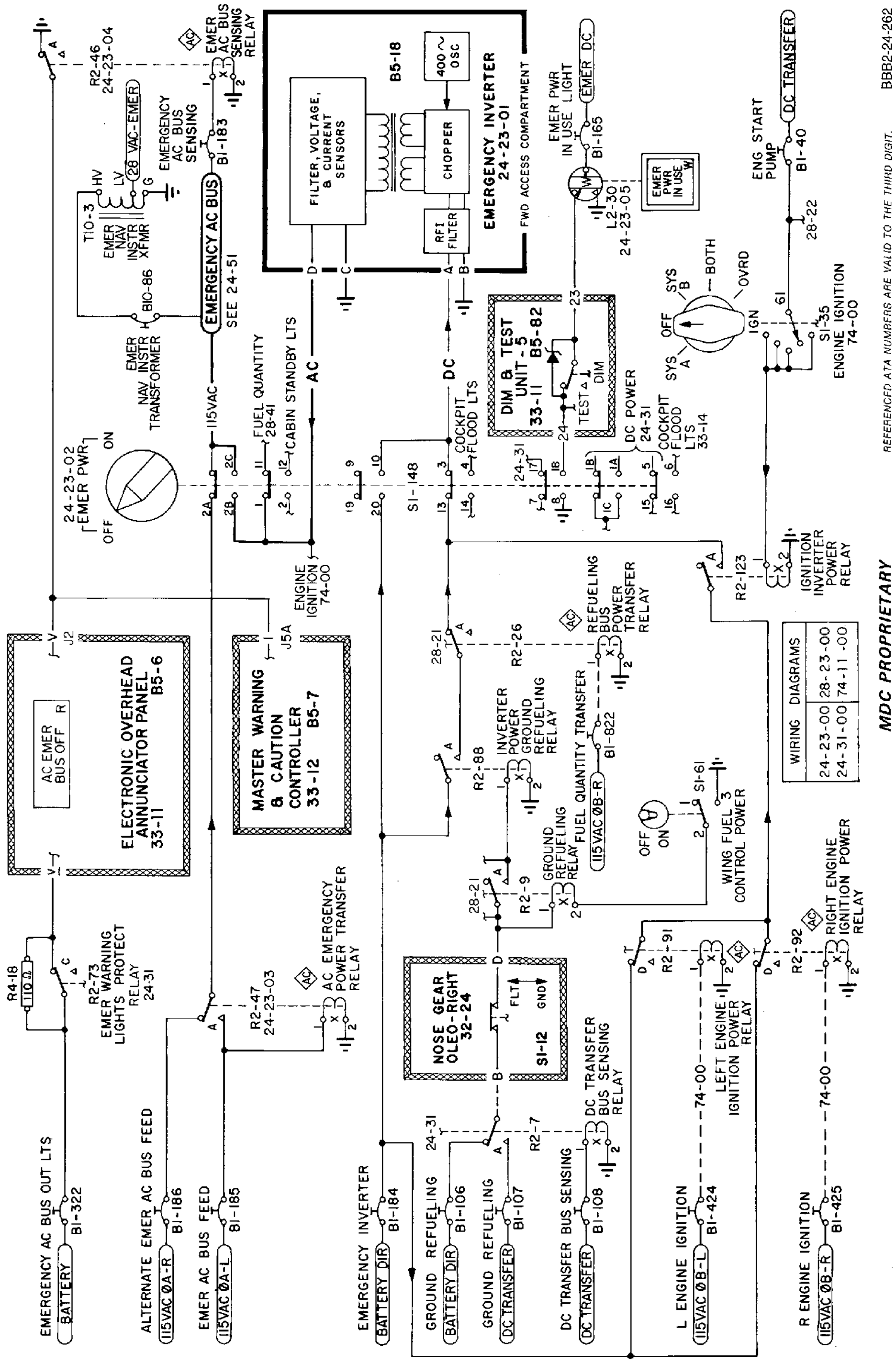
AC Voltmeter Resistors -- Location
Figure 201/24-20-00-990-829



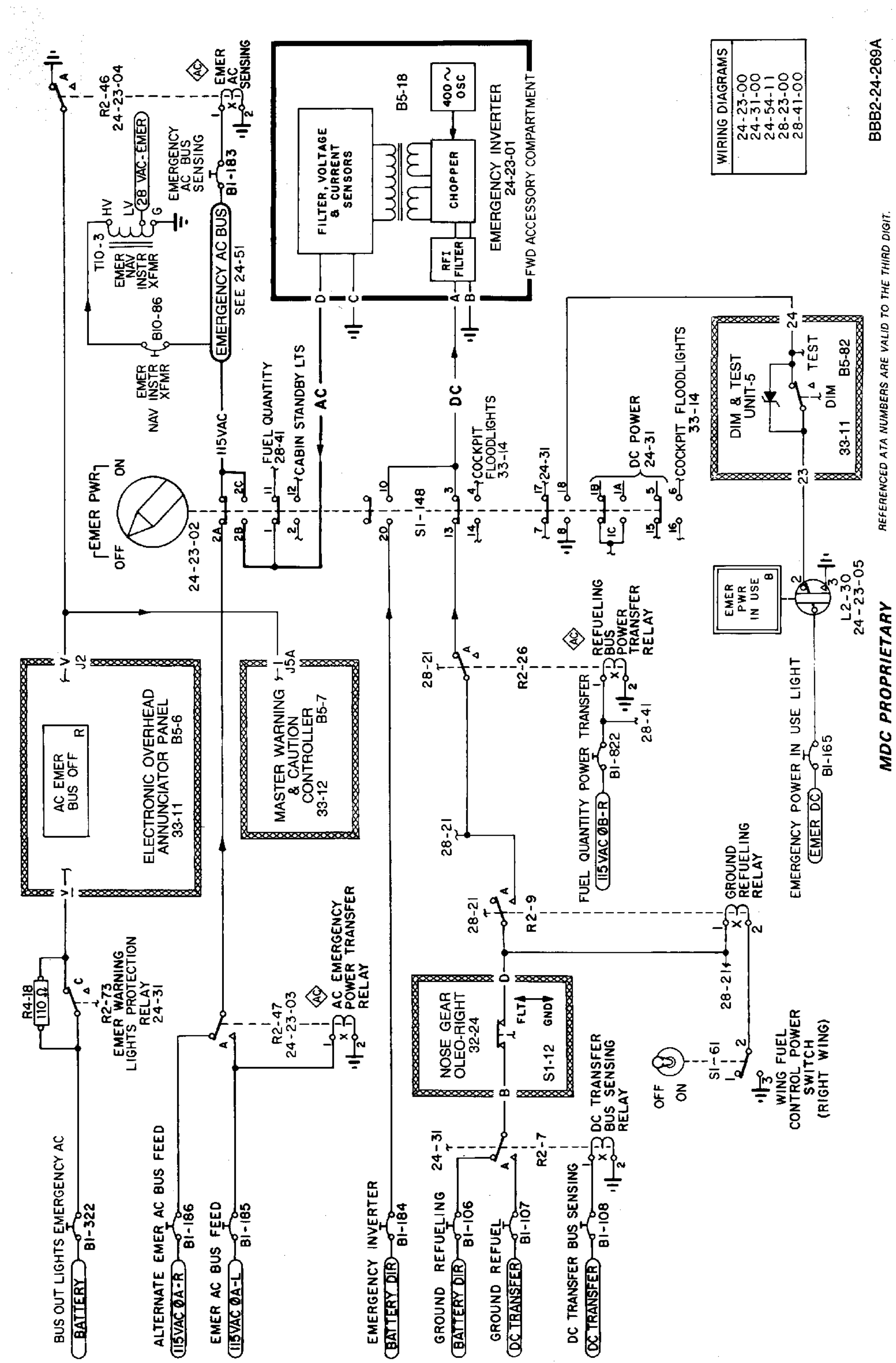
Battery/Ammeter Circuit Breaker Panel
Figure 202/24-20-00-990-830



AC Emergency Power and Control -- Schematic
Figure 203/24-20-00-990-831 (Sheet 1 of 3)



AC Emergency Power and Control -- Schematic
Figure 203/24-20-00-990-831 (Sheet 2 of 3)



AC Emergency Power and Control -- Schematic
Figure 203/24-20-00-990-831 (Sheet 3 of 3)

AC GENERATION - ADJUSTMENT/TEST

1. **General**

   A. This procedure contains MSG-3 task card data.

TASK 24-20-00-710-801

2. **Operational Check of the Engine Generator Field Disconnect**

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
24-00-00 P/B 001	GENERAL - DESCRIPTION AND OPERATION
71	POWER PLANT

B. Prepare for the Operational Check of the Engine Generator Field Disconnect

SUBTASK 24-20-00-860-001

(1) Verify BATT switch is ON.

(2) Energize aircraft electrical buses with external or APU electrical power. (GENERAL - DESCRIPTION AND OPERATION, PAGEBLOCK 24-00-00/001)

(3) Place both AC BUS X TIE switch and DC BUS X TIE switch to OPEN.

(4) Place AC VOLT/FREQ selector switch to system being tested and start engine for that system. (POWER PLANT, CHAPTER 71)

NOTE: If necessary, reset generator by momentarily placing respective generator control switch in RESET position.

C. Operational Check of the Engine Generator Field Disconnect

SUBTASK 24-20-00-710-001

(1) Do an operational check of the engine generator field disconnect.

(a) Verify that meters show voltage of 115 VAC and frequency of 400 Hz. This indicates field circuit is complete and generator control relay (GCR) contacts are closed.

(b) Place respective generator control switch, located on forward overhead panel, in ON position.

1) Check that GEN OFF light (located on annunciator panel) goes off.

2) Verify that some load appears on loadmeter to indicate generator relay has closed onto load.

CAUTION: DO NOT ROTATE ENGINE FIRE CONTROL HANDLE.

(c) Slowly pull applicable engine fire control handle, located on upper instrument panel, until GEN OFF light comes on.

NOTE: To avoid shutting the engine down during test, observe engine parameters when pulling fire control handle. If parameters decrease (engine shut down), immediately place fuel shutoff handle located on the pedestal to OFF position.

(d) Place engine fire control handle to full in position.

1) Check that respective GEN OFF light remains on.

2) Verify that respective generator AC voltage is zero.

(e) Reset generator GCR by momentarily placing respective generator control switch in RESET position then to ON position.

1) Verify GEN OFF light goes off.

2) Verify loadmeter, voltmeter, and frequency meter reads normal.

D. Job Close-up

SUBTASK 24-20-00-868-001

(1) Shut down engine. (POWER PLANT, CHAPTER 71)

SUBTASK 24-20-00-862-001

(2) De-energize electrical system. (GENERAL - DESCRIPTION AND OPERATION, PAGEBLOCK 24-00-00/001)

——— END OF TASK ———

TASK 24-20-00-710-802

3. Operational Check of the APU Generator Field Disconnect

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
24-00-00 P/B 001	GENERAL - DESCRIPTION AND OPERATION
49-00-00	GENERAL

B. Prepare for the Operational Check of the APU Generator Field Disconnect

SUBTASK 24-20-00-860-002

(1) Verify BATT switch is ON.

(2) Energize aircraft electrical buses with external electrical power. (GENERAL - DESCRIPTION AND OPERATION, PAGEBLOCK 24-00-00/001)

(3) Place both AC BUS X TIE switch and DC BUS X TIE switch to OPEN.

(4) Place AC VOLT/FREQ selector switch to APU and start APU. (GENERAL, SUBJECT 49-00-00)

NOTE: If necessary, reset generator by momentarily placing APU GEN control switch in RESET position.

C. Operational Check of the APU Generator Field Disconnect

SUBTASK 24-20-00-710-002

(1) Do an operational check of the APU generator field disconnect.

(a) Verify that meters show voltage of 115 VAC and frequency of 400 Hz. This indicates field circuit is complete and generator control relay (GCR) contacts are closed.

(b) Place APU L BUS and APU R BUS switches, located on forward overhead panel, in ON position.

1) Check that APU GEN OFF light (located on annunciator panel) goes off.

2) Verify that some load appears on loadmeter to indicate APU generator relays have closed onto load.

(c) Place APU FIRE CONT switch (located on overhead panel) in OFF & AGENT ARM position.

1) The APU will shut down immediately.

2) APU GEN OFF light comes on.

(d) Start APU. (GENERAL, SUBJECT 49-00-00)

1) APU GEN OFF light will remain on.

2) APU generator voltage will be zero.

(e) Reset APU generator.

1) Verify APU GEN OFF light goes off.

2) Verify that some load appears on loadmeter to indicate APU generator relays have closed onto load.

D. Job Close-up

SUBTASK 24-20-00-868-002

(1) Shut down APU. (GENERAL, SUBJECT 49-00-00)

SUBTASK 24-20-00-861-001

(2) De-energize electrical system. (GENERAL - DESCRIPTION AND OPERATION, PAGEBLOCK 24-00-00/001)

——— END OF TASK ———

TASK 24-20-00-710-803

4. Operational Check of the Generator Load Shed

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
71-00-00	GENERAL

B. Prepare for the Operational Check of the Generator Load Shed

SUBTASK 24-20-00-868-003

(1) Start both engines. (GENERAL, SUBJECT 71-00-00)

(a) Make certain that both generators come on line.

C. Operational Check of the Generator Load Shed

SUBTASK 24-20-00-710-003

(1) Do an operational check of the generator load shed.

(a) Place APU GEN and EXT PWR L and R bus switches, located on overhead panel, in OFF position.

(b) Place GALLEY power switch, located on overhead panel, in ON position.

1) Make certain that galley is powered.

(c) Place L GEN switch, located on overhead panel, in OFF position.

1) Make certain that electrical power to the galley is shed.

(d) Place L GEN switch in ON position.

1) Check that power is restored to the galley.

(e) Place R GEN switch, located on overhead panel, in OFF position.

1) Make certain that electrical power to the galley is shed.

(f) Place R GEN switch in ON position.

1) Check that power is restored to the galley.

(g) Place APU GEN and EXT PWR L and R bus switches in ON position.

D. Job Close-up

SUBTASK 24-20-00-868-004

(1) Shut down engines. (GENERAL, SUBJECT 71-00-00)

END OF TASK

AC GENERATORS - REMOVAL/INSTALLATION

1. General

A. Removal and installation procedures are identical for each of the engine-driven ac generators. Access to the generator is through the nacelle lower door.

2. Equipment and Materials

CAUTION: FIRE DETECTOR SENSING ELEMENTS LOCATED WITHIN ENGINE AREA ARE VERY SENSITIVE. PHYSICAL CONTACT WITH THESE ELEMENTS CAN CAUSE HIDDEN DAMAGE. CONSTANT DIMENSION MUST BE MAINTAINED BETWEEN ELEMENTS AND SUPPORT TUBE.

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

Table 401

Name and Number	Manufacturer
Antifretting compound 688272 DPM 3565	Sundstrand Aviation Div.
Inconel Lockwire 0.020 in NASM20995N20, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.020 in NASM20995C20, DPM 5865	Not Specified
Torque wrench (0 to 175 inch pounds (0 to 19.8 N·m)	

3. Removal/Installation Ac Generator

WARNING: THE GENERATOR WEIGHS APPROXIMATELY 86 POUNDS (39.0 KG). DUE TO THE WEIGHT AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR REMOVAL PROCEDURES.

WARNING: MAKE SURE ALL AIRCRAFT ELECTRICAL POWER IS REMOVED. THIS WILL PREVENT INJURIES TO PERSONS CAUSED BY THE CHARGED COMPONENTS.

WARNING: BE CAREFUL WHEN YOU WORK ON THE ENGINE COMPONENTS IMMEDIATELY AFTER THE ENGINE IS SHUTDOWN. THE ENGINE COMPONENTS CAN STAY HOT FOR UP TO ONE HOUR AND CAN CAUSE INJURY.

A. Remove Ac Generator

(1) Remove clamp to disconnect cooling air inlet duct from generator blast cap.

(2) Disconnect electrical connector from right side of generator.

(3) Remove terminal block cover from generator terminal block; tag and disconnect power leads.

NOTE: Do not remove guide block from generator power leads. Guide block aids in proper installation of generator wiring by keeping power leads separated.

(4) Remove air exit duct from generator exhaust air shroud; discard gasket.

(5) Loosen T-bolts nuts sufficiently to separate and remove two halves of shroud as follows:

(a) Remove left shroud section.

(b) Lift right shroud section to clear generator mounting flange and move aft approximately 2 inches (50 mm) to clear angle locator.

(c) Rotate right shroud section 180 degrees counterclockwise on generator.

(d) Remove right shroud section.

(6) Loosen nuts that attach generator to CSD transmission.

NOTE: The keyhole-type generator mounting holes are larger at one end than the attaching nuts. This permits removing generator without removing nuts from CSD transmission studs. Attaching nuts must be loosened enough to rotate generator and center studs in large end of generator mounting holes.

CAUTION: BE CERTAIN TO SUPPORT AFT END OF GENERATOR TO PREVENT UNIT FROM FALLING.

(7) Rotate generator until CSD transmission studs are in large end of generator mounting holes.

CAUTION: AVOID SUPPORTING OR LIFTING GENERATOR BY DRIVE SHAFT TO PREVENT POSSIBLE DAMAGE TO SHAFT OR INTERNAL DAMAGE TO GENERATOR.

(8) Slowly move generator aft until splined drive shaft of generator disengages CSD transmission.

(9) Cover generator drive pad opening on CSD transmission to prevent entrance of foreign material.

(10) If original generator is not to be installed, remove blast cap.

WARNING: GENERATOR WEIGHS APPROXIMATELY 86 POUNDS (39.0 KG). DUE TO WEIGHT AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR INSTALLATION PROCEDURES.

CAUTION: A GENERATOR SHAFT THAT DOES NOT ROTATE FREELY CAN CAUSE EXTENSIVE DAMAGE TO CSD TRANSMISSION.

B. Install Ac Generator

NOTE: Prior to installation of generator, check its shaft for free rotation.

NOTE: Paragraph 3.B.(1) and Paragraph 3.B.(2) are not applicable if original generator is to be installed.

(1) Install blast cap; safety screws with lockwire.

NOTE: Outlet must face to right hand bottom of terminal block.

(2) Provide electrical bond at three places on generator mounting flange. (Figure 401)

(3) Remove protective covering from generator drive pad.

WARNING: ANTI-FRETTING COMPOUND IS AN AGENT THAT IS POISONOUS AND AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN ANTI-FRETTING COMPOUND IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET ANTI-FRETTING COMPOUND IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA.
- APPROVED SAFETY EQUIPMENT.
- EMERGENCY MEDICAL AID.
- TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(4) Apply at least 10 cubic cmm of antifretting compound No. 688272, (Sundstrand Aviation) or equivalent, in constant speed drive output spline.

CAUTION: AVOID SUPPORTING OR LIFTING GENERATOR BY DRIVE SHAFT TO PREVENT POSSIBLE DAMAGE TO SHAFT OR INTERNAL DAMAGE TO GENERATOR.

(5) Center large end of holes in generator mounting flange over attaching nuts on CSD transmission studs.

NOTE: Position generator so that power lead terminal strip is on upper right side of generator and bottom terminal is approximately horizontal to generator.

(6) Slowly move generator forward until splined drive shaft of generator engages CSD transmission.

(7) Rotate generator clockwise to bottom CSD transmission studs in small end of generator mounting holes; tighten attaching nuts to torque of 144 to 168 inch-pounds (16.27 to 18.98 N·m).

CAUTION: IF WASHERS RIDE OUTSIDE EDGE OF SPOTFACED AREA, INSTALLATION WILL BE INSECURE AND GENERATOR MAY BECOME LOOSE.

(8) Check generator installation to be sure that captive washers on mounting nuts are within spotfaced area around each mounting hole of generator mounting flange.

NOTE: Air exit opening should be positioned on horizontal centerline, right side of generator, at completion of rotation.

(9) Position right shroud section at left side of generator and rotate shroud 180 degrees clockwise.

(10) Move right shroud section forward approximately 2 inches (50 mm), lift to engage generator mounting flange, and align with angle locator.

(11) Install left shroud section, making certain left and right shroud sections mate properly.

(12) Connect clamp T-bolts and tighten to torque of 25 to 30 inch-pounds (2.82 to 3.39 N·m).

(13) Install air exit duct onto shroud.

(14) Check the torque of the generator terminal block nuts.

(a) The terminal block nuts should be torqued to 160 to 190 inch-pounds (18.08 to 21.46 N·m).

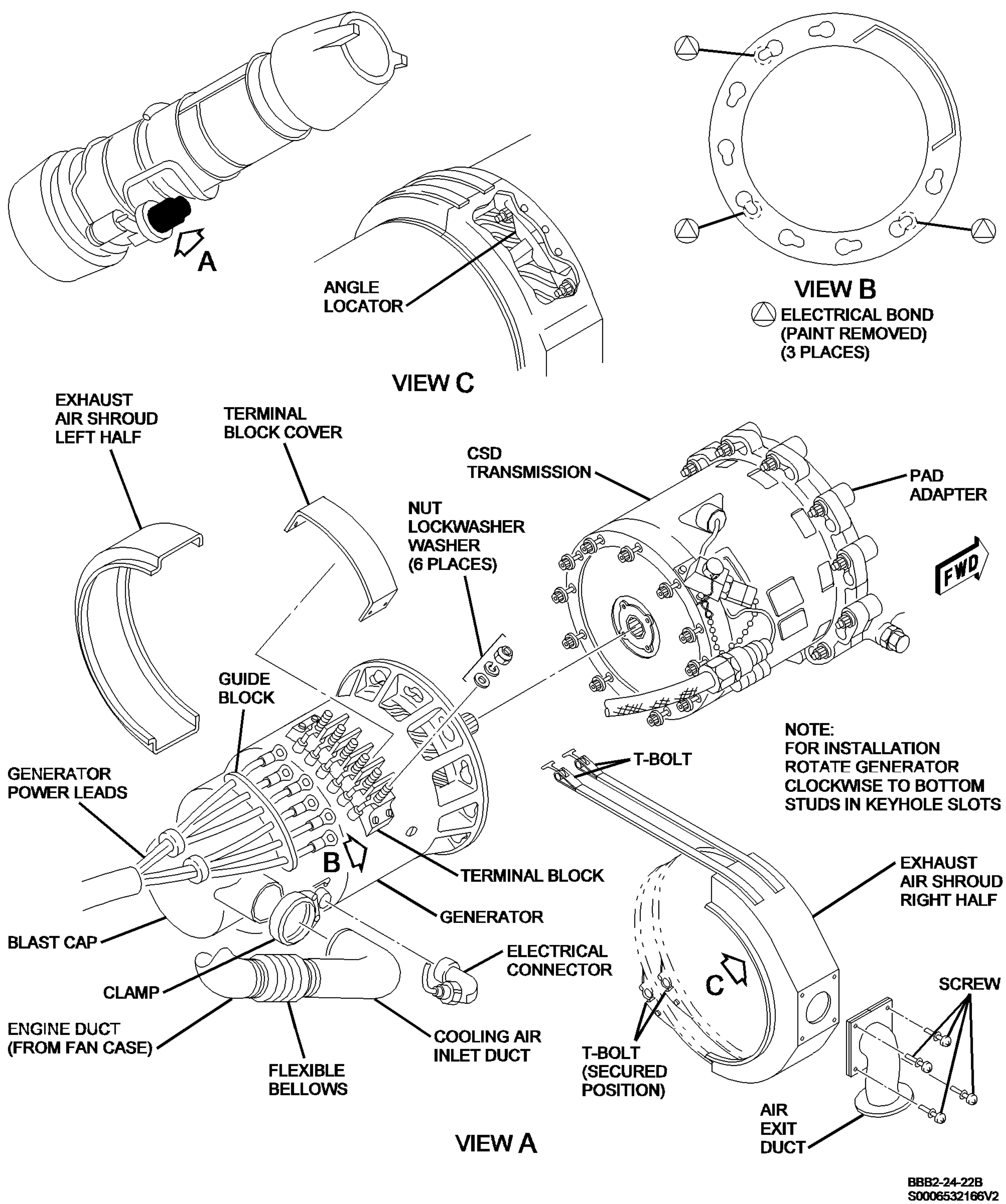
(15) Install terminal block cover on terminal block.

(16) Connect generator electrical connector; safety with lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(17) Install clamp securing cooling air inlet duct to generator blast cap, tighten to torque value specified on clamp.

NOTE: Position clamp so that, when tightening, there will be no interference with fire detector connector.

(18) Check output of applicable generator at next engine run. If volts/frequency are not within specification (115(±3) volts/400(±4) hertz), adjust generator. (PAGEBLOCK 24-20-01/501)



Ac Generator -- Installation
Figure 401/24-20-01-990-801

AC GENERATORS - ADJUSTMENT/TEST

1. **General**

   A. This section contains adjustment/test procedures to be used after installation of an engine-driven ac generator. The procedures are identical for left or right generator systems.

   B. Ac external or APU power must be supplied to the ac buses, to ensure having power available for engine instruments during adjustment of generator voltage.

2. **Equipment and Materials**

   NOTE: Equivalent substitutes may be used instead of the following listed item:

   NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 501

Name and Number	Manufacturer
Portable precision ac volt meter with 0 to 150-volt scale, calibrated at 115 (±0.4) volts	

3. **Adjustment/Test Ac Generators**

   A. Adjust Ac Generator

      (1) Place generator control switch of system to be functioned in OFF position.

      (2) Place AC BUS X TIE switch in OPEN position.

      (3) Check that DC BUS X TIE switch is in OPEN position.

      (4) Place AC VOLT/FREQ switch in applicable position (L or R); AC VOLTS and FREQUENCY meter should read zero.

         NOTE: FREQUENCY meter does not have a zero indication marked on the scale. When a procedural step states that frequency meter should indicate zero, the frequency meter pointer should be on the dot at lower end of scale.

      (5) Check that BATT switch is in ON position.

      (6) Check following corresponding lights for operation for system (left or right) to be tested.

         (a) AC BUS OFF...OFF

         (b) GEN OFF..ON

         (c) CSD OIL..ON

         (d) APU or EXT PWR AVAIL light......................ON

      WARNING: USE EXTREME CAUTION WHEN WORKING IN EPC AREA AS VOLTAGES ENCOUNTERED CAN BE FATAL. WHEN MEASURING VOLTAGE, OBSERVE SAFETY PRECAUTIONS NORMALLY FOLLOWED WHEN WORKING WITH HIGH VOLTAGES.

      (7) Connect portable precision voltmeter between GR side of aircraft ac voltmeter resistor and ground.

         NOTE: Resistor is located in lower aft side of the EPC, adjacent to corresponding power relay.

      (8) Start engine as engine reaches operating rpm, check following. (GENERAL, SUBJECT 71-00-00, Page 501)

         (a) CSD OIL light goes off.

(b) Applicable CSD oil temperature indicator should show an increase in outlet temperature and remain in normal operating range (below yellow band).

(c) AC VOLTS and FREQUENCY meter indications should increase. Ac VOLTS should stabilize at 115 (±3) volts, and FREQUENCY meter should stabilize at 400 (±4) Hz.

NOTE: Engine is to be run at idle rpm while performing generator adjustment/test procedures.

CAUTION: SHUT DOWN ENGINE IMMEDIATELY IF VOLTAGE AND FREQUENCY DO NOT REGISTER.

(9) If AC VOLTS and FREQUENCY meter indications are at zero, momentarily place GEN control switch in RESET position and back to OFF.

(10) Adjust applicable AC Generator Control Unit as follows.

(a) Hole labeled VOLT ADJ at lower right of face plate of generator control unit is for potentiometer adjustment.

(b) Adjust potentiometer to obtain, as nearly as possible, 115(±0.4) volts on precision voltmeter.

NOTE: Turn voltage adjustment potentiometer clockwise to increase voltage and counterclockwise to decrease voltage.

(c) Place GEN control switch in ON position.

CAUTION: IF AC LOAD METER INDICATES MORE THAN 1.0 CONTINUOUS LOAD, REDUCE LOADS TO PREVENT DAMAGE.

(d) Place applicable left or right AIR CONDITIONING SUPPLY switch in AUTO position to ensure load on generator system.

(e) Check precision voltmeter to be certain that voltage remains at 115 volts.

NOTE: If voltage indication decreases when load is added to system, generator control unit may be defective.

(f) Check AC VOLTS indication on overhead switch panel for system adjusted; if indication is not within tolerance of 115(±3) volts, replace AC VOLTS meter.

(g) Place AIR CONDITIONING SUPPLY switch in OFF position.

(11) Remove precision voltmeter.

(12) Check applicable lights as follows.

(a) AC BUS OFF...OFF

(b) GEN OFF..OFF

(c) APU or EXT PWR AVAIL light.....................OFF

(13) Check that applicable AC LOAD meter indicates some load.

(14) Place opposite applicable (APU or EXT PWR) bus switch in OFF position; AC BUS off light for that bus should come on.

CAUTION: IF AC LOADMETER INDICATES MORE THAN 1.0 CONTINUOUS LOAD, REDUCE LOADS TO PREVENT DAMAGE.

(15) Place AC BUS X TIE switch in AUTO position. AC LOAD meter for operating generator system should show an increase in load, AC BUS off light for opposite bus should go off.

(16) Place APU or EXT PWR BUS switches in ON position. AC LOAD meter for operating generator should show a decrease in load; applicable PWR AVAIL light for opposite bus should come on.

(17) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

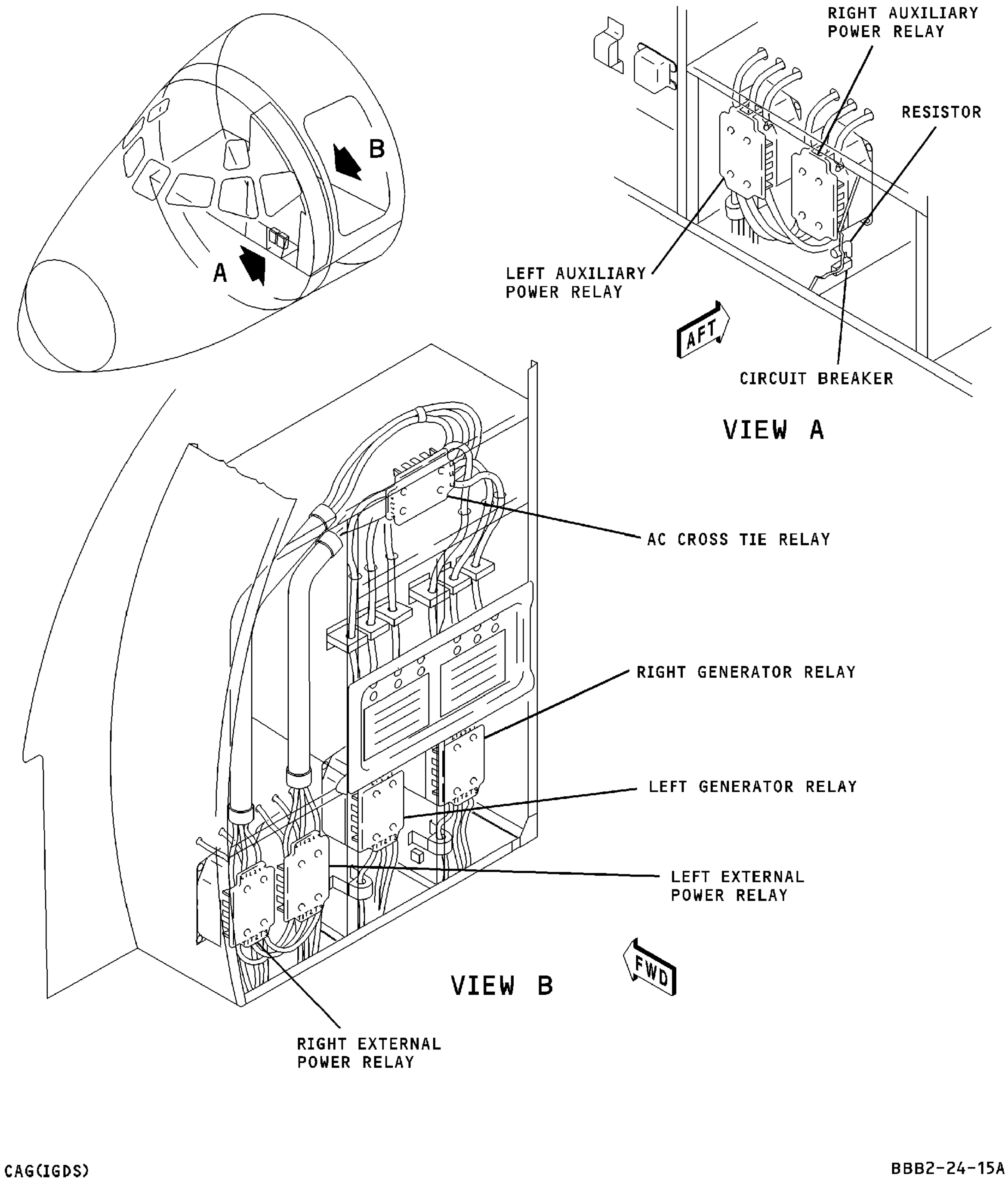
(18) As engine rpm drops, AC VOLTS and FREQUENCY meter readings should decrease; check following corresponding lights for system tested.

(a) GEN OFF..ON

(b) CSD OIL...ON

(c) Applicable APU or EXT PWR AVAIL...........ON

(19) Adjustment completed, position electrical power control switches as required.



AC Voltmeter Resistor -- Location
Figure 501/24-20-01-990-802

4. **AC Cross-tie Lockout Alert Display Test**

A. Preliminary Setup

(1) Remove electrical power from aircraft.

(2) Locate right external power relay R2-38 in electrical power center.

(3) Install jumper between connections 4CM and 4NO on relay R2-38.

(4) Start APU and select APU L bus switch to ON position. (GENERAL, SUBJECT 49-00-00, Page 501)

(5) On overhead panel, make sure that AC BUS X-TIE switch is selected to AUTO position.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(6) Open these circuit breakers and install safety tags:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

B. Check AC CROSS-TIE LOCKOUT display is ON as follows:

(1) On overhead panel, make sure that AC "R" bus is dead.

(a) "R AC BUS OFF" in overhead annunciator panel is illuminated.

(2) Remove jumper between 4CM and 4NO on R2-38 relay.

(a) Make sure AC "R" bus is dead.

(3) Remove the safety tags and close these circuit breakers:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893 (Continued)

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

(a) Make sure AC "R" bus is dead.

(4) On overhead panel, select APU R BUS switch to ON position.

(a) AC "R" bus should be powered.

(5) On upper or lower EPC circuit breaker panel, place AC CROSS-TIE RESET switch momentarily to RESET position.

(a) Display AC CROSS-TIE LOCKOUT on overhead annunciator panel should be extinguished.

(6) Shutdown APU. (GENERAL, SUBJECT 49-00-00, Page 501)

(7) Return aircraft to required configuration.

AC GENERATORS - ADJUSTMENT/TEST

1. General

A. This procedure contains MSG-3 task card data.

TASK 24-20-01-710-801

2. Operational Check of the AC Crosstie Lockout Alert

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
24-40-00 P/B 001	EXTERNAL POWER - DESCRIPTION AND OPERATION
49-00-00	GENERAL

B. Prepare for the Operational Check of the AC Crosstie Lockout Alert

SUBTASK 24-20-01-860-002

(1) Remove electrical power from aircraft and disconnect external power source. (EXTERNAL POWER - DESCRIPTION AND OPERATION, PAGEBLOCK 24-40-00/001)

SUBTASK 24-20-01-010-001

(2) Open access panel.

SUBTASK 24-20-01-860-004

(3) Install jumper between connections 4CM and 4NO on relay R2-38, located in the electrical power center.

C. Operational Check of the AC Crosstie Lockout Alert

SUBTASK 24-20-01-710-001

(1) Do an operational check of the AC crosstie lockout alert.

(a) Start APU. (GENERAL, SUBJECT 49-00-00)

(b) Select APU L bus switch to ON position.

(c) On overhead panel, make sure that AC BUS X-TIE switch is selected to AUTO position.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(d) Open these circuit breakers and install safety tags:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY

WJE 417, 419, 421, 423, 865, 869, 871, 872 (Continued)

(Continued)

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

(e) Check AC CROSS-TIE LOCKOUT display is ON as follows:

1) On overhead panel, make sure that AC R bus is dead.

a) R AC BUS OFF in overhead annunciator panel is illuminated.

2) Remove jumper between 4CM and 4NO on R2-38 relay.

a) Make sure AC R bus is dead.

3) Remove the safety tags and close these circuit breakers:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

a) Make sure AC R bus is dead.

4) On overhead panel, select APU R BUS switch to ON position.

a) AC R bus should be powered.

5) On upper or lower EPC circuit breaker panel, place AC CROSS-TIE RESET switch momentarily to RESET position.

a) Display AC CROSS-TIE LOCKOUT on overhead annunciator panel should be extinguished.

D. Job Close-up

SUBTASK 24-20-01-868-001

(1) Shutdown APU. (GENERAL, SUBJECT 49-00-00)

SUBTASK 24-20-01-942-001

(2) Remove all the tools and equipment from the work area. Make sure the area is clean.

SUBTASK 24-20-01-410-001

(3) Close access panel.

END OF TASK

AUXILIARY POWER UNIT AC GENERATOR - REMOVAL/INSTALLATION

1. General

CAUTION: FIRE DETECTOR SENSING ELEMENTS LOCATED WITHIN APU COMPARTMENT ARE VERY SENSITIVE. PHYSICAL CONTACT WITH THESE ELEMENTS CAN CAUSE HIDDEN DAMAGE. CONSTANT DIMENSION MUST BE MAINTAINED BETWEEN ELEMENTS AND SUPPORT TUBE.

A. Removal and installation of the auxiliary power unit (APU) AC generator can be accomplished without removing the APU from the airplane. The generator is accessible through the APU compartment access doors and also through an access hole in the upper bulkhead of the APU compartment. This access hole is reached from inside the aft accessory compartment.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

Table 401

Name and Number	Manufacturer
Antifretting compound, 688272	Sunstrand Aviation Div. Rockford, IL
Torque wrench (Capable of 0 to 300 inch-pounds, 0 to 33.9 N·m)	
Inconel Lockwire 0.20 in NASM20995N20, DPM 684	Not specified
Corrosion Resistant Steel Lockwire 0.020 in NASM20995C20, DPM 5865	Not Specified
Lockwire (AN995N14 .014 soft copper, FED-J-W-001177/9)	

3. **Removal/Installation APU AC Generator**

WARNING: GENERATOR WEIGHS APPROXIMATELY 86 POUNDS (39.0 KG). DUE TO WEIGHT OF UNIT AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR REMOVAL PROCEDURES.

WARNING: MAKE SURE ALL PERSONS ARE CLEAR OF THE HOT APU. DO NOT LET YOUR SKIN OR MATERIALS THAT BURN TOUCH THE HOT APU. LET THE APU TEMPERATURE DECREASE FOR A MINIMUM OF 30 MINUTES BEFORE YOU GO NEAR THE APU. THIS WILL HELP PREVENT INJURY TO PERSONS.

CAUTION: MAKE SURE THAT THE FIRE-SENSING-CABLES ON THE FIRE-DETECTOR-UNITS ARE NOT TWISTED OR WITH KINKS OR DENTS. THIS WILL PREVENT DAMAGE TO FIRE-SENSING-CABLES.

CAUTION: BEFORE THE APU GENERATOR IS LIFTED OR LOWERED, MAKE SURE ALL WIRE BUNDLES, POWER CABLES, HOSES, APU COMPONENTS AND AIRCRAFT STRUCTURE ARE CLEAR OF THE APU HOIST CABLE. THIS WILL HELP PREVENT CHAFING DAMAGE TO THE AIRCRAFT AND EQUIPMENT.

A. Remove APU AC Generator

(1) Remove cooling air inlet T-duct.

(a) Loosen clamp securing tee of turbine oil cooler air inlet duct to generator blast cap.

(b) Loosen clamp on inboard end of T-duct.

(2) Disconnect electrical connector at forward side of generator.

(3) Tag and disconnect starter wires.

(4) Remove clamp encircling generator that secures power lead support assembly and wire bundle clip.

NOTE: It is not necessary to remove power lead support assembly from power leads. Support will aid in proper installation of generator wiring by keeping power leads separated.

(5) Remove terminal block cover from generator terminal block; tag and disconnect power leads.

(6) Remove clamp connecting exhaust air duct from generator exhaust air shroud.

(7) Loosen T-bolt nuts sufficiently to remove two halves of shroud.

(8) Loosen nuts that attach generator to generator drive pad.

NOTE: The keyhole-type generator mounting holes are larger at one end than the attaching nuts. This permits removing generator without removing nuts from generator mounting studs. Attaching nuts must be loosened enough to rotate generator and center studs in large end of generator mounting holes.

CAUTION: SUPPORT AFT END OF GENERATOR TO PREVENT UNIT FROM FALLING.

(9) Rotate generator until studs are in large end of generator mounting holes.

CAUTION: AVOID SUPPORTING OR LIFTING GENERATOR BY DRIVE SHAFT TO PREVENT POSSIBLE DAMAGE TO SHAFT OR INTERNAL DAMAGE TO GENERATOR.

(10) Slowly move generator outboard until splined drive shaft of generator disengages female drive of APU.

(11) Cover generator drive pad opening to prevent entrance of foreign material.

(12) If original generator is not to be installed, remove blast cap.

WARNING: GENERATOR WEIGHS APPROXIMATELY 86 POUNDS (39.04 KG). DUE TO WEIGHT OF UNIT AND NECESSARY PRECAUTIONS, TWO MEN ARE REQUIRED FOR INSTALLATION PROCEDURES.

B. Install APU AC Generator

NOTE: Paragraph 3.B.(1) is not applicable if generator removed is to be reinstalled.

(1) Install blast cap; safety screws with (0.014 inch soft copper) lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

WARNING: ANTI-FRETTING COMPOUND IS AN AGENT THAT IS POISONOUS AND AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN ANTI-FRETTING COMPOUND IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET ANTI-FRETTING COMPOUND IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(2) Apply film of antifretting compound No. 688272 (Sundstrand Aviation), or equivalent, onto generator drive shaft splines.

(3) Remove protective covering from generator drive pad.

CAUTION: AVOID SUPPORTING OR LIFTING GENERATOR BY DRIVESHAFT TO PREVENT POSSIBLE DAMAGE TO SHAFT OR INTERNAL DAMAGE TO GENERATOR.

(4) Center large end of holes in generator mounting flange over attaching nuts on generator drive pad.

NOTE: Position generator so that terminal T1 of power lead terminal strip is at bottom centerline of generator.

(5) Slowly move generator inboard until male splined drive shaft of generator engages female drive of APU.

CAUTION: CHECK GENERATOR INSTALLATION TO ENSURE THAT CAPTIVE WASHERS ON MOUNTING NUTS ARE WITHIN SPOT-FACED AREA AROUND EACH MOUNTING HOLE OF GENERATOR MOUNTING FLANGE. IF WASHERS RIDE OUTSIDE EDGE OF SPOT-FACE, INSTALLATION WILL BE INSECURE AND GENERATOR MAY BECOME LOOSE.

(6) Rotate generator to bottom generator drive pad studs in small end of generator mounting holes; tighten attaching nuts to torque of 144 to 168 inch-pounds (16.27 to 18.98 N·m).

(7) Install shroud; leave attaching nuts sufficiently loose to reposition shroud as necessary.

(8) Install clamp securing exhaust air duct to shroud. Tighten attaching nut to torque of 35 to 45 inch-pounds (3.95 to 5.08 N·m).

(9) Tighten nuts locking two halves of shroud to torque of 25 to 35 inch-pounds (2.82 to 3.95 N·m).

(10) Connect power leads to generator terminal strip, making certain that all wires are connected properly tighten terminal nuts to torque of 160 to 190 inch-pounds (18.08 to 21.46 N·m). (Ref. Wiring Diagram Manual);

(11) Install terminal block cover on terminal block.

(12) Install clamp encircling generator; position clamp, wire bundle support clip, and power lead support. (Figure 401, View A-A)

(13) Connect starter wires, making certain that wires are connected properly. (Ref. Wiring Diagram Manual)

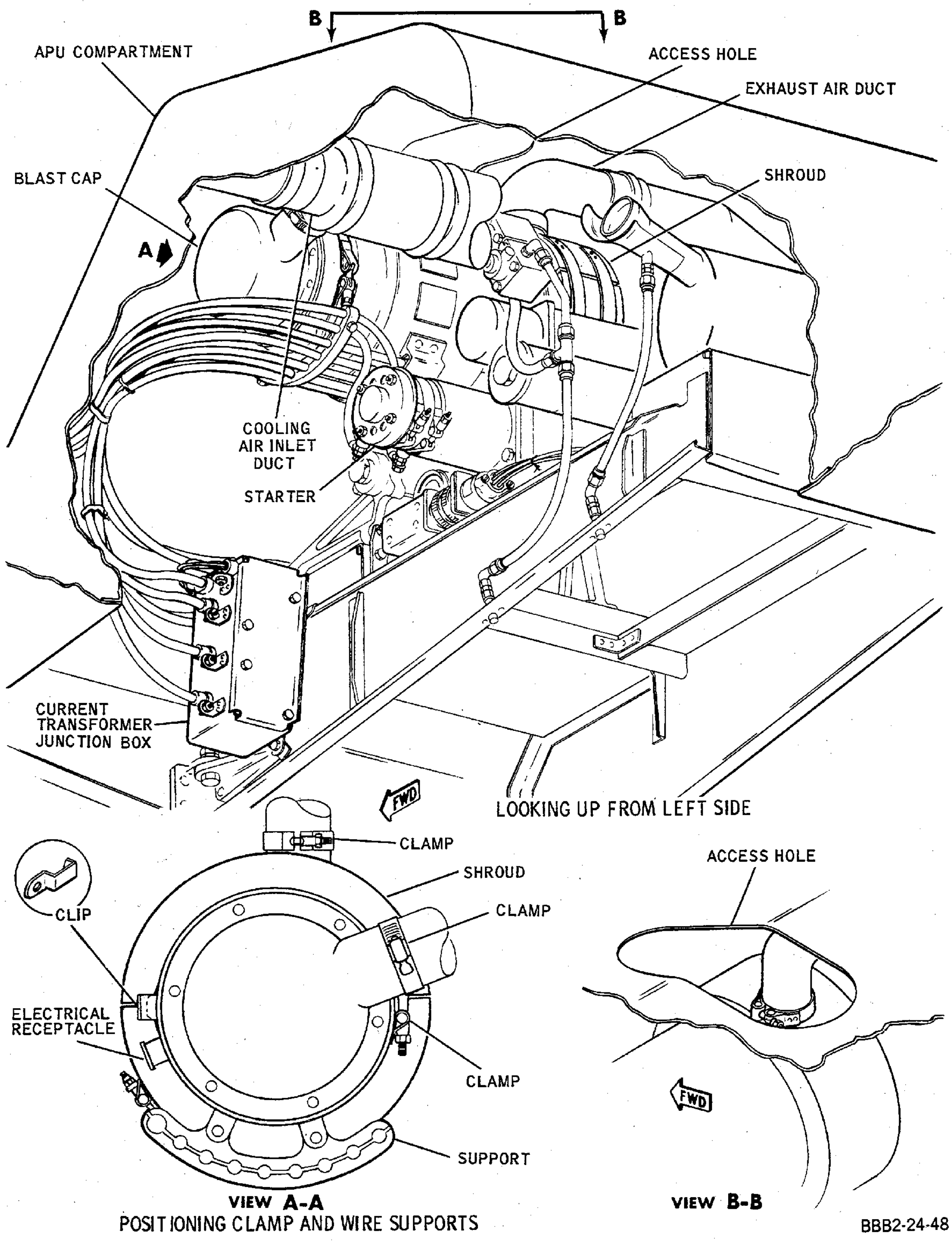
(14) Connect generator electrical connector; safety with lockwire. (LOCKWIRE SAFETYING - MAINTENANCE PRACTICES, PAGEBLOCK 20-10-18/201)

(15) Install cooling air inlet T-duct.

   (a) Tighten clamp on inboard end of T-duct.

   (b) Tighten clamp on generator blast cap inlet.

(16) Test APU generator. (PAGEBLOCK 24-20-02/501)



APU Generator Installation
Figure 401/24-20-02-990-802

AUXILIARY POWER UNIT AC GENERATOR - ADJUSTMENT/TEST

1. General

CAUTION: BE CERTAIN THAT NOSE GEAR IS SUFFICIENTLY COMPRESSED FOR GROUND SENSING MECHANISM TO ACTUATE NOSE GEAR OLEO SWITCH TO ENSURE LOCKOUT OF AC BUS CROSSTIE RELAY.

A. This section contains procedures to be used when a complete adjustment/test of the APU AC generator system is to be accomplished. These procedures are also to be used to test the system when it is necessary to replace the APU generator control unit.

NOTE: The following adjustment/test procedures can be accomplished with or without external power being supplied to the AC buses.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed item:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 501

Name and Number	Manufacturer
Portable precision AC volt meter with 0 to 150-volt scale, calibrated at 115 (±0.4) volts	

3. Adjustment/Test Auxiliary Power Unit AC Generator

CAUTION: NORMAL POWER SUPPLY TO VARIOUS LOAD DEMANDS THROUGHOUT AIRCRAFT IS NOT ASSURED WHILE FOLLOWING ADJUSTMENT/TEST PROCEDURES ARE BEING PERFORMED. BE CERTAIN THAT SWITCHES FOR ALL OTHER AIRCRAFT SYSTEMS ARE IN OFF OR DISARMED POSITION BEFORE STARTING ADJUSTMENT/TEST PROCEDURES FOR APU AC GENERATOR.

A. Adjust AC Generator

NOTE: Master caution lights or master warning lights will come on at various points in the procedures. Lights should be reset immediately before proceeding with the next step of the procedure.

(1) Check that APU L BUS, APU R BUS, and APU PWR-GROUND SERVICE ELECT PWR switches are in OFF position.

(2) Place AC BUS X TIE switch in OPEN position.

(3) Check that DC BUS X TIE switch is in OPEN position.

(4) Place AC VOLT/FREQ switch in VOLT/FREQ APU position; AC VOLTS meter and FREQUENCY meter should read ZERO.

(5) Check that BATT switch is in ON position.

(6) Check following annunciator panel lights for operation.

(a) With external power supplied to AC and DC buses and with EXT PWR LEFT BUS and EXT PWR RIGHT BUS switches ON:

Annunciator Light	ON/OFF
1) L AC BUS OFF	OFF
2) R AC BUS OFF	OFF

(Continued)

Annunciator Light	ON/OFF
3) EXT PWR L BUS	ON
4) EXT PWR R BUS	ON
5) EXT PWR AVAIL	ON
6) APU L BUS	OFF
7) APU R BUS	OFF
8) APU PWR AVAIL	OFF
9) APU GEN OFF	OFF
10) AC CROSSTIE LOCKOUT	OFF
11) TRANSFER BUS OFF	OFF
12) DC BUS OFF	OFF
13) AC EMER BUS OFF	OFF
14) DC EMER BUS OFF	OFF

(b) Without external power supplied to AC and DC buses and with EXT PWR LEFT BUS and EXT PWR RIGHT BUS switches OFF:

Annunciator Light	ON/OFF
1) L AC BUS OFF	ON
2) R AC BUS OFF	ON
3) EXT PWR L BUS	OFF
4) EXT PWR R BUS	OFF
5) EXT PWR AVAIL	OFF
6) APU L BUS	OFF
7) APU R BUS	OFF
8) APU PWR AVAIL	OFF
9) APU GEN OFF	OFF
10) AC CROSSTIE LOCKOUT	OFF
11) TRANSFER BUS OFF	OFF
12) DC BUS OFF	ON
13) AC EMER BUS OFF	ON
14) DC EMER BUS OFF	ON

(7) Start APU (GENERAL, SUBJECT 49-00-00, Page 501); when APU MASTER switch (at time of APU start), is moved out of OFF position, APU GEN OFF light should come ON; when APU speed reaches approximately 95 percent, FREQUENCY meter should read approximately 380 Hz and APU PWR AVAIL light should come ON at the overhead switch panel and ground service electric power panel. All other lights noted in Paragraph 3.A.(6)(b) will not change.

(8) If APU PWR AVAIL light is not on when APU speed has stabilized, momentarily place APU GEN RESET switch in RESET position and release.

NOTE: If after APU start, the APU generator power available lights remain extinguished even though APU speed has stabilized, reset the APU generator switch. Resetting the APU generator brings electrical power to the buses. Only one (1) reset is permitted for each APU start. If the generator has to be reset several times after the APU start, this would indicate a system problem and maintenance investigation is warranted.

(9) AC VOLTS meter should read 115 (±3) volts; FREQUENCY meter should read 404(±2) Hz; APU AC LOAD meter should read zero.

WARNING: USE EXTREME CAUTION WHEN WORKING IN EPC AREA AS VOLTAGES ENCOUNTERED CAN BE FATAL. WHEN MEASURING VOLTAGES, OBSERVE SAFETY PRECAUTIONS NORMALLY FOLLOWED WHEN WORKING WITH HIGH VOLTAGES.

(10) If AC VOLTS meter indication is not within tolerance of 115(±3) volts, adjust voltage. (PAGEBLOCK 24-20-01/501)

(11) If AC frequency meter indication in Paragraph 3.A.(9) is not within tolerance, adjust APU per procedures given in Check and Adjust Fuel Control Governor Speed Setting to frequency of 404(±2) Hz. (GENERAL, SUBJECT 49-00-00, Page 501)

(12) The above steps are conducted with no load on APU (bleed and electrical). If APU generator voltage and frequency are observed under an electrical load condition, allowable limits change. The following values are acceptable for both flight and ground operations with an APU generator load meter reading between 0.2 and 1.2 units: frequency 405(±15) Hz, voltage 115(±3) volts.

(13) With left and right external power switches ON, place APU L BUS switch in ON position; APU AC LOAD meter should indicate some load.

(a) With external power supplied to AC buses, annunciator and panel indicator should be as follows:

Annunciator Light	ON/OFF
1) L AC BUS OFF	OFF
2) R AC BUS OFF	OFF
3) EXT PWR L BUS (blue light)	OFF
4) EXT PWR R BUS (blue light)	ON
5) EXT PWR AVAIL (blue light) (two places)	ON
6) APU L BUS (blue light)	ON
7) APU R BUS (blue light)	OFF
8) APU PWR AVAIL (blue light) (two places)	ON
9) APU GEN OFF	OFF
10) AC CROSSTIE LOCKOUT	OFF
11) DC TRANSFER BUS OFF	OFF
12) DC BUS OFF	OFF
13) AC EMER BUS OFF (red light)	OFF
14) DC EMER BUS OFF (red light)	OFF

(b) Without external power supplied to AC buses:

Annunciator Light	ON/OFF
1) L AC BUS OFF	OFF
2) R AC BUS OFF	ON
3) EXT PWR L BUS (blue light)	OFF
4) EXT PWR R BUS (blue light)	OFF
5) EXT PWR AVAIL (blue light) (two places)	OFF
6) APU L BUS (blue light)	ON
7) APU R BUS (blue light)	OFF
8) APU PWR AVAIL (blue light) (two places)	ON
9) APU GEN OFF	OFF
10) AC CROSSTIE LOCKOUT	OFF
11) DC TRANSFER BUS OFF	OFF
12) DC BUS OFF	ON
13) AC EMER BUS OFF (red light)	OFF
14) DC EMER BUS OFF (red light)	OFF

CAUTION: IF APU AC LOAD METER INDICATES MORE THAN 1.25 CONTINUOUS LOAD, REDUCE LOADS TO PREVENT DAMAGE TO APU GENERATOR.

(14) Place APU R BUS switch in ON position; APU AC LOAD meter should show an increase in load; check following lights for operation.

(a) With external power supplied to AC buses:

Annunciator Light	ON/OFF
1) L AC BUS OFF	OFF
2) R AC BUS OFF	OFF
3) EXT PWR L BUS (blue light)	OFF
4) EXT PWR R BUS (blue light)	OFF
5) EXT PWR AVAIL (blue light) (two places)	ON
6) APU L BUS (blue light)	ON
7) APU R BUS (blue light)	ON
8) APU PWR AVAIL (blue light) (two places)	ON
9) APU GEN OFF	OFF
10) AC CROSSTIE LOCKOUT	OFF
11) DC TRANSFER BUS OFF	OFF
12) DC BUS OFF	OFF
13) AC EMER BUS OFF (red)	OFF
14) DC EMER BUS OFF (red)	OFF

(b) Without external power supplied to AC buses:

Annunciator Light	ON/OFF
1) L AC BUS OFF	OFF
2) R AC BUS OFF	OFF
3) EXT PWR L BUS (blue light)	OFF
4) EXT PWR R BUS (blue light)	OFF
5) EXT PWR AVAIL (blue light) (two places)	OFF
6) APU L BUS (blue light)	ON
7) APU R BUS (blue light)	ON
8) APU PWR AVAIL (blue light)(two places)	ON
9) APU GEN OFF	OFF
10) AC CROSSTIE LOCKOUT	OFF
11) DC TRANSFER BUS OFF	OFF
12) DC BUS OFF	OFF
13) AC EMER BUS OFF (red)	OFF
14) DC EMER BUS OFF (red)	OFF

(15) Place AC BUS X TIE switch in AUTO position; there should be no changes.

(16) With external power supplied to the aircraft; place EXT PWR L BUS and EXT PWR R BUS switches in OFF position; there should be no changes.

(17) Place APU L BUS switch in OFF position; APU AC load meter should show decrease in load; L AC BUS OFF and DC BUS OFF lights should come ON; APU L BUS blue light should go OFF.

(18) Place APU L BUS switch in ON position; APU AC load meter should show increase in load; L AC BUS OFF and DC BUS OFF lights should go OFF. APU L BUS (blue) light should come ON.

(19) Place APU R BUS switch in OFF position; APU AC load meter should show decrease in load; R AC BUS OFF and DC BUS OFF lights should come ON. APU R BUS (blue) light should go OFF.

(20) Place APU R BUS switch in ON position; APU AC load meter should show increase in load; R AC BUS OFF and DC BUS OFF lights should go off. APU R BUS (blue) light should come ON.

NOTE: The previous steps check APU for proper ground operation. The following steps check APU crosstie operation, simulating flight condition.

(21) Place APU R BUS switch in OFF position; APU AC load meter should show decrease in load; R AC BUS OFF and DC BUS OFF lights should come ON. APU R BUS (blue) light should go OFF.

WARNING: NORMAL ELECTRICAL POWER TO VARIOUS SYSTEMS MAY BE INTERRUPTED WHEN GROUND CONTROL RELAY CIRCUIT BREAKERS ARE OPENED. IF GROUND CONTROL RELAY CIRCUIT BREAKERS ARE TO BE OPENED WHILE PERFORMING PROCEDURES, MAKE CERTAIN SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITION TO PREVENT INADVERTENT OPERATION OF EQUIPMENT.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(22) Open these circuit breakers and install safety tags:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

WJE ALL

(23) R AC BUS OFF and DC BUS OFF lights should go OFF. APU AC LOAD meter should show increase in load.

WARNING: NORMAL ELECTRICAL POWER TO VARIOUS SYSTEMS MAY BE INTERRUPTED WHEN GROUND CONTROL RELAY CIRCUIT BREAKERS ARE OPENED. IF GROUND CONTROL RELAY CIRCUIT BREAKERS ARE TO BE OPENED WHILE PERFORMING PROCEDURES, MAKE CERTAIN SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITION TO PREVENT INADVERTENT OPERATION OF EQUIPMENT.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(24) Open these circuit breakers and install safety tags:

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

(25) There should be no change in readings obtained in Paragraph 3.A.(23).

(26) Place APU L BUS switch in OFF position; R AC BUS OFF, L AC BUS OFF, APU GEN OFF, DC BUS OFF, AC EMER BUS OFF, and DC EMER BUS OFF lights should come ON; APU AC load meter should show no load.

(27) Place APU R BUS switch in ON position; R AC BUS OFF, L AC BUS OFF, APU GEN OFF, DC BUS OFF, AC EMER BUS OFF, and DC EMER BUS OFF lights should go OFF; APU AC load meter should show same load as in Paragraph 3.A.(23).

(28) Remove the safety tags and close these circuit breakers:

UPPER EPC, R AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
L	30	B1-24	RIGHT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
L	33	B1-24	RIGHT GROUND CONTROL RELAY

WJE ALL

(29) L AC BUS OFF, and DC BUS OFF lights should come ON. APU AC LOAD meter should show decrease in load.

(30) Remove the safety tags and close these circuit breakers:

UPPER EPC, L AC BUS

Row	Col	Number	Name
WJE 417, 419, 421, 423, 865, 869, 871, 872			
K	30	B1-23	LEFT GROUND CONTROL RELAY
WJE 401-412, 414-416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873-881, 883, 884, 886, 887, 891-893			
K	33	B1-23	LEFT GROUND CONTROL RELAY

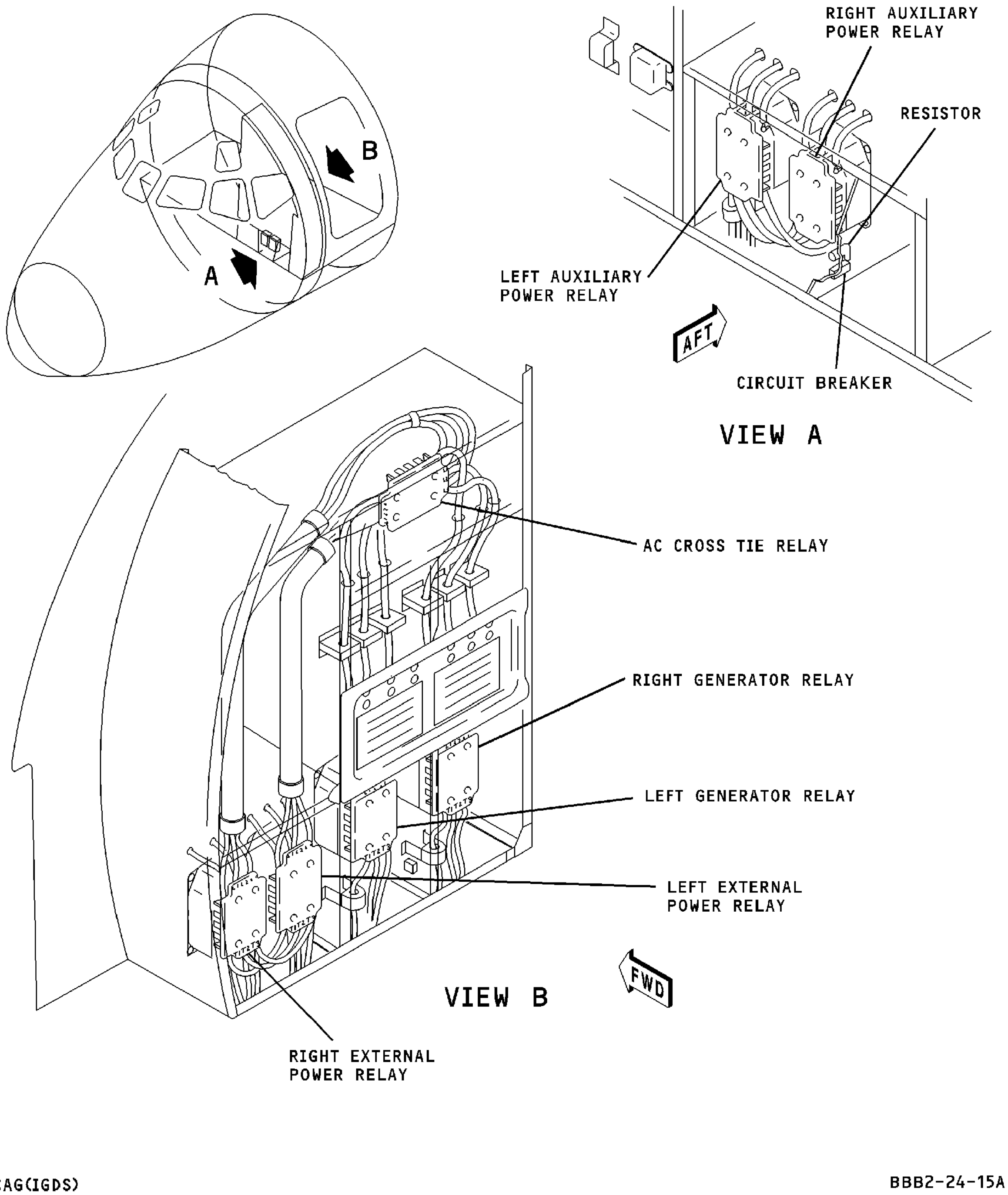
WJE ALL

(31) There should be no change in reading obtained in Paragraph 3.A.(29).

(32) If external power is available, place EXT PWR L BUS and EXT PWR R BUS switches in ON position.

(33) Shut down APU. (GENERAL, SUBJECT 49-00-00, Page 501)

(34) Test completed, position electrical power switches as required.



AC Voltmeter Resistors -- Location
Figure 501/24-20-02-990-801

AC GENERATION POWER RELAYS - MAINTENANCE PRACTICES

1. General

A. This maintenance practice provides removal/installation procedures for the generator relays (GR), auxiliary power relays (APR), external power relay (EPR), and cross tie relay (ACTR).

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 201

Name and Number	Manufacturer
Torque wrench (0-135 inch pounds range, 0-15.2 N·m)	
Multimeter Model 260	Simpson

3. Removal/Installation Power Relay

A. Remove Power Relay (GR, ACTR, APR). (Figure 201)

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(2) Placard engine and APU start switches with suitable WARNING to prevent engine operation.

(3) Make certain BATT. switch is in OFF position and external electrical power is deenergized.

(4) Place AC BUS X TIE switch in OPEN position.

(5) Place APU L BUS and APU R BUS switches to OFF position and verify bus lights are off.

(6) Place EXT PWR L BUS and EXT PWR R BUS to OFF position and verify bus lights are off.

(7) For power relay GR and ACTR:

(a) Remove forward cabin attendants seat (forward entrance area). (PAGEBLOCK 25-23-01/201)

(b) Open this access panel:

Number	Name/Location
4603A	Electrical Power Panel and Following Relays: Right External Power Left External Power Left Generator Right Generator

(8) For power relay APR:

(a) Open this access panel:

Number	Name/Location
4425A	Left Auxiliary Power Relay, Auxiliary Power Unit Voltmeter, Circuit Breaker (1/2 amp), Right Auxiliary Power Relay

(9) Remove relay cover and disconnect power cables and control power cables from relay terminals. Tag and identify each cable as to correct terminal location.

(10) Remove the six ACTR limiters, relay and replace relay cover.

B. Install Power Relay (GR, ACTR, APR) (Figure 201)

NOTE: If aircraft configuration permits, all AC power may be removed, the bus control switches on the overhead turned OFF and tagged, and the battery switch to OFF as an alternate to circuit breaker opening.

(1) For GR and ACTR power relays. Make sure this access panel is open:

Number	Name/Location
4603A	Electrical Power Panel and Following Relays: Right External Power Left External Power Left Generator Right Generator

(2) For APR power relays. Make sure this access panel is open:

Number	Name/Location
4425A	Left Auxiliary Power Relay, Auxiliary Power Unit Voltmeter, Circuit Breaker (1/2 amp), Right Auxiliary Power Relay

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(3) Make sure that these circuit breakers are open and have safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

(4) Verify engines or APU are not operating.

(5) Verify BATT. switch is in OFF position and external electrical power is deenergized.

(6) Verify AC BUS X TIE switch is in OPEN position.

(7) Verify APU L BUS and APU R BUS switches in OFF position and verify bus lights are off.

(8) Verify EXT PWR L BUS and EXT PWR R BUS switches in OFF position and bus lights are off.

(9) Remove relay cover and prior to installing, verify relay is open (tripped) by verifying continuity is not present across terminals L1 and T1. Relay may be opened by applying 28 VDC to terminals TRP (Pos) and TRG (Neg) of relay.

CAUTION: POWER RELAY MUST BE IN OPEN (TRIPPED) POSITION DURING INSTALLATION OR DAMAGE TO ASSOICATED GENERATOR MAY RESULT.

(10) Install ACTR six limiters on relay and install power relay. (GENERAL INSTALLATIONS HARDWARE - MAINTENANCE PRACTICES, SWPM 20-20-03)

(11) Connect input power cables to terminals T1, T2, T3, and output power cables to terminals L1, L2, and L3 on power relay. Torque the terminals connections to 90 +0 / -8 in-lb (10 +0 / -1 N·m).

(12) Connect control wires to terminals on power relay. Torque the terminals connections to12 ±2 in-lb (1.36 ±0.23 N·m).

(13) Torque terminal strips that follow whenever there is maintenance on the power relays.Table 202

Table 202 Terminal Strips and Location

Name	Number	Location	Torque
Left Generator and Control	S3–19	F.S 342	125 ±5 in-lb (14 ±1 N·m)
Left Generator and Control	S3–280	F.S. 1221	125 ±10 in-lb (14.1 ±1.2 N·m)
Right Generator and Control	S3–21	F.S 249	125 ±5 in-lb (14 ±1 N·m)
Right Generator and Control	S3–281	F.S. 1260	125 ±10 in-lb (14.1 ±1.2 N·m)
APU Generator and Control	S3–23	F.S. 342	125 ±5 in-lb (14 ±1 N·m)
APU Generator and Control	S3–282	F.S 1221	125 ±10 in-lb (14.1 ±1.2 N·m)
NOTE: An alternate means of accessing terminal strips S3-19, S3-21 and S3-23 for torquing can be done by removing the generator control rack panel, P/N 5956639-(Ref).			

(14) Close the applicable access panels:

Number	Name/Location
4425A	Left Auxiliary Power Relay, Auxiliary Power Unit Voltmeter, Circuit Breaker (1/2 amp), Right Auxiliary Power Relay

(Continued)

Number	Name/Location
4603A	Electrical Power Panel and Following Relays: Right External Power Left External Power Left Generator Right Generator

(15) Reinstall the forward cabin attendant seat. (PAGEBLOCK 25-23-01/201)

(16) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(17) Place AC BUS X TIE switches in AUTO position.

(18) Verify BATT switch in OFF position.

(19) Remove engine and APU start switch WARNING placards.

(20) Perform operational check during engine run-up availability but prior to flight. (Paragraph 4.)

C. Remove Power Relay (EPR) (Figure 201)

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(2) Make certain all engines are not operating and will not be started during EPR removal.

(3) Remove forward cabin attendant seat (forward entrance area). (PAGEBLOCK 25-23-01/201)

(4) Open this access panel:

Number	Name/Location
4603A	Electrical Power Panel and Following Relays: Right External Power Left External Power Left Generator Right Generator

(5) Remove relay cover and disconnect power cables and control power cables from relay terminals. Tag and identify each cable as to correct terminal location.

D. Install Power Relay (EPR) (Figure 201)

(1) Make sure that this access panel is open:

Number	Name/Location
4603A	Electrical Power Panel and Following Relays: Right External Power Left External Power Left Generator Right Generator

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(2) Make sure that these circuit breakers are open and have safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(3) Make certain all engines are not operating and will not be started during EPR installation.

(4) Remove relay cover and prior to installing verify relay is open (tripped) by verifying continuity is not present across terminals L1 and TI. Relay may be opened by applying 28 VDC to terminals TRP (Pos) and TRG (Neg) of relay.

(5) Connect input power cables to terminals T1, T2, T3, and output power cables to terminals L1, L2, and L3 on power relay. Torque the terminals connections to 90 +0 / -8 in-lb (10 +0 / -1 N·m).

(6) Torque terminal strips that follow whenever there is maintenance on the power relays.Table 202

(7) Remove terminal identification tags.

(8) Close this access panel:

Number	Name/Location
4603A	Electrical Power Panel and Following Relays: Right External Power Left External Power Left Generator Right Generator

(9) Replace forward cabin attendants seat. (PAGEBLOCK 25-23-01/201)

(10) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

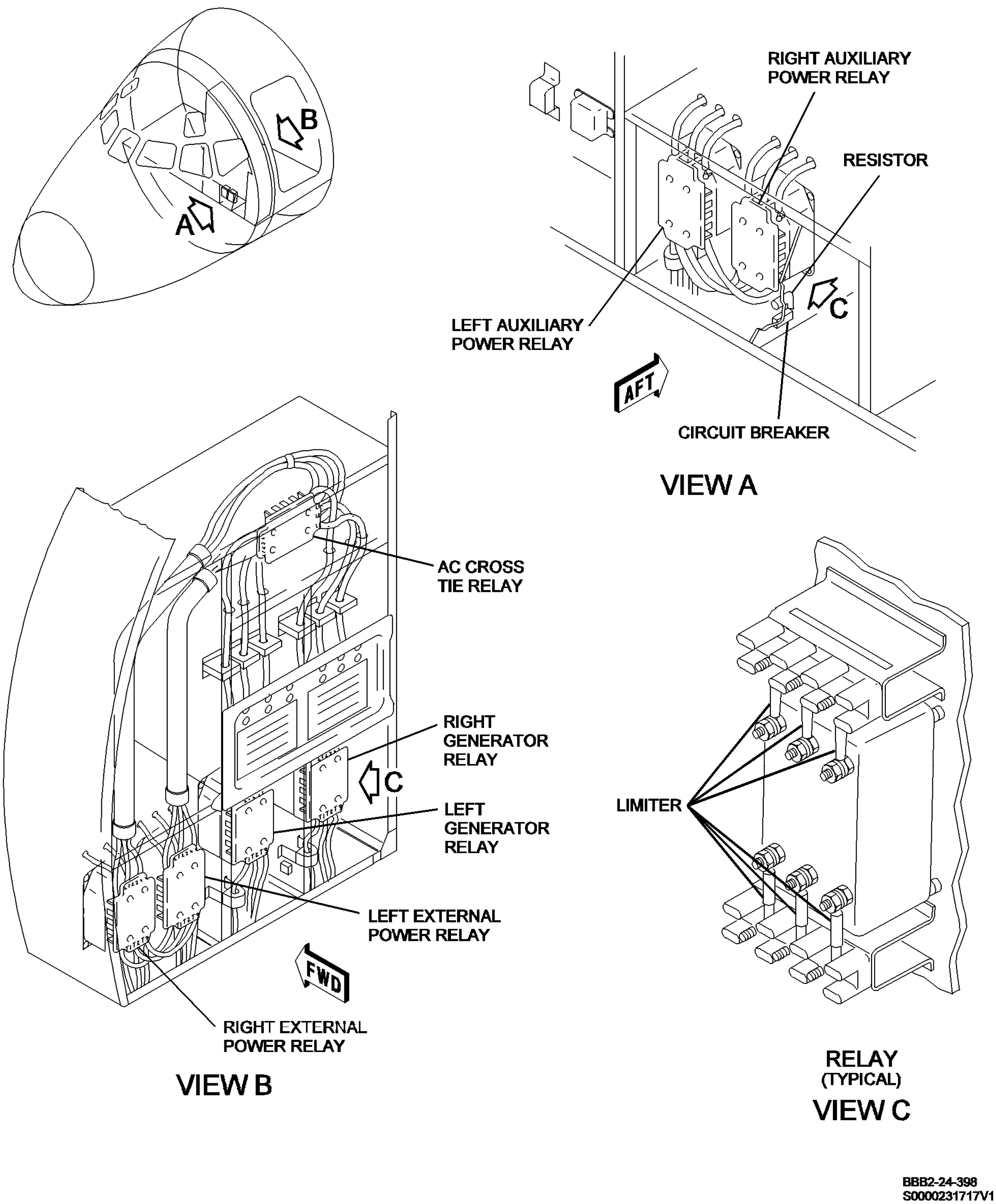
LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(11) Perform test of power relay for proper connection during engine run availability but prior to flight. (Paragraph 4.)



AC Generation Power Relays -- Location
Figure 201/24-20-06-990-801

4. **Test Power Relay for Proper Connection**

A. Test for Proper Connection

(1) Check external electrical power system according to EXTERNAL POWER - DESCRIPTION AND OPERATION, PAGEBLOCK 24-40-00/001.

(2) Start APU and disconnect external power. (GENERAL, SUBJECT 49-00-00, Page 501)

(3) Perform AC Crosstie Check with APU Generator. (AC GENERATION - MAINTENANCE PRACTICES, PAGEBLOCK 24-20-00/201)

(4) Perform AC Crosstie Check with Engine Generators. (AC GENERATION - MAINTENANCE PRACTICES, PAGEBLOCK 24-20-00/201)

AC GENERATOR CONTROL UNIT - DESCRIPTION AND OPERATION

1. General

A. Three generator control (GCU) units, one each for the left and right engine-driven AC generators and the APU generator, are located in the generator control rack in the electrical/electronics compartment. The generator control panel contains protection functions, control, and maintenance (fault) annunciator for the individual generator system.

B. The function of the protection circuits is to sense and isolate a fault condition before it can damage the overall system or its loads. The circuits are capable of distinguishing between normal transient condition and actual fault condition; they are coordinated to first permit the distribution system protection to function, and then to isolate the faulted area when it exists within the generating system. The protection functions are differential protection, undervoltage, underfrequency, overvoltage, and phase sequence.

C. The control functions are: power ready, generator control, anti-cycle, AC crosstie relay (ACTR), time delay (CTTD), fault selector time delay (FSTD), undervoltage time delay (UVTD), and underfrequency time delay (UFTD).

D. The maintenance annunciator contains the functions to indicate the most probable source of AC system failure . The components annunciated are distribution system (DISTR SYS), AC generator (GEN), AC generator control unit (AC GEN CONTROL), and constant-speed drive transmission (DRIVE).(Figure 1)

2. Operation

A. Protection Circuits

(1) Differential protection (DP) is used to sense the presence of a line-to-line or line-to-neutral fault occurring on the main AC wiring of a generator system between the generator neutral lead and the load bus. The DP zone includes the generator output winding and terminals, generator feeders, and generator relay. A DP fault will cause the GCR to trip and the ACTR will be locked out. The GCR trip causes power ready relay (PRR) to drop out and this causes the main generator power relay (GR) to trip and send a signal to annunciate a DP fault.

(2) When a DP fault exists, a differential current will flow in the DP loop. This current is applied across burden resistors and is half-wave rectified. The half wave rectified signal is filtered and then applied to an operation amplifier. When the DP fault is of sufficient magnitude (20 to 40 amperes) a DP fault exists. The DP signal causes the GCR to trip, which causes the PRR to drop out, which in turn causes the GR to trip. The DP signal turns on transistor switches which provides 28 VDC to lockout the ACTR. This lockout signal is annunciated on the overhead annunciator panel. A 28 Volt signal causes the DSAR to trip lighting the distribution system light on the GCU (maintenance panel indication).

(3) The AC crosstie relay (ACTR) is locked out to prevent a good system from being connected to the faulted system.

(4) The undervoltage (UV) protection circuit is normally set to operate at approximately 95 volts line to neutral. Under normally operating conditions, the UV circuits are passive in nature.

(5) When an undervoltage (UV) condition exists 90 to 105 volts line to neutral, the UV condition is sensed and several actions will take place. The crosstie time delay (CTTD), fault selector time delay (FSTD) are initiated, and a signal is sent to the underfrequency (UF) circuit to keep it locked in.

(6) When CTTD times out (2.0 to 4.0 seconds), a signal is sent to the bus control to trip the ACTR. If the UV condition recovers, the UV sensing circuit will energize, sending an ACTR lockout signal to the BC. At the same time, UV circuit will reset the CTTD and FSTD. No other action is taken.

(7) If the UV condition persists after the ACTR is tripped, FSTD times out (5.0 to 7.0 seconds) starting UVTD, locking in FSTD, and tripping the GR. If the UV condition recovers after the GR is tripped, a signal is sent to the BC to lockout the ACTR.

(8) When UVTD times out (0.4 to 1.0 second), a signal is sent to trip the GCR. Also, the UVTD sends a signal to the maintenance annunciator circuit. If the UV condition does not recover before UVTD times out, the ACTR will not be locked out.

(9) The underfrequency (UF) protection circuit is used to protect the system in the event of low RPM output of the drive. The circuit is adjusted so that UFR energizes at 380 Hz and deenergizes at 375 Hz. The UF circuit is single-phase sensing. Using phase C under normal frequency conditions, the UF circuit is passive, UFTD is deenergized, and no protective action is required.

