SECTION IV
ELECTRICAL & LIGHTING

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SECTION IV
ELECTRICAL & LIGHTING

ELECTRICAL POWER SYSTEMS

INTRODUCTION

Primary dc electrical power is provided by two engine-driven starter/generator units supplying 28-vdc power to a split bus electrical system. The generators are limited to 300 amps. An automatic electrical load shedding system has been incorporated to prevent generator overloading and prolong battery duration in the event of a single or dual generator failure. Secondary dc electrical power is supplied by two main airplane batteries that will power essential avionics, communication and instrumentation. A single emergency battery is provided to power standby equipment in case of airplane electrical system failure and to power certain equipment that must remain powered during engine start.

A ground power unit can provide electrical power for system operation prior to engine start, to assist in engine start and to charge airplane batteries.

The ac electrical power is provided by two engine-driven alternators for the sole purpose of powering the windshield ice and fog protection system. The alternators are rated at 200-vac, 200-400 Hz, 5kva.

GENERAL

The electrical system incorporates a split, multiple bus system for power distribution interconnected by contactors, fuses, and circuit breakers which react automatically to isolate a malfunctioning circuit. Manual isolation is also possible by turning off power to an affected bus via the electrical control panel or by opening the appropriate circuit breakers.

In the event of a dual generator failure, the main airplane batteries may be used to power the essential, essential avionics and hot bus components for a limited period of time. An emergency battery is also provided to operate equipment connected to the emergency battery bus and emergency hot bus.

It is possible to power the dc electrical systems from the airplane batteries, engine driven generators, or a Ground Power Unit (GPU).

MAIN BATTERIES

Two main electrical system batteries are located, one above the other, in the tailcone. The upper battery is connected to the left generator bus when selected On via the L BATT switch and the lower battery is connected to the right generator bus when selected On via the R BATT switch. The main batteries provide a source of electrical power for engine starting and for emergency operation in the event of dual generator failure. They also provide power to three hot buses and two emergency hot buses even when the batteries are selected off.

The standard batteries installed are 24-vdc nickel-cadmium (NICAD) rated at 27-amp-hours. Optional 38-amp-hours NICAD batteries may also be installed.

Gases produced by the main batteries are vented overboard through two tubes. The end of the tubes are cut at an angle so that one tube takes air in and the other exhausts the gases from the battery cases.

Electrical power from each battery is used to close the corresponding battery contactor when the L and R BATT switches are selected On. When the battery contactors are closed, the main batteries are connected to the respective generator bus. When the airplane is on the ground, the battery contactors are controlled by voltage sensors to prevent discharge below 14 volts. If a battery is below 14 volts, the contactor will not close when the BATT switch is selected On. If the battery voltage falls below 14 volts for more than 10 seconds while on the ground, the contactor will open. Battery depletion protection is inhibited when airborne and during engine starting on the ground. If the batteries are above 14 volts, they can be connected and recharged from a GPU, or aircraft generator.

Individual battery voltages can be read on the SUMRY or ELEC schematic displays which are selectable on the EICAS or MFD display units.

Battery temperature monitoring and overtemperature warning for NICAD batteries are provided via the EICAS/MFD displays and the Crew Warning Panel (CWP). The above is described further under ELECTRICAL SYSTEM INDICATORS in this section and under BATTERY OVERHEAT.

In the event of a dual generator failure, the aircraft batteries, in conjunction with the emergency battery, will provide power for the necessary essential equipment for a limited duration. For more information, see DUAL GENERATOR FAILURE in this section.

EMERGENCY BATTERY

The emergency battery installed is one 24-vdc, 10-amp-hour, lead-acid battery which is located in the nose section of the airplane. The emergency battery is connected to the emergency battery bus when selected On, but only provides power to that bus when the electrical system is not being powered by a GPU or airplane generator. The emergency battery also provides power to both emergency hot buses even with the emergency battery selected OFF. The emergency battery provides power to the emergency battery bus in the event of a dual generator failure or an inflight electrical fire. The installation also enables the essential and essential avionics buses to be powered by the emergency battery in isolation from the main system during the engine start sequence, thus preventing problems caused by engine start voltage fluctuations. This is described further under DISTRIBUTION in this section.

The emergency battery is charged by the airplane electrical system and provides power to the emergency bus for a limited time if the airplane dc generators fail. See DUAL GENERATOR FAILURE in this section for more information.

A shunt, located between the emergency battery and the emergency battery contactor allows for monitoring of battery recharge and discharge current. If the emergency battery is selected to On and a battery discharge current is sensed by the shunt, the white EMER caption on the EMER BATT switch will illuminate, indicating emergency battery discharge. A white EMER BATT annunciator on the CWP will also illuminate for this condition. Battery charging from the airplane generators precludes these indications under normal operation. The emergency battery has the same battery depletion protection on the ground as the main batteries.

The shunt also monitors emergency battery charging. If it exceeds 10 amps for 1 minute, an amber EMER BATT LOW will be displayed on the CAS alerting the crew to an emergency battery recharging condition.

The emergency battery voltage can be checked by observing the EMER-V or EMER BUS VOLTS on the EICAS/MFD SUMRY or ELEC systems schematic displays prior to applying GPU, or airplane generator power to the electrical system.

Eleven different components are connected directly to the emergency battery bus and will be available when that bus is being powered by the emergency battery, aircraft generator, or GPU. Main airplane batteries alone will not power the emergency battery bus because the isolation contactors will both be open if both generators are off-line.

The EMER BATT is selected On before engine start and remains on throughout the flight. When the EMER BATT switch on the electrical control panel is depressed, current from the emergency battery closes the emergency battery contactor and the OFF indication on the switch extinguishes.

When the emergency battery is selected OFF, the contactor will open and the OFF indication on the switch will illuminate, assuming at least one essential bus is still powered by another power source.

GENERATORS

Two engine-driven starter/generators, one on each engine accessory section, provide the normal source of 28-vdc power to the airplane. Each starter/generator is equipped with a "quick attach/detach" mounting to facilitate maintenance. Unless a GPU is powering the airplane electrical system, the generator will automatically come on line when the DEEC determines the engine is up to speed (approximately 95% of N1 idle). If a GPU is used for engine start, the generators will automatically come on line after the engines are running when the GPU is disconnected, or when the EXT PWR switch on the electrical control panel is depressed, changing the annunciation from ON to AVAIL.

In flight, cooling air is routed from a scoop on the associated engine nacelle to the starter/generator. Cooling while on the ground is provided by a fan mounted on the generator shaft.

During normal operation, both generators operate independently unless the bus tie is closed. When both generators are on line, the bus-tie will normally be open and the left generator will recharge the left main battery and the right generator will recharge the right main battery and the emergency battery. If the bus-tie is closed, both generators will recharge the main batteries and the emergency battery. The generators supply dc power to all dc powered equipment on the airplane under normal conditions.

GENERATOR CONTROL UNITS

Left and right Generator Control Units (GCUs) are provided to monitor and control the engine driven starter/generators. They regulate the voltage of the generators to approximately 28 volts and limit the output on the ground and for in-flight cross starting. The GCUs will automatically disconnect the generators from the electrical system if a generator malfunction is detected. If the generator fault was momentary or has cleared, generator operation may be restored by depressing the generator switch for one second. If the fault has cleared, this will reset the field relay allowing the generator to be energized and the line contactor to close. The field flashing relay and associated circuitry ensures that the generator can be built up from residual voltage without any other power source required. The GCUs also provide several engine starting functions.

