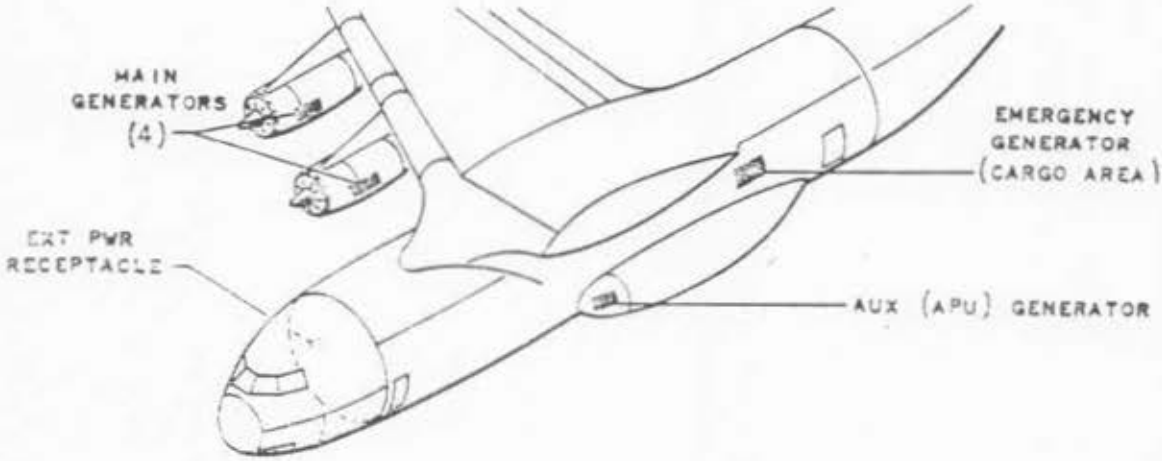
ELECTRICAL POWER SYSTEM

GENERAL.

The electrical power required by the StarLifter systems is normally supplied by four main, engine-driven, brushless A-C generators (alternators). Each generator is a 40/50 KVA unit which supplies 115/200-volt AC to the systems. The main generators are driven by the engines through hydro-mechanical Constant Speed Drives (CSD) to provide an output of three-phase, 400-Hertz (Hz) AC.



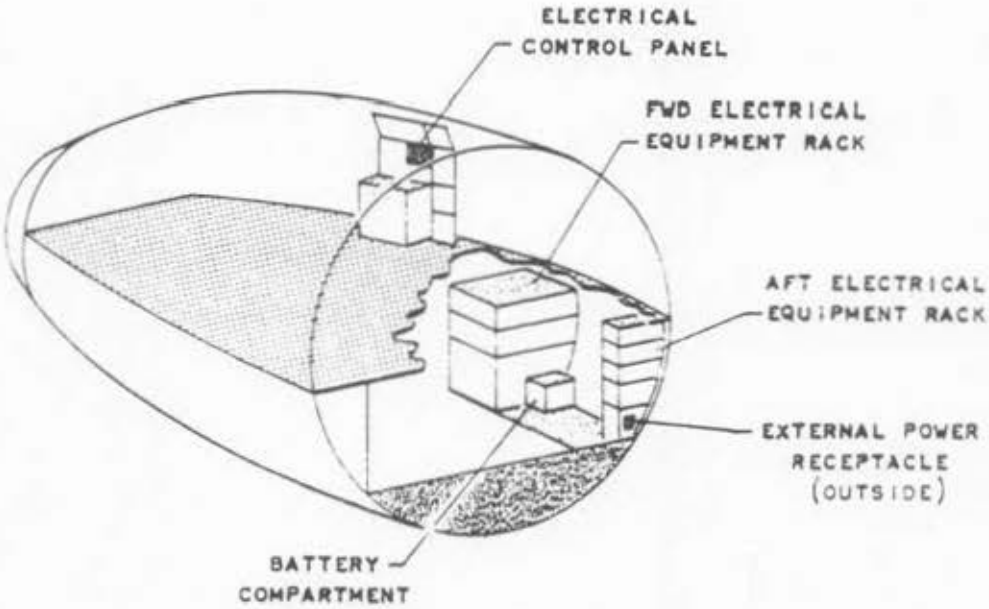
GENERATOR LOCATIONS

Auxiliary A-C power is supplied by a fifth generator, identical to the main generators. The auxiliary generator is driven directly by the Auxiliary Power Unit (APU) in the left main wheel well fairing. The APU and its generator are used only during ground checkout of the aircraft systems.

An emergency generator provides A-C and D-C power as necessary to prevent a total loss of electrical power. The generator is rated at 2 KVA, 115/200-volt AC, at 400 Hertz and 28-volt DC at 20 amperes. The emergency generator is a hydraulic motor-generator unit which is located in the No. 2 hydraulic service center in the cargo area.

