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STUDENT GUIDE

FOR

UH-60 ELECTRICAL SYSTEM

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APRIL 2003

BLACK HAWK UH-60 ELECTRICAL SYSTEM

TABLE OF CONTENTS

This TSP supersedes None TSP Number, Dated NA.

SECTION I. -INTRODUCTION

TERMINAL LEARNING OBJECTIVE:

ACTION: Identify the characteristics of the UH-60 electrical system.

CONDITIONS: As a UH-60 Maintenance test pilot.

STANDARD: In Accordance with (IAW) UH-60 Technical Manuals.

SAFETY REQUIREMENTS: Will be addressed as NOTES, CAUTIONS, and WARNINGS throughout the lesson outline.

RISK ASSESSMENT LEVEL: Low

ENVIRONMENTAL CONSIDERATIONS: There are no environmental concerns for this lesson.

EVALUATION: None

SECTION II. -PRESENTATION

A. ENABLING LEARNING OBJECTIVE ELO No. 1:

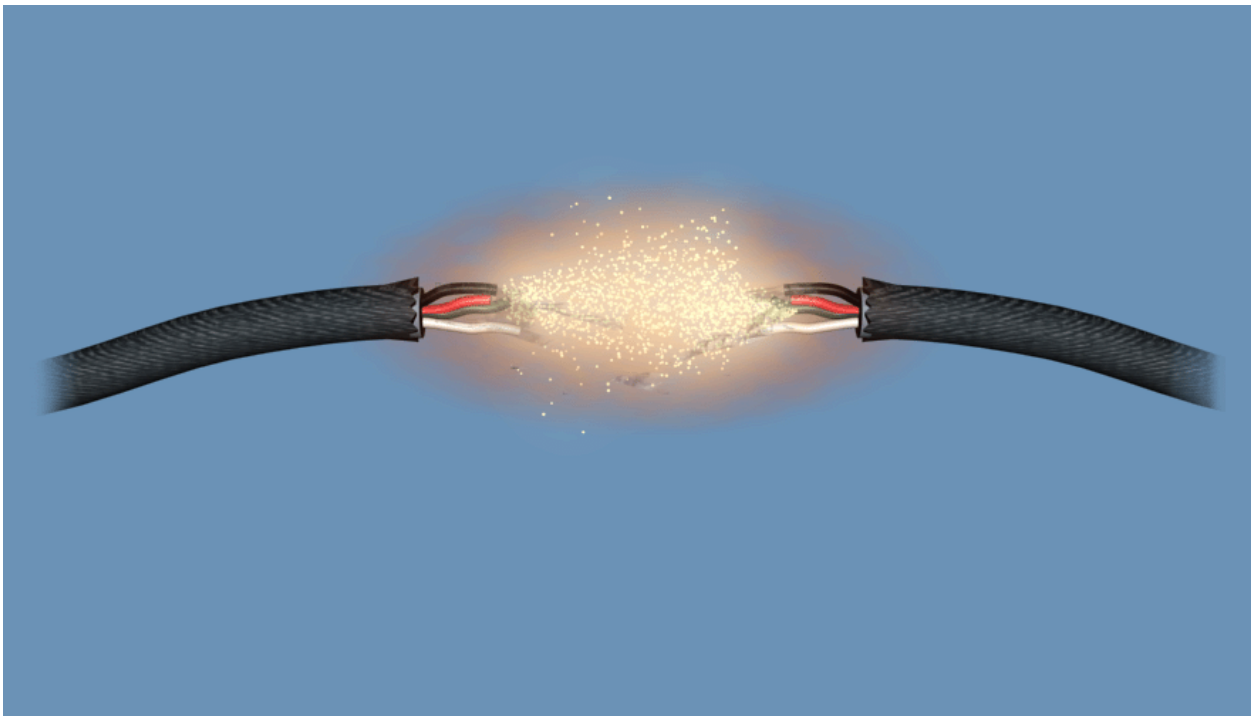
ACTION: Identify the general characteristics of electricity.

CONDITION: As a UH-60 Maintenance test pilot.
STANDARD: IAW UH-60 Black Hawk TM 1 Series Manuals.