GCU functions are as follows:

VOLTAGE REGULATION — To maintain a preset constant voltage at the generator output terminal, the GCU controls the shunt field current when the generator is rotating within its normal speed range. With both generators on line, the GCUs also perform a paralleling function in the unlikely event of an inadvertent bus-tie condition between the generator buses.

GENERATOR CURRENT LIMITING — When activated by a main gear weight-on-wheels switch/starter selection, the generator output is restricted by appropriate suppression of generator voltage. This action prevents excessive generator heating when charging depleted batteries and when assisting opposite engine starting.

AUTOMATIC STARTER CUTOFF — As the engine start cycle progresses, the starter/generator shunt field is weakened to enhance torque performance. At 50% N_2, the start cycle is terminated automatically when starter cutoff speed is sensed by a magnetic pickup in the starter. This is a back-up starter cutoff to the normal cutoff at 50% N_2 input to the GCU from the DEEC.

LINE CONTACTOR CONTROL — In the generating mode, power is automatically provided to the line contactor in order to connect the generator to the generator bus when the output voltage is at an adequate level. During an engine shutdown, as the generator runs down, reverse current is sensed and signals the line contactor to open, disconnecting the starter/generator from its bus.

OVERVOLTAGE PROTECTION — In the event of a failure of normal voltage regulation, and with due allowances for surges and transients, an independent circuit causes the line contactor to open, disconnecting the starter/generator from the generator bus if the voltage exceeds approximately 32 volts.

OVERSPEED (RUNAWAY) PROTECTION — Should a starter shaft shear during the starting mode, the starter/generator is de-energized as the speed passes the starter/cutoff point, preventing further damage by the overspeed condition. It is the starter speed, rather than engine speed that is sensed to provide this function.

STARTER ABORT OPERATION — If during a start cycle, the corresponding thrust lever is selected to CUTOFF, the starter will automatically disengage.

UNDERVOLTAGE PROTECTION — Should voltage regulation fail, causing a generator undervoltage condition (less than 10 volts for 5 seconds), the generator will disconnect from the system by de-energizing the field relay, causing the line contactor to open.

DIFFERENTIAL CURRENT PROTECTION — Should the output current at the generator differ significantly from the sensed load within the power distribution panel (due to a generator feeder line fault) the generator will be deenergized and disconnected from the system by the differential current protection circuit.

GROUND POWER UNIT (GPU)

Ground power can be connected to the airplane through a receptacle located on the lower left side of the fuselage just aft of the tailcone baggage door. The anti-flash contactor that connects the output of the GPU to the aircraft electrical system will only close if the voltage and polarity are within acceptable limits. The acceptable voltage limits are approximately 24 to 32 volts. The GPU should be regulated to 28-vdc and limited to 1,500 amps.

The EXT PWR switch is located on the cockpit electrical control panel. The green AVAIL caption on the EXT PWR switch will illuminate if the plugged-in GPU is within acceptable parameters. Depressing the EXT PWR switch when the green AVAIL light is illuminated will close the GPU anti-flash contactor, connecting the GPU output to the left generator bus. The ON caption will illuminate and the green AVAIL caption will extinguish. The GPU may be deselected with the same switch.

The bus-tie contactor automatically closes when a GPU is connected to the airplane electrical system. The entire dc system is powered, assuming the AV MSTR and BATT switches are on and no buses have been deselected via the electrical control panel.

The airplane generators will not come on line with the GPU selected ON; and if they are on when the GPU is selected, they will drop off line. Airplane generators will automatically come on line after engine start, but not if the GPU is selected ON. The aircraft main batteries do not have to be on to close the GPU anti-flash contactor; however, only the bus-tie and non-essential bus contactors will close if neither battery is selected On. In this case GPU power would only be available to the left and right generator buses, the left and right non-essential buses, and the hot buses.

GPU output voltage is indicated on the EICAS/MFD SUMRY page and on the ELEC system schematic under L/R ESS VOLTS. The EMER BUS VOLTS will also show GPU voltage. No indication of amps drawn from the GPU is provided.

The CAS will provide an EXTERNAL POWER message when an external power cable is connected and EXT PWR will also be annunciated on the EICAS/MFD ELEC system schematic. These indications will appear whenever a GPU cable is connected to the airplane, and a voltage of greater than 5 volts is sensed by the power monitor. It is not an indication that the GPU meets acceptable parameters nor does it indicate that the GPU is powering the airplane electrical system.

Operation of the EXT PWR switch on the electrical control panel is also described under ELECTRICAL SWITCHES in this section.

ELECTRICAL CONTROL PANEL

The dc power system electrical control panel is designed to provide ease of operation and dark cockpit integration. The automatic load shedding design for operation with single or dual generator failure relieves the pilot of manual deselection of electrical buses to prevent an overload. The control panel reflects and displays batteries, generators, or buses that have been isolated (automatically shed) in the event of a fault. The pilot has a manual override option of selecting, recycling or deselecting some of the buses on the dc system. During engine start, the generator autostart feature reduces engine start switch selections and pilot workload.

The electrical control panel consists of an illuminated panel with thirteen switches. Each switch incorporates lighted captions showing system status (i.e. OFF/ON). All captions have white letters on a black background except for AVAIL on the GPU switch, which is green on a black background. For normal flight conditions, none of the switch captions should be illuminated.

ELECTRICAL SWITCHES

Following is a description of the switches on the electrical control panel:

L/R BATT — The battery switches are momentary action switches. If the aircraft electrical system is powered (one BATT, EXT PWR, or GEN on), the OFF caption will be illuminated in the L/R BATT switch whenever the corresponding battery contactor is open. If the battery meets satisfactory voltage and temperature conditions, the OFF caption will extinguish when the switch is momentarily depressed and the battery contactor will close, connecting the battery to the respective generator bus. The switch will be blank when the battery is on. It will also be dark (with no OFF annunciations illuminated) when there is no electrical power applied to the airplane even though the contactor would be open in this case. The battery contactor will open and the OFF caption will illuminate if the battery switch is depressed a second time or if the battery is automatically turned off due to an overheat or an undervoltage condition.

BUS-TIE — Normal automatic operation of this momentary action switch displays a horizontal bar when the generator buses are tied and no indication will be illuminated when the buses are split. Automatic bus-tie operation is described under DISTRIBUTION in this section.

If required, this switch may be depressed to manually override an automatic bus-tie operation to provide a split system or to tie the electrical system together. One exception is that it cannot be used to open the bus-tie when it has been closed automatically due to GPU operation. The bus-tie manual selection may also be used, in accordance with AFM procedures, to close the bus-tie if it fails to automatically close within five seconds after an inflight generator failure. When the bus-tie switch is depressed, a MAN (manual) caption is illuminated to show that the automatic operation is disabled and the bus-tie will be held in the existing position until deselected by the crew. The CAS also provides a BUS TIE CLSD and BUS TIE MANUAL message.

EXT PWR — The external power switch is a momentary action switch. The green AVAIL caption will illuminate only when a supply of correct voltage and polarity is sensed on a connected GPU. When the EXT PWR switch is pressed to provide external power to the aircraft, AVAIL extinguishes and the white ON is illuminated. The ON caption indicates that the contactor is closed, connecting the GPU to the left generator bus.