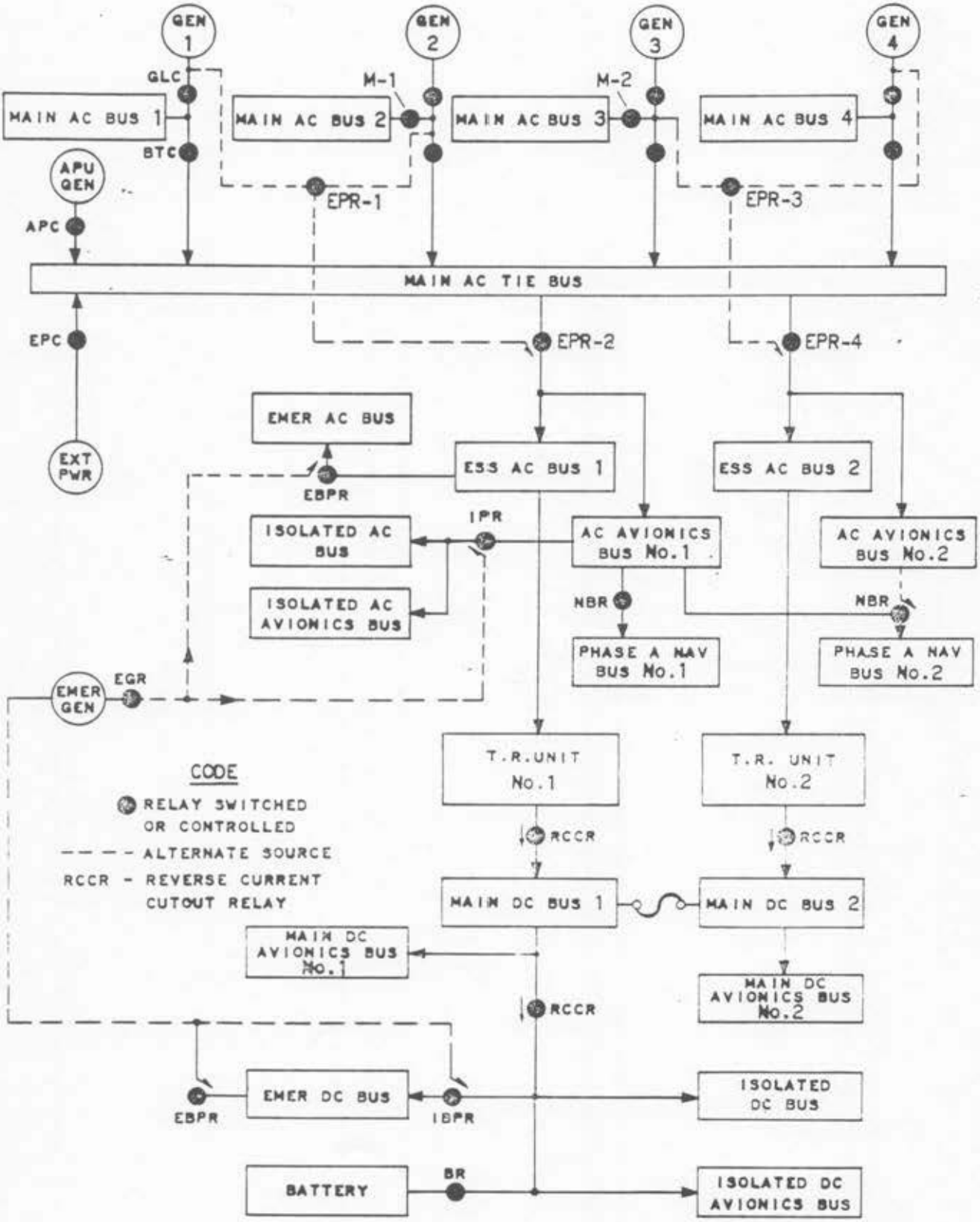
External A-C power can be used with the electrical systems for ground checkout. An external power receptacle is located on the forward right side of the fuselage. The Ground Power Unit (GPU) should supply a minimum of 50 KVA, at 115/200-volt AC at 400 Hertz. Phase sequence of the three-phase AC from the GPU must match the phase sequence of the aircraft systems or the unit cannot be used.

The DC power for the systems is supplied by two 28-volt DC Transformer Rectifier (TR) units. These units change AC to DC and provide 28- volt DC with a load capacity of 200 amperes per unit. A battery provides DC for APU ignition during starting when external A-C power is not available. The battery is rated at 24 volts and 11 Amperes Hours (AH). TR units are located in the electrical equipment rack below the flight station, and the battery is in a compartment between the racks.



RIGHT HAND UNDERDECK EQUIPMENT RACKS

An electrical control panel is provided at the flight engineer's station. Control switches, meters, and warning lights for the power sources are on this panel. Main generators normally operate in parallel to supply the electrical loads. Emer-



ELECTRICAL BUS DISTRIBUTION

gency generator operation is usually automatic but can be controlled by an instrument power switch on the pilot's instrument panel. The D-C system is automatic, controlled by the A-C system. The battery is switch-controlled so that it can be used or charged as necessary.

Each generator is rated to produce 120/200-volts AC. Voltage regulator units, protection panels, load controllers, and a bus protection panel are located in the electrical equipment racks. These units provide control, protection, regulation, and automatic sequencing of the power sources and the bus distribution system.