(10) When an underfrequency condition exists, the UF circuit starts the UFTD. When UFTD times out (0.75 to 1.25 seconds), the power ready relay (PRR) deenergizes and a PRR contact closes tripping the GR, and the generator is removed from the bus.

(11) At the same time UFTD starts timing, a signal from the UF circuit prevents the UV circuit from starting CTTD and FSTD. This prevents the UV circuit from operating during engine shutdown.

(12) The overvoltage (OV) protection circuit is used to protect the system on OV condition. The OV circuit is adjusted for operation at 126 to 137 volts line to neutral with nominal setting at 130 volts line to neutral. The OV circuit has an inverse time delay. Under normal conditions, the voltage applied to the OV circuit is not high enough to start the inverse time delay and the circuit is inactive.

(13) When an overvoltage condition exists, the OV inverse time delay is started. The greater the OV condition, the shorter the time required for tripping the GCR. The GCR contact opens and the PRR deenergizes. When the PRR deenergizes, a PRR contact closes tripping the GR. Also, when the OV is sensed, a signal is sent to the maintenance annunciator circuit.

(14) Protection from improper phase rotation buildup of the generator is provided by monitoring two phases (A and B). In order for the circuit to close the PRR, the phase rotation must be ABC. If the phase rotation is incorrect (ACB), the PRR will not close.

B. Control Circuits

(1) Output of the generator PMG is applied to GC pins A5 and A6. The DC output of the PMG transformer-rectifier (PMG TR) is fed to the 28-volt DC bus in the GC. This 28-volt bus is also fed by the airplane DC transfer bus through pin A10. The DC output of the PMG TR, under normal conditions, is higher than the DC transfer bus and will block power from the dc transfer bus. However, under some conditions such as power relay operation, power may be taken from the dc transfer bus. PMG power for regulator circuit operation is fed through a GCR contact to the regulator circuit. A voltage regulator circuit supplies the 15-volt DC bus in the GC unit.

(2) When the power ready relay (PRR) energizes, a PRR contact closes in the generator relay (GR) close coil circuit. If the FSTD and the DBC are not energized and if the ACTR, EPR and APR are open, the GR close coil circuit is complete and the GR will close. The GR can be tripped by moving the generator control switch to the off position, by deenergizing the PRR, or by FSTD being energized.

(3) The generator control relay (GCR) will close when the generator control switch is placed momentarily to reset position. A GCR contact circuit will close supplying PMG power to the voltage regulator and another GCR contact will open allowing 15-volt DC power to each PRR amplifier circuit.

(4) The GCR is tripped by closing the generator cutoff switch (pulling fire control handle) or by the OV, DP, or UVTD circuits being energized. When the GCR is tripped, the contacts open, removing power from the regulator circuit and PRR amplifier. The PRR will deenergize without any time delay. At the same time the GCR is tripped, an anti-cycle circuit will latch to prevent cycling the GCR if the generator control switch is held in the reset position when a fault exists.

(5) With the generator control switch in on position and the proper phase sequence (PS) present and when no UV and UF conditions exist, the logic connected to these three circuits will allow the PRR to energize. Once the PRR is energized, a latching circuit effectively bypasses this logic. Contacts of PRR open the GR trip circuit and close the GR close circuit. Other PRR contacts give a signal to the bus control panel that the generator is supplying the applicable bus.

(6) The PRR can be deenergized by either tripping the GCR or by underfrequency time delay (UFTD). When the GCR is tripped, a GCR contact removes power from the PRR amplifier circuit and PRR will deenergize with no time delay. Under normal frequency conditions, UFTD has power input and a no-start signal input through the underfrequency circuit (UF). When an underfrequency condition exists, the UF circuit energizes, UFTD begins to time out (0.75 to 1.25 seconds) and after UFTD times out the PRR will deenergize. If the frequency recovers before UFTD times out, the PRR will not deenergize.

(7) AC-crosstie time delay (CTTD) and fault selector time delay (FSTD) are both disabled by the UV circuit under normal operation. If an underfrequency condition occurs before an undervoltage condition, the underfrequency circuit will energize, disabling the CTTD and FSTD. If an undervoltage condition exists before an underfrequency condition, the UV circuit energizes, latches out the UF circuit, and starts the CTTD and FSTD.

(8) CTTD will time out in 2.0 to 4.0 seconds and the circuit will energize. When the CTTD energizes, a transistor is turned on which applies 28 VDC to the bus control unit to trip the ACTR. If the voltage recovers to normal after the ACTR is tripped, the UV circuit will send a signal to the bus control unit to lock out the ACTR. At the same time a UV circuit will reset the CTTD and FSTD and no other action is taken.

(9) Voltage will be applied to FSTD at the same time that it is applied to CTTD. FSTD will time out in 5.0 to 7.0 seconds. The FSTD trips the GR by turning on a switching transistor. The FSTD will also start the UVTD. Once started the FSTD is locked in the energized position and cannot be reset until the GCR is tripped. If the voltage recovers to normal after the GR is tripped and before GCR is tripped, a normal UV signal is sent to the BC panel which locks out the ACTR. However, if the voltage does not recover after the GR is tripped and before GCR is tripped, the ACTR will not be locked out.

(10) The undervoltage time delay (UVTD) energizes a GCR trip circuit and trips the GCR. Another contact closes to provide a signal to the maintenance annunciator circuit. When the GCR is tripped, action is taken as described in Paragraph 2.B.(4),Paragraph 2.B.(5), Paragraph 2.B.(6).

C. Maintenance Annunciator Circuits

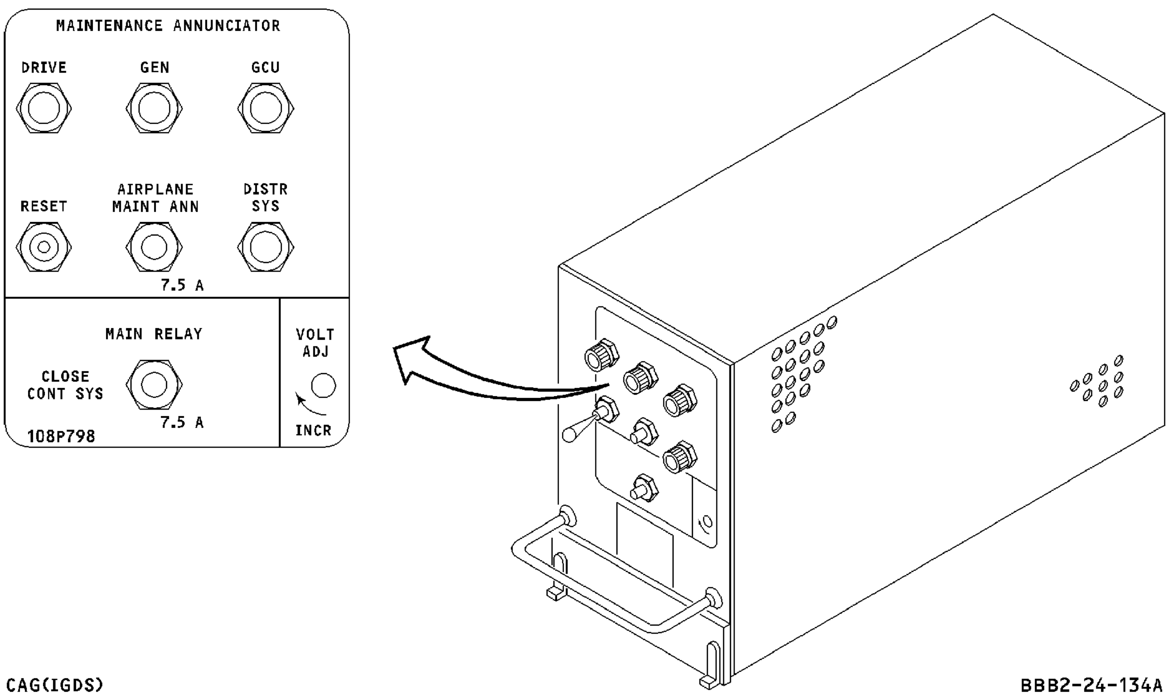
(1) When the PRR is energized and FSTD and the dead bus circuit are not energized, a signal is applied through GC pin B13 to the annunciator reset circuit which resets all annunciator relays. The annunciator can also be reset by closing the annunciator RESET switch.

(2) The drive annunciator relay (DAR) will trip and close a contact to provide 28 VDC to illuminate the drive annunciator light only when the drive disconnect (DD) switch is in NORM position (CSD connected and DD relay not tripped), engine PMG signal is present (engine running), and there is no signal from the drive PMG. If the engine PMG signal is not present, the GAR will trip open a contact and remove power from the DAR trip coil to prevent the DAR from tripping.

(3) The generator annunciator relay (GAR) will trip and close a contact to provide 28 VDC to illuminate the generator annunciator light only if the following conditions exist: drive PMG signal is present and there is no generator PMG signal or the voltage regulator circuit is OK (VROK) and the UVTP has energized.

(4) The distribution system annunciator relay (DSAR) will trip and close contact to provide 28 VDC to illuminate the distribution system annunciator light only if a DP fault occurs and the generator control unit annunciator relay (GCAR) is closed. If the GCAR trips before the DP fault occurs, power will be removed from the trip circuit of the DSAR by an open GCAR contact. If the GCAR trips after the DSAR trips a GCAR contact will close and apply 28 VDC to close the DSAR and simultaneously remove power from the DSAR trip coil.

(5) The generator control unit annunciator relay (GCAR) will trip and close a contact to provide 28 VDC to illuminate the distribution system annunciator light when the OVTD energizes, or the UVTD energizes, or the differential protection time delay (DPTD) energizes, or the voltage regulator OK (VROK) signal is not present.



AC Generator Control Unit - (Typical)
Figure 1/24-20-07-990-802

ABBREV.	NAME	ABBREV.	NAME
ACTL	AC CROSSTIE LOCKOUT	GCU	AC GENERATOR CONTROL UNIT
ACTLIR	AC CROSSTIE LOCKOUT INDICATION RELAY	GCUAR	GENERATOR CONTROL UNIT ANNUNCIATOR RELAY
ACTLS	AC CROSSTIE LOCKOUT RELAY SLAVE	GEN	GENERATOR
ACTR	AC CROSSTIE RELAY	GFFW	GENERATOR FEEDER FAULT WARNING
AEPTR	AC EMERGENCY POWER TRANSFER RELAY	GPS	GENERATOR PHASE SEQUENCE
AGSTR	AC GROUND SERVICE TIE RELAY	GR	GENERATOR RELAY
APCR	AUXILIARY POWER CONTROL RELAY	GRR	GROUND REFUELING RELAY
APGC	GEN CONTROL UNIT (AUXILIARY POWER)	GSAPR	GROUND SERVICE AUXILIARY POWER RELAY
APPRR	POWER READY RELAY (AUXILIARY POWER)	GSEPR#1	GROUND SERVICE EXTERNAL POWER RELAY NO.1
APR	AUXILIARY POWER RELAY	GSEPR#2	GROUND SERVICE EXTERNAL POWER RELAY NO.2
APSR	AUXILIARY POWER UNIT STARTER RELAY	INV	INVERTER
APU	AUXILIARY POWER UNIT	L	LEFT
ARSW	ANNUNCIATOR RESET SWITCH	LAPCR#1	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
BAT	BATTERY	LAPCR#2	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
BC	AC BUS CONTROL UNIT	LAPR	LEFT AUXILIARY POWER RELAY
BCHG	BATTERY CHARGER	LDBC	LEFT DEAD BUS CIRCUIT
BCTR	BATTERY CHARGER TRANSFER RELAY	LDBS	LEFT DEAD BUS SLAVE
BR	BATTERY RELAY	LEPCR	LEFT EXTERNAL POWER RELAY CONTROL RELAY
BS	BATTERY SWITCH	LEPR	LEFT EXTERNAL POWER RELAY
C&TGSI	BATTERY CHARGER & DC TRANSFER BUS GROUND SERVICE INTERLOCK	LGC	LEFT GENERATOR CONTROL UNIT
C&TR	BATTERY CHARGER & DC TRANSFER BUS RELAY	LGR	LEFT GENERATOR RELAY
C&TRCR	BATTERY CHARGER & DC TRANSFER BUS RELAY CONTROL RELAY	LGRS	LEFT GENERATOR RELAY SLAVE
CB	CIRCUIT BREAKER	LPRR	LEFT POWER READY RELAY
CSD	CONSTANT SPEED DRIVE	OV	OVER VOLTAGE
CT	CURRENT TRANSFORMER	OVTD	OVER VOLTAGE TIME DELAY CIRCUIT
CTTD	AC CROSSTIE RELAY TIME DELAY CIRCUIT	PMG	PERMANENT MAGNET GENERATOR
DAR	DRIVE ANNUNCIATOR RELAY	PR	POWER RELAY
DBC	DEAD BUS CIRCUIT	PRR	POWER READY RELAY
DCTR	DC CROSSTIE RELAY	PS	PHASE SEQUENCE
DDR	DRIVE DISCONNECT RELAY	R	RIGHT
DEPTR	DC EMERGENCY POWER TRANSFER RELAY	RAPCR#1	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
DGSTR	DC GROUND SERVICE TIE RELAY	RAPCR#2	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
DP	DIFFERENTIAL PROTECTION	RAPR	RIGHT AUXILIARY POWER RELAY
DPCT-A	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ΦA)	RCD	REVERSE CURRENT (BLOCKING DIODE)
DPCT-B	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ΦB)	RDBC	RIGHT DEAD BUS CIRCUIT
DPCT-C	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ΦC)	RDBS	RIGHT DEAD BUS SLAVE
DPTD	DIFFERENTIAL PROTECTION TIME DELAY	REPCR	RIGHT EXTERNAL POWER RELAY CONTROL RELAY
DRSR	DRIVE RUNNING SIGNAL RELAY	REPR	RIGHT EXTERNAL POWER RELAY
DSAR	DISTRIBUTION SYSTEM ANNUNCIATOR RELAY	RGC	RIGHT GENERATOR CONTROL UNIT
DTBSR	DC TRANSFER BUS SENSING RELAY	RGR	RIGHT GENERATOR RELAY
ECSW	EMERGENCY POWER CONTROL SWITCH	RGRS	RIGHT GENERATOR RELAY SLAVE
EDBSR	EMERGENCY DC BUS SENSING RELAY	RPRR	RIGHT POWER READY RELAY
EPM	EXTERNAL POWER MONITOR	SW	SWITCH
EPPSC	EXTERNAL POWER PHASE SEQUENCE CIRCUIT	TD	TIME DELAY
EPR	EXTERNAL POWER RELAY	TR	TRANSFORMER-RECTIFIER
ERSR	ENGINE RUNNING SIGNAL (SSR)	UF	UNDER FREQUENCY
FSTD	FAULT SELECTOR TIME DELAY CIRCUIT	UFTD	UNDER FREQUENCY TIME DELAY CIRCUIT
GAR	GENERATOR ANNUNCIATOR RELAY	UV	UNDER VOLTAGE
GCR	GENERATOR CONTROL RELAY	UVTD	UNDER VOLTAGE TIME DELAY CIRCUIT
		VR	VOLTAGE REGULATOR CIRCUIT
		VROK	VOLTAGE REGULATOR OK

BBB2-24-125A

Electrical Power Abbreviations
Figure 2/24-20-07-990-803

AC GENERATOR CONTROL UNIT - REMOVAL/INSTALLATION

1. General

A. This section provides procedures for removal/installation of the AC Generator Control Unit (GCU).

B. Three GCU's, one each for generator left, right, and APU, are mounted in the generator control rack in the electrical/ electronics compartment and are accessible through the electrical/electronics compartment access door 4501A.

C. Removal/installation procedures are similar for each GCU.

2. Removal/Installation AC Generator Control Unit

A. Remove Unit

NOTE: If aircraft configuration permits, all AC power may be removed, the bus control switches on the overhead turned OFF and tagged, and the battery switch to OFF as an alternate to circuit breaker opening.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(2) Placard engine and APU start switches with suitable WARNING to prevent engine operation.

(3) Make certain BATT switch on overhead switch panel is in OFF position.

(4) Make certain external electric power is deenergized and placarded with suitable WARNING.

(5) Place AC BUS X TIE switch in OPEN position.

(6) Place APU L BUS and APU R BUS switches to OFF position and verify bus lights are off.

(7) Place EXT PWR L BUS and EXT PWR R BUS to OFF position and verify bus lights are off.

(8) Loosen holddown nuts securing GCU to mounting rack.

(9) Carefully slide GCU out to disengage rack mounted electrical connectors and remove GCU from mounting rack.

B. Install Unit

NOTE: If aircraft configuration permits, all AC power may be removed, the bus control switches on the overhead turned OFF and tagged, and the battery switch to OFF as an alternate to circuit breaker opening.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Make sure that these circuit breakers are open and have safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(2) Verify engines or APU are not operating.

(3) Verify BATT switch is in OFF position and external electrical power is deenergized.

(4) Verify AC BUS X TIE switch is in OPEN position.

(5) Verify L and R APU BUS switches in OFF position.

(6) Verify L and R EXT PWR BUS switches in OFF position and bus lights are off.

(7) Locate GCU on mounting rack and carefully slide GCU in, engaging rack mounted electrical connectors.

(8) Tighten holddown nuts securing GCU to mounting rack.

(9) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
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U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

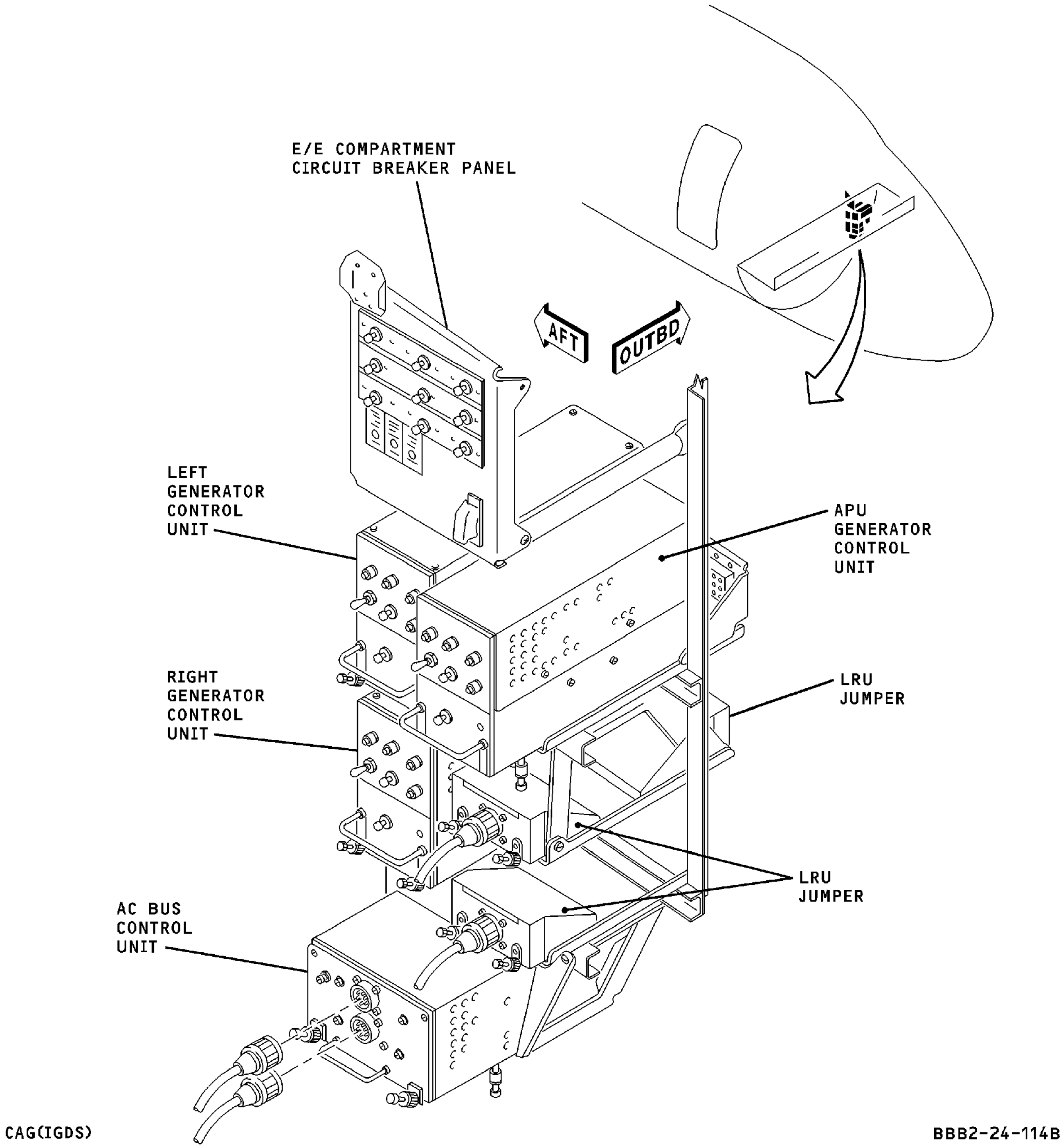
Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(10) Place AC BUS X TIE switches in AUTO position.

(11) Verify BATT switch in OFF position.

(12) Remove engine start switch WARNING placard.

(13) Check AC generation system frequency and voltage during next engine run-up but prior to flight. Frequency meter should indicate 400 (+/- 4) Hz and voltmeter should indicate 115 (+/- 3) volts AC.



AC Generator Control Unit -- Installation
Figure 401/24-20-07-990-801

AC BUS CONTROL UNIT - DESCRIPTION AND OPERATION

1. General

Figure 1

A. The AC Bus Control Unit contains the control and protection circuitry for the AC Crosstie Relay (ACTR) and for the Left and Right External Power Relays (LEPR) and (REPR).

B. The unit also includes dead bus sensing circuitry, circuitry for auxiliary power differential current transformer connection when the APU is in use, and interlocking circuitry which coordinates overall system operation and prevents inadvertent paralleling of two power sources.

2. Operation

A. Dead Bus Sensing (Typical Left or Right)

(1) Voltage from the ac bus is applied to the BC unit. The voltage is rectified and applied to the dead bus circuitry.

(2) When the 3-phase AC bus voltage is 46.5 volts or greater, the dead bus circuit will energize and the following results: The close coil circuit of the generator relay (LGR or RGR) and the auxiliary power relay (LAPR or RAPR) are opened; the dead bus slave relay (LDBSR or RDBSR) is energized, opening the close coil circuit of the external power relay (LEPR or REPR); and, the Left AC Bus OFF light of Right AC Bus OFF light circuit is opened.

(3) When both LDBC and RDBC are energized, the ACTR close circuit is open. But, if either circuit is deenergized, a circuit is complete to close the ACTR, if all other conditions give a close signal.

(4) When either DBC is deenergized, the circuit is completed to the corresponding ac bus off light, located on the master warning and caution system annunciator panel, and the light comes on.

B. AC Crosstie Relay Control

(1) During normal operation, with each generator supplying the applicable ac bus and the AC BUS X TIE switch is in AUTO position, the ACTR cannot be closed as both DBC's are energized and the ACTR close circuit is open. Also, signals through the RGC and LGC are applied to the "1 of 3" circuit in the panel. (The "1 of 3" circuit has a high output voltage (5.6 VDC) if two or more power sources are available but has a low output voltage (2.5 VDC) if only one power source is available.) The "1 of 3" circuit has a voltage output to the NOT circuit which blocks operation of the ACTR close amplifier circuit and prevents the ACTR from closing.

(2) A power loss on either left or right generator, or bus, will deenergize the dead bus circuit to the ACTR close coil. The input of the affected bus is removed from the "1 of 3" circuit causing the circuit to have a low voltage output that is insufficient to block the amplifier. The AC Crosstie Lockout Slave (ACTLS) signal will then apply 28-volts DC to the ACTR close coil and open the ACTR trip circuit.

(3) If the ACTR is closed, it can be tripped as follows:

(a) If each generator is capable of supplying the applicable ac bus, there is a DC signal from both of the ac generator control units to the "1 of 3 circuit" in the ac bus control unit.

(b) If CTTD in a GC is energized, a 28-volt DC signal is applied to the NOT circuit of the ACTR close amplifier in the BC, to trip the ACTR.

(c) When the left or right EPR is closed, or if either the left or right APR is closed while the aircraft is on the ground (nose gear strut fully compressed), a 28-volt DC signal is applied to the NOT circuit of the ACTR close amplifier to trip the ACTR.

(d) If no ac power source is connected to either ac bus, there is a 28-volt DC signal to the NOT circuit of the ACTR close amplifier to trip the ACTR.

(e) If the AC BUS X TIE switch is moved to the OPEN position, the ACTR is tripped.

(4) The ACTR can be locked out by energizing the AC Crosstie Lockout Circuit (ACTL), when the ACTL signal and power to the ACTLS is removed. At the same time, 28-volts DC power is applied to ACTL, locking ACTL in. When ACTLS signal is removed, the ACTR close circuit opens and the ACTR trip circuit is closed. To reset the ACTR circuit, all DC power must be removed from the BC unit by activating the crosstie lockout reset switch.

(5) The AC CROSSTIE LOCKOUT light, located on the master warning and caution systems annunciator panel, is controlled by a relay connected in parallel with the ACTL. The light comes on whenever the ACTL is energized and remains on until the ACTL is deenergized.

(6) An AC Crosstie Lockout Reset switch is located on the generator control rack circuit breaker panel in the flight compartment. In the event that the crosstie lockouts in the ac electrical system during ground operation, the switch allows maintenance personnel to reset the ac crosstie lockout relay without removing all power to the electrical power system.

WJE 401-412, 414-419, 421, 423, 425, 426, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 892, 893; WJE 420, 422, 424, 427, 429, 891 POST DC9-24-082

NOTE: An AC Crosstie Lockout Reset switch is located on the upper electrical power center circuit breaker panel in the flight compartment.

WJE ALL

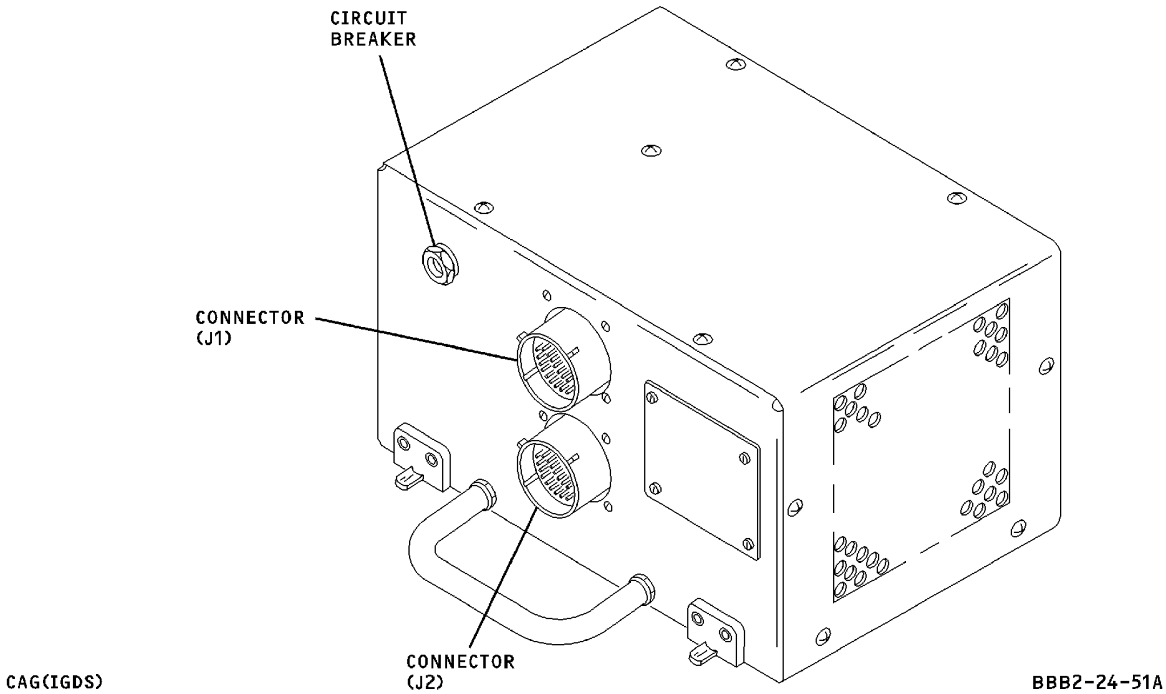
C. Auxiliary Power DPCT Connection Control

(1) The APU current transformers (APLCT and APRCT) are connected to the differential protection circuit through the left and right generator relay slave circuit when the circuits are deenergized. When the LGRS circuits and RGRS are energized, the transformers are shorted out and disconnected from the DP circuit. The circuits are energized during normal operation by a 28-volt signal from the APGC through contacts of the energized generator relays (LGR and RGR). The LGRS and RGRS circuits are also energized when one generator is used to supply power to both the left and right buses through the ACTR.

(2) If external power is connected to the airplane, the same action as described for the RGR and LGR will take place when the REPR and LEPR are closed.

(3) For example, assume that the APU is used to supply the left bus. The right generator is supplying the right bus, the ACTR is open, and no external power is connected. The RGR is closed, energizing RGRS and shorting the APRCT. The LGR is open, LGRS circuit is deenergized, and circuits for the three phases are open, removing the short from the APLCT. LGRS transistors for the three phases are closed connecting the APLCT and the APGCT together. Leads are connected from the APGCT to the DP sensing pin of the APGC, completing the DP loop.

(4) The APRCT's are connected to the APGCT's in the same manner except that the operation of LGRS and RGRS circuits are reversed.



AC Bus Control Unit
Figure 1/24-20-08-990-802

ABBREV.	NAME
ACTL	AC CROSSTIE LOCKOUT
ACTLIR	AC CROSSTIE LOCKOUT INDICATION RELAY
ACTLS	AC CROSSTIE LOCKOUT RELAY SLAVE
ACTR	AC CROSSTIE RELAY
AEPTR	AC EMERGENCY POWER TRANSFER RELAY
AGSTR	AC GROUND SERVICE TIE RELAY
APCR	AUXILIARY POWER CONTROL RELAY
APGC	GEN CONTROL UNIT (AUXILIARY POWER)
APPRR	POWER READY RELAY (AUXILIARY POWER)
APR	AUXILIARY POWER RELAY
APSR	AUXILIARY POWER UNIT STARTER RELAY
APU	AUXILIARY POWER UNIT
ARSW	ANNUNCIATOR RESET SWITCH
BAT	BATTERY
BC	AC BUS CONTROL UNIT
BCHG	BATTERY CHARGER
BCTR	BATTERY CHARGER TRANSFER RELAY
BR	BATTERY RELAY
BS	BATTERY SWITCH
C&TGSI	BATTERY CHARGER & DC TRANSFER BUS GROUND SERVICE INTERLOCK
C&TR	BATTERY CHARGER & DC TRANSFER BUS RELAY
C&TRCR	BATTERY CHARGER & DC TRANSFER BUS RELAY CONTROL RELAY
CB	CIRCUIT BREAKER
CSD	CONSTANT SPEED DRIVE
CT	CURRENT TRANSFORMER
CTTD	AC CROSSTIE RELAY TIME DELAY CIRCUIT
DAR	DRIVE ANNUNCIATOR RELAY
DBC	DEAD BUS CIRCUIT
DCTR	DC CROSSTIE RELAY
DDR	DRIVE DISCONNECT RELAY
DEPTR	DC EMERGENCY POWER TRANSFER RELAY
DGSTR	DC GROUND SERVICE TIE RELAY
DP	DIFFERENTIAL PROTECTION
DPCT-A	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ϕA)
DPCT-B	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ϕB)
DPCT-C	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ϕC)
DPTD	DIFFERENTIAL PROTECTION TIME DELAY
DRSR	DRIVE RUNNING SIGNAL RELAY
DSAR	DISTRIBUTION SYSTEM ANNUNCIATOR RELAY
DTBSR	DC TRANSFER BUS SENSING RELAY
ECSW	EMERGENCY POWER CONTROL SWITCH
EDBSR	EMERGENCY DC BUS SENSING RELAY
EPM	EXTERNAL POWER MONITOR
EPPSC	EXTERNAL POWER PHASE SEQUENCE CIRCUIT
EPR	EXTERNAL POWER RELAY
ERSR	ENGINE RUNNING SIGNAL (SSR)
FSTD	FAULT SELECTOR TIME DELAY CIRCUIT
GAR	GENERATOR ANNUNCIATOR RELAY
GCR	GENERATOR CONTROL RELAY
GCU	AC GENERATOR CONTROL UNIT
GCUAR	GENERATOR CONTROL UNIT ANNUNCIATOR RELAY
GEN	GENERATOR
GFFW	GENERATOR FEEDER FAULT WARNING
GPS	GENERATOR PHASE SEQUENCE
GR	GENERATOR RELAY
GRR	GROUND REFUELING RELAY
GSAPR	GROUND SERVICE AUXILIARY POWER RELAY
GSEPR#1	GROUND SERVICE EXTERNAL POWER RELAY NO.1
GSEPR#2	GROUND SERVICE EXTERNAL POWER RELAY NO.2
INV	INVERTER
L	LEFT
LAPCR#1	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
LAPCR#2	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
LAPR	LEFT AUXILIARY POWER RELAY
LDBC	LEFT DEAD BUS CIRCUIT
LDBS	LEFT DEAD BUS SLAVE
LEPCR	LEFT EXTERNAL POWER RELAY CONTROL RELAY
LEPR	LEFT EXTERNAL POWER RELAY
LGC	LEFT GENERATOR CONTROL UNIT
LGR	LEFT GENERATOR RELAY
LGRS	LEFT GENERATOR RELAY SLAVE
LPRR	LEFT POWER READY RELAY
OV	OVER VOLTAGE
OVTD	OVER VOLTAGE TIME DELAY CIRCUIT
PMG	PERMANENT MAGNET GENERATOR
PR	POWER RELAY
PRR	POWER READY RELAY
PS	PHASE SEQUENCE
R	RIGHT
RAPCR#1	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
RAPCR#2	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
RAPR	RIGHT AUXILIARY POWER RELAY
RCD	REVERSE CURRENT (BLOCKING DIODE)
RDBC	RIGHT DEAD BUS CIRCUIT
RDBS	RIGHT DEAD BUS SLAVE
REPCR	RIGHT EXTERNAL POWER RELAY CONTROL RELAY
REPR	RIGHT EXTERNAL POWER RELAY
RGC	RIGHT GENERATOR CONTROL UNIT
RGR	RIGHT GENERATOR RELAY
RGRS	RIGHT GENERATOR RELAY SLAVE
RPRR	RIGHT POWER READY RELAY
SW	SWITCH
TD	TIME DELAY
TR	TRANSFORMER-RECTIFIER
UF	UNDER FREQUENCY
UFTD	UNDER FREQUENCY TIME DELAY CIRCUIT
UV	UNDER VOLTAGE
UVTD	UNDER VOLTAGE TIME DELAY CIRCUIT
VR	VOLTAGE REGULATOR CIRCUIT
VROK	VOLTAGE REGULATOR OK

BBB2-24-125A

Electrical Power Abbreviations
Figure 2/24-20-08-990-803

AC BUS CONTROL UNIT - REMOVAL/INSTALLATION

1. General

A. This section contains procedures for removal/installation of the AC Bus Control Unit (BCU).

B. The BCU is mounted in the generator control rack in the electrical/electronics compartment and is accessible through the electrical/electronics compartment access door 4501A.

2. Removal/Installation AC Bus Control Unit

A. Remove Unit

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(2) Placard engine and APU start switches with suitable WARNING to prevent engine operation.

(3) Make certain electrical power from external sources is deenergized and placarded with suitable WARNING.

(4) Make certain BATT switch on overhead switch panel is in OFF position.

(5) Loosen holddown nuts securing BCU to mounting rack.

(6) Carefully slide BCU out to disengage rack mounted electrical connectors and remove BCU from mounting rack.

B. Install Unit

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Make sure that these circuit breakers are open and have safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(2) Placard engine and APU start switches with suitable WARNING to prevent engine operation.

(3) Make certain electrical power from external sources is deenergized.

(4) Make certain BATT switch on overhead switch panel is in OFF position.

(5) Locate BCU on mounting rack and carefully slide BCU in, engaging rack mounted electrical connectors.

(6) Tighten holddown nuts securing BCU to mounting rack.

(7) Remove the safety tags and close these circuit breakers:

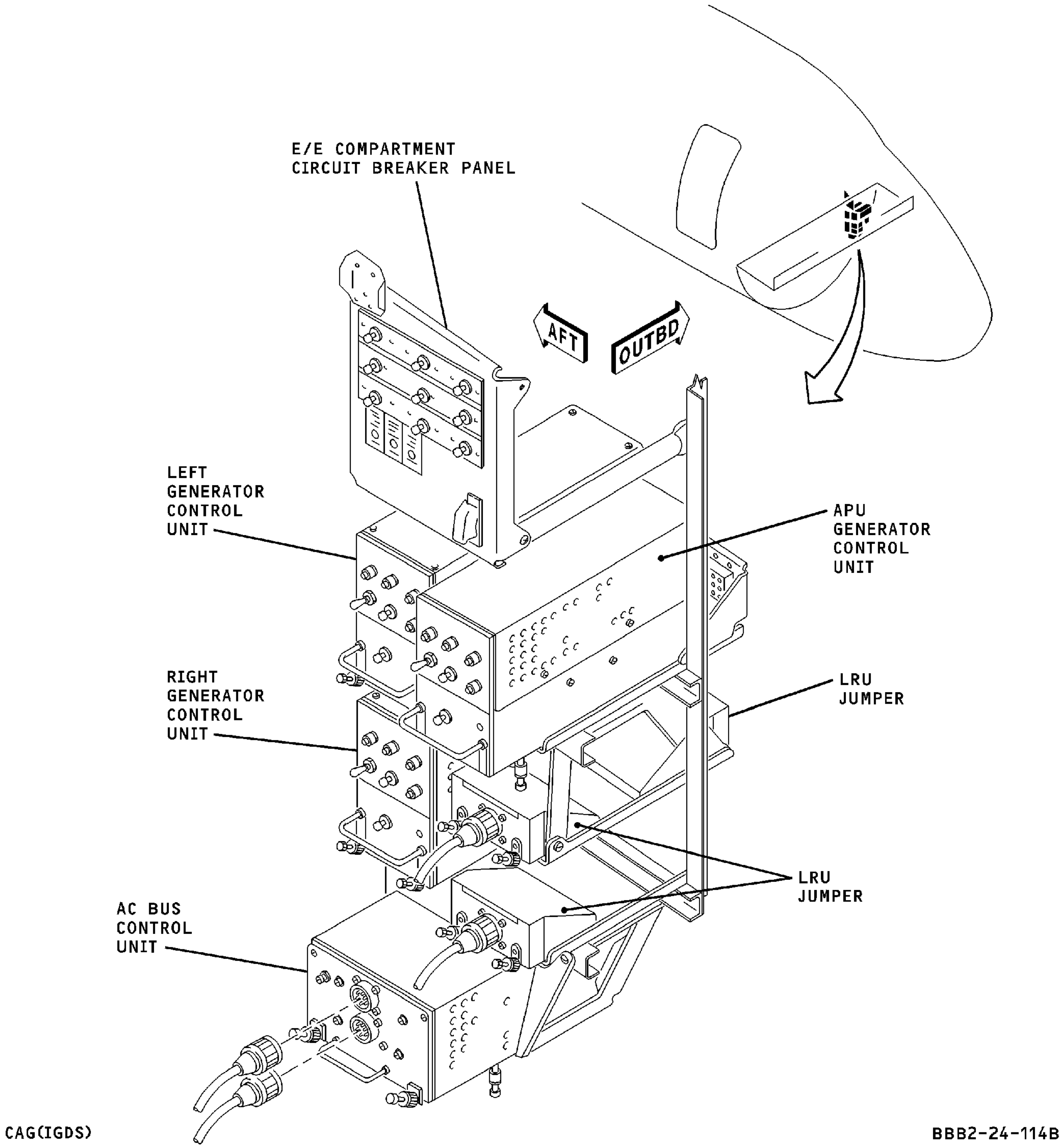
LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	36	B1-195	GENERATOR CONTROL APU
U	37	B1-194	GENERATOR CONTROL RIGHT
U	38	B1-193	GENERATOR CONTROL LEFT
X	38	B1-250	EXTERNAL POWER RELAYS

OVERHEAD BATTERY BUS

Row	Col	Number	Name
B	21	B1-291	APU CONTROL

(8) Check ac generation system frequency and voltage during next engine run-up but prior to flight. Frequency meter should indicate 400(±4) Hz and voltmeter should indicate 115(±3) volts AC.



AC Bus Control Unit -- Installation
Figure 401/24-20-08-990-801

EMERGENCY INVERTER - MAINTENANCE PRACTICES

1. General

A. This maintenance practice provides removal/installation procedure for the emergency (static) inverter.

B. The emergency inverter is installed in the forward accessory compartment and access is through the forward accessory compartment access door 4302A.

WARNING: WEIGHT OF UNIT REQUIRES USE OF APPROVED HANDLING METHODS DURING REMOVAL.

C. Weight of the emergency inverter is approximately 24 pounds (Vap-Air) or 13 pounds (Leland).

2. Equipment and Materials

A. A customer furnished component hoist may be used to remove/install inverter.

NOTE: Equivalent substitutes may be used instead of the following listed item:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 201

Name and Number	Manufacturer
Torque wrench (capable of 0-175 inch-pounds (0-19.8 N·m))	

3. Removal/Installation Emergency Inverter

A. Remove Emergency Inverter

(1) Placard engine and APU start switches with suitable WARNING to prevent engine operation.

(2) Make certain external electric power is deenergized and placarded with suitable WARNING.

(3) Make certain BATT switch on overhead switch panel is in OFF position and placarded with suitable WARNING.

(4) Place EMER PWR switch on overhead switch panel in OFF position and placard with suitable WARNING.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(5) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
Z	38	B1-107	GROUND REFUEL

OVERHEAD BATT DIR BUS

Row	Col	Number	Name
WJE 401-409, 411, 412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893			
B	16	B1-106	GROUND REFUELING

WJE 401-409, 411, 412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893 (Continued)

(Continued)

OVERHEAD BATT DIR BUS

Row	Col	Number	Name
WJE 401-409, 411, 412, 414, 875-881, 883, 884, 886, 887			
B	17	B1-913	ELECTRONIC CLOCK
WJE 410			
B	17	B1-106	GROUND REFUELING
WJE 410, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887			
B	18	B1-913	ELECTRONIC CLOCK
WJE ALL			
C	18	B1-184	EMERGENCY INVERTER

(6) Remove terminal board cover. (Figure 201)

(7) Disconnect aircraft wiring. Replace terminal attaching hardware.

NOTE: Tag and identify wiring.

(8) Install terminal cover.

(9) Remove emergency inverter.

B. Install Emergency Inverter

(1) Verify engine and APU start switches are tagged with suitable WARNING to prevent engine operation.

(2) Verify external electric power is deenergized and placarded with suitable WARNING.

(3) Verify BATT switch on overhead switch panel is in OFF position and placarded with suitable WARNING.

(4) Verify EMER PWR switch on overhead switch panel is in OFF position and placarded with suitable WARNING.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(5) Make sure that these circuit breakers are open and have safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
Z	38	B1-107	GROUND REFUEL

OVERHEAD BATT DIR BUS

Row	Col	Number	Name
WJE 401-409, 411, 412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893			
B	16	B1-106	GROUND REFUELING
WJE 401-409, 411, 412, 414, 875-881, 883, 884, 886, 887			
B	17	B1-913	ELECTRONIC CLOCK

WJE 401-409, 411, 412, 414, 875-881, 883, 884, 886, 887 (Continued)

(Continued)

OVERHEAD BATT DIR BUS

Row	Col	Number	Name
WJE 410			
B	17	B1-106	GROUND REFUELING
WJE 410, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887			
B	18	B1-913	ELECTRONIC CLOCK
WJE ALL			
C	18	B1-184	EMERGENCY INVERTER

(6) Position emergency inverter on electrical rack in forward accessory compartment and install attaching hardware. (Figure 201)

(7) Remove terminal cover.

(8) Connect aircraft wiring. Observe proper polarity. Torque 28 VDC input terminal attaching nuts to 60 inch-pounds (6.72 N·m) maximum. Torque output terminal attaching nuts to 24 inch-pounds (2.69 N·m) maximum.

(9) Install terminal cover.

(10) Remove engine and APU start switch WARNINGS.

(11) Remove external power WARNING.

(12) Remove BATT switch WARNING.

(13) Remove EMER PWR switch WARNING.

(14) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
Z	38	B1-107	GROUND REFUEL

OVERHEAD BATT DIR BUS

Row	Col	Number	Name
WJE 401-409, 411, 412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893			
B	16	B1-106	GROUND REFUELING
WJE 401-409, 411, 412, 414, 875-881, 883, 884, 886, 887			
B	17	B1-913	ELECTRONIC CLOCK
WJE 410			
B	17	B1-106	GROUND REFUELING
WJE 410, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887			
B	18	B1-913	ELECTRONIC CLOCK
WJE ALL			
C	18	B1-184	EMERGENCY INVERTER

(15) Place BATT switch on overhead switch panel to ON position.

(16) Check battery voltage indicates 28(±2) volts. (DC GENERATION - DESCRIPTION AND OPERATION, PAGEBLOCK 24-30-00/001).

(17) Check that AC EMER BUS OFF and DC EMER BUS OFF annunciator lights on overhead panel come on.

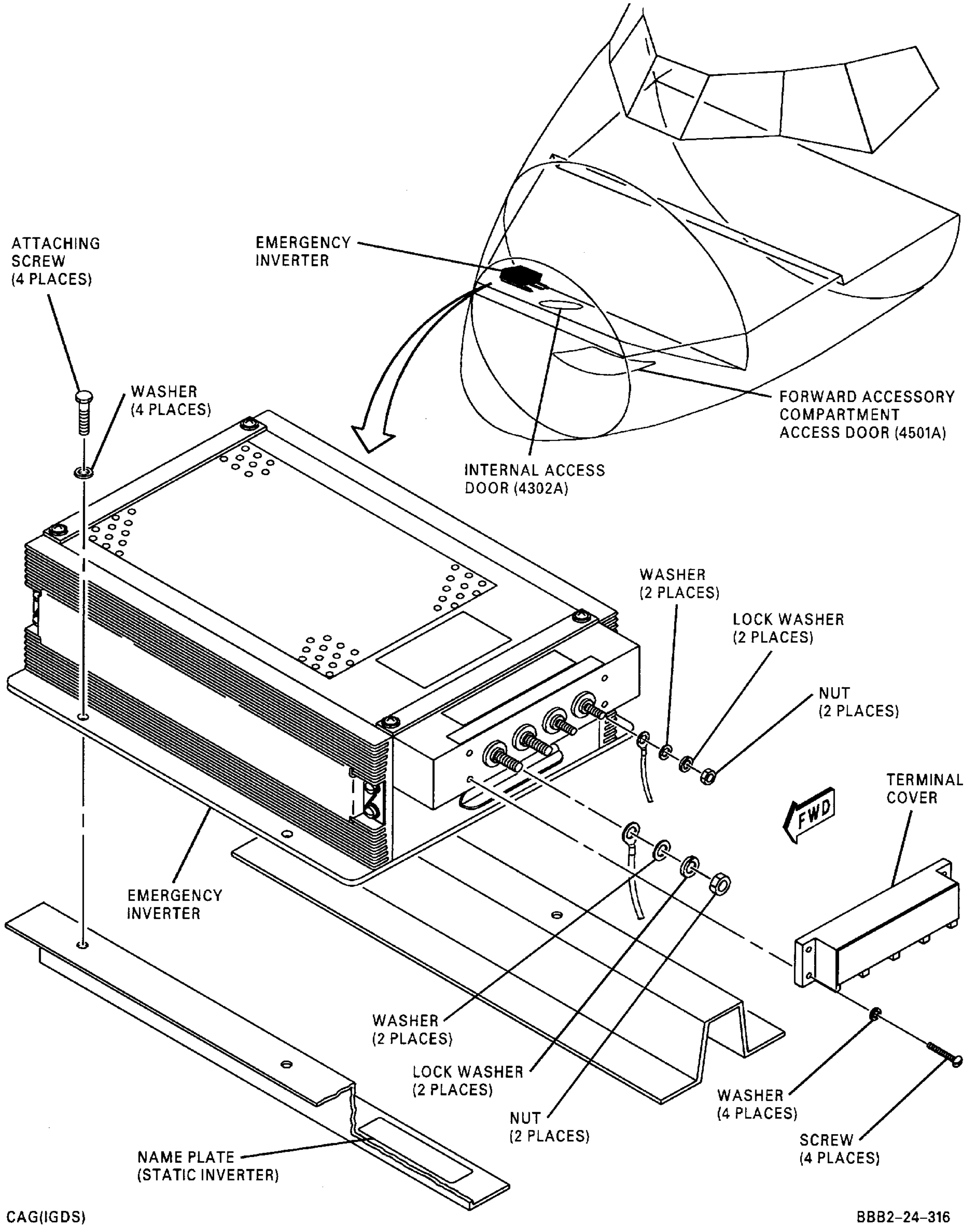
(18) Rotate EMER PWR switch on overhead switch panel to ON position. Check that EMER POWER IN USE light comes on.

NOTE: When the EMERGENCY POWER switch is turned ON, while AC generator power is on, you might see random indications of the ADF pointers, and VHF NAV control panels. This is a known anomaly.

(19) Check that AC EMER BUS OFF and DC EMER BUS OFF annunciator lights on overhead panel go off.

(20) Rotate EMER PWR switch to OFF position.

(21) Place BATT switch on overhead switch panel to OFF position.



Emergency Inverter -- Removal/Installation
Figure 201/24-23-01-990-801

EMERGENCY POWER SWITCH - REMOVAL/INSTALLATION

1. General

A. This chapter provides removal/installation procedures for the emergency power switch. The emergency power switch is located in the overhead switch panel.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of following listed items.

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

Table 401

Name and Number	Manufacturer
Torque wrench 0-20 inch-pounds range (0-2.5 N·m)	Commercially available
Compound, anti- tamper, EC-1252 (DPM 570)	3M Co Los Angeles, CA
Silicone sealant (DMS 1799)	

3. Removal/Installation

A. Remove Switch

WARNING: TO PREVENT INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT, ENSURE ELECTRICAL POWER IS REMOVED FROM CIRCUIT UNDER TEST.

(1) Make sure APU and engines are shut down.

(2) Place warning tags on engine and APU start switches.

WARNING: MAKE SURE EXTERNAL ELECTRICAL POWER IS NOT CONNECTED TO THE AIRCRAFT UNTIL ALL ELECTRICAL MAINTENANCE IS COMPLETED. THIS WILL PREVENT INJURY TO PERSONS.

(3) Disconnect external electrical power source.

(4) Place warning tag on external power receptacle and EXT PWR switch on the aft overhead switch panel.

WARNING: MAKE SURE YOU REMOVE ALL AIRCRAFT ELECTRICAL POWER, AND TURN OFF AND TAG THE BATTERY SWITCH. MAKE SURE THIS IS DONE BEFORE YOU DO MAINTENANCE WORK IN THIS AREA. THIS WILL PREVENT INJURY TO PERSONS.

(5) Place BATT switch, located on the overhead switch panel in the OFF position

(6) Disconnect battery power connectors from both battery cases.

WARNING: GET SUFFICIENT AID FROM PERSONS AND EQUIPMENT TO HOLD THE COMPONENT DURING REMOVAL AND INSTALLATION. THIS COMPONENT WEIGHS APPROXIMATELY 60 LBS (27.2 KG). THIS WILL PREVENT INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(7) Release quarter-turn fasteners on overhead switch panel and lower panel.

(8) Remove the sealant from knob to access the setscrews.

(9) Remove the three setscrews.

(10) Remove knob from EMER PWR switch.

(11) Remove shaft-support from EMER PWR switch.

(12) Remove three attaching screws from the top plate of the EMER PWR switch. Retain three screws, three lockwashers, and nine flat washers for assembly.

NOTE: Three flat washers are installed between the top plate and standoffs under each screw. These washers are required for correct switch spacing during reassembly.

(13) Remove top plate of the EMER PWR switch.

(14) Remove EMER PWR switch from overhead switch panel pan.

CAUTION: WIRES MUST BE LABELED TO PREVENT INCORRECT PLACEMENT WHEN SWITCH IS INSTALLED.

(15) Disconnect wires from EMER PWR switch terminals.

B. Install Switch

WARNING: MAKE SURE ALL AIRCRAFT ELECTRICAL POWER IS REMOVED. THIS WILL PREVENT INJURIES TO PERSONS CAUSED BY THE CHARGED COMPONENTS.

(1) Make sure APU and engines are shut down.

(2) Make sure warning tags are on engine and APU start switches.

WARNING: MAKE SURE EXTERNAL ELECTRICAL POWER IS NOT CONNECTED TO AIRCRAFT UNTIL ALL ELECTRICAL MAINTENANCE IS COMPLETED. THIS WILL PREVENT INJURY TO PERSONS.

(3) Make sure external electrical power is disconnected.

(4) Make sure a warning tag is on external power receptacle and EXT PWR switch on the aft overhead switch panel.

WARNING: MAKE SURE BATTERY SWITCH IS IN OFF POSITION UNTIL ALL ELECTRICAL MAINTENANCE IS COMPLETED. THIS WILL PREVENT INJURY TO PERSONS.

(5) Make sure BATT switch, located on the overhead switch panel is in the OFF position

(6) Make sure battery power connectors are disconnected from both battery cases.

(7) Install top plate on switch.

NOTE: Make sure lettering on top plate is facing the shaft-support. Make sure plate alignment hole is aligned with switch alignment pin.

(8) Install lock washer and shaft support on switch.

(9) Install EMER PWR switch knob.

WARNING: SILICONE SEALANT IS AN AGENT THAT IS POISONOUS, CARCINOGENIC, CORROSIVE, AND AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN SILICONE SEALANT IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET SILICONE SEALANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIERS MSDS FOR:

- MORE PRECAUTIONARY DATA.
- APPROVED SAFETY EQUIPMENT.
- EMERGENCY MEDICAL AID.
- TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(10) Encapsulate the three setscrews with silicone sealant. Make sure that the sealant is flush with the knob, no protruding sealant permissible.

(11) Connect wires to EMER PWR switch terminals. (Figure 403)

(12) Install screws and washers in top plate to secure EMER PWR switch in overhead switch panel pan.

(13) Tighten shaft-support on EMER PWR switch.

(14) Torque all #6 terminal screws to 8(±1) inch-pounds (.90(±.1) N·m).

(15) Torque all #10 terminal screws to 14(±1) inch-pounds (1.58(±.1) N·m).

WARNING: ANTI-TAMPER SEALING COMPOUND IS AN AGENT THAT IS FLAMMABLE, EXPLOSIVE, POISONOUS, AND AN IRRITANT. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN ANTI-TAMPER SEALING COMPOUND IS USED.

- GAS/AIR MIXTURES MORE THAN THE LOWER EXPLOSIVE LIMIT (LEL) CAN CAUSE AN EXPLOSION IF HIGH HEAT, SPARKS, OR FLAMES SUPPLY IGNITION.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET ANTI-TAMPER SEALING COMPOUND IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIERS MSDS FOR:

- MORE PRECAUTIONARY DATA.
- APPROVED SAFETY EQUIPMENT.
- EMERGENCY MEDICAL AID.
- TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(16) Brush small stripe of anti-tamper compound on all terminal screws.

WARNING: GET SUFFICIENT AID FROM PERSONS AND EQUIPMENT TO HOLD THE COMPONENT DURING REMOVAL AND INSTALLATION. THIS COMPONENT WEIGHS APPROXIMATELY 60 LBS (27.2 KG). THIS WILL PREVENT INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(17) Raise overhead switch panel and secure quarter-turn fasteners.

(18) Make sure shaft-support extends past surface of overhead switch panel by 0.094 ±0.015 in. (2.388 ±0.381 mm).

NOTE: If shaft-support does not extend past surface of overhead switch panel by 0.094 ±0.015 in. (2.388 ±0.381 mm), add to or reduce the number of washers between top plate and stand-offs to achieve correct spacing. (Figure 402)

(19) Connect battery power connectors on both battery cases.

(20) Remove warning tag on external power receptacle and EXT PWR switch on aft overhead switch panel.

(21) Remove warning tags on engine and APU start switches.

(22) Perform Emergency Inverter System Test. (EMERGENCY INVERTER - MAINTENANCE PRACTICES, PAGEBLOCK 24-23-01/201)

C. Perform Emergency Power Switch Test

(1) Make certain APU and engines are shut down.

(2) Place warning tags on engine and APU start switches. (Figure 401)

(3) Connect external electrical power to aircraft. Make certain left and right AC buses are energized.

(4) Perform following procedures to test Emergency AC Bus, Emergency DC Bus Feed, Batt & Transfer Relay, Charger & Transfer Relay Control, and emergency inverter:

(a) Place BATT switch in ON position.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(b) Open this circuit breaker and install safety tag:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	37	B1-159	EMERGENCY DC BUS FEED

(c) DC EMER BUS OFF light should come ON.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(d) Open these circuit breakers and install safety tags:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(e) AC EMER BUS OFF light should come ON.

(f) Place EMER PWR switch in ON position; DC EMER BUS OFF light should go OFF; EMER POWER IN USE light should come ON; AC EMER BUS OFF light should go OFF.

NOTE: When the EMERGENCY POWER switch is turned ON, while AC generator power is on, you might see random indications of the ADF pointers, and VHF NAV control panels.

(g) Place DC BUS VOLT selector switch in BATT VOLT, then in BATT AMP position. In each position, record voltage and amperage as indicated on dc AMPS-VOLTS meter.

(h) Place EMER PWR switch in OFF position; EMER POWER IN USE light should go OFF; DC EMER BUS OFF light should come ON; AC EMER BUS OFF light should come ON.

(i) Record battery voltage and amperage; voltage should show an increase and amperage should show an opposite indication from readings taken in Paragraph 3.C.(7)(g)

(j) Remove the safety tag and close this circuit breaker:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	37	B1-159	EMERGENCY DC BUS FEED

(k) DC EMER BUS OFF light should go OFF.

(l) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(m) AC EMER BUS OFF light should go OFF.

(5) Test emergency cockpit floodlights as follows:

(a) Make certain that BATT switch, on overhead switch panel, is in ON position.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(b) Open these circuit breakers:

LOWER EPC, DC AIR CONDITIONING & MISCELLANEOUS

Row	Col	Number	Name
W	28	B1-378	ALTERNATE THUNDER STORM

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	37	B1-159	EMERGENCY DC BUS FEED
N	38	B1-167	CHARGER & TRANSFER RELAY CONTROL

LOWER EPC, LIGHTS - LEFT DC BUS

Row	Col	Number	Name
M	33	B1-293	COCKPIT OVERHEAD WHITE FLOOD

(c) Check that Captain's, first officer's, left pedestal, and center instrument panel left floodlights come on at fixed level:

(d) Rotate EMER PWR switch, on overhead switch panel, to ON position. Check that floodlights remain on.

NOTE: Due to switching transient time, floodlights may flicker momentarily.

(e) Rotate FLOOD knob, on OVHD CONSOLE LTS control panel, fully clockwise from OFF position. Check that overhead floodlight comes on dim and gets brighter.

(f) Rotate FLOOD knob, on OVHD CONSOLE LTS control panel, counterclockwise to approximately mid position. Check that right overhead floodlight decreases in intensity.

(g) Place THNDRSTRM LT switch, on overhead switch panel, in ON position. Check that floodlights increase in intensity.

(h) Place THNDRSTRM LT switch in OFF position. Check that floodlights decrease in intensity.

(i) Rotate FLOOD knob, on OVHD CONSOLE LTS control panel, counterclockwise to OFF position. Check that right overhead floodlight dims and goes off.

(j) Rotate EMER PWR switch to OFF position.

(k) Remove the safety tags and close these circuit breakers:

LOWER EPC, DC AIR CONDITIONING & MISCELLANEOUS

Row	Col	Number	Name
W	28	B1-378	ALTERNATE THUNDER STORM

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	37	B1-159	EMERGENCY DC BUS FEED
N	38	B1-167	CHARGER & TRANSFER RELAY CONTROL

LOWER EPC, LIGHTS - LEFT DC BUS

Row	Col	Number	Name
M	33	B1-293	COCKPIT OVERHEAD WHITE FLOOD

(l) Place BATT switch in OFF position.

(6) Test cabin standby lights as follows:

(a) Make sure that these circuit breakers are closed:

OVERHEAD EMERGENCY DC BUS

Row	Col	Number	Name
WJE 401-409, 411, 412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893			
A	12	B1-165	EMERGENCY POWER IN USE LIGHTS
A	13	B1-42	CABIN STANDBY LIGHTS
WJE 410			
A	13	B1-165	EMERGENCY POWER IN USE LIGHTS
A	14	B1-42	CABIN STANDBY LIGHTS

WJE ALL

(b) Make certain EMER PWR switch, on overhead switch panel, is in OFF position.

(c) Place BATT switch, on overhead switch panel, in ON position.

(d) Place EMER PWR switch in ON position.

(e) Check that EMER PWR IN USE light, on overhead panel comes on. Check that all cabin standby lights come on.

(f) Place EMER PWR switch in OFF position.

(g) Check that EMER PWR IN USE light, and all cabin standby lights go out.

(h) Place BATT switch, on overhead switch panel, in OFF position.

(7) Test fuel quantity indicators as follows:

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(a) Open this circuit breaker:

UPPER EPC, FUEL

Row	Col	Number	Name
J	17	B1-822	FUEL QUANTITY POWER TRANSFER

(b) Make certain NOSE GEAR OLEO-RIGHT switch is in ground mode position.

(c) Make certain EMER PWR switch, on overhead panel, is in OFF position.

(d) Make certain BATT switch, on overhead panel, is in OFF position.

(e) Place WING FUEL CONTROL POWER switch, on refueling power panel, in ON position.

(f) Check for fuel quantity indication on Fuel Quantity Cockpit Display.

(g) Place EMER PWR switch, on overhead panel, in ON position.

(h) Check for no indication on Fuel Quantity Cockpit Display.

(i) Place EMER PWR switch in OFF position.

(j) Place WING FUEL CONTROL POWER switch, on refueling power panel, in OFF position

(k) Remove the safety tag and close this circuit breaker:

UPPER EPC, FUEL

Row	Col	Number	Name
J	17	B1-822	FUEL QUANTITY POWER TRANSFER

(8) Remove external power from aircraft.

(9) Remove tags from engine and APU start switches.

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893

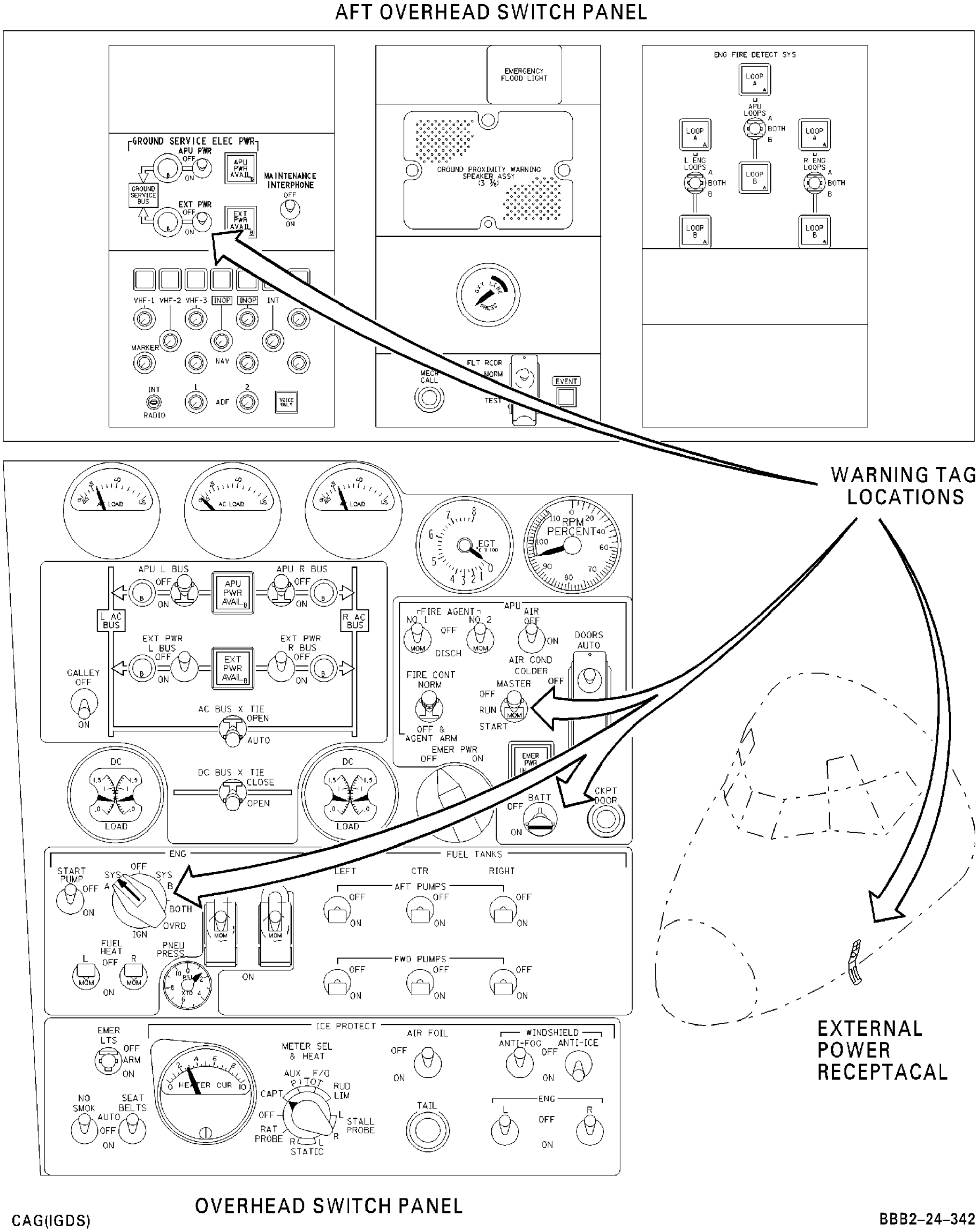
(10) Reset/adjust the clocks. (CLOCK - MAINTENANCE PRACTICES, PAGEBLOCK 31-21-00/201 Config 1)

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887

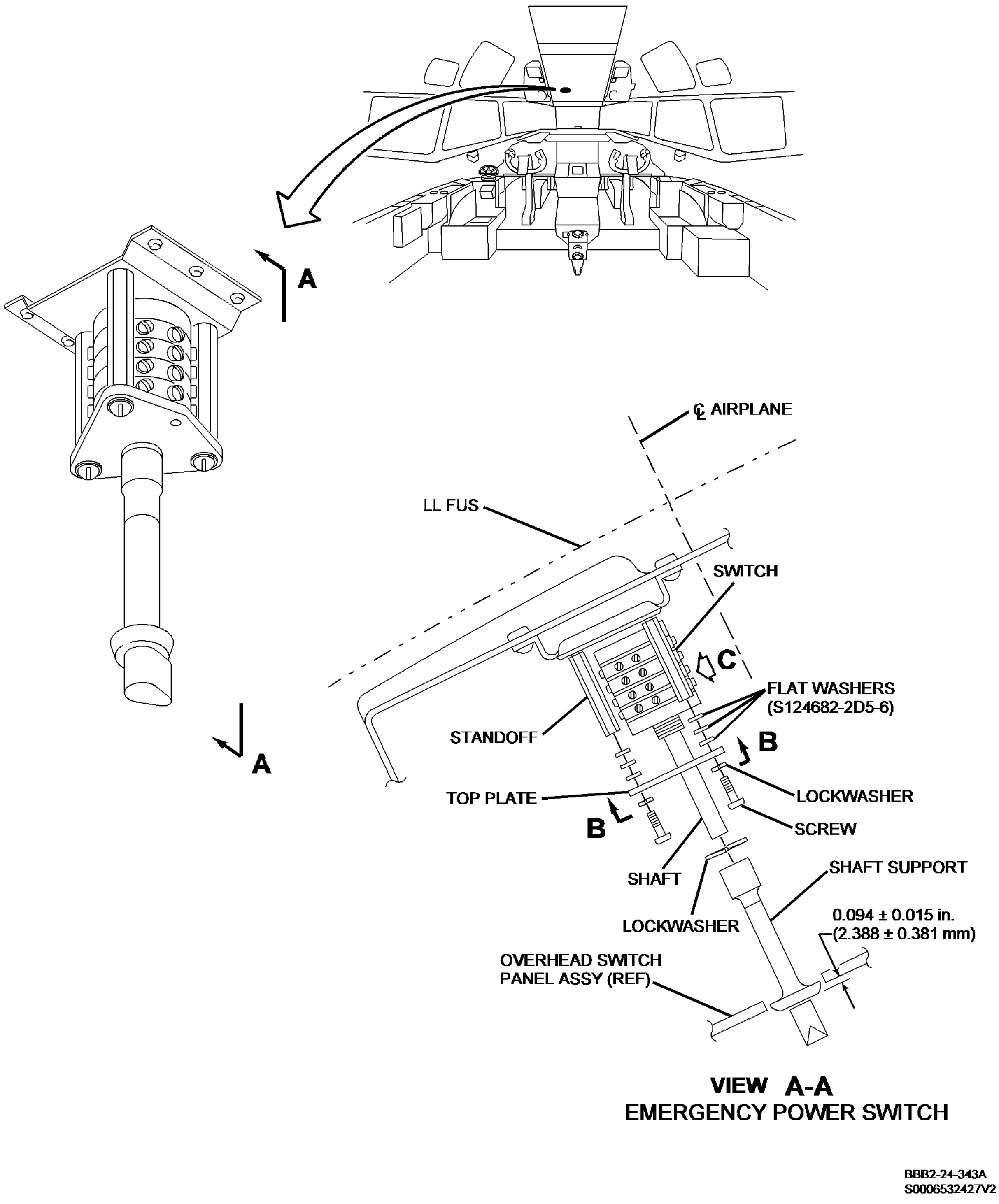
(11) Reset/adjust the clocks. (DIGITAL CLOCK - MAINTENANCE PRACTICES, PAGEBLOCK 31-21-00/201 Config 2)

WJE ALL

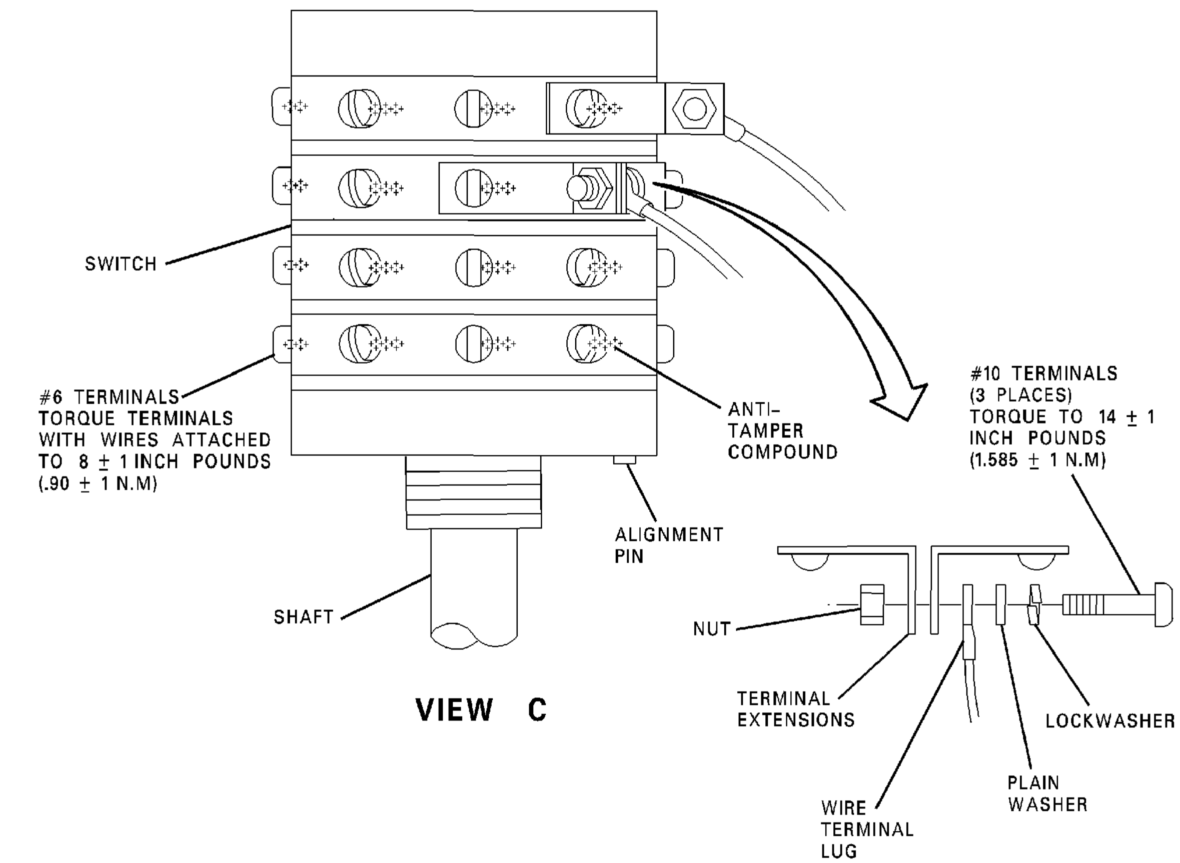
(12) After completion of test, position switches as required.

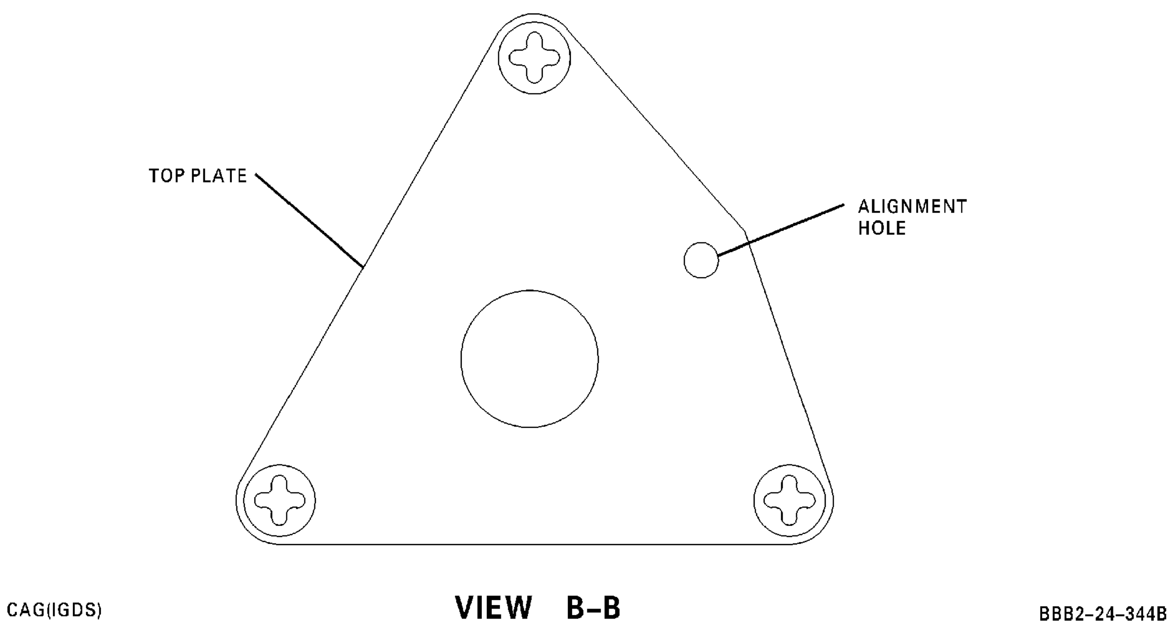


WARNING Tag locations
Figure 401/24-23-02-990-801



Emergency Power Switch - Installation
Figure 402/24-23-02-990-802





Emergency Power Switch Detail
Figure 403/24-23-02-990-803

EMERGENCY POWER SWITCH - REMOVAL/INSTALLATION

1. General

A. This procedure contains MSG-3 task card data.

TASK 24-23-02-901-801

2. Discard the Emergency Power Switch (S1-148)

NOTE: This procedure is a scheduled maintenance task.

A. General

(1) This task is applicable to airplanes equipped with switch P/N 103–2200.

NOTE: Refer to Special Compliance Item 24-1 and AD 95-11-12.

B. References

Reference	Title
24-23-02 P/B 401	EMERGENCY POWER SWITCH - REMOVAL/INSTALLATION
31-00-03 P/B 201	OVERHEAD PANELS - GENERAL - MAINTENANCE PRACTICES

C. Emergency Power Switch (S1-148) Discard

SUBTASK 24-23-02-030-001

(1) Lower the forward overhead switch panel. (OVERHEAD PANELS - GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 31-00-03/201)

SUBTASK 24-23-02-901-001

(2) Remove EMER PWR switch (S1-148). (EMERGENCY POWER SWITCH - REMOVAL/INSTALLATION, PAGEBLOCK 24-23-02/401)

(3) Discard the removed switch.

(4) Install serviceable EMER PWR switch. (EMERGENCY POWER SWITCH - REMOVAL/INSTALLATION, PAGEBLOCK 24-23-02/401)

SUBTASK 24-23-02-430-001

(5) Close the forward overhead switch panel. (OVERHEAD PANELS - GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 31-00-03/201)

D. Job Close-up

SUBTASK 24-23-02-942-001

(1) Remove all the tools and equipment from the work area. Make sure the area is clean.

END OF TASK

EMERGENCY POWER SWITCH - ADJUSTMENT/TEST

1. General

A. This procedure contains task card data.

B. Refer to All Operator Letter AOL 9-2160.

TASK 24-23-02-720-801

2. Torque Check of the Emergency Power Switch

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
31-00-03 P/B 201	OVERHEAD PANELS - GENERAL - MAINTENANCE PRACTICES

B. Tools/Equipment

Reference	Description
STD-7866	Wrench - Torque, 0-25 in-lbs (0-3 N-m)

C. Prepare for the Torque Check of the Emergency Power Switch

SUBTASK 24-23-02-720-001

(1) Lower the forward overhead switch panel. (OVERHEAD PANELS - GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 31-00-03/201)

(2) Check torque of the emergency power switch terminal screws using torque wrench, STD-7866.

(a) Torque for all No. 6 terminal screws are 8 ±1 in-lb (0.9 ±0.1 N·m).

(b) Torque for all No. 10 terminal screws are 14 ±1 in-lb (2 ±1 N·m).

(3) Close forward overhead switch panel. (OVERHEAD PANELS - GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 31-00-03/201)

D. Job Close-up

SUBTASK 24-23-02-942-002

(1) Remove all the tools and equipment from the work area. Make sure the area is clean.

——— END OF TASK ———

AC EMERGENCY POWER TRANSFER RELAY - MAINTENANCE PRACTICES

1. GENERAL

A. This chapter provides removal/installation and adjustment/test procedures for the AC emergency power transfer relay. The relay is located in the electrical power center.

2. Removal/Installation - AC Emergency Power Transfer Relay

A. Remove relay

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Open these circuit breakers and install safety tags:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(2) Open access panel 4423A.

(3) Tag and remove wires from AC emergency power transfer relay, R2-47.

(4) Remove relay.

B. Install relay

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Make sure that these circuit breakers are open and have safety tags:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(2) Install relay to electrical power center.

(3) Install wires to correct terminals on relay. Remove tags from wires.

(4) Close access panel.

(5) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

3. Adjustment/Test - AC Emergency Power Transfer Relay

A. Test Relay

(1) Make certain external power is applied to left and right generator buses, and that EXT PWR lights on overhead panel are on.

(2) Make certain EMER PWR switch on overhead panel is in OFF position.

(3) Check that AC EMER BUS OFF light on annunciator panel is off.

(4) Open this circuit breaker:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

(5) Check that AC EMER BUS OFF light on annunciator panel is off.

(6) Open this circuit breaker:

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(7) Check that AC EMER BUS OFF light on annunciator panel, comes on.

(8) Close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(9) Check that AC EMER BUS OFF light on annunciator panel is off.