L/R GEN—These are momentary action switches. Normal generator operation is automatic and the OFF indication changes with the on/off-line operation of the generator. If a battery start is made, the generator will automatically come on line after start and the OFF caption will extinguish. If the start is made with GPU power connected, the generators will not come on line until the GPU is deselected or disconnected. With the generator on line, the pilot may select to over-ride the automatic operation and select it off line by pressing the generator switch. Depressing the switch when the generator is off line also initiates a reset signal to the GCU which eliminates the need for a separate momentary generator reset switch.

If a generator trips off line, the switch displays OFF and the CAS displays an amber L or R GEN FAIL message. In accordance with AFM procedures, the GEN switch should be depressed once to attempt a reset. If the generator does not reset, the switch again illuminates OFF. If both generators are off or failed, a red L R GEN FAIL message will be displayed by the CAS and a red GEN FAIL annunciator on the CWP will also illuminate. The L R GEN FAIL messages on the CAS will not display if the corresponding thrust lever(s) is/are in the cutoff position; instead a white L R ENG SHUTDOWN collector message will be displayed.

L/R NON-ESS & L/R MAIN — These momentary action switches are only depressed if the crew needs to override the automatic operation of these buses during generator failure. The OFF indication changes automatically to indicate bus condition. Selection of the switch in normal operation (both generators on line) will isolate the corresponding bus and display OFF. Reselection resumes normal operation. The non-essential buses will automatically be OFF whenever the electrical system is being powered strictly by battery power and also in flight if one generator fails. The main and non-essential buses will automatically be shed in-flight if both generators have failed.

L/R AV MSTR — These switches are alternate action and allow the crew to connect or disconnect both main avionics and essential avionics buses by manual selection. The main avionics bus contactors automatically open during engine start on the ground and during starter-assisted airstart.

EMER BATT — The bottom half of this alternate action switch displays OFF when manually selected to OFF (i.e. emergency battery contactor de-energized). This switch is selected on before engine start and will normally remain on during flight. The OFF caption will extinguish when the switch is selected on.

The top half of the EMER BATT switch displays EMER when the emergency battery is powering the emergency battery bus and an airplane generator, or GPU is not providing power to the emergency battery bus. This provides advisory information that the battery is discharging and should not be left on for an extended period while on the ground. In flight, this is an indication that generator power to the emergency battery bus has been lost and that the emergency battery is powering the emergency battery bus. It is normal for this annunciator to be illuminated during start and for a short period before start when generator, or GPU power is not available. A white EMER BATT annunciator on the Crew Warning Panel (CWP) also illuminates when the emergency battery is discharging.

ELECTRICAL SYSTEM INDICATORS

Monitoring of the dc electrical system is menu selectable on the EICAS or MFD displays. Electrical system parameters are usually monitored on the EICAS SUMRY page while the MFD is usually used for navigation display, TCAS, WX Radar, Checklists, etc. The SUMRY display is the power-up default display on the EICAS and MFD. Electrical system parameters in the form of a system schematic may also be monitored on the ELEC system schematic on the EICAS or MFD.

The EICAS/MFD system SUMRY page displays VOLTS, left and right. These two digital displays are an indication of the voltage on the left and right essential buses. Depending on what is powering the airplane electrical system, this can be an indication of airplane main battery volts, GPU volts, or airplane generator volts.

An indication of EMER-V (emergency bus voltage) is displayed on the SUMRY page immediately below VOLTS, left and right. Emergency bus voltage can be monitored on the EICAS/MFD displays. The CAS also monitors the emergency bus volts and will generate an amber EMER BUS VOLTS message if emergency bus voltage is less than 22 volts or more than 29.5 volts.

The left and right generator AMPS are displayed below the emergency bus voltage. There is no display for the amperage being drawn from a GPU.

The last electrical parameter displayed on the SUMRY page is left and right battery TEMP in degrees Celsius. Battery temperature is displayed only for airplanes equipped with NICAD batteries.

All of the electrical system information presented on the SUMRY page is also displayed in a schematic format on the EICAS/MFD ELEC system schematic page. Additionally, the ELEC system schematic display shows whether EXT PWR is connected to the airplane.

Electrical system volts and amps may also be selected for display on either RMU. Under some conditions, the #1 RMU will automatically display the first of two backup engine pages which provide engine operating indications and other system data. The electrical system volts and amps appear on page 2 of the RMU backup engine displays, which is selectable with the PGE button on the RMU. After 20 seconds, the display returns to page 1. Returning the RMU to the communication and navigation function is accomplished with the RMU PGE button. However, if the #1 RMU is displaying engine information due to an

automatic selection, that RMU will return to page 1 of the backup engine display 20 seconds after the last pilot selection on the RMU.

The display of volts, amps and battery temperature on the EICAS/MFD are color coded. As limits are exceeded, the digital data changes color (amber or red). When the data is in its normal operating range, the data is displayed in white. If any of the data exceeds a limit, the data changes to the appropriate color and is boxed in that same color. The exception to the display is when the actual battery temperature is below -23° C (-9.4° F). Below this temperature, the EICAS/MFD will display a flashing amber numeric display. If the actual battery temperature falls below -25° C (-13° F), the numeric digits will be replaced by amber dashes in a cyan box. This indicates the battery temperature(s) is/are below the valid indicating system range, it is not a system failure.

In certain cases, to alert the operator to a parameter exceedance or malfunction, a color coded message will be presented in the upper right corner of the EICAS. This section of the EICAS is known as the Crew Alerting System (CAS). Warning messages will be in red and caution messages will be in amber. A red or amber message will be accompanied by flashing Master Warning (red) or Caution (amber) light, while advisory messages will only flash in white lettering for 5 seconds and then go steady.

The crew is also alerted to certain malfunctions or conditions with illumination of a red or white annunciator on the Crew Warning Panel (CWP). The following annunciators relating to the electrical system are located on the CWP:

L & R BATT OVHT (red) — Illuminates if the corresponding battery temperature exceeds 70° C (160° F).

GEN FAIL (red) — Illuminates if both generators are inoperative or off line.

EMER BATT (white) — Illuminates when the emergency battery is on and is discharging.

DISTRIBUTION

Basic dc power distribution is illustrated in Figure 4-1. With the main airplane batteries installed, power from the left and right batteries, through two 40-amp fuses, is always available to the "hot wired" items connected to the rear hot bus, the left and right hot buses, and the left and right emergency hot buses. Battery power to the left and right hot buses also passes through a single 20-amp fuse and 15-amp circuit breakers for each bus.

The left and right fire extinguishers and the left and right Firewall Shut-off Valves (FWSOVs) receive power through the left and right emergency hot buses, respectively. These items can also receive power from the emergency battery, either engine generator, or external power source. The tailcone utility light, Single-Point Pressure Refueling (SPPR) and baggage compartment lights are powered through the rear hot bus. Additional hot bus items include the cockpit overhead lights and entry lights. The hot buses are connected directly to both of the main batteries and to the external power connector through the left generator bus.