Frame #3005 (MENU)

a. Definition of Electricity

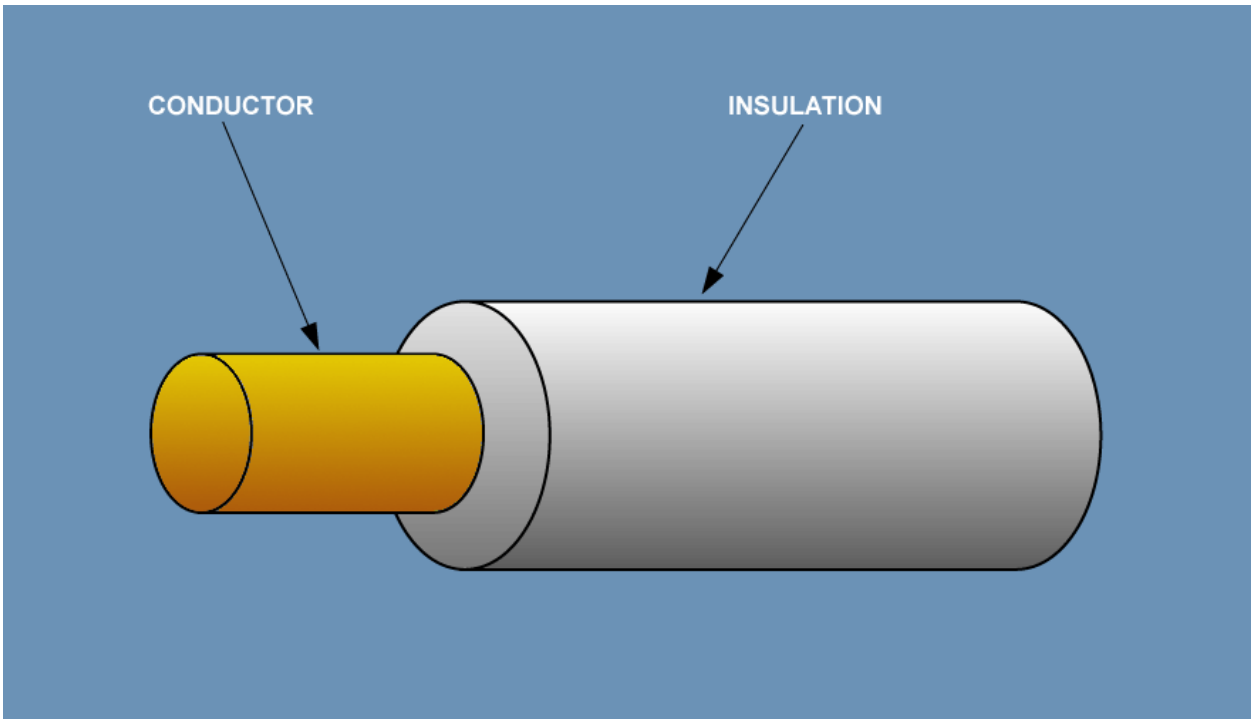
Frame #3010 (Definition of Electricity)



(1) Electricity is the energy made available by the flow of an electric charge through a conductor.

b. Definition of a Conductor

Frame #3015 (Definition of a Conductor)