DC GENERATION - DESCRIPTION AND OPERATION

1. General

A. DC power is provided for the airplane from transformer-rectifier (TR) units and batteries to operate all equipment requiring 28 VDC. The DC system is divided into two parts, the left side and the right side. Each side is designed to be normally operated as an independent system, with a power source and bus to supply power to the various DC load demands throughout the airplane. (Figure 1)

B. During normal operation, four transformer-rectifiers supply DC power to the main DC load buses. The output from two TR units, operating in parallel, is supplied to the LEFT DC BUS. The output from the third TR unit is supplied to the RIGHT DC BUS. The output from the fourth TR unit is supplied to one of two buses, the RIGHT DC BUS or the DC TRANSFER BUS, as determined by operating conditions. During normal operation the output from the fourth TR unit is in parallel with the third TR unit, supplying power to the RIGHT DC BUS. When only ground servicing power is required on the airplane, power output from the fourth TR unit is supplied to only the DC TRANSFER BUS.

C. If either the LEFT or RIGHT DC BUS should lose power, a DC Crosstie Relay is provided so that the dead bus can be supplied power from the opposite bus. Operation of the crosstie relay is controlled by the DC BUS X TIE switch located on the overhead switch panel. The DC system is normally operated with the DC BUS X TIE switch in the OPEN position. If the two TR units that are operating in parallel should cease operation, the DC Crosstie Relay can be closed and both DC buses will be supplied power from the two operating TR units, provided, the loss of power is not caused by a DC Bus Fault. A 75-ampere DC tie limiter fuse, located in the lower aft portion of EPC, prevents cross-tying an operating DC BUS to a faulty bus.

D. Two 14 VDCbatteries are connected in series to provide 28 VDC power to the BATT DIRECT BUS and the BATTERY BUS. Power is provided directly from the batteries, through the Battery Direct Bus circuit breaker, to the BATT DIRECT BUS which is powered whenever the batteries are connected regardless of battery switch position. Circuit design is such that none of the loads connected to this bus will draw power from the batteries when the airplane is in a stowed (shutdown) condition. The BATTERY BUS receives power from the BATT DIRECT BUS, through the Battery Relay. The Battery Relay is controlled by operation of the BATT switch, located on the overhead switch panel.

E. Battery power is used, when no other power is being supplied to the load buses, to supply the DC requirements necessary for starting an engine, starting the APU, and fueling operations. The batteries are also capable of supplying power for operation of the inverter and to the most important DC operated equipment when normal AC power is not available during flight.

F. System design prevents power from the transformer-rectifiers being supplied to the BATT DIRECT BUS or the BATTERY BUS, and prevents power from the batteries being supplied to the left and right DC buses.

2. DC Generation Components

A. Major components of the DC power system consist of four transformer-rectifier (TR) units, four reverse current diodes, batteries, battery charger, a blocking rectifier assembly, two DC loadmeters, and a combination DC voltmeter/ammeter. Power seeking and/or interlocking relays control power to the DC buses. The Charger and Transfer Relay (C&TR) is described because operation of this relay is unlike other standard relays used in the circuitry.

B. Transformer-Rectifiers (Figure 2)

(1) The four 50-ampere, unregulated transformer-rectifiers (TR) supply DC power to all DC load buses except the BATT DIRECT BUS and the BATTERY BUS. The TR units are mounted on the equipment rack located in the forward accessory compartment. Access to the compartment is through a plug-type door in the upper bulkhead of the nosewheel well. TR left No. 1 and TR right No. 1 are mounted on the right side; TR right No. 2 and TR left No. 2 are mounted on the left side.

(2) The function of the TR units is to convert 115 VAC, 3-phase, 400-hertz input to 28 VDC output. The TR units will be operating whenever the corresponding AC bus, to which each unit is connected, is powered. The TR has a delta primary and a double wye secondary with an inter-phase transformer and phase-doubling on the interphase. This phase-doubling circuit provides a pseudo-twelve-phase output ripple. Radio noise suppression is accomplished with input and output filters.

(3) To complete the circuitry for each TR, the DC ground return is connected through a 75-ampere, 50-millivolt shunt. The shunt is also utilized in the DC loadmeter circuit to monitor the output load.

C. Reverse Current Diodes

(1) There are four reverse current diodes (RCD) mounted on two relay panels located in the flight compartment forward of the rudder pedals. Access to the RCD's may be gained through the access door located in the forward accessory compartment. Each RCD is connected in series with the output of a corresponding TR unit for protection against losing the corresponding DC bus.

D. Batteries (Figure 3)

CAUTION: THE SLIGHTEST ACID CONTAMINATION WILL DETERIORATE THE NICKEL-CADMIUM BATTERY. WHEN SERVICING BATTERIES MAKE CERTAIN THAT ALL BATTERY SERVICE EQUIPMENT IS ACID FREE.

(1) There are two, 11-cell 14 VDC, nickel-cadmium batteries, connected in series to provide a 28 VDC power source. The batteries are packaged as 11-cell units only for ease of maintenance. Electrically, the battery should be considered as a 22-cell 28 VDC battery. In all cases, if one battery is to be replaced, both batteries must be replaced. The batteries are located in the electrical/electronics compartment, forward of the access door.

(2) The electrolyte in a nickel-cadmium battery is a solution of distilled water and potassium hydroxide. The electrolyte is used only as a conductor and does not react with the plates as does the electrolyte in a lead-acid type battery. A lens located in the cap of each cell provides visual indication at low electrolyte levels. A higher degree of brightness on the lens indicates the electrolyte level has reached a point requiring maintenance. The state of battery charge cannot readily be determined by a specific gravity reading, since the electrolyte does not change appreciably. The plates within the battery are porous and absorb the electrolyte while discharging and expel the electrolyte while charging.

(3) The negative plates of the battery are cadmium oxide, and the positive plates are nickel oxide. During charging, all the oxygen is driven out of the negative plates and only cadmium remains. The oxygen dispelled from the negative plates is picked up by the positive plates to form nickel dioxide. Toward the end of the charging process, the electrolyte will gas due to electrolysis taking place in the electrolyte. A slight amount of gassing is necessary to completely charge the battery. Therefore, the battery will lose a certain amount of water.

(4) During discharge, the reverse chemical action takes place. The negative plates gradually gain back the oxygen, as the positive plates lose oxygen. Due to this interchange of oxygen, the chemical energy of the plates is converted into electrical energy and the electrolyte is absorbed by the plates. For this reason, the level of the electrolyte should be checked only when the batteries are fully charged.

(5) One characteristic of the nickel-cadmium battery is that the cells can become unbalanced. Occurrence is generally a result of operation of the battery system for extended periods of operation without total discharge cycling. It is recommended that the batteries be inspected and removed for periodical checks for reconditioning of the battery according to the manufacturers specifications. (BATTERY, SUBJECT 24-30-01)

E. Battery Charger

(1) The battery charger is installed forward of the batteries in the electrical/electronics compartment. Although battery charger output is applied to the BATT DIRECT BUS only during a charging operation, the primary function of the charger is to keep the batteries at a fully charged state.

(2) The battery charger output will be supplied to the batteries any time the GROUND SERVICE BUS is powered, providing the BATT switch is in the ON position. The charging operation will depend on the state of the battery charge and the temperature of the batteries, as sensed by a temperature sensor installed on the underside of the left battery, mounted directly into the battery pan assembly.

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893; WJE 420, 422, 424-427, 429, 868, 884, 891 POST DC9-24-093

NOTE: The charging operation will depend on the state of the battery charge and the temperature of the batteries, as sensed by the temperature sensor. There is one temperature sensor installed under each battery on the aircraft. The battery is mounted directly into the battery pan assembly.

WJE ALL

(3) When the battery state of charge is low, the battery charger goes into a constant charging mode of operation. The charge voltage varies as a function of temperature as indicated by the battery temperature sensor. As the battery approaches full charge, the battery charger goes into a pulse charging mode. When the battery is fully charged, intervals between pulses become longer depending on battery current drain. The longer time interval between pulses would indicate a battery becoming more and more fully charged. Pulse intervals can be expected to vary from 1 second to approximately 20 minutes depending on whether operation is with APU, engine or external power, battery load being used, and the general condition of the batteries.

(4) The Utah Research and Development Corporation battery charger (203BC102-1) is equipped with a built-in-test (BIT) annunciator. The annunciator has three indicators that show failures of the system. These indicators are BATT, CHG, and SEN. When any of the annunciators are lit the battery charger shuts down automatically. The BATT indicator signifies a failure in the battery, i.e. voltage too low or open circuit. The CHG indicator signifies an internal failure in the battery charger. The SEN indicator signifies that both temperature sensors have failed short or either temperature sensor has failed open. If the three annunciator indicators are not lit, while power is applied to the unit, the battery charger should be functioning properly.

F. Battery Charger and DC Transfer Bus Relay

(1) The Charger and Transfer Relay (C&TR) is a single-pole, double-throw, with center-off, type relay. The relay has two coils which are used to actuate the relay contacts into the required position according to operating conditions, four main power terminals which are used to connect the power leads, and two auxiliary terminals.

(2) The C&TR is located in the electrical/electronics compartment, to the left of the battery charger. One coil is energized by AC current; the second coil is energized by DC current. Interlocking circuits in the airplane wiring prevent both coils from being energized at the same time. If neither coil is energized, the movable portion of the power contacts are in a neutral position and no continuity will exist between the power terminals A1-A2 or B1-B2. All the auxiliary contacts are in the open position with power off.

(3) When the Ground Service Bus is powered, only the AC coil can be energized, and the contacts will move so that continuity exists between terminals A1-A2 and the battery charger output is connected to the batteries. At the same time, the auxiliary contacts also close and complete the ground circuit for the coil of the emergency lights protection relay.

(4) If the AC and DC load buses are not powered, only the DC coil of the C&TR can be energized, provided the BATT switch is in the ON position. When the DC coil is energized, the contacts move so that continuity exists between the power lead terminals B1-B2 and battery voltage is applied to the DC TRANSFER BUS.

G. Blocking Rectifier Assembly (Figure 4)

(1) The blocking rectifier assembly, installed at the outboard aft side of the Electrical Power Center (EPC), consists of three blocking rectifiers, a four-post terminal strip, and a stud mounted on a common plate assembly. The blocking rectifiers are used to simplify the three circuits which feed power to the DC TRANSFER BUS. System design is such that only one source of power is supplied to the DC TRANSFER BUS at any one time, through a corresponding blocking rectifier. The remaining two rectifiers block the current from flowing back into the other circuits.

(2) The power lead from the batteries is connected to terminal 1. Voltage is applied at this terminal only when the AC and DC buses are not powered and the BATT switch is in the ON position. The power lead from the TR right No. 2 is connected to terminal 2. Voltage will be applied at this terminal only when ground servicing power is on the airplane. A power lead from the DC buses is connected to terminal 3. Voltage will be applied at terminal 3 when the left DC BUS is powered, or if the LEFT BUS loses power from the RIGHT DC BUS. When power is applied at each terminal, as noted, current will pass through the corresponding blocking rectifier, and the plate assembly on which the blocking rectifiers are mounted acts as a common tie point. The stud provides a means to electrically connect the DC TRANSFER BUS power lead.

H. DC Load Meters

(1) The DC LOAD Meters, installed on the electrical power section of the overhead switch panel, are dual scale meters provided to give a visual indication of the output current in proportion to the rated capacity of the corresponding transformer-rectifier. The meters have two individual scales which are placed vertically on the face of the meter. Each indicating portion of the meter is connected to a corresponding external 75-ampere, 50-millivolt shunt located within the supplying TR unit.

(2) The meter mounted on the left side of the electrical power section is connected to the two left TR units. The load of TR left No. 1 is shown on the left scale of the meter, and the load of TR left No. 2 is shown on the right scale. The other meter, mounted on the right side of the electrical power section, is connected to the two right TR units. The load of TR right No. 1 is shown on the left scale of the meter, and the load of the TR right No. 2 is shown on the right scale.

(3) Each scale is divided into increments with 0, 0.5, 1.0, and 1.5 markings at the corresponding increment. An indicator reading of 0.5 shows that the applicable TR unit is operating at 50 percent of the rated capacity. At a meter reading 1.0; the TR unit is operating at 100 percent of the rated capacity. Maximum allowable continuous load for individual transformer-rectifiers is 1.0.

I. VOLTS AMPS Meter

(1) The DC VOLTS AMPS meter, located on the electrical power section of the overhead switch panel, is a dual purpose meter used to indicate voltage or amperage according to the position of the indicator selector switch. The meter utilizes one needle, or pointer, and a common scale with a zero center. The figures at the top of the scale are used when reading amperage and the figures at the bottom are used when reading voltage.

(2) When indicating amperes, the pointer may swing to the left or right of zero, as determined by operating conditions. During normal operation, the meter will indicate to the left of zero the amount of indication varying due to the state of battery charge and the mode of operation of the battery charger. If the AC and DC buses are not powered and battery power only is being used, as during ground fueling operations or during engine starting, the pointer will swing to the right of zero.

(3) When reading voltage, the pointer will always swing to the right of zero. With the indicator selector switch in the L or R position, voltage on the applicable DC BUS will be indicated on the meter. When the indicator selector switch is placed in the battery volt position, voltage at the batteries will be indicated. If no power is on the airplane AC load buses, the indication will be the voltage of the batteries. During normal operation, the voltage indication will vary according to the state of battery charge and the mode of operation of the battery charger. If the batteries state of charge is low, the battery charger is in a constant charging mode, and the voltage indication may be as high as 40 volts. With the batteries fully charged, the battery charger will be in a pulse charging mode and the indication will vary due to the battery charger pulses. Between pulses the indication should be approximately 30 volts.

3. Operation

A. Transformer-Rectifier Power

(1) Transformer-rectifier left No. 1 and transformer-rectifier left No. 2 are powered the from LEFT AC BUS and supply power, in parallel, to the LEFT DC BUS. Transformer-rectifier right No. 1 is powered from the RIGHT AC BUS and supplies power to the RIGHT DC BUS. Transformer-rectifier right No. 2 is powered from the ground service bus and supplies power to one of two buses. During normal operation, transformer-rectifier right No. 2 supplies power to the DC RIGHT BUS through contacts of the energized DC Ground Service Tie Relay (DGSTR). DGSTR is energized when the RIGHT AC BUS is powered. When electrical power is needed for ground servicing only, transformer-rectifier right No. 2 supplies power to the DC TRANSFER BUS through the deenergized DGSTR.

(2) The left and the right DC buses, normally operated as two individual systems, can be tied together through the DC Crosstie Relay (DCTR) and DC tie limiter fuse, if one of the buses should lose power. Operation of the DCTR is controlled by the DC BUS X TIE switch, located on the electrical power section of the overhead switch panel. Normally the switch is in the OPEN position, the DCTR is deenergized, and the left and right DC buses operate independently from each other. Placing the switch in the CLOSE position will energize the DCTR, tying the two systems together. If loss of TR power is caused by a DC BUS fault, the DC tie limiter fuse will blow (open) and prevent cross tying a normal operating DC BUS to a faulty bus.

(3) During normal operation, the EMERGENCY DC BUS and the DC Transfer Bus are powered from the LEFT DC BUS through contacts of the energized DC Emergency Power Transfer Relay (DEPTR). The coil of the DEPTR is energized from the LEFT DC BUS. When the LEFT DC BUS is powered, the DEPTR is actuated. If the LEFT DC BUS loses power, the DEPTR will deenergized, and the EMERGENCY DC BUS and the DC TRANSFER BUS will receive power from the RIGHT DC BUS.

B. Battery/Battery Charger Power

(1) The batteries are connected directly to the BATT DIRECT BUS, through the Battery Direct Bus Feed circuit breaker. The BATT DIRECT BUS is powered when the batteries are connected regardless of battery switch position. Circuit design is such that none of the loads connected to the bus will draw power from the batteries when the airplane is in a stowed (shutdown) condition.

(2) A Battery Relay (BR) controls battery power supplied to the BATTERY BUS from the BATT DIRECT BUS. The BATT switch, located on the electrical power section of the overhead switch panel, controls the BR. When the BATT switch is placed in the ON position, a ground circuit for the BR coil is completed, the BR is energized, and power is supplied to the battery bus.

(3) Battery power can be used for fueling operations when no other power is supplied to the airplane load buses. DC supply to the ground refueling system is controlled through operation of the DC Transfer Bus Sensing Relay (DTBSR), the right nosegear oleo switch, and the Ground Refueling Relay (GRR). The coil of the DTBSR is connected directly to the DC TRANSFER BUS and ground. When the DC TRANSFER BUS is not powered, the DTBSR is deenergized, and the battery power from the BATT DIRECT BUS is applied through the right nose-gear oleo switch to a contact of the GRR. The oleo switch ensures that the ground refueling system is energized only when the airplane is on the ground with the nosegear compressed sufficiently for the ground sensing mechanism to deactuate the oleo switch. When the FUELING CONTROL PANEL POWER switch is placed in the ON position, GRR will energize, supplying battery power to the Ground Refueling System and at the same time supplying power to the emergency inverter. Operation of the emergency inverter provides single-phase AC power for operation of the fuel quantity indicators during the fueling operation if no other AC power is available.

(4) The battery charger, installed forward of the batteries, ensures that the batteries are kept at a fully charged state. AC power for battery charger operation is supplied from the GROUND SERVICE AC BUS. During normal operation the GROUND SERVICE BUS is powered from the RIGHT AC BUS, through the AC Ground Service Tie Relay (AGSTR); when only ground servicing power is on the airplane, the GROUND SERVICE BUS is powered directly from a power source, that is, external power or APU power.

(5) Three conditions must exist before the battery charger output is connected to the batteries: (1) AC power must energize the AC coil of the Charger and Transfer Relay (C&TR), (2) the EMER PWR switch must be in the OFF position, and (3) the Battery Relay must be energized (BATT switch in ON position). The AC coil of the C&TR is supplied power from phase A of the 3-phase input supply power. During normal operation, the ground return circuit for the coil is through contacts of the energized Charger and Transfer Relay Control Relay (C&TRCR), the EMER PWR switch (OFF position), and the energized Battery Relay (BR). The C&TRCR is energized when either the LEFT DC BUS or the RIGHT DC BUS is powered.

(6) During ground service operation, the RIGHT DC BUS is dead; and, since the DC Ground Service Tie Relay (DGSTR) is powered from the RIGHT AC BUS, this relay will be deenergized. With the DGSTR deenergized, the coil of the Charger and Transfer Ground Service Interlock (C&TGSI) will be energized from the GROUND SERVICE BUS through contacts of the deenergized DGSTR. Now the ground return for the AC coil of the C&TR is through contacts of the energized C&TGSI, the emergency power switch, and the energized Battery Relay.

C. Emergency DC Power

(1) The batteries and the inverter are the sources of power on the airplane when operating without normal AC power.

During this condition of operation, in addition to supplying power to the BATT DIRECT BUS and the BATTERY BUS in the same manner as during normal operation, the batteries supply power to the DC TRANSFER BUS, EMERGENCY DC BUS, and the single-phase inverter. The inverter supplies AC power necessary for operation of instruments and radio equipment considered important to flight.

(2) Battery power being supplied to the DC TRANSFER BUS is an automatic operation, when, during normal operation, the loss of 3-phase AC power occurs. As a result of the AC buses not being powered, the AC coil of the C&TR will deenergize. At the same time the AC buses lose power, the DC buses also lose power as a result of no TR output, and C&TRCR deenergizes. When the C&TRCR deenergizes, power is supplied from the BATT DIRECT BUS through a set of contacts of the BATT switch (normally on), contacts of the C&TRCR (deenergized), and contacts of the C&TGSI deenergized, to the DC coil of the C&TR. With the DC coil of the C&TR energized, a set of contacts close and battery power is supplied from the batteries to the DC TRANSFER BUS.

(3) Power supplied to the EMERGENCY DC BUS and the emergency inverter is taken from the BATTERY DIRECT BUS, and the operator must place the EMER PWR switch in the ON position. Power is supplied directly to the EMERGENCY DC BUS through contacts of the switch. Power is supplied to the DC terminal of the emergency inverter through a circuit breaker and another set of contacts of the emergency power switch.

D. Indications

CAUTION: MAXIMUM ALLOWABLE CONTINUOUS LOAD FOR INDIVIDUAL TR UNITS IS 1.0. IF DC LOAD METER INDICATES MORE THAN 1.0, REDUCE LOADS USING POWER TO PREVENT DAMAGE TO TR UNITS.

(1) To complete the circuitry for each transformer-rectifier, the DC ground return is connected through a 75-ampere, 50-millivolt shunt which is an internal part of each TR unit. The shunt is used in the DC LOAD meter circuit to give an indication of the load on each TR. At any time a TR unit is operating and supplying power to the applicable bus, the corresponding DC LOAD meter should indicate a load.

(2) DC bus voltage, battery voltage, and battery circuit amperage is shown on a combination DC voltmeter/ammeter. Voltage for DC BUS indication is from the left and right DC buses and applied to terminals of type selector switch. Placing the selector switch in the L or R position will indicate the voltage on the applicable bus.

(3) Wiring necessary for battery voltage and amperage indications is connected to a 100-ampere, 50-milivolt shunt installed in the battery circuit. This wiring is also connected to terminals of the selector switch. When the selector switch is placed in the BATT VOLT position, voltage at the batteries is indicated on the meter. If the battery charger is not operating, the voltage indication will be that of the batteries and should show approximately 28 VDC. When the battery charger is operating, this voltage indication will vary depending upon the mode of operation of the battery charger. If the batteries are not fully charged, the battery charger will be in the constant charging mode, and the voltage indication should be between 30 and 33 VDC. If the batteries are fully charged, the battery charger will be in the pulse charging mode, and the voltage indication should vary due to the battery charger pulses. Between pulses, the indication should be approximately 30 VDC.

(4) When the selector switch is placed in the BATT AMP position the voltmeter/ammeter should indicate to the left of zero. The amount of indication will be related to the state of battery charge. If the batteries are severely discharged, current limiting function of the charger may occur. This condition will appear as a rapid oscillation of the needle to the left side of zero between approximately 40 and 45 amperes. The meter indication will become steady at approximately 45 amperes gradually reducing in current with respect to time to approximately 40 amperes. As the batteries become charged, the charger will go into the pulse mode of operation with interval between pulses ranging from 5 seconds to approximately 30 minutes. Between pulses the meter should read zero. When the AC load buses are not powered and the battery charger is not operating, battery loads during fueling operations, engine starting, or when operating under emergency conditions will be reflected on the meter and to the right of zero, the amount varying according to the loads applied. During emergency operation, the meter will read between 10 and 35 amperes.

(5) Caution and warning lights, installed on the flight compartment overhead switch panel, are intended to alert the operator that a condition exists which requires corrective action. The DC BUS OFF light indicates that either the LEFT DC BUS or the RIGHT DC BUS has lost power. Power source for the light is taken from the DC TRANSFER BUS. Ground circuit for the light is through contacts of one of two relays. During normal operation, the DC Emergency Power Transfer Relay (DEPTR) is energized from the LEFT DC BUS and the Dead Sensing Relay (DESR) is energized from the RIGHT AC BUS. If either bus should lose power, the corresponding relay will deenergize, contacts of the relay will close, completing the ground circuit, and the DC BUS OFF light will come ON. If the DC BUS OFF light does come on during normal operation, placing the DC BUS X TIE switch in the CLOSE position will cause DC Crosstie Relay (DCTR) to energize, power will be supplied from the powered bus to the dead bus, and the DC BUS OFF light should go OFF.

(6) The DC EMER BUS OFF light indicates that the EMERGENCY DC BUS has lost power. The DC TRANSFER BUS OFF light indicates that the DC TRANSFER BUS has lost power. Both lights are powered from the BATTERY BUS. Due to the high voltage applied to the bus when the battery charger is in a charging mode, each light is protected by a corresponding 100-ohm resistor used in conjunction with a switching relay. When the battery charger output is connected through the battery charger and DC TRANSFER BUS Relay (AC coil energized), the auxiliary contacts of the relay complete the ground circuit for the coil of the emergency lights protection relay. Actuation of the emergency lights protection relay opens the relay contacts, and power to each light is through the resistors. When the AC coil of the C&TR is energized, the emergency lights protection relay is deenergized and power to the lights is through contacts of the emergency lights protection relay.

(7) The ground circuit for the EMER DC BUS OFF light is through the Emergency DC Bus Sensing Relay (EDBSR) which is energized whenever the EMERGENCY DC BUS is powered. If the EMERGENCY DC BUS should lose power, EDBSR will deenergize, a set of contacts will close, and the EMER DC BUS OFF light will come ON.

(8) The ground circuit for the DC TRANSFER BUS OFF light is through the DC Transfer Bus Sensing Relay (DTBSR), which is energized whenever the DC TRANSFER BUS is powered. If the DC TRANSFER BUS should lose power, the DTBSR will deenergize, a set of contacts will close, and the DC TRANSFER BUS OFF light will come ON.

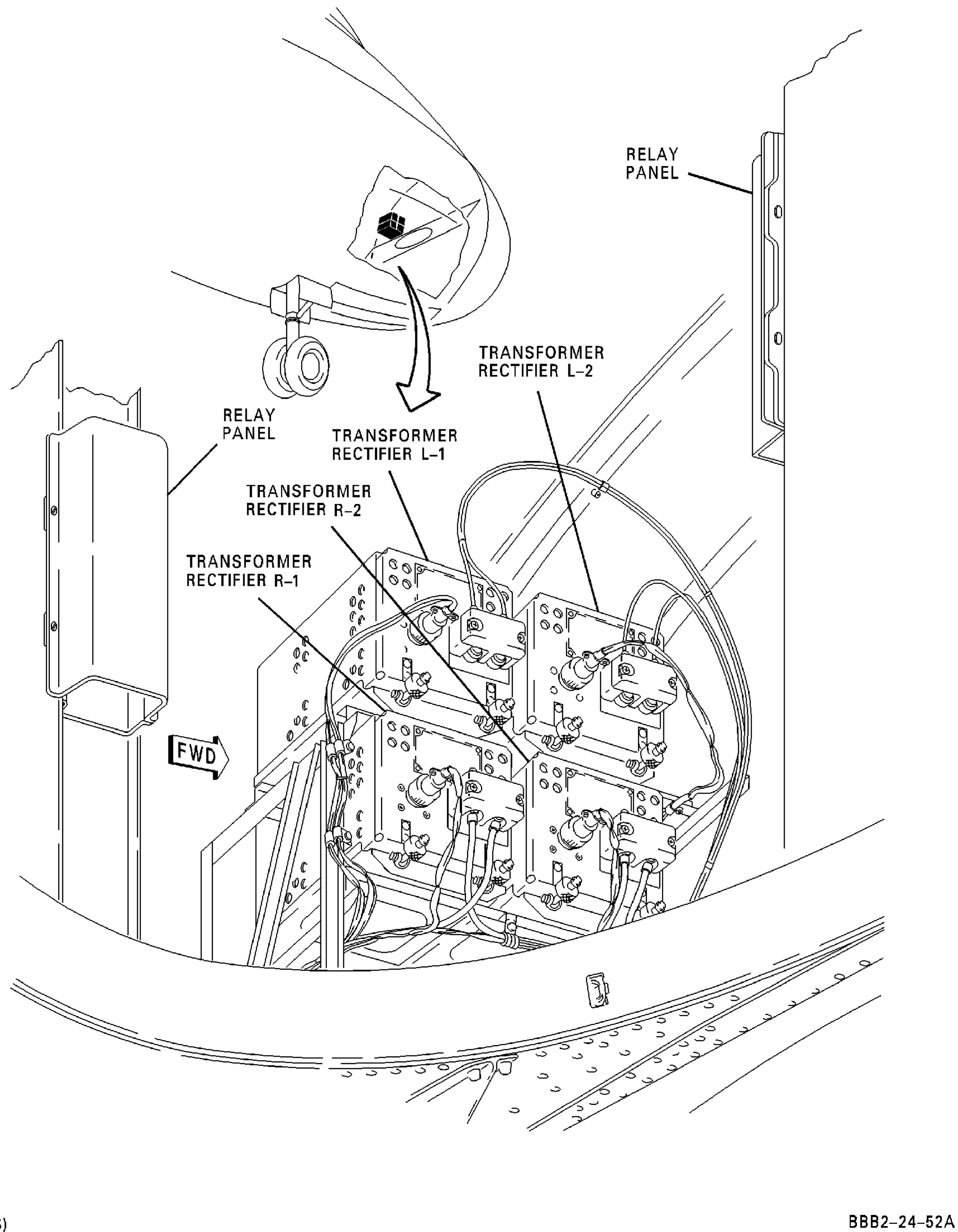
(9) During normal operation the EMERGENCY DC BUS and the DC TRANSFER BUS are powered from the same source. If the EMER DC BUS OFF light and the DC TRANSFER BUS OFF light should come ON simultaneously, it would indicate that all the transformer-rectifiers have ceased operating. The operator should then go to emergency power operation by placing the EMER PWR switch in the ON position. Both lights should then go off as battery power is supplied to the DC EMERGENCY DC BUS and the DC TRANSFER BUS.

ABBREV.	NAME
ACTL	AC CROSSTIE LOCKOUT
ACTLIR	AC CROSSTIE LOCKOUT INDICATION RELAY
ACTLS	AC CROSSTIE LOCKOUT RELAY SLAVE
ACTR	AC CROSSTIE RELAY
AEPTR	AC EMERGENCY POWER TRANSFER RELAY
AGSTR	AC GROUND SERVICE TIE RELAY
APCR	AUXILIARY POWER CONTROL RELAY
APGC	GEN CONTROL UNIT (AUXILIARY POWER)
APPRR	POWER READY RELAY (AUXILIARY POWER)
APR	AUXILIARY POWER RELAY
APSR	AUXILIARY POWER UNIT STARTER RELAY
APU	AUXILIARY POWER UNIT
ARSW	ANNUNCIATOR RESET SWITCH
BAT	BATTERY
BC	AC BUS CONTROL UNIT
BCHG	BATTERY CHARGER
BCTR	BATTERY CHARGER TRANSFER RELAY
BR	BATTERY RELAY
BS	BATTERY SWITCH
C&TGSI	BATTERY CHARGER & DC TRANSFER BUS GROUND SERVICE INTERLOCK
C&TR	BATTERY CHARGER & DC TRANSFER BUS RELAY
C&TRCR	BATTERY CHARGER & DC TRANSFER BUS RELAY CONTROL RELAY
CB	CIRCUIT BREAKER
CSD	CONSTANT SPEED DRIVE
CT	CURRENT TRANSFORMER
CTTD	AC CROSSTIE RELAY TIME DELAY CIRCUIT
DAR	DRIVE ANNUNCIATOR RELAY
DBC	DEAD BUS CIRCUIT
DCTR	DC CROSSTIE RELAY
DDR	DRIVE DISCONNECT RELAY
DEPTR	DC EMERGENCY POWER TRANSFER RELAY
DGSTR	DC GROUND SERVICE TIE RELAY
DP	DIFFERENTIAL PROTECTION
DPCT-A	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ϕA)
DPCT-B	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ϕB)
DPCT-C	DIFFERENTIAL PROTECTION CURRENT TRANSFORMER (ϕC)
DPTD	DIFFERENTIAL PROTECTION TIME DELAY
DRSR	DRIVE RUNNING SIGNAL RELAY
DSAR	DISTRIBUTION SYSTEM ANNUNCIATOR RELAY
DTBSR	DC TRANSFER BUS SENSING RELAY
ECSW	EMERGENCY POWER CONTROL SWITCH
EDBSR	EMERGENCY DC BUS SENSING RELAY
EPM	EXTERNAL POWER MONITOR
EPPSC	EXTERNAL POWER PHASE SEQUENCE CIRCUIT
EPR	EXTERNAL POWER RELAY
ERSR	ENGINE RUNNING SIGNAL (SSR)
FSTD	FAULT SELECTOR TIME DELAY CIRCUIT
GAR	GENERATOR ANNUNCIATOR RELAY
GCR	GENERATOR CONTROL RELAY

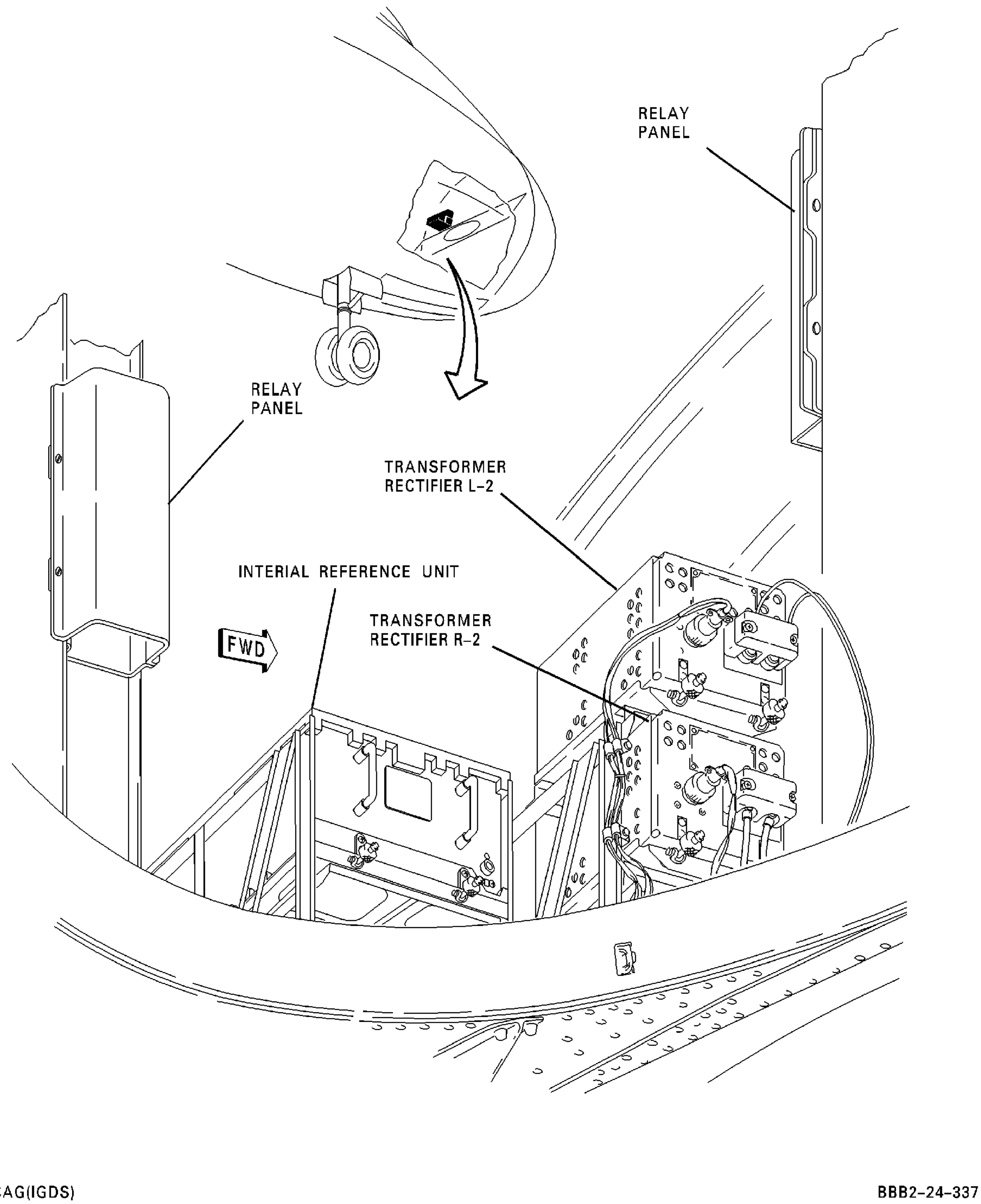
ABBREV.	NAME
GCU	AC GENERATOR CONTROL UNIT
GCUAR	GENERATOR CONTROL UNIT ANNUNCIATOR RELAY
GEN	GENERATOR
GFFW	GENERATOR FEEDER FAULT WARNING
GPS	GENERATOR PHASE SEQUENCE
GR	GENERATOR RELAY
GRR	GROUND REFUELING RELAY
GSAPR	GROUND SERVICE AUXILIARY POWER RELAY
GSEPR#1	GROUND SERVICE EXTERNAL POWER RELAY NO.1
GSEPR#2	GROUND SERVICE EXTERNAL POWER RELAY NO.2
INV	INVERTER
L	LEFT
LAPCR#1	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
LAPCR#2	LEFT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
LAPR	LEFT AUXILIARY POWER RELAY
LDBC	LEFT DEAD BUS CIRCUIT
LDBS	LEFT DEAD BUS SLAVE
LEPCR	LEFT EXTERNAL POWER RELAY CONTROL RELAY
LEPR	LEFT EXTERNAL POWER RELAY
LGC	LEFT GENERATOR CONTROL UNIT
LGR	LEFT GENERATOR RELAY
LGRS	LEFT GENERATOR RELAY SLAVE
LPRR	LEFT POWER READY RELAY
OV	OVER VOLTAGE
OVTD	OVER VOLTAGE TIME DELAY CIRCUIT
PMG	PERMANENT MAGNET GENERATOR
PR	POWER RELAY
PRR	POWER READY RELAY
PS	PHASE SEQUENCE
R	RIGHT
RAPCR#1	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 1
RAPCR#2	RIGHT AUXILIARY POWER RELAY CONTROL RELAY NO. 2
RAPR	RIGHT AUXILIARY POWER RELAY
RCD	REVERSE CURRENT (BLOCKING DIODE)
RDBC	RIGHT DEAD BUS CIRCUIT
RDBS	RIGHT DEAD BUS SLAVE
REPCR	RIGHT EXTERNAL POWER RELAY CONTROL RELAY
REPR	RIGHT EXTERNAL POWER RELAY
RGC	RIGHT GENERATOR CONTROL UNIT
RGR	RIGHT GENERATOR RELAY
RGRS	RIGHT GENERATOR RELAY SLAVE
RPRR	RIGHT POWER READY RELAY
SW	SWITCH
TD	TIME DELAY
TR	TRANSFORMER-RECTIFIER
UF	UNDER FREQUENCY
UFTD	UNDER FREQUENCY TIME DELAY CIRCUIT
UV	UNDER VOLTAGE
UVTD	UNDER VOLTAGE TIME DELAY CIRCUIT
VR	VOLTAGE REGULATOR CIRCUIT
VROK	VOLTAGE REGULATOR OK

BBB2-24-125A

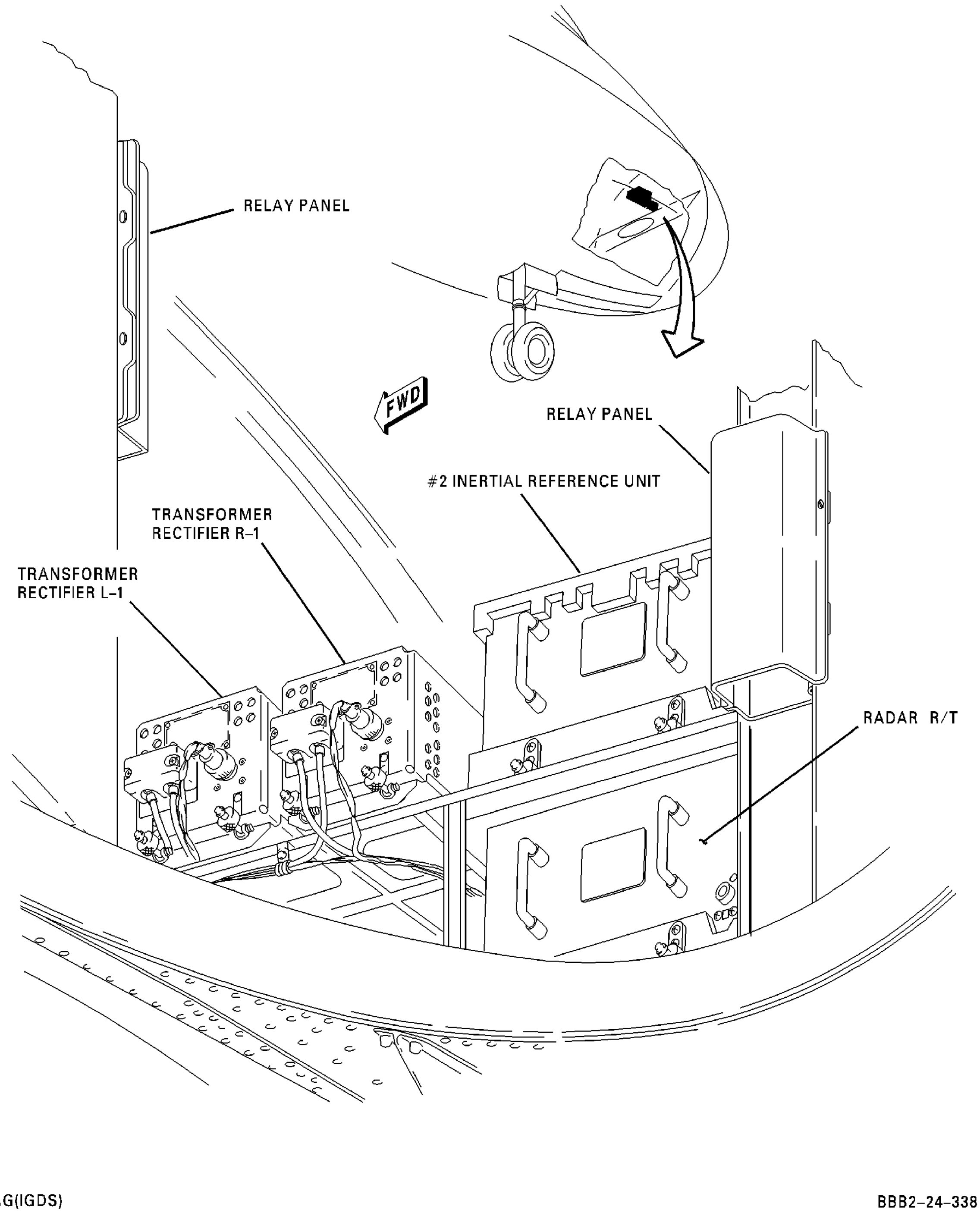
Electrical Power Abbreviations
Figure 1/24-30-00-990-805



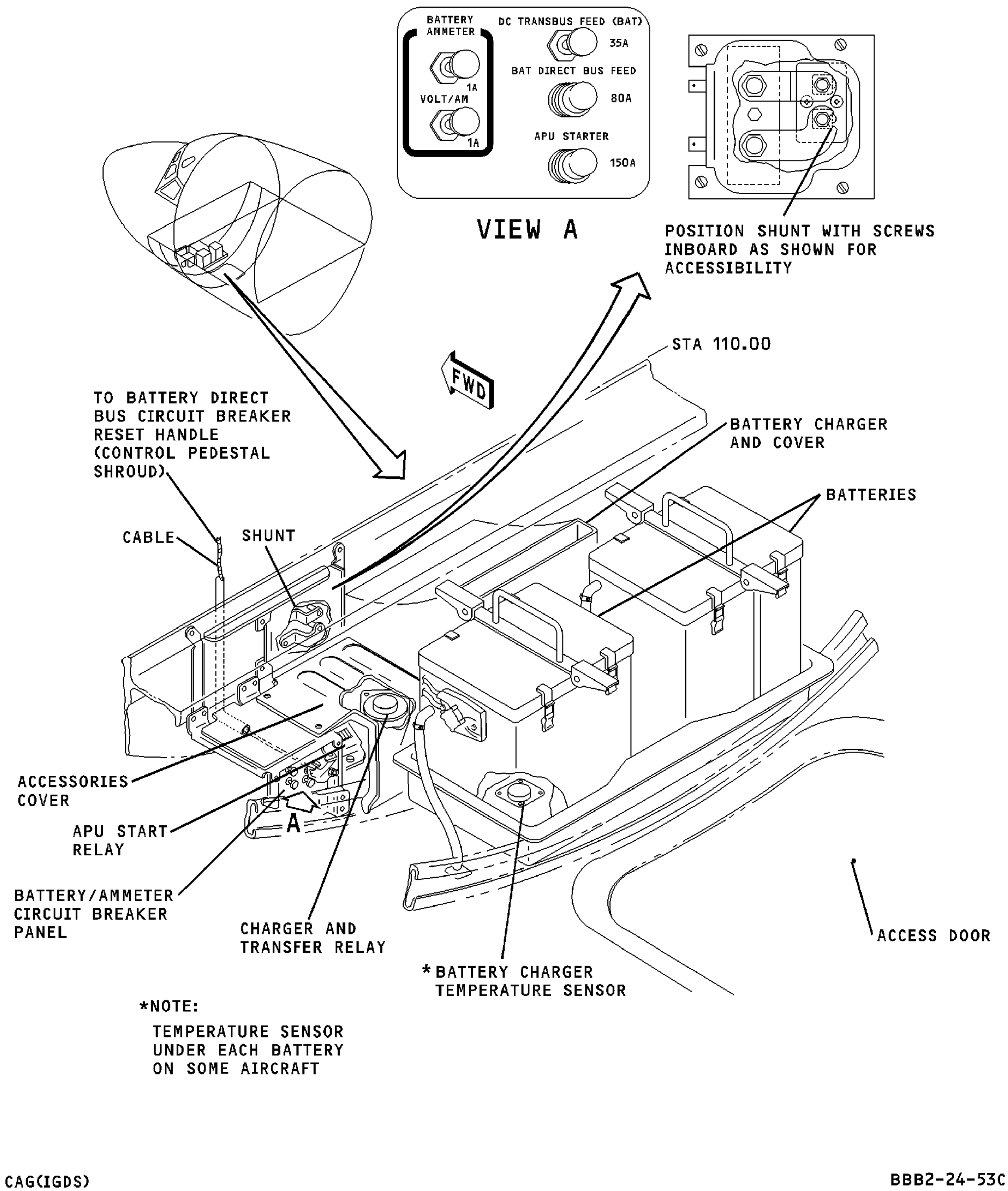
Transformer-Rectifier -- Installation
Figure 2/24-30-00-990-806 (Sheet 1 of 3)



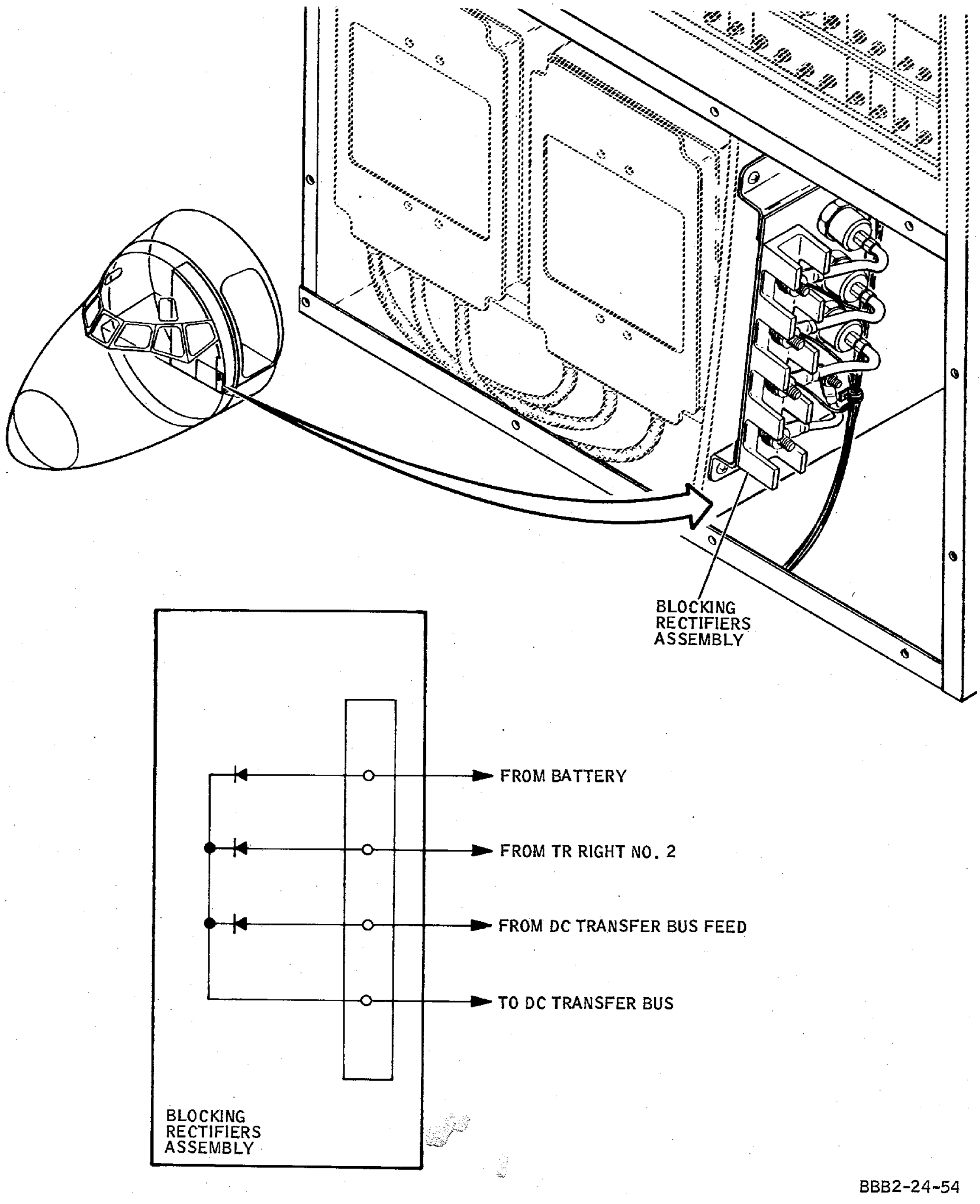
Transformer-Rectifier -- Installation
Figure 2/24-30-00-990-806 (Sheet 2 of 3)



Transformer-Rectifier -- Installation
Figure 2/24-30-00-990-806 (Sheet 3 of 3)



Dc Components Installation -- Battery Area
Figure 3/24-30-00-990-807



Blocking Rectifiers - Installation
Figure 4/24-30-00-990-808

DC GENERATION - TROUBLE SHOOTING

1. General

A. Trouble shooting the DC generation system is first dependent on having an operating AC power system. If a transformer-rectifier (TR) is provided with AC input and has a low or no DC output, the TR is defective. If output DC power is available but not supplied to its bus, the reverse current diode is defective. Trouble shooting procedures therefore, are confined mainly to malfunctioning power seeking, or transfer relays, and blocking rectifiers. A shorted relay coil may cause a circuit breaker to open or the relay coil may be open or relay contacts may become burned and not pass the required current, in any case the relay is defective.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 101

Name and Number	Manufacturer
Multimeter (Model 2000A)	Dana
Phase rotation indicator or phase meter	Local

3. Trouble Shooting DC Generation

Table 102

	Possible Causes	Isolation Procedure	Correction
WARNING: USE EXTREME CAUTION WHEN WORKING IN EPC AREA AS VOLTAGES ENCOUNTERED CAN BE FATAL. OBSERVE SAFETY PRECAUTIONS NORMALLY FOLLOWED WHEN WORKING WITH HIGH VOLTAGES.			
A.	DC BUS OFF ANNUNCIATOR LIGHT IS ON, VOLTAGE INDICATION FOR BOTH LEFT AND RIGHT DC BUS NORMAL		
(1)	DC Emergency Power Transfer Relay (DEPTR) not energized	Check for open relay coil.	If defective, replace relay.
(2)	Right DC Bus Sensing Relay (DBSR) not energized	Check for open or defective DC BUS OUT circuit breaker. Check for defective relay coil.	Close or replace circuit breaker. If defective, replace relay.
B.	DC BUS OFF ANNUNCIATOR LIGHT IS ON, DC BUS CROSSTIE SWITCH IN CLOSED POSITION; DC BUSES WILL NOT CROSSTIE		
(1)	DC Crosstie Relay (DCTR) not energized	Check for open or defective DC BUS CROSS TIE CONTROL circuit breaker.	Close or replace circuit breaker.
		Check for defective relay.	If relay defective, replace.
(2)	DC bus fault	Check for blown DC tie limiter fuse. If fuse is blown, check for ground or short fault on dead DC bus.	Clear bus fault before replacing limiter fuse.

Table 102 (Continued)

Possible Causes		Isolation Procedure	Correction
C.	DC TRANSFER BUS OFF ANNUNCIATOR LIGHT IS ON, VOLTAGE INDICATION FOR BOTH LEFT AND RIGHT DC BUS NORMAL		
(1)	DC Transfer Bus Sensing Relay (DTBSR) not energized	Check for open or defective DC TRANSFER BUS SENSING circuit breaker. Check for defective relay coil.	Close or replace circuit breaker. If defective, replace relay.
(2)	DC TRANSFER BUS not powered	Check for open or defective DC TRANSFER BUS FEED circuit breaker.	Close or replace circuit breaker.
		Check for defective No. 3 blocking rectifier.	Replace blocking rectifier if defective.
D.	EMERGENCY DC BUS OFF LIGHT IS ON, VOLTAGE INDICATION FOR BOTH LEFT AND RIGHT DC BUS NORMAL		
(1)	Emergency DC Bus Sensing relay (EDBSR) not energized	Check for open or defective EMER DC BUS SENSING circuit breaker. Check for defective relay coil	Close or replace circuit breaker. If defective, replace relay.
(2)	DC EMERGENCY BUS not powered	Check for open or defective EMER DC BUS FEED circuit breaker.	Close or replace circuit breaker.
E.	BATTERY CHARGER DOES NOT CHARGE BATTERIES AND NO CHARGE INDICATION ON AMMETER/VOLTMETER, ALL AC BUSES NORMAL		
WJE 420, 422, 424-427, 429, 868, 884, 891			
(1)	Battery charger has no output	Place BATT switch in OFF position. Check for approximately 40 volts DC (no load) at terminal A2 of charger and transfer relay.	If charger output voltage is as specified, Ref. step (3).
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893			
(1)	Battery charger has no output	Check for illuminated built in test equipment (BITE) indicators on end of battery charger opposite terminal strips.	Illuminated indicator will identify fault.
WJE ALL			
(2)	Battery charger has defective 3-phase input	Using phase meter, check for phase rotation A-B-C at charger input terminals.	If incorrect phase rotation, correct; if any phase open, check for defective 3-phase, companion-trip, BATTERY CHARGER circuit breakers or repair wiring.
			If charger input voltage is correct, but output voltage not as specified, replace charger.
(3)	Charger and Transfer Relay (C&TR) AC coil not energized	Place BATT switch in ON position. Check for 115 VAC and ground at relay terminals X1 and X2 respectively.	If voltage and ground are present, replace relay.

Table 102 (Continued)

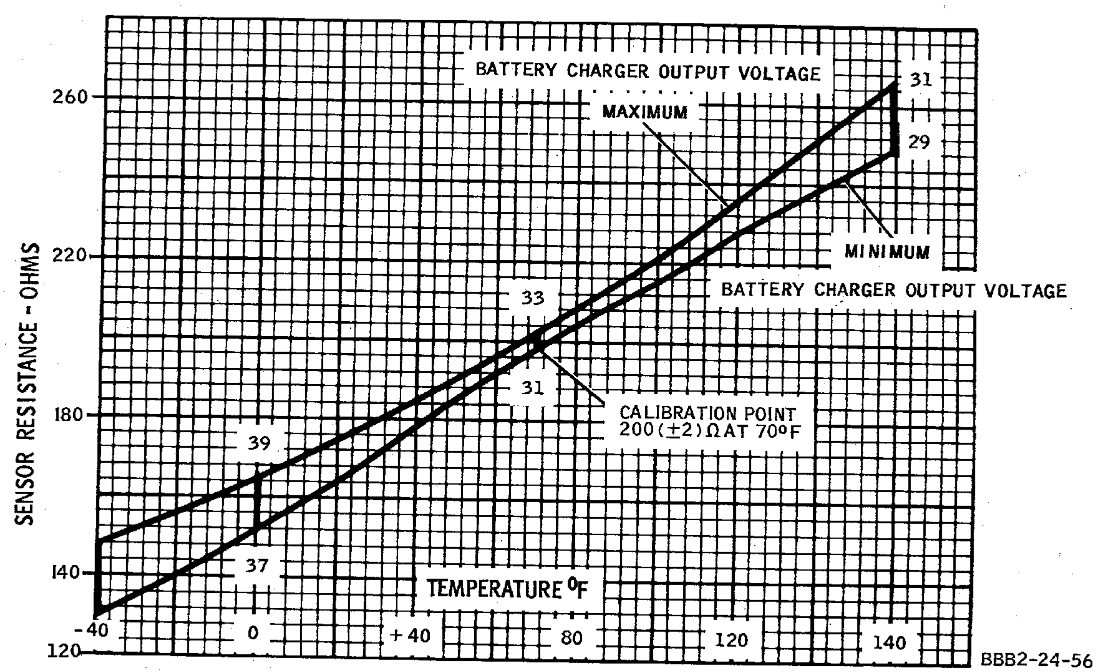
Possible Causes		Isolation Procedure	Correction
(4)	Charger and Transfer Relay Control Relay (C&TRCR) not energized	Check for 28 VDC and normal ground at relay terminals X1 and X2, respectively.	If voltage and ground avail able, replace relay. If voltage not available, check CHARGER and TRANSFER RELAY CONTROL circuit breaker and, wiring through contacts of EMER PWR control switch.
(5)	Battery Relay (BR) not energized	Check for 28 VDC and ground at relay terminals X1 and X2, respectively.	If voltage and ground avail able, replace relay.
(6)	Charger and Transfer Relay (C&TR) AC coil ground return circuit is open, C&TRCR and BR relays are energized	Open 3-phase, companion- trip, BATTERY CHARGER circuit breaker. Progressively check continuity of ground return circuit through contacts of energized C&TRCR, EMER PWR control switch, and energized BR to ground.	Repair wiring, if necessary replace component, if contacts are burned. Close BATTERY CHARGER circuit breaker, when check is completed.
WJE 420, 422, 424-427, 429, 868, 884, 891			
(7)	Battery temperature sensor defective	Check battery temperature sensor resistance per chart , and wiring for open or short.(Figure 101)	If sensor resistance is not as specified, replace; if wiring defective, repair.
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893			
(7)	Battery temperature sensor defective	Check SEN illumination of BITE indicator on battery charger. Check battery temperature sensor resistance per chart , and wiring for open or short.(Figure 101)	If sensor resistance is not as specified, replace if wiring defective, repair
WJE 420, 422, 424-427, 429, 868, 884, 891			
F.	BATTERY CHARGER OUTPUT CURRENT CONTINUOUSLY HIGH, NO PULSING		
(1)	Battery charger will not operate in pulsing mode due to defective wiring, shorted battery, or defective battery charger	Check for ground fault in wiring between charger and batteries.	If wiring defective, repair. If wiring is not defective, replace both batteries. If fault still exists, replace battery charger.
G.	BATTERY CHARGER OUTPUT CURRENT LESS THAN 30 AMPERES, CONTINUOUS OR PULSE CHARGING MODES		
(1)	Improper phase rotation on input to charger	Check phase rotation at charger input terminals.	Correct wiring to input terminals A, B, C.
(2)	Battery electrolyte very low or dry from improper servicing	None.	Replace batteries.
NOTE: Always replace both batteries when either is replaced.			
(3)	Battery charger defective	Refer to: Paragraph E., Step (2).	Replace battery charger.
H.	BATTERY CHARGER DOES NOT CHARGE BATTERIES AND NO CHARGE INDICATION ON AMMETER/VOLTMETER, ALL AC BUSES NORMAL, BATTERY VOLTAGE BELOW 25 VOLTS		

WJE 420, 422, 424-427, 429, 868, 884, 891 (Continued)

Table 102 (Continued)

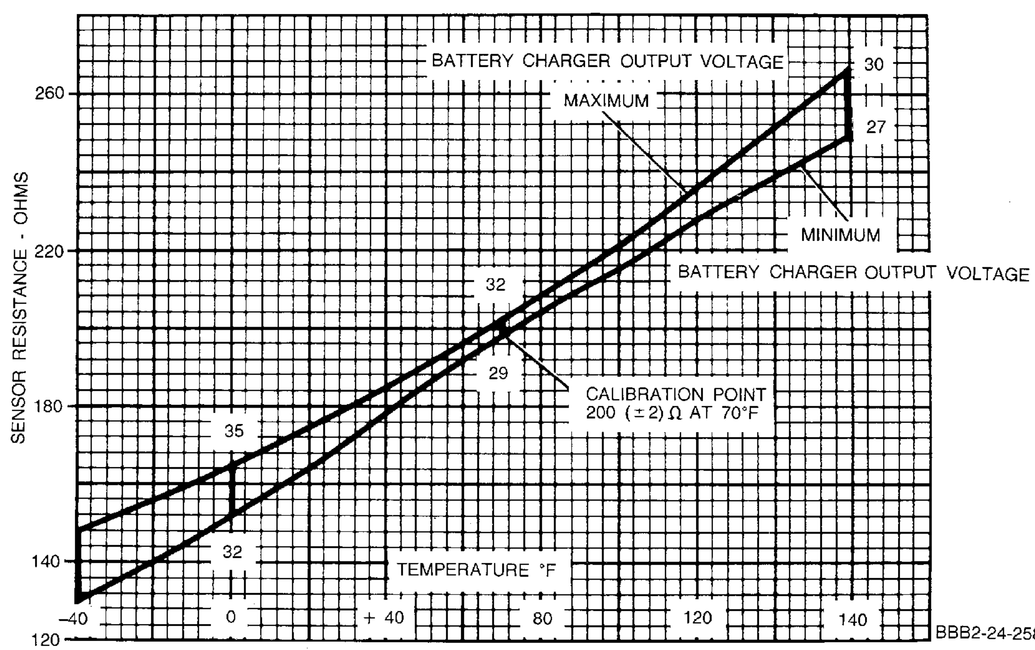
Possible Causes		Isolation Procedure	Correction
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893			
F.	BATTERY CHARGER DOES NOT CHARGE BATTERIES AND NO CHARGE INDICATION ON AMMETER/VOLTMETER, ALL AC BUSES NORMAL, BATTERY VOLTAGE BELOW 25 VOLTS		
WJE ALL			
(1)	Open on battery ground circuit.	Check for loose and/or corroded battery ground connection.	If defective, repair.
(2)	Batteries discharged	Place AC VOLT/FREQ selector switch (overhead switch panel) to BATT VOLT. AMPS VOLTS meter should read 26 volts or greater.	If charger operation and battery voltage is normal, no further action is required.
		Battery voltage less than 25 volts.	Remove and replace both batteries.
		If battery voltage above 26 volts: (a) Check BATT switch ON. (b) Check AC power to 115 VAC GROUND SERVICE BUS. (c) Check all pertinent circuit breakers are closed.	If charger operation and/or battery voltage is not normal, replace battery charger. (BATTERY CHARGER - MAINTENANCE PRACTICES, PAGEBLOCK 24-30-02/201)
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893			
G.	URDC BITE INDICATOR SYSTEM		
NOTE: Acme - Utah Research and Development Co. (URDC).			
(1)	Failed charger	CHG indicator illuminated.	Check charger.
(2)	Failed battery	BAT indicator illuminated.	Check battery.
(3)	Failed sensor	SEN indicator illuminated	Check battery temperature sensor.
WJE ALL			

WJE 420, 422, 424-427, 429, 868, 884, 891

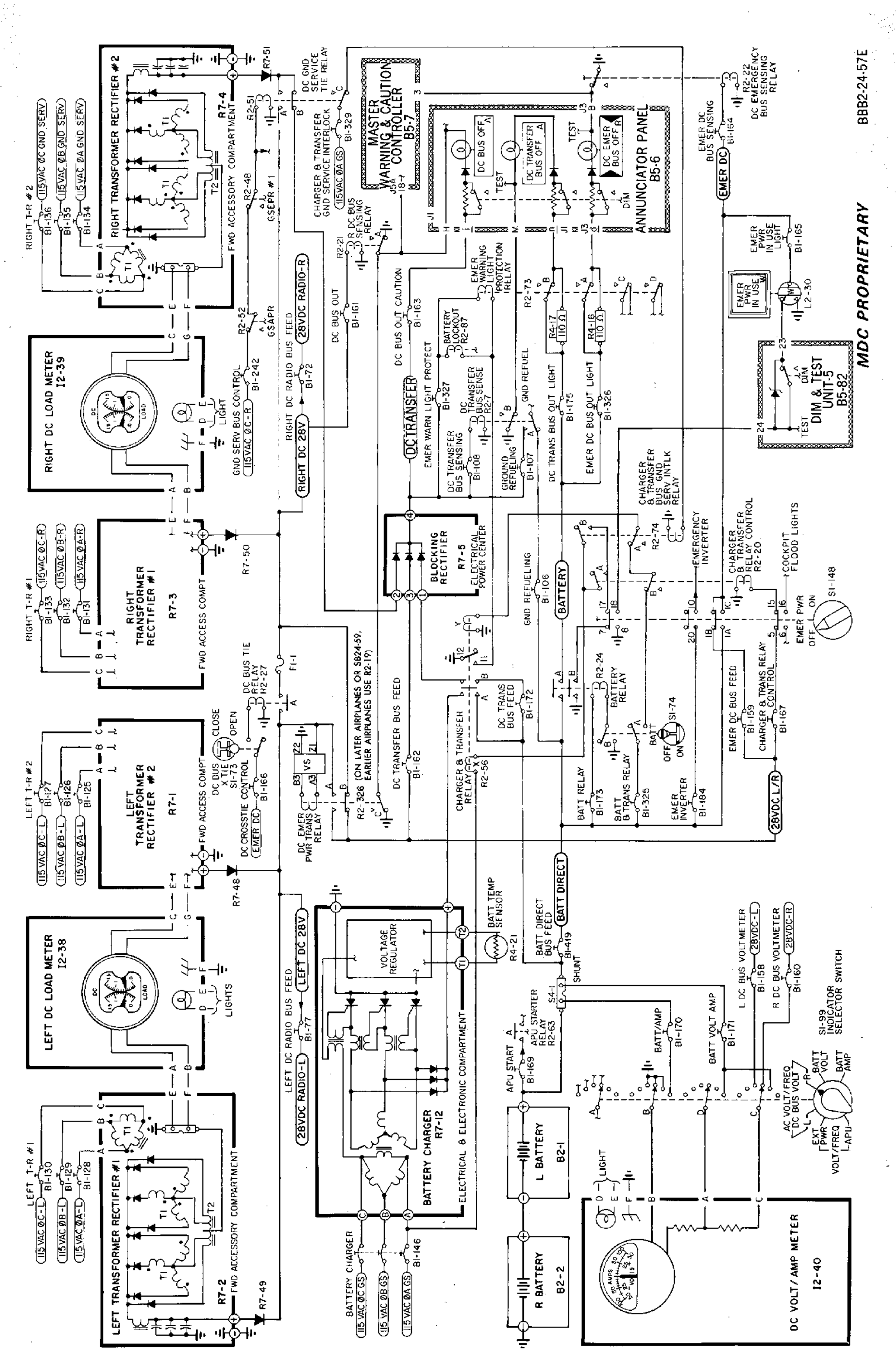


Battery Charger Temperature Sensor -- Chart
Figure 101/24-30-00-990-804 (Sheet 1 of 2)

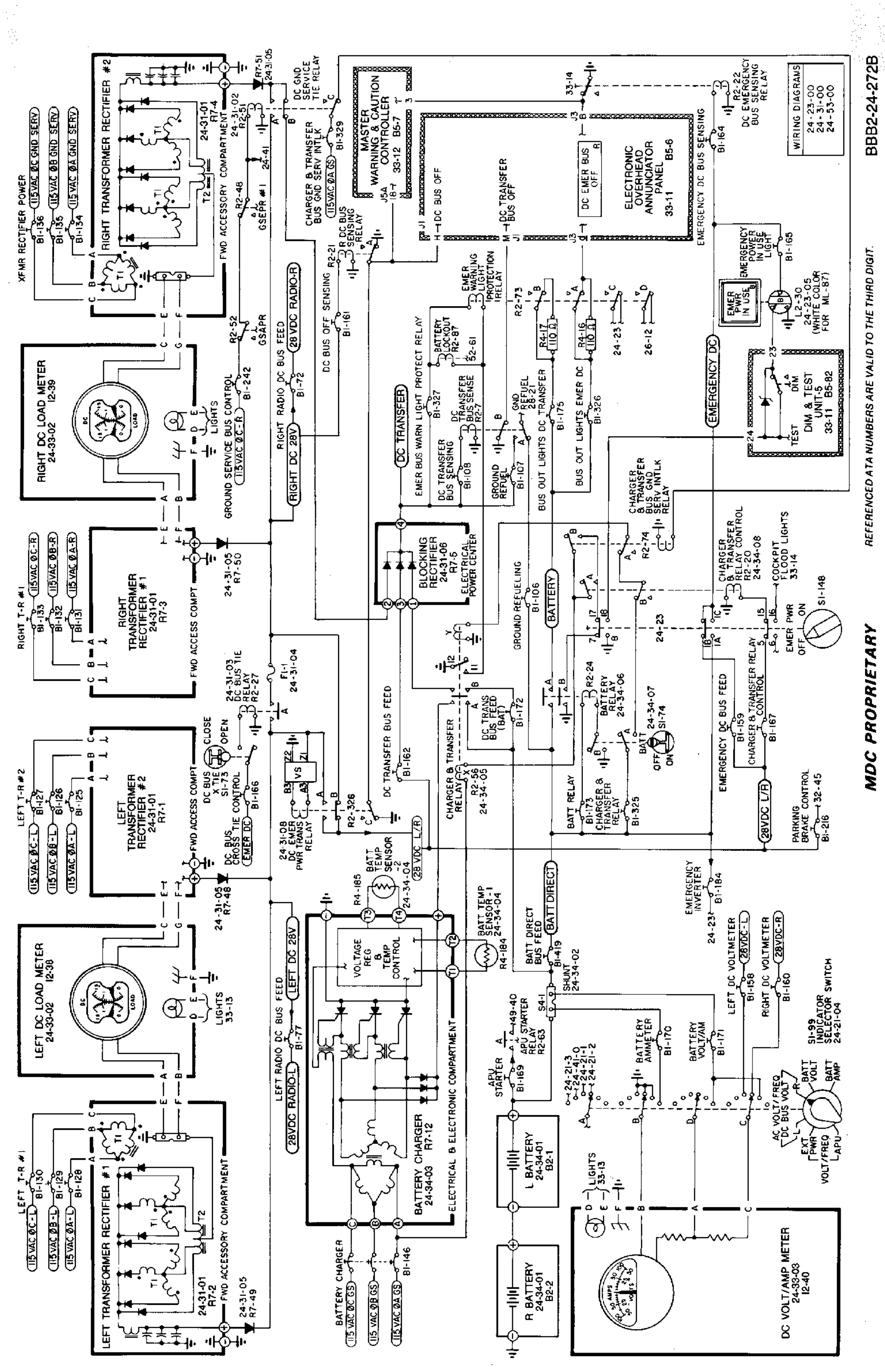
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893



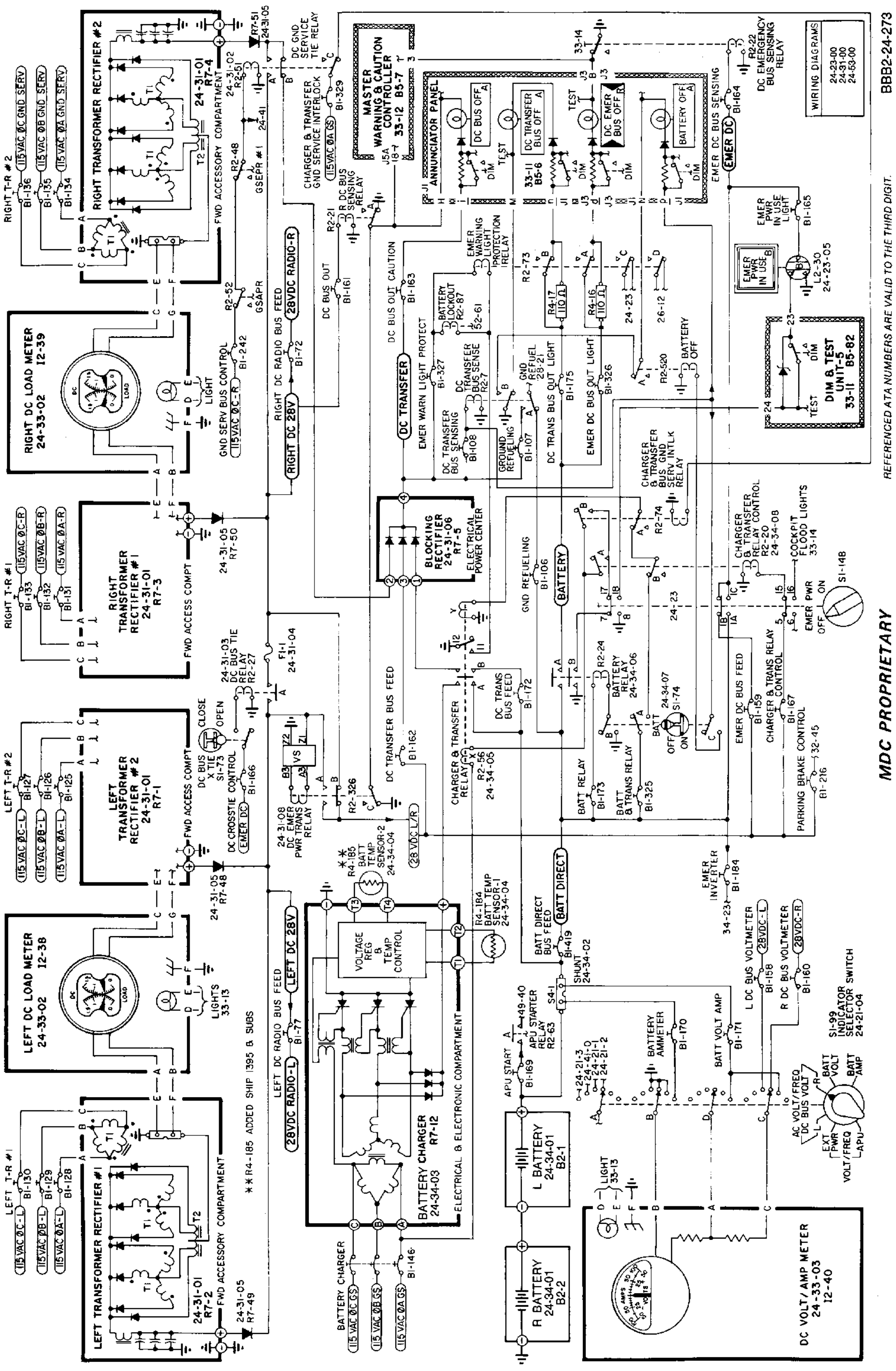
Battery Charger Temperature Sensor -- Chart
Figure 101/24-30-00-990-804 (Sheet 2 of 2)



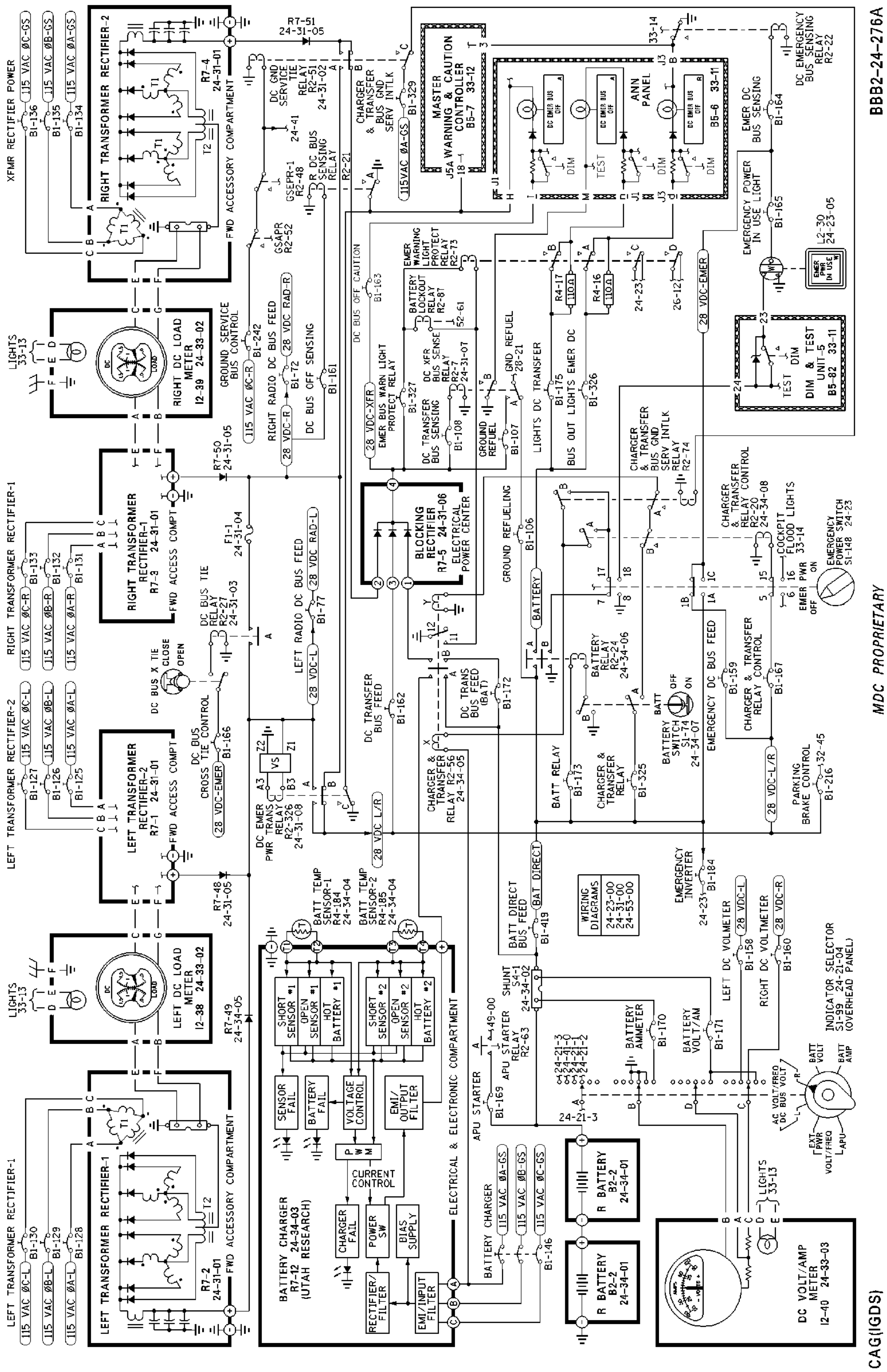
DC Power and Control -- Schematic
Figure 102/24-30-00-990-809 (Sheet 1 of 4)



DC Power and Control -- Schematic
Figure 102/24-30-00-990-809 (Sheet 2 of 4)



DC Power and Control -- Schematic
Figure 102/24-30-00-990-809 (Sheet 3 of 4)



DC Power and Control -- Schematic
Figure 102/24-30-00-990-809 (Sheet 4 of 4)

DC GENERATION - MAINTENANCE PRACTICES

1. General

   A. This maintenance practice provides removal/installation procedures for the transformer-rectifiers (TR) and adjustment/test of DC generation.

      (1) The four TR's are mounted in the forward accessory compartment. Access to the forward accessory compartment is through the nose landing gear wheel well and remove access panel 4302A.

      (2) The removal/installation procedures for all TR's are identical unless otherwise specified.

   B. To accomplish the adjustment/test procedures of the DC system, AC power must first be supplied to all AC buses to provide power for operation of the transformer-rectifiers (TR) and battery charger. Input power to each TR is protected by three circuit breakers, one for each AC phase. The circuit breakers for TR right No. 2 are located on the ground service bus portion of the lower main circuit breaker panel and are identified as XMFR RECTIFIER POWER. The circuit breakers for the remaining three TR units are located on the AC portion of the upper main circuit breaker panel. These circuit breakers can be easily associated with the applicable TR unit due to the similarity of the circuit breaker identification and the TR identification.

CAUTION: WHEN TESTING OPERATION OF INDIVIDUAL TRANSFORMER-RECTIFIERS, IF APPLICABLE DC LOADMETER INDICATES MORE THAN 1.0, REDUCE LOADS TO PREVENT DAMAGE TO RECTIFIER.

   C. Procedures for checking blocking rectifiers assembly are contained in Paragraph 5..

      NOTE: If APU generator is supplying AC power, APU switches and lights will be substituted as applicable in procedural steps referring to operation of external power switches or external power bus lights.

      NOTE: Be certain that nosegear is sufficiently compressed for ground sensing mechanism to deactivate nosegear oleo switches to ensure lockout of AC bus crosstie relay.