Power to the radio control hot bus is controlled with a momentary action switch on the center pedestal, just forward of the throttle quadrant. The radio control hot bus can only be selected ON when the airplane batteries are OFF. If the radio control hot bus is selected ON and the batteries are subsequently selected ON, the radio control hot bus will automatically be turned off and the ON annunciator on the switch will extinguish. The switch is labeled RADIO CONTROL HOT BUS. When this switch is depressed, the ON annunciator on the switch will illuminate and main battery power through the right forward hot bus will power the following (normal power source shown in parenthesis):

- Left audio control unit (L ESS)

- Clearance delivery radio (L ESS)

- Comm sections of the integrated communication unit #1 (L ESS)

- Nav section of the integrated navigation unit #1 (L ESS)

Ground power can be connected to the airplane as previously described in this section under GROUND POWER UNIT. With ground power connected, the bus-tie will automatically close and the output of the GPU is applied to the left and right generator buses and non-essential buses. With the main and emergency batteries selected On, external power is distributed to the rest of the dc electrical system. The airplane batteries (main and emergency) will then be charged from the power supplied by the GPU.

The external power supplied to the dc electrical system can then be monitored as described under ELECTRICAL SYSTEM INDICATORS in this section.

Various-sized fuses are installed throughout the electrical system to provide circuit protection. Each fuse will carry more than its rated capacity for a short period of time. Extreme or prolonged overloading will cause a fuse to blow, isolating a particular circuit and precluding progressive failure of other electrical components. Fuses cannot be reset. When a fuse has blown, it must be replaced. Fuses are located within the aft and forward left and right Power Distribution Panels (PDPs).

Contactors which are particularly suited for circuits with heavy electrical loads are used throughout the electrical system. Contactors function as remote switches to make or break power circuits. Most of the contactors in the electrical system automatically close and open for given conditions. Some, such as the battery, and GPU, are manually selected open and closed with the respective switches on the electrical control panel, but can also open automatically if monitored faults are detected.

A circuit breaker is designed to open and interrupt current flow in the event of a malfunction. Once opened, it may be reset by pushing it back in. An open circuit breaker may be identified by a white base which can only be seen when it is in the open or tripped position.

Most of the airplane's circuit breakers are located on two circuit breaker panels in the cockpit, one on the pilot's left side panel and one on the copilot's right side panel.

The circuit breakers are thermal type mechanisms and the amperage ratings are stamped on the top of each circuit breaker.

The circuit breakers are grouped by systems rather than by buses.

Emergency bus circuit breakers have red rings around them to easily distinguish them from the other circuit breakers.

The individual circuit breaker labels, grouping labels and dividing lines are illuminated with electroluminescent lighting. There are no bulbs in the panels, but the panels glow when current is flowing through wires imbedded in them. The silk-screened panels allow light to shine through the lettering on the panels. The intensity of the lighting is controlled with the CB PANEL rheostat located on the pilot's and copilot's CREW LIGHTS panels.

SPLIT BUS SYSTEM

The split bus electrical system has a left and right generator bus (GEN BUS) located in a left and right Power Distribution Panel (PDP) in the tailcone. The generator buses supply power to the respective left and right essential, left and right main and left and right non-essential buses located on the left and right circuit breaker panels in the cockpit. Under normal flight conditions, the generator buses are split (bus-tie open), increasing safety in that any major electrical system fault will only affect one side of the system.

GENERATOR BUSES

The generator buses are the central distribution point for the split bus system. The left generator bus powers the left side buses and the right generator bus powers the right side buses. Some services including landing lights, taxi lights, navigation lights, recognition lights and baggage heat are connected through fuses and circuit breakers directly to the generator buses. Each generator bus is connected to a starter/generator and a main battery, with the GPU connecting to the left generator bus. Normally, the two buses operate independently; however, they are automatically "tied" through a bus-tie contactor when the GPU is connected to the electrical system, during engine starting and in flight following a single generator failure. The generator buses can be tied or split manually using the BUS-TIE switch on the electrical control panel, except the bus-tie cannot be manually opened when a GPU is being used.

The CAS presents a BUS TIE CLSD message when the bus-tie is closed and a BUS TIE MANUAL message when closed manually. Also, the bar on the BUS-TIE switch illuminates any time the BUS-TIE is closed and it extinguishes when the bus-tie is open.