BUS DISTRIBUTION

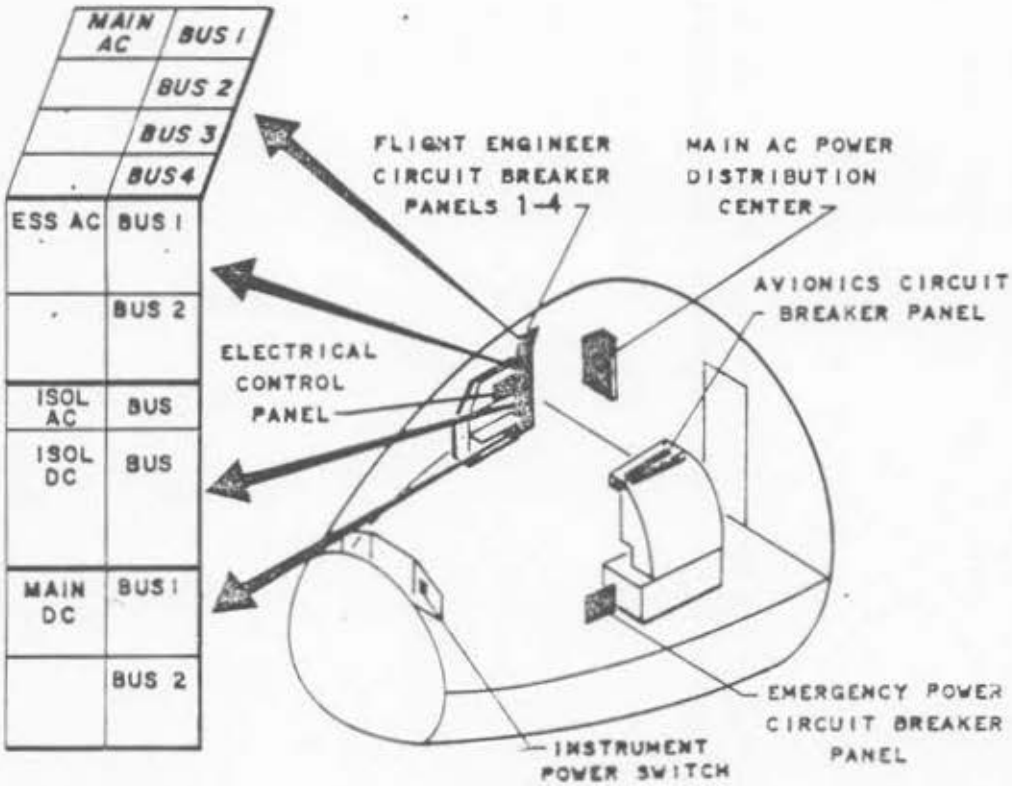
The main generator is normally connected to a main A-C bus through contacts of a Generator Line Contactor (GLC). Four main A-C buses are used, one for each main generator. Main generators also connect to a main A-C tie bus through Bus Tie Contactors (BTC). The GLC and BTC for each generator are in the same contactor housing. The BTC's and Main A-C tie bus are used for parallel operation (load sharing) of the main generators. Isolated operation is possible if the BTC's are opened by switches on the electrical control panel.

Main A-C buses No. 2 and No. 3 are controlled by monitor relays which prevent the buses from being energized until two or more main generators are operating. The relays automatically protect the generators by decreasing the electrical load when only one main generator is operating. The monitor relays may be energized through an "override" switch to energize the buses.

Two essential A-C buses are part of the electrical system. These buses are normally energized from the main A-C tie bus through four power relays. Alternate essential bus power sources are provided through the relays, allowing the main generators to supply the buses when the tie bus is not energized.

External A-C power or auxiliary generator power can be supplied to the main A-C tie bus. External and auxiliary power cannot be used simultaneously, and they will not parallel with any other power source. A combination External Power Contactor-APU Contactor (EPC/APC) connects the selected power source to the tie bus. The BTC's close to allow the main A-C tie bus to energize all main AC buses when the main generators are not operating. The BTC's open to prevent paralleling when the generators are operating and external power or Auxiliary power is in use.

The low-power emergency generator automatically supplies power to the isolated and emergency A-C and D-C buses when the normal power source fails. The normal power source is essential A-C bus No. 1.



CIRCUIT BREAKER PANELS

The heavy duty contactors and relays associated with the power sources and bus distribution are located in the main A-C distribution center. The distribution center is on the right side of the bulkhead between the cargo area and flight station. Power feeder circuit breakers, on the front of the panel in the flight station, distribute power to flight station circuit breaker panels. Relays, contactors, and the main A-C tie bus are accessible from the cargo area.

Other A-C buses, in addition to the main and essential, are the Avionics AC buses No. 1 and No. 2, phase A navigation buses No. 1 and No. 2, isolated, and emergency A-C buses. These buses are normally energized from the essential A-C buses.

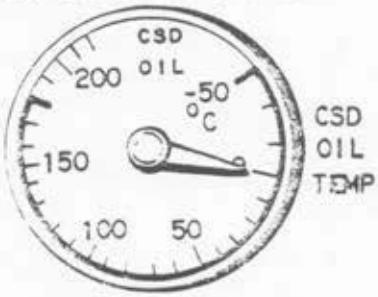
The D-C buses are automatically energized from the essential A-C buses through the TR units. These buses are main D-C No. 1 and No. 2; main D-C avionics buses No. 1 and No. 2; and emergency D-C buses. Emergency power can be supplied to the isolated and emergency D-C buses when the emergency generator is operating. The battery can be used to supply the isolated D-C bus when other power sources

are not available. Relays associated with the D-C system are located behind the circuit breaker panels.

A-C SYSTEM OPERATION

The Constant Speed Drive (CSD) unit oil temperature indicator, located on the electrical system control panel represents the beginning of the generating system and provides an indication of oil outlet temperature from the CSD. If oil temperature is above normal, the CSD load can be decreased by turning the main generator off, allowing the oil to cool. Above 179°C oil temperature, a switch closes causing illumination of the CSD OVERHT (overheat) light. The CSD can be disconnected from the engine drive by the CSD disconnect switch to prevent damage. Once disconnected, the CSD and generator cannot be used since reset must be accomplished mechanically at the CSD unit on the engine.

NO.1 GENERATOR SYSTEM

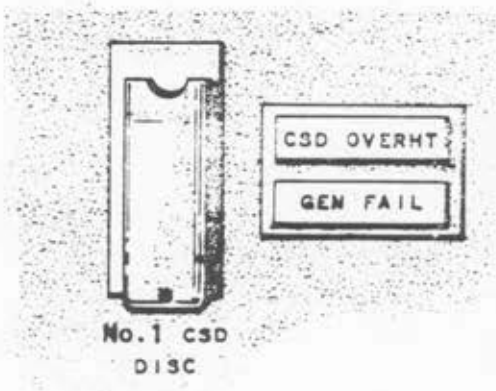


The generator fail light provides an indication of generator mechanical failure. To prevent damage to the generator or CSD, the CSD should be disconnected, and the generator replaced. The CSD is reset by pulling the reset plunger on the CSD unit (engine stopped).