   D. Procedures for checking reverse current diodes are contained in Paragraph 6..

      NOTE: A discolored diode assembly only affects the appearance, is not an operational or a safety issue, and can remain in the aircraft.

2. **Equipment and Materials**

   NOTE: Equivalent substitutes may be used instead of the following listed items:

   NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 201

Name and Number	Manufacturer
Multimeter Model 2000A	Dana
Resistor 150 ohms	
Tag - Electrical Wire STD-859	
154 Dust Cap - Electrical Connector, Plastic	

3. Removal/Installation Transformer-Rectifier

A. Remove Transformer-Rectifier

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(1) Open these circuit breakers and install safety tags:

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
WJE 401-404, 406-408, 410-412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891-893			
		B1-134	RIGHT XFMR RECTIFIER - 2 PHASE A
		B1-135	RIGHT XFMR RECTIFIER - 2 PHASE B
		B1-136	RIGHT XFMR RECTIFIER - 2 PHASE C
WJE 405, 409, 880, 884			
		B1-134	XFMR RECTIFIER POWER PHASE A
		B1-135	XFMR RECTIFIER POWER PHASE B
		B1-136	XFMR RECTIFIER POWER PHASE C

WJE ALL

(2) In nose landing gear wheelwell, remove access panel 4203A.

(3) Disconnect electrical connector from receptacle and install electrical connector plastic dust cap on receptacle and connector. (Figure 204)

(4) Remove screws, lock washers and washers and remove terminal block cover.

(5) Install electrical wire tags on the two terminal block cables.

(6) Remove nuts, lock washers and terminal block cables from terminals.

(7) Loosen hold-down nuts that secure transformer-rectifier, and swing downward to clear hold-down hooks.

(8) Remove transformer-rectifier.

B. Install Transformer-Rectifier

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(1) Make sure that these circuit breakers are open and have safety tags:

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
WJE 401-404, 406-408, 410-412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891-893			
		B1-134	RIGHT XFMR RECTIFIER - 2 PHASE A
		B1-135	RIGHT XFMR RECTIFIER - 2 PHASE B
		B1-136	RIGHT XFMR RECTIFIER - 2 PHASE C
WJE 405, 409, 880, 884			
		B1-134	XFMR RECTIFIER POWER PHASE A
		B1-135	XFMR RECTIFIER POWER PHASE B
		B1-136	XFMR RECTIFIER POWER PHASE C

WJE ALL

(2) Install transformer-rectifier into mount. (Figure 204)

(3) Raise hold-down nuts, mate with hold-down hooks on transceiver and adapter, and tighten securely.

(4) Install terminal block cables on terminals and install lock washers and nuts.

(5) Remove electrical wire tags from the two terminal block cables.

(6) Install terminal block cover using screws, lock washers and washers.

(7) Remove electrical connector plastic dust cap from receptacle and connector.

(8) Examine the electrical connector and receptacle for damage and unwanted material (ELECTRICAL CONNECTORS - MAINTENANCE PRACTICES, SWPM 20-31-00).

(9) Connect electrical connector to receptacle.

(10) In nose landing gear wheelwell, install access panel 4203A.

(11) Remove the safety tags and close these circuit breakers:

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
WJE 401-404, 406-408, 410-412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891-893			
		B1-134	RIGHT XFMR RECTIFIER - 2 PHASE A
		B1-135	RIGHT XFMR RECTIFIER - 2 PHASE B
		B1-136	RIGHT XFMR RECTIFIER - 2 PHASE C
WJE 405, 409, 880, 884			
		B1-134	XFMR RECTIFIER POWER PHASE A
		B1-135	XFMR RECTIFIER POWER PHASE B
		B1-136	XFMR RECTIFIER POWER PHASE C

WJE ALL

(12) Perform Adjustment/Test DC Generation (Paragraph 4.)

4. Adjustment/Test DC Generation

A. Test Transformer-rectifier and DC System

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(1) Open these circuit breakers and install safety tags:

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
WJE 401-404, 406-408, 410-412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891-893			
		B1-134	RIGHT XFMR RECTIFIER - 2 PHASE A
		B1-135	RIGHT XFMR RECTIFIER - 2 PHASE B
		B1-136	RIGHT XFMR RECTIFIER - 2 PHASE C
WJE 405, 409, 880, 884			
		B1-134	XFMR RECTIFIER POWER PHASE A
		B1-135	XFMR RECTIFIER POWER PHASE B
		B1-136	XFMR RECTIFIER POWER PHASE C

WJE 405, 409, 880, 884 (Continued)

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

WJE 415-427, 429, 861-866, 868, 869, 871, 872, 891

NOTE: The XFMR RECTIFIER POWER (3) circuit breakers apply.

WJE ALL

(2) Place EXT PWR R BUS switch in OFF position.

(3) Place BATT switch in ON position and DC BUS X TIE switch in OPEN position.

(4) Place DC BUS VOLT selector switch in L position; DC AMPS-VOLTS meter should indicate 26 to 30 volts; DC LOAD meter for transformer-rectifier left No. 1 should indicate load.

(5) Check following lights for operation:

(a) DC EMER BUS OFF .... OFF

(b) DC TRANSFER BUS OFF .... OFF

(c) DC BUS OFF .... ON

(d) EXT PWR L BUS .... ON

(e) EXT PWR R BUS .... OFF

(6) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(7) Open these circuit breakers and install safety tags:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	1	B1-128	LEFT TRANSFORMER RECTIFIER - 1 PHASE A
K	2	B1-129	LEFT TRANSFORMER RECTIFIER - 1 PHASE B
K	3	B1-130	LEFT TRANSFORMER RECTIFIER - 1 PHASE C

(8) Check DC AMPS-VOLTS meter indicates 26 to 30 volts and DC LOAD meter for transformer-rectifier left No. 2 indicates some load; lights will remain as described in Paragraph 4.A.(5).

(9) Close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	1	B1-128	LEFT TRANSFORMER RECTIFIER - 1 PHASE A
K	2	B1-129	LEFT TRANSFORMER RECTIFIER - 1 PHASE B
K	3	B1-130	LEFT TRANSFORMER RECTIFIER - 1 PHASE C

(10) DC LOAD meters for both left transformer-rectifiers should indicate load.

(11) Place DC BUS X TIE switch in CLOSE position; both left DC LOAD meters should show an increase in load; DC BUS OFF light should go OFF.

(12) Place DC BUS X TIE switch in OPEN position and EXT PWR L BUS switch in OFF position; check following lights for operation:

(a) DC EMER BUS OFF .... ON

(b) DC TRANSFER BUS OFF .... OFF

(c) EXT PWR L BUS .... OFF

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(13) Open these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	1	B1-128	LEFT TRANSFORMER RECTIFIER - 1 PHASE A
K	2	B1-129	LEFT TRANSFORMER RECTIFIER - 1 PHASE B
K	3	B1-130	LEFT TRANSFORMER RECTIFIER - 1 PHASE C
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

(14) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

(15) Place EXT PWR R BUS switch in ON position; check following lights for operation:

(a) DC EMER BUS OFF .... OFF

(b) DC TRANSFER BUS OFF .... OFF

(c) DC BUS OFF .... ON

(d) EXT PWR R BUS .... ON

(16) Place DC BUS VOLT selector switch in R position; DC AMPS-VOLTS meter should indicate 26 to 30 volts; DC LOAD meter for transformer-rectifier right No. 1 should indicate load.

(17) Remove the safety tags and close these circuit breakers:

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
WJE 401-404, 406-408, 410-412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891-893			
		B1-134	RIGHT XFMR RECTIFIER - 2 PHASE A
		B1-135	RIGHT XFMR RECTIFIER - 2 PHASE B
		B1-136	RIGHT XFMR RECTIFIER - 2 PHASE C
WJE 405, 409, 880, 884			
		B1-134	XFMR RECTIFIER POWER PHASE A
		B1-135	XFMR RECTIFIER POWER PHASE B
		B1-136	XFMR RECTIFIER POWER PHASE C

WJE ALL

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(18) Open these circuit breakers:

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

(19) Check DC AMPS-VOLTS meter indicates 26 to 30 volts and DC LOAD meter for transformer-rectifier right No. 2 indicates load.

(20) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

(21) DC LOAD meters for both right transformer-rectifiers should indicate load.

(22) Place DC BUS VOLT selector switch in BATT AMP position; if batteries are not fully charged, DC AMPS-VOLTS meter indication should be to left of zero at approximately 45 amperes gradually reducing to 40 amperes. If batteries are fully charged, DC AMPS-VOLTS meter indication should be pulsing to left of zero. Between pulses, indication should be zero.

NOTE: Pulse intervals can be expected to be from 5 seconds to approximately 20 minutes depending on whether operation is with APU, engine or external power, battery load being used, and the general condition of the batteries.

(23) Place DC BUS X TIE switch in CLOSED position; both RIGHT DC LOAD meters should show an increase in load; DC BUS OFF light should go OFF.

(24) Place DC BUS X TIE switch in OPEN position and EXT PWR R BUS switch in OFF position; check following lights for operation:

(a) DC EMER BUS OFF .... ON

(b) DC TRANSFER BUS OFF .... OFF

(c) DC BUS OFF .... ON

(d) EXT PWR R BUS .... OFF

(25) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	1	B1-128	LEFT TRANSFORMER RECTIFIER - 1 PHASE A
K	2	B1-129	LEFT TRANSFORMER RECTIFIER - 1 PHASE B
K	3	B1-130	LEFT TRANSFORMER RECTIFIER - 1 PHASE C
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

WJE 415-427, 429, 861-866, 868, 869, 871, 872, 891

NOTE: The XFMR RECTIFIER POWER (3) circuit breakers apply.

WJE ALL

(26) Place EXT PWR switch, located on GROUND SERVICE ELECT PWR panel, in ON position; DC LOAD meter for transformer-rectifier right No. 2 should indicate load.

(27) Check following lights for operation:

(a) DC EMER BUS OFF .... ON

(b) DC TRANSFER BUS OFF .... OFF

(c) DC BUS OFF .... ON

(d) EXT PWR L BUS .... OFF

(e) EXT PWR R BUS .... OFF

(f) GRPOND SERVIVE BUS ....ON

(28) Check DC AMPS-VOLTS meter is indicating to left of zero at approximately 45 amperes gradually reducing to approximately 40 amperes, if batteries are not fully charged. If batteries are fully charged, DC AMPS-VOLTS meter indication should be pulsing to the left of zero. Between pulses, indication should be zero.

NOTE: Pulse intervals can be expected to be from 5 seconds to approximately 20 minutes depending on whether operation is with APU, engine or external power, battery load being used, and the general condition of the batteries.

(29) Test completed, position electrical power control switches as required.

B. Test DC Emergency Power System and Battery Charger Operation

(1) Place BATT switch in ON position.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(2) Open this circuit breaker and install safety tag:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	37	B1-159	EMERGENCY DC BUS FEED

(3) DC EMER BUS OFF light should come ON.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(4) Open these circuit breakers and install safety tags:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(5) AC EMER BUS OFF light should come ON.

(6) Place EMER PWR switch in ON position; DC EMER BUS OFF light should go OFF; EMER POWER IN USE light should come ON; AC EMER BUS OFF light should go OFF.

NOTE: Ignore any random and intermittent indications of the No. 1 VHF NAV Control Panel.

(7) Place DC BUS VOLT selector switch in BATT VOLT, then in BATT AMP position. In each position, record voltage and amperage as indicated on DC AMPS-VOLTS meter.

(8) Place EMER PWR switch in OFF position; EMER POWER IN USE light should go OFF; DC EMER BUS OFF light should come ON; AC EMER BUS OFF light should come ON.

(9) Record battery voltage and amperage; voltage should show an increase and amperage should show an opposite indication from readings taken in Paragraph 4.B.(7).

(10) Remove the safety tag and close this circuit breaker:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	37	B1-159	EMERGENCY DC BUS FEED

(11) DC EMER BUS OFF light should go OFF.

(12) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	7	B1-185	EMER AC BUS FEED

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	8	B1-186	ALTERNATE EMER AC BUS FEED

(13) AC EMER BUS OFF light should go OFF.

(14) Test completed, position electrical power control switches as required.

5. Adjustment/Test Blocking Rectifiers Assembly

A. Test Blocking Rectifiers

(1) Place BATT switch in ON position.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(2) Open this circuit breaker and install safety tag:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	36	B1-162	DC TRANSFER BUS FEED

(3) DC TRANSFER BUS OFF light should come ON.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(4) Open this circuit breaker and install safety tag:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	38	B1-167	CHARGER & TRANSFER RELAY CONTROL

(5) DC TRANSFER BUS OFF light should go off.

(6) Using multimeter, check for approximately 28 volts DC (battery voltage) between terminal 1 of blocking rectifiers assembly and ground.

NOTE: The blocking rectifiers assembly is located in the lower, outboard corner of the EPC. Access is through door 4425 (Figure 201)

(7) Connect resistive load and multimeter between terminal 2 of blocking rectifiers assembly and ground; DC voltage reading should be less than 5 volts.

NOTE: It is not necessary to disconnect aircraft wiring for this test.

(8) Connect resistive load and multimeter between terminal 3 of blocking rectifiers assembly and ground; DC voltage reading should be less than 5 volts.

(9) Remove the safety tags and close these circuit breakers:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	36	B1-162	DC TRANSFER BUS FEED
N	38	B1-167	CHARGER & TRANSFER RELAY CONTROL

(10) DC TRANSFER BUS OFF light should remain OFF.

(11) Connect resistive load and multimeter between terminal 1 of blocking rectifiers assembly and ground; DC voltage reading should be less than 5 volts.

(12) Test completed, position electrical power control switches as required.

6. Adjustment/Test Reverse Current Diodes

A. Test Reverse Current Diodes

NOTE: A Reverse Current Diode showing signs of discoloration affects the appearance only and is not an operational and/or safety issue. Refer to Service Letter MD-80 SL# 80-SL-24-101.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(1) Open these circuit breakers and install safety tags:

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
WJE 401-404, 406-408, 410-412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891-893			
		B1-134	RIGHT XFMR RECTIFIER - 2 PHASE A
		B1-135	RIGHT XFMR RECTIFIER - 2 PHASE B
		B1-136	RIGHT XFMR RECTIFIER - 2 PHASE C
WJE 405, 409, 880, 884			
		B1-134	XFMR RECTIFIER POWER PHASE A
		B1-135	XFMR RECTIFIER POWER PHASE B
		B1-136	XFMR RECTIFIER POWER PHASE C

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

WJE 415-427, 429, 861-866, 868, 869, 871, 872, 891

NOTE: The XFMR RECTIFIER POWER (3) circuit breakers apply.

WJE ALL

NOTE: Energize only transformer-rectifier (TR) circuit being tested.

NOTE: Reverse current diodes are located in the aft portion of the forward accessory compartment. Access is through door 4302A. Figure 202

(2) Using multimeter, check for approximately 28 volts DC between PWR terminal of diode on output side of left transformer-rectifier-1 and ground.

(3) Place DC BUS X TIE switch in CLOSE position; left and right DC buses should be energized.

(4) Connect resistive load and multimeter between diode PWR terminal and ground of left transformer-rectifier-2, right transformer rectifier-1, and right transformer-rectifier-2 (respectively); voltage should be less than 5 volts DC.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(5) Open these circuit breakers and install safety tags:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	1	B1-128	LEFT TRANSFORMER RECTIFIER - 1 PHASE A
K	2	B1-129	LEFT TRANSFORMER RECTIFIER - 1 PHASE B
K	3	B1-130	LEFT TRANSFORMER RECTIFIER - 1 PHASE C

(6) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

(7) Using multimeter, check for approximately 28 volts DC between PWR terminal of diode on output side of left transformer-rectifier-2 and ground.

(8) Connect resistive load and multimeter between diode PWR terminal and ground of left transformer-rectifier--1, right transformer-rectifier-1; and right transformer-rectifier-2 respectively; voltage should be less than 5 volts DC.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(9) Open these circuit breakers and install safety tags:

UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

(10) Remove the safety tags and close these circuit breakers:

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

(11) Using multimeter, check for approximately 28 volts DC between PWR terminal of diode on output side of right transformer-rectifier-1 and ground.

(12) Connect resistive load and multimeter between diode PWR terminal and ground of left transformer-rectifier-1, left transformer-rectifier-2, and right transformer-rectifier-2 respectively; voltage should be less than 5 volts DC.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(13) Open these circuit breakers and install safety tags:

UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

(14) Remove the safety tags and close these circuit breakers:

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
WJE 401-404, 406-408, 410-412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891-893			
		B1-134	RIGHT XFMR RECTIFIER - 2 PHASE A
		B1-135	RIGHT XFMR RECTIFIER - 2 PHASE B
		B1-136	RIGHT XFMR RECTIFIER - 2 PHASE C
WJE 405, 409, 880, 884			
		B1-134	XFMR RECTIFIER POWER PHASE A
		B1-135	XFMR RECTIFIER POWER PHASE B
		B1-136	XFMR RECTIFIER POWER PHASE C

WJE ALL

(15) Using multimeter, check for approximately 28 volts DC between PWR terminal of diode on output side of right transformer-rectifier--2 and ground.

(16) Connect resistive load and multimeter between diode PWR terminal and ground of left transformer-rectifier--1, left transformer-rectifier--2, and right transformer-rectifier--1 respectively; voltage should be less than 5 volts DC.

(17) Remove the safety tags and close these circuit breakers:

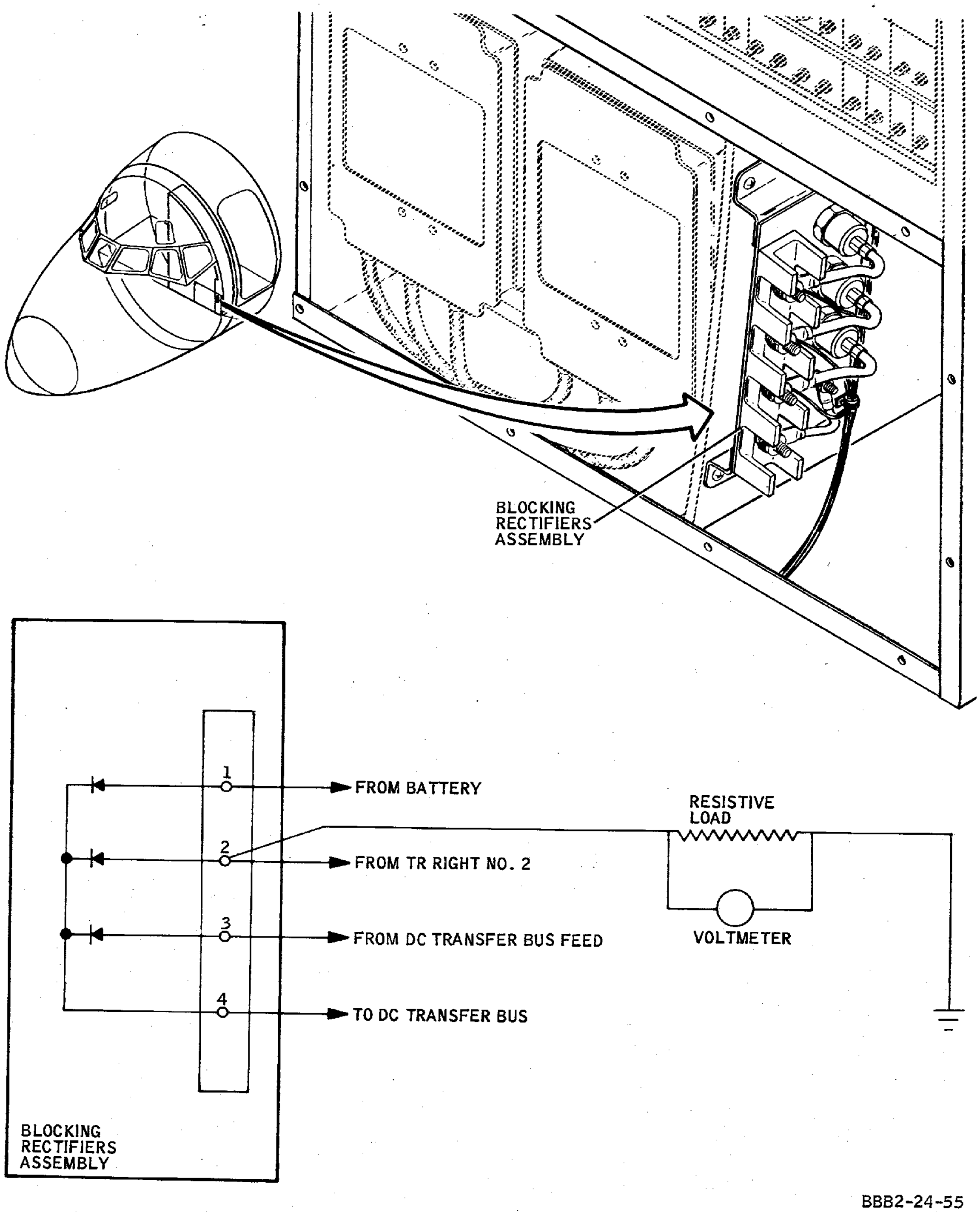
UPPER EPC, POWER - LEFT AC BUS

Row	Col	Number	Name
K	1	B1-128	LEFT TRANSFORMER RECTIFIER - 1 PHASE A
K	2	B1-129	LEFT TRANSFORMER RECTIFIER - 1 PHASE B
K	3	B1-130	LEFT TRANSFORMER RECTIFIER - 1 PHASE C
K	4	B1-125	LEFT TRANSFORMER RECTIFIER - 2 PHASE A
K	5	B1-126	LEFT TRANSFORMER RECTIFIER - 2 PHASE B
K	6	B1-127	LEFT TRANSFORMER RECTIFIER - 2 PHASE C

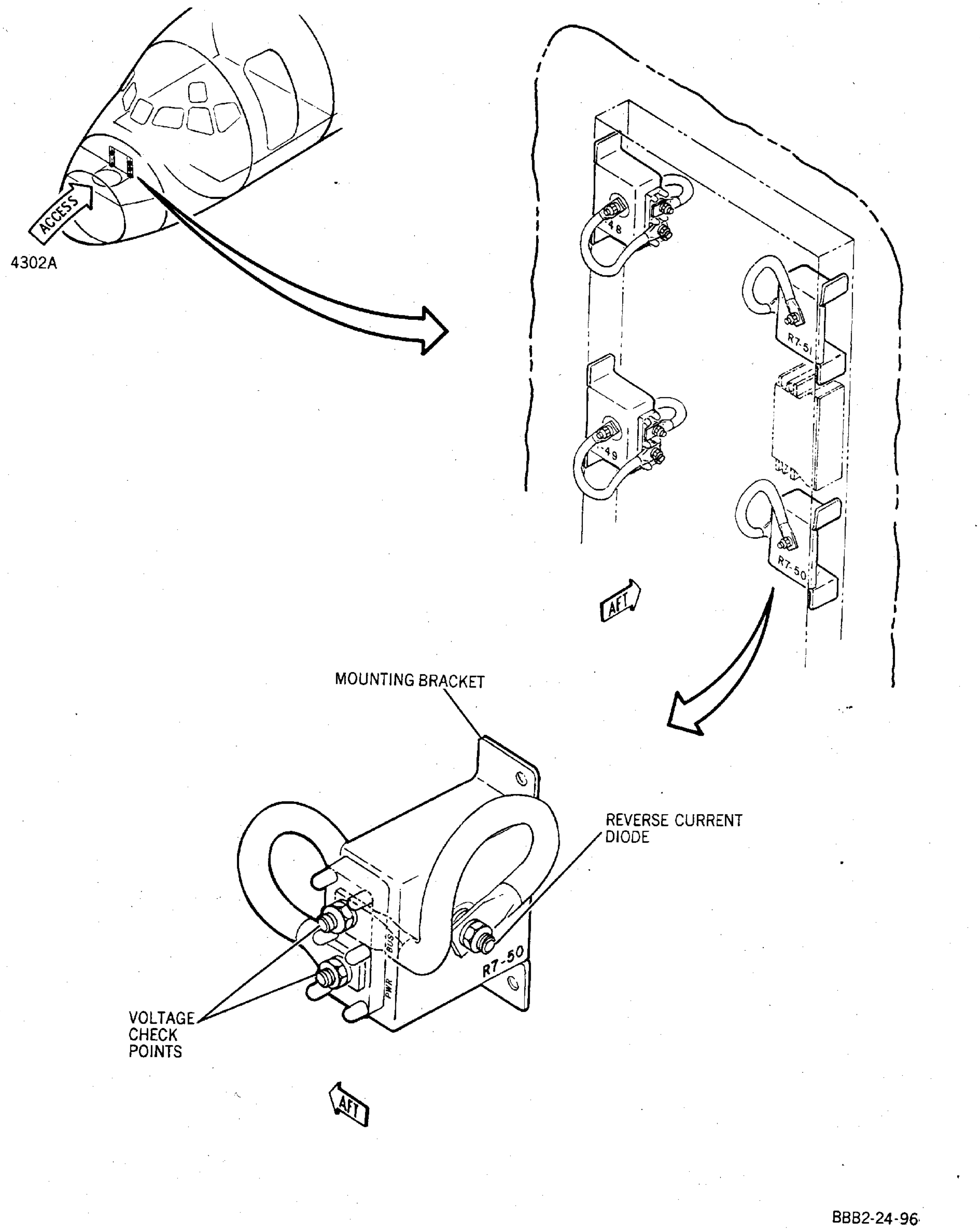
UPPER EPC, POWER - RIGHT AC BUS

Row	Col	Number	Name
L	1	B1-131	RIGHT TRANSFORMER RECTIFIER - 1 PHASE A
L	2	B1-132	RIGHT TRANSFORMER RECTIFIER - 1 PHASE B
L	3	B1-133	RIGHT TRANSFORMER RECTIFIER - 1 PHASE C

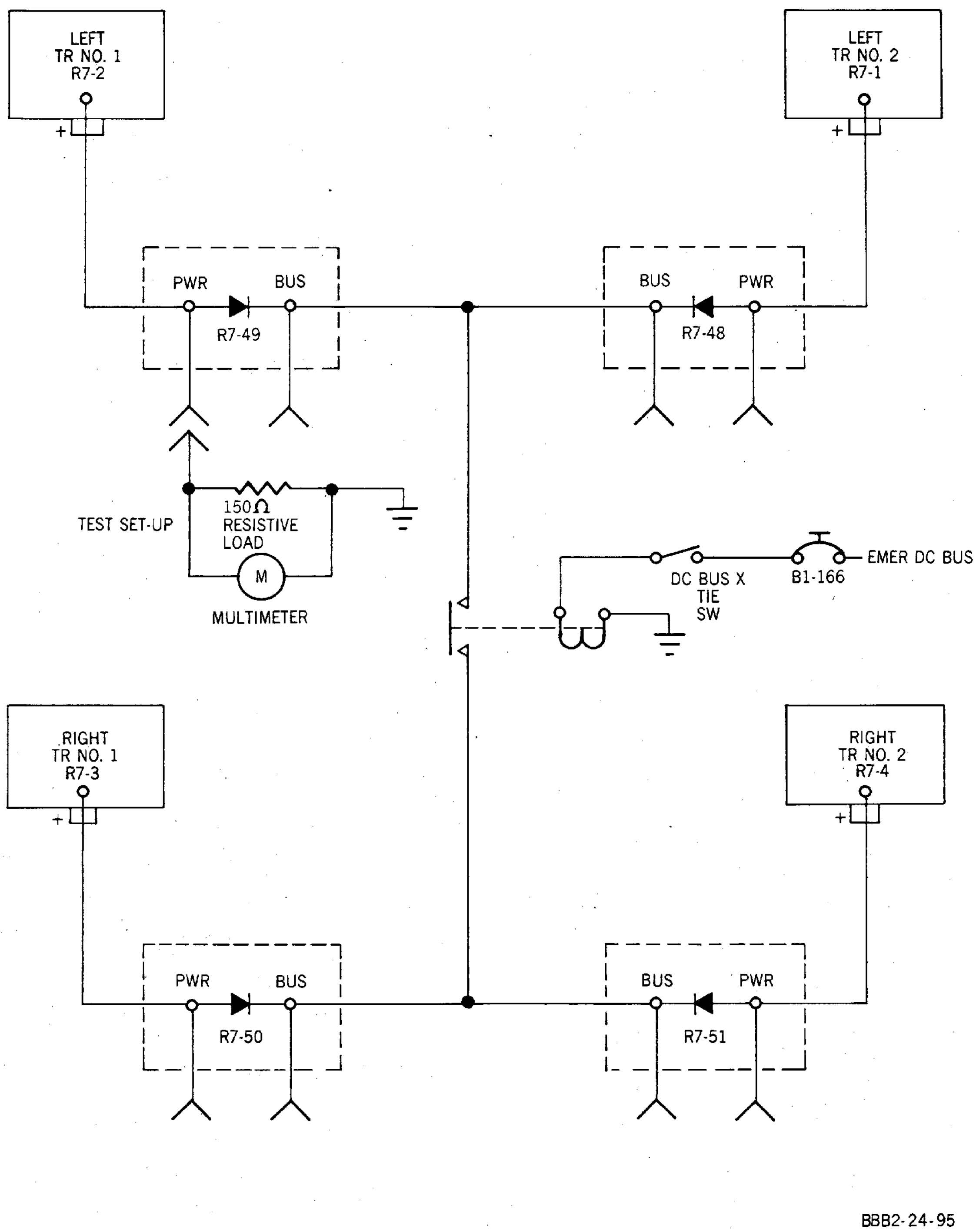
(18) Test completed, position electrical power control switches as required.



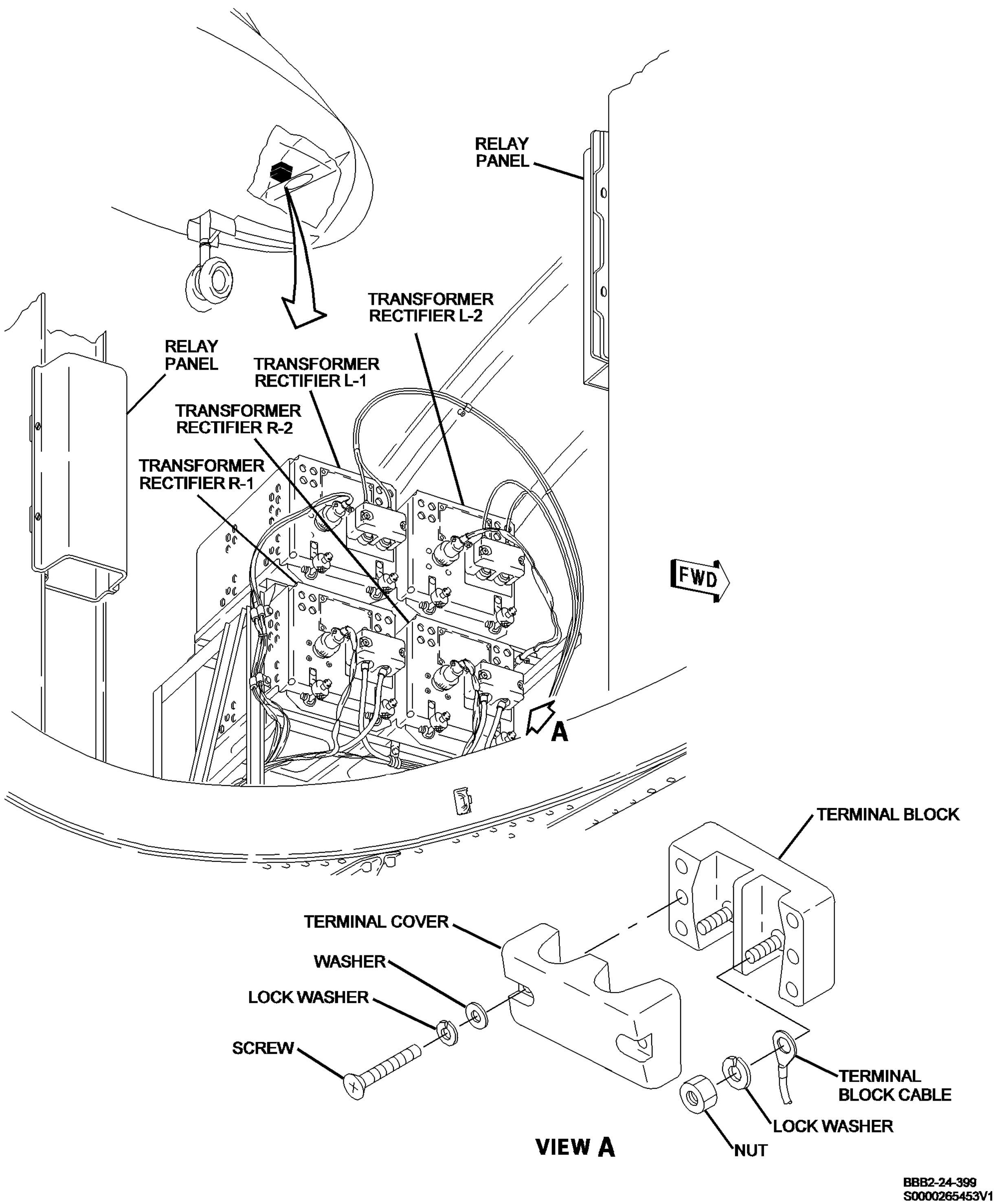
Blocking Rectifiers Test -- Functional
Figure 201/24-30-00-990-801



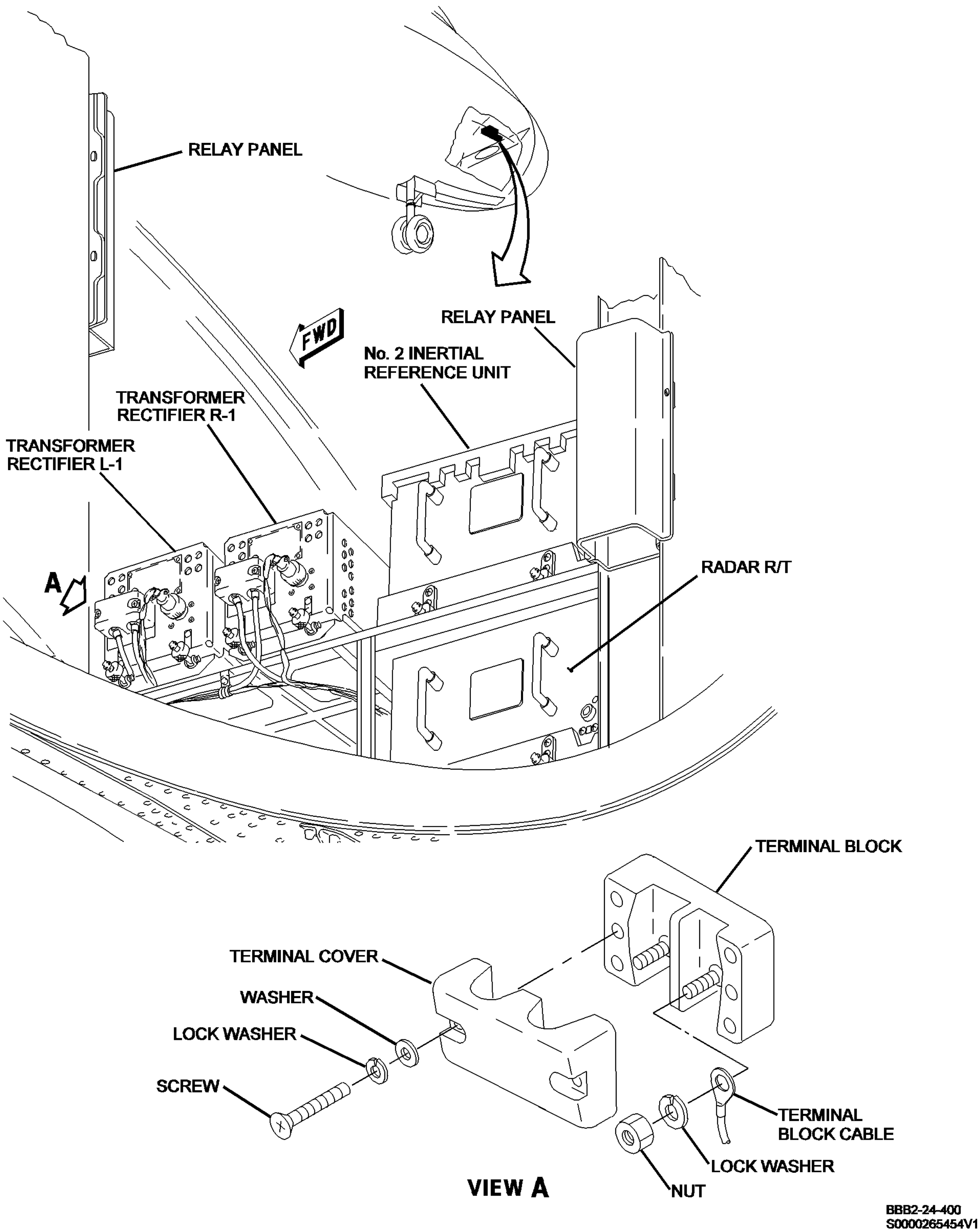
Reverse Current Diodes -- Location
Figure 202/24-30-00-990-802



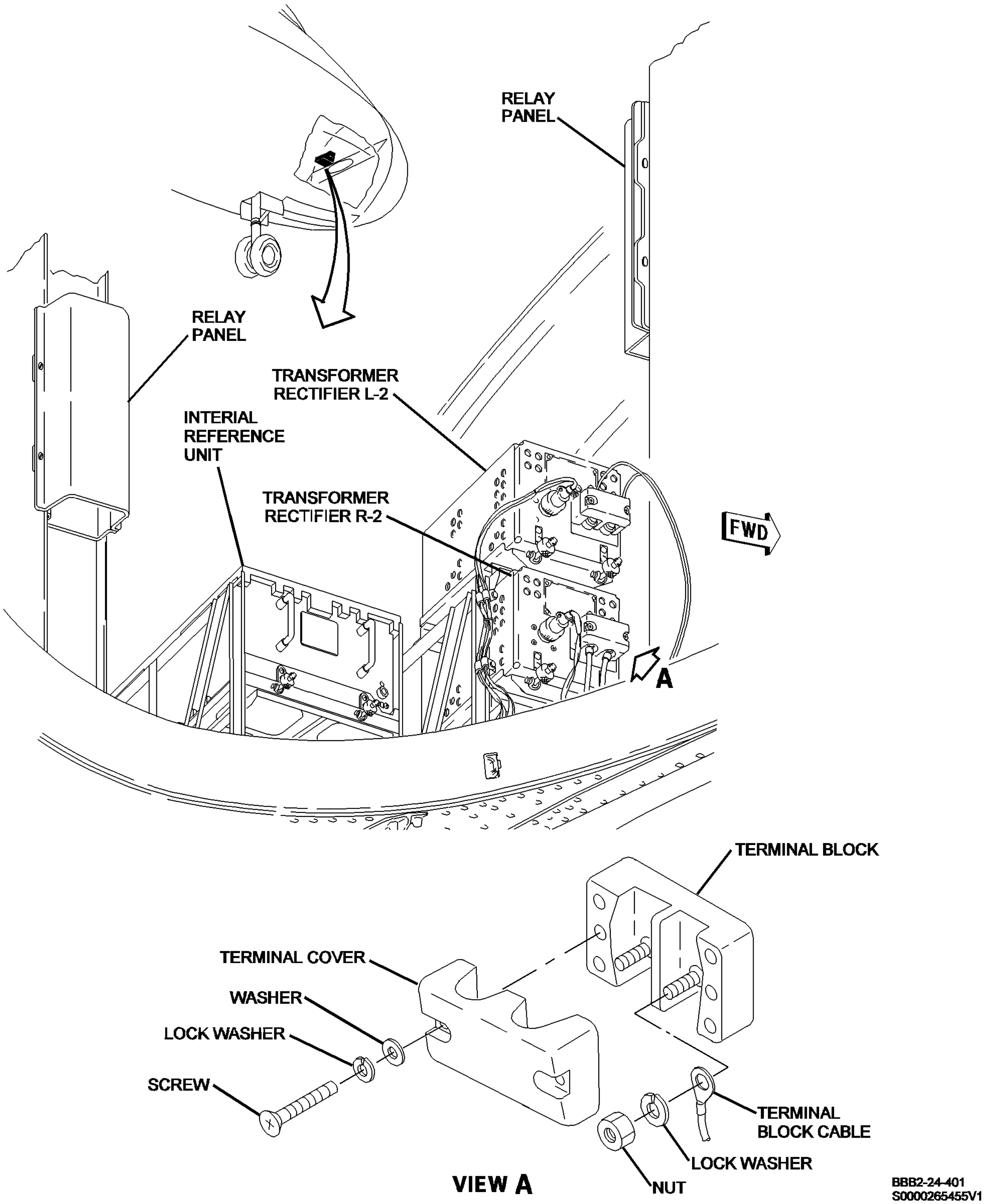
Reverse Current Diode Test -- Functional
Figure 203/24-30-00-990-803



Transformer-Rectifier -- Removal/Installation
Figure 204/24-30-00-990-810 (Sheet 1 of 3)



Transformer-Rectifier -- Removal/Installation
Figure 204/24-30-00-990-810 (Sheet 2 of 3)



Transformer-Rectifier -- Removal/Installation
Figure 204/24-30-00-990-810 (Sheet 3 of 3)

BATTERY - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures are presented as an aid to servicing batteries in the shop (approved area). Battery trouble in the aircraft can usually be traced to defective circuit wiring or defective component. Battery failure may be internal, caused by defective battery charger, or battery charger temperature sensor, or improper adjustment of electrolyte level. In either case a defective battery in the aircraft should be removed for servicing.

NOTE: Do not change one battery only. If it is necessary to change a battery, change both batteries.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 101

Name and Number	Manufacturer
Torque Wrench 0 to 200 inch-pounds (0 - 22.60 N·m)	

3. Trouble Shooting

Table 102

Possible Causes	Isolation Procedure	Correction
A. NO BATTERY TERMINAL VOLTAGE, COMPLETE FAILURE TO OPERATE		
(1) Loose or corroded cell connection	Check for corrosion or evidence of burning, or arcing.	Clean and tighten connections to torque of 60 to 72 inch-pounds (6.78 to 8.13 N·m). On Marathon batteries (part numbers 27183 and 30475 002) torque connections to 100 to 125 inch pounds (11.30 to 14.12 N·m).
(2) Dry cell	Remove cell. (BATTERY - APPROVED REPAIRS, PAGEBLOCK 24-30-01/801)	Flush cell thoroughly with distilled water; refill with electrolyte (potassium hydroxide (KOH) 1.300 specific gravity).
(3) Dead cell	Check for distortion of cell cases.	Remove and replace, if distorted.
B. APPARENT LOSS OF CAPACITY		
(1) Cell unbalance or defective cell	Equalize cells. (BATTERY - ADJUSTMENT/TEST, PAGEBLOCK 24-30-01/501)	If cell does not regain capacity, replace cell.
C. VOLTAGE DROPS BELOW 11.6 VOLTS WHEN NORMAL LOAD IS APPLIED		
(1) Discharged condition	Check cells. (BATTERY - ADJUSTMENT/TEST, PAGEBLOCK 24-30-01/501)	If cell is defective, replace.
(2) Loose cell connection	None.	Tighten connection screw to torque of 60 to 72 inch-pounds (6.78 to 8.13 N·m). On Marathon batteries (part numbers 27183 and 30475 002) torque connections to 100 to 125 inch pounds (11.30 to 14.12 N·m).

Table 102 (Continued)

(3) Defective cell	None.	Remove and replace.
D. HIGH TRICKLE CHARGE AFTER REPLACING CELLS, OR BATTERY WILL NOT DELIVER RATED CAPACITY		
(1) Unbalance of cells	None.	Discharge battery completely and short out individual cells for approximately 12 hours. Recharge, using approved constant-current or constant potential charging method. Check capacity; if acceptable, recharge.
NOTE: When replacing cells, battery should be shorted out so that equalization of battery will result in bringing battery up to charged condition.		

BATTERY - SERVICING

1. General

A. Servicing the battery while installed in the aircraft is limited to visually checking the electrolyte level and to adding chemically pure, distilled water if the level is low. If the battery state-of-charge is low, as determined by a fast pulse charging rate or by a high and steady battery charger current indication, see Paragraph 3.A.(2), or if there is excessive electrolyte in the cells, both batteries should be removed from the aircraft and serviced in a designated area. Battery cleaning should only be performed after removal from the aircraft.

B. There are four types of batteries in use with the following significant differences:

CAUTION: DO NOT INTERMIX THE FOUR TYPES OF BATTERIES. IF IT IS FOUND THAT BATTERIES HAVE BEEN INTERMIXED, IMMEDIATELY REMOVE ALL BATTERIES AND REPLACE WITH TWO OF THE SAME TYPE.

(1) Battery (Part Number 43B034LB02) employs a perforated baffle design and a small electrolyte cavity. Thus servicing for this type battery will be more frequent, based on customer maintenance program and usage.

(2) Battery (Part Numbers 43B034LB03 and 021904-000) is a low maintenance type battery with a considerably larger electrolyte cavity and a stepped baffle design. This battery has an indicator eye to visually indicate, without cap removal, that electrolyte level is low. A higher degree of brightness on the lens indicates that the electrolyte level is low and the battery requires service. Distilled water may be added to the baffle step at any state of charge and electrolyte spewage is less likely to occur.

(3) Battery (Part Number 27183, Type CA-13) is a long life type of battery with a stepped baffle design. Distilled water should be added before charging to bring the electrolyte level to the bottom step.

(4) Battery (Part Number 30475-002, Type SP-138) is a long life type of battery with a perforated baffle design. Distilled water should be added before charging to bring the electrolyte level to the bottom of lower hole.

C. The level of electrolyte in each cell will vary with the battery state-of-charge, rising during charging and subsiding fully within 2 hours after charging. The level also subsides during discharge. Therefore, it is important to know the condition of the battery prior to servicing on the aircraft. The battery should be allowed to rest at least 5 minutes on an open circuit before checking and/or adjusting electrolyte level. This will assure that cell internal pressure has subsided before the vent caps are removed, thus enhancing safety to personnel and avoiding possible electrolyte contamination of the aircraft.

D. A battery which has spewed electrolyte excessively will usually display large crystalline deposits on the tops of the cells. In some cases, a considerable amount of liquid will collect in the bottom of the battery container. A battery in this condition has been subjected to high charge voltages or high ambient temperatures during charging, or a combination of the two. The liquid level may also have been improperly adjusted. To correct this condition, remove the battery from the aircraft, clean, charge as required, and adjust the electrolyte level. The battery can then be placed back into service.

WARNING: BATTERY ELECTROLYTE IS CAUSTIC POTASSIUM HYDROXIDE AND WILL BURN SKIN AND CLOTHING. IF SPILLED, NEUTRALIZE WITH VINEGAR OR (3 TO 5 PERCENT ACETIC ACID SOLUTION) OR MILD (3 TO 5 PERCENT) BORIC ACID SOLUTION OR, IF THESE ITEMS ARE NOT AVAILABLE, WASH THOROUGHLY WITH WATER. IMMEDIATE MEDICAL ATTENTION IS REQUIRED IF ELECTROLYTE HAS CONTACTED EYES.

(1) Mix solution using 3 to 5 percent boric acid or acetic acid and water.

(2) Apply neutralizing solution or vinegar with nonmetallic brush or clean cloth.

(3) Allow solution to remain on affected area until reaction ceases, but not longer than 20 minutes.

(4) Remove neutralizing solution by rinsing with clear cold water.

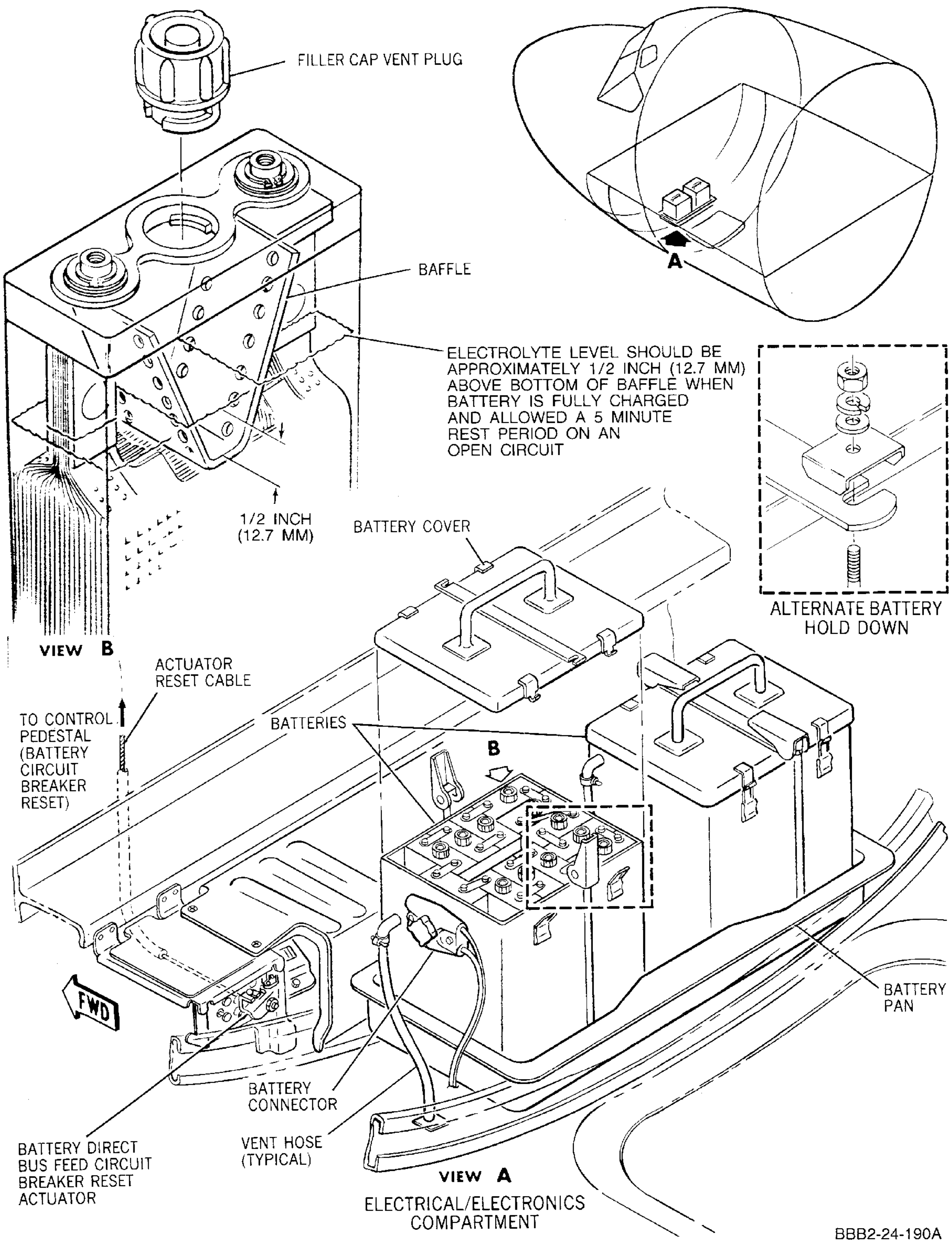
(5) Dry treated area by wiping with clean dry cloths.

2. Equipment and Materials

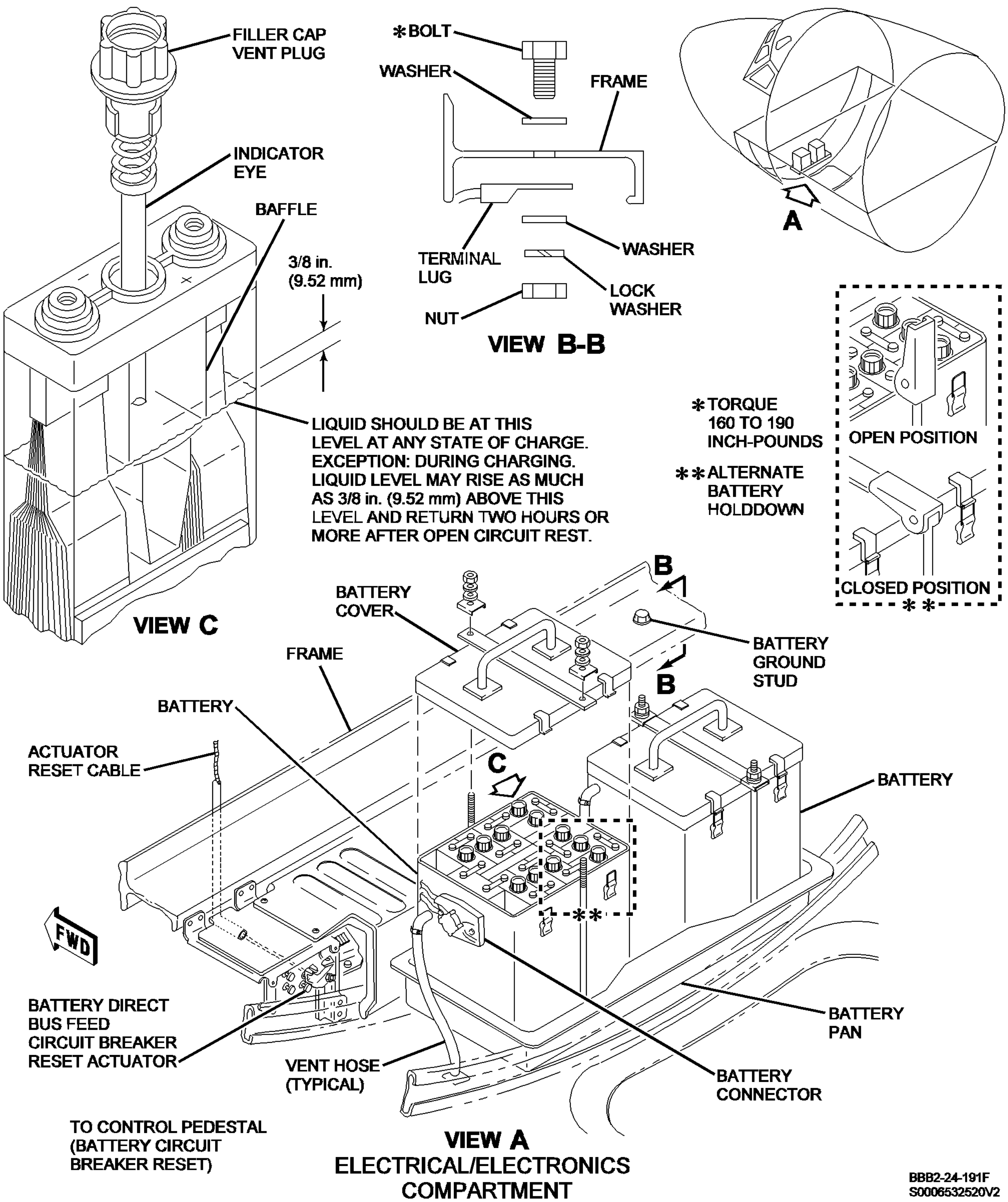
NOTE: Equivalent substitutes may be used instead of the following listed items.

Table 301

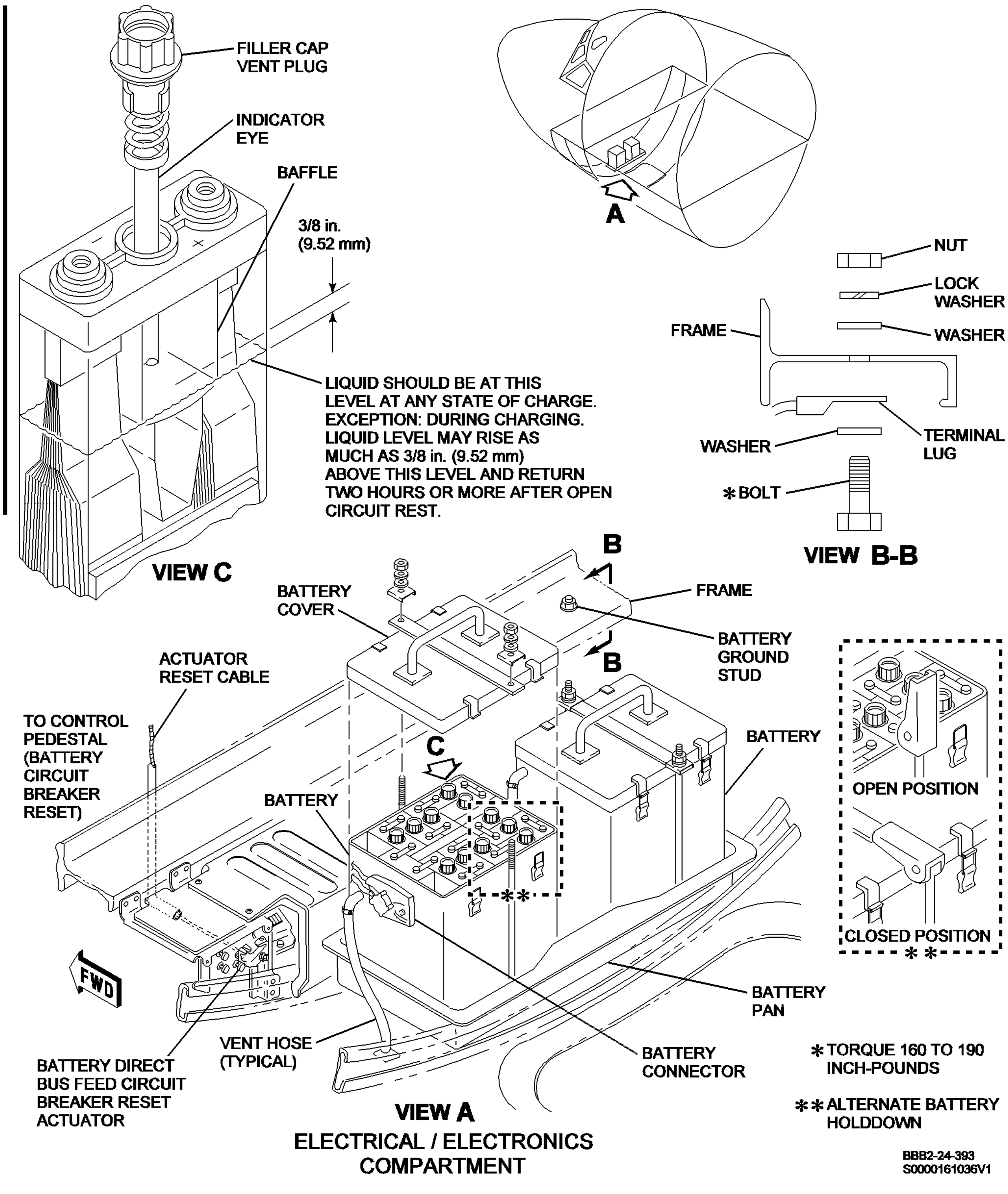
Name and Number	Manufacturer
CAUTION: TOOLS OR EQUIPMENT USED FOR SERVICING LEAD-ACID BATTERIES MUST NOT BE USED FOR SERVICING NICKEL-CADMIUM BATTERIES.	
Filler cap vent plug wrench 162A7836 (or equivalent)	General Electric Co. Battery Product Section Gainesville, FL
Filler cap vent plug wrench 16979-001 (or equivalent)	Marathon Power Technologies Waco, TX
Small syringe	Local
Nonmetallic acid resistant brush DPM 5690	Local



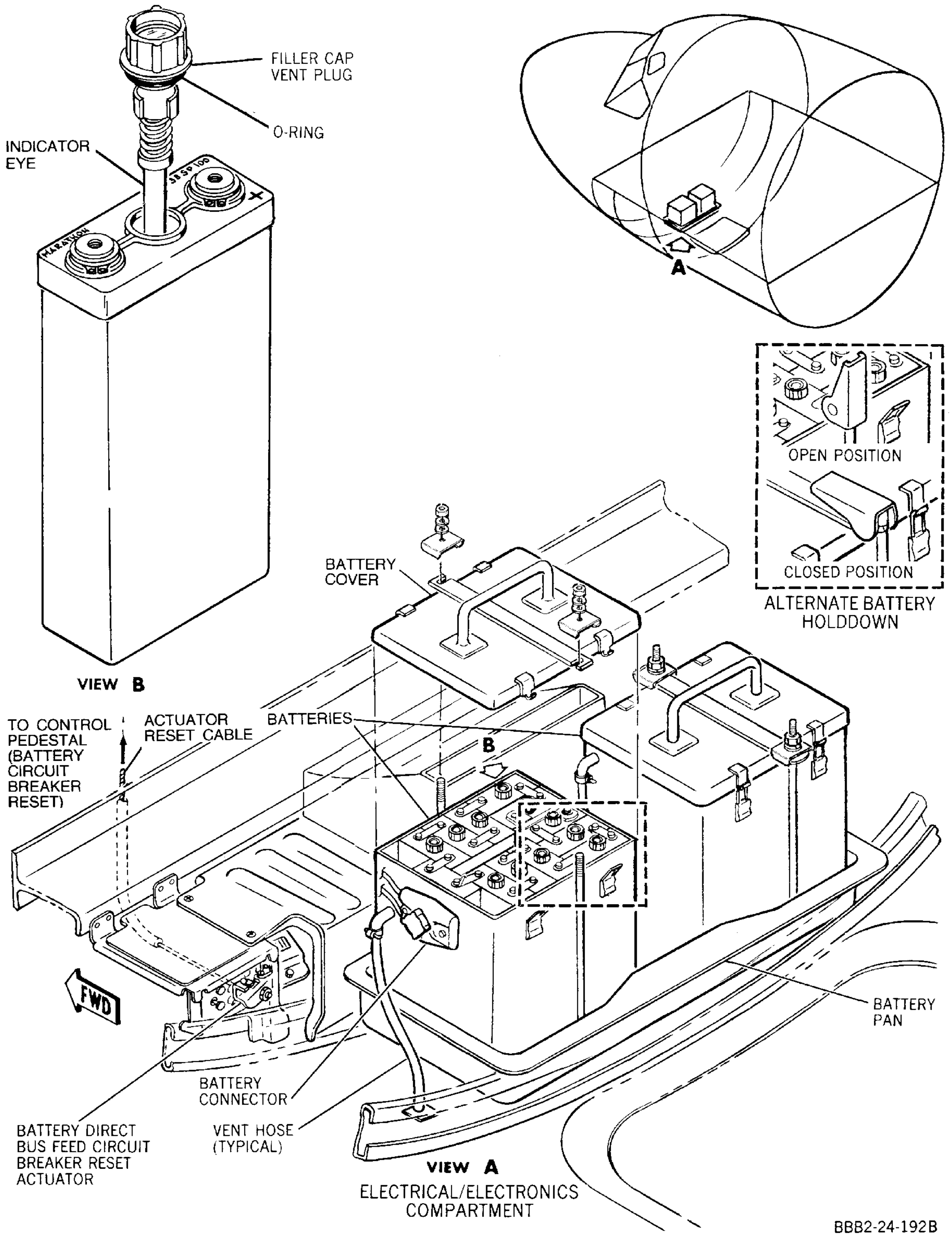
Battery Installation -- Servicing (Battery GE Part Number 43B034LB02)
Figure 301/24-30-01-990-806



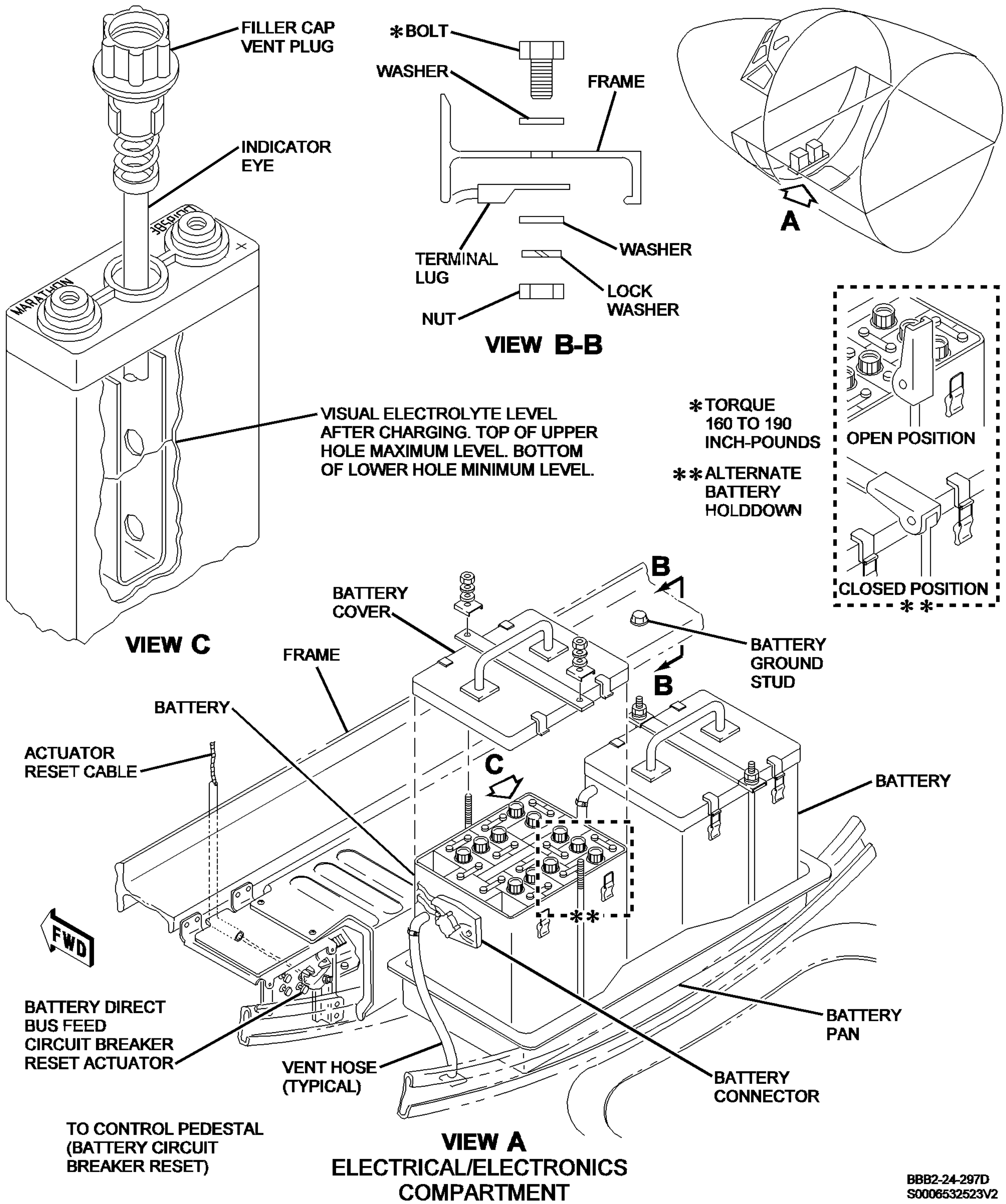
Battery Installation -- Servicing (Battery GE Part Number 43B034LB03) (Battery SAFT Part Number 021904-000)
Figure 302/24-30-01-990-812 (Sheet 1 of 2)



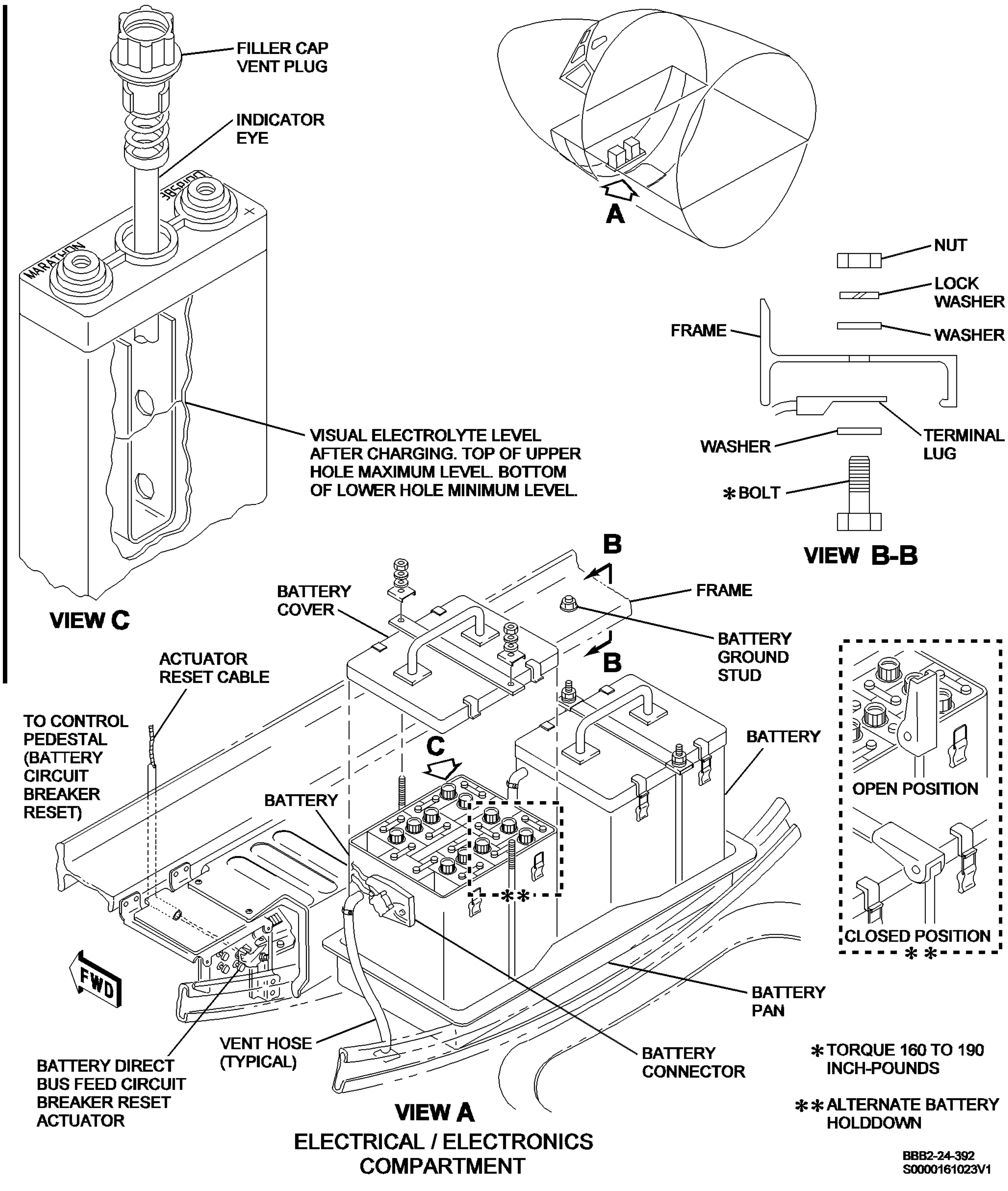
Battery Installation -- Servicing (Battery GE Part Number 43B034LB03) (Battery SAFT Part Number 021904-000)
Figure 302/24-30-01-990-812 (Sheet 2 of 2)



Battery Installation -- Servicing (Battery Marathon Part Number 27183, Sonotone Type CA-13)
Figure 303/24-30-01-990-808



Battery Installation -- Servicing (Battery Marathon Part Number 30475-002, Type SP-138)
Figure 304/24-30-01-990-809 (Sheet 1 of 2)



Battery Installation -- Servicing (Battery Marathon Part Number 30475-002, Type SP-138)
Figure 304/24-30-01-990-809 (Sheet 2 of 2)

3. Servicing Battery

WARNING: BATTERY ELECTROLYTE IS CAUSTIC POTASSIUM HYDROXIDE AND WILL BURN SKIN AND CLOTHING. IF SPILLED, NEUTRALIZE WITH VINEGAR OR (3 TO 5 PERCENT ACETIC ACID SOLUTION) OR MILD (3 TO 5 PERCENT) BORIC ACID SOLUTION OR, IF THESE ITEMS ARE NOT AVAILABLE, WASH THOROUGHLY WITH WATER. IMMEDIATE MEDICAL ATTENTION IS REQUIRED IF ELECTROLYTE HAS CONTACTED EYES.

CAUTION: DO NOT SPILL WATER OR ELECTROLYTE INTO BATTERY CONTAINER. RESULTANT ELECTROLYTE CORROSION MAY CAUSE DAMAGE.

A. Servicing Battery Installed in Aircraft

(1) For cleaning a liquid/chemical spill, including battery electrolyte, refer to SRM 51-10-3E.

(2) Check battery state-of-charge as follows:

(a) Place all AC electrical power source switches in OFF position.

(b) Place battery switch in ON position.

(c) Place indicator selector switch in BATT VOLT position.

(d) Verify battery voltage on voltmeter/ammeter is equal to or greater than 25 volts.

(e) If condition in Paragraph 3.A.(2)(d) cannot be obtained; remove and replace both batteries. (BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401)

(f) Energize AC ground service bus with AC external power, auxiliary power, or engine driven generator.

(g) Place indicator selector switch to BATT AMP position.

(h) Check battery charger pulsing rate on voltmeter/ammeter.

(i) Check that time interval between pulses is not less than 5 seconds.

NOTE: It may take up to 30 minutes to obtain this condition after Paragraph 3.A.(2)(f) has been accomplished and ac power has been on the aircraft and batteries charging. (BATTERY CHARGER - DESCRIPTION AND OPERATION, PAGEBLOCK 24-30-02/001)

(j) If condition in Paragraph 3.A.(2)(i) cannot be obtained, remove and replace both batteries. (BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401)

(3) Check and adjust electrolyte level as follows:

WARNING: TAG BATTERY DIRECT BUS FEED CIRCUIT BREAKER RESET HANDLE, LOCATED IN FLIGHT COMPARTMENT.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(a) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
		B1-146	BATTERY CHARGER PHASE A, B, & C

NOTE: AC power may be removed from the aircraft during electrolyte level check, but it is not necessary.

CAUTION: IF WAITING PERIOD OF AT LEAST 5 MINUTES IS NOT OBSERVED, SPEWAGE AND LEAKAGE OF ELECTROLYTE MAY OCCUR.

(b) Allow battery to rest on open circuit for at least 5 minutes before checking electrolyte level.

CAUTION: BE CERTAIN THAT METAL PORTIONS OF BATTERY COVERS DO NOT TOUCH INTERNAL PARTS OF BATTERY DURING REMOVAL. DO NOT USE ANY METAL TOOLS NEAR BATTERY WITH COVER REMOVED. ALSO BE CERTAIN THAT COVERS ARE NOT PLACED ON ANY PORTION OF AIRCRAFT OR ON OTHER EQUIPMENT.

(c) Loosen battery holddown clamps and remove covers from both batteries.

CAUTION: BEFORE REPLACING BATTERY, MAKE CERTAIN THAT BATTERY PAN AND SURROUNDING AREA IS THOROUGHLY CLEANED OF RESIDUE TO PREVENT POSSIBLE CORROSION.

(d) Check for evidence of excessive spewage, loose terminal connections, burning or discoloration of terminal connections; if condition exists, remove and replace both batteries.

(e) On aircraft with battery (Part Number 43B034LB02), perform following steps:

WARNING: ELECTROLYTE WILL CAUSE SERIOUS BURNS IF ALLOWED TO CONTACT FLESH.

1) Using nylon wrench (stored in battery case), remove filler cap vent plug from one cell.

NOTE: Do not place filler cap vent plug on aircraft structure or equipment.

WARNING: DO NOT USE ACID. BODILY INJURY MAY RESULT AND EQUIPMENT DAMAGE WILL OCCUR. MAKE CERTAIN THAT ALL BATTERY SERVICING EQUIPMENT IS ACID FREE.

CAUTION: IF ELECTROLYTE LEVEL IS HIGH, DO NOT ATTEMPT TO REMOVE EXCESS. THIS WOULD CAUSE CHANGE IN BATTERY CAPACITY. REPLACE BOTH BATTERIES. (BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401)

2) Check and if necessary adjust level of electrolyte. Electrolyte level should be approximately 1/2 inch (14.7 mm) above bottom of baffle third hole in baffle. (Figure 301)

NOTE: If electrolyte level is low, add only chemically pure, distilled water. The above high level is for battery that is fully charged that has rested on open circuit for one to two hours. Adjust electrolyte level with distilled water only to this level. Prior to charging if no electrolyte is visible, add distilled water to level of bottom of indicator. This will prevent over filling and consequent electrolyte spewage.

(f) On aircraft with battery (Part Number 43B034LB03), visually check level of electrolyte.

NOTE: An indicator eye in the cap of each cell provides visual indication of low level. A higher degree of brightness on the lens indicates that the level has reached a point requiring addition of distilled water.

CAUTION: IF ELECTROLYTE LEVEL IS HIGH, DO NOT ATTEMPT TO REMOVE EXCESS. THIS WOULD CAUSE CHANGE IN BATTERY CAPACITY. REPLACE BOTH BATTERIES. BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401

1) If level is low, use nylon wrench (stored in battery case) to remove filler cap vent plug from cell, and add chemically pure distilled water to level of baffle step. (Figure 302)

(g) On aircraft with battery (Part Number 27183, Type CA-13), perform following steps:

WARNING: ELECTROLYTE WILL CAUSE SERIOUS BURNS IF ALLOWED TO CONTACT FLESH.

1) Using vent wrench (stored in battery case), remove filler cap vent plug from one cell.

NOTE: Do not place filler cap vent plug on aircraft structure or equipment.

WARNING: DO NOT USE ACID. BODILY INJURY MAY RESULT AND EQUIPMENT DAMAGE WILL OCCUR. MAKE CERTAIN THAT ALL BATTERY SERVICING EQUIPMENT IS ACID FREE.

CAUTION: IF ELECTROLYTE LEVEL IS HIGH, DO NOT ATTEMPT TO REMOVE EXCESS. THIS WOULD CAUSE CHANGE IN BATTERY CAPACITY. REPLACE BOTH BATTERIES. (BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401)

2) Using a glass pipette, check and if necessary adjust level of electrolyte with chemically pure distilled water. Electrolyte level shall not exceed 1/2 inch (14.7 mm) above base of baffle when fully charged. (Figure 303)

NOTE: If electrolyte level is low, add only chemically pure distilled water. The above high level is for battery that is fully charged that has rested on open circuit for three hours. Adjust electrolyte level with distilled water to this level. Prior to charging if no electrolyte is visible add distilled water to level of base of baffle.

(h) On aircraft with battery (Part Number 30475-002, Type SP-138), perform following steps:

WARNING: ELECTROLYTE WILL CAUSE SERIOUS BURNS IF ALLOWED TO CONTACT FLESH.

1) Using vent wrench (stored in battery case), remove filler cap vent plug from one cell.

NOTE: Do no place filler cap vent plug on aircraft structure or equipment.

WARNING: DO NOT USE ACID. BODILY INJURY MAY RESULT AND EQUIPMENT DAMAGE WILL OCCUR. MAKE CERTAIN THAT ALL BATTERY SERVICING EQUIPMENT IS ACID FREE.

CAUTION: IF ELECTROLYTE LEVEL IS HIGH, DO NOT ATTEMPT TO REMOVE EXCESS. THIS WOULD CAUSE CHANGE IN BATTERY CAPACITY. REPLACE BOTH BATTERIES. (BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401)

2) Using a glass pipette, check and if necessary adjust level of electrolyte with chemically pure distilled water. Electrolyte level shall not exceed top of upper hole of baffle when fully charged. (Figure 304)

NOTE: If electrolyte level is low, add only chemically pure distilled water. The above high level is for battery that is fully charged that has rested on open circuit for three hours. Adjust electrolyte level with distilled water to this level. Prior to charging if no electrolyte is visible add distilled water to bottom of lower hole.

(i) Install filler cap vent plug; tighten with nylon wrench.

(j) Perform Paragraph 3.A.(3)(e) or Paragraph 3.A.(3)(f), as applicable, for each cell of each battery.

(k) Install filler cap vent plug (nylon) wrench in battery case.

(l) Install battery covers; secure battery covers and batteries holddown clamps.

(4) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
		B1-146	BATTERY CHARGER PHASE A, B, & C

NOTE: Reset clocks after closing BATTERY DIRECT BUS FEED circuit breaker. (PAGEBLOCK 31-21-00/201 Config 1 or PAGEBLOCK 31-21-00/201 Config 2)

(5) Perform test procedure for DC Generation. (DC GENERATION - MAINTENANCE PRACTICES, PAGEBLOCK 24-30-00/201)

BATTERY - REMOVAL/INSTALLATION

1. General

CAUTION: DUE TO CORROSIVE MATERIALS, BATTERIES SHALL NOT BE SERVICED IN AIRPLANE. RETURN BATTERIES TO REPAIR FACILITY.