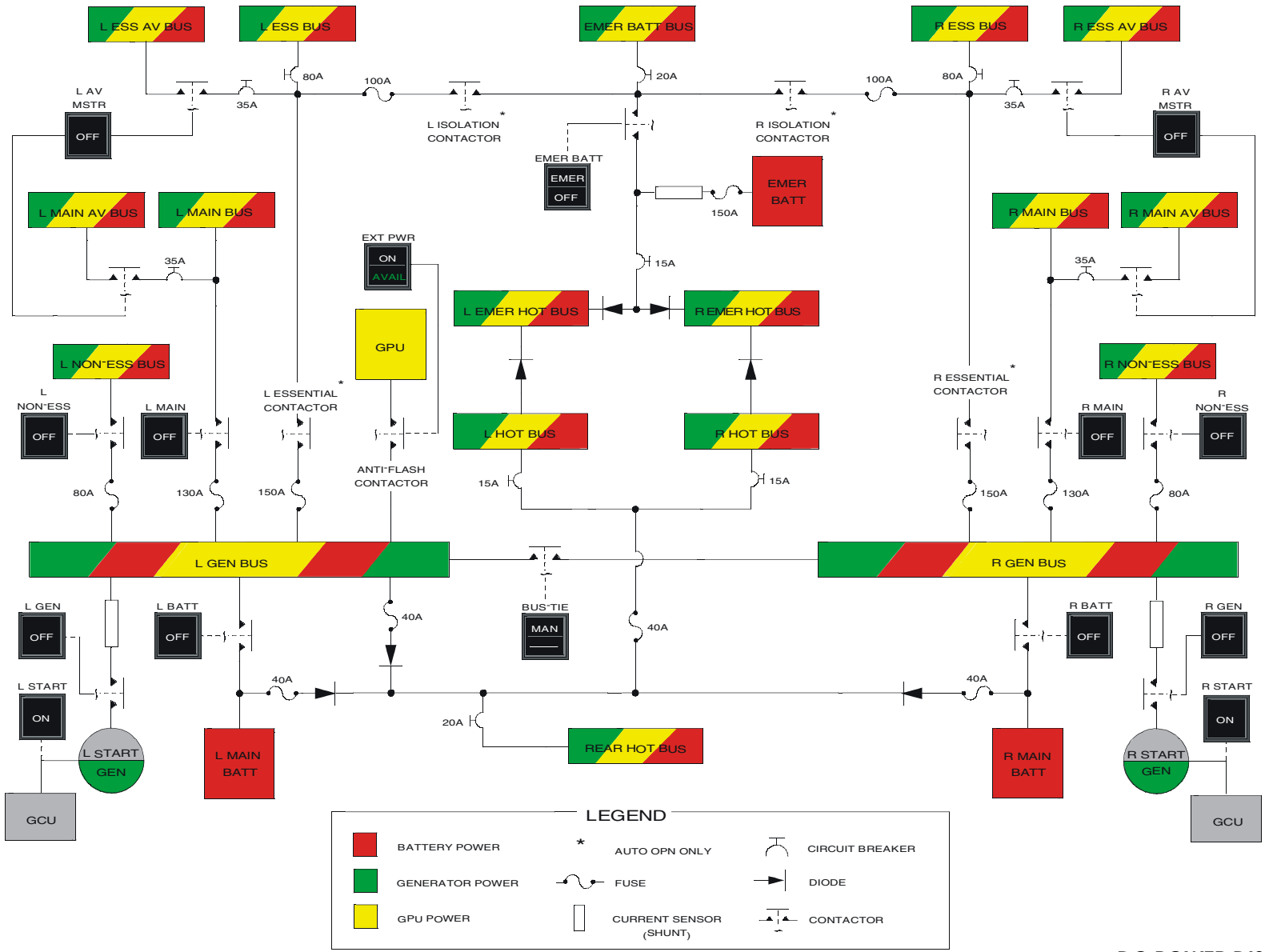
MAIN BUSES

The left and right main buses are fed by the respective left and right generator buses through fuses and contactors. The main buses, in turn, supply power to the left and right main avionics buses through circuit breakers and contactors. Both of the main buses are automatically disconnected in the unlikely event of a dual generator failure and the OFF caption will illuminate on the MAIN bus switches. The main avionics buses will also be depowered in this case, but the OFF caption does not illuminate on the AV MSTR switches since the essential avionics buses will still be powered. The main and main avionics buses may be reconnected by manual selection after reducing the bus load.

MAIN AVIONICS BUSES

The left and right main avionics buses are supplied by the respective main buses through contactors and circuit breakers. The essential and main avionics bus contactors are closed and opened by manual selection of the left and right AV MSTR switches. If the AV MSTR switches are on, the main avionics buses are automatically depowered during engine starting to prevent possible equipment damage from voltage spikes.

The essential avionics buses remain powered during engine start since they power flight critical display units. The AV MSTR switches need not be on during ground starts since the primary flight displays are not needed and DU2 (EICAS) is still powered with the AV MSTR switches OFF.



DC POWER DISTRIBUTION
Figure 4-1

ESSENTIAL BUSES

All essential power loads are connected to the left and right essential buses, including cockpit warning systems and the engine, flap, hydraulic, pressurization, and spoiler controls. Normally, the essential buses are fed by the left and right generator buses respectively through 150-amp fuses, essential bus contactors and 80-amp circuit breakers. The left and right essential bus contactors automatically close when the respective left and right BATT switches are turned on and they automatically open during starter operation. The essential buses are tied together by a left and right isolation contactor so that they are both powered by the emergency battery during engine start and they will be powered by either generator bus if an essential bus contactor should fail in flight.

ISOLATION CONTACTORS

There are two isolation contactors located within the electrical system. The right isolation contactor is located between the right essential contactor and the emergency battery bus, and the left isolation contactor is located between the left essential contactor and the emergency battery bus. The isolation contactors are automatically controlled and there are no provisions for the crew to manually override their operation.

Except during starter-assisted engine start, the left isolation contactor is normally open and the right isolation contactor is normally closed. With the right isolation contactor closed, the right generator bus powers the emergency battery bus and charges the emergency battery.

During ground engine starting and for starter-assisted airstarts, the isolation contactors close and the left and right essential contactors automatically open. This allows the emergency battery to power the emergency battery bus, essential buses, and essential avionics buses and isolates these buses from voltage fluctuations caused by starter operation. After starter drop-out, the left isolation contactor opens and the essential contactors close.

ISOLATION CONTACTORS (CONT)

There are two abnormal conditions that will cause the left isolation contactor to automatically close. If either essential contactor fails (opens), the left isolation contactor will close. Since the right isolation contactor is normally closed, either generator bus can then provide generator power through the essential contactor that is closed to the left and right essential buses and to essential avionics buses, the emergency battery bus and to charge the emergency battery. This failure will be displayed as a white L/R ESS BUS FAULT message on the CAS.

The left isolation contactor will also close in the event that the right isolation contactor fails (open). This will allow the emergency battery bus and emergency battery to receive power from the left generator bus. There is no apparent indication of this condition to alert the crew.

ESSENTIAL AVIONICS BUSES

The left and right essential avionics buses are powered from the left and right generator buses respectively through the left and right essential contactors and left and right essential avionics contactors. In addition to the 150-amp fuses protecting the essential bus feeders, the essential avionics buses are also protected with 35-amp circuit breakers. Under normal conditions, the essential contactors will automatically be closed, providing power to the essential avionics contactors. The essential and main avionics contactors are closed and opened by manual selection of the left and right AV MSTR switches. These essential avionics buses, like the essential buses, are powered by the emergency battery during starter-assisted airstarts while the main avionics buses are depowered.

EMERGENCY BATTERY BUS

The emergency battery bus is normally powered from the right generator bus through the right essential contactor and right isolation contactor, but for engine starting and in the event of dual generator failure, it is powered directly from the emergency battery. Emergency battery bus services include landing gear control and indication, inboard brakes/anti-skid, standby instruments, and the #1 RMU for a backup EICAS display.

In the event of a dual generator failure, the right isolation contactor opens (left one already open), leaving the main aircraft batteries to power the respective essential buses and the emergency battery to power the emergency battery bus. Hence, three independent battery power sources are operating following a dual generator failure. The standard 10-ampere-hour emergency battery will power the emergency battery bus for at least one hour after being isolated from the rest of the electrical system.

NON-ESSENTIAL BUSES

The left and right non-essential buses, normally connected to the respective generator buses, are used to supply noncritical loads, including certain cabin lighting and domestic loads. When the airplane electrical system is powered with airplane batteries only, the non-essential buses are not powered and the OFF captions will be illuminated on both NON-ESS switches. If the GPU is selected ON, but the main batteries are OFF, only the non-essential buses are powered. When the GPU or airplane generator is powering the electrical system, and the main batteries are On, the non-essential bus contactors will automatically close and the OFF captions will extinguish if the airplane is on the ground. However, if either generator fails in flight, the non-essential buses are both automatically disconnected to reduce the electrical load. One or both non-essential buses may be subsequently reconnected by depressing the NON-ESS switches on the electrical control panel.

DISTRIBUTION SUMMARY

When only main and emergency battery power is On (and the AV MSTR switches are On), the non-essential buses are not powered and cannot be selected On.

When external power (GPU) is connected and the emergency battery is selected On, the bus-tie connecting the two generator buses is automatically closed. When the AV MSTR switches are selected to On, the contactors to the left and right essential avionics buses and the left and right main avionics buses will close. Note that the EMER BATT switch caption EMER will no longer illuminate since the emergency battery will no longer be discharging.

During an engine start (using airplane batteries) the essential buses and emergency battery bus are isolated and are powered from the emergency battery. The non-essential buses and main avionics buses are also automatically depowered for engine start.

When one engine-driven generator comes on line, the essential bus contactors will close and the left isolation contactor will open. Also, the contactors to the non-essential buses will close. The bus-tie contactor remains closed at this point so that both generator buses are powered by the single generator.

During normal flight conditions (two engine-driven generators on line), the bus-tie opens and will remain open as long as both generators remain on line and the bus-tie is not manually selected closed.