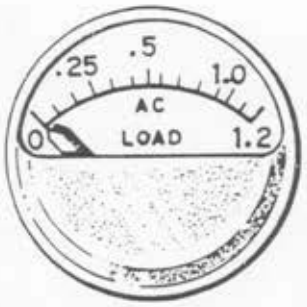
MAIN GENERATOR

The A-C loadmeter provides an indication of the percent load on phase A of the main generator output. Since balanced three-phase loading is used in the aircraft systems, the indication is representative of each phase load. One hundred percent load represents a total three-phase load of 50 KVA. When the generators are in parallel, the meter readings should be equal since the generators are sharing the load.

The GEN OUT light illuminates when the generator switch is "ON" and the generator is not functioning to supply the required load. The light is extinguished when the trouble is cleared. The generator circuit can be reset by positioning the generator switch to "OFF" then "ON". If a differential fault has occured, the circuit will not be reset from the switch. To reset after a differential fault has been cleared, the engine must be stopped and a reset push-button on the generator protection panel

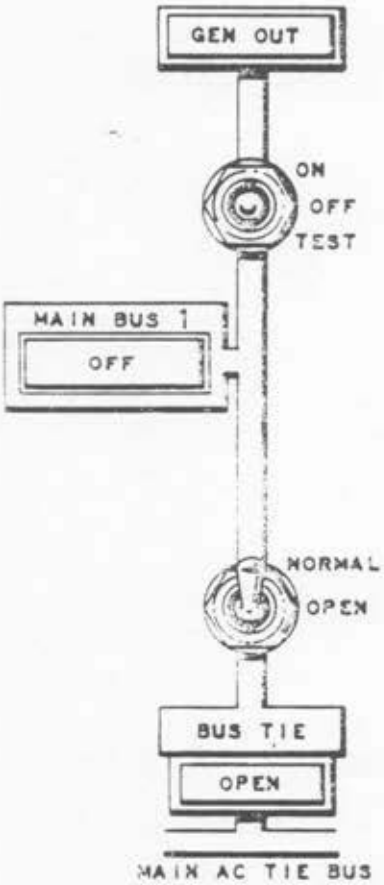


must be depressed. A differential fault is indicated when the GEN OUT light remains illuminated in the "OFF" position of the generator switch.



The "ON" position of the generator switch is used to energized the GLC which connects the generator to the main AC bus load. The "OFF" position deenergizes the GLC and the generator output. The momentary "TEST" position is used to check the generator output voltage and frequency without a load. The switch is spring-loaded from "TEST" to "OFF."

The main bus OFF light illuminates when the bus is not energized or has a low voltage power source. The light is normally extinguished.



BUS TIE

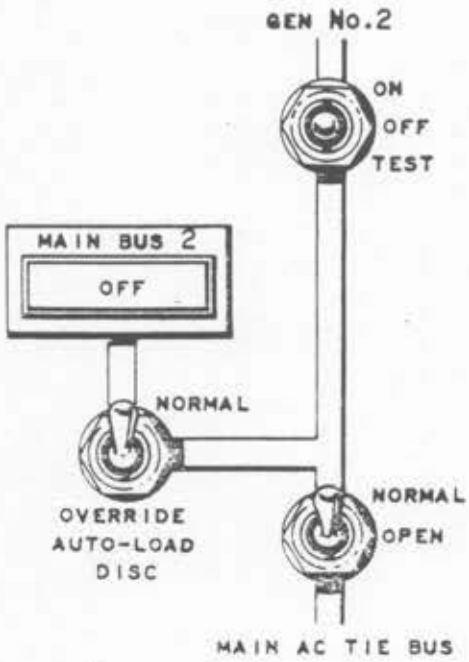
The "NORMAL" position of the bus tie switch controls the BTC, allowing the generator to automatically supply the main A-C tie bus during generator parallel operation. It also allows the main A-C tie bus source to supply the main A-C bus when the associated generator is not operating. The "OFF" position of the switch opens the BTC, isolating the generator and main A-C bus from the tie bus.

The bus tie OPEN light illuminates when the BTC is not energized. In the "OFF" position of the bus tie switch, the light remains illuminated. In "NORMAL", the light extinguishes when the generator switch is turned "ON" or when the main A-C tie bus is energized. The BTC circuit may be reset if the light fails to extinguish by positioning the bus tie switch to "OFF" then "NORMAL."

All main generators normally operate in parallel, sharing the load equally. The GLC's BTC's and buses are normally energized with the associated light extinguished. Generator isolated operation can be accomplished by positioning the

bus tie switches to "OFF". The electrical buses are energized in parallel or isolated operation.

Main A-C buses No. 2 and 3 are controlled by monitor relays. The relays decrease the electrical load when only one engine generator or the auxiliary generator is operating. Monitor relay No. 1 controls the main A-C bus No. 2, and monitor relay No. 2 controls main A-C bus No. 3. Main A-C buses No. 1 and 4 do not have monitor relays.