A. Two 14-volt batteries are located in the electrical/electronics (E/E) compartment and are accessible through the E/E compartment access door. The two series-connected batteries are electrically the same as one 28-volt battery, therefore, if one battery is to be replaced, both batteries must be replaced.

2. Removal/Installation Battery

A. Remove Battery

CAUTION: FAILURE TO PLACE BATT SWITCH IN OFF POSITION MAY CAUSE AN ARC WHEN DISCONNECTING BATTERY CONNECTOR, IF BATTERY CHARGER IS OPERATING.

(1) Place BATT switch in OFF position.

(2) Disconnect battery connector from battery case.

(3) Loosen clamps and remove vent hoses from battery vents.

(4) Open two battery holddown clamps, remove battery from battery tray.

B. Battery Installation

WARNING: ELECTROLYTE IN BOTH LIQUID AND POWDERED STATE WILL CAUSE SERIOUS BURNS IF ALLOWED TO CONTACT FLESH.

WARNING: IF ELECTROLYTE HAS CONTACTED SKIN, NEUTRALIZE WITH VINEGAR OR MILD BORIC ACID SOLUTION. IF THESE ITEMS NOT AVAILABLE, WASH THOROUGHLY WITH WATER.

WARNING: IMMEDIATE MEDICAL ATTENTION IS REQUIRED IF ELECTROLYTE HAS CONTACTED EYES.

(1) Check battery connectors, hold down clamps, vent hoses, tray and immediate surroundings for physical condition and for presence of spilled electrolyte (liquid or powdered state). Clean and/or repair as necessary.

(2) Check battery temperature sensor for condition and presence of corrosion. Clean or replace as necessary.

C. Install Battery

CAUTION: NO FOREIGN OBJECTS, DEBRIS, OR ACCUMULATIONS OF DIRT ALLOWED TO COLLECT IN THIS INSTALLATION.

(1) Check that battery temperature sensor is securely mounted. Clean battery tray, micarta spacer and bottom of battery case as necessary to ensure proper installation.

WARNING: MAKE SURE YOU REMOVE THE RED FILLER CAP SHIPPING PLUGS BEFORE YOU INSTALL THE BATTERY. IF THE PLUGS ARE NOT REMOVED, YOU CAN CAUSE DAMAGE TO THE EQUIPMENT AND INJURY TO PERSONS.

CAUTION: REMOVE DUST COVERS FROM NEW OR REPLACEMENT BATTERY PRIOR TO USE.

(2) With micarta spacer installed, set battery in proper position.

NOTE: Make sure that battery temperature sensor makes clean physical contact with battery case.

(3) Secure battery with two holddown clamps.

(4) Remove vent plugs. Install battery vent hoses and tighten clamps.

(5) Connect battery electrical connector; handtighten.

NOTE: The battery connector is an over-center locking-detent type connector. If the battery connector does not lock, then it must be replaced. The battery connector does not require safety wire.

(6) Reset/adjust the clocks. (CLOCK - MAINTENANCE PRACTICES, PAGEBLOCK 31-21-00/201 Config 1 or DIGITAL CLOCK - MAINTENANCE PRACTICES, PAGEBLOCK 31-21-00/201 Config 2)

(7) Perform Battery Charger System Test (PAGEBLOCK 24-30-02/201).

BATTERY - REMOVAL/INSTALLATION

1. **General**

   A. This procedure contains MSG-3 task card data.

TASK 24-30-01-902-801

2. **Restoration of the Main Aircraft Batteries**

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
24-30-01 P/B 401	BATTERY - REMOVAL/INSTALLATION

B. Prepare for the Restoration of the Main Aircraft Batteries

SUBTASK 24-30-01-010-001

(1) Open the electrical/electronics (E/E) compartment access door.

C. Restoration of the Main Aircraft Batteries

SUBTASK 24-30-01-020-001

(1) Remove the main aircraft batteries. (BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401)

SUBTASK 24-30-01-902-001

(2) Send the main aircraft batteries to the shop for restoration.

SUBTASK 24-30-01-420-001

(3) Install serviceable main aircraft batteries. (BATTERY - REMOVAL/INSTALLATION, PAGEBLOCK 24-30-01/401)

D. Job Close-up

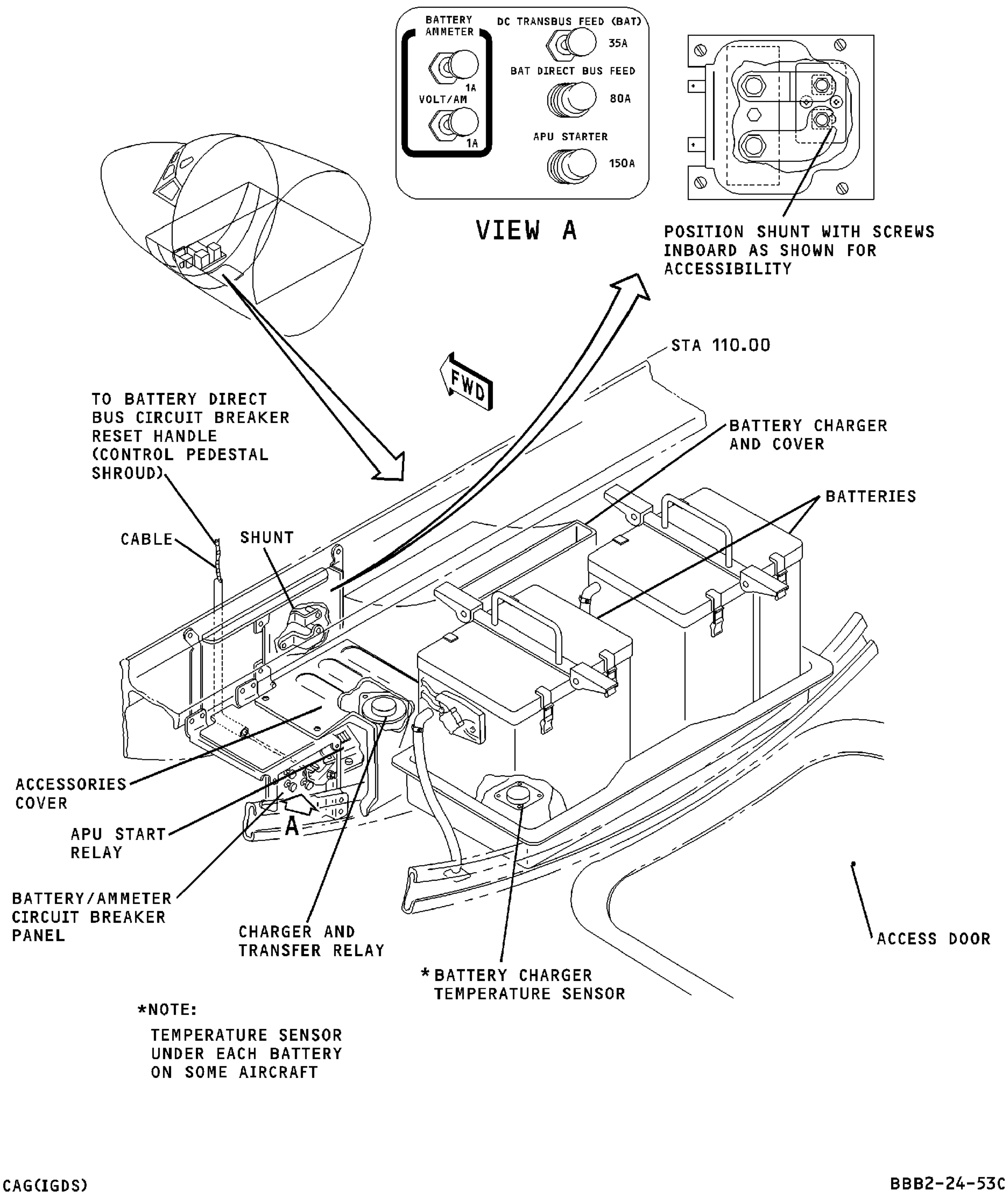
SUBTASK 24-30-01-942-001

(1) Remove all the tools and equipment from the work area. Make sure the area is clean.

SUBTASK 24-30-01-410-001

(2) Close E/E compartment access door.

END OF TASK



MAIN AIRCRAFT BATTERIES
Figure 401/24-30-01-990-811

BATTERY - ADJUSTMENT/TEST

1. General

A. This section outlines procedures for battery charging and periodic tests recommended by the manufacturer.

B. All procedures are to be accomplished in a designated service area away from the aircraft.

C. A completely discharged battery requires 56 ampere-hours of charge (current in amperes times hours of charge).

D. Procedures are identical for each of the two batteries.

NOTE: All procedures outlined in this section are to be performed in an area having a constant temperature of approximately 77°F (25°C).

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 501

Name and Number	Manufacturer
Constant- current battery charging equipment or constant potential battery charging equipment BC 14-50 FU	Christie Electric Corp.
Battery discharging equipment capable of discharging battery at a fixed resistive rate (TN 12A)	Christie Electric Corp.
Precision multimeter (Mod 8100B)	John Fluke Mfg. Co. Inc.
Shorting resistors (5 to 6 ohms) (11 required)	
Filler cap vent plug wrench (nylon) 162A7836	General Electric Co. Battery Pro duct Section
Cell puller 201A3254	General Electric Co.

3. Adjust/Test Battery

NOTE: If battery state-of-charge is not known, discharge battery completely before recharging.

WARNING: BATTERY ELECTROLYTE IS CAUSTIC POTASSIUM HYDROXIDE AND WILL BURN SKIN AND CLOTHING. IF SPILLED, NEUTRALIZE WITH VINEGAR OR (3 TO 5 PERCENT ACETIC ACID SOLUTION) OR MILD (3 TO 5 PERCENT) BORIC ACID SOLUTION OR, IF THESE ITEMS ARE NOT AVAILABLE, WASH THOROUGHLY WITH WATER. IMMEDIATE MEDICAL ATTENTION IS REQUIRED IF ELECTROLYTE HAS CONTACTED EYES.

CAUTION: TO ELIMINATE POSSIBILITY OF DAMAGE TO CELLS, FROM CHARGING WHILE DRY, ALWAYS ASSURE THAT SUFFICIENT QUANTITY OF ELECTROLYTE IS AVAILABLE TO COVER CELL PLATE AREA, BEFORE CHARGING IS ATTEMPTED.

A. Constant-current Charging

(1) Charge battery at maximum rate of 8 amperes for 7 hours.

NOTE: Charge rate depends on maximum current output times the time to a given 56 ampere-hours charge.

B. Constant-Potenetial Charging (Figure 501)

CAUTION: IN NO CASE SHOULD TIME EXCEED THAT WHICH IS REQUIRED TO ATTAIN 56 AMPERE HOURS CHARGING.

(1) Charge battery at 16 to 16.5 volts for 1 to 2 hours. Battery should be fully charged when charging current drops to less than 2 amperes.

NOTE: It is not necessary to have a current limiting charger for constant-potential charging, as the ability of the battery to accept a charge current is limited by the internal impedance.

(2) Check individual cell voltages when ammeter indicates 2 amperes. Individual cell voltages should be 1.50 (±.03) volts.

4. Equalizing Cells

(Figure 502)

A. Loss of capacity over period of time is normal for nickel-cadmium battery and is usually due to cell unbalance. Battery can be restored to full rated capacity as follows.

(1) Using filler cap vent plug wrench, loosen but do not remove battery filler cap vent plugs.

(2) Discharge battery at fixed-resistive rate until battery voltage is 11.6 volts (approximately 1.05 volts per cell).

(3) Install shorting resistor across each cell terminal, and short battery for at least 12 hours.

(4) Remove shorting resistors.

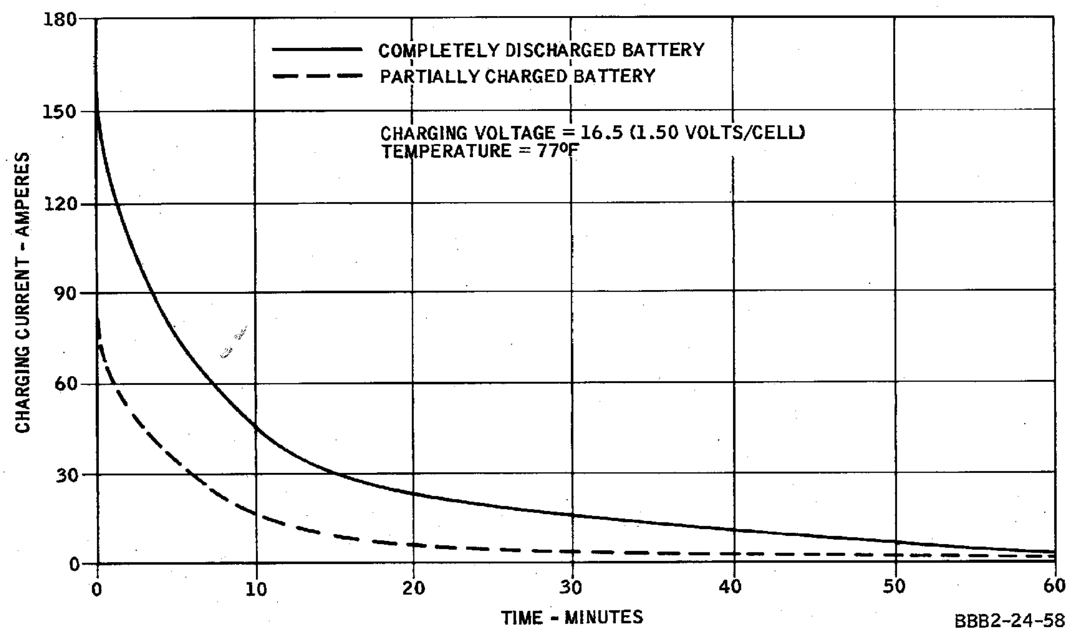
(5) Charge battery for 56 ampere-hours. (Paragraph 3.)

WARNING: DO NOT USE ACID. BODILY INJURY MAY RESULT AND EQUIPMENT DAMAGE WILL OCCUR. MAKE CERTAIN THAT ALL BATTERY SERVICING EQUIPMENT IS ACID FREE.

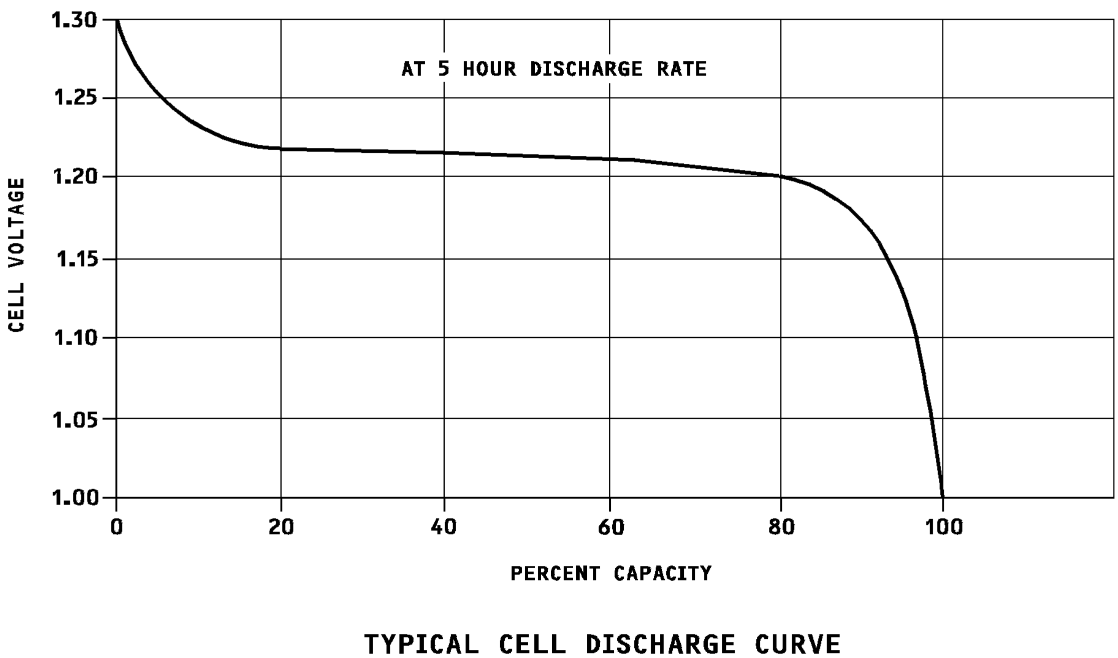
(6) Allow battery minimum of 2 hours resting time on open circuit, then check and, if necessary, adjust level of electrolyte in each cell to hole in baffle. (Figure 503)

NOTE: Electrolyte level is adjusted by using small clean syringe to remove excess electrolyte or add clean distilled water only.

(7) Tighten filler cap vent plugs; use filler cap vent plug wrench.



Typical Constant Potential Charging Curves -- 40 A.H. Battery - 11 Cells
Figure 501/24-30-01-990-802



Typical Cell Discharge Curve
Figure 502/24-30-01-990-803

5. Capacity Check

(Figure 503)

NOTE: This check will also serve to equalize the battery cells.

A. Whenever check of battery condition is desired, proceed as follows.

(1) Using filler cap vent plug wrench, loosen but do not remove battery filler cap vent plugs.

(2) Discharge battery at fixed-resistive rate until battery voltage is 11.6 volts (approximately 1.05 volts per cell).

(3) After battery has cooled, completely charge battery. (Paragraph 3.)

(4) Check and adjust electrolyte level. (Paragraph 4.)

(5) Discharge battery at fixed rate of approximately 45 amperes (0.31 ohms resistive) until battery voltage is 11.6 volts. Discharge time should not take less than 45 minutes.

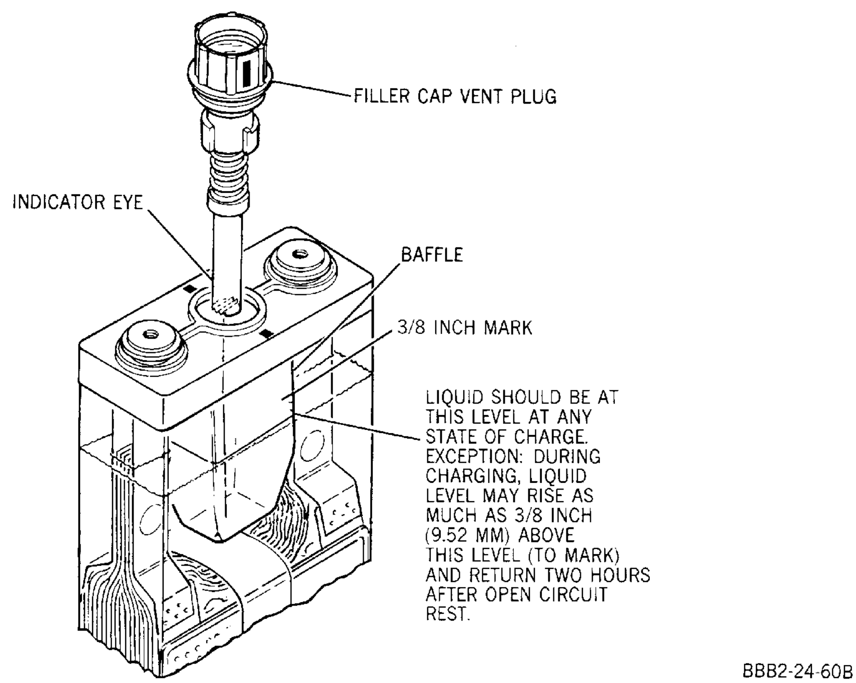
NOTE: During the last minute of discharge check the individual cell voltages. There should not be a cell voltage variation from the high to the low of greater than 0.3 volts.

(6) If voltage of any cell is less than 1.05, cell is defective. Remove and replace cell. (PAGEBLOCK 24-30-01/801)

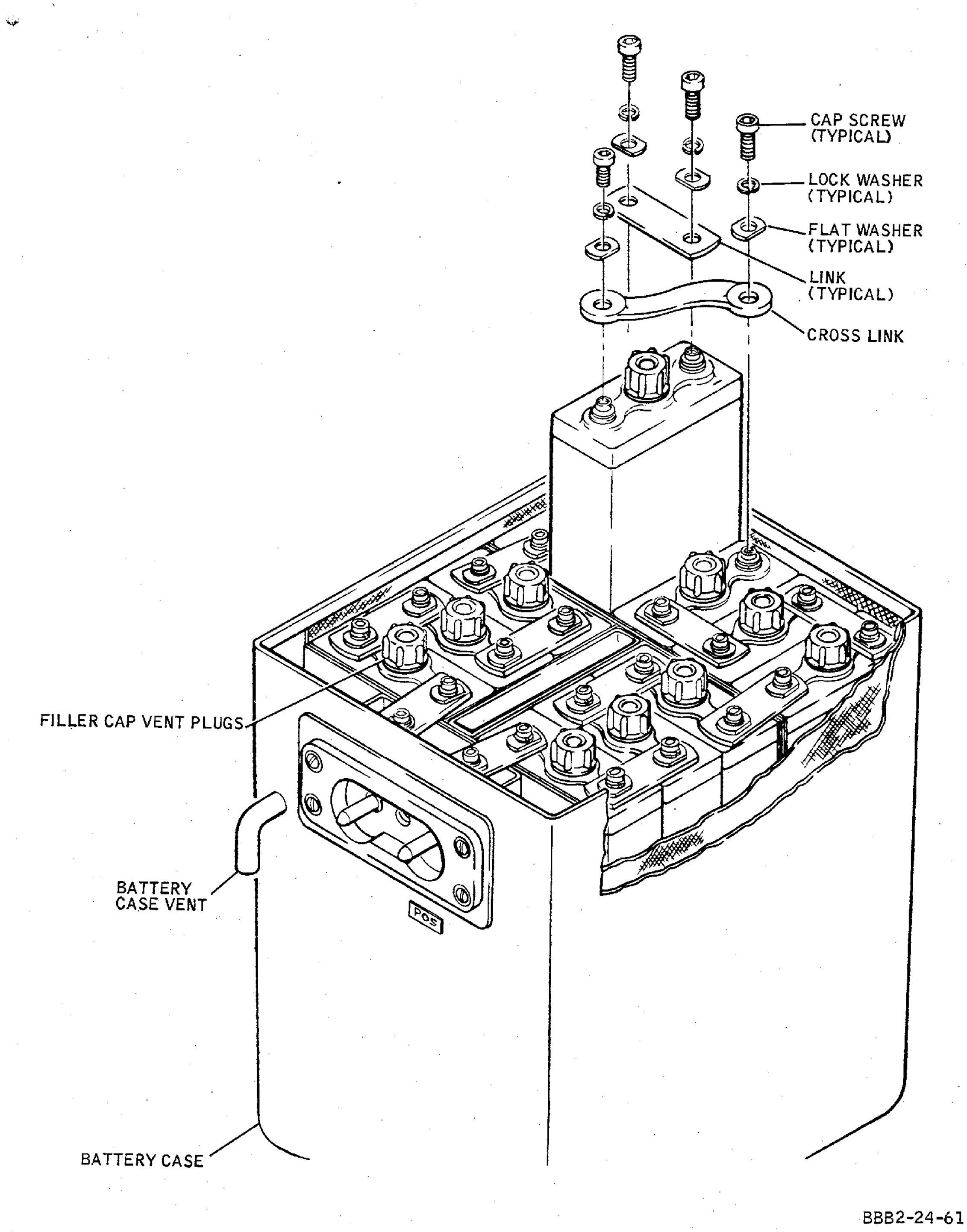
(7) Charge battery. (Paragraph 3.)

(8) Check and adjust electrolyte level. (Paragraph 4.)

(9) Tighten filler cap vent plugs.



Adjusting Electrolyte Level in Approved Area
Figure 503/24-30-01-990-804



Cell Removal
Figure 504/24-30-01-990-805

BATTERY - CLEANING/PAINTING

1. General

A. Cleaning battery may be accomplished with battery installed in the aircraft or in area designated for battery servicing. If a white deposit has formed on top of cells, it is potassium carbonate which is harmless and can be removed by brushing with a nonmetallic, acid resistant brush or with a cleaning cloth.

WARNING: DO NOT USE WIRE BRUSH TO CLEAN BATTERY AS ARCING WILL OCCUR AND CAUSE PERSONAL INJURY OR DAMAGE TO BATTERY.

B. Cleaning procedures are identical for each of the two batteries.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 701

Name and Number	Manufacturer
Filler cap vent plug wrench (nylon) (162A7836)	General Electric Co. Battery Product Section
Nonmetallic acid resistant brush	
Cleaning cloth	

3. Cleaning/Painting Battery

A. Cleaning Battery

WARNING: BATTERY ELECTROLYTE IS CAUSTIC POTASSIUM HYDROXIDE AND WILL BURN SKIN AND CLOTHING. IF SPILLED, NEUTRALIZE WITH VINEGAR OR (3 TO 5 PERCENT ACETIC ACID SOLUTION) OR MILD (3 TO 5 PERCENT) BORIC ACID SOLUTION OR, IF THESE ITEMS ARE NOT AVAILABLE, WASH THOROUGHLY WITH WATER. IMMEDIATE MEDICAL ATTENTION IS REQUIRED IF ELECTROLYTE HAS CONTACTED EYES.

CAUTION: DO NOT USE SOLVENTS FOR CLEANING BATTERY. DAMAGE TO BATTERY CASE LINER AND COVER GASKET MAY RESULT.

DO NOT WASH BATTERY WITH WATER.

(1) Wipe off battery case and cover with cleaning cloth.

(2) Remove cover.

CAUTION: DO NOT USE WIRE BRUSH TO CLEAN BATTERY AS SHORTING WILL OCCUR, AND DAMAGE TO CELL CASES, FILLER CAP VENT PLUGS, AND BATTERY TERMINAL LINKS MAY RESULT.

(3) Brush top of cell cases, filler cap vent plugs, and battery terminal links with brush to loosen all white deposits.

(4) Wipe top of cell cases, filler cap vent plugs, and battery terminal links with cleaning cloth to remove all foreign material.

B. Cleaning Battery Filler Cap Vent Plug

WARNING: ELECTROLYTE WILL CAUSE SERIOUS BURNS IF ALLOWED TO CONTACT FLESH.

(1) Using filler cap vent plug wrench, remove filler cap vent plugs.

(2) Wash filler cap vent plug under running water.

(3) Remove white deposits from filler cap vent plug using nonmetallic, acid resistant brush.

(4) Dry filler cap vent plug with cleaning cloth or dry compressed air if available.

(5) Install filler cap vent plug.

BATTERY - APPROVED REPAIRS

1. General

A. Approved repairs consist of determining the cause of a defective battery and making the necessary repairs to place the battery back in service.

B. All procedures are to be performed in a designated service area away from the aircraft, having a constant temperature of approximately 77°F (25°C). The area should not be used for servicing lead-acid type batteries. Acid or acid fumes are highly detrimental to nickel-cadmium batteries.

WARNING: POTASSIUM HYDROXIDE IS AN AGENT THAT IS CORROSIVE. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN POTASSIUM HYDROXIDE IS USED.

- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET POTASSIUM HYDROXIDE IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

C. A 30-percent (by weight) solution of potassium hydroxide (KOH) in distilled water is used as an electrolyte. During operation of the battery, no appreciable chemical change takes place in the electrolyte. Therefore, testing the specific gravity of the electrolyte cannot determine the battery state-of-charge.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

Table 801

Name and Number	Manufacturer
Filler cap vent plug wrench (nylon) (162A7836)	General Electric Co. Battery Product Section
Hydrometer	
Small, clean syringe	
Potassium hydroxide electrolyte (1.300 specific gravity) DPM 950-35	
Precision dc volt meter capable of indicating tenths-of-a volt or better, with resolution to read hundredths	
Petroleum jelly or silicone grease	

Table 801 (Continued)

Name and Number	Manufacturer
Torque wrench (0-75 inch-pounds (0 - 8.47 N·m) range)	

3. Battery Repair

A. Check and Determine Battery Condition

(1) Clean battery.

(2) Remove filler cap vent plugs using filler cap vent plug wrench.

(3) Check electrolyte level in each cell. (PAGEBLOCK 24-30-01/501)

NOTE: If there is evidence of excessive spewage or liquid in the bottom of battery case, a cell may be leaking.

(4) If cell is leaking, or otherwise appears defective; replace cell.

(5) Check capacity of battery. (PAGEBLOCK 24-30-01/501)

(6) Check cell connecting links; if evidence of being loose, tighten screws to torque of 60 to 72 inch-pounds (6.78 to 8.13 N·m).

B. Replacing Damaged or Defective Cells

(1) Clean battery.

(2) Discharge battery to a shorted condition. (PAGEBLOCK 24-30-01/501)

(3) Remove end terminal connections; save hardware.

(4) Remove all filler cap vent plugs; use filler cap vent plug wrench.

(5) Remove enough cell connecting links to permit cell to be withdrawn from battery case.

NOTE: Do not remove cell unless replacement cell is immediately available.

(6) Remove defective cell.

CAUTION: MAKE CERTAIN THAT REPLACEMENT CELL IS IDENTICAL TO THE CELL REMOVED. CELLS OF DIFFERENT CAPACITY CANNOT BE USED.

(7) Install new cell; make certain cell is inserted with polarity symbols in correct direction.

NOTE: Cells are connected plus to minus. If cell is difficult to insert, apply a light coat of petroleum jelly or silicone grease to the sides of cell case before reassembly.

CAUTION: DO NOT USE SUBSTITUTE HARDWARE. MANY OF THESE PARTS ARE SPECIFICALLY DESIGNED TO PRODUCE ADEQUATE ELECTRICAL CONNECTION AND/OR CARRY SPECIFIC ELECTRICAL LOAD.

(8) Install connectors and hardware fingertight.

(9) Tighten terminal connection screws to torque of 60 to 72 inch-pounds (6.78 to 8.13 N·m).

(10) Discharge entire battery. (PAGEBLOCK 24-30-01/501)

NOTE: Monitor each cell to determine that all cells are completely discharged. Should some cells reverse polarity and others retain a portion of their charge, it will be necessary to individually short the cells until each cell is completely at zero.

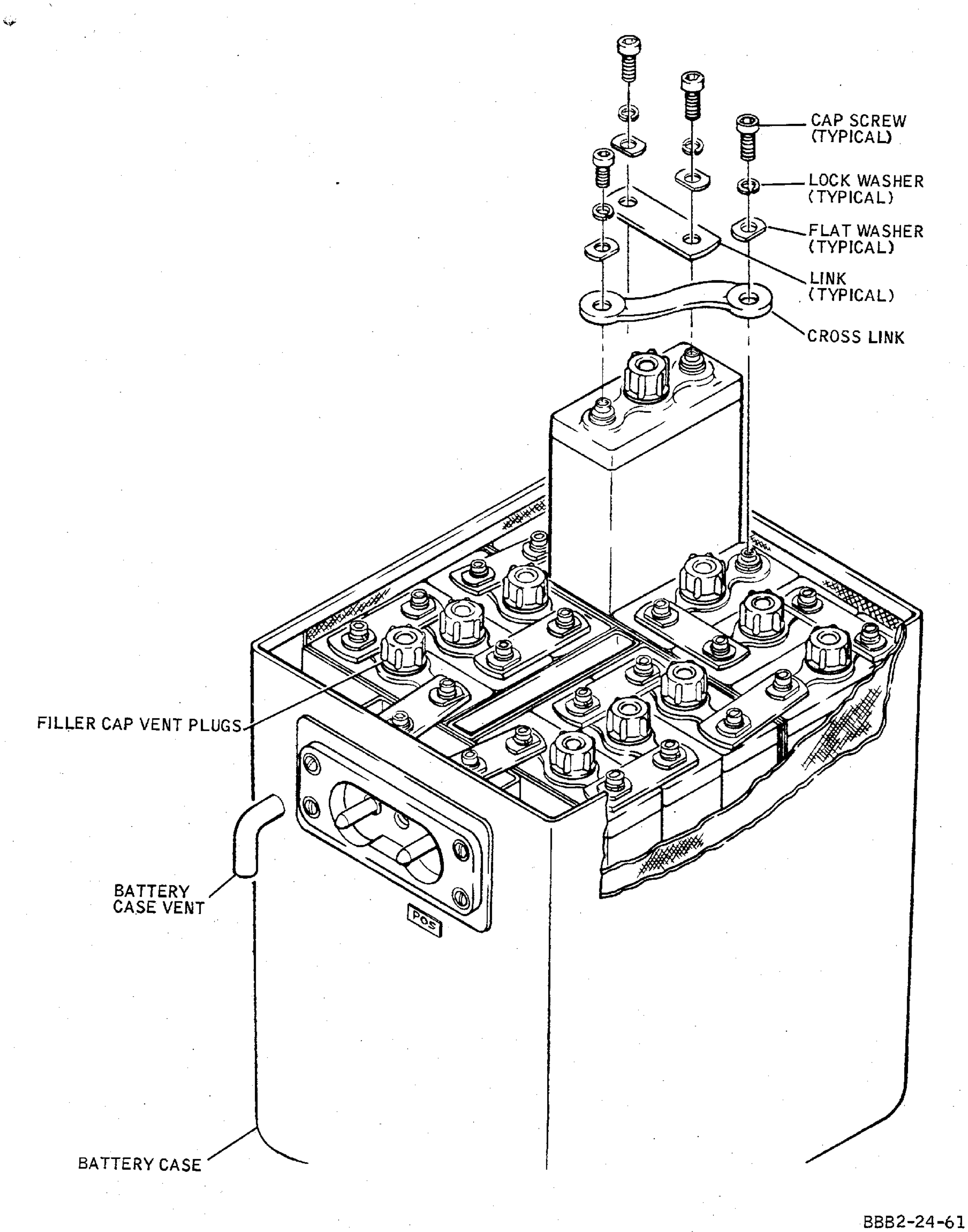
(11) Charge battery. (PAGEBLOCK 24-30-01/501)

(12) Allow battery minimum 2-hour rest period on open circuit.

(13) Adjust cell electrolyte level where required. (PAGEBLOCK 24-30-01/501)

(14) Install all filler cap vent plugs, tighten with filler cap vent plug wrench.

(15) Install battery case cover.



Battery Cell -- Removal and Installation 1
Figure 801/24-30-01-990-801

BATTERY CHARGER - DESCRIPTION AND OPERATION

1. General

A. A current-limited type battery charger is installed to maintain the batteries in a fully charged condition. The charger is located forward of the batteries, in the electrical/electronics compartment.

WJE 420, 422, 424-427, 429, 868, 884, 891

B. The battery charger converts three-phase, 200-volt (line-to-line), 400-hertz power into dc power suitable for charging the batteries. An automatic control circuit, within the charger, senses the battery temperature and the charger output terminal voltage and switches the charger off or on to maintain the correct output voltage for the particular battery temperature. On aircraft with two battery temperature sensors, the hottest of the two temperatures regulates the automatic control circuit. The battery temperature sensor is mounted directly into the battery pan assembly, and makes physical contact with the underside of the left battery case (both battery cases on two-sensor aircraft). The battery charger output (charging current) is limited to 45 amperes by circuitry within the charger.

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

C. The battery charger converts three-phase, 200-volt (line-to-line), 400-hertz power into dc power suitable for charging the batteries. An automatic control circuit, within the charger, senses the battery temperature and the charger output terminal voltage and switches the charger off or on to maintain the correct output voltage for the particular battery temperature. The battery temperature sensors are mounted directly into the battery pan assembly, and make physical contact with the underside of the battery cases. The battery charger output (charging current) is limited to 45 amperes by circuitry within the charger.

WJE ALL

D. The battery charger is supplied input power through a 3-phase, companion-trip, 8-ampere circuit breaker from the ground service ac bus. Battery charger output is connected to the batteries whenever the ground service ac bus is powered, emergency power switch is in the off position, and the battery switch is in the on position. Refer to DC GENERATION - TROUBLE SHOOTING, PAGEBLOCK 24-30-00/101 for action of relays and interlocking protective circuitry.

WJE 420, 422, 424-427, 429, 868, 884, 891

E. Operation of the battery charger is entirely automatic and is dependent on the battery state-of-charge and the temperature of the batteries, as sensed by the battery temperature sensor. Charger operation is observed on the dc voltmeter/ammeter, located on the forward overhead switch panel, and from the selected amperage or voltage indications obtained, the operator can evaluate the battery state-of-charge.

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

F. Operation of the battery charger is entirely automatic and is dependent on the battery state-of-charge and the temperature of the batteries, as sensed by the battery temperature sensors. Charger operation is observed on the dc voltmeter/ammeter, located on the forward overhead switch panel, and from the selected amperage or voltage indications obtained, the operator can evaluate the battery state-of-charge.

WJE ALL

2. Operation

WJE 420, 422, 424-427, 429, 868, 884, 891

A. As the output current of the battery charger increases to a value where the input current of phase A reaches 9.2 to 9.6 amperes SCR 1 triggers, shutting the charger off. Capacitors in the circuit produce a time delay which turn the charger on after 10 to 20 milliseconds duration. This on-off operation will occur until the input current of phase A drops below 9.2 amperes in which time the charger will go into full-on operation. (Figure 1)

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

B. Figure 1 provides a curve of output current versus time and a graphical presentation of the current which would be observed on the voltmeter/ammeter during the current limit mode of operation. It is noted that the on-off operation will appear as an oscillation and the time period will be dependent on the severity of discharge of the battery.

WJE 420, 422, 424-427, 429, 868, 884, 891

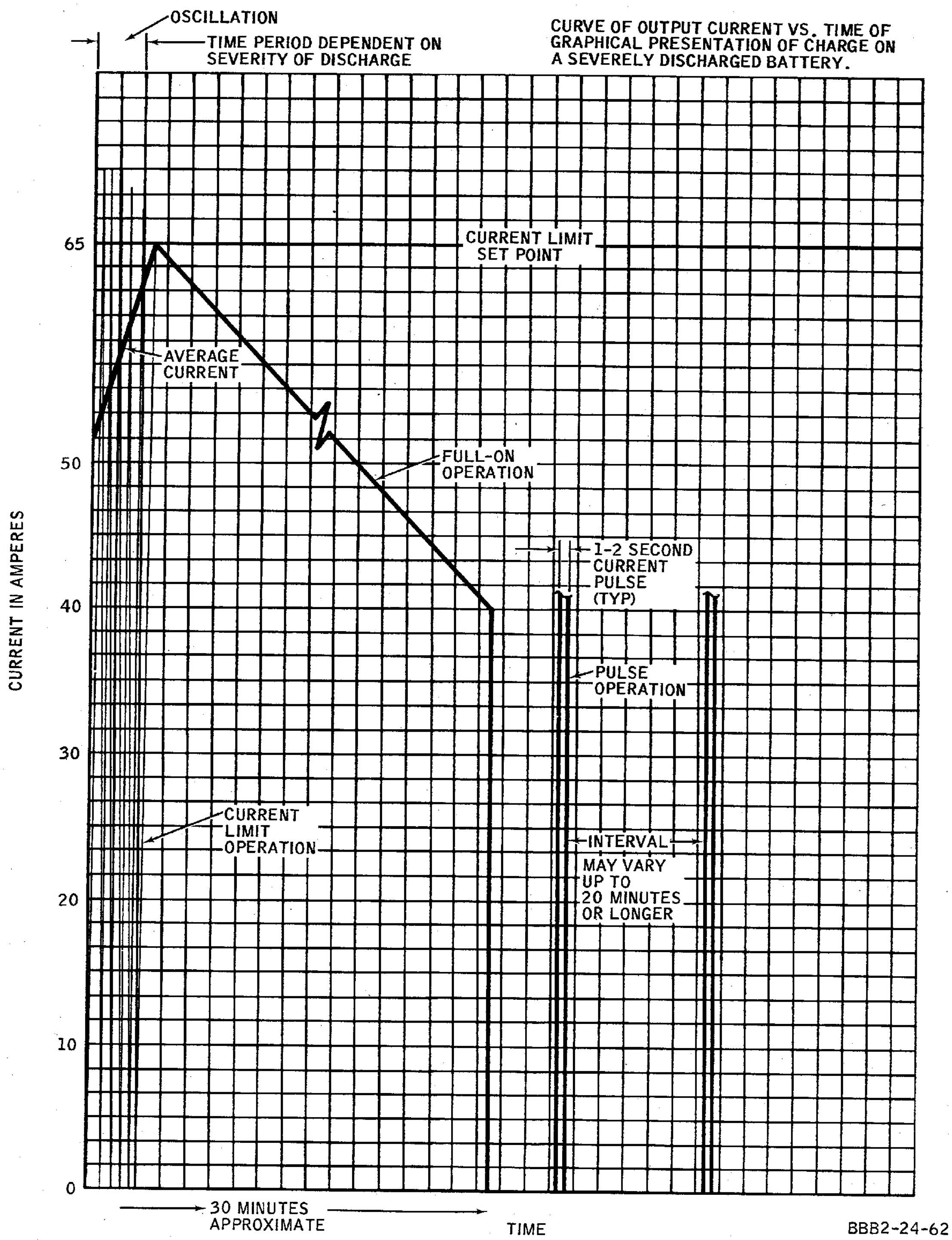
C. Figure 1 provides a curve of output current versus time and a graphical presentation of the current which would be observed on the voltmeter/ammeter during the current limit mode of operation. It is noted that the on-off operation will appear as an oscillation and the time period will be dependent on the severity of discharge of the battery.

D. When the battery state-of-charge is such that the charger is in full-on operation, current indication should be steady, to the left of zero at approximately 65 amperes and gradually reducing in current with respect to time to approximately 40 ampers. Voltage indication during this period should be between 30 and 33 volts. As the batteries approach a fully charge condition, the charger will commence to pulse. Intervals between pulses become longer, depending on battery current drain. The longer time interval between pulses would indicate the batteries becoming more fully charged. Between pulses the amperage reading should be zero, and the voltage reading should be approximately 30 volts. Pulse intervals can be expected to be from approximately 1 second to 30 minutes or longer depending on whether operation is with APU, engine or external power, battery load being used, and the general condition of the batteries.

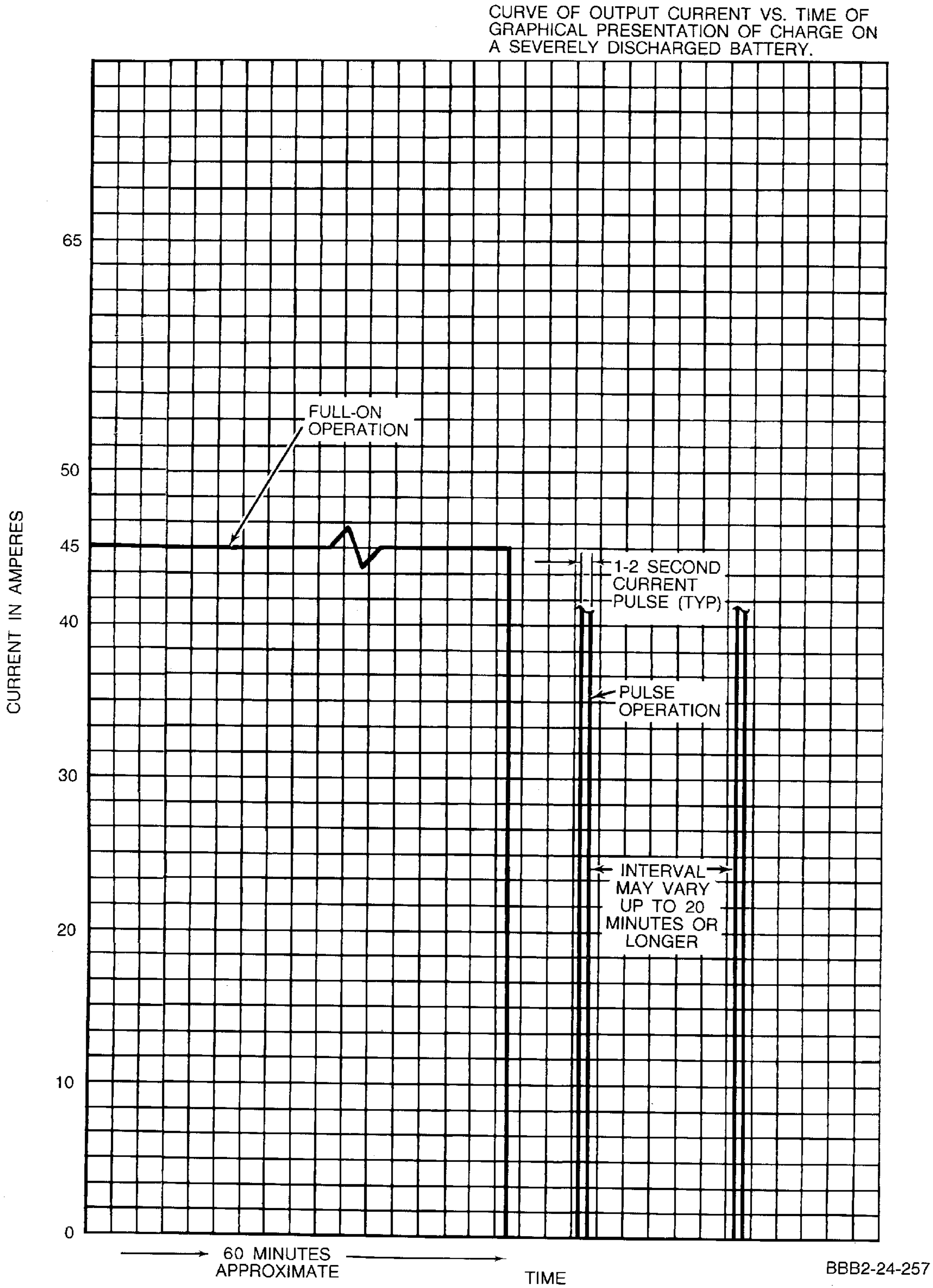
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

E. When the battery state-of-charge is such that the charger is in full-on operation, current indication should be steady, to the left of zero at approximately 45 amperes. Voltage indication during this period should be between 30 and 33 volts. As the batteries approach a fully charge condition, the charger will commence to pulse. Intervals between pulses become longer, depending on battery current drain. The longer time interval between pulses would indicate the batteries becoming more fully charged. Between pulses the amperage reading should be zero, and the voltage reading should be approximately 30 volts. Pulse intervals can be expected to be from approximately 1 second to 30 minutes or longer depending on whether operation is with APU, engine or external power, battery load being used, and the general condition of the batteries. The pulse time interval is reduced by turning the emergency power switch to the ON position for approximately one half minute and then returning it to the OFF position.

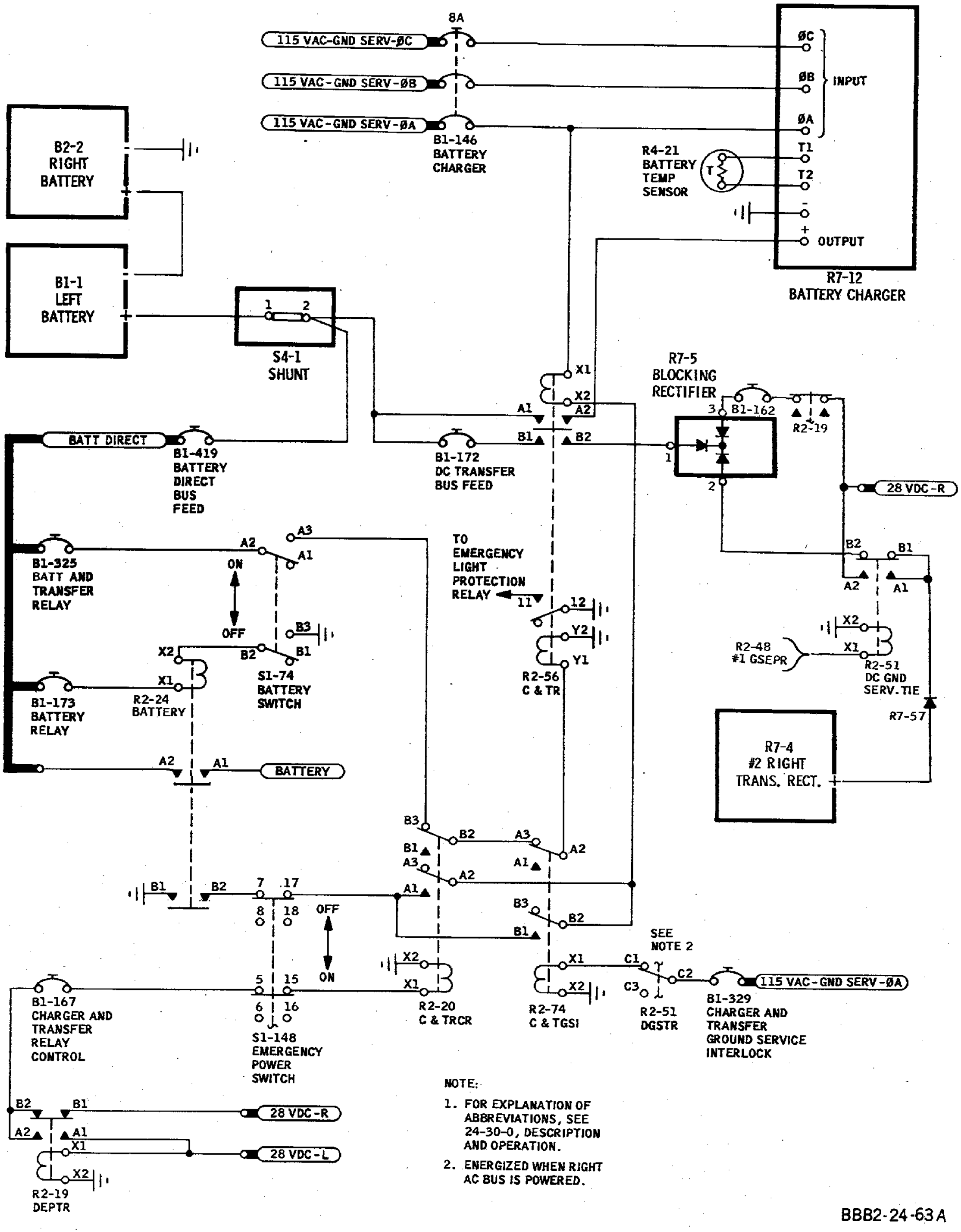
WJE ALL



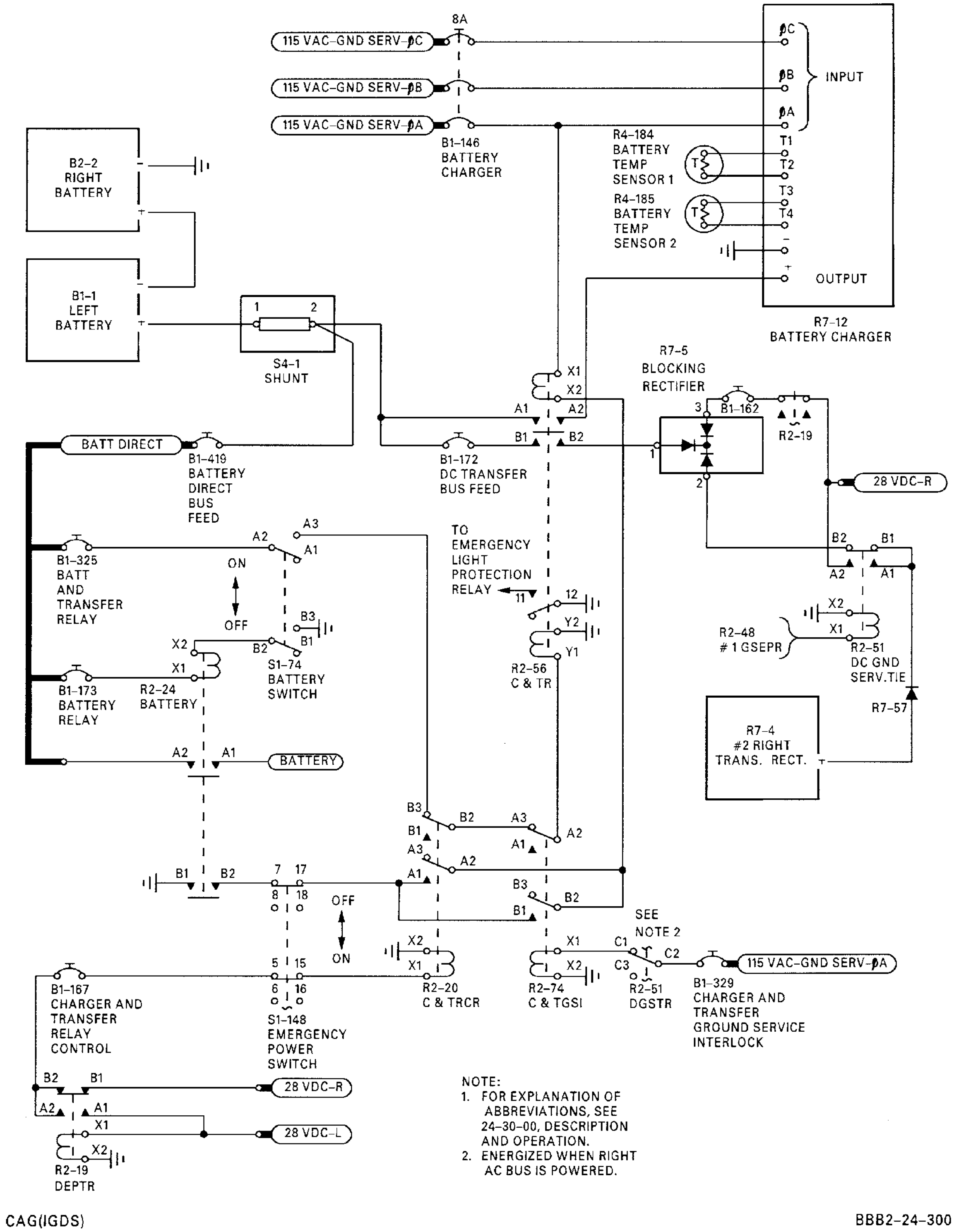
Battery Charger Operation Graph
Figure 1/24-30-02-990-801 (Sheet 1 of 2)



Battery Charger Operation Graph
Figure 1/24-30-02-990-801 (Sheet 2 of 2)



Battery Charger and Transfer Relay System -- Simplified Schematic
Figure 2/24-30-02-990-802 (Sheet 1 of 2)



Battery Charger and Transfer Relay System -- Simplified Schematic
Figure 2/24-30-02-990-802 (Sheet 2 of 2)

BATTERY CHARGER - MAINTENANCE PRACTICES

1. **General**

   A. Maintenance practices for the battery charger consists of Removal/Installation procedures and functional test in the aircraft. No adjustments are provided for the charger unit. For the battery charger system trouble shooting procedures, refer to DC GENERATION - TROUBLE SHOOTING, PAGEBLOCK 24-30-00/101.

2. **Equipment and Materials**

   NOTE: Equivalent substitutes may be used instead of the following listed items:

WJE 420, 422, 424-427, 429, 868, 884, 891

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

WJE ALL

Table 201

Name and Number	Manufacturer
Multimeter 2000A	Dana
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893	
Temperature sensor selector switch tool P/N 622	DESCO Corp. Walnut, CA
WJE ALL	
Torque wrench (capable of 0 to 100 foot-pounds) (0 to 1200 inch-pounds) (0 to 135.6 N·m)	
WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893	
Torque wrench (0 to 50 inch pounds range)	
WJE ALL	

3. **Removal/Installation Battery Charger**

   A. Remove Battery Charger

   (1) Place BATT switch in OFF position.

   WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

   (2) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
		B1-146	BATTERY CHARGER PHASE A, B, & C

(3) Disconnect battery connectors from both batteries.

(4) Loosen clamps and remove vent hoses from battery vents.

(5) Open battery holddown clamps and remove both batteries from battery tray.

(6) Remove cable clamps routing No. 4 gage wire to charger.

CAUTION: BE CERTAIN THAT THERE IS NO AC POWER ON CHARGER INPUT TERMINALS.

(7) Remove screws securing battery charger.

(8) Slide charger aft and rotate to expose terminal block cover. (Figure 201)

(9) Remove charger terminal block cover, disconnect and tag wires.

(10) Remove charger.

(11) Check resistance of battery temperature sensor (two sensors on some aircraft).(Figure 202)

(12) If sensor is defective, perform the following:

(a) Cut wires from defective temperature sensor at temperature sensor end.

(b) Attach wiring from defective temperature sensor to wiring to new temperature sensor.

(c) Carefully pull wiring through tubing.

(d) Once wiring to new temperature sensor is through tubing, disconnect the old wiring and connect new temperature sensor wiring to battery charger terminal strip.

B. Install Battery Charger

(1) Make sure that these circuit breakers are open and have safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
		B1-146	BATTERY CHARGER PHASE A, B, & C

(2) Position charger with one corner resting on battery tray. Connect wiring to charger terminals. (Figure 201)

WJE 420, 422, 424-427, 429, 868, 884, 891

(3) Torque terminals per decal on battery charger and check that all lockwashers are compressed.

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

(4) Torque temperature sensor terminals (#6) to 10 to 12 inch-pounds (1.13-1.36 N·m); torque 3Ø AC terminals (#10) to 22 to 26 inch-pounds (2.47-2.94 N·m); and torque DC terminals (1/4 inch (6.4 mm)) to 44-48 inch-pounds (4.97-5.42 N·m). Check that all lockwashers are compressed.

WJE ALL

(5) Install terminal block cover.

CAUTION: BE CERTAIN THAT WIRES ARE CONNECTED IN MANNER THAT WILL PREVENT CHAFING OR PRELOADING, WHEN CHARGER IS INSTALLED.

(6) Rotate charger to mounting position and slide forward to engage mounting clips.

(7) Secure charger with screws and washers.

NOTE: Charger base must be electrically bonded to the support structure at the two screw attachments.

(8) Install wiring clamps.

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

CAUTION: DO NOT INSTALL BATTERY CHARGER COVER ON URDC BATTERY CHARGER.

(9) Set temperature sensor selector switch to SINGLE position if only one battery temperature sensor is connected. Set temperature sensor selector switch to DUAL position if two battery temperature sensors are connected. Use temperature sensor selector tool to change switch position.

WJE 420, 422, 424-427, 429, 868, 884, 891

(10) Install battery charger cover and tighten camlocks.

WJE ALL

(11) Position both batteries on battery tray.

(12) Check that left battery case (both battery cases on some aircraft) makes clean, physical contact with battery temperature sensor.

(13) Install battery vent hoses and tighten hose clamps.

(14) Secure both batteries with holddown clamps.

(15) Connect and handtighten battery electrical connectors.

(16) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

LEFT CONSOLE, GROUND SERVICE BUS

Row	Col	Number	Name
		B1-146	BATTERY CHARGER PHASE A, B, & C

NOTE: Reset the electronic clocks whenever the batteries/charger are removed/reinstalled, which results in loss of power from the electronic clocks.

(17) Perform System Test.

4. System Test Battery Charger

A. Test Battery Charger

(1) Place EXT PWR switch to ON position; GROUND SERVICE BUS light should come ON.

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

(2) Place BATT switch to ON position. Utah Research and Development Co. (URDC) battery charger should commence to operate.

WJE 420, 422, 424-427, 429, 868, 884, 891

(3) Place BATT switch to ON position. Battery charger should commence to operate.

WJE ALL

(4) Place EMER PWR switch in ON position for approximately 10 seconds, then place switch to OFF position. Battery charger should immediately turn full on for approximately 5 seconds then go into pulse mode of operation. Ascertain that pulse interval reaches 1 second or more between pulses.

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893

(5) Place DC BUS VOLT switch to BATT AMP position; charger output current should indicate to left of zero, at approximately 45 amperes immediately after charger commences operation.

NOTE: Severely discharged batteries may cause current limit action.

WJE 420, 422, 424-427, 429, 868, 884, 891

(6) Place DC BUS VOLT switch to BATT AMP position; charger output current should indicate to the left of zero, at approximately 65 amperes immediately after charger commences operation, gradually reducing current with respect to time to approximately 40 amperes.

NOTE: Severely discharged batteries may cause current limit action. If this does occur, oscillation of the needle will be observed for a short time before charger current becomes stable at the approximate 65 amperes point.

WJE ALL

(7) Place DC BUS VOLT switch to BATT VOLT position during period of steady charging mode; voltage indication should read between 30 and 33 volts.

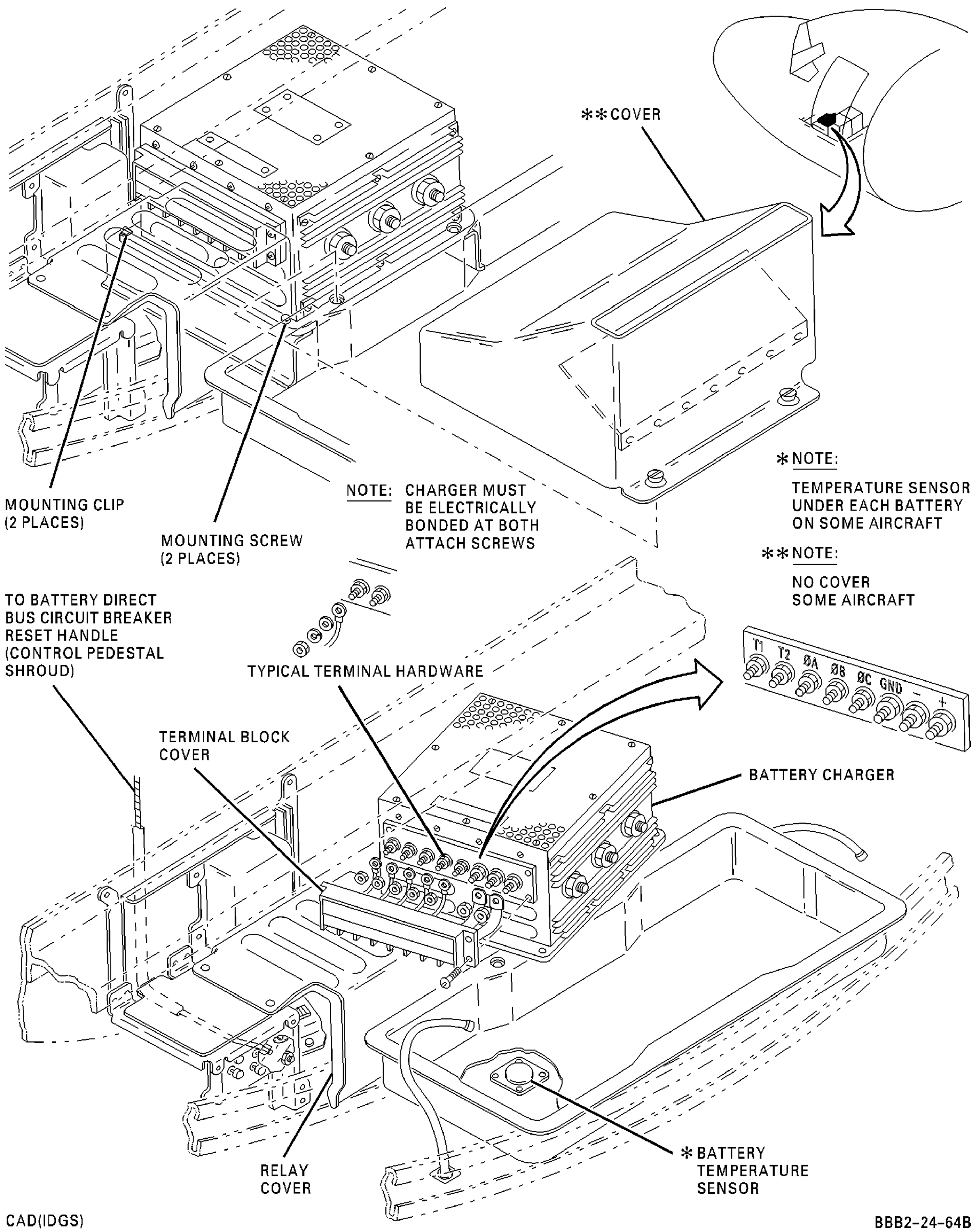
(8) Place DC BUS VOLT switch to BATT AMP. At time as determined by battery state-of-charge and battery temperature, charger will commence to pulse. Current indication during pulse should be to left of zero at approximately 40 amperes. Between pulses, indication should be zero. Pulse interval will vary in time, getting farther apart as battery becomes charged.

(9) Place EMER PWR switch to ON position. Current indication should read battery discharge between 10 and 25 amperes to the right side of zero.

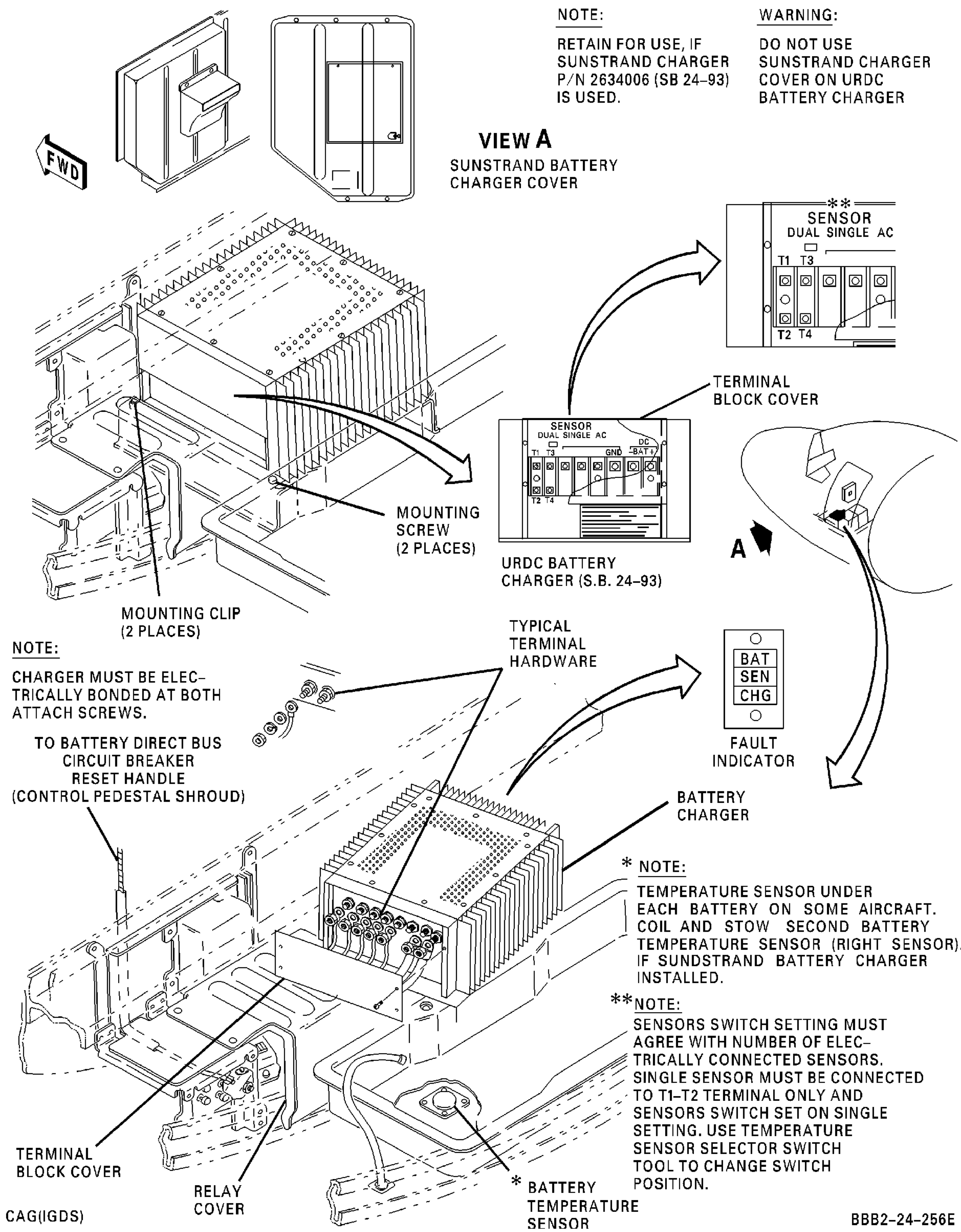
NOTE: Sufficient dc load equipment must be operational on the EMERGENCY DC BUS, BATTERY BUS, and the BATT DIRECT BUS to provide adequate battery discharge.

(10) Place EMER PWR switch in ON position for approximately 10 seconds, then place switch to OFF position. Battery charger should immediately turn full on for approximately 5 seconds then go into pulse mode of operation. Ascertain that the pulse interval reaches 1 second or more between pulses.

(11) Place BATT switch to OFF position. Current indication should be zero.

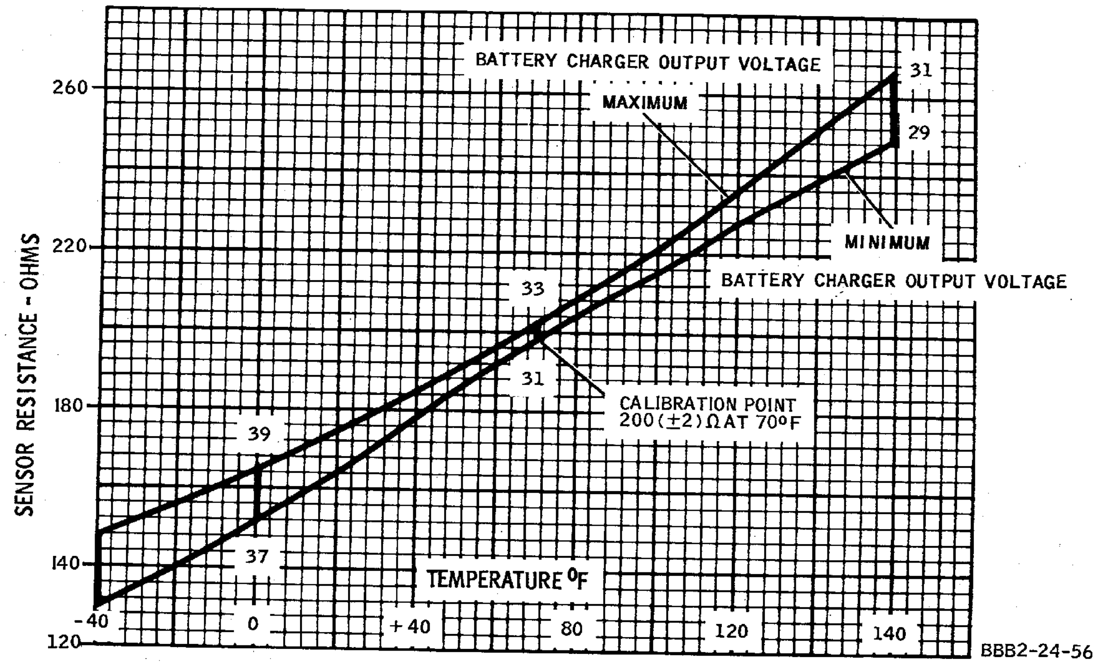


Battery Charger -- Removal/Installation
Figure 201/24-30-02-990-803 (Sheet 1 of 2)



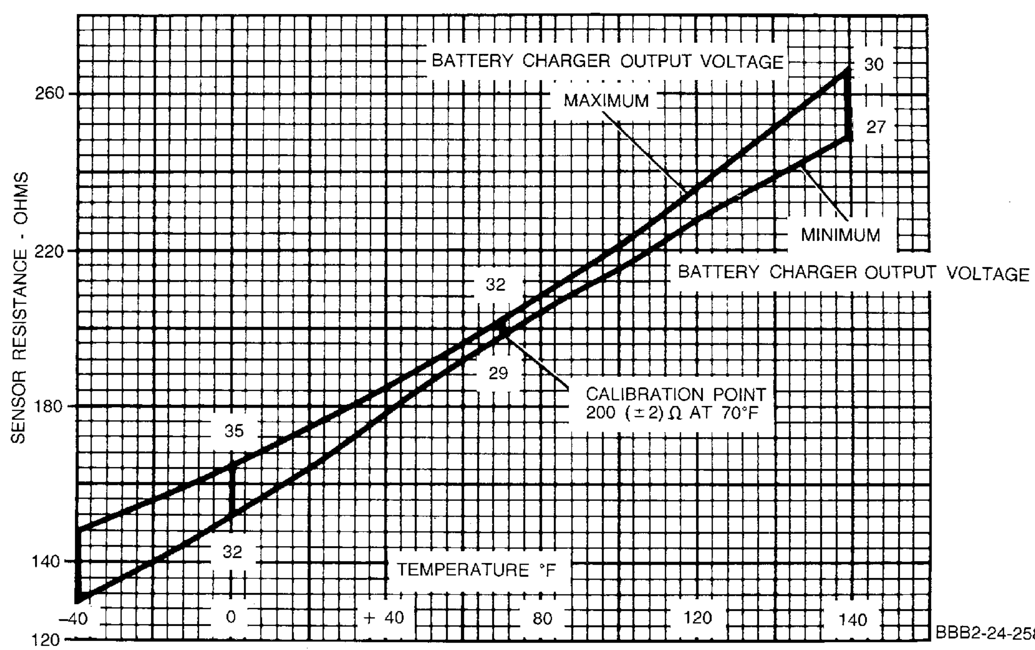
Battery Charger -- Removal/Installation
Figure 201/24-30-02-990-803 (Sheet 2 of 2)

WJE 420, 422, 424-427, 429, 868, 884, 891



Battery Charger Temperature Sensor -- Chart
Figure 202/24-30-02-990-804 (Sheet 1 of 2)

WJE 401-412, 414-419, 421, 423, 861-866, 869, 871-881, 883, 886, 887, 892, 893



Battery Charger Temperature Sensor -- Chart
Figure 202/24-30-02-990-804 (Sheet 2 of 2)

BATTERY DIRECT BUS CIRCUIT BREAKER RESET - MAINTENANCE PRACTICES

1. General

A. The battery direct bus circuit breaker can be manually reset from the flight compartment if the breaker has tripped due to temporary overload. A hinged door-type lever on the pedestal lower shroud is cable connected to the circuit breaker actuator in the E/E compartment. The cable guide is preformed 1/4-inch corrosion-resistant tubing, electrically insulated at the circuit breaker area. The cable is prefabricated, with two swaged-ball cable terminals at a distance of 64 3/8 inches (1.635 m) between centers. The actuator arm is spring-loaded in a manner to permit the circuit breaker to trip open on overload. (Figure 201)

2. Removal/Installation

A. Remove Tubing or Cable

(1) On overhead panel, place BATT switch in OFF position.

(2) Disconnect battery positive (+) connector from left battery.

(3) To remove cable, disconnect ball cable terminals from reset lever and actuator; pull cable through tube.

(4) To remove guide tubing, remove cover to expose lower clamps; remove clamps and seal under flight compartment floor.

B. Install Tubing or Cable

(1) Check that BATT switch is in OFF position.

(2) Check that battery positive (+) connector is disconnected from battery.

CAUTION: TUBING MUST NOT CONTAIN SHARP BENDS, DENTS, OR FLAT SPOTS THAT WILL PREVENT CABLE INSTALLATION OR PROPER OPERATION.

(3) To install guide tubing, install clamps and the seal under floor (Figure 201)

(4) To install cable, pull cable through tubing; connect ball terminals through slot in lever and actuator; safety with small screw, washer and locknut. (Figure 201) (Figure 202)

(5) When installing lower end of cable, position end of tubing in clamps so as to eliminate any slack in cable when actuator is in relaxed position. Perform adjustment/test.

3. Adjustment/Test

A. Adjust Actuator

(1) Adjust actuator striker to 0.080 - 0.125 inches (2.032 - 3.175 mm) from circuit breaker, in tripped (open) position.

NOTE: Under adverse tolerance conditions this dimension can vary if following conditions are met. Circuit breaker must be resettable from flight compartment. Circuit breaker striker must not restrict tripping of circuit breaker.

WARNING: INADEQUATE CLEARANCE BETWEEN DC TRANSFER BUS FEED CIRCUIT BREAKER WIRE TERMINAL AND BATTERY DIRECT BUS CIRCUIT BREAKER RESET CABLE CONDUIT MAY RESULT IN ARCING AND SHORT CIRCUIT OF BREAKER.

(2) Check clearance between circuit breaker wire terminal lug and cable conduit.

(a) If clearance is 0.062 inch (1.57 mm) or greater, proceed to Paragraph 3.A.(3).

(b) If clearance is less than 0.062 inch (1.57 mm), rotate wire terminal lug of circuit breaker downward until minimum clearance of 0.062 inch (1.57 mm) is achieved. If not, proceed to Paragraph 3.A.(2)(c).

(c) Remove straight terminal lug from wire and replace with flag lug terminal installed with lug barrel down and forward. This should produce clearance of 0.062 inch (1.57 mm) or greater.

(3) Connect battery connector to battery; handtighten.

B. Test Circuit Breaker Reset

(1) Open the electrical/electronics (E/E) compartment access door to gain access to the battery direct bus circuit breaker.

(2) Open this circuit breaker:

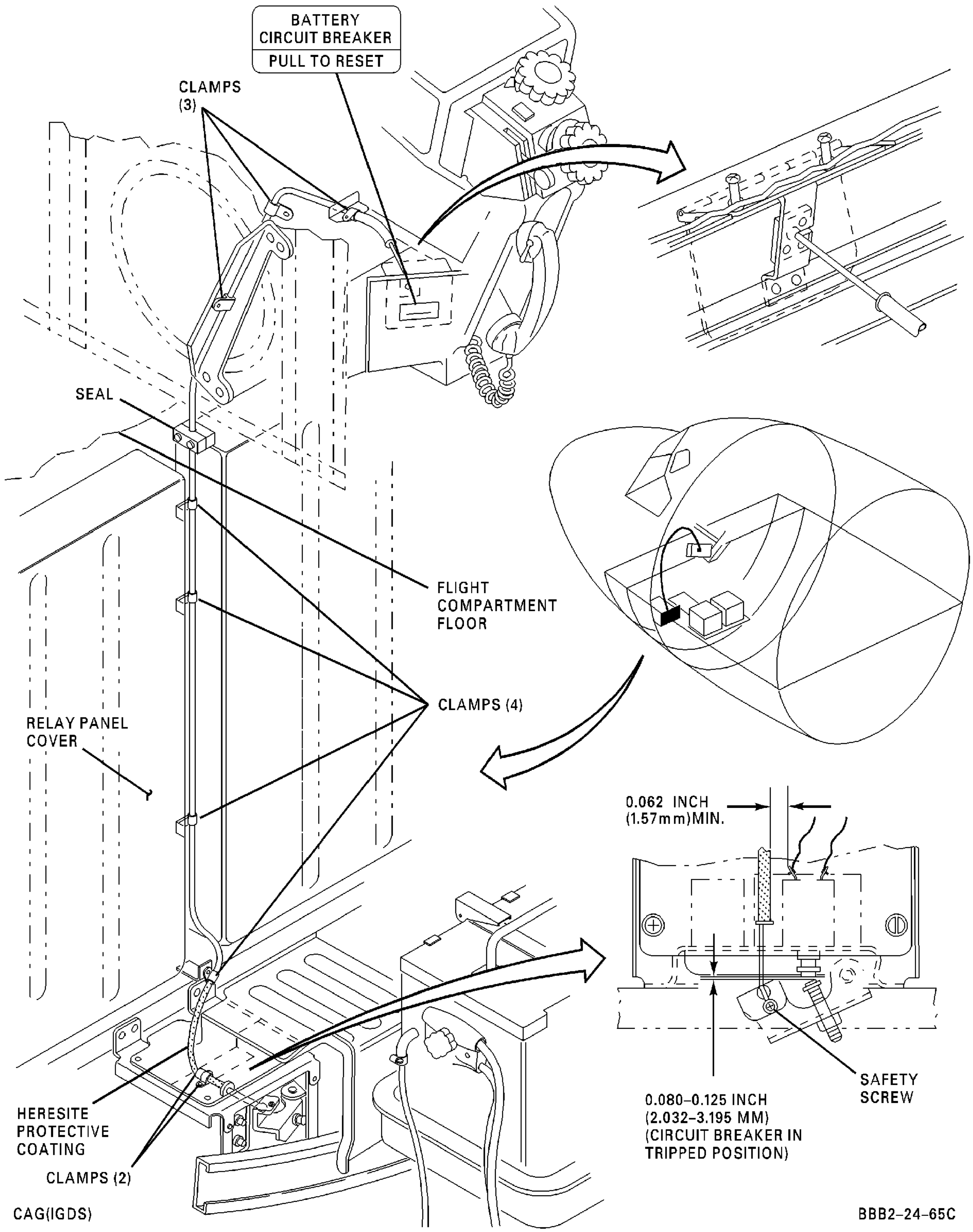
EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

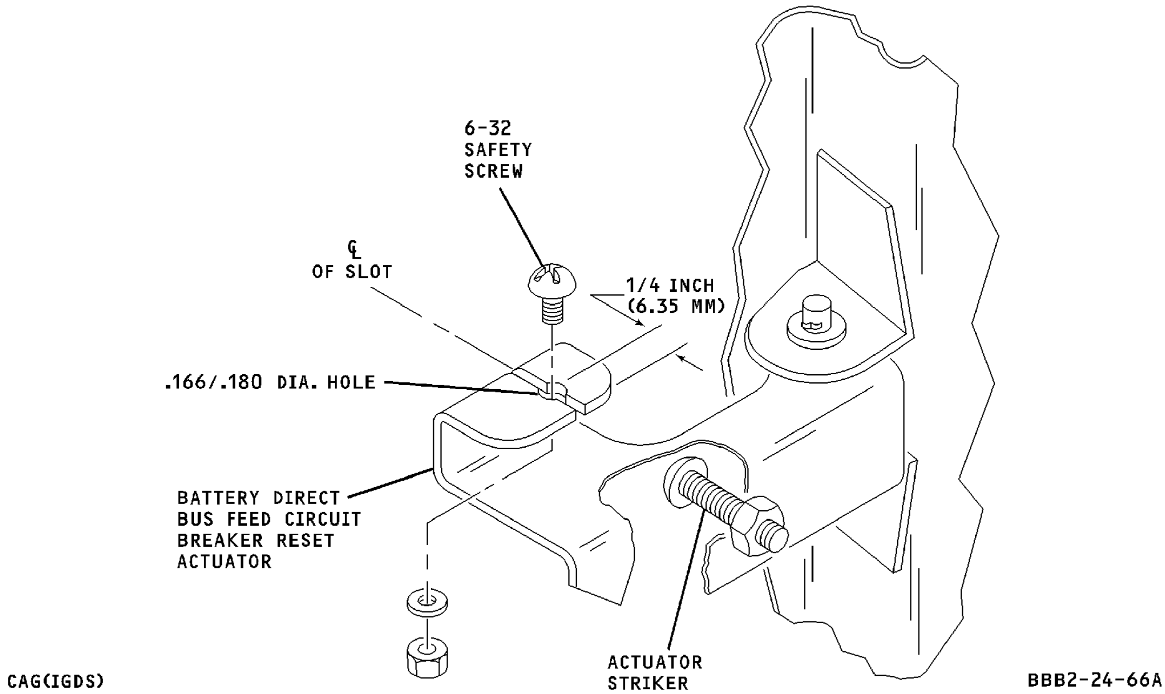
(3) Pull battery direct bus circuit breaker reset lever, installed in the flight compartment on pedestal lower shroud.