ABNORMAL MODES OF OPERATION

SINGLE GENERATOR FAILURE

In the event of a single generator failure in flight, the operating generator must supply the load for both sides of the dc electrical power system. To prevent shock loading of the remaining generator, load shedding of the non-essential buses automatically occurs. After a 5 second voltage check delay, to see that there is no fault on the generator bus associated with the failed generator, the bus-tie automatically closes. The CAS will display an amber L or R GEN FAIL message and a white BUS TIE CLSD message after the bus-tie automatically closes. Indications on the electrical control panel would be illuminated OFF captions on the left and right NON-ESS bus switches, an illuminated OFF caption on the GEN switch of the failed generator and an illuminated bar on the BUS-TIE switch. All other systems will continue to operate normally. If necessary, the crew should reduce the load further and if conditions warrant, attempt to reset the failed generator. Non-essential buses may be regained by selecting the appropriate NON-ESS switch. No aircraft electrical system power is required to reset a generator, however, the corresponding L GEN or R GEN circuit breaker must be in to sustain generator operation.

DUAL GENERATOR FAILURE

Dual generator failure would become most apparent with illumination of the red GEN FAIL annunciator on the CWP and the accompanying flashing Master Warning lights. Also the CAS would display a red L R GEN FAIL message. Generator failure can be verified by noting zero left and right amps on the EICAS/MFD SUMRY or ELEC system schematic display and OFF illuminated in each GEN switch.

With a dual generator failure, main airplane batteries and the emergency battery powers the dc electrical systems. Both main buses, both main avionics buses and both non-essential buses will be automatically depowered to immediately shed the electrical load. Also, the right isolation contactor automatically opens leaving the emergency battery to power the emergency battery bus. The bus-tie remains open, so the left battery will power the left essential bus and left essential avionics bus, and the right battery will power the right essential bus and the right essential avionics bus. The AFM procedure for L and R GEN FAIL is to turn off the AV MSTR switches which will also cause the loss of the left and right essential avionics buses.

The duration of the standard main batteries (27-amp-hour) is a minimum of 30 minutes and the optional main batteries (38-amp-hour) is a minimum of 60 minutes. The duration of the emergency battery (10-amp-hour) is approximately 1 hour. Expected duration assumes the electrical load is reduced in accordance with the L R GEN FAIL procedure in the Emergency Section of the AFM.

Indications of a dual generator failure would be OFF captions on the left and right MAIN bus switches, NON-ESS bus switches and GEN switches. Also, the EMER captions on the EMER BATT switch would be illuminated indicating the emergency battery is powering the emergency battery bus. The OFF captions in the L and R AV MSTR will also be illuminated when the AV MSTR switches are selected OFF per the AFM procedure.

During a dual generator failure, both essential avionics buses, both main buses and both main avionics buses are available by manual selection if desired; however, this will significantly reduce the main battery duration.

BATTERY OVERHEAT

If either nickel-cadmium main battery exceeds the established temperature values, the crew is alerted in several different ways. First, the Master Caution or Master Warning annunciators, depending on battery temperature, is activated. A corresponding CAS message is generated for a battery overheat. An amber L or R BATT OVHT message is displayed for battery temperature exceeding 60° C and a red message is displayed if the battery temperature exceeds 70° C. Also, if battery temperature exceeds 70° C, a red L or R BATT OVHT annunciator on the CWP will illuminate and the corresponding battery is automatically switched OFF if not already switched OFF by the crew. The battery temperature must be less than 60° C before it can again be turned on.

If the SUMRY or ELEC system schematic is being displayed on the EICAS or MFD displays, the digital readout of the battery temperature for the affected battery will change color and flash. If the battery temperature exceeds 60° C (140° F) the digital battery temperature display will change from white to a boxed amber and if the temperature exceeds 70° C (160° F) it will change to boxed red.

AC POWER

As part of the anti-ice protection system, left and right windshield heaters are powered by two, left and right engine-driven alternators. The alternators are mounted to the front of the engine accessory section, next to the starter/generator, and operate from 6,000 to 12,000 rpm.

These alternators will supply 200-vac, 200-400 Hz at a maximum of 5kva single phase output. The alternator output is controlled by a separate control unit that contains the monitor circuitry for the windshield. There are no provisions for directly monitoring alternator output on the EICAS displays, but loss of ac power from an alternator would be detected by failure of windshield anti-ice.

The output of the alternators is only used by the windshield anti-ice. See Section VI, ANTI-ICE & ENVIRONMENTAL for additional information.

LIGHTING

INTRODUCTION

Lighting is used to illuminate the cockpit area and all flight instruments. The majority of the instruments are internally lighted. For general illumination and floodlights, Light Emitting Diodes (LEDs) are used. Rheostatic controlled goose-neck map lights are installed on both the left and right side panels. The standard warning lights are available for the cabin area, and emergency lights are provided to illuminate the exits in the event of an emergency. Exterior lighting consists of landing, taxi, recognition, strobe, navigation, beacon, and a wing inspection light. Optional exterior lighting consists of tail logo lights and exterior convenience lights that illuminate the single-point pressure refueling and baggage door areas.

GENERAL

Cockpit lighting consists of map lights, glareshield floodlights, instrument/indicator lights, panel lights, dome lights and two cockpit switch panels to control the lights.

Cabin lighting consists of entry, overhead, passenger table and reading lights, galley, and lavatory lights.

Tailcone baggage lighting is provided within the baggage compartment.

Tailcone maintenance lighting consists of lighting within the tailcone equipment compartment.

Additional interior lighting consists of an emergency cabin lighting package and optional illuminated lavatory mirror. The emergency cabin lighting package utilizes existing overhead lights, additional exit lights and seat base mounted floor proximity lights. The optional illuminated lavatory mirror utilizes additional lights installed behind the mirror.

Optional exterior lighting is available to illuminate the general areas around the baggage compartment and the Single-Point Pressure Refueling (SPPR) area.

COCKPIT LIGHTING

Cockpit lighting is controlled through two cockpit control panels and two Light Control Units (LCUs) that are located within the forward avionics bay. Each LCU (pilot LCU and copilot LCU) has four separate channels that distribute power resources to lighting groups.

LEFT CREW LIGHTS PANEL

The L CREW LIGHTS panel is 28-vdc powered from the left essential bus and protected by a circuit breaker labeled CKPT INSTRS L ESS PWR, located within the LIGHTS group of circuit breakers on the pilot's circuit breaker panel. The four pilot LCU channels control:

- Channels 1 and 2 — Pilot's instrument panel, overlays, and instruments.
- Channel 3 — Pilot's circuit breaker panel.
- Channel 4 — Left side bulbs for switch lighting.

Following is a description of each of the potentiometer controls located on the L CREW LIGHTS panel.

OVRHD — The pilot's overhead swivel light is controlled by the OVRHD potentiometer. The pilot overhead light can also be turned on with the COCKPIT switch on the entryway switch panel assembly when the cabin door is open and the OVRHD control is off. When the upper cabin door is closed, cockpit overhead light control from the entryway switch panel assembly is disabled. The overhead light is powered by the right main bus and is protected by the OVRHD circuit breaker within the CABIN group on the copilot's circuit breaker panel. When the pilot's overhead light is controlled via the entryway switch panel assembly, it receives power from the airplane hot bus system.

INSTR — The pilot's instrument panel lighting is controlled via the INSTR potentiometer. Display units and the radio management units have internal lighting, and the intensity is controlled through sensors and controls. The bezel controller backlighting for these units are controlled by the INSTR control, however. The pilot's instrument panel lights receive 28-vdc power from the left main bus and are protected by a circuit breaker labeled L INSTR located within the LIGHTS group on the pilot's circuit breaker panel.