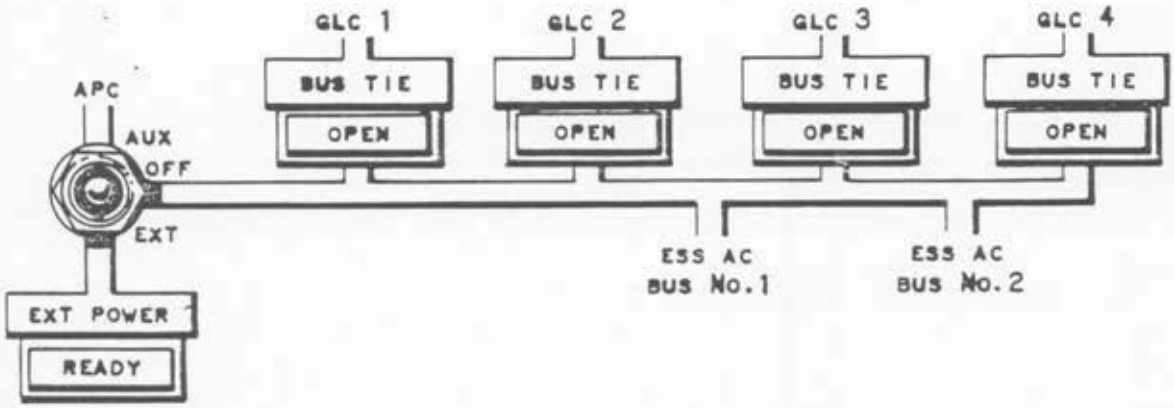
When the auto-load disc switch is in "NORMAL" and two or more main generators are operating, the monitor relays automatically energize. The relays also energize when external A-C power is used. The OVERRIDE switch is used to energize the monitor relay, bypassing the automatic relay control circuit. Override must be used in order to energize main A-C bus No. 2 and 3 when the auxiliary generator or one main generator is the only power source.

The main A-C tie bus is normally energized through the BTC's by the four main generators in parallel. If a generator fails, or is turned off, the other generators pick up the load through the BTC circuit. The main generators share the load equally as indicated on the loadmeters.

EXTERNAL A-C POWER

When the external A-C power plug is inserted into the external power receptacle, the green READY light on the electrical panel illuminates. If the AUX/OFF/EXT power switch is positioned to "EXT", external power will connect to the main A-C tie bus. Since the same switch is used for the auxiliary and external power sources ("AUX" and "EXT" positions) only one power source can be selected at a time. With external power as the only power source, the BTC's close to energize all A-C buses. If a main generator is turned on, the associated BTC opens to isolate the power sources.

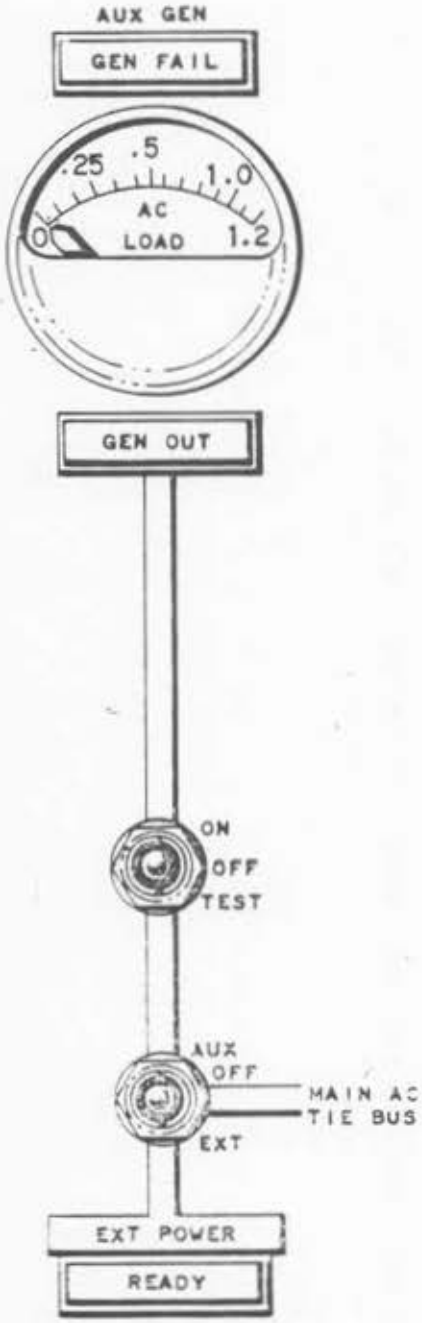
External A-C power or the auxiliary generator cannot be paralleled with the engine generators. If external power or APU power is selected while the engine generators are operating, the four BTC's open. The generators then supply the main buses and the external or APU power is supplied to the tie bus. When a main generator is turned off, the BTC automatically closes, allowing the tie bus to supply the associated main A-C bus.



AUXILIARY (AUX) GENERATOR

The auxiliary generator is driven directly by the APU when the aircraft is on the ground. The generator is used for ground checkout of the aircraft systems. Since a CSD is not used with the APU, an oil temperature indicator, overheat light, and CSD disconnect switch are not provided.

Two switch selections are required to connect the auxiliary generator to the main A-C tie bus. The generator switch allows the generator to supply the tie bus when the switch is "ON", and the AUX/OFF/EXT power switch is in the "AUX" position. When the tie bus is energized, the BTC's close, allowing main A-C buses No. 1 and 4 to be energized. Main A-C buses No. 2 and 3 can also be energized by positioning the AUTO LOAD DISC switch to "OVERRIDE", energizing the monitor relays. If a main generator is turned on, the BTC opens to isolate the power sources. If a fault occurs causing loss of the generator, the circuit can be reset by positioning the control switch to "OFF" then "ON."



MAIN A-C TIE BUS

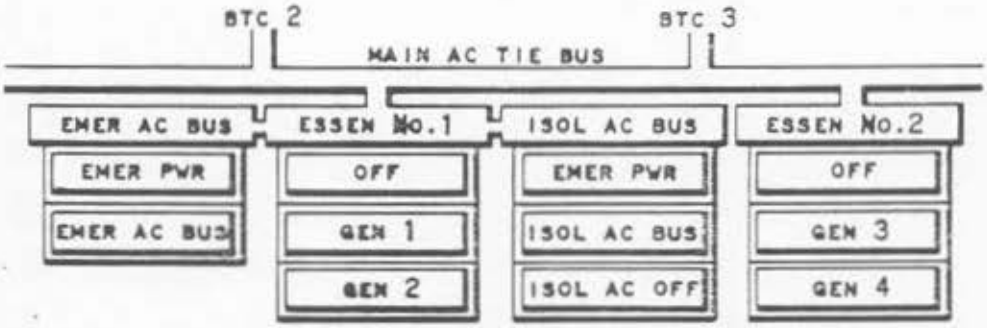
The main A-C tie bus is the source supply point for all aircraft systems except those connected to the four main A-C buses. The tie bus can be energized from the four main generators individually or combined, during flight or on the ground. External power or auxiliary generator power can energize the tie bus when the aircraft is on the ground.