(4) Check that the battery direct bus circuit breaker, located in E/E compartment, is fully closed.

(5) Close E/E compartment access door.



Battery Direct Bus Circuit Breaker Reset
Figure 201/24-30-03-990-801



Method of Installing Actuator Cable Safety
Figure 202/24-30-03-990-802

BATTERY DIRECT BUS CIRCUIT BREAKER RESET - ADJUSTMENT/TEST

1. General

A. This procedure contains MSG-3 task card data.

TASK 24-30-03-710-801

2. Operational Check of the Battery Direct Bus Circuit Breaker Reset

NOTE: This procedure is a scheduled maintenance task.

A. General

(1) The battery direct bus circuit breaker (CB) is the mechanical remote 80 amp CB noted in the MRB.

B. Prepare for the Operational Check of the Battery Direct Bus Circuit Breaker Reset

SUBTASK 24-30-03-010-001

(1) Open the electrical/electronics (E/E) compartment access door to gain access to the battery direct bus circuit breaker.

C. Operational Check of the Battery Direct Bus Circuit Breaker Reset

SUBTASK 24-30-03-710-001

(1) Do an operational check of the battery direct bus circuit breaker reset.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(a) Open this circuit breaker:

EE COMPARTMENT

Row	Col	Number	Name
		B1-419	BATTERY DIRECT BUS FEED

(b) Pull battery direct bus circuit breaker reset lever, installed in the flight compartment on pedestal lower shroud.

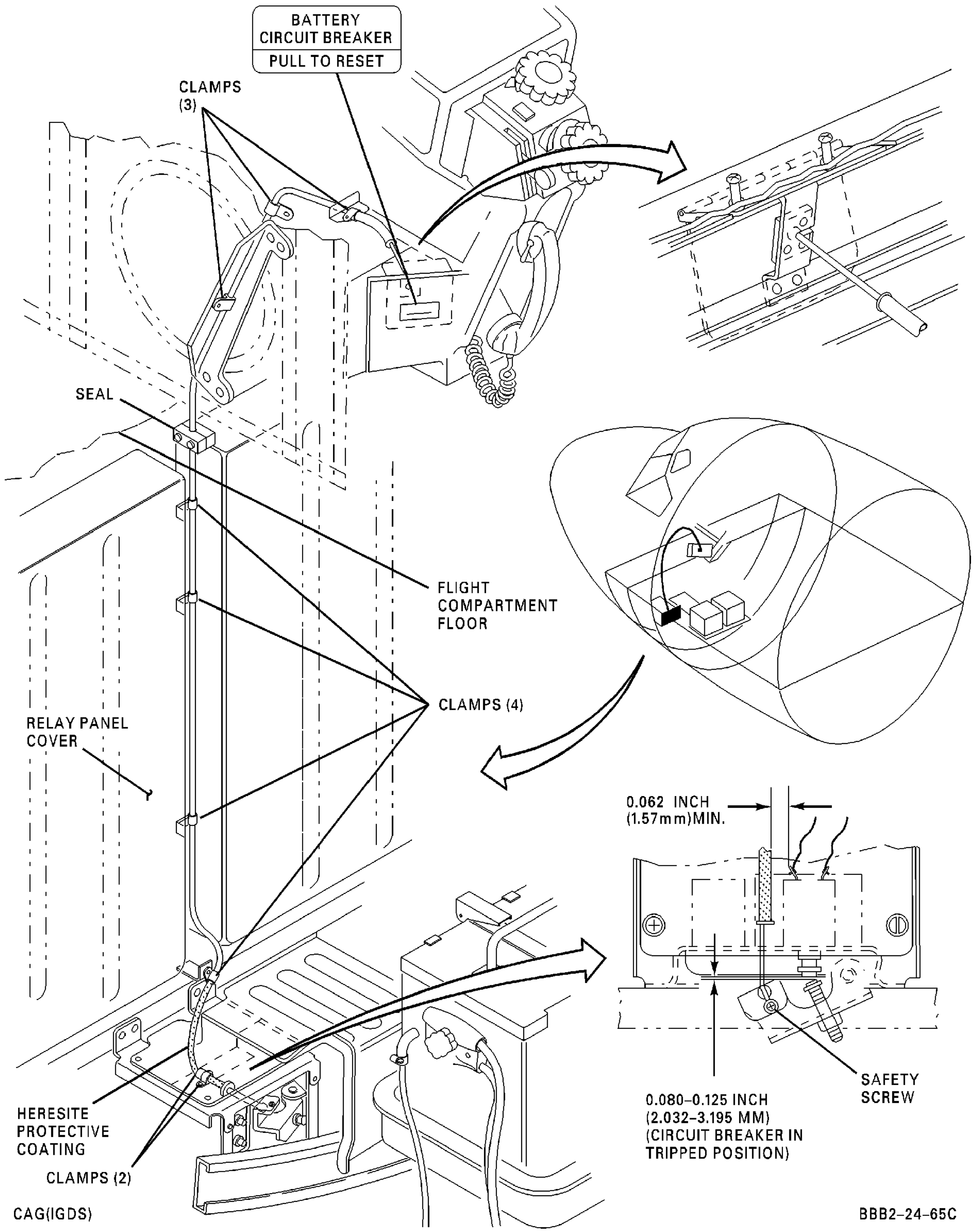
(c) Check that the battery direct bus circuit breaker, located in E/E compartment, is fully closed.

D. Job Close-up

SUBTASK 24-30-03-410-001

(1) Close E/E compartment access door.

END OF TASK



BATTERY DIRECT BUS CIRCUIT BREAKER RESET
Figure 501/24-30-03-990-803

EXTERNAL POWER - DESCRIPTION AND OPERATION

1. General

A. External power electrical circuits are incorporated in the aircraft to enable connection of a 115/200-volt, 3-phase, 400 hertz external power source to supply power to the ac load buses during ground operations when the engine-driven generators or the APU generator are not operating. Through the use of control switches and relays, external power can be selected to supply power to the left ac buses, right ac buses, the ground service bus, or to all ac load buses simultaneously. Interlocking circuits prevent external ac power from being supplied to any bus receiving power from a generator.

B. The external power supply receptacle and the external power control panel are installed behind an access door on the left side of the fuselage nose section exterior, between stations 95 and 100. The receptacle is installed slanting slightly forward to minimize the possibility of damage to the aircraft or equipment in the event that pulling the external power supply cord was overlooked before taking the power cart away from the aircraft. The external power receptacle is a six-prong male receptacle, having four large prongs and two smaller prongs. Three of the large prongs, identified A, B, and C, are used for power feed-through of the corresponding phases from the external power source to the wiring of the aircraft. The fourth large prong, identified as N, is used for a ground connection between the structure of the aircraft and the external power source. the two small prongs, E and F, are used in a portion of the external power control circuitry installed in the aircraft. (Figure 1)

C. The external power control panel is located directly above the receptacle.

D. Control

WJE 405, 407-409, 411, 880, 884, 892, 893

(1) Supply of external power to the ac load buses is controlled by a portion of the ac bus control unit, switches located on the flight compartment overhead switch panel, and sensing relays installed in the electrical power center. A phase sequence sensing circuit and a transformer-rectifier inside the ac bus control panel are used for controlling and applying external power to the electrical circuitry of the aircraft. The phase sequence circuit senses the phase rotation of two phases and will actuate only if the rotation is correct; i.e., A-B-C. The external power transformer-rectifier converts the 3-phase 115-volt ac to 28-volt dc. This output voltage then passes through the phase sequence circuit and is utilized as the power source for energizing the coils of the external power control relays, through the external power bus switches. Transformer-rectifier output is also utilized for the external power available lights; for the external power in-use lights; to energize the close coils of the left-and right-external power relays; and to energize the coil of the ground service external power relay. (Figure 2)

WJE 401-404, 406, 410, 412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891

(2) Supply of external power to the ac load buses is controlled by a portion of the ac bus control unit, switches located on the flight compartment overhead switch panel, an external power monitor installed in the generator control rack, and sensing relays installed in the electrical power center. A phase sequence sensing circuit and a EPTR inside the ac bus control panel are used for controlling and applying external power to the electrical circuitry of the aircraft. Both units receive 3-phase power from the external power source. The phase sequence circuit senses the phase rotation of the two phases and will actuate only if the rotation is correct; i.e., A-B-C. The external power transformer-rectifier converts the 115-volt ac to 28-volt dc. The external power monitor also receives 3-phase power input, and will actuate to close a set of contacts if voltage and frequency of the external power unit is within normal operating limits. This output voltage then passes through the phase sequence circuit and is utilized as the power source for energizing the coils of the external power control relays, through the external power bus switches. EPTR output is also utilized for the external power available lights; for the external power in-use lights; to energize the close coils of the left-and right-external power relays; and to energize the coil of the ground service external power relay. (Figure 2)

WJE ALL

E. The external power control panel is located directly above the receptacle. Installed on this panel are three 150-ampere circuit breakers (EXTERNAL POWER) øA, øB, øC, one for each phase of the incoming external power; one 1-ampere circuit breaker (IND) used in the voltmeter, frequency meter, and external power not-in-use light circuit; two 5-ampere circuit breakers used in control and indicating light circuits; EXT PWR NOT-IN-USE light; EXT PWR AVAIL light; interphone jacks (FLIGHT INPH SERVICE INPH); a push-button (PILOTS CALL) switch; and a two-position toggle switch to control the wheelwell lights.

F. Distribution

WJE 401-404, 406, 410, 412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891

(1) Distribution of external power to the ac load buses is controlled by switches on the overhead switch panel and power relays installed in the electrical power center. With only external power being supplied to the aircraft, placing the EXT PWR L BUS and EXT PWR R BUS, located on the electrical power section of the overhead switch panel, in the ON position will energize the close coil of the corresponding external power relay and supply external power to the applicable bus. Power for ground servicing only may be obtained by placing the EXT PWR switch on the GROUND SERVICE ELECT PWR panel in the ON position and the APU PWR switch in the OFF position. The two switch circuits are interlocked to prevent applying both sources of power simultaneously to the ground service bus. The ground service external power relay will energize and supply ac external power to the ground service bus only.

WJE 405, 407-411, 880, 884, 892, 893

(2) Distribution of external power to the ac load buses is controlled by switches on the overhead switch panel and power relays installed in the electrical power center. With only external power being supplied to the aircraft and all circuit protection properly established, placing the EXT PWR L BUS and EXT PWR R BUS, located on the electrical power section of the overhead switch panel, in the ON position will energize the close coil of the corresponding external power relay and supply external power to the applicable bus. Power for ground servicing only may be obtained by placing the EXT PWR switch on the GROUND SERVICE ELECT PWR panel in the ON position and the APU PWR switch in the OFF position. The two switch circuits are interlocked to prevent applying both sources of power simultaneously to the ground service bus. The ground service external power relay will energize and supply ac external power to the ground service bus only.

WJE ALL

G. Indication

(1) Power for voltage and frequency indicator readings of the external power is taken from phase A at the receptacle. With the indicator selector switch in the EXT PWR position the AC VOLTS meter should indicate 115(±3) volts and the FREQUENCY CPS meter should indicate 400(±4) hertz.

(2) Indicating lights are installed to give a visual indication of external power usage on the aircraft. Power for the press-to-test feature of these lights is taken from the DC TRANSFER BUS. Three external power available lights will be on whenever an ac external power source, with the proper phase sequence, is connected to the aircraft. One external power available light is installed on each of the following panels: External Power Control Panel, Ground Service Electrical Power Panel, and Electrical Power Panel.

(3) One white EXT PWR NOT-IN-USE light, installed on the External Power Control Panel, will be on whenever ac external power is connected to the aircraft but is not supplying power to any ac load bus. If the external power is supplying power to any bus, the light will be off. The external power supply plug should not be removed when light is off unless the external power source supply has been shut off.

(4) Three blue lights are installed to indicate the buses to which external power is being supplied. Two of these lights, the left external power in-use light (EXT PWR L BUS) and the right external power in-use light (EXT PWR R BUS), are installed on the electrical power section of the overhead switch panel. A third light, the ground service external power in-use light (EXT PWR) is installed on the ground service electrical power panel. These lights will be on whenever external power is being supplied to the corresponding ac load bus.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

(5) The electronic overhead annunciator panel (EOAP) contains dedicated annunciators on the right part of the unit and dual display screens in the center and left parts. The dedicated annunciator lights come on to indicate specific warnings. The display screens are capable of displaying and storing many different caution messages. The electrical power system messages are accessed by pressing the ELECT bottom below the display screens.

(a) The electronic overhead annunciator panel (EOAP) provides the following electrical power system (yellow) caution messages:

1) L AC BUS OFF - indicates the left ac bus is not energized when displayed.

2) R AC BUS OFF - indicates the right ac bus is not energized when displayed.

3) L GEN OFF - indicates the left engine generator is not supplying power when displayed.

4) R GEN OFF - indicates the right engine generator is not supplying power when displayed.

5) DC BUS OFF - indicates either the right or left (or both) dc bus is not energized when displayed.

6) DC TRANSFER BUS OFF - indicates the dc transfer bus is not energized when displayed.

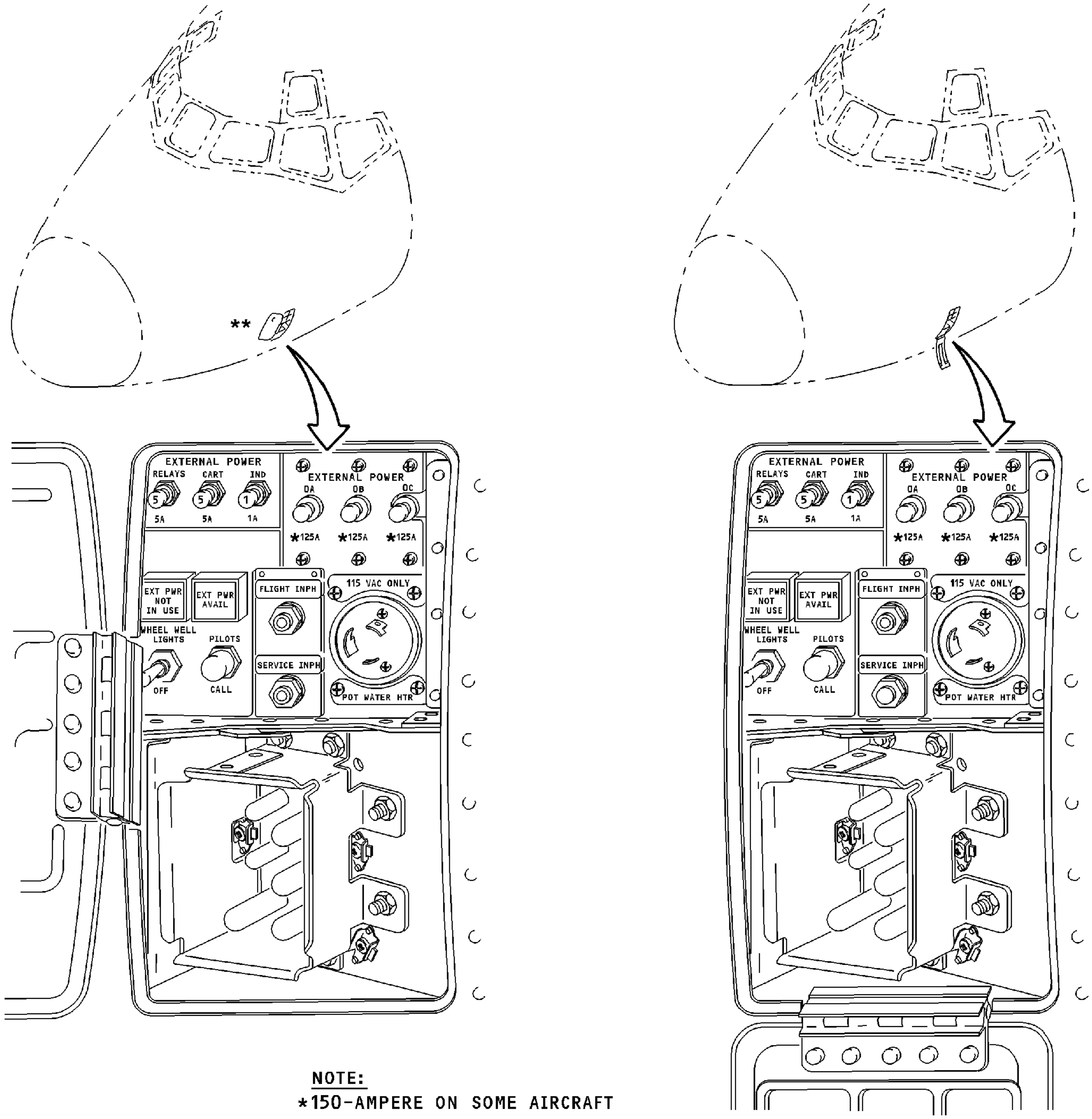
(b) The electronic overhead annunciator panel (EOAP) provides two dedicated electrical power system (red) warning annunciators:

1) AC EMER BUS OFF - indicates the ac emergency bus is not energized when displayed.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887 (Continued)

2) DC EMER BUS OFF - indicates the dc emergency bus is not energized when displayed.

WJE ALL

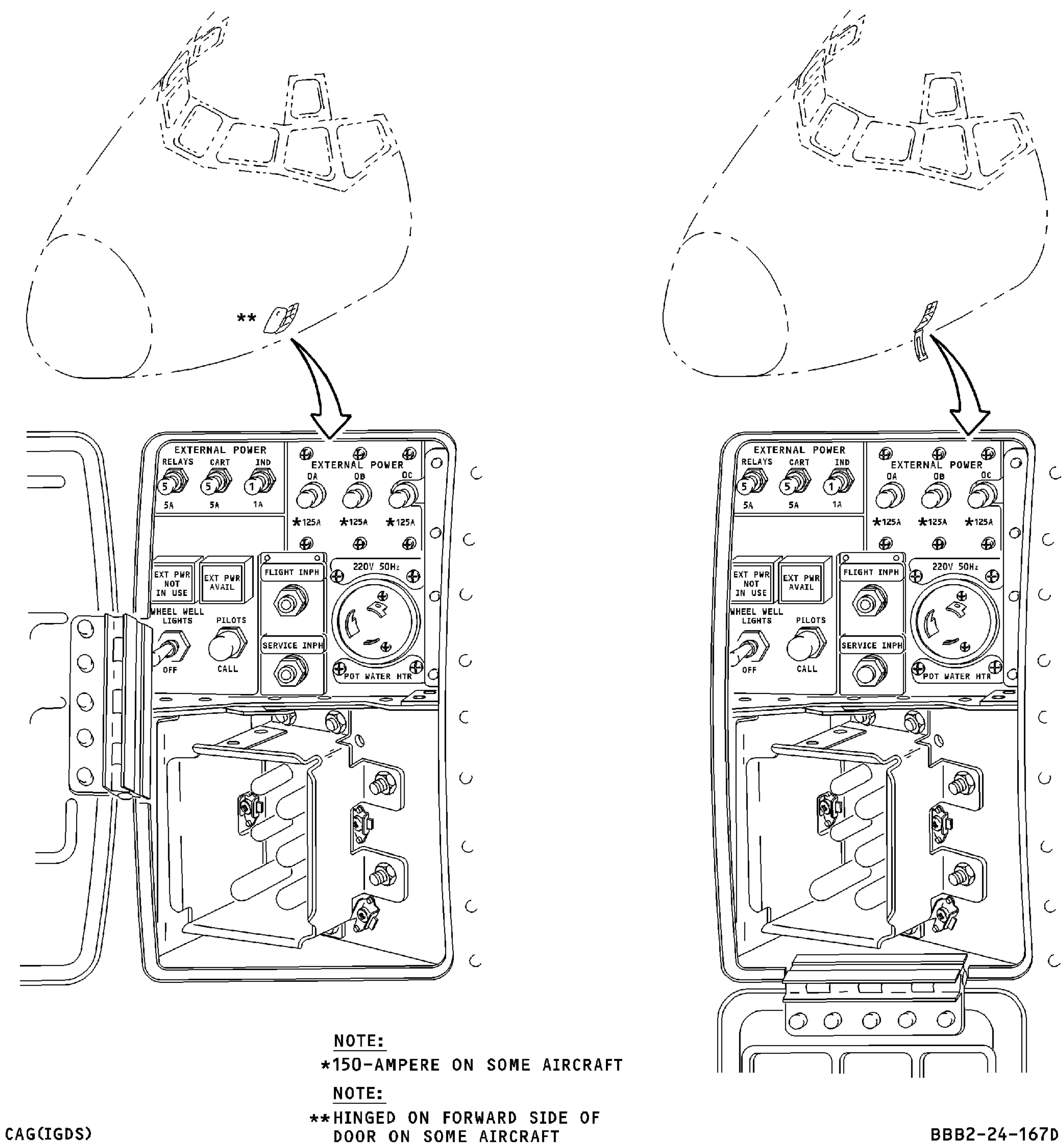


NOTE:
*150-AMPERE ON SOME AIRCRAFT

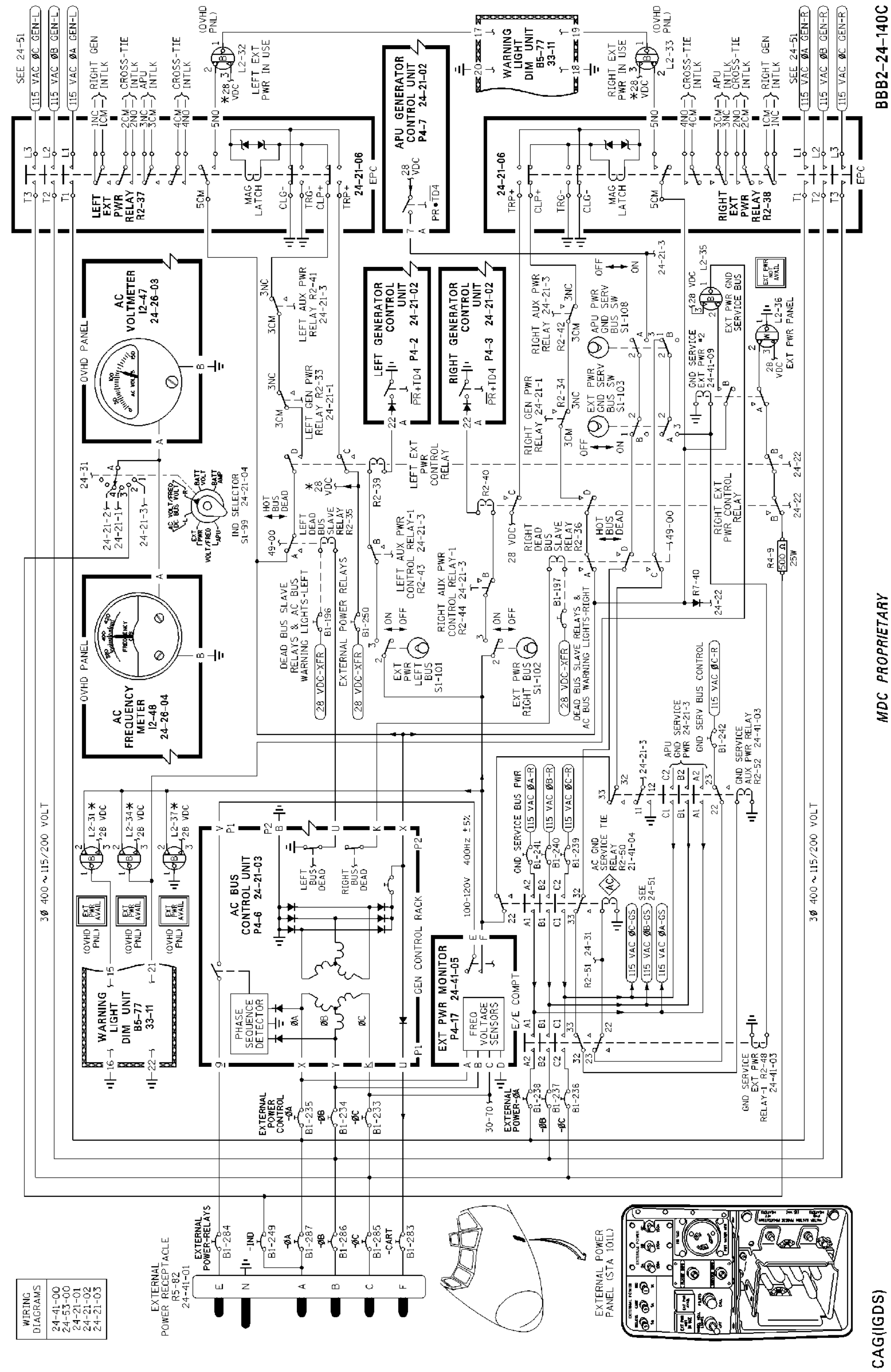
NOTE:
**HINGED ON FORWARD SIDE OF DOOR ON SOME AIRCRAFT

CAG(IGDS) BBB2-24-67E

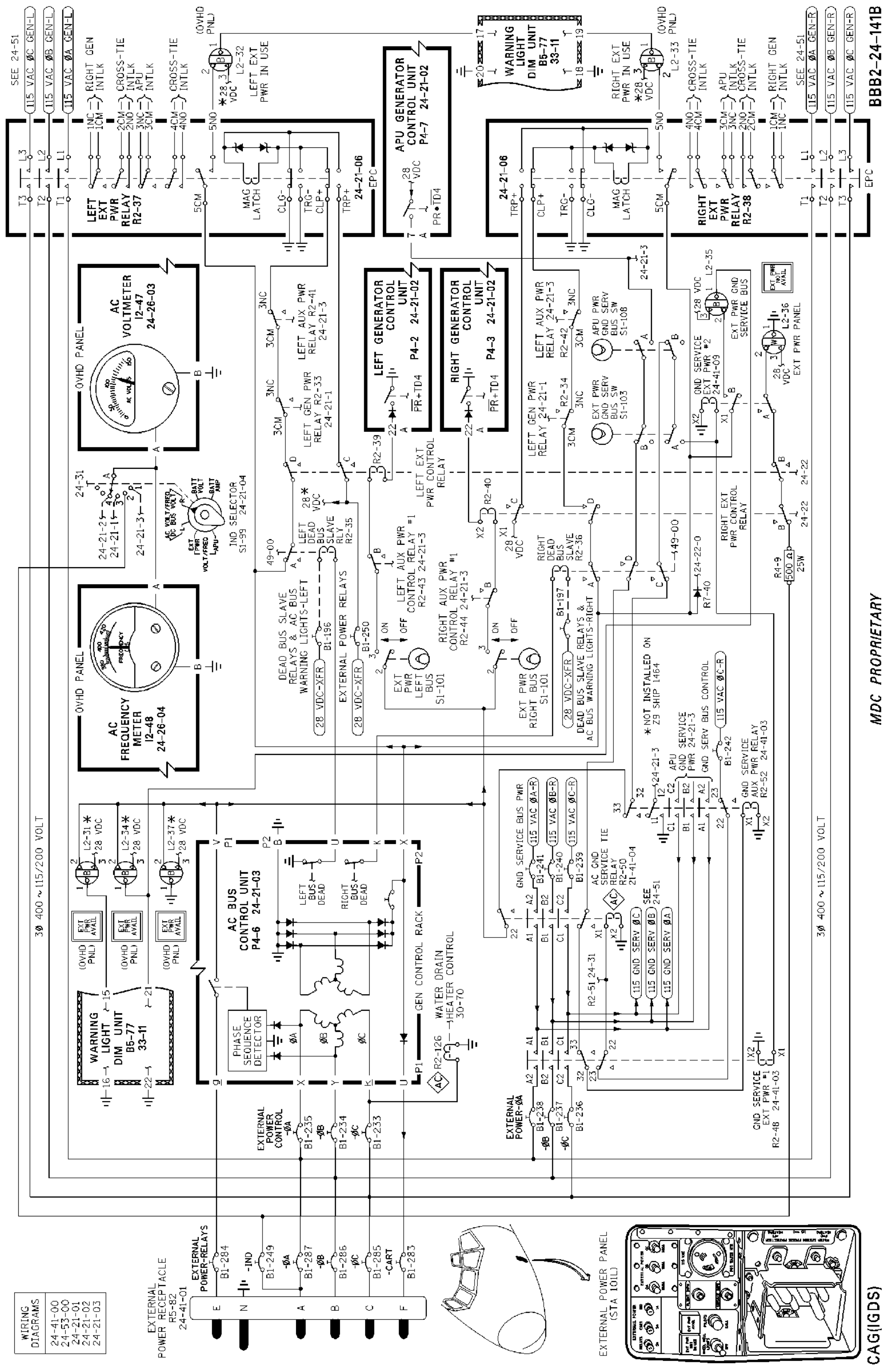
External Power Receptacle and Control Panel
Figure 1/24-40-00-990-801 (Sheet 1 of 2)



External Power Receptacle and Control Panel
Figure 1/24-40-00-990-801 (Sheet 2 of 2)



External Power Control and Indication -- Schematic
Figure 2/24-40-00-990-802 (Sheet 1 of 2)



External Power Control and Indication -- Schematic
Figure 2/24-40-00-990-802 (Sheet 2 of 2)

2. Operation

A. When an external power source is connected and supplying 115- volt, 3-phase ac power to the aircraft, external power indications are given on the overhead panel and on the external power ground control panel. From phase A at the external power receptacle, power is applied to the indicator selector switch on the overhead switch panel. With the indicator selector switch in the EXT PWR position, voltage and frequency readings can be observed on the applicable indicator at all times that external power source is operating and connected to the aircraft. Power for the EXT PWR NOT-IN-USE light, taken from the same point as for the indicators, passes through a 500-ohm resistor, the normally closed contacts of the de-energized Right External Power Control Relay (REPCR), Left External Power Control Relay (LEPCR), and the Ground Service External Power Relay No. 2 (GSEPR No. 2) to the light. The light will come on and remain on until one of these relays is energized, breaking the circuit to the light. When the EXT PWR NOT-IN-USE light goes off, it indicates to the electrician on the ground that external power is being used to supply power to an ac load bus.

WJE 406, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-879, 881, 883, 891

B. Incoming 3-phase power is applied to the External Power Phase Sequence circuit (EPPSC) the External Power Monitor (EPM), and to the external power transformer-rectifier within the ac bus control unit. When the phase sequence EPTR circuit senses that the three phases of the external power are A-B-C, the relay will close. When the external power monitor senses the voltage and frequency of the external power supply are within normal operating limits, a contact of the external power monitor will close. If the external power supply unit should develop an overvoltage, overfrequency, underfrequency, or undervoltage (excluding transients) condition the external power monitor contacts will open. The EPTR converts the 115-volt ac input power to 28-volt dc which is used to supply power to two control circuits. The first circuit to be discussed supplies power to pin F of the external power receptacle. When the external power is connected to the aircraft, 28-volt EPTR power is applied from pin F to pin E through a jumper in the external power supply plug. If the supply plug does not contain a jumper, 28 volts dc must be supplied to pin E from the external power source supply unit. From pin E power is supplied through the energized phase sequence circuit to the three external power available lights, which indicate that external power is ready for use; to the external power left and right bus switches, and to the external power ground service switch. Since the external power on-off control circuits for the left and right buses are similar, energizing only the left bus will be discussed. Ground service operation is discussed later in this section.

WJE 405, 407-411, 884, 892, 893

C. Incoming 3-phase power is applied to the External Power Phase Sequence circuit (EPPSC) and to the external power transformer-rectifier within the ac bus control unit. The phase sequence circuit sense phase A and B to verify that the three phases of the external power are A-B-C. The external power transformer-rectifier (EPTR) converts the 115-volt ac input power to 28-volt dc which is used to supply power to two control circuits. The first circuit to be discussed supplies power to pin F of the external power receptacle. When the external power is connected to the aircraft, 28-volt EPTR power is applied from pin F to pin E through a jumper in the external power supply plug. If the supply plug does not contain a jumper, 28 volts dc must be supplied to pin E from the external power source supply unit. From pin E power is supplied through the energized phase sequence circuit to the three external power available lights, which indicate that external power is ready for use; to the external power left and right bus switches, and to the external power ground service switch. Since the external power on-off control circuits for the left and right buses are similar, energizing only the left bus will be discussed. Ground service operation is discussed later in this section.

WJE ALL

D. Placing the EXT PWR L BUS switch in the ON position will allow external power transformer-rectifier output voltage to be supplied to the coil of the left external power control relay, energizing the relay. The power side of the coil circuit is interlocked with the APU generation system through the Left Auxiliary Power Control Relay No. 1 (LAPCR No. 1). The ground return side of the coil is interlocked with the engine-driven generation system through the Left Power Ready Relay (LPRR), located in the left generator control unit. If either the APU generator or the engine-driven generator is supplying power to the left ac load buses, the external power control relay cannot be energized.

WJE 401-412, 414-427, 429, 861-866, 868, 869, 871, 872, 875-880, 884, 886, 887, 891-893

E. The second circuit from the external power transformer-rectifier supplies the power necessary for energizing the Left External Power Relay (LEPR), which will connect external power to the left ac bus and to the EXT PWR L BUS light which will come on when the left external power relay is energized. This circuit is not protected by the phase sequence circuit, since the left external power relay cannot be energized until the left external power control relay is energized. However, power to the relay is interlocked through the Left Dead Bus Slave Relay (LDBSR), Left generator Relay (LGR), and Left Auxiliary Power Relay (LAPR) to make sure external power cannot be connected to the left bus if the bus is being supplied power from either the engine-driven generator or the APU generator system.

WJE 873, 874, 881, 883

F. The second circuit from the EPTR supplies the power necessary for energizing the Left External Power Relay (LEPR), which will connect external power to the left ac bus and to the EXT PWR L BUS light which will come on when the left external power relay is energized. This circuit is not protected by the phase sequence circuit, since the left external power relay cannot be energized until the left external power control relay is energized. However, power to the relay is interlocked through the Left Dead Bus Slave Relay (LDBSR), Left generator Relay (LGR), and Left Auxiliary Power Relay (LAPR) to ensure that external power cannot be connected to the left bus if the bus is being supplied power from either the engine-driven generator or the APU generator system.

WJE ALL

G. External power for ground servicing purposes only is controlled by the external power ground service switch. With external power connected to the aircraft and the phase sequence circuit energized, the external power transformer-rectifier output voltage is supplied to the external power ground service switch through normally closed contacts of the de-energized Ac Ground Service Tie Relay (AGSTR), Ground Service Auxiliary Power Relay (GSAPR), and the Right Dead Bus Slave Relay (RDBSR). In addition to the relays interlocking contacts, EPTR power must also pass through the APU PWR switch when the switch is placed in OFF position. Each of these relays and the switch (in off position) is part of an interlocking system that prevents external power being supplied to the ground service bus at any time the bus is energized from another source. When the EXT PWR ground service is placed in the ON position, EPTR voltage energizes the Ground Service External Power Relays No. 1 and No. 2 (GSEPR No. 1 and GSEPR No. 2). TR voltage is supplied to the ground service EXT PWR in-use light, through the closed contacts of GSEPR No. 2, and the light will come on. Actuation of the Ground Service External Power Relay connects the external power to the ground service bus.

H. Automatic transfer of external power to engine-driven generator power supplied to the ac load buses is accomplished during engine start, by placing the generator control switch in the on position prior to start. As a generator reaches normal operating speed, the Power Ready Relay (PRR) will energize, opening the ground return circuit of the External Power Control Relay (EPCR) and de-energizing the relay. Normally closed contacts of the de-energized EPCR will apply power to the External Power Relay (EPR) trip coil, removing external power from the ac load bus and the corresponding EXT PWR in-use light will go off. The corresponding Dead Bus Circuit (DBC) sensing loss of ac bus power will de-energize. Twenty-eight-volt dc control power is supplied through a set of normally open contacts of the now energized generator PRR, the de-energized DBC, to the close coil of the applicable generator relay, the relay will close and put generator power on the corresponding bus. The corresponding generator off light will go off. The EXT PWR NOT-IN-USE light will come on only when the second generator comes on the corresponding bus.

I. In order to continue supplying power to the ac load buses during and immediately after engine shutdown, an operating external power source must be connected to the aircraft, and the EXT PWR L BUS and EXT PWR R BUS switches must be placed in the ON position. The EXT PWR AVAIL light and the EXT PWR NOT-IN-USE light will come on. At the time the engine is shut down, the generator relay will trip off the line; the Dead Bus Slave Relay, sensing that the bus is no longer powered from the generator, will de-energize. The generator off annunciator light will come on, the generator AC LOAD meter will drop to zero, and at some point during engine coast-down the CSD OIL light will come on. De-energizing the Power Ready Relay will complete the circuit necessary to energize the External Power Control Relay. Tripping the Generator Relay, de-energizing the Dead Bus Slave Relay, and energizing the External Power Control Relay will complete the circuit to energize the External Power Relay, thus powering the corresponding ac load bus from external power. The EXT PWR NOT-IN-USE light will go off and the applicable EXT PWR BUS light will come on. During the short period of time required for the system to transfer from engine-driven generator power to external power, the AC BUS OFF light will momentarily flash on and then off.

3. To Operate System

CAUTION: IF ALL LOAD BUSES ARE TO BE ENERGIZED, USE AN EXTERNAL ELECTRICAL POWER SUPPLY UNIT CAPABLE OF SUPPLYING NECESSARY AIRCRAFT POWER REQUIREMENTS (60 KVA OR MORE) WITHOUT OVERLOADING POWER UNIT. IF ALL LOAD BUSES ARE NOT TO BE ENERGIZED, POWER UNIT OF CORRESPONDING LOWER CAPACITY CAN BE USED.

CAUTION: IF AIRCRAFT HAS BEEN EXPOSED TO AN EXTERNAL POWER OVERVOLTAGE EXCEEDING 134 VAC, FOR ANY DURATION, DO A RETURN-TO-SERVICE TEST OF THE COMPONENTS IN TABLE 1 (IF INSTALLED) BEFORE AIRCRAFT IS RETURNED TO SERVICE.

A. Do a Return-to-Service (R-T-S) Test of the Following Components (If installed)

Table 1

COMPONENT	MAINTENANCE MANUAL REFERENCE
Digital Flight Guidance Computer	DIGITAL FLIGHT GUIDANCE COMPUTER, SUBJECT 22-01-01
3 Axis Accelerometers	DUAL 3-AXIS ACCELEROMETER, SUBJECT 22-19-01
Lateral Accelerometers	DUAL LATERAL ACCELEROMETER, SUBJECT 22-19-02
WJE 401-404, 407, 408, 410-412, 414, 875-879, 881, 883, 892	
High Frequency Receiver/Transmitters	HF TRANSCEIVER, SUBJECT 23-10-01

WJE 401-404, 407, 408, 410-412, 414, 875-879, 881, 883, 892 (Continued)

Table 1 (Continued)

COMPONENT	MAINTENANCE MANUAL REFERENCE
WJE ALL	
Very High Frequency Receiver/Transmitters	VHF COMMUNICATIONS TRANSCEIVER, SUBJECT 23-20-01
Cockpit Voice Recorder	MICROPHONE VOICE RECORDER MONITOR, SUBJECT 23-70-01
EPR Indicators	INSTRUMENTS - GENERAL, SUBJECT 31-00-01
Flight Data Acquisition Unit	DATA ACQUISITION SYSTEM, SUBJECT 31-31-02
Central Aural Warning Unit	CENTRAL AURAL WARNING UNIT, SUBJECT 31-51-02
WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
System Display Panel	ELECTRONIC SYSTEMS DISPLAY PANEL, SUBJECT 31-61-01
WJE ALL	
Altimeter (Electric)	ALTIMETER, SUBJECT 34-12-01
Mach Airspeed Indicator	MACH AIRSPEED INDICATOR, SUBJECT 34-13-01
WJE 405, 409, 416, 420, 422, 424-427, 429, 861, 862, 868, 874, 880, 881, 883, 884, 891-893	
Central Air Data Computer	CENTRAL AIR DATA COMPUTER, SUBJECT 34-16-01
Stall Warning Computer	COMPUTER STALL WARNING, SUBJECT 34-19-02
WJE 405, 409, 410, 415, 416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873, 874, 880, 881, 883, 884, 891-893	
Directional Gyro	DIRECTIONAL GYRO, SUBJECT 34-21-04
WJE 406-408, 411, 877	
Radio Magnetic Indicator	RADIO MAGNETIC INDICATOR, SUBJECT 34-21-05
WJE 405, 409, 410, 415, 416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873, 874, 880, 881, 883, 884, 891-893	
Compass Indicator	COMPASS INDICATOR, SUBJECT 34-21-07
WJE 406-408, 411, 886, 887	
Attitude Heading Reference Unit	ATTITUDE/HEADING REFERENCE UNIT, SUBJECT 34-21-10
WJE 401-404, 412, 414, 417, 419, 421, 423, 865, 869, 871, 872, 875-879, 886, 887	
Radio Distance Magnetic Indicator	RADIO DISTANCE MAGNETIC INDICATOR, SUBJECT 34-21-12
WJE 405, 409, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 891-893	
Horizontal Situation Indicator	HORIZONTAL SITUATION INDICATOR, SUBJECT 34-22-03
WJE 401-404, 406-408, 410-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
Navigation Display Unit	EFIS NAVIGATION DISPLAY UNIT, SUBJECT 34-22-06
Symbol Generator	EFIS SYMBOL GENERATOR, SUBJECT 34-22-10

WJE 401-404, 406-408, 410-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887 (Continued)

Table 1 (Continued)

COMPONENT	MAINTENANCE MANUAL REFERENCE
WJE 405, 409, 410, 415, 416, 418, 420, 422, 424-427, 429, 861-864, 866, 868, 873, 874, 880, 881, 883, 884, 891-893	
Vertical Gyro	VERTICAL GYRO, SUBJECT 34-23-01
WJE 405, 409, 416, 420, 422, 424-427, 429, 861, 862, 868, 874, 880, 881, 883, 884, 891-893	
Attitude Director Indicator	ATTITUDE DIRECTOR INDICATOR, SUBJECT 34-23-02
WJE 401-404, 406-408, 410-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
Primary Flight Display	PRIMARY FLIGHT DISPLAY (PFD), SUBJECT 34-23-06
WJE ALL	
Standby Horizon Indicator	STANDBY HORIZON INDICATOR, SUBJECT 34-28-01
Standby Horizon Static Inverter	STANDBY HORIZON STATIC INVERTER, SUBJECT 34-28-02
VOR/ILS Receiver	VOR/ILS RECEIVER, SUBJECT 34-32-02
VHF NAV Control Panel	VHF NAV CONTROL PANEL, SUBJECT 34-32-03
Radio Altimeter Transceiver	RADIO ALTIMETER TRANSCEIVER, SUBJECT 34-42-03
WJE 401-404, 412, 414, 417, 419, 421, 423, 865, 869, 871, 872, 875-879	
Inertial Reference Unit	INERTIAL REFERENCE UNIT, SUBJECT 34-43-01
WJE ALL	
Ground Proximity Warning Computer	ENHANCED GROUND PROXIMITY WARNING COMPUTER, SUBJECT 34-45-01
WJE 410, 412, 414, 875-879	
Traffic Collision Avoidance Computer	TCAS COMPUTER, SUBJECT 34-46-01
WJE 401-404, 406-412, 414, 417, 419, 421, 423, 864, 865, 869, 871-879, 884, 886, 887, 892, 893	
Windshear Computer	WINDSHEAR COMPUTER, SUBJECT 34-47-01
WJE ALL	
ADF Receiver	ADF RECEIVER, SUBJECT 34-53-05
WJE 405, 409, 410, 874, 881, 883, 884, 886, 887, 892	
Omega Receiver Processor Unit	OMEGA RECEIVER PROCESSOR UNIT, SUBJECT 34-55-01
Omega Control Display Unit	CONTROL DISPLAY UNIT, SUBJECT 34-55-02
WJE 405-411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873, 874, 880, 881, 883, 884, 886, 887, 891-893	
Performance Management Control Display Unit	PERFORMANCE MANAGEMENT CONTROL DISPLAY UNIT, SUBJECT 34-63-01
Performance Management Computer Unit	PERFORMANCE MANAGEMENT COMPUTER, SUBJECT 34-63-02
WJE 401-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-881, 883, 884	
Flight Management Computer	ADVANCED FLIGHT MANAGEMENT COMPUTER, SUBJECT 34-63-03

WJE 401-412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-881, 883, 884 (Continued)

Table 1 (Continued)

COMPONENT	MAINTENANCE MANUAL REFERENCE
Multipurpose Control Display Unit	MULTIPURPOSE CONTROL DISPLAY UNIT, SUBJECT 34-63-04
WJE 401-406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 875-879, 886, 887	
Electronic Engine Display Panel	ENGINE DISPLAY PANEL, SUBJECT 77-42-00
WJE ALL	
NOTE: The master caution lights or master warning lights will come on at various points in the procedures. Lights should be reset immediately before proceeding with the next step of this procedure.	
NOTE: Light operation, as stated in the following procedural steps, is given only if a particular light operation is changed due to the repositioning of a switch.	

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

B. Energize All Load Buses from External Power

(1) On overhead switch panel, set EXT PWR L BUS and EXT PWR R BUS in OFF position.

(2) On overhead switch panel, make sure AC BUS X TIE and DC BUS X TIE switches are in open position.

(3) Connect external power cord to aircraft external power receptacle.

WJE 410

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(4) Make sure that these circuit breakers are open and have safety tags:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 401-404, 406, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

(5) Make sure that these circuit breakers are closed:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

(6) Start external power unit; check for voltage of 115(±3) line to neutral and frequency of 400(±4) hertz on øA, øB, øC.

(7) Place external power unit master switch in on position.

WJE 410

(8) Remove the safety tags and close these circuit breakers:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

(9) Check that the three EXT PWR AVAIL lights and EXT PWR NOT-IN-USE light come ON.

(10) Place aircraft selector switch in VOLT/FREQ EXT PWR position; AC VOLTS meter should indicate 115(±3) volts; FREQUENCY CPS meter should indicate 400(±4) hertz.

(11) Place BATT switch in ON position. EOAP displays the following messages and annunciations:

(a) L AC BUS OFF.

(b) R AC BUS OFF.

(c) L GEN OFF.

(d) R GEN OFF.

(e) DC BUS OFF.

(f) AC EMER BUS OFF.

(g) DC EMER BUS OFF.

(12) On overhead switch panel, set EXT PWR R BUS switch in ON position. EXT PWR R BUS light comes on. EXT PWR NOT-IN-USE light goes off. Both right DC LOAD meters indicate some load.

(13) EOAP no longer displays the following messages and annunciations:

(a) R AC BUS OFF.

(b) AC EMER BUS OFF.

(c) DC EMER BUS OFF.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(14) Open this circuit breaker and install safety tag:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	36	B1-162	DC TRANSFER BUS FEED

EOAP also displays DC TRANSFER BUS OFF message.

(15) Remove the safety tag and close this circuit breaker:

LOWER EPC, DC PWR FEED

Row	Col	Number	Name
N	36	B1-162	DC TRANSFER BUS FEED

EOAP no longer displays DC TRANSFER BUS OFF message.

(16) On overhead switch panel, set indicator selector switch in DC BUS VOLT R position. Dc VOLTS meter indicates 26 volts minimum.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887 (Continued)

(17) Set DC BUS X TIE switch in CLOSE position. EOAP no longer displays DC BUS OFF message. Both right DC LOAD meters indicate equal load.

(18) Set DC BUS X TIE switch in OPEN position. EOAP also displays DC BUS OFF message.

(19) On overhead switch panel, set EXT PWR R BUS switch in OFF position. EXT PWR R BUS light goes off. EXT PWR NOT-IN-USE light comes on. Both right DC LOAD meters indicate zero load.

(20) EOAP displays following messages and annunciations:

(a) L AC BUS OFF.

(b) R AC BUS OFF.

(c) L GEN OFF.

(d) R GEN OFF.

(e) DC BUS OFF.

(f) AC EMER BUS OFF.

(g) DC EMER BUS OFF.

(21) On overhead switch panel, set EXT PWR L BUS switch in ON position. EXT PWR L BUS light comes on. EXT PWR NOT-IN-USE light goes off. Both left and right DC LOAD meters indicate some load.

(22) EOAP no longer displays the following messages and annunciations:

(a) L AC BUS OFF.

(b) AC EMER BUS OFF.

(c) DC EMER BUS OFF.

(23) On overhead switch panel, set indicator selector switch in DC BUS VOLT L position. Dc VOLTS meter indicates 26 volts minimum.

(24) Set DC BUS X TIE switch in CLOSE position. EOAP no longer displays DC BUS OFF message. Both left DC LOAD meters indicate equal load.

(25) Set DC BUS X TIE switch in OPEN position. EOAP also displays DC BUS OFF message.

(26) On overhead switch panel, set EXT PWR R BUS switch in ON position. EXT PWR R BUS light comes on. Both right DC LOAD meters indicate some load.

(27) EOAP no longer displays following messages and annunciations:

(a) R AC BUS OFF.

(b) DC BUS OFF.

NOTE: The BATT switch can be put in the OFF position after ground power is established. This will prevent a drain on the battery.

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-881, 883, 884, 891-893

C. Energize All Load Buses from External Power

(1) Verify EXT PWR L BUS and EXT PWR R BUS switches located on overhead panel are in OFF position.

(2) Verify AC BUS X TIE and DC BUS X TIE switches located on overhead panel are in OPEN position.

(3) Connect external power cord to aircraft external power receptacle.

WJE 405, 407-409, 411, 880, 884, 892, 893

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(4) Make sure that these circuit breakers are open and have safety tags:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 416, 420, 422, 424-427, 429, 861, 862, 868, 873-879, 881, 883, 891

(5) Make sure that these circuit breakers are closed:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-881, 883, 884, 891-893

(6) Start external power unit; check for voltage of 115(±3) line to neutral and frequency of 400(±4) hertz on øA, øB, øC.

(7) Place external power unit master switch in on position.

WJE 405, 407-409, 411, 880, 884, 892, 893

(8) Remove the safety tags and close these circuit breakers:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-881, 883, 884, 891-893

(9) Check that the three EXT PWR AVAIL lights and EXT PWR NOT-IN-USE light come ON.

(10) Place aircraft selector switch in VOLT/FREQ EXT PWR position; AC VOLTS meter should indicate 115(±3) volts; FREQUENCY CPS meter should indicate 400(±4) hertz.

(11) Place BATT switch in ON position; check following lights for operation:

(a) L AC BUS OFF .... ON.

(b) R AC BUS OFF .... ON.

(c) L GEN OFF .... ON.

(d) R GEN OFF .... ON.

(e) AC EMER BUS OFF .... ON.

(f) DC EMER BUS OFF .... ON.

(g) DC TRANSFER BUS OFF .... OFF.

(h) DC BUS OFF .... ON.

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-881, 883, 884, 891-893 (Continued)

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(12) Open this circuit breaker and install safety tag:

EE COMPARTMENT

Row	Col	Number	Name
		B1-172	DC TRANS BUS FEED (BAT)

(a) On aircraft with annunciator panel: DC TRANSFER BUS OFF annunciator lit, DC BUS OFF annunciator off. Close DC TRANSFER BUS FEED (BAT) circuit breaker: DC TRANSFER BUS OFF annunciator off, DC BUS OFF annunciator lit.

(b) On aircraft with Electronic Overhead Annunciator Panel (EOAP): All EOAP displays off (no messages or annunciations displayed). Close DC TRANSFER BUS FEED (BAT) circuit breaker: EOAP annunciations displayed.

(13) Place EXT PWR L BUS switch in ON position, both left DC LOAD meters may indicate some load; check following lights for operation:

(a) EXT PWR L BUS .... ON.

(b) EXT PWR NOT-IN-USE .... OFF (External power control panel).

(c) L AC BUS OFF .... OFF.

(d) AC EMER BUS OFF .... OFF.

(e) DC EMER BUS OFF .... OFF.

(14) Place DC BUS VOLT selector switch in L-position; dc AMPS-VOLTS meter should indicate equal to or greater than 26 volts.

(15) Place DC BUS X TIE switch to CLOSE position.

(16) DC BUS OFF light located on overhead panel should go off. Both left DC load meters should indicate equal load (±0.05 per unit).

NOTE: If loadmeters indicate unbalance (PAGEBLOCK 24-30-00/101).

(17) Place DC BUS X TIE switch to OPEN position.

(18) Place EXT PWR L BUS switch in OFF position.

(a) EXT PWR L BUS .... OFF.

(b) EXT PWR NOT-IN-USE .... ON (External power control panel).

(c) L AC BUS OFF .... ON.

(d) AC EMER BUS OFF .... ON.

(e) DC EMER BUS OFF .... ON.

(19) Place EXT PWR R BUS switch in ON position, both right DC LOAD meters may indicate some load; check following lights for operation:

(a) EXT PWR R BUS .... ON.

(b) EXT PWR NOT-IN-USE...................... OFF (External power control panel).

(c) DC BUS OFF .... ON.

(d) R AC BUS OFF .... OFF.

(e) AC EMER BUS OFF.................... OFF.

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-881, 883, 884, 891-893 (Continued)

(f) DC EMER BUS OFF.................... OFF.

(20) Place DC BUS VOLT selector switch in R-position; dc AMPS-VOLTS meter should indicate equal to or greater than 26 volts.

(21) Place DC BUS X TIE switch to CLOSE position.

(22) DC BUS OFF light should go off. Both right DC load meters should indicate equal load (±0.05 per unit).

NOTE: If loadmeters indicate unbalance (PAGEBLOCK 24-30-00/101).

(23) Open DC BUS X TIE switch.

(24) Place EXT PWR R BUS switch to OFF position.

NOTE: The BATT switch can be put in the OFF position after ground power is established. This will prevent a drain on the battery.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

D. Energize AC Ground Service Bus from External Power

(1) Connect external power cord to aircraft external power receptacle.

WJE 410

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(2) Open these circuit breakers and install safety tags:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 401-404, 406, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

(3) Make sure that these circuit breakers are closed:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

(4) Start external power unit; check external power unit voltage of 115(±3) line to neutral and frequency of 400(±4) hertz on øA, øB, øC.

(5) Set external power unit master switch in ON position.

WJE 410

(6) Remove the safety tags and close these circuit breakers:

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C

Three EXT PWR AVAIL lights and EXT PWR NOT-IN-USE light comes on.

WJE 401-404, 406, 410, 412, 414, 415, 417-419, 421, 423, 863-866, 869, 871, 872, 886, 887

(7) On overhead switch panel, set indicator selector switch in VOLT/FREQ EXT PWR position. AC VOLTS meter indicates 115(±3) volts and FREQUENCY CPS meter indicates 400(±4) hertz.

(8) On overhead switch panel, set BATT switch in ON position. EOAP displays the following messages and annunciations:

(a) L AC BUS OFF.

(b) R AC BUS OFF.

(c) L GEN OFF.

(d) R GEN OFF.

(e) DC BUS OFF.

(f) AC EMER BUS OFF.

(g) DC EMER BUS OFF.

(9) On GROUND SERVICE ELEC PWR panel, located in the aft overhead switch panel, set EXT PWR switch to ON position. EXT PWR light comes on. EXT PWR NOT-IN-USE light goes off. Right scale of right DC LOAD meter indicates some load.

(10) EOAP displays attenuate messages and annunciations:

(a) AC EMER BUS OFF.

(b) DC EMER BUS OFF.

(11) On overhead switch panel, set indicator selector switch in BATT VOLT position. Dc VOLTS meter indicates 30 to 40 volts.

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-881, 883, 884, 891-893

E. Energize AC Ground Service Bus from External Power

(1) Connect external power cord to external power receptacle of aircraft.

(2) Start external power unit; check for voltage of 115(±3) and frequency of 400(±4) hertz.

(3) Place external power unit master switch in on position.

(4) Check that the three EXT PWR AVAIL lights and the EXT PWR NOT-IN-USE light come ON.

(5) Place selector switch in VOLT/FREQ EXT PWR position; AC VOLTS meter should indicate 115(±3) volts; frequency meter should indicate 400(±4) hertz. Verify EXT PWR L BUS and EXT PWR R BUS switches in OFF position.

(6) Place EXT PWR ground service switch in ON position; DC LOAD meter No. 2 may indicate some load; check following lights for operation:

(a) EXT PWR NOT-IN-USE .... OFF.

(b) Ground service EXT PWR .... ON.

(7) Place external power ground service bus (EXT PWR) switch in OFF position.

WJE 405, 407-409, 411, 416, 420, 422, 424-427, 429, 861, 862, 868, 873-881, 883, 884, 891-893 (Continued)

(8) Place BATT switch in ON position.

(9) Place selector switch in BATT VOLT position; DC AMPS-VOLTS meter should indicate 30 to 40 volts.

NOTE: The BATT switch can be put in the OFF position after ground power is established. This will prevent a drain on the battery.

EXTERNAL POWER - TROUBLE SHOOTING

1. General

A. Dc voltage for control of ac external power circuits is obtained from the external power transformer-rectifier (EPTR), and passes through contacts of the external power phase sequence circuit (EPPSC), both units are located in the bus control (BC) unit. The control voltage passes through contacts of the external power phase sequence relay located in the Ac Bus Control unit (if phase sequence is correct), and through contacts of the external power monitor located in the generator control rack (if voltage and frequency is within limits). Three circuit breakers providing control voltage protection are labeled external power dc supply (EPCB1) (located on the BC), and external power cart interlock and external power relays (located on the ac external power panel). Ground return for the control circuit is through normally closed contacts of the power ready relay (PRR) in the corresponding R or L generator control (GC) unit.

B. The procedures for trouble shooting the ac external power circuits requires, first making certain that 20 to 30 volts dc is available for control circuits, indicated by the ac external power available light coming on. Progressively checking for availability of dc control voltage will disclose fault in wiring or circuit component.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed item:

Table 101

Name and Number	Manufacturer
Multimeter Model 2000A	Dana

3. Trouble Shooting AC External Power System

NOTE: The following procedures require the connection of a 115-volt, 3-phase, 400 Hz, power source while trouble shooting the ac external power circuits.

Table 102

Possible Causes		Isolation Procedure	Correction
A.	AC EXTERNAL POWER AVAILABLE LIGHT IS NOT ON		
(1)	Phase sequence fault	Check ac external power source and wiring to external power relay.	Correct phase sequence of power source; repair wiring.
(2)	No dc voltage from the EPTR, in the BC	Check for open circuit breakers on BC and ac external power panels.	Reset circuit breaker, if open.
WJE 401-404, 406, 412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891			
(3)	External Power Monitor fault	Check voltage and frequency of external power source.	If not within limits, correct. If within limits, replace External Power Monitor.
		Check per Paragraph 4.B.	Replace bus control panel.
WJE ALL			
B.	EXTERNAL POWER WILL NOT CONNECT TO AC BUS; AC EXTERNAL POWER AVAILABLE LIGHT IS ON		
(1)	Control circuit fault	Check per Paragraph 4.C.	
(2)	Power relay close circuit fault	Check per Paragraph 4.D.	

4. **Fault Isolation Checking Procedures**

A. General

(1) The following procedures provide detailed trouble shooting information and supplement the general trouble shooting procedures in Paragraph 3.

B. Check for dc voltage to External Power Control Circuit (EXT PWR AVAIL light on forward overhead switch panel is not ON).

(1) Place EXT PWR L BUS and EXT PWR R BUS switches in OFF position. Check for 20 to 30 volts dc at terminal A3 to ground of Dead Bus Slave Relays; if zero voltage, replace bus control (BC) unit.

(2) If voltage is within limits, check for 20 to 30 volts dc from external power receptacle pin E to ground and pin F to ground. If voltage is indicated at both points, check phase sequence. If zero voltage at both points, replace bus control (BC) unit. If zero voltage at pin E and 20 to 30 volts at pin F, check wiring in external power source connector plug.

WJE 401-404, 406, 412, 414-427, 429, 861-866, 868, 869, 871-879, 881, 883, 886, 887, 891

(3) If external power available light does not now come on, check external power source voltage and frequency. If not within normal operating limits, adjust; if within, replace External Power Monitor.

WJE ALL

C. Check for AC External Power Control Circuit Fault (External Power Will Not Connect to AC Bus; EXT PWR AVAIL light is ON).

(1) Place EXT PWR L BUS and EXT PWR R BUS switches in ON position, and APU L BUS and APU R BUS switches in OFF position. Check for 20 to 30 volts dc to ground at following points:

(a) Terminal B2 of (L or R) APCR No. 1

(b) Terminal B3 of (L of R) APCR No. 1

(c) Terminal X1 of (L or R) EPCR

(d) Terminal X2 of (L or R) EPCR.

(2) If no voltage is present at step (a), check ac external power bus switch wiring for open circuit. If voltage is present at any one step and not at next, fault is in circuit between the two check points.

(3) If there is 20 to 30 volts dc at terminal X2 of EPCR, remove ac generator control unit. Place EXT PWR L BUS and EXT PWR R BUS switches in OFF position. Use ohmmeter set on low scale to check continuity between pin A22 of GCU connector and terminal X2 of LEPCR (or REPCR). If continuity is indicated, replace generator control unit. If there is no continuity, check wiring between EPCR and generator control unit for open circuit.

NOTE: Ohmmeter leads may have to be reversed to read continuity in ac generator control unit.

D. Check for External Power Relay Close Coil Circuit Fault (External Power Will Not Connect to AC Bus; EXT PWR AVAIL light is ON).

(1) Place EXT PWR (L or R) BUS switch in the ON position and the APU (L and R) BUS switches in the OFF position; check for 20 to 30 volts dc between ground and the following points of L or R ac system as applicable. If voltage is present at any one step and not at the next, the fault is in the circuit between the two check points.

(a) Terminal A3 of dead bus slave relay (LDBSR or RDBSR)

(b) Terminal A2 of dead bus slave relay (LDBSR or RDBSR)

(c) Terminal D2 of external power control relay (LEPCR or REPCR)

(d) Terminal D1 of external power control relay (LEPCR or REPCR)

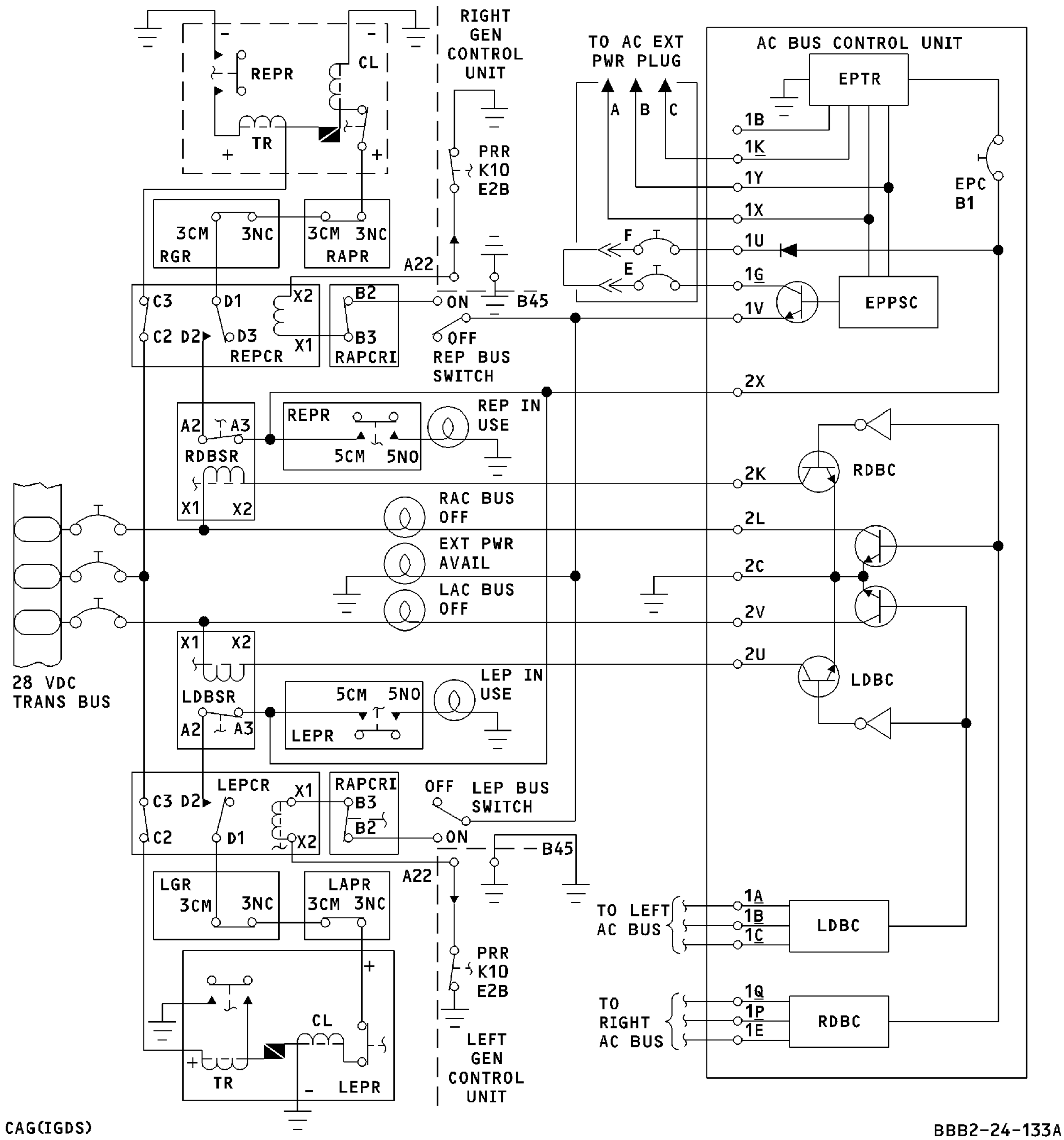
(e) Terminal 3CM of generator relay (LGR or RGR)

(f) Terminal 3NC of generator relay (LGR or RGR)

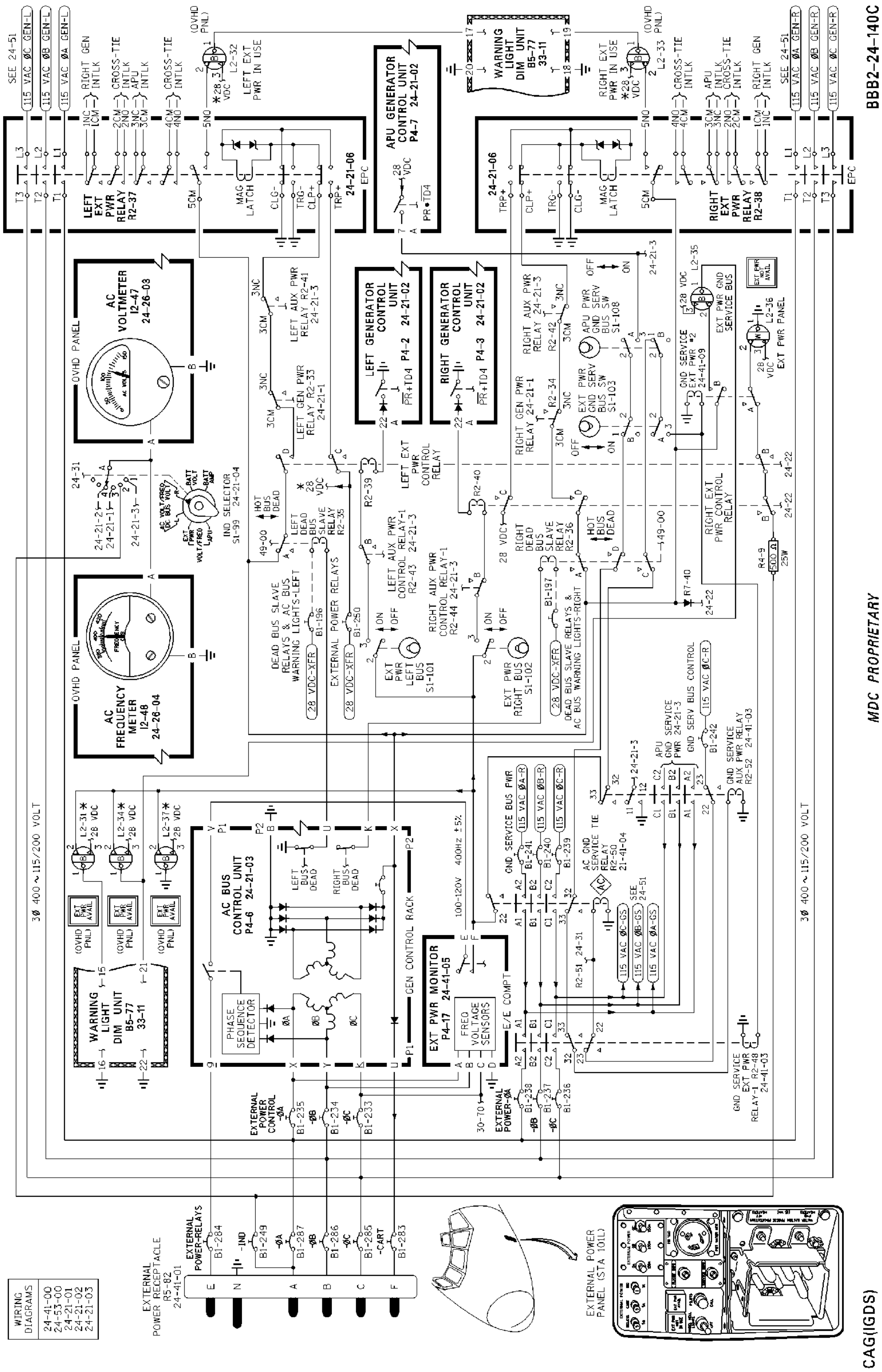
(g) Terminal 3CM of auxiliary power relay (LAPR or RAPR)

(h) Terminal 3NC of auxiliary power relay (LAPR or RAPR)

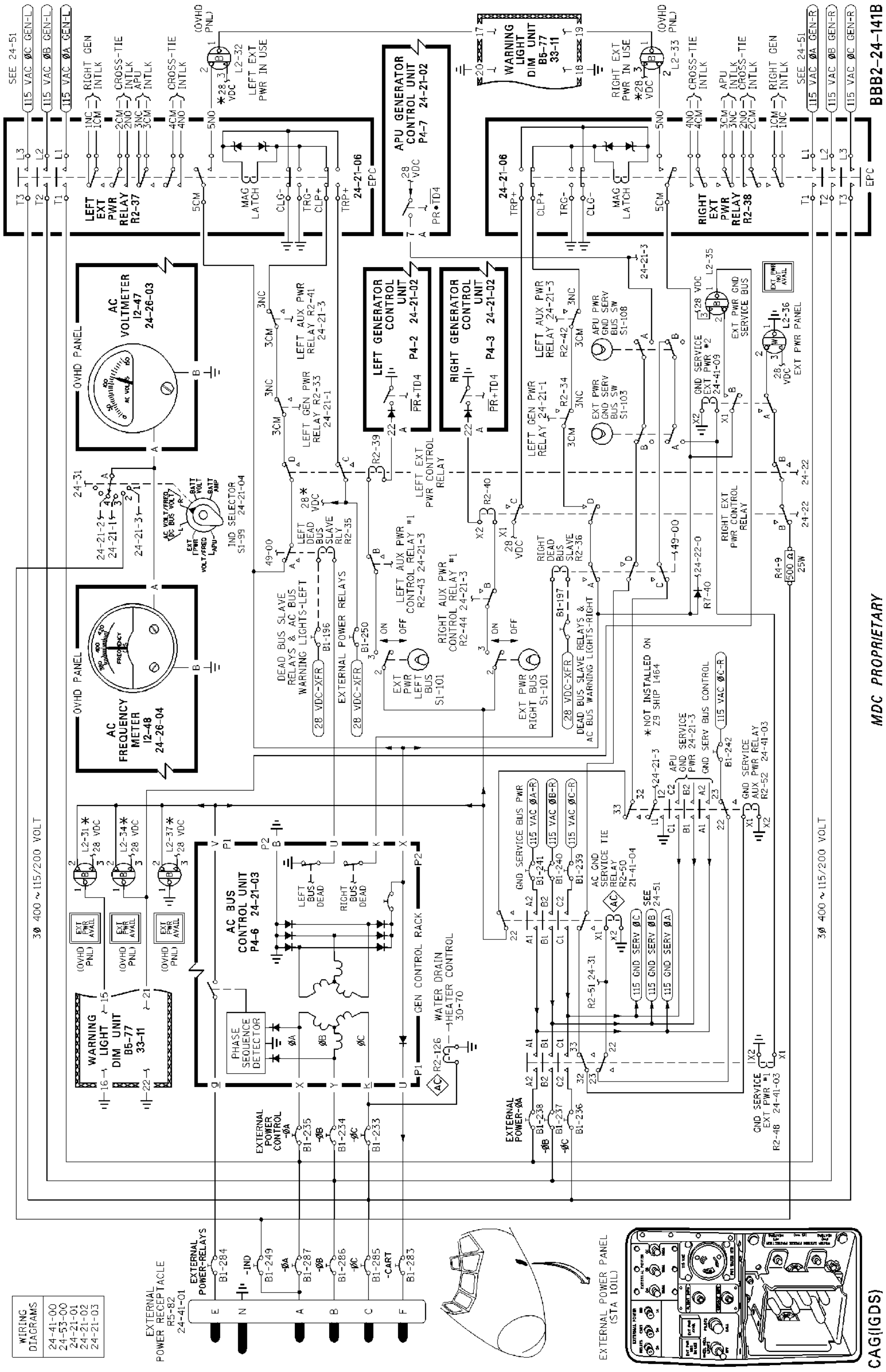
(i) Terminal CLP (+) of external power relay (LEPR or REPR).



Ac External Power Control
Figure 101/24-40-00-990-803



External Power and Control -- Schematic
Figure 102/24-40-00-990-804 (Sheet 1 of 2)



External Power and Control -- Schematic
Figure 102/24-40-00-990-804 (Sheet 2 of 2)

EXTERNAL POWER RECEPTACLE - MAINTENANCE PRACTICES

1. General

A. This maintenance practice provides instructions for the external power receptacle. This procedure includes:

- Removal/Installation of the external power receptacle
- Inspection of the external power receptacle
- Measure airplane resistance to ground.

B. There is one external power receptacle for the electrical power distribution system. The receptacle is located on the external power panel.

C. The external power receptacle access door is on the left side of the fuselage nose section. The interior surface of the external power receptacle is accessible through the nose wheel well door.

D. The inspection procedure uses a wear gage to do a check of the pins on the receptacle. The wear gage is used to make sure that the pins are in tolerance.

2. Equipment and Materials

NOTE: Equivalent substitutes may be used instead of the following listed items:

NOTE: It is possible that some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 201

Name and Number	Manufacturer
Torque wrench (capable of 0 to 25 inch-pounds) (0 to 2.8 N·m)	
Torque wrench (capable of 0 to 200 inch-pounds) (0 to 23.8 N·m)	
DO NOT OPERATE Tag	
F70284-1 Kit, wear gage (F70284-2, wear gage, ac power pin, F70284-3, wear gage, dc power pin, IN-25, instrument scale)	
Ohmmeter	

3. Removal/Installation External Power Receptacle

A. Remove External Power Receptacle

CAUTION: DO NOT CONNECT OR DISCONNECT EXTERNAL ELECTRICAL POWER AT AIRCRAFT RECEPTACLE WHILE SUPPLY UNIT IS SUPPLYING POWER.

(1) Make certain EXT PWR L BUS, EXT PWR R BUS, and EXT PWR GROUND SERVICE BUS switches on overhead switch panel are in OFF position.

(2) Disconnect external power input connector from external power receptacle.

WARNING: TAG AND SAFETY CIRCUIT BREAKERS.

(3) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(4) Tag and place BATT switch located on overhead switch panel to OFF position.

(5) Remove three screws that attach receptacle cover to external power receptacle (external access). (Figure 201)

(6) Remove external power receptacle cover (interior access).

(7) Remove aircraft wiring from external power receptacle studs (interior access).

NOTE: Tag and identify wiring.

(8) Remove external power receptacle.

B. Install External Power Receptacle

(1) Make certain that external power input connector is disconnected from external power receptacle.

(2) Make certain BATT switch, EXT PWR L BUS, EXT PWR R BUS, and EXT PWR GROUND SERVICE BUS switches on overhead switch panel are in OFF position.

(3) Make sure that these circuit breakers are open and have safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A

(Continued)

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(4) Check condition of doubler located between external power receptacle and external power panel, replace if necessary.

(5) Install external power receptacle, less three screws that retain receptacle cover.

(6) Install aircraft wiring to external power receptacle studs, making certain that all wires are connected properly. (WDM 24-41-01)

(7) Check torque values of terminal studs on external power receptacle and retorque as needed.

(a) The four larger diameter studs A, B, C, and N torque value should be 125 ±5 in-lb (14.1 ±0.6 N·m).

(b) The two smaller diameter studs E and F torque value should be 25 ±5 in-lb (2.8 ±0.6 N·m).

(8) Install external power receptacle cover.

CAUTION: DO NOT CONNECT OR DISCONNECT EXTERNAL ELECTRICAL POWER AT AIRCRAFT RECEPTACLE WHILE SUPPLY UNIT IS SUPPLYING POWER.

(9) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(10) Connect external power input connector to external power receptacle.

(11) Place BATT switch located on overhead switch panel in ON position and remove tag.

(12) The EXT PWR NOT IN USE light and the EXT PWR AVAILABLE light on the external power panel will come on when the external power plug is connected to the external power receptacle and external electrical power is applied.