FLOOD — The entire instrument panel can be illuminated by a floodlight located beneath the glareshield. Dimming is controlled via this potentiometer. Power to the floodlight is from the left essential bus and is protected by the FLOOD circuit breaker within the LIGHTS group on the pilot's circuit breaker panel.

CB PANEL — This potentiometer controls the intensity of overlay lighting on the pilot's circuit breaker panel. The panel receives 28-vdc power from the left main bus and is protected by a circuit breaker labeled L CB located within the LIGHTS group on the pilot's circuit breaker panel.

RIGHT CREW LIGHTS PANEL

The R CREW LIGHTS panel is 28-vdc powered from the right main bus and protected by a circuit breaker labeled CKPT INSTRS R ESS PWR, located within the LIGHTS group of circuit breakers on the copilot's circuit breaker panel. The four copilot LCU channels control:

- Channels 1 and 2 — Copilot's instrument panel and glareshield overlays, instruments, and pedestal overlays.
- Channel 3 — Copilot's circuit breaker panel.
- Channel 4 — Right side bulbs for switch lighting.

Following is a description of each of the potentiometer controls located on the R CREW LIGHTS panel.

INSTR — The copilot's instrument panel lighting is controlled via the INSTR potentiometer. Display units and the radio management units have internal lighting, and the intensity is controlled through sensors and controls. The bezel controller backlighting for these units is controlled by the INSTR control, however. The copilot's instrument panel lights receive 28-vdc power from the right main bus and is protected by a circuit breaker labeled R INSTR located within the LIGHTS group on the copilot's circuit breaker panel.

OVRHD — The copilot's overhead swivel light is controlled by the OVRHD potentiometer. When the upper cabin door is closed, cockpit overhead light control from the entryway switch panel assembly is disabled. The overhead light is powered by the right main bus and is protected by the OVRHD circuit breaker within the CABIN group on the copilot's circuit breaker panel. When the copilot's overhead light is controlled via the entryway switch panel assembly, it receives power from the airplane's hot bus system.

PEDESTAL — This potentiometer controls the lighting intensity of equipment installed in the pedestal. The FMS display intensity is regulated by the dim button on FMS control panel. Pedestal lighting receives power from the right main bus and is protected by a circuit breaker labeled PEDESTAL located within the LIGHTS group on the copilot's circuit breaker panel.

CB PANEL — This potentiometer controls the intensity of overlay lighting to the copilot's circuit breaker panel. The panel receives 28-vdc power from the right main bus and is protected by a circuit breaker labeled R CB located within the LIGHTS group on the copilot's circuit breaker panel.

SWITCH LIGHTING

A majority of the switches in the cockpit are push button switches with lighted indicators. They are designed so that none of the indicators are illuminated under normal conditions, which supports the "quiet or dark cockpit" concept. For example, the GEN switches are black (blank) when the generators are On and OFF illuminates when the generators are off.

For redundancy, each of the switches contain four bulbs and receive power from two different sources. The pilot's Lighting Control Unit (LCU) supplies power to the two left bulbs and the copilot's LCU supplies power to the two right bulbs in most cases. Exceptions to this are the RAD HOT BUS switch, which receives power from the hot bus, and the master WARN/CAUT and engine FIRE PUSH switches which receive power through the Crew Warning Panel (CWP).

A bulb test may be initiated by selecting LTS on the system test knob (center pedestal) and depressing the PRESS-TO-TEST button.

MAP LIGHTS

Two multi-directional, goose-neck map lights are located in the cockpit, one on each side. Power is provided to each light by the left essential bus and is protected by a circuit breaker labeled MAP located on the pilot's circuit breaker panel in the LIGHTS group. Dimming is controlled by a rheostat located at the base of each light assembly.

CABIN LIGHTING

Cabin (passenger compartment) lighting consists of entry/exit, overhead, passenger reading/table, galley cabinet, lavatory (read/vanity) and NO SMOKING/FASTEN SEAT BELT lights.

Primary cabin lighting control is through the entryway switch panel assembly which is located on the left storage cabinet just above the main cabin door entry hand rail. Additional lighting controls are located in the individual seat passenger lighting control unit (for reading and table lights), master control panel and the lavatory passenger control panel assembly.

The master control panel is located in the right mid aft seat storage box (in the standard configuration). When the menu item indicated by the Liquid Crystal Display (LCD) is cabin lights, for example, operation of the SELECT switch provides ON/VARIABLE/OFF control.

Cabin lighting (except entry/exit light and overhead lights) is powered by the LEFT and RIGHT NON-ESSENTIAL Buses. This arrangement allows cabin lighting to be used with a GPU powering the non-essential buses, but with the rest of the electrical system not powered. See GPU and the non-essential bus system in ELECTRICAL, this section for more information.

ENTRY/EXIT LIGHTS

The cabin entry/exit door light is installed in the upper door to provide illumination of the lower door steps and/or ground when both doors are open. This light is controlled by the ENTRY light switch on the entryway switch panel assembly and is powered by the hot bus regardless of the BATT switch position. The light is inoperative when the upper entry door is closed. The entry/exit light is protected by a circuit breaker labeled ENTRY, located within the CABIN light group on the copilot's circuit breaker panel.

OVERHEAD LIGHTS

The overhead lights consist of indirect downwash lighting located within the convenience panel. Covered by lenses, the overhead lights are controlled by the CABIN switch on the entryway switch panel assembly and the master control panel. The cabin overhead lights are powered by the left main bus and are protected by the CABIN circuit breaker within the CABIN group on the pilot's circuit breaker panel.

PASSENGER READING AND TABLE LIGHTS

Reading and table lighting consists of lights installed in the convenience panels above the seats on each side of the cabin. The seats have only one light, while the table lights consist of a two-light assembly, installed above each table. Control for the reading lights is by the passenger lighting control unit mounted near each passenger seat and by the SPOTLIGHT switch on the entryway switch panel assembly. Power for the reading lights is provided by the left and right non-essential bus and they are protected by the L and R SPOT circuit breakers located within the CABIN group on the pilot's and copilot's circuit breaker panels.

GALLEY LIGHTS

Lighting (LEDs) for the passenger refreshment area is powered by the right non-essential bus and protected by the GALLEY circuit breaker within the CABIN group on the copilot's circuit breaker panel.

LAVATORY LIGHTS

Lighting of the lavatory area consists of spotlights and downwash lights.

The spotlights (one located on the left side above the toilet and one located on the right side above the aft cabin stowage compartment) are controlled using the READ, BAGGAGE, MIRROR LIGHTS switch on the lavatory passenger control panel assembly.

The downwash lights run lengthwise on the left and right convenience panels and are controlled using either the LAV LIGHTS switch on the lavatory passenger control panel assembly or the LAVATORY switch on the entryway switch panel assembly located near the main cabin door.

All the lavatory lights are powered by the left and right non-essential bus and are protected by the CABIN group LAV LIGHTS and L and R SPOT LIGHT circuit breakers on the pilot's and copilot's circuit breaker panels.