The main A-C tie bus normally supplies power to the essential A-C buses. The essential bus No. 1 supplies the emergency and isolated A-C buses. Warning lights illuminate to indicate the bus condition or alternate power source. Normally all bus lights are extinguished.

The normal power source for essential bus No. 1 is the main A-C tie bus. The first alternate power source for essential No. 1 is Generator No. 1 and the second alternate is Generator No. 2. The "GEN 1" or "GEN 2" lights illuminate to indicate the power source when the tie bus is not energized. If all three sources are not energized, the essential OFF light illuminates indicating bus power failure.

When the essential bus No. 1 is deenergized, the emergency generator automatically turns on the supply the emergency and isolated A-C buses. In this condition the EMER PWR - EMER AC BUS and the EMER PWR - ISOL AC BUS lights illuminate. The lights identify the bus and power source. If the isolated AC bus is not energized, the ISOL AC OFF light illuminates and the other two lights remain extinguished.

Essential bus No. 2 is similar to bus No. 1 except generator No. 4 is the first alternate power source and generator No. 3 is the second. Essential bus No. 2 does not control the emergency generator and cannot be used to supply the isolated and emergency A-C buses.



EMERGENCY GENERATOR

The emergency generator has priority over the normal power source to supply the isolated and emergency buses. The generator is controlled by the instrument power switch on the pilot's instrument panel. In the "OFF" position of the switch the generator will not operate. In the "NORMAL" position generator operation is automatic, and loss of power to the essential A-C bus No. 1 causes the generator to turn on. While on, the emergency generator supplies power to the emergency and isolated A-C and D-C buses and the EMER PWR ON light illuminates.

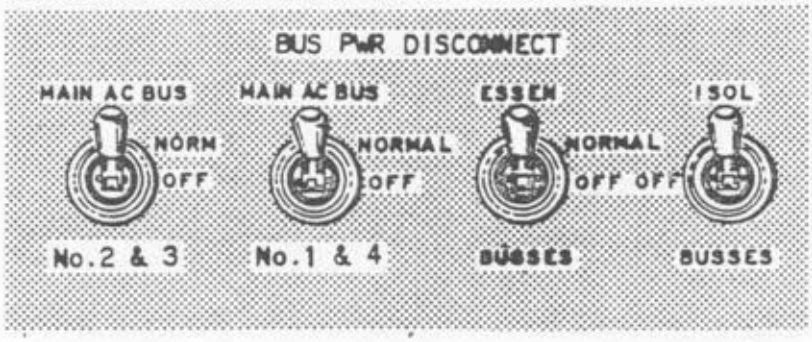
In the "EMERG" switch position, the automatic function is bypassed and the generator continuously supplies the emergency and isolated buses. The generator is driven by a hydraulic motor and requires hydraulic pressure from the No. 2 hydraulic system. The generator and associated components are located in the No. 2 hydraulic service center.

An emergency power test switch at the flight engineer's station allows the voltage and frequency of the generator to be checked under a "No-load" condition. The switch is springloaded from "TEST" to "NORMAL."

BUS POWER DISCONNECT

Bus power disconnect switches provide bus isolation to remove power from the various buses in case of internal fire or emergency. The "NORMAL" switch positions allow automatic control of the system. The "OFF" positions isolate the buses by controlling relays and contactors.

With the main generators operating in parallel and the main A-C buses' No. 2 and 3 switch in the "OFF" position, the two monitor relays deenergize causing loss of main A-C buses No. 2 and 3. The main A-C buses No. 1 and 4 switch opens GLC 1 and 4 and BTC 1 and 4, causing loss of main A-C buses No. 1 and 4. The essential buses switch causes the loss of both essential A-C buses, and the emergency generator turns on to supply isolated and emergency AC and DC. Loss of the essential A-C buses results in failure of the TR units, resulting in loss of main A-C and D-C buses. The only buses remaining energized are the emergency A-C and D-C buses, which are energized by the emergency generator. When the switches are positioned to "NORMAL" the system is again energized from the parallel generators.