(13) Rotate AC VOLT/FREQ switch located on overhead switch panel to EXT PWR position. AC VOLT indicator should indicate 115(±3) volts. FREQUENCY CPS indicator should indicate 400(±4) Hz.

C. Inspection of the External Power Receptacle

(1) Remove electrical power. (EXTERNAL POWER - DESCRIPTION AND OPERATION, PAGEBLOCK 24-40-00/001)

(2) Do the external power receptacle inspection as follows: (Figure 202)

(a) Look for pins that are loose, bent or have a crack.

(b) Look for discolored, burned or pitted pins.

(c) Look for damage or cracks on the base insulation.

(d) Try to install the wear gage, F70284-2, on the large pins A, B, C and N on each receptacle.

NOTE: The part number for the wear gage set is F70284-1. Use the gage, F70284-2, to examine the four large pins A, B, C and N for worn areas. Use the gage, F70284-3, to examine the two small pins E and F for worn areas.

1) Make sure that the four large pins, A, B, C and N, will not go into the gage.

2) If the pin(s) go into the gage and the end of the gage is more than 0.5 in. (12.7 mm) from the face of the external power receptacle, do not replace the pin(s).

(e) Try to install the wear gage, F70284-3, on the small pins E and F on each receptacle.

1) Make sure that the two small pins, E and F, will not go into the gage.

2) If the pin(s) go into the gage and the end of the gage is more than 0.5 in. (12.7 mm) from the face of the external power receptacle, do not replace the pin(s).

(f) If the pin(s) go into the gage and the end of the gage is less than or equal to 0.5 in. (12.7 mm) from the face of the external power receptacle, replace the pin(s). (Paragraph 3.)

(3) Remove all the tools and equipment from the work area. Make sure that the area is clean.

D. Measure airplane resistance to ground as follows:

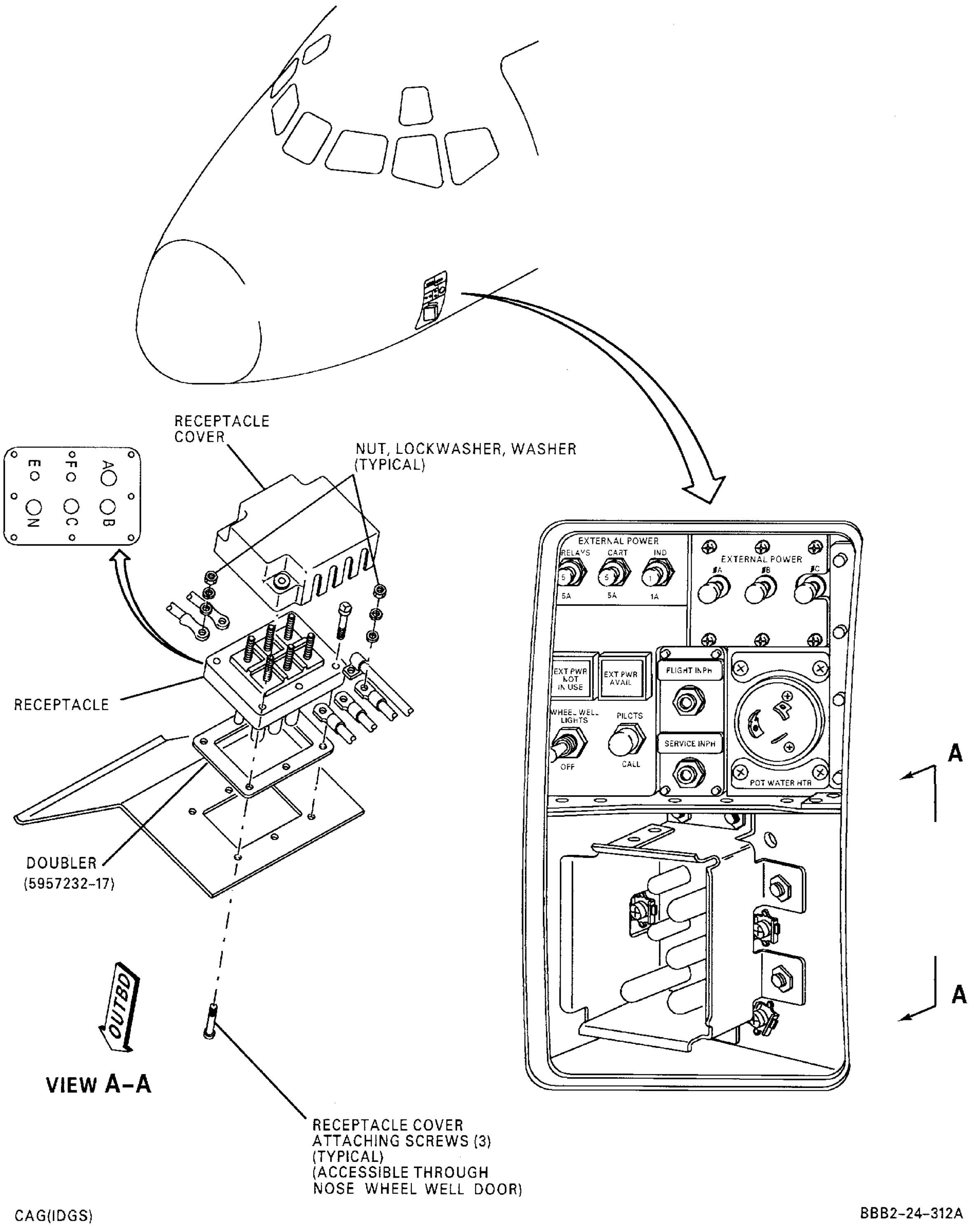
(1) Remove external power. (EXTERNAL POWER - DESCRIPTION AND OPERATION, PAGEBLOCK 24-40-00/001)

(2) At the external power panel, use the ohmmeter to measure the resistance from neutral pin to the grounding stud located on any landing gear.

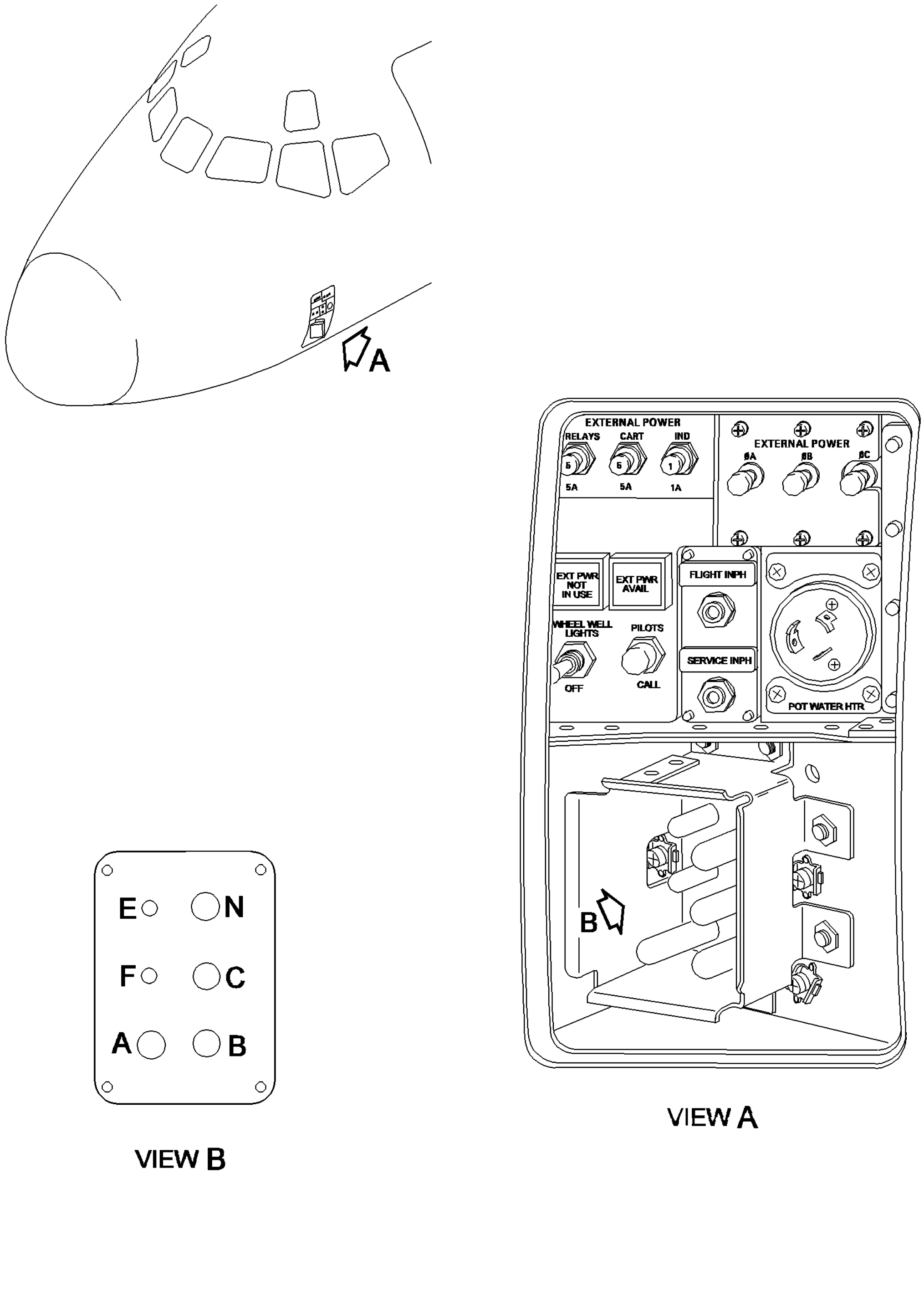
(3) Make sure the resistance is less than 0.1 ohm.

(4) If the resistance exceeds 0.1 ohm, do an inspection and/or repair. (EXTERNAL POWER RECEPTACLE - MAINTENANCE PRACTICES, 24-41-01/201)

(5) Return aircraft to serviceable condition.



External Power Receptacle -- Removal/Installation
Figure 201/24-41-01-990-801



External Power Receptacle Inspection
Figure 202/24-41-01-990-802

EXTERNAL POWER RECEPTACLE - ADJUSTMENT/TEST

1. General

A. This procedure contains MSG-3 task card data.

TASK 24-41-01-720-801

2. Functional Check of the External Power Receptacle Studs with a GO/NO Go Gage

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
24-41-01 P/B 201	EXTERNAL POWER RECEPTACLE - MAINTENANCE PRACTICES

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-1625	Wear Gage Set - Ground Power Plug and Receptacle **MD80-81, -82, -83, -88** Part #: F70284-1 Supplier: 81205

C. Functional Check of the External Power Receptacle Studs with a GO/NO Go Gage

SUBTASK 24-41-01-720-001

(1) Do the external power main receptacle inspection as follows:

CAUTION: DO NOT CONNECT OR DISCONNECT EXTERNAL ELECTRICAL POWER AT AIRCRAFT RECEPTACLE WHILE SUPPLY UNIT IS SUPPLYING POWER.

(a) Make certain EXT PWR L BUS, EXT PWR R BUS, and EXT PWR GROUND SERVICE BUS switches on overhead switch panel are in OFF position.

(b) Disconnect external power input connector from external power receptacle.

(c) Open these circuit breakers and install safety tags:

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(d) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A

(Continued)

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(e) Tag and place BATT switch located on overhead switch panel to OFF position.

(f) Look for pins that are loose, bent or have a crack.

(g) Look for discolored, burned or pitted pins.

(h) Look for damage or cracks on the base insulation.

(i) Try to install the wear gage set, SPL-1625 on the large pins A, B, C and N on each receptacle.

NOTE: The part number for the wear gage set, SPL-1625 is F70284-1. Use the gage, F70284-2, to examine the four large pins A, B, C and N for worn areas. Use the gage, F70284-3, to examine the two small pins E and F for worn areas.

1) Make sure that the four large pins, A, B, C and N, will not go into the gage.

2) If the pin(s) go into the gage and the end of the gage is more than 0.5 in. (12.7 mm) from the face of the external power receptacle, do not replace the pin(s).

(j) Try to install the wear gage set, SPL-1625 on the small pins E and F on each receptacle.

1) Make sure that the two small pins, E and F, will not go into the gage.

2) If the pin(s) go into the gage and the end of the gage is more than 0.5 in. (12.7 mm) from the face of the external power receptacle, do not replace the pin(s).

(k) If the pin(s) go into the gage and the end of the gage is less than or equal to 0.5 in. (12.7 mm) from the face of the external power receptacle, replace the pin(s). (EXTERNAL POWER RECEPTACLE - MAINTENANCE PRACTICES, PAGEBLOCK 24-41-01/201)

(l) Remove the safety tags and close these circuit breakers:

(m) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B

(Continued)

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(n) Place BATT switch located on overhead switch panel in ON position and remove tag.

(o) Remove all the tools and equipment from the work area. Make sure that the area is clean.

END OF TASK

EXTERNAL POWER RECEPTACLE - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 24-41-01-211-801

2. Detailed Inspection of the External Power Receptacle (Internal)

A. Detailed Inspection of the External Power Receptacle

CAUTION: DO NOT CONNECT OR DISCONNECT EXTERNAL ELECTRICAL POWER AT AIRCRAFT RECEPTACLE WHILE SUPPLY UNIT IS SUPPLYING POWER.

SUBTASK 24-41-01-211-001

(1) Do a detailed inspection of the external power receptacle as follows:

(a) Make certain EXT PWR L BUS, EXT PWR R BUS, and EXT PWR GROUND SERVICE BUS switches on overhead switch panel are in OFF position.

(b) Disconnect external power input connector from external power receptacle.

WARNING: TAG AND SAFETY OPEN CIRCUIT BREAKERS.

(c) Open these circuit breakers and install safety tags:

Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(d) Tag and place BATT switch located on overhead switch panel to OFF position.

(e) Remove three screws that attach receptacle cover to external power receptacle (external access).

(f) Remove external power receptacle cover (interior access).

(g) Perform a detailed inspection of the external power connector for signs of corrosion, looseness, and arcing.

(h) Install external power receptacle cover.

(i) Remove the safety tags and close these circuit breakers:

Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

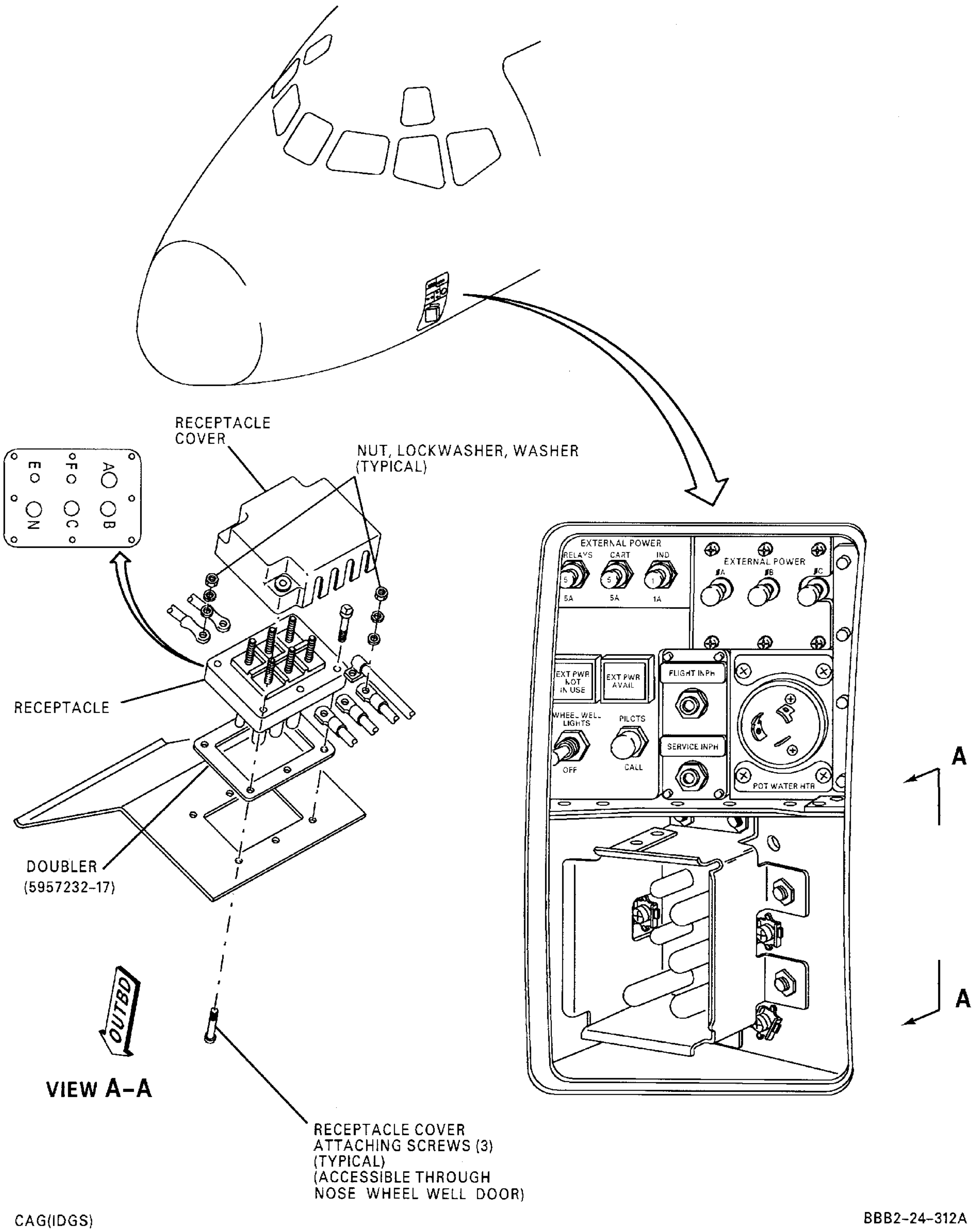
Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(j) Place BATT switch located on overhead switch panel in ON position and remove tag.

END OF TASK



External Power Receptacle
Figure 601/24-41-01-990-803

EXTERNAL POWER MONITOR - DESCRIPTION AND OPERATION

1. General

A. The external power monitor (EPM) monitors the output of external ground power units. Given the proper voltage and frequency conditions, it controls the supply of external power to the aircraft buses through the left and right external power relays and ground service external power relay if other additional conditions are also met. (Figure 1)

B. The operation of the EPM may be divided into four major functions: output, overvoltage sensing, undervoltage sensing, and over and underfrequency sensing.

2. Operation

A. Output

(1) The output is a normally open relay contact between pins E and F of the EPM. Under normal conditions and with proper voltage and frequency applied, the relay will energize and close its contacts within 4 seconds.

(2) This continuity between pins E and F of the EPM will permit the external ground power source to power AC buses if other additional conditions (phase sequence, priority, etc.) are met.

(3) Should a fault condition described in steps B., C., and D. arise, this relay would de-energize, opening continuity between E to F. The time delay for opening the E to F circuit depends on the fault condition.

(4) On some models a lockout feature will operate to prevent on/off cycling during out of tolerance conditions. Reset is accomplished by interrupt/reapplication of external power.

B. Overvoltage Sensor

(1) The overvoltage protection circuit senses all 3 phases.

(2) When the voltage on any one phase reaches 130 volts line to neutral, the relay becomes de-energized opening continuity between E to F within 2 to 15 seconds.

(3) If the voltage reaches 160 volts line to neutral, the relay becomes de-energized opening continuity between E to F within 0.12 to 0.80 second.

C. Undervoltage Sensor

(1) The undervoltage protection circuit senses A phase only.

(2) When the voltage of A phase falls below 90 volts line to neutral, the relay becomes de-energized opening continuity between E to F within 4 seconds.

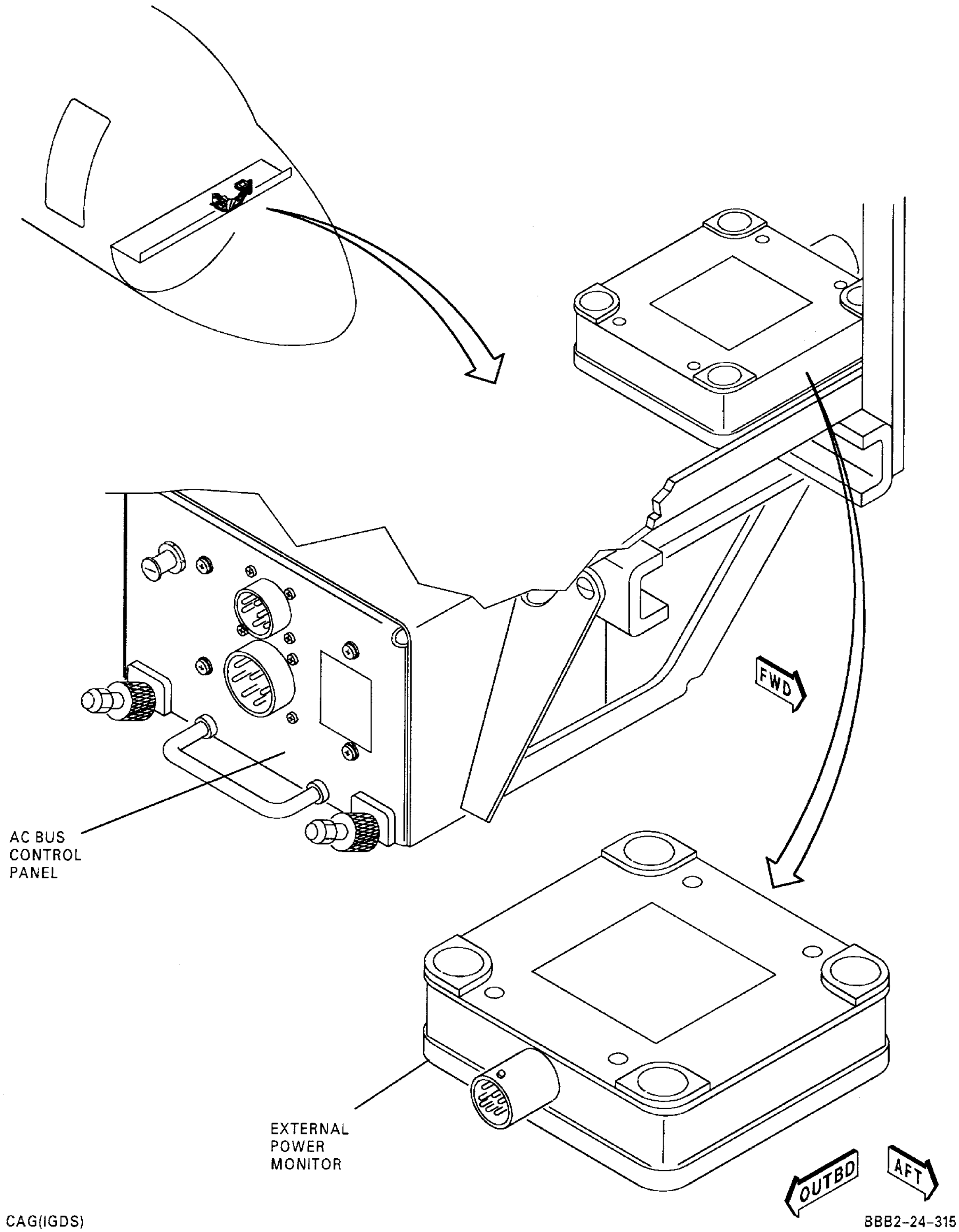
(3) It should be noted that if any one or both of the other two phases fails completely, the monitor would not drop out as long as A phase has nominal voltage.

D. Over and Underfrequency Sensor

(1) Over and underfrequency protection circuit senses overfrequency and underfrequency on A phase.

(2) For overfrequency, continuity between E to F would open at 425(±5) Hz in 2.0 to 4.0 seconds and reclose when frequency is reduced to 420 Hz.

(3) For underfrequency, continuity between E to F would open at 375(±5) Hz in 2.0 to 4.0 seconds and reclose as the frequency increases to 380 Hz.



External Power Monitor
Figure 1/24-41-05-990-801

EXTERNAL POWER MONITOR - MAINTENANCE PRACTICES

1. General

A. This maintenance practice provides removal/installation procedure for the external power monitor.

B. There is one external power monitor for the electrical power distribution system. The monitor is located on the AC generator control rack. The monitor is accessible through the electrical/electronics compartment door.

2. Removal/Installation External Power Monitor

A. Remove External Power Monitor

CAUTION: DO NOT CONNECT OR DISCONNECT EXTERNAL ELECTRICAL POWER AT AIRCRAFT RECEPTACLE WHILE SUPPLY UNIT IS SUPPLYING POWER.

(1) Make certain EXT PWR L BUS, EXT PWR R BUS, and EXT PWR GROUND SERVICE BUS switches on overhead switch panel are in OFF position.

(2) Disconnect external power input connector from external power receptacle.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(3) Open these circuit breakers and install safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(4) Tag and place BATT switch located on overhead switch panel to OFF position.

(5) Disconnect electrical connector from external power monitor.

NOTE: Tag and identify wiring.

(6) Remove screws that attach monitor to AC generator control rack (Figure 201).

(7) Remove external power monitor.

B. Install External Power Monitor

(1) Make certain that external power input connector is disconnected from external power receptacle.

(2) Make certain BATT switch, EXT (7) Remove external power monitor.

C. Install External Power Monitor

(1) Make certain that external power input connector is disconnected from external power receptacle.

(2) Make certain BATT switch, EXT are tagged:

Make sure that these circuit breakers are open and have safety tags:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

(3) Install external power monitor.

(4) Install screws and washers that attach monitor to AC generator control rack.

(5) Install electrical connector to external power monitor.

CAUTION: DO NOT CONNECT OR DISCONNECT EXTERNAL ELECTRICAL POWER AT AIRCRAFT RECEPTACLE WHILE SUPPLY UNIT IS SUPPLYING POWER.

(6) Remove the safety tags and close these circuit breakers:

EE COMPARTMENT

Row	Col	Number	Name
		B1-238	EXTERNAL POWER PHASE A
		B1-237	EXTERNAL POWER PHASE B
		B1-236	EXTERNAL POWER PHASE C

EXTERNAL POWER PANEL

Row	Col	Number	Name
		B1-283	EXTERNAL POWER CART
		B1-249	EXTERNAL POWER IND
		B1-287	EXTERNAL POWER PHASE A
		B1-286	EXTERNAL POWER PHASE B
		B1-285	EXTERNAL POWER PHASE C
		B1-284	EXTERNAL POWER RELAYS

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
X	38	B1-250	EXTERNAL POWER RELAYS

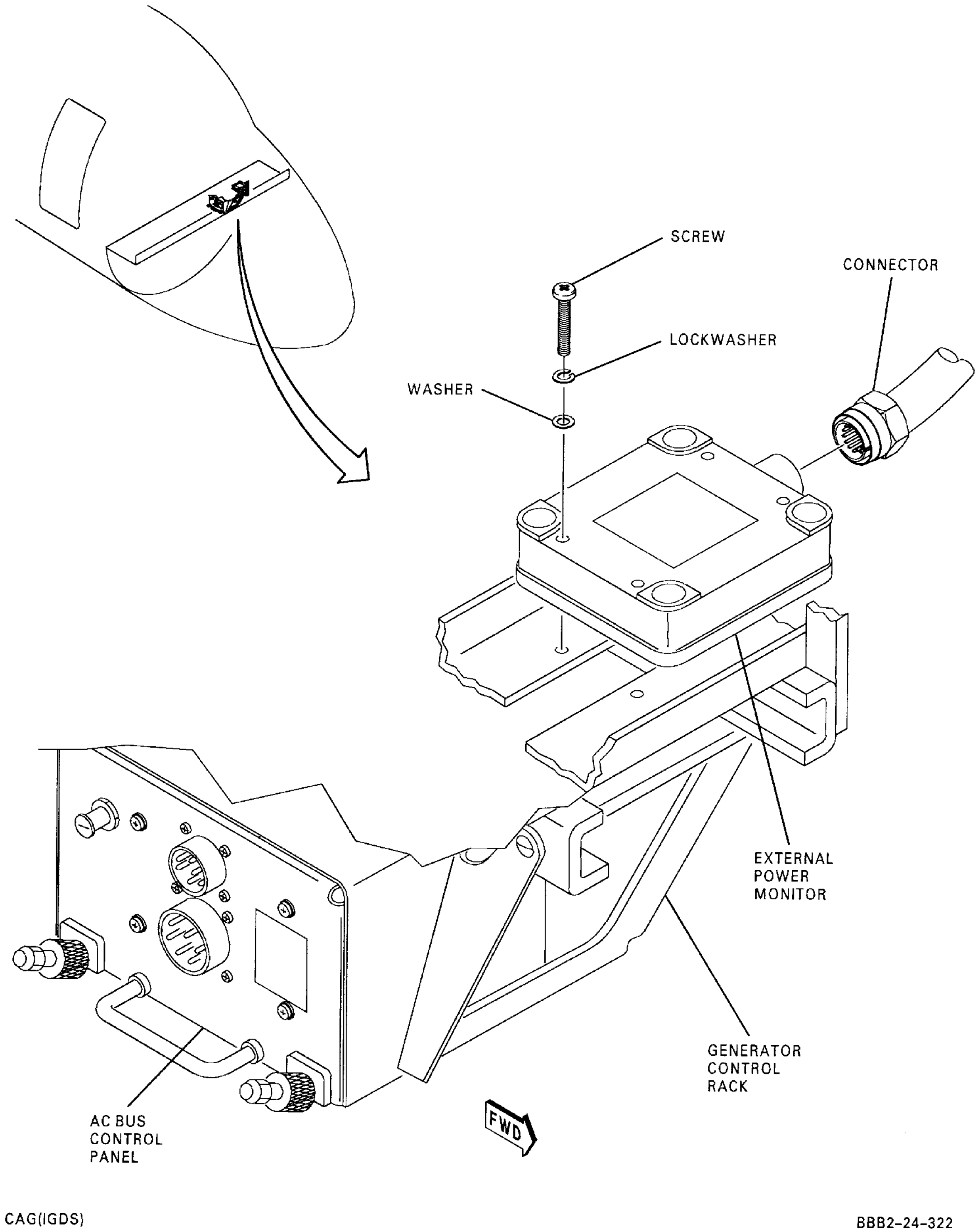
(7) Connect external power input connector to external power receptacle.

(8) Place BATT switch located on overhead switch panel in ON position and remove tag.

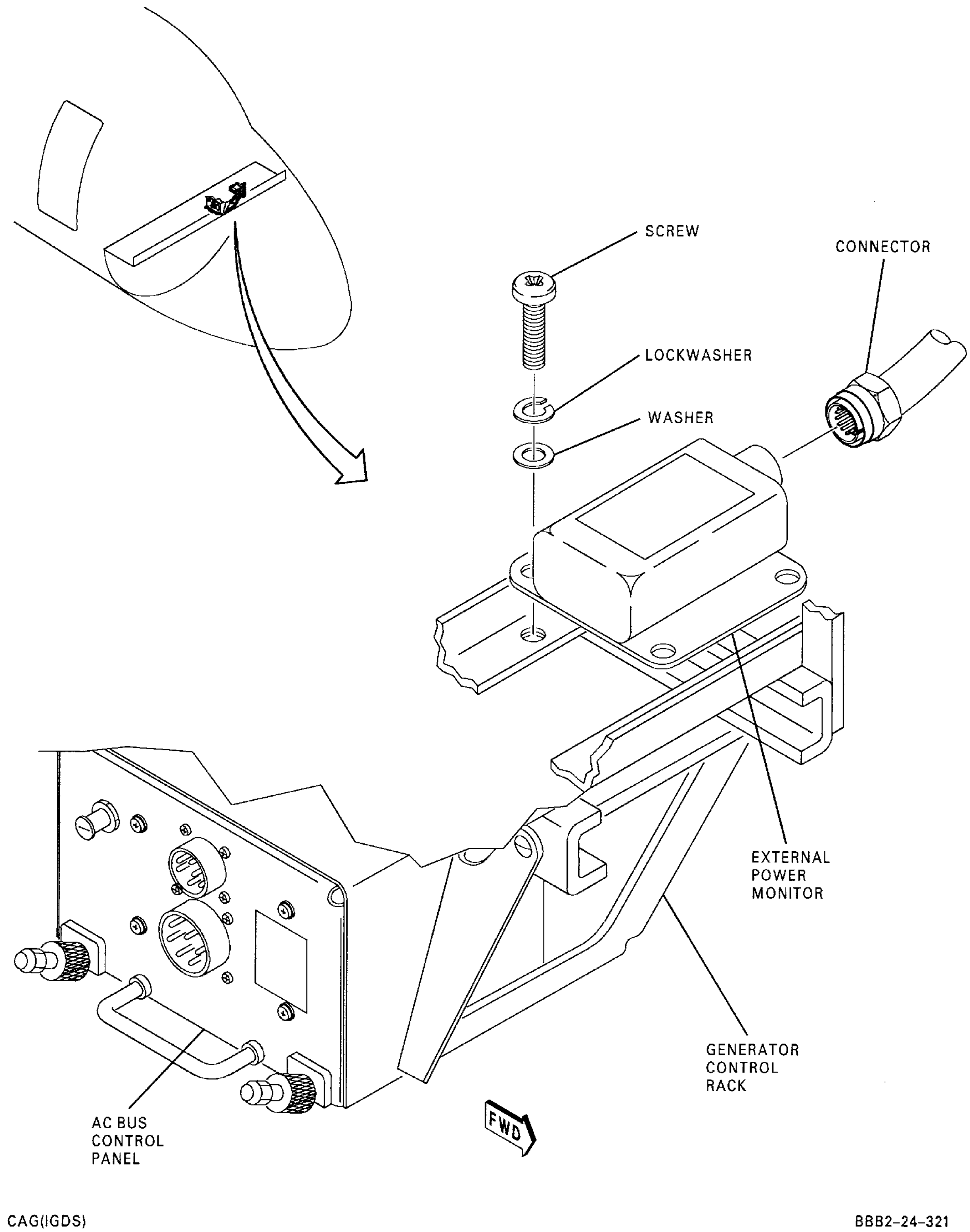
(9) EXT PWR NOT IN USE light and EXT PWR AVAILABLE light on external power panel will come on when external power plug is connected to external power receptacle and external electrical power is applied.

(10) The blue EXT PWR AVAIL light on overhead switch panel and blue GROUND SERVICE BUS light on aft overhead switch panel will come on.

(11) Rotate AC VOLT/FREQ switch located on overhead switch panel to EXT PWR position. AC VOLT indicator should indicate 115(±3) volts. FREQUENCY CPS indicator should indicate 400(±4) Hz.



External Power Monitor -- Removal/Installation
Figure 201/24-41-05-990-804 (Sheet 1 of 2)



External Power Monitor -- Removal/Installation
Figure 201/24-41-05-990-804 (Sheet 2 of 2)

ELECTRICAL LOAD DISTRIBUTION - DESCRIPTION AND OPERATION

1. General

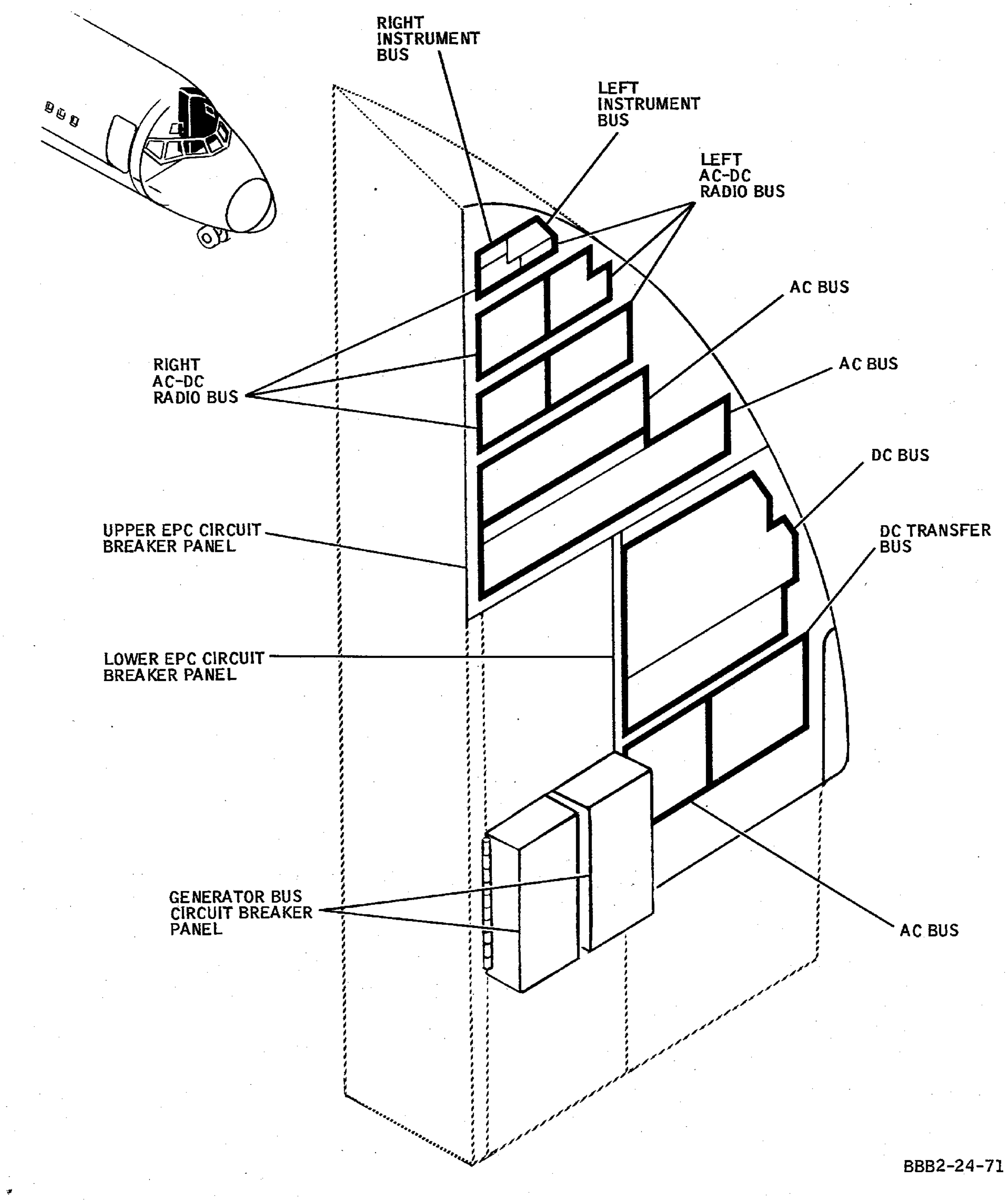
A. Electrical load distribution, from the power sources to the various using systems throughout the airplane, is accomplished by wiring, tie buses, power feeds, buses, and circuit breakers. The electrical power center (EPC), Ref. Figure 1, provides a central location for distribution of electrical power. Most of the buses and circuit breakers used in the electrical system are located in EPC.

B. There is generator bus (left or right) for each of the three phases of 115-volt ac power. The generator buses are connected to a corresponding output power terminal of the left or right generator relay and supply power to circuit breakers located on the generator bus circuit breaker panel. Except for ground service or emergency operations, all sources of ac power are applied to the generator buses. Power distribution to the ac buses, radio ac buses, and other large loads, such as heat exchanger fans and auxiliary hydraulic pumps, is taken from the generator buses. Circuit breakers protect each phase of ac power that is supplied to the applicable using load.

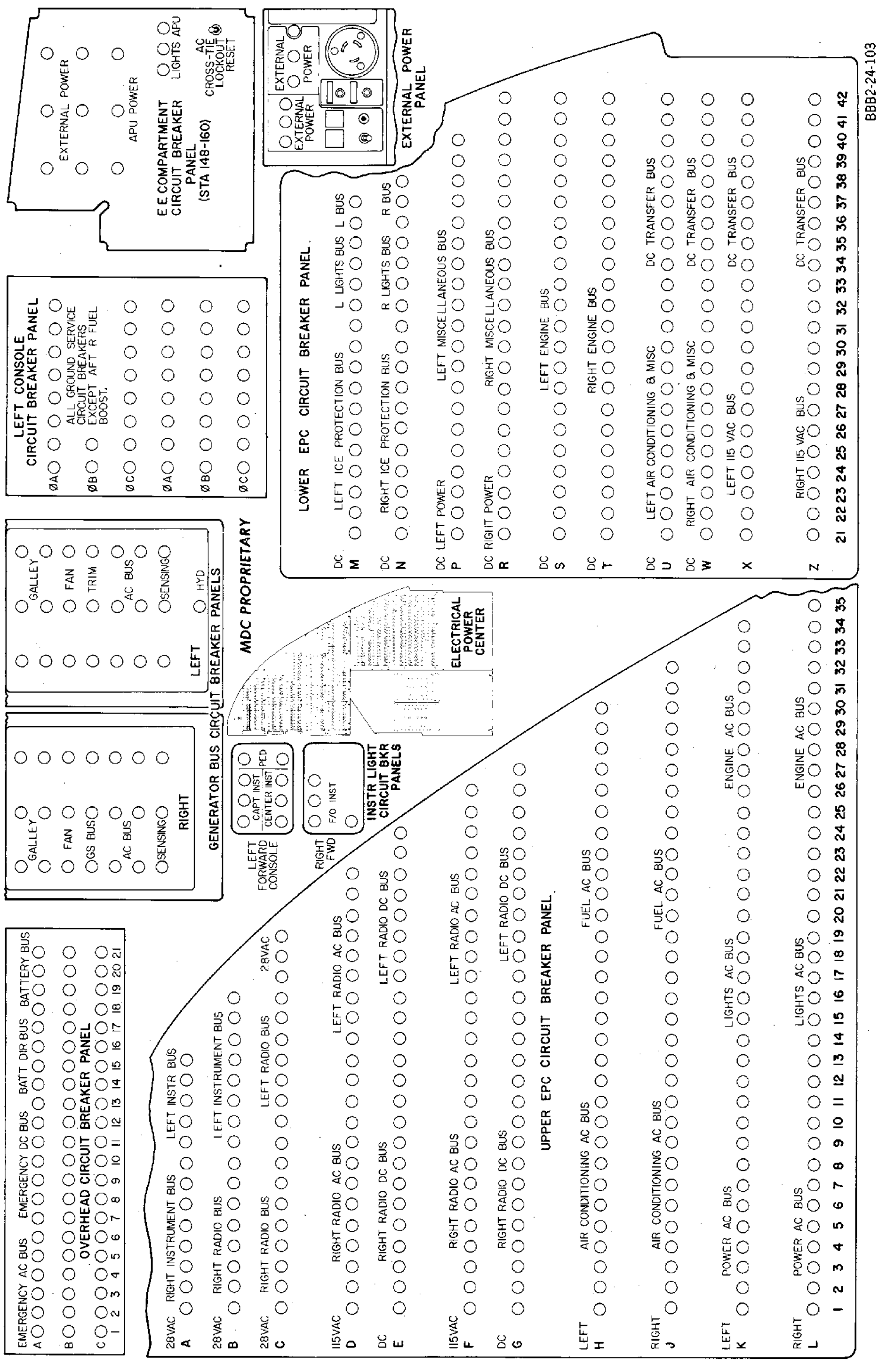
C. During normal operation, dc output power from the four transformer-rectifiers is supplied to a four-post terminal strip, located on the structure in the EPC, adjacent to the dc bus portion of the lower main circuit breaker panel. From the terminal strip, power is fed through power feeds, to the left or right dc buses.

D. The circuit breakers located on the forward side of the EPC are installed on two panels, the upper main and the lower main circuit breaker panels. Each panel is divided into outlined sections containing a group of circuit breakers. The sections are identified to indicate the bus to which the circuit breakers within the area are connected.

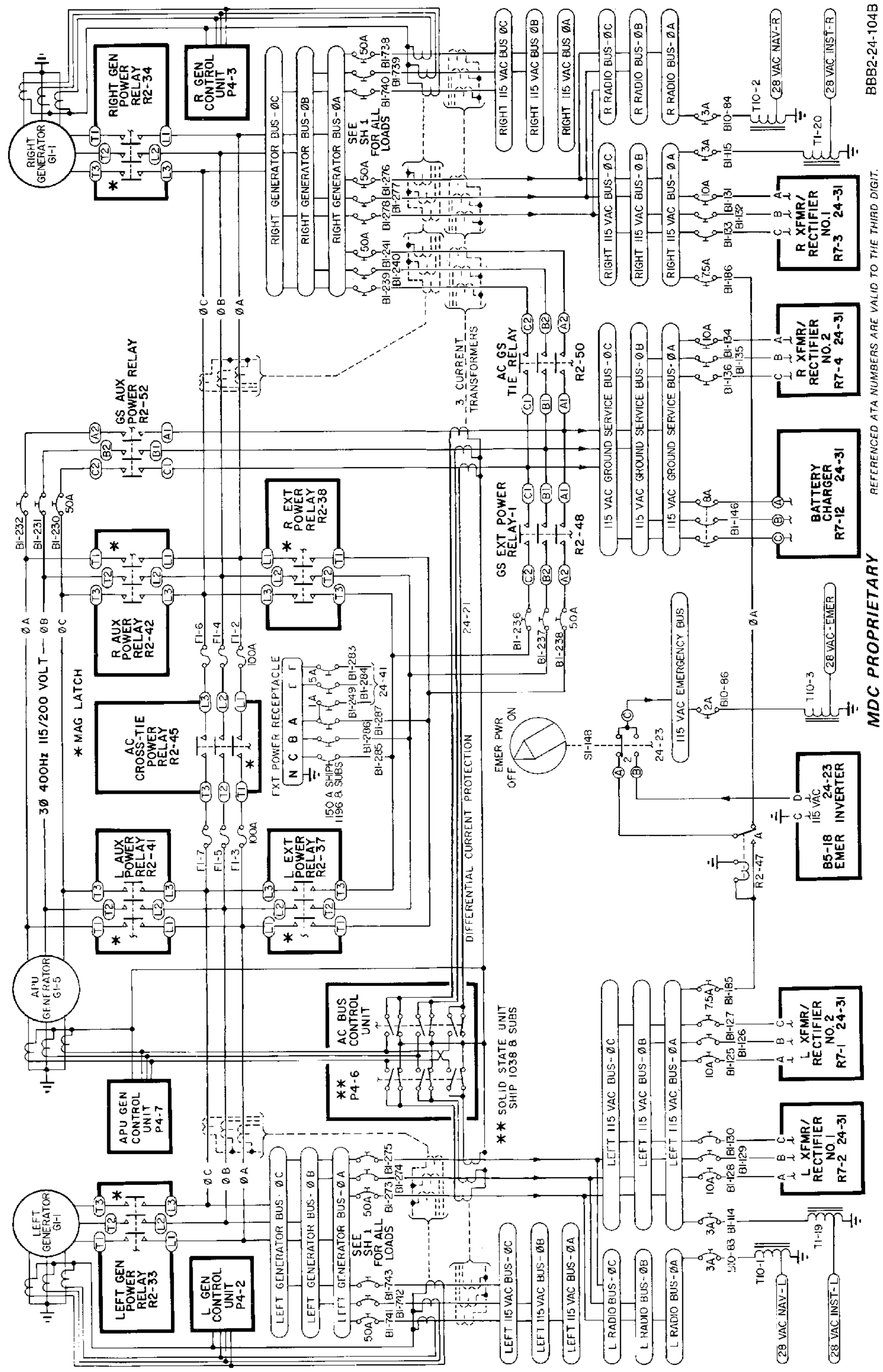
E. The upper main circuit breaker panel is divided into sections containing circuit breakers powered from the ac bus (left and right), the ac-dc radio buses, and the 28-volt instrument bus. The lower main circuit breaker panel is divided into sections containing circuit breakers powered from the dc bus (left and right), the dc transfer bus, and the ground service ac bus.



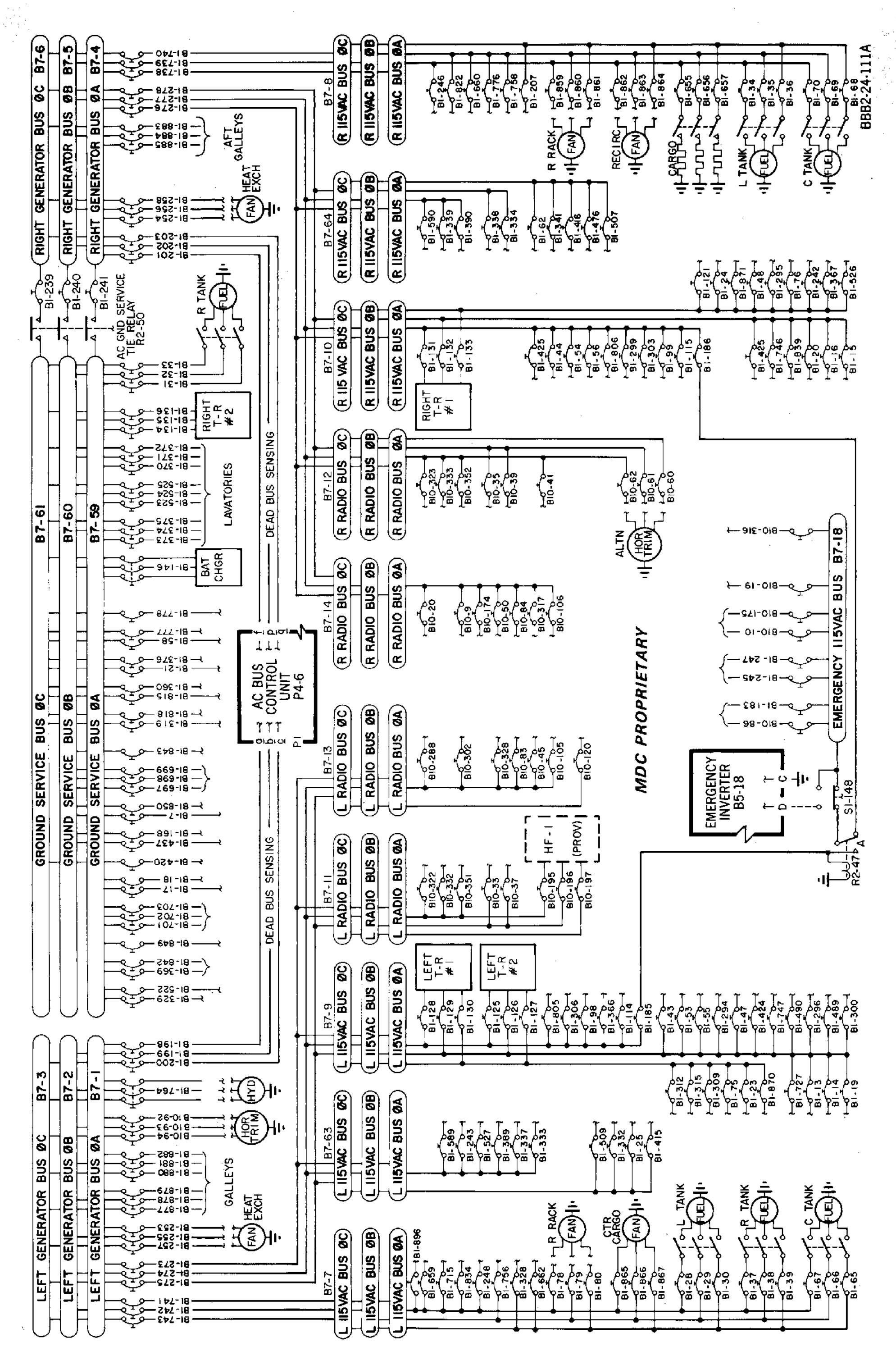
Electrical Power Distribution -- EPC
Figure 1/24-50-00-990-801



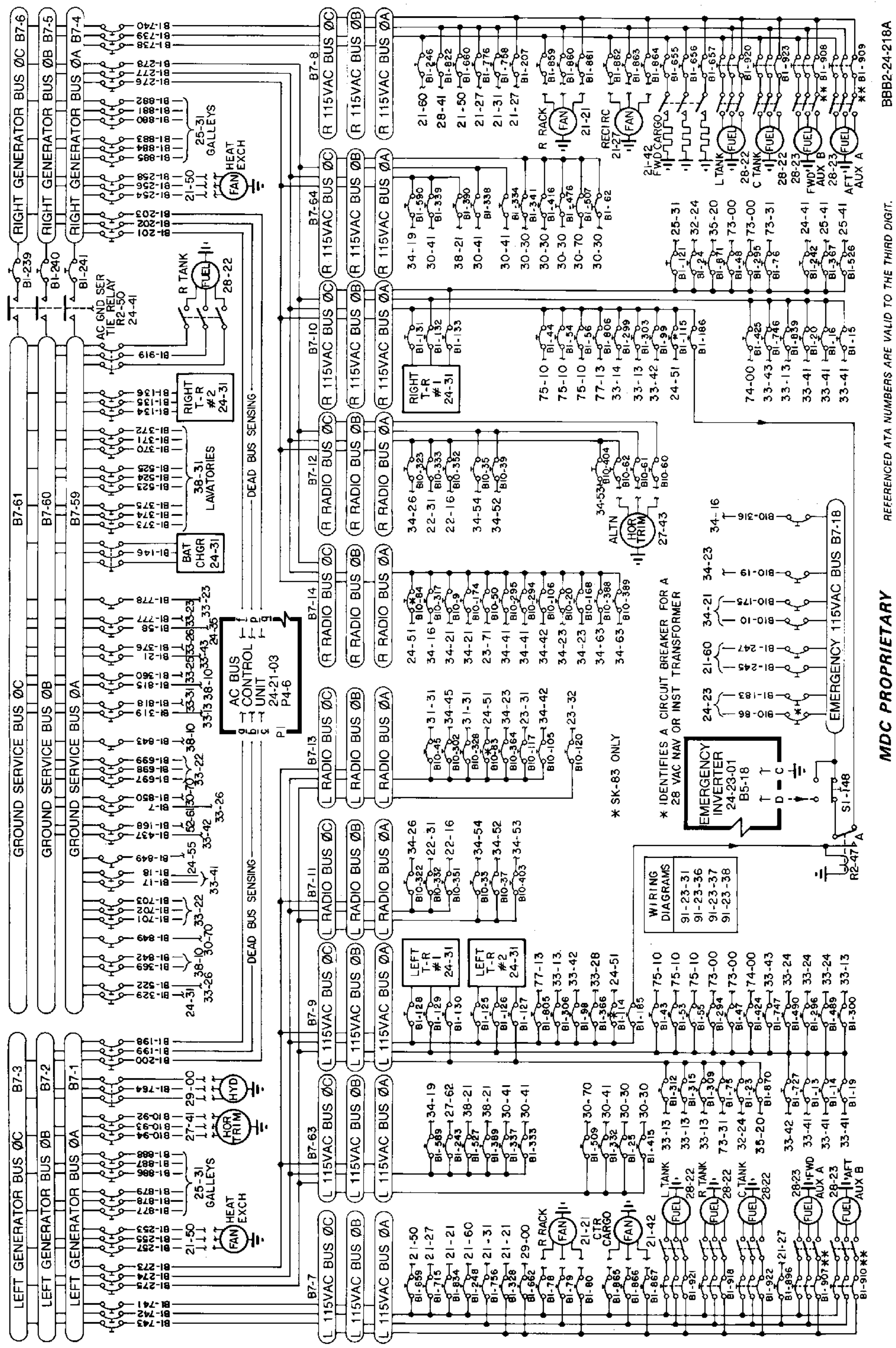
Circuit Breaker Panels
Figure 2/24-50-00-990-802



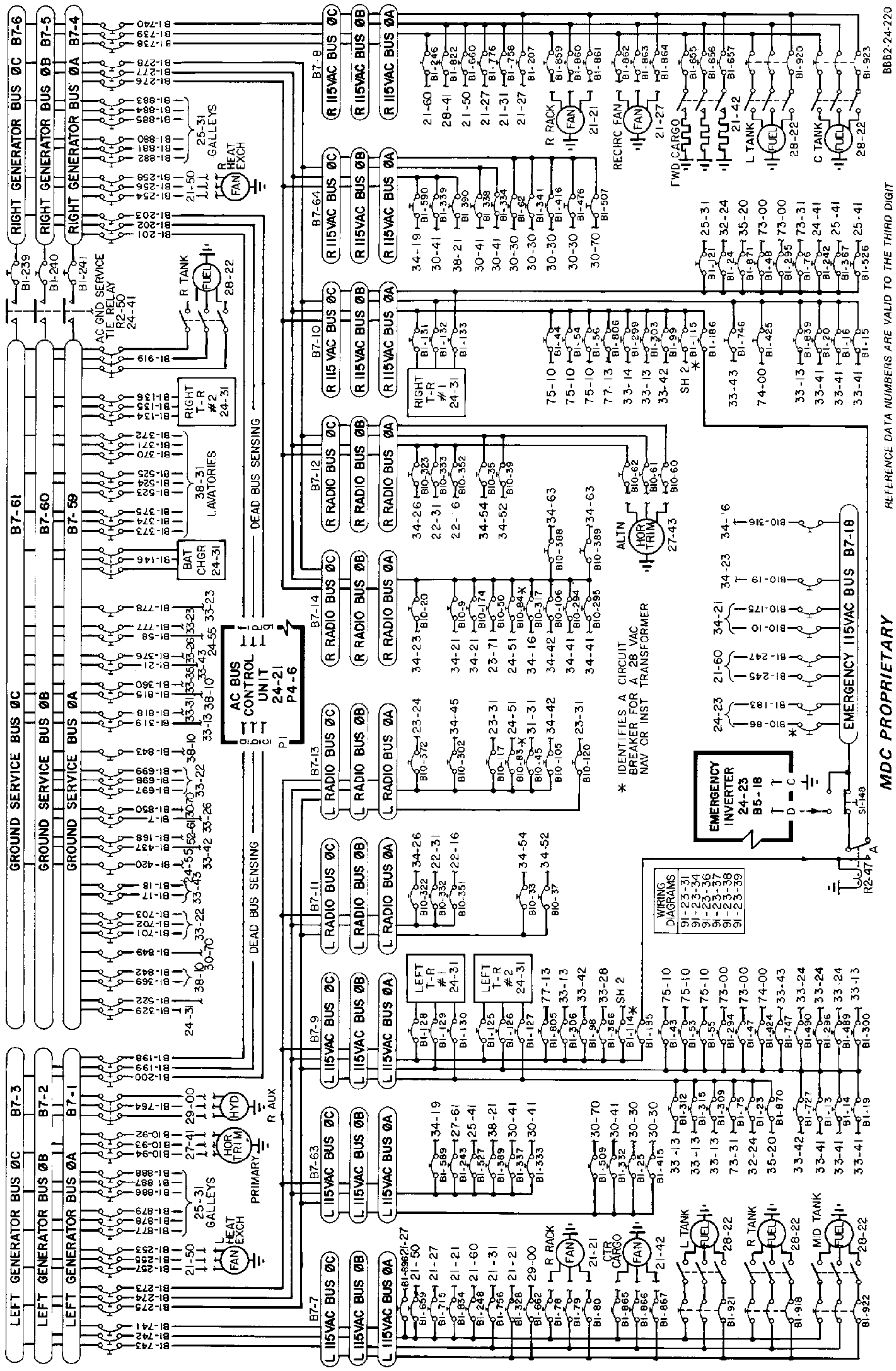
AC Power Distribution -- Schematic
Figure 3/24-50-00-990-803



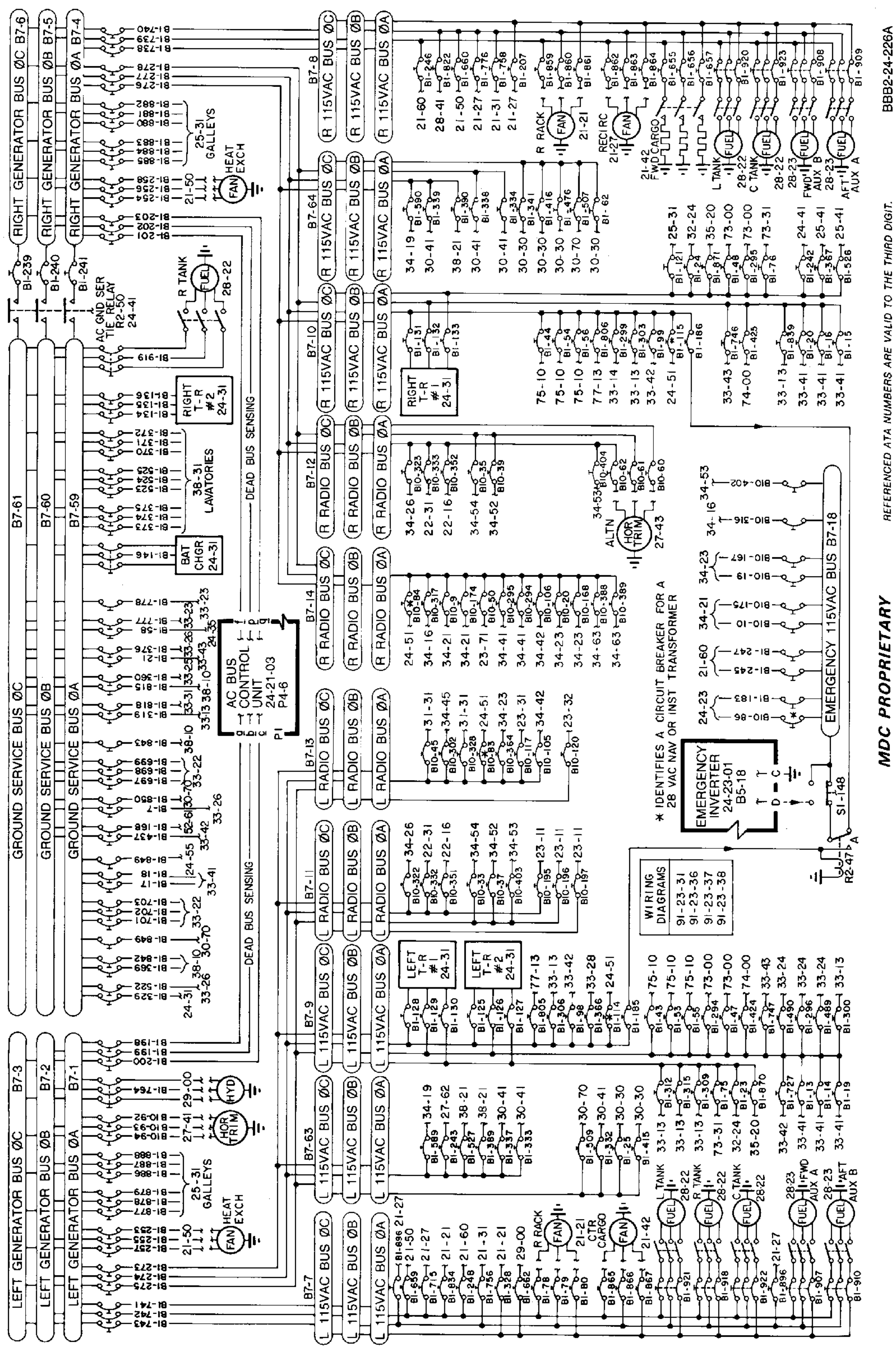
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 1 of 10)



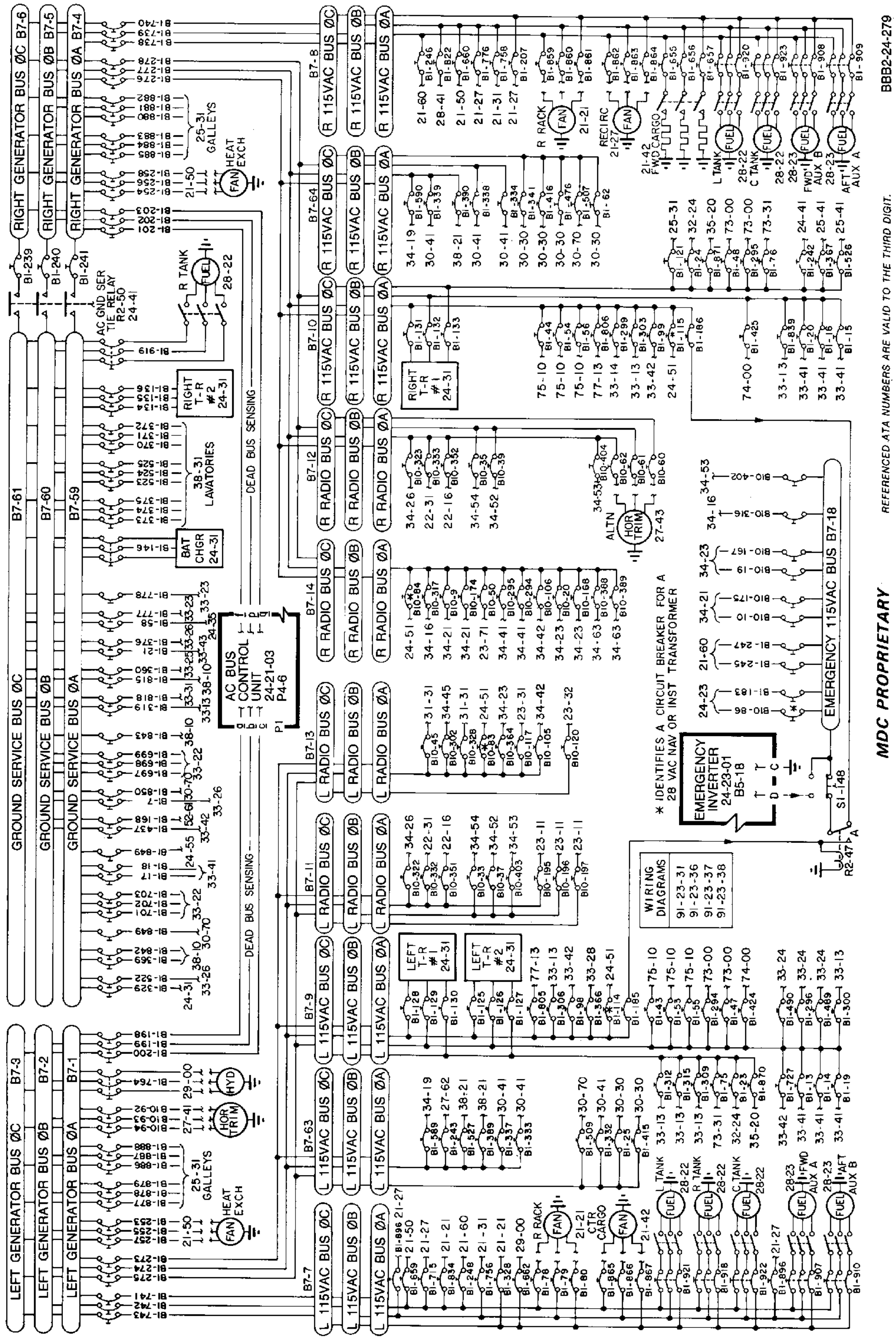
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 2 of 10)



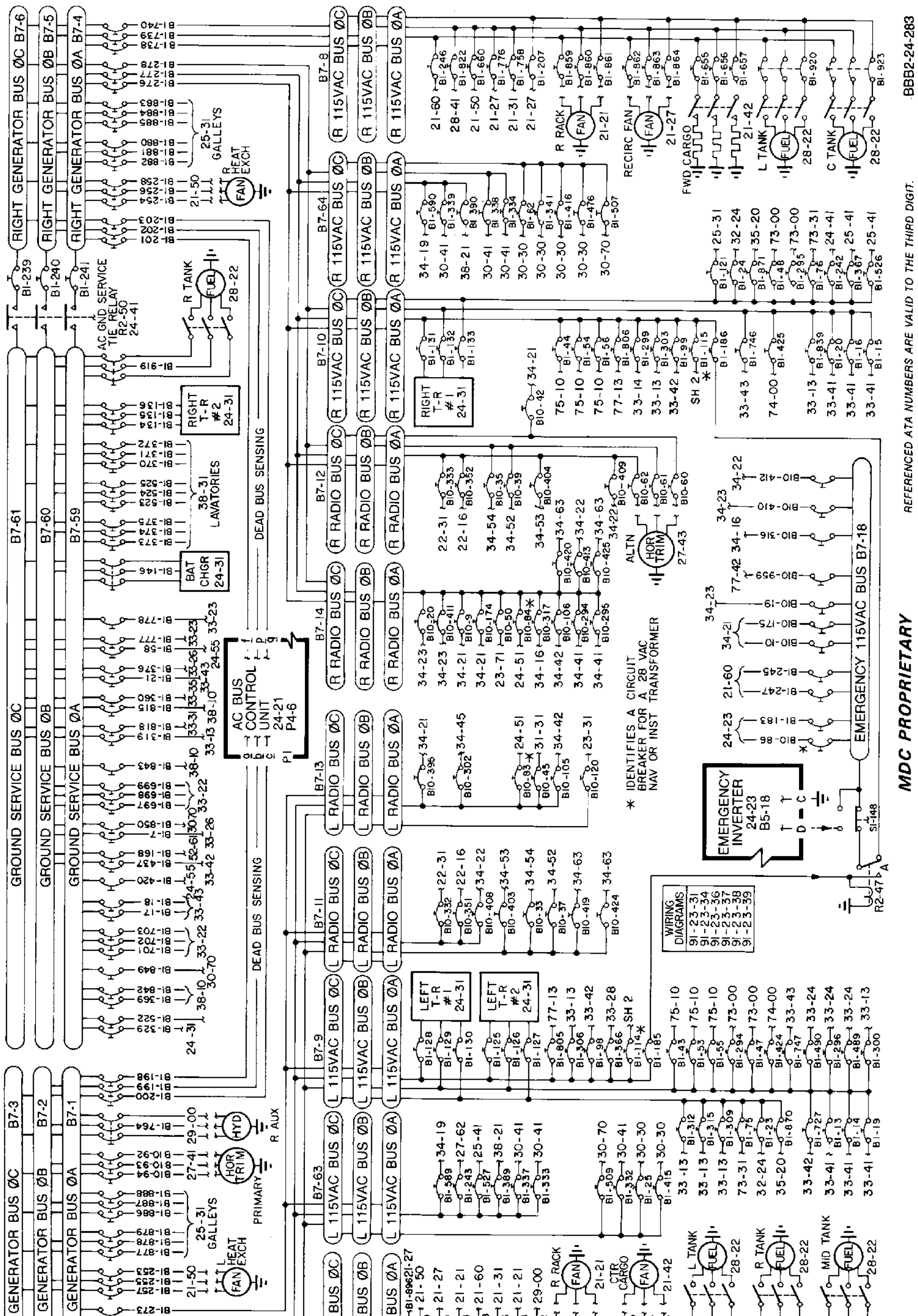
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 3 of 10)



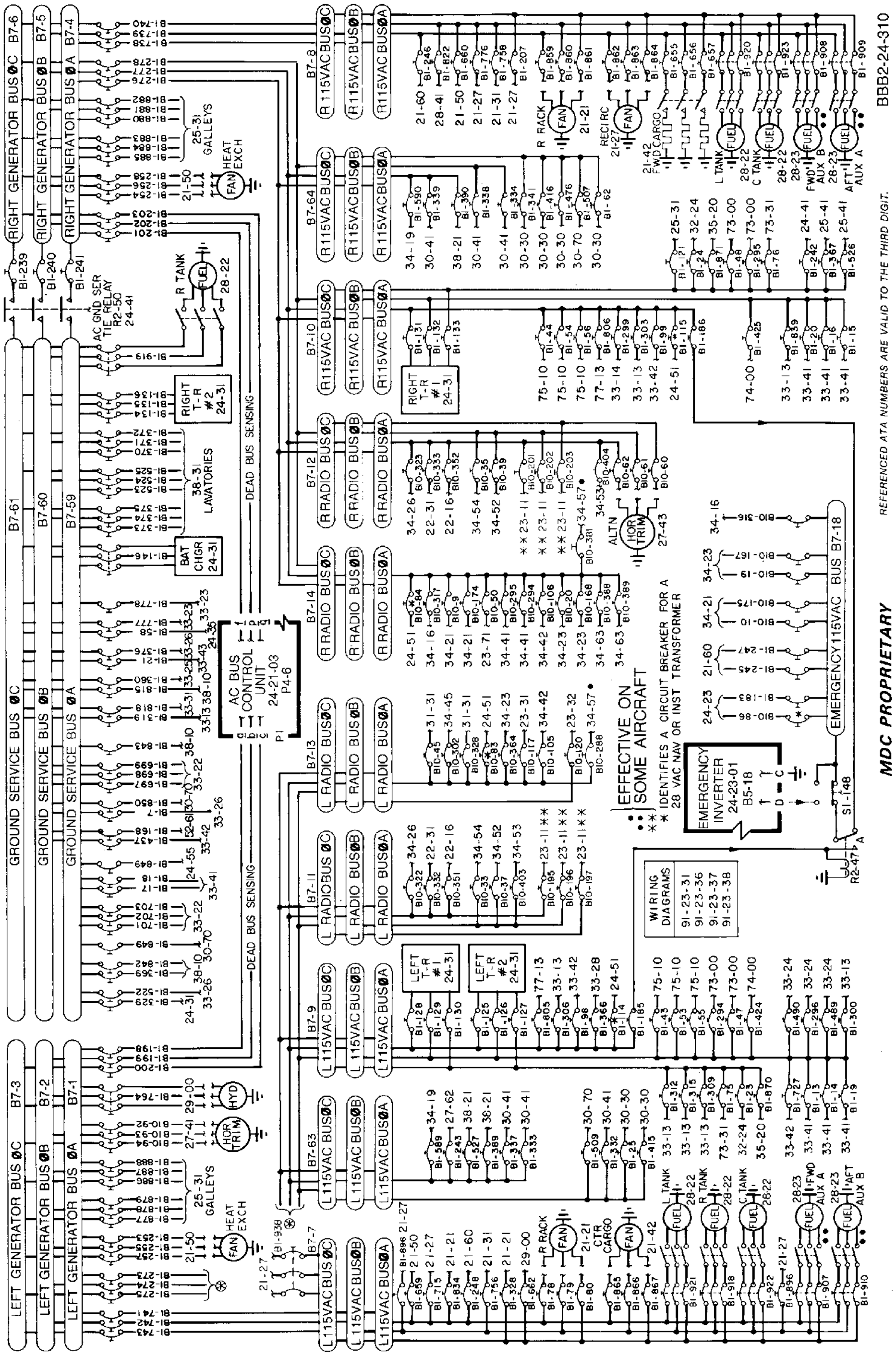
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 4 of 10)



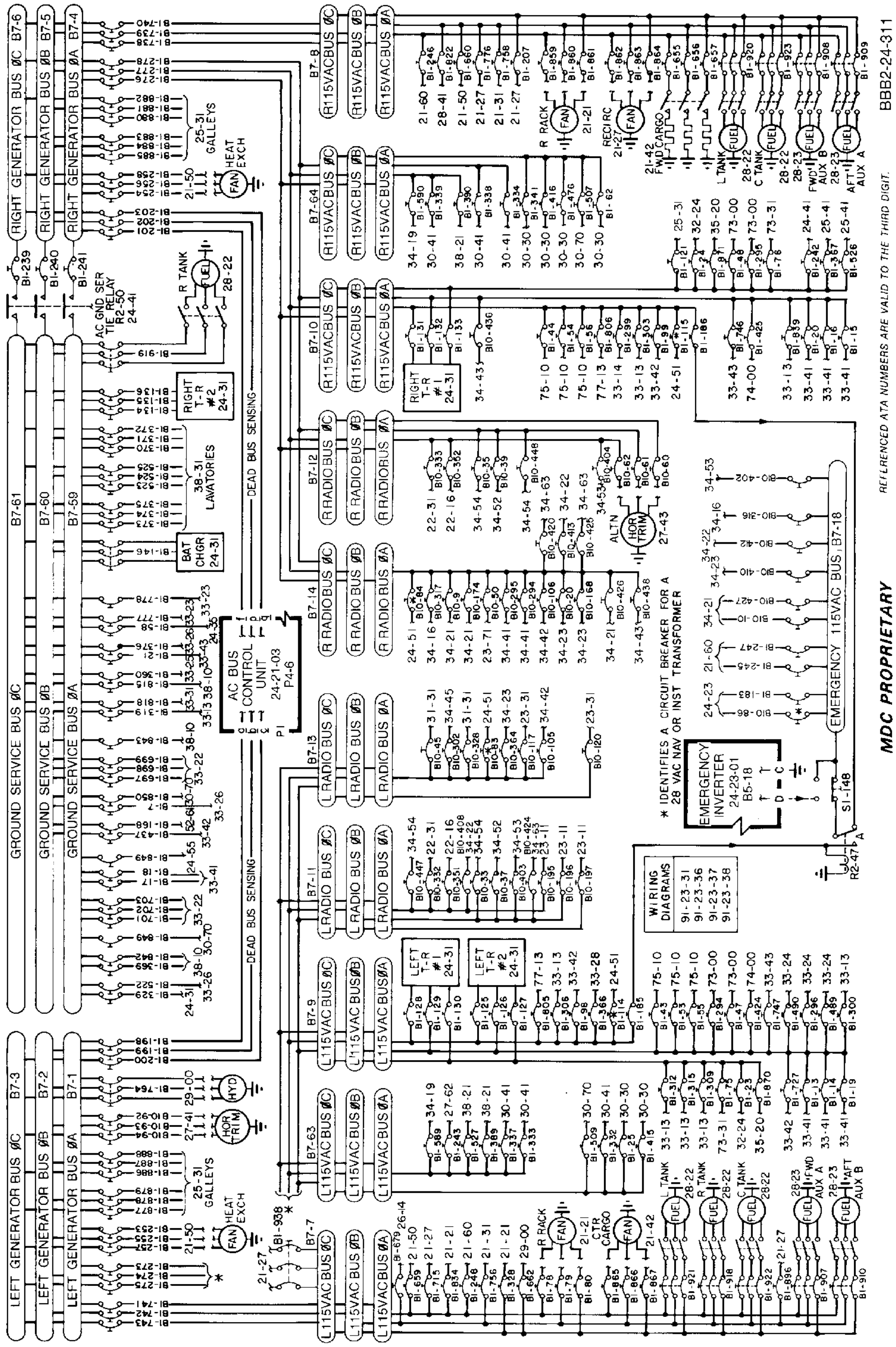
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 5 of 10)



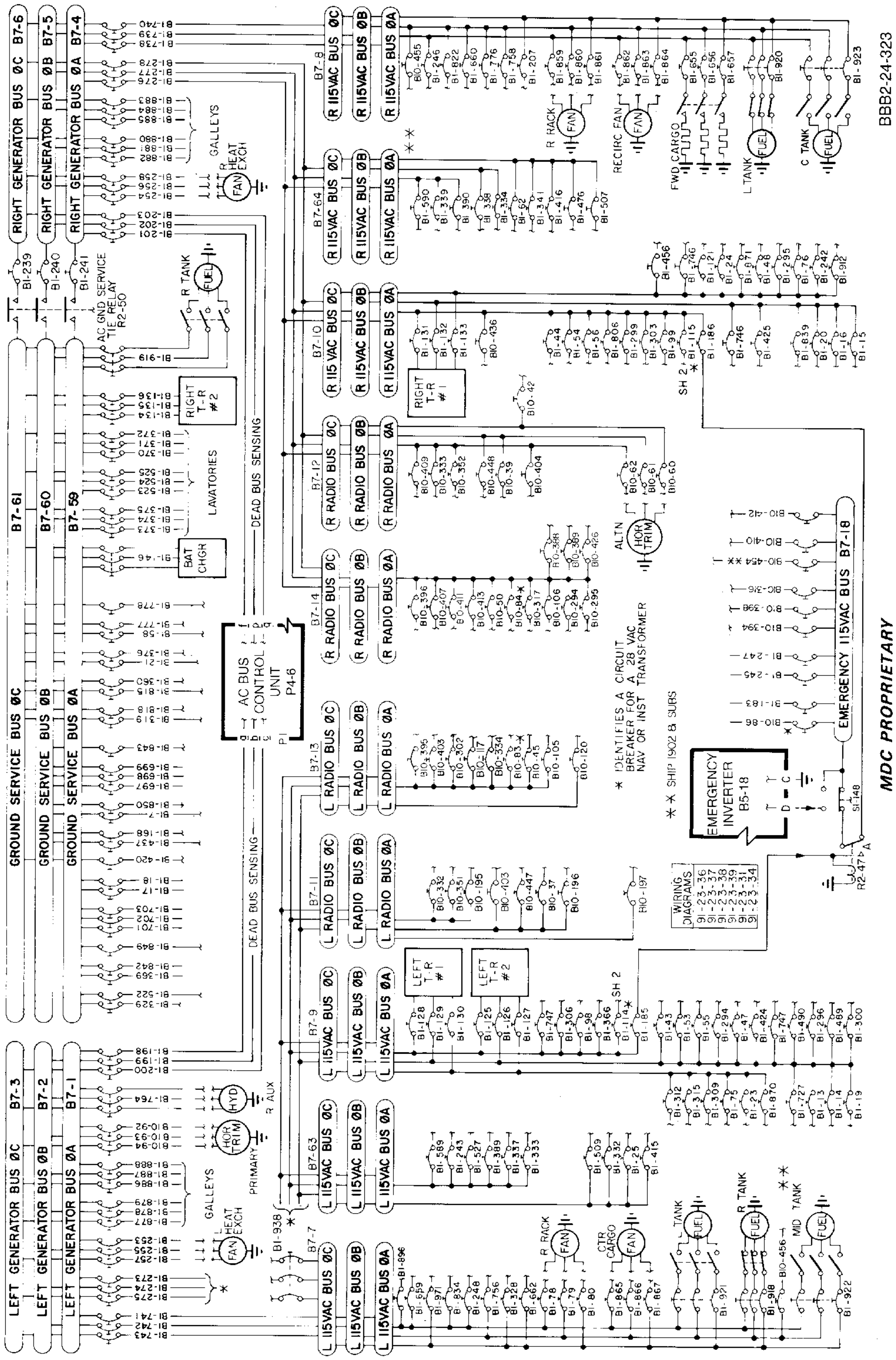
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 6 of 10)