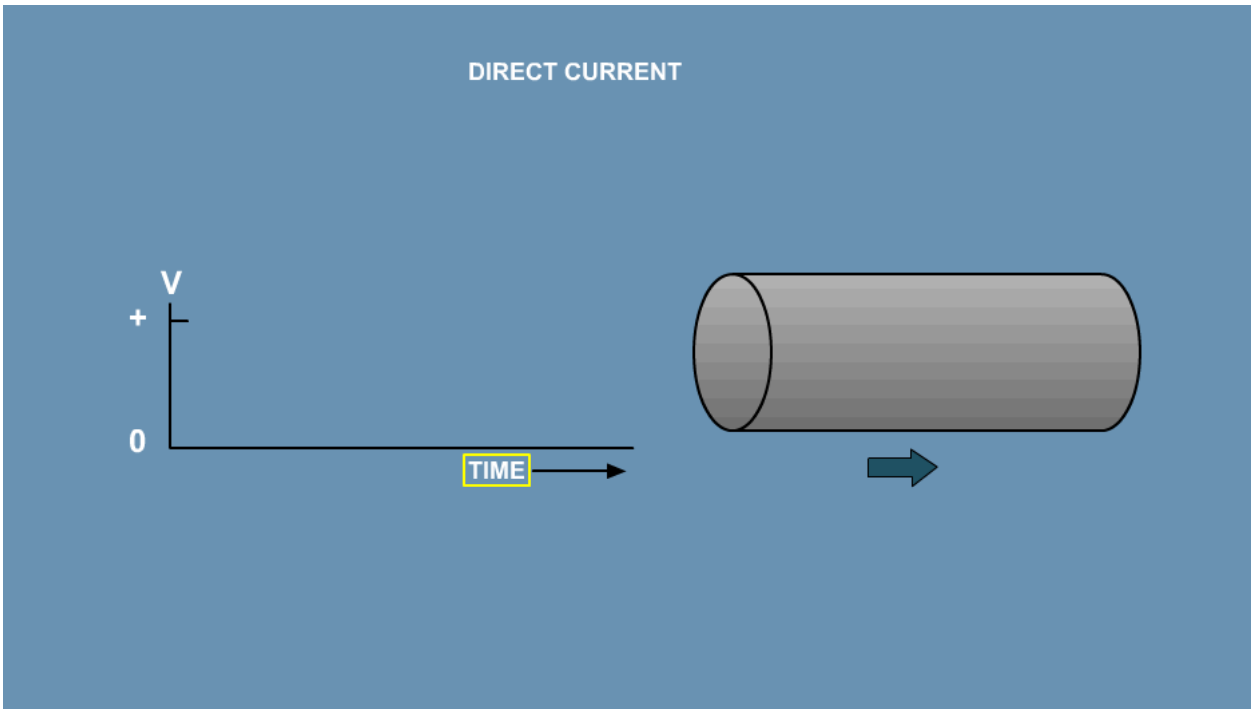
(1) A conductor is a substance, which allows free motion of a large number of electrons.

(a) Conductor - allows free flow.

(b) Insulator - allows free flow but only with large inputs of energy.

c. Characteristics of Electricity

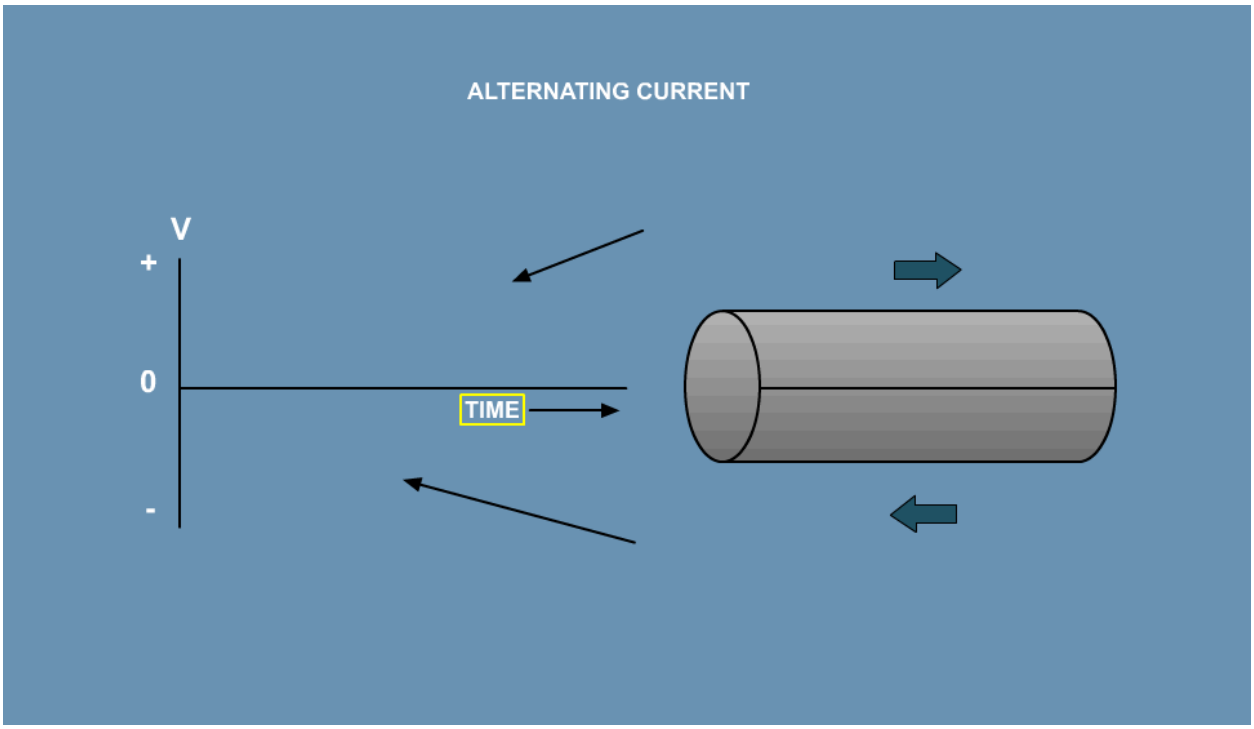
Frame #3020 (Characteristics of Electricity FLASH)