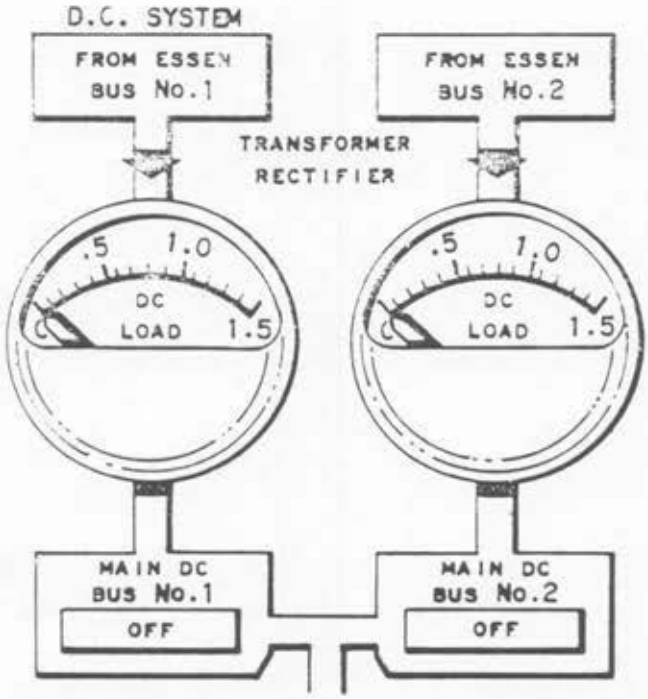


D-C SYSTEM OPERATION

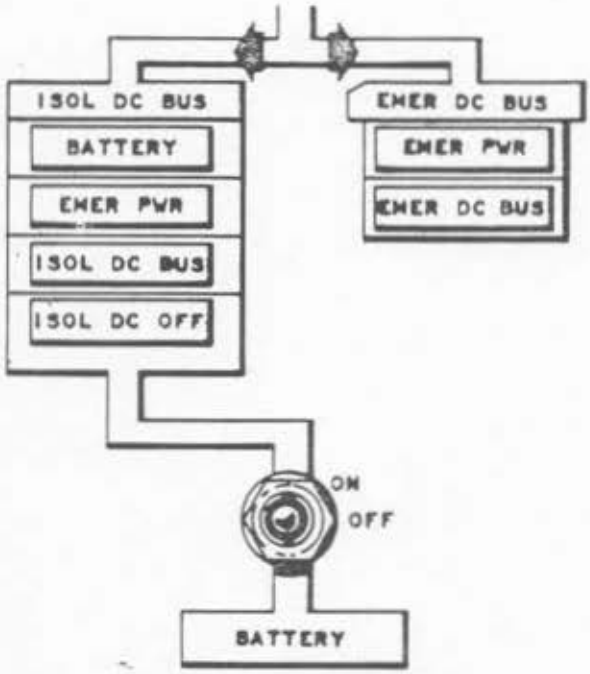
The D-C system of the aircraft receives 28-volt DC from two Transformer-Rectifier (TR) units. These units change three-phase from the essential A-C buses to 28 volt DC to the main D-C buses.

TR UNITS

Loadmeters indicate the percent of the load carried by each TR unit. One hundred percent load is 200 amperes. The output of TR unit No. 1 is supplied to main D-C bus No. 1, and TR unit No. 2 supplied main D-C bus No. 2. The main D-C buses are paralleled to share the aircraft loads. If the main D-C buses are not energized, the main bus OFF lights illuminate.



The main D-C buses supply 28-volt DC to the isolated

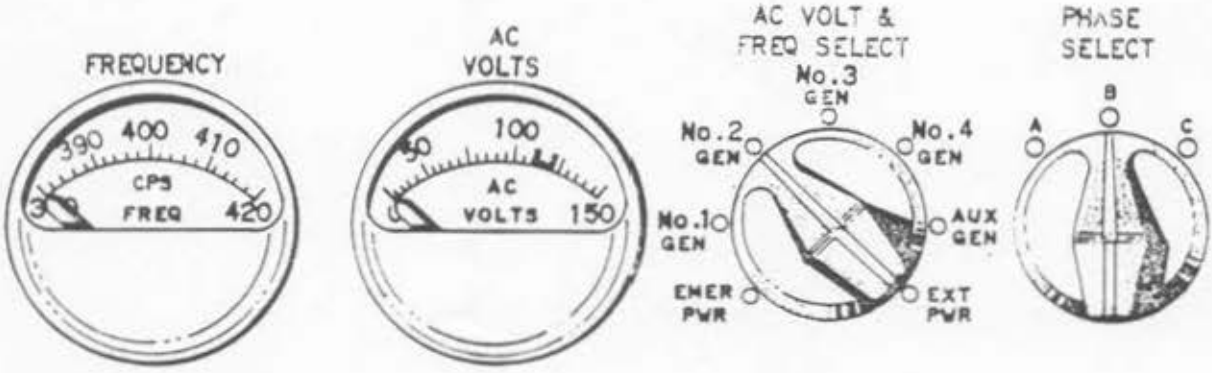


and emergency D-C buses. If the isolated D-C bus is not energized, the ISOL DC OFF light is illuminated. When the emergency generator is supplying DC to the isolated and emergency buses, the EMER PWR - ISOL DC BUS and EMER PWR - EMER DC BUS lights are illuminated.

BATTERY

An additional power source for the isolated D-C bus is the aircraft battery. When the battery switch is "ON", the battery connects to the isolated D-C bus and the BATTERY light illuminates. When main D-C bus voltage is supplied to the isolated D-C bus, the battery is charging and the light extinguished. The battery switch "OFF" position disconnects the battery from the bus. When emergency generator power is in use, relays disconnect the battery from the isolated bus.

Battery voltage is required when external power is not available for APU ignition and control. The APU is started hydraulically from an accumulator which is part of hydraulic system No. 3. The engines are started pneumatically with compressed air from the APU.



ELECTRICAL METERS

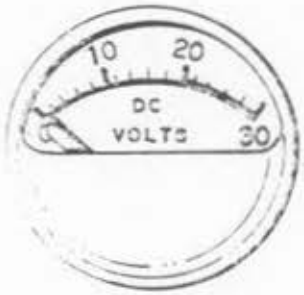
The frequency meter and A-C voltmeter are connected in parallel to provide a voltage and frequency indication for the generators and external power. The A-C VOLT & FREQUENCY SELECT switch, and PHASE SELECT switch determine the meter selections.