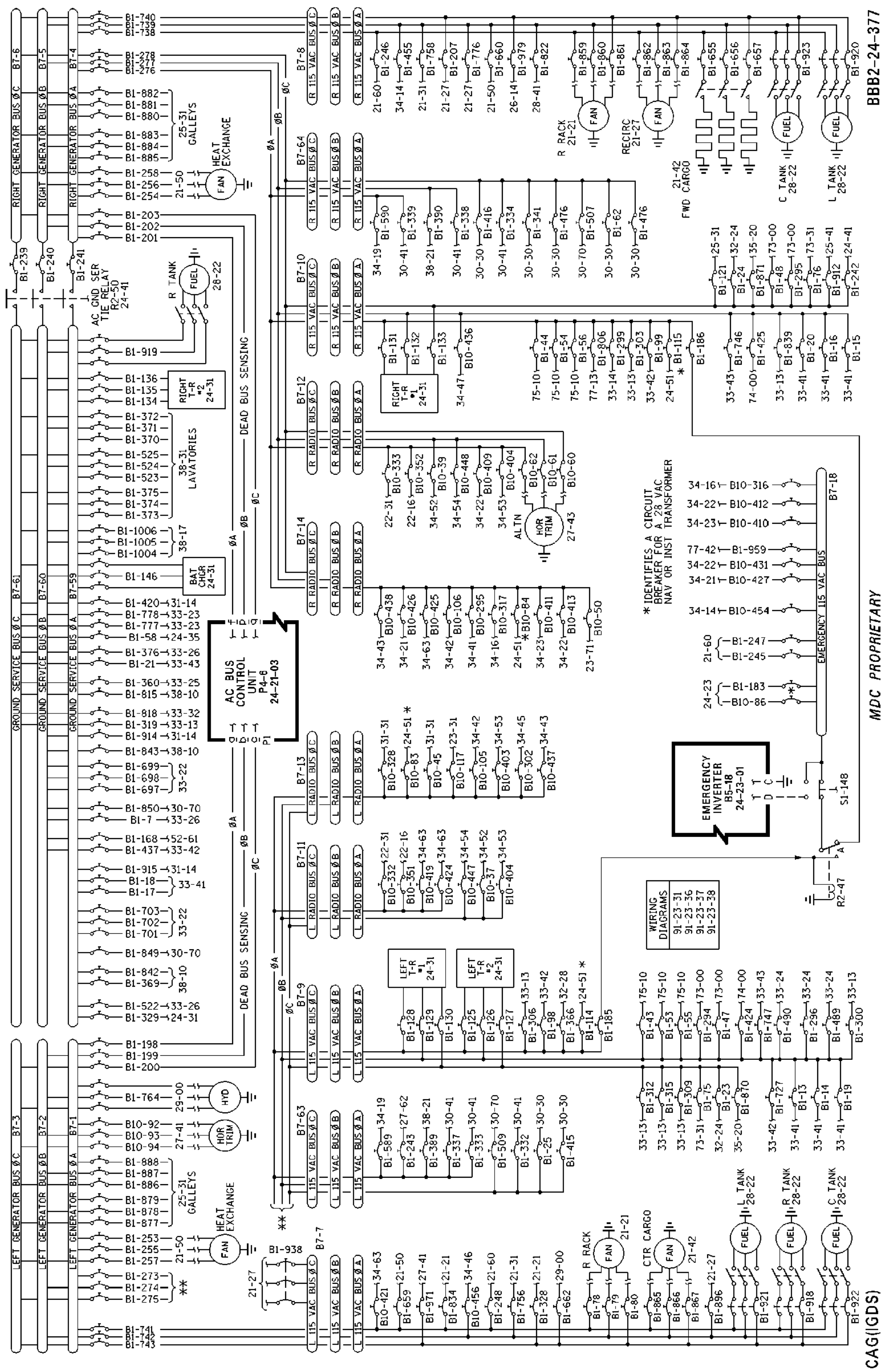
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 7 of 10)



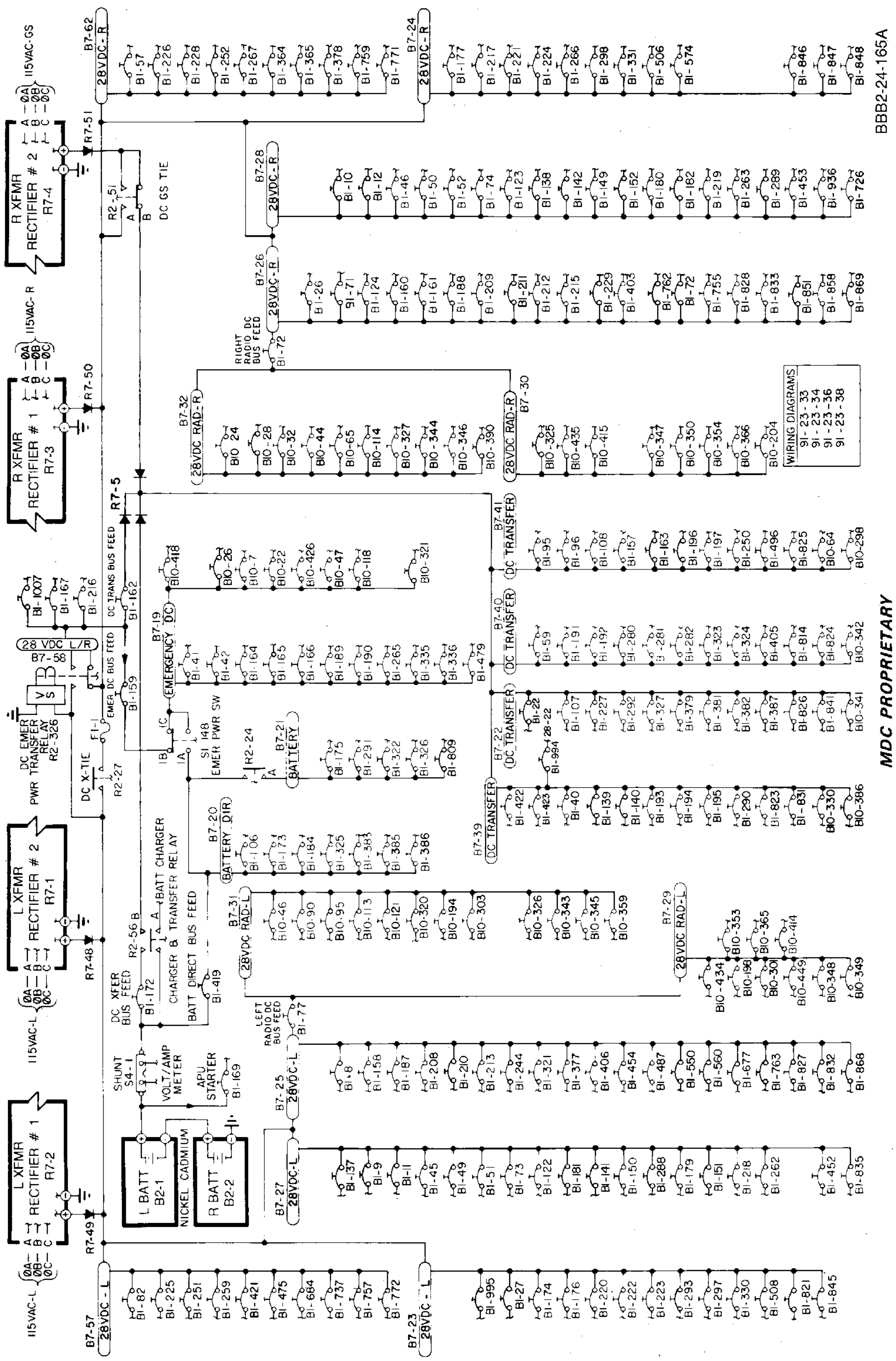
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 8 of 10)



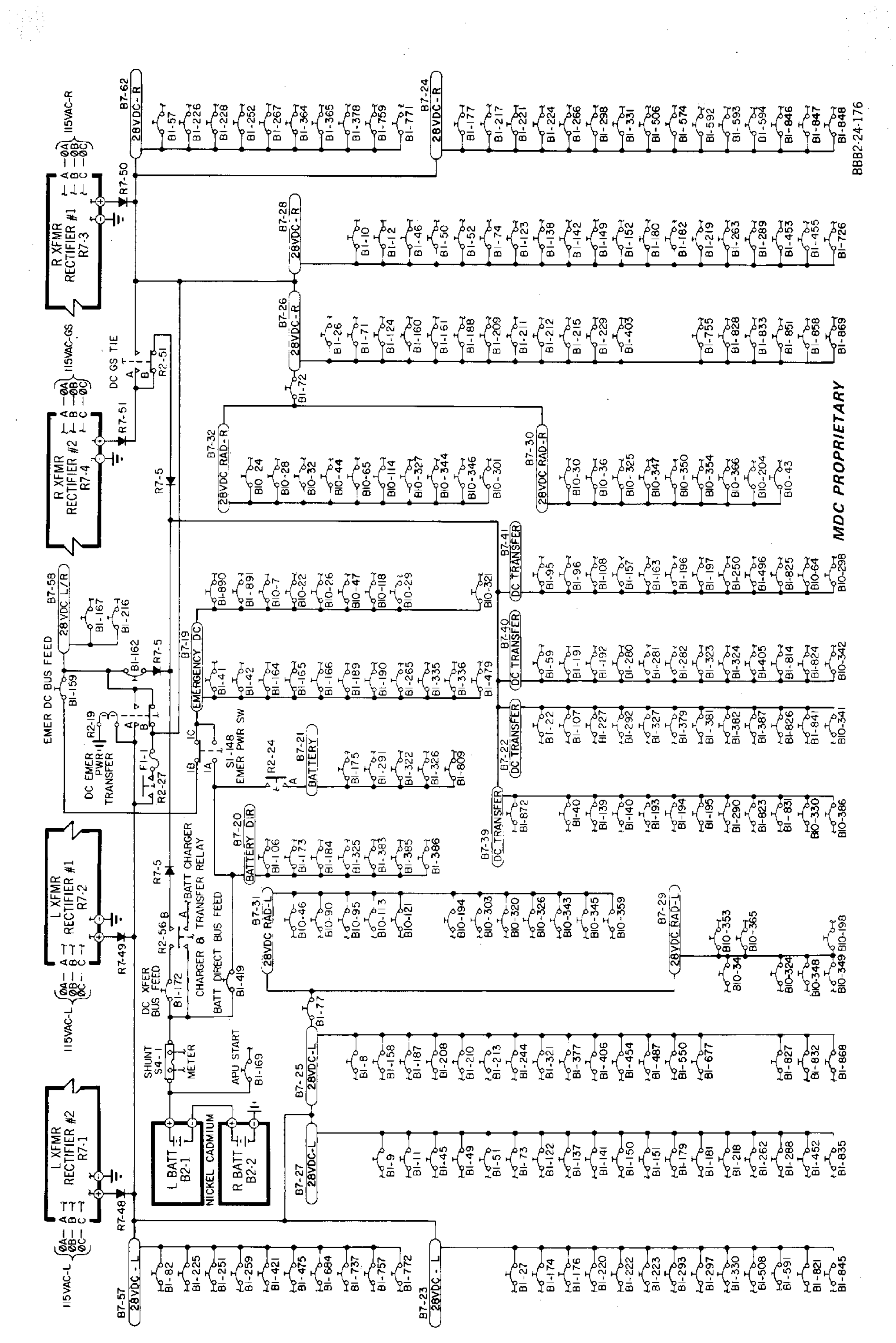
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 9 of 10)



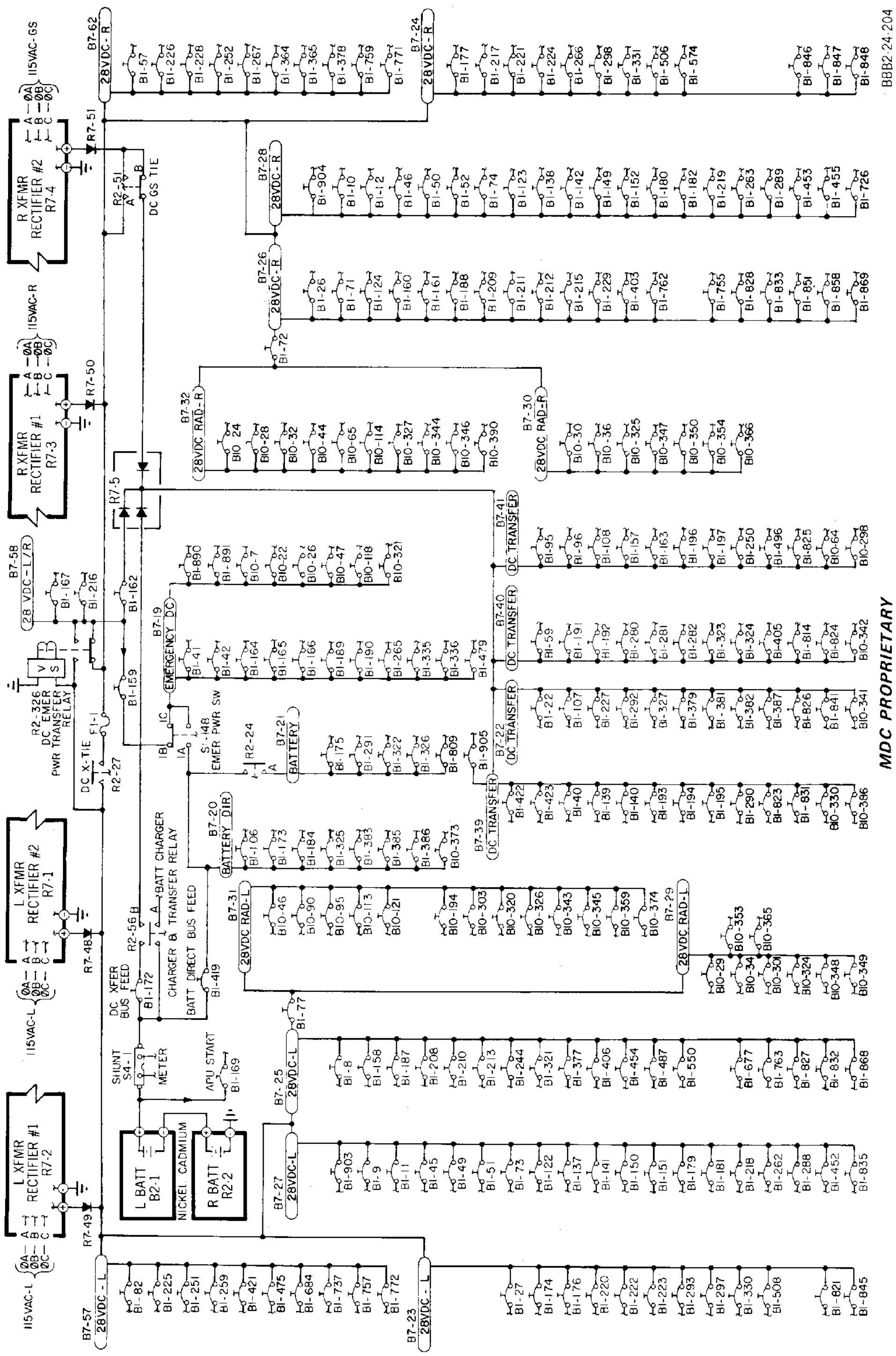
115 VAC Power Distribution -- Schematic
Figure 4/24-50-00-990-804 (Sheet 10 of 10)



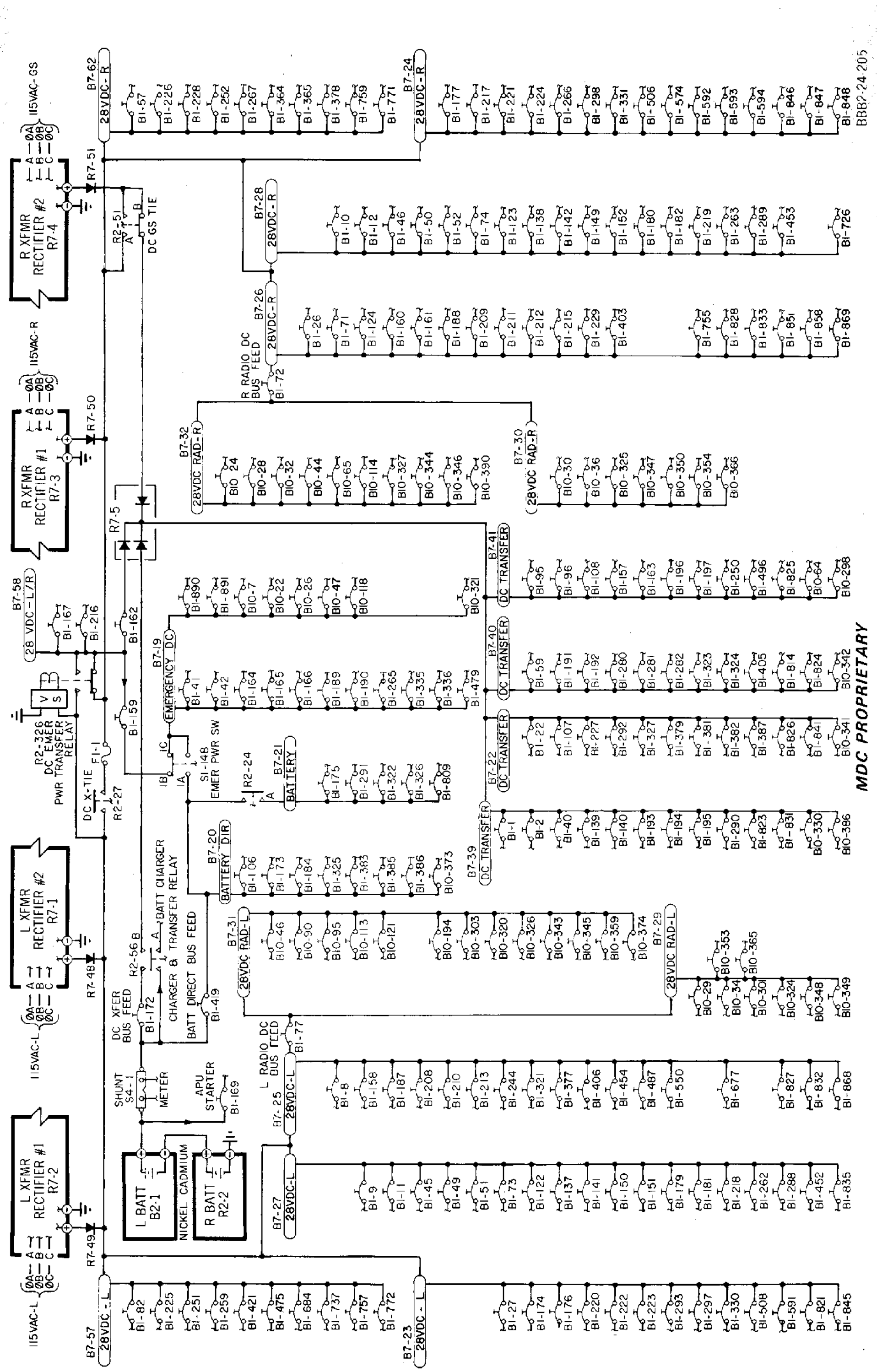
DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 1 of 9)



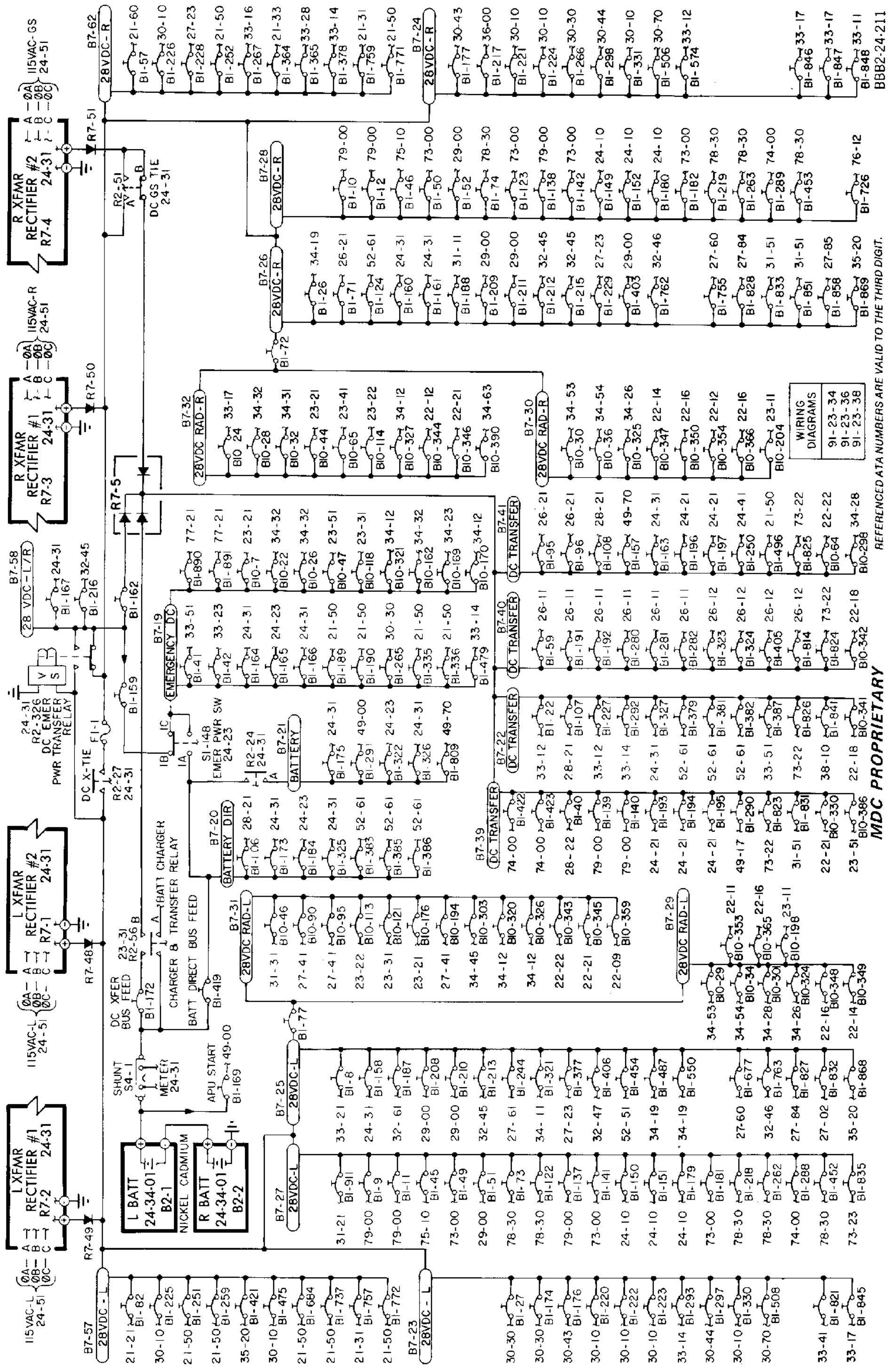
DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 2 of 9)



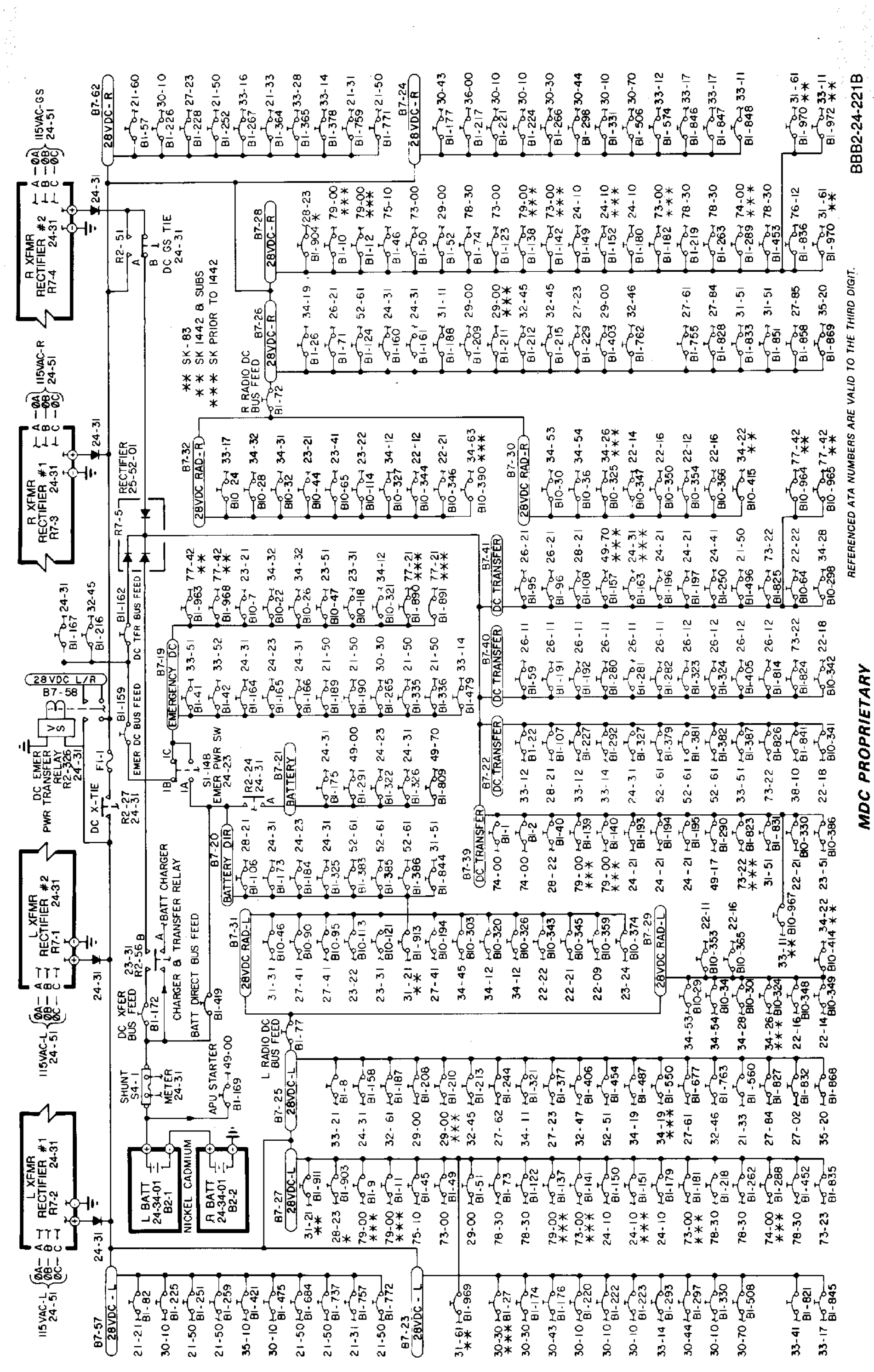
DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 3 of 9)



DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 4 of 9)

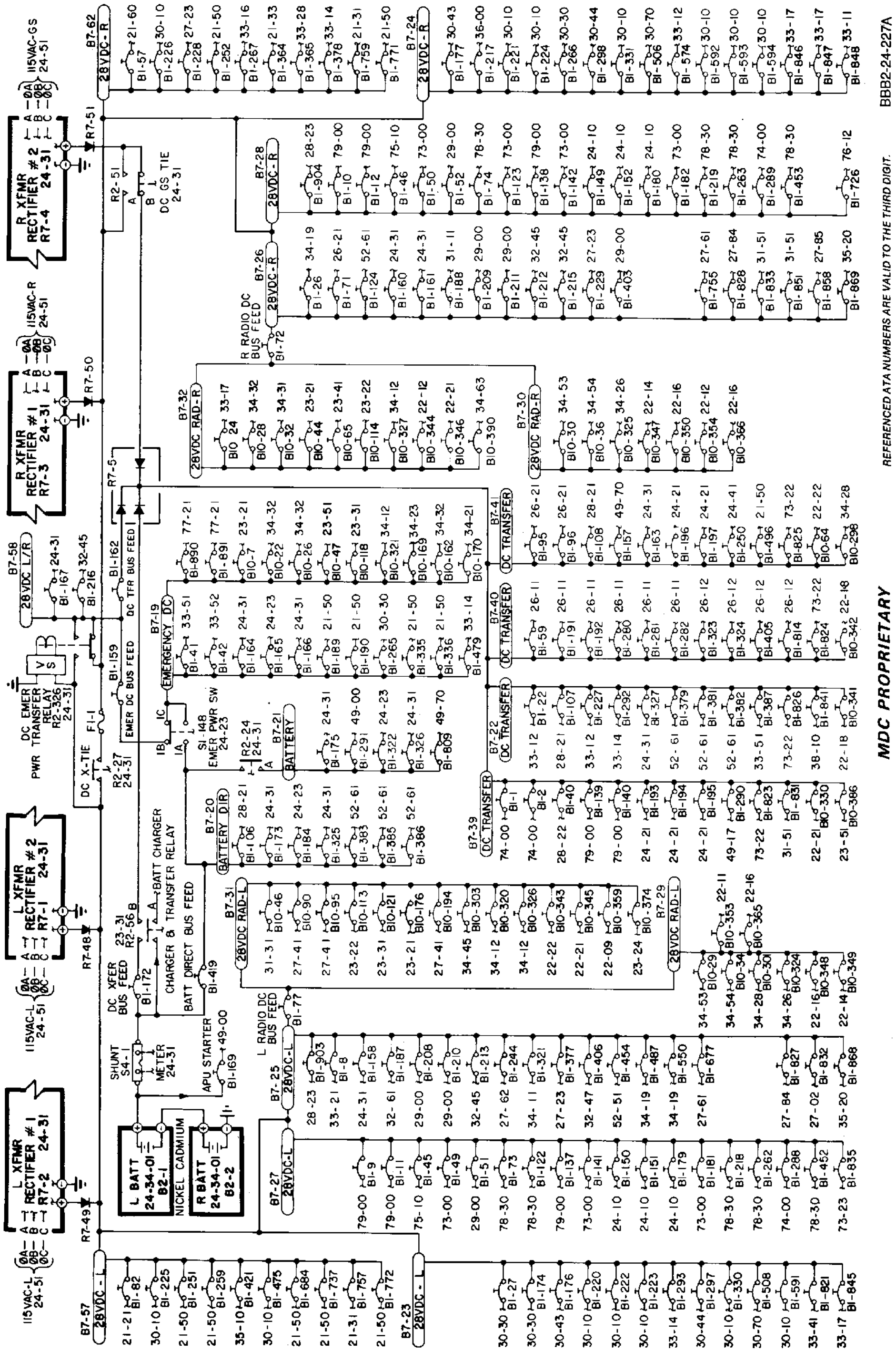


DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 5 of 9)

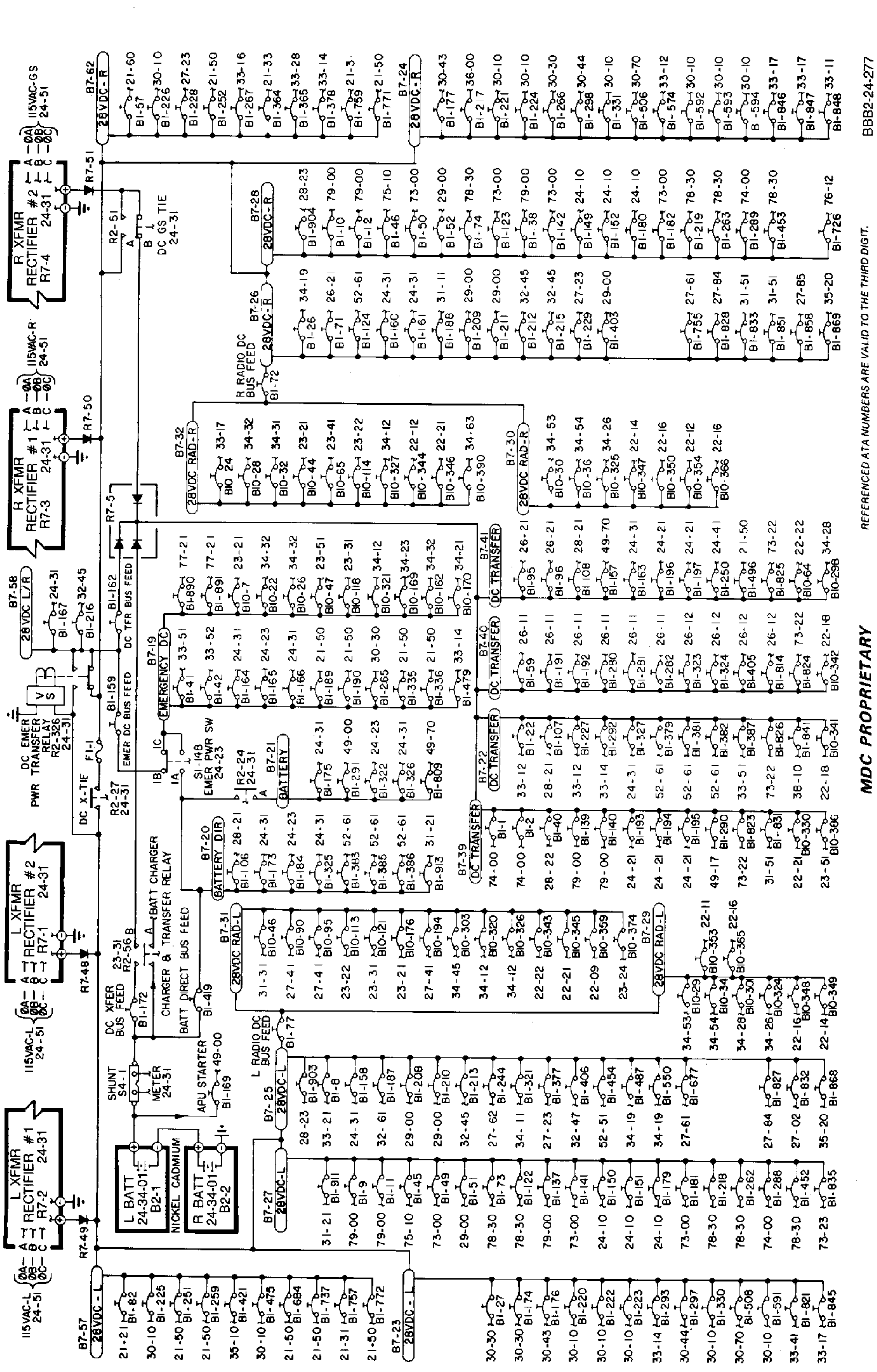


DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 6 of 9)

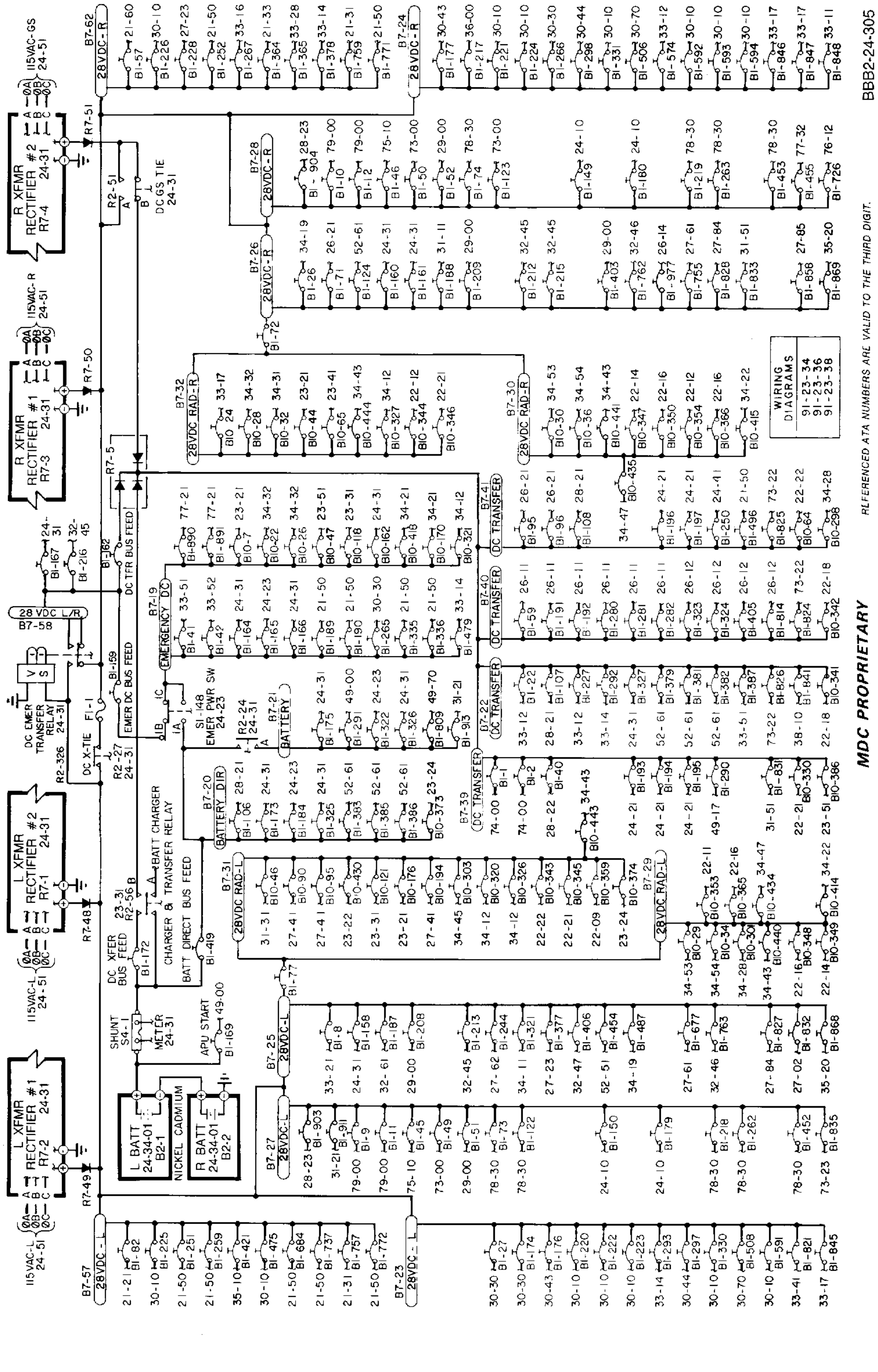
EFFECTIVITY
WJE 415-427, 429, 861-866, 868, 869, 871, 872, 891



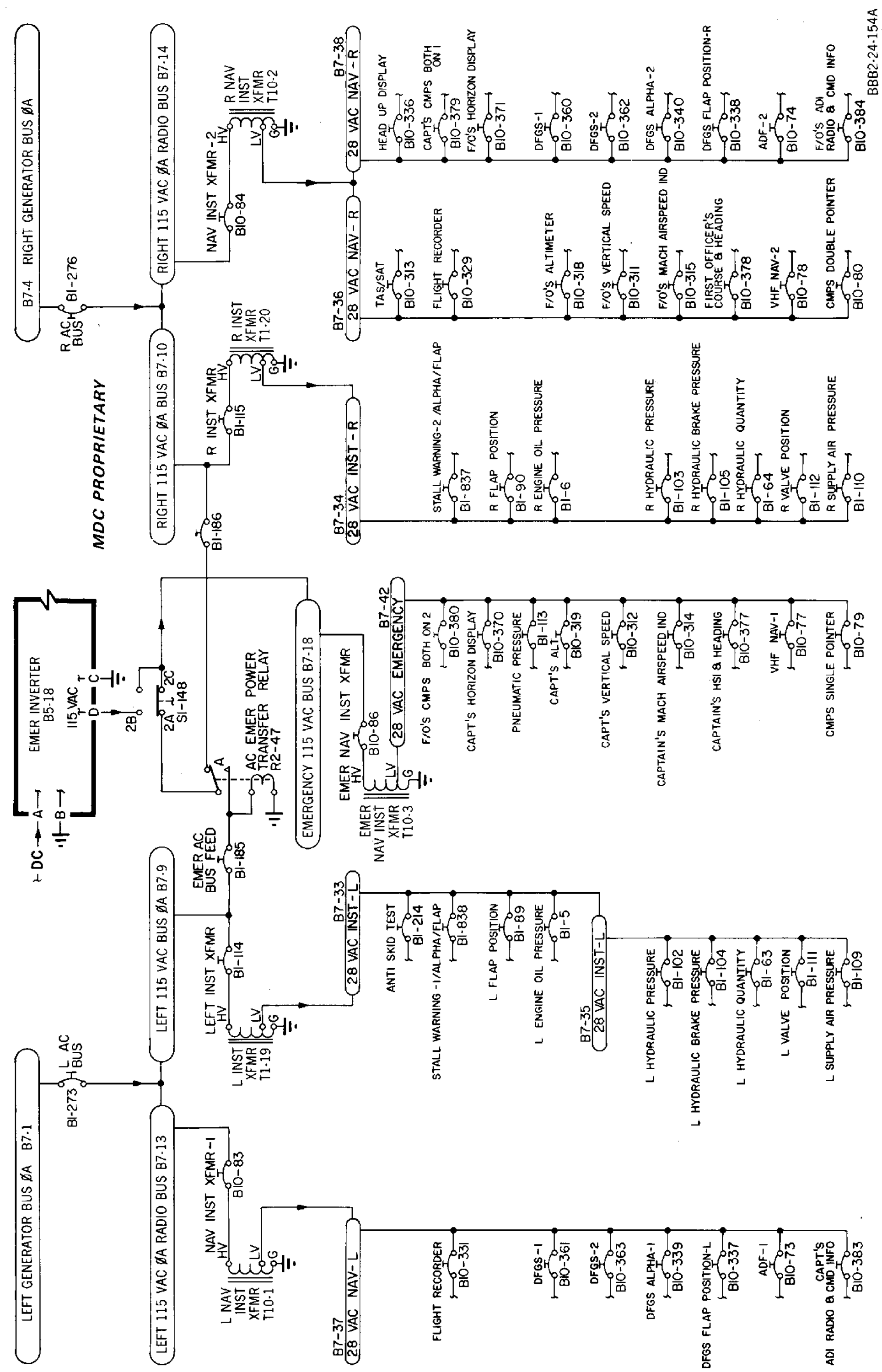
DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 7 of 9)



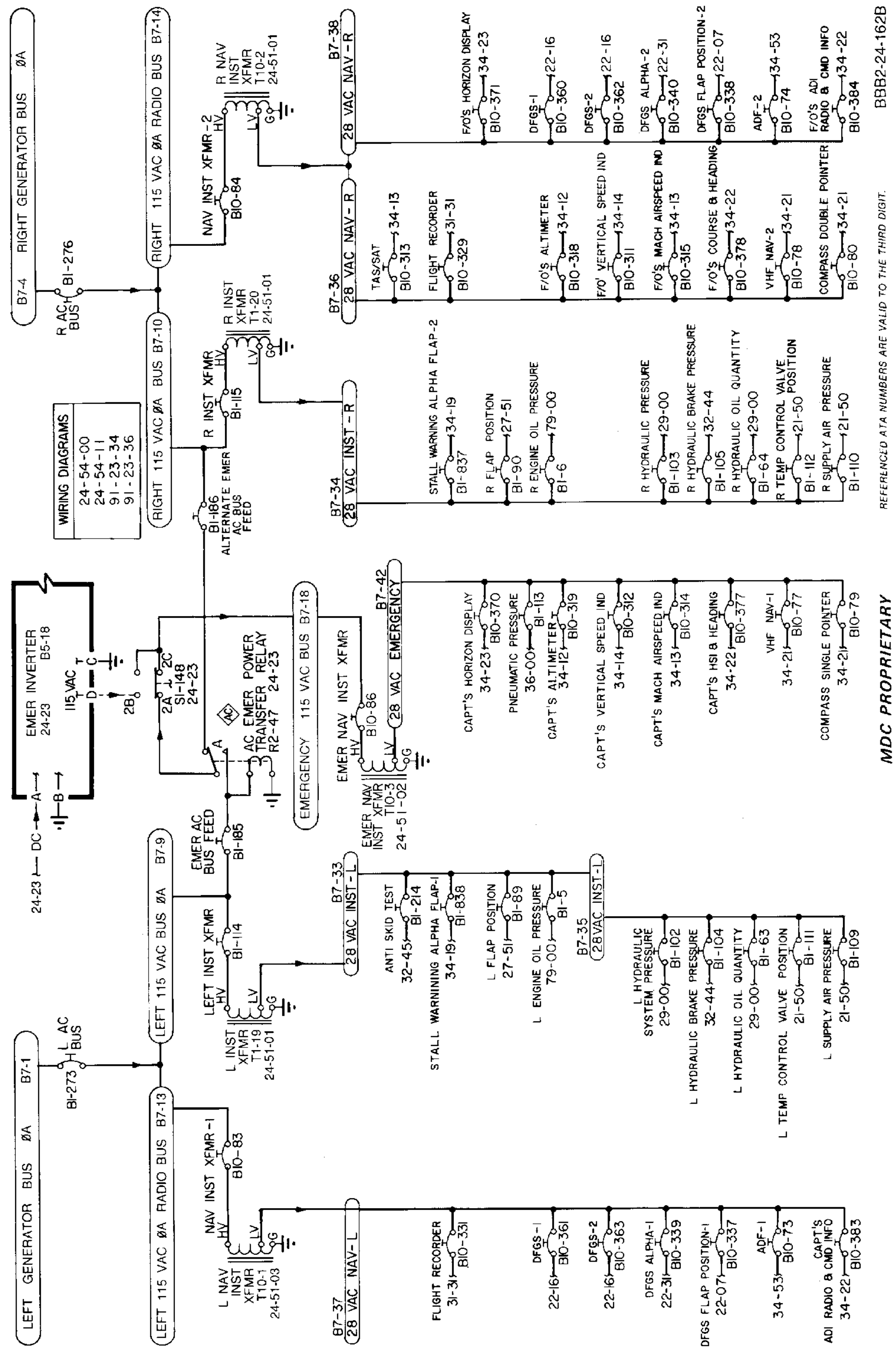
DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 8 of 9)



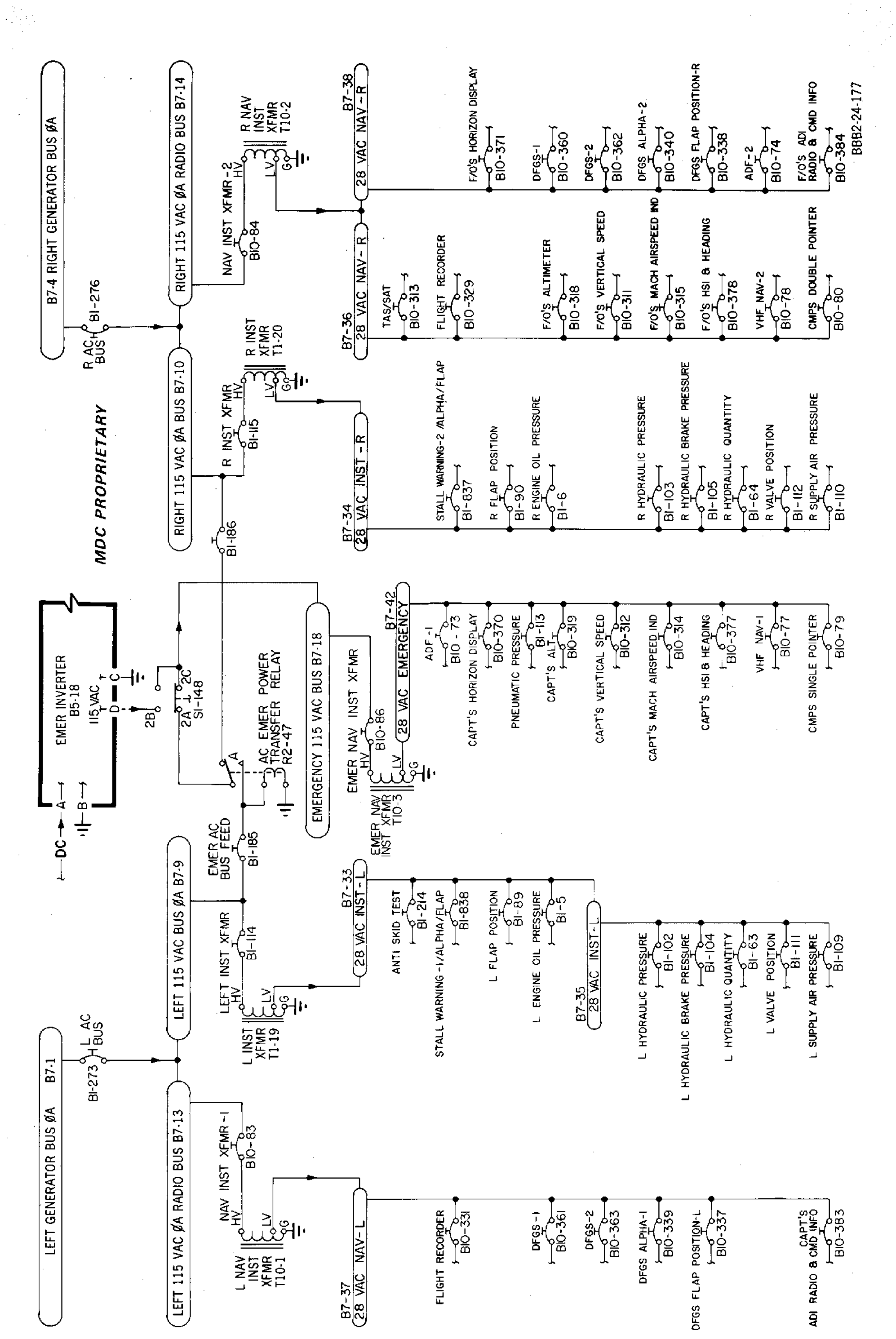
DC Power Distribution -- Schematic
Figure 5/24-50-00-990-805 (Sheet 9 of 9)



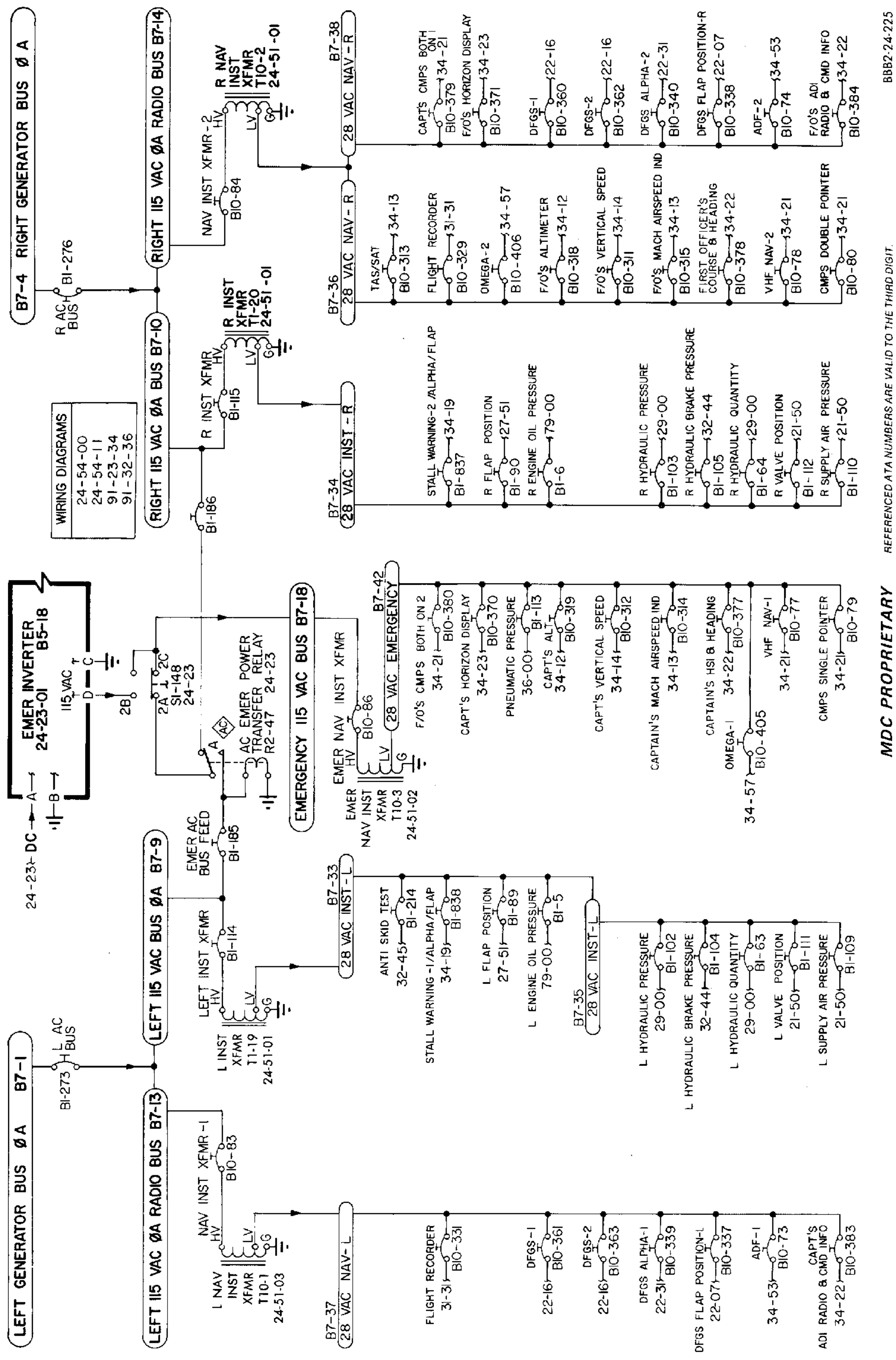
28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 1 of 9)



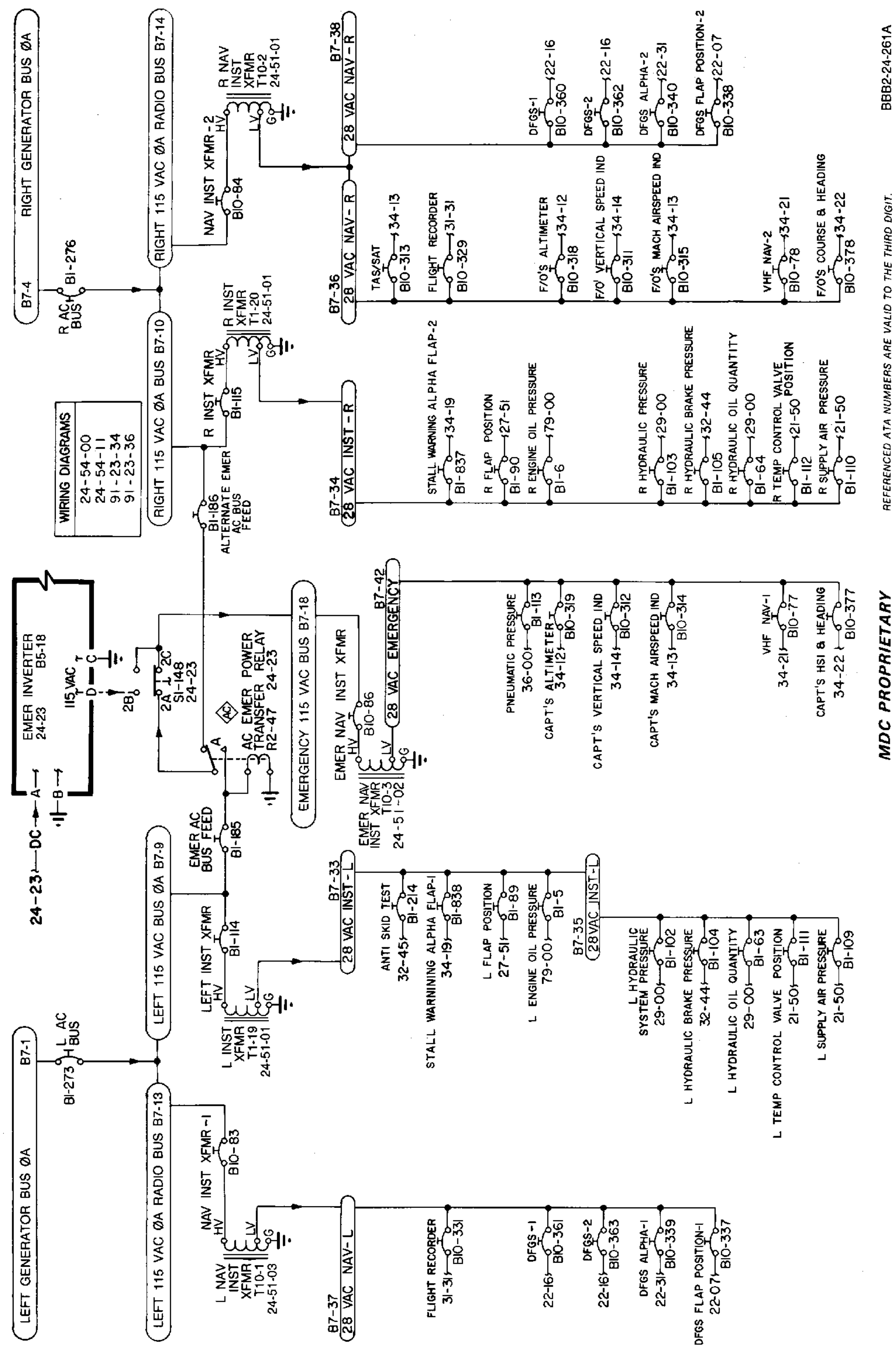
28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 2 of 9)



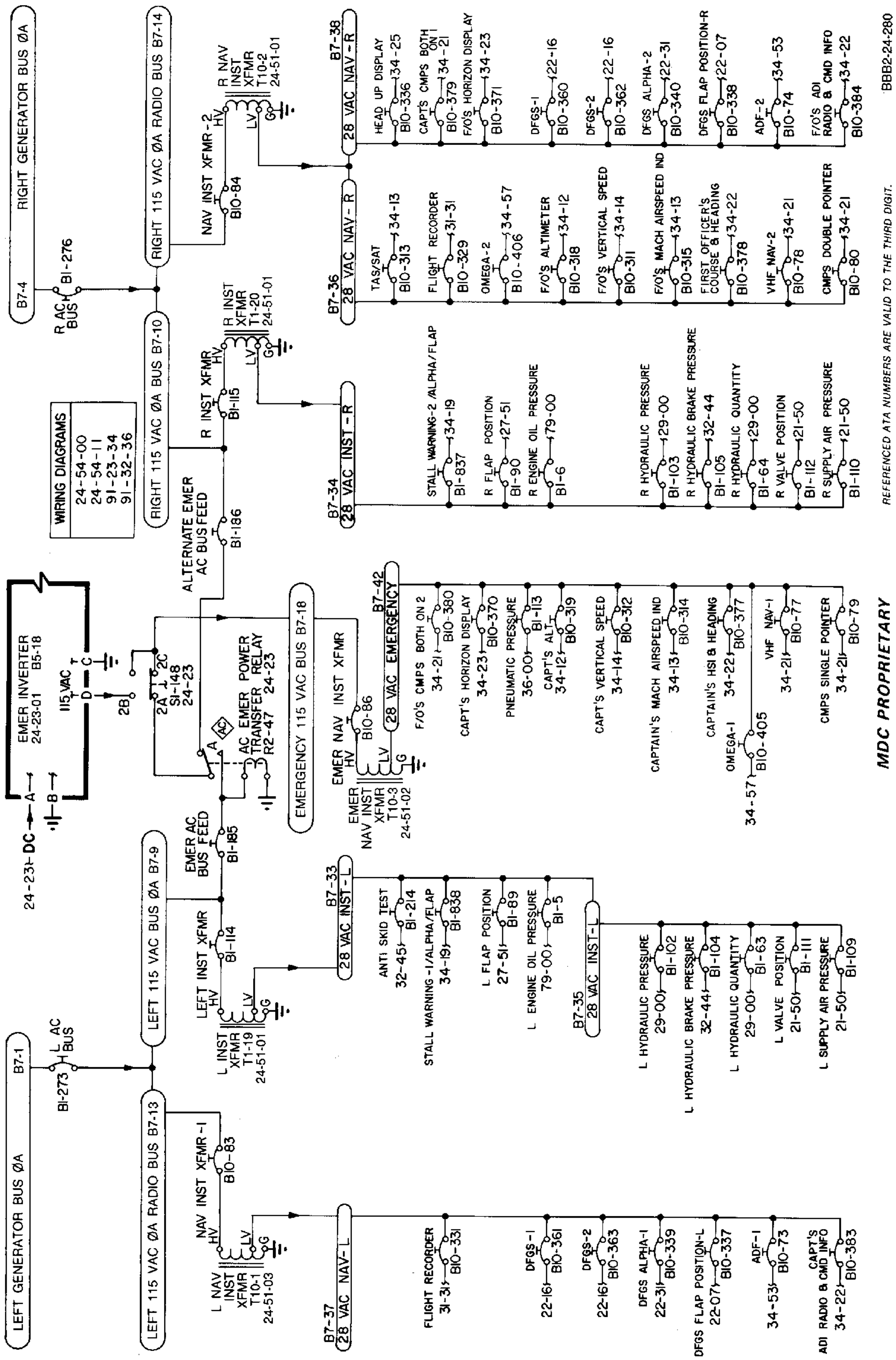
28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 3 of 9)



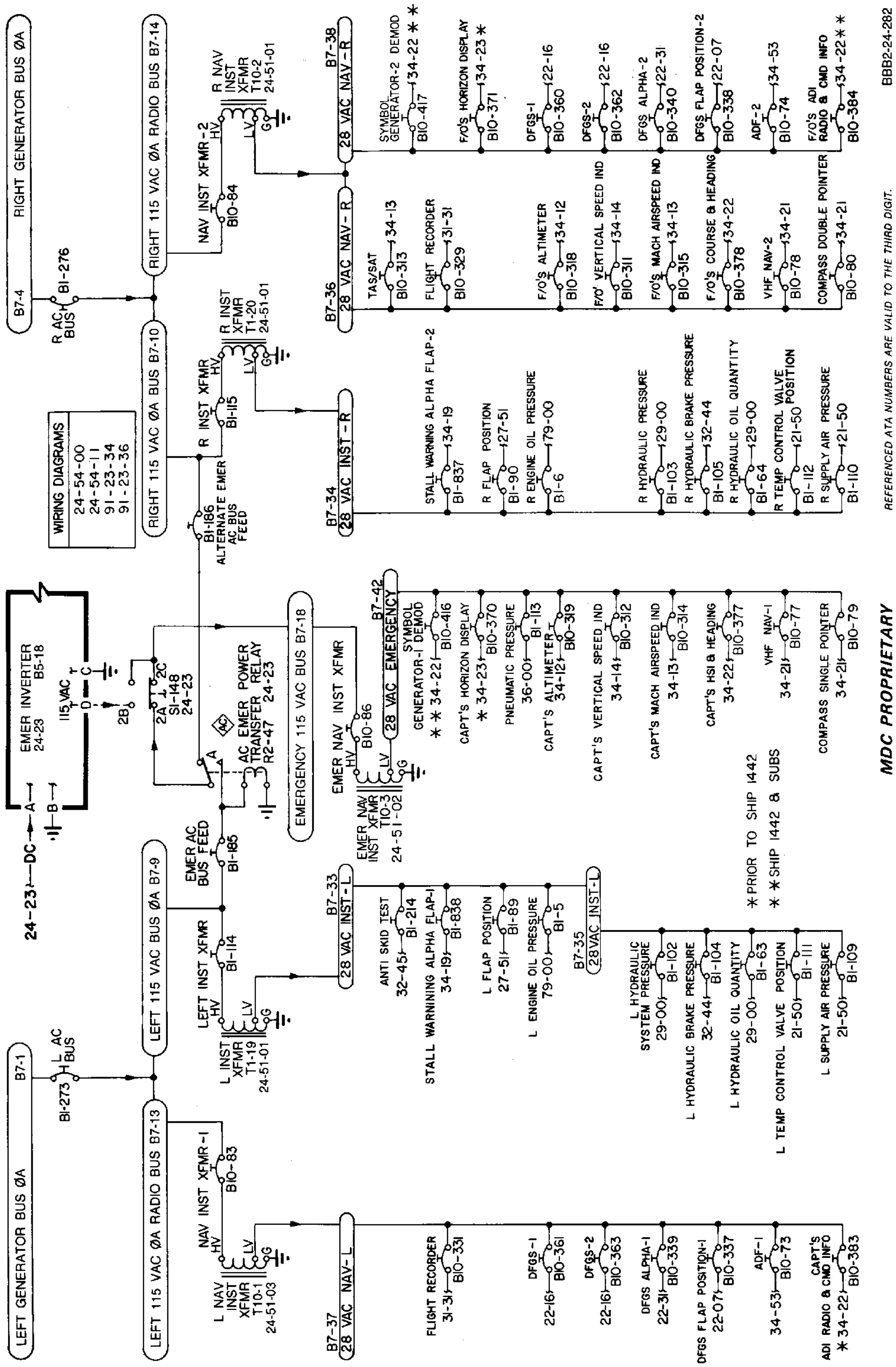
28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 4 of 9)



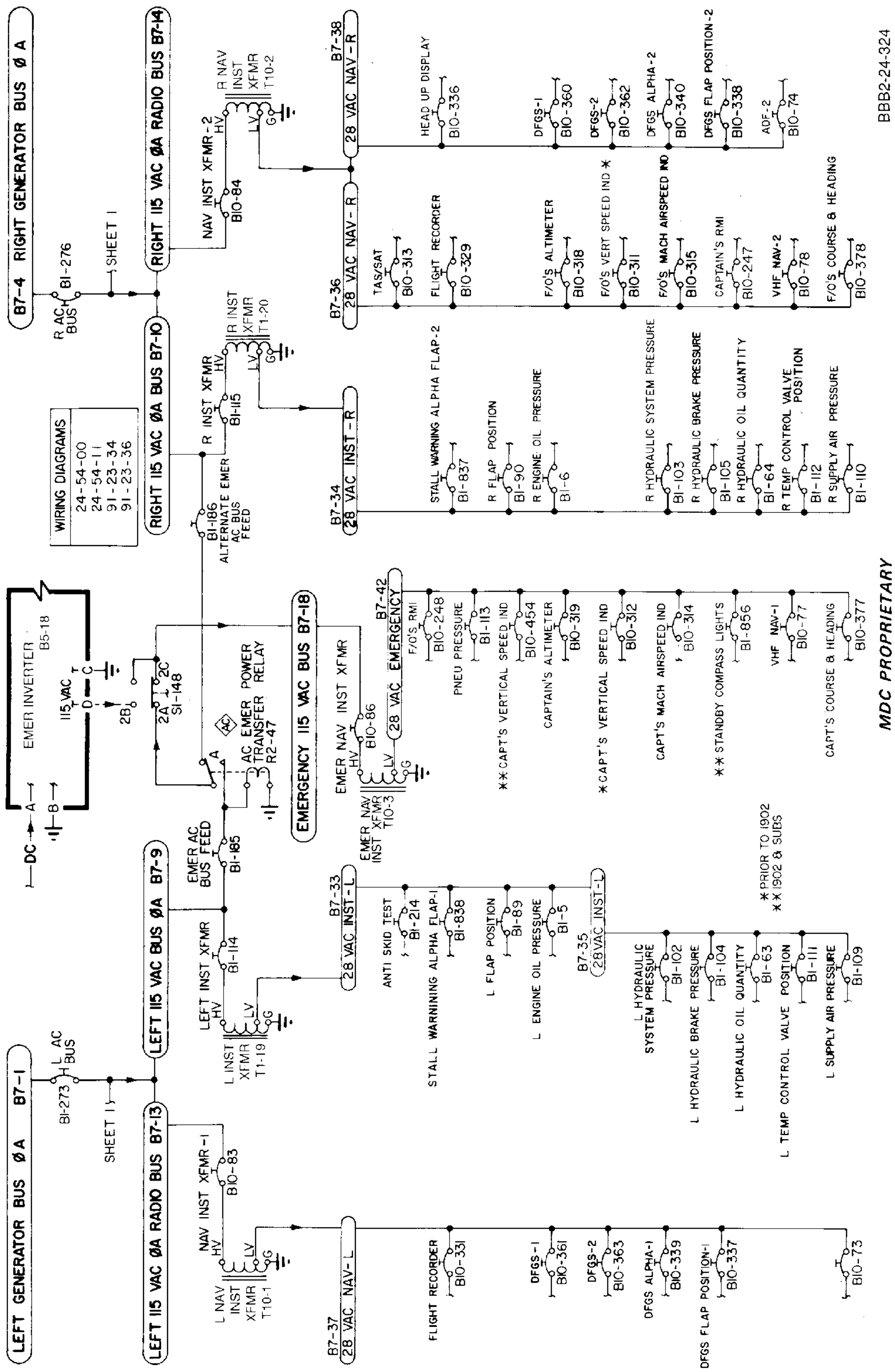
28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 5 of 9)



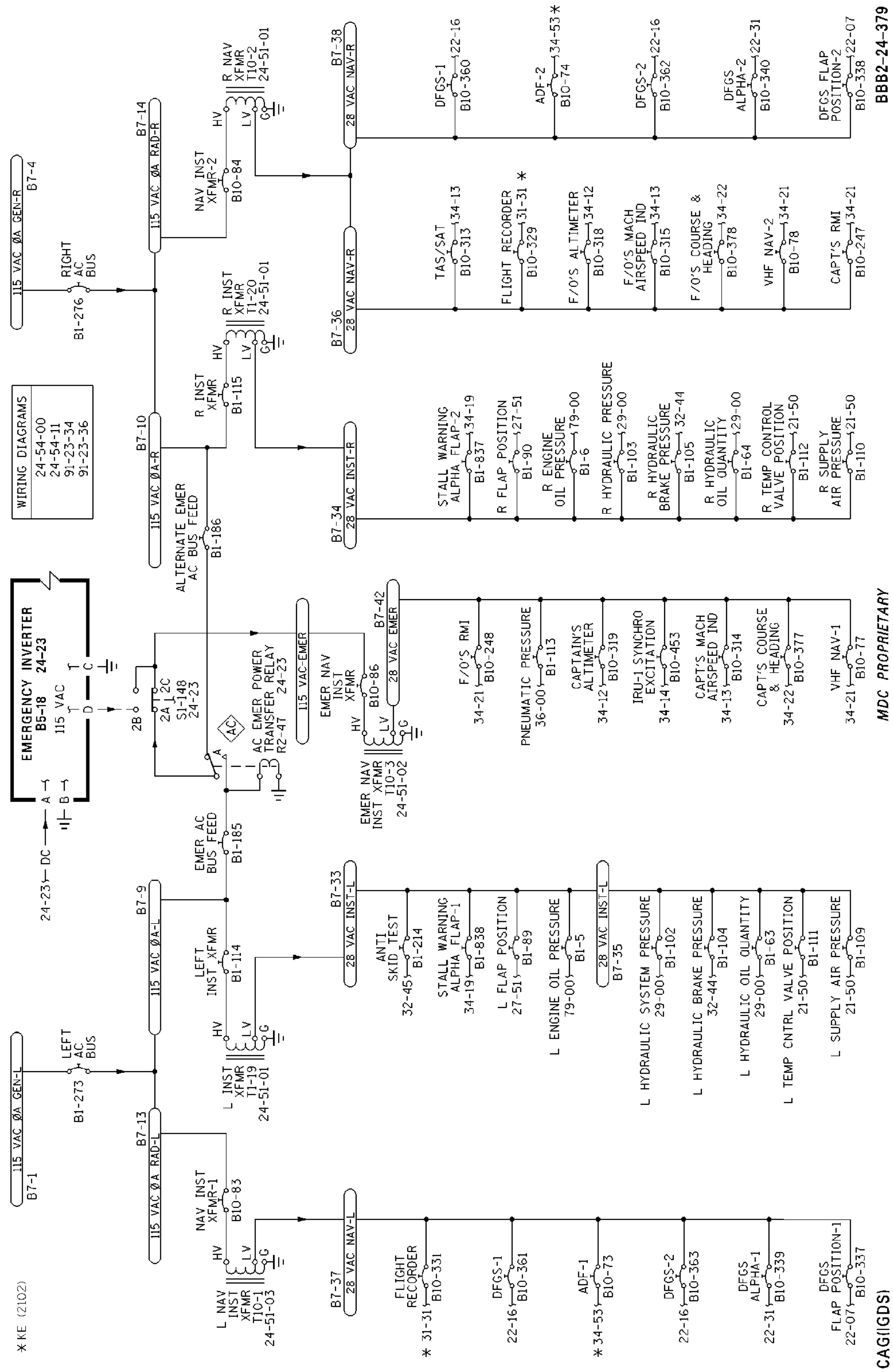
28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 6 of 9)



28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 7 of 9)



28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 8 of 9)



28 VAC Power Distribution -- Schematic
Figure 6/24-50-00-990-806 (Sheet 9 of 9)

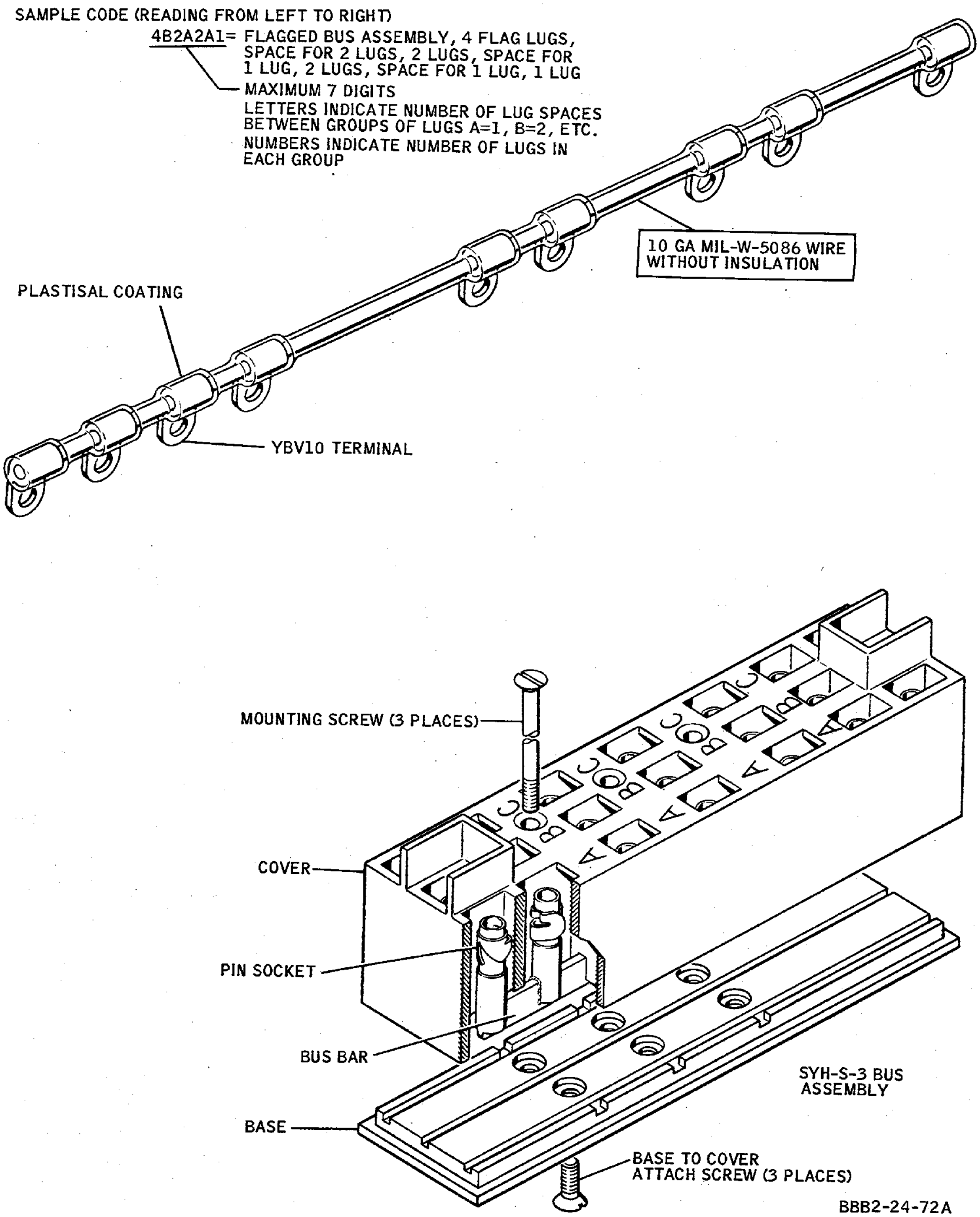
BUS ASSEMBLIES - DESCRIPTION AND OPERATION

1. General

A. Bus assemblies, provide a means of connecting a common power source to a group of circuit breakers. The circuit breakers protect the various circuits using this power source. (Figure 1)

B. The bus assemblies used for the 115-volt AC and radio AC buses are mounted in horizontal rows on the aft side of the upper main circuit breaker panel. Each assembly is composed of three bus bars, one for each phase of AC power, and a module consisting of a base and a cover. The three bus bars are mounted parallel to each other in the module. Along each bar, pin sockets are provided for connecting short leads (circuit breaker feeders) from the bus to the individual circuit breakers. Each lead has a pin terminal at one end that is locked in place when inserted into a pin socket of the bus. A special tool, Burndy J-155 or equivalent, must be used to unlock the pinlock before removing a lead from the bus bar. The base and the cover are made of a plastic material for insulating purposes. Flush-head type screws, through the base, secure the cover in place.

C. The bus used for 28-volt dc power distribution consists of a predetermined length of uninsulated 10-gage wire with flag lugs crimped on at intervals to enable direct connection of the bus to the circuit breakers. The bus, also used for the AC ground service bus, is insulated with plastisal coating along the entire length after the lugs are crimped in position.



Electrical Power Buses
Figure 1/24-51-01-990-801

GROUND CONTROL RELAYS - DESCRIPTION AND OPERATION

1. **General**

   A. The ground control relay circuits provide a means of switching various electrical and electronic circuits between ground and flight mode of operation. The relays are four-pole, double-throw, non-latching type and are located on station 110 relay panel in the electrical/electronics compartment. All relays are deenergized and energized simultaneously by the action of two nose gear oleo switches, actuated by the ground sensing control mechanism. The relays are deenergized in flight and energized when the airplane is on the ground and the nose gear strut is compressed.

   B. AC power is supplied to the coils of the ground control relays through two circuit breakers, identified as ground control relay, left and right, located on the upper circuit breaker panel of the EPC. The left circuit breaker is supplied power from the 115-volt left AC bus, and the right circuit breaker from the 115-volt, right AC bus. These circuit breakers should not be opened during ground tests unless specifically instructed in procedures. Ground return of the relay coils is through the oleo switches when the nose gear strut is compressed.

WARNING: IF ANY GROUND CONTROL RELAY IS TO BE REPLACED, REMOVE ALL ELECTRICAL POWER FROM THE AIRPLANE.

   C. Ground control relay operation affects portions of certain systems.