If installed, the optional lavatory mirror provides additional indirect lighting of the lavatory area. The indirect lighting is controlled using the same switch as the spotlights. Depressing the READ, BAGGAGE, MIRROR LIGHTS switch on the lavatory passenger control panel assembly will either illuminate or extinguish the optional mirror indirect lighting.

Control of the NO SMOKING/FASTEN SEAT BELT signs is through a switch located on the LIGHTS control panel in the cockpit. This switch is a three-position switch labeled OFF, BELTS and NO SMOKING/BELTS.

BAGGAGE/TAILCONE LIGHTING

Lighting for the baggage compartment consists of two overhead dome lights. The lights are controlled by the LIGHTS toggle switch located on the ceiling near the baggage compartment door. The baggage compartment lights are powered by the airplane's hot bus system. If inadvertently left on, it will automatically extinguish when the access door is closed.

The tailcone equipment bay internal light is also powered by the hot bus system. The switch is located near the access door and if inadvertently left on, the light automatically extinguishes when the door is closed.

EMERGENCY LIGHTING SYSTEM

The emergency lighting system is standard and consists of cabin discrete overhead, floor proximity lights (seat-base mounted lighting units), and emergency exit area lights that illuminate in the event of a failure of the normal electrical system. Control of the emergency lighting system is through a three-position switch located on the LIGHTS control panel.

The emergency lighting group consists of:

- 5 exit signs (2 per door, 1 on forward face of lavatory partition)
- 4 PSU lights
- 6 floor proximity lights (4 white lens, 2 red lens on each side of the aft right emergency exit)
- Main door egress light (when upper door open)
- Emergency exit egress light
- Lavatory light

The cockpit EMER LIGHTS switch is lever-locked and labeled OFF, ARM and ON. When the cockpit switch is in the OFF position, the emergency lights are inhibited. When the cockpit switch is in the ON position, the emergency lighting group illuminates.

Activation periods are limited by a timing circuit to a minimum of 10 minutes and a maximum of 12 minutes.
To function automatically, the cockpit switch must be in the ARM position. Once armed, the emergency lighting system automatically illuminates when normal electrical power is lost (dual generator failure) or when the passenger oxygen mask deployment occurs. When the emergency lights are activated automatically, they may be deactivated by placing the EMER LIGHTS switch to the OFF position. The crew is alerted when airplane power is on and the emergency lights are not armed. To indicate this condition, a white EMER LTS CAS message is illuminated.

The emergency lights receive power from the left main battery and the emergency battery. The emergency lights are divided into four lighting zones (forward, mid-forward, mid-aft, and aft), and each zone is powered in parallel from both electrical sources. The emergency battery is inhibited from supplying power to the emergency lights in the air, conserving power for ground egress illumination. If activated while on the ground, the emergency lights operate for approximately 10 minutes to adequately allow for safe egress. Circuit breaker protection for the emergency lights is located in the tailcone on the power distribution panel.

LANDING and TAXI LIGHTS

The landing lights consist of two dual bulb light assemblies mounted just forward of the wing fuselage fairing. The taxi lights consist of a single filament light mounted on each main landing gear strut.

The landing lights are controlled from two toggle switches located on the LIGHTS control panel. When these switches are positioned to the LDG (landing) position, all four bulbs (two in each light assembly) illuminate. Control of the taxi lights is via the same switch, but positioned to the TAXI position. The taxi lights also illuminate whenever the main landing gear is down and locked, the gear doors are up and locked and the landing light switches are in the LDG position. For ground operations, selecting the TAXI position illuminates only the taxi lights.

The landing and taxi lights are powered from the left and right main buses, respectively and are protected by circuit breakers labeled L and R TAXI/LDG CTRL located on the pilot's and copilot's circuit breaker panels in the LIGHTS group.

RECOGNITION LIGHTS

The standard recognition lights consist of the outboard bulbs on each of the two landing light assemblies. Moving the RECOG switch to the RECOG position illuminates both outboard landing lights (recognition lights). The recognition lights are protected by the 5-amp R and L TAXI/LDG CTRL circuit breakers located on the pilot's and copilot's circuit breaker panels.

An optional tail recognition light may be installed in the upper leading edge of the vertical stabilizer. The tail recognition light is controlled by the RECOG switch. When RECOG is selected, the standard and tail recognition lights illuminate. It is protected by the 1-amp TAIL RECOG circuit breaker, located on the pilot's circuit breaker panel.

An optional pulsating recognition light system is available which consists of a three-position recognition light switch and a pulse controller unit. The pulsating recognition light switch is labeled RECOG/PULSE/OFF. Moving the RECOG switch to the RECOG position will illuminate both wing recognition lights (outboard landing lights) and the tail recognition light, if installed. Moving the RECOG switch to the PULSE position will cause the recognition lights to pulse at a rate of approximately 45 cycles per minute.

NAVIGATION LIGHTS

The navigation lights system consists of three lights, two wing-tip (winglet) position lights that are viewable from each side and one tail mounted position light that is viewable from the rear. The left and right position lights are located on the outboard side of the left winglet (aviation red) and the outboard side of the right winglet (aviation green). The aft position light (aviation white) is located on the top trailing edge of the vertical stabilizer.

All three navigation lights are controlled by the NAV light switch. Additionally, setting the NAV light switch to NAV (or to NAV/LOGO) automatically dims all cockpit switch lights on the instrument panel and the center pedestal. The NAV switch is a two-position (OFF-NAV) switch on airplanes not equipped with the optional LOGO lights. When an airplane is equipped with the LOGO lights, a third position (NAV/LOGO) is added to the NAV light switch.

The navigation lights receive 28-vdc power from the right main bus and are protected by the NAV circuit breaker located on the copilot's circuit breaker panel within the LIGHTS group.

ANTI-COLLISION LIGHTS (BEACON/STROBE)

The anti-collision light system consists of two beacon/strobe light units. The upper anti-collision light is located on the top of the vertical stabilizer, and the lower light is mounted on the bottom of the wing/fuselage fairing.

Each light unit incorporates two flash tubes, one with an aviation red filter and one with a clear filter. Control over both anti-collision lights is via the three-position BCN/STROBE-BCN/OFF light switch on the LIGHTS control panel. When the switch is placed in the BCN/STROBE position, the red light in each unit flashes if the airplane is on the ground, or the clear flashtube flashes, if airborne. When the switch is placed in the BCN position, the red flashtube in each light unit flashes whether the airplane is on the ground or airborne.

The combined anti-collision light system, with each light unit pulsed independently, has a flash rate of approximately 100 pulses per minute. The system receives power from the left main bus and is protected by the BCN/STROBE circuit breaker located within the LIGHTS group on the pilot's circuit breaker panel.

WING INSPECTION LIGHT

The wing inspection light system provides the copilot with a means to visually detect ice buildup on the airplane wings during night operations. The system consists of a WING INSP light pushbutton, located on the LIGHTS control panel; a halogen spotlight assembly, flush-mounted in the right side of the fuselage aft of the cockpit; and a black spot located on the right wing leading edge. The black spot enhances visual detection of ice accumulation; however, clear ice may not be detectable by visual inspection alone.

The WING INSP push button is a momentary action switch, meaning that the inspection spotlight illuminates the wing area only when the switch is held depressed. The system is powered by the right main bus and is protected by the WING INSP circuit breaker located within the LIGHTS group on the copilot's circuit breaker panel.