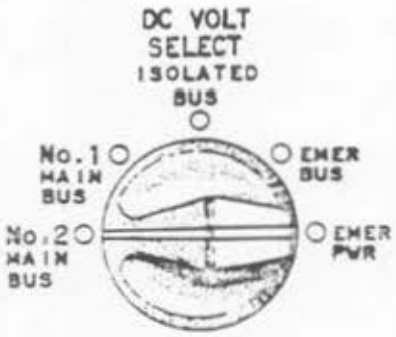
The frequency of the six generators and external A-C power can be displayed on the 380-420 Hertz scale of the frequency meter. The voltmeter provides an indication of the phase voltage (A-B-C) for each of the generators, or external A-C power, on a 0 to 150-volts scale. The frequency should be 400 Hertz and the voltage 115-volt AC. The frequency is controlled by engine speed through the CSD, and the voltage is controlled by the voltage regulator unit.

A D-C voltmeter and selector switch provides an indication of the D-C bus voltages as selected. The meter scale is 0 to 30-volt DC and should indicate 28 volts, DC. When the battery is the only power source, the isolated bus reading should be 24-volt DC.

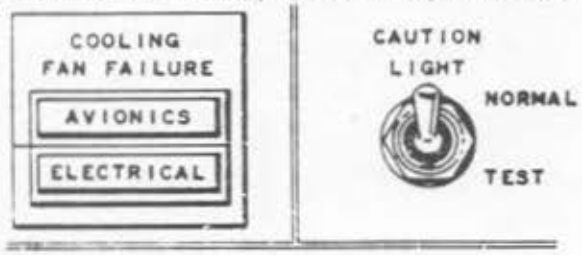
COOLING FANS

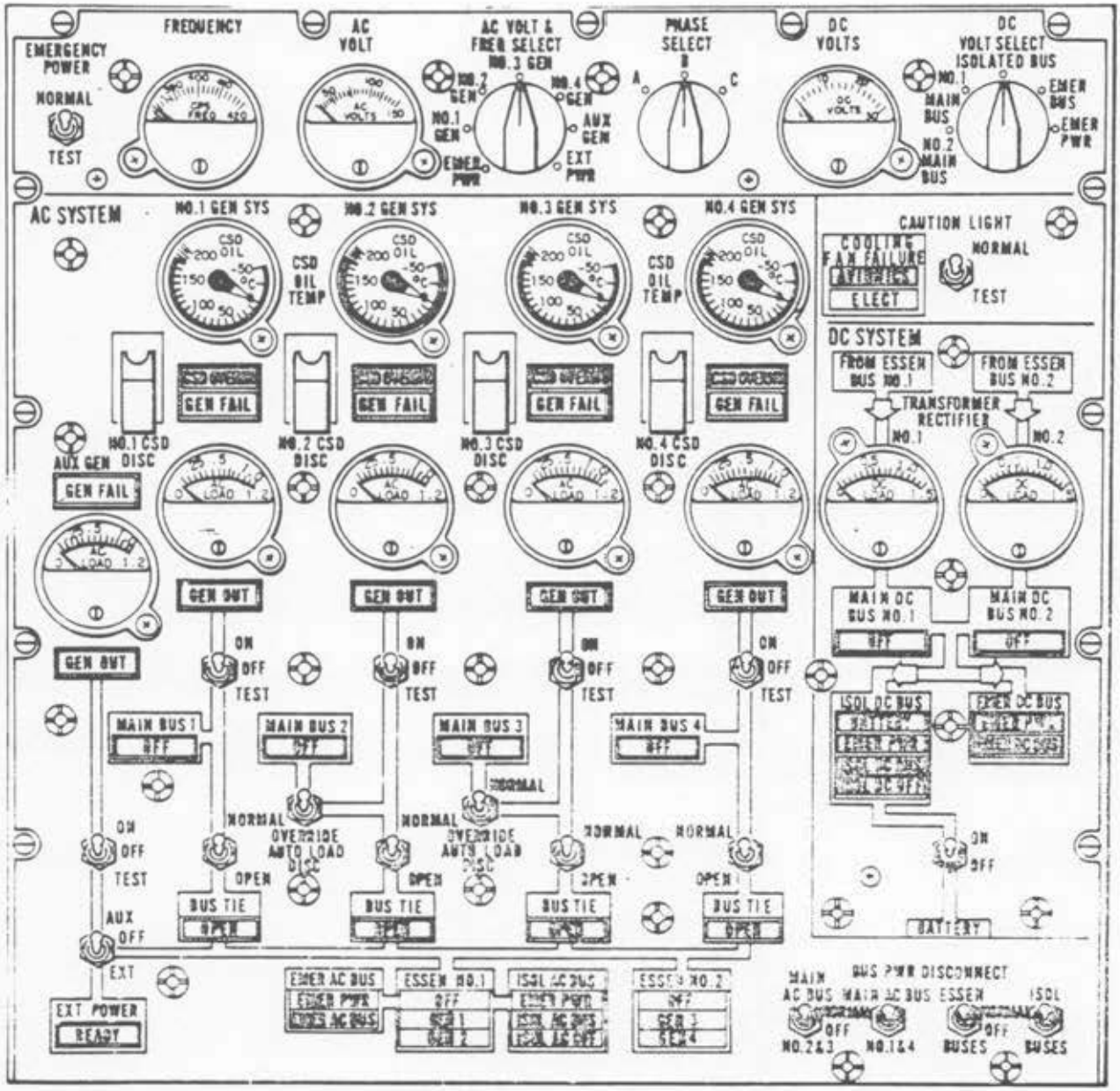
Dual cooling fans are installed in cooling ducts of the electrical and avionics cooling system. If the fans fail, the warning lights illuminate. The AVIONICS fan circulates air through the avionics equipment in the left and center avionics equipment racks. The ELECTRICAL fan circulates air around the electrical equipment racks.





A caution lights TEST - NORMAL switch, springloaded to "NORMAL", allows simultaneous test of all warning lights at the flight engineer's station. If a light fails, the lens may be rotated 180 degrees for replacement.





FLIGHT ENGINEERS ELECTRICAL CONTROL PANEL