(1) DC (Direct Current) - An electric current that flows in one direction only and is constant in value.

(2) The visual representation on the left is what the electrical current would look like on an oscilloscope, which measures the speed (frequency) and amount of current through a conductor.

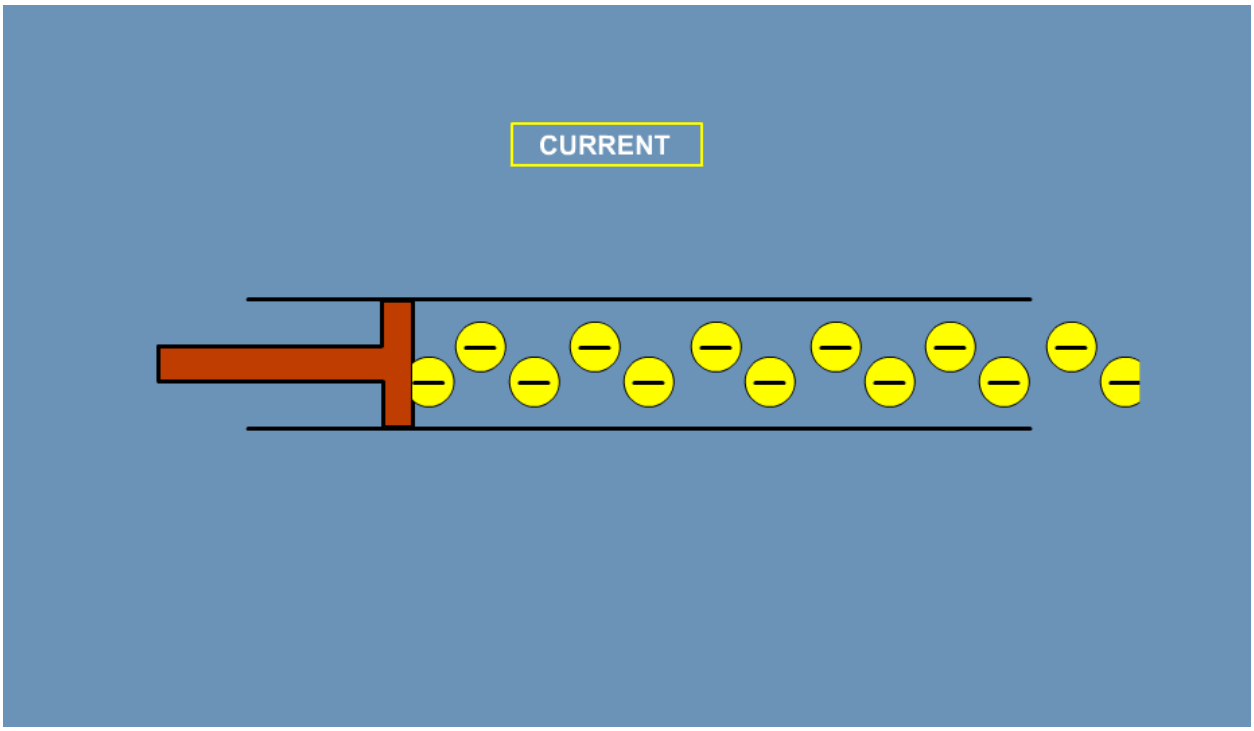
Frame # 3021 (Alternating Current FLASH)



(3) AC (Alternating Current) - An electrical current that reverses its direction at regularly recurring intervals.

(4) The visual representation on the left is what the electrical current would look like on an oscilloscope, which measures the speed (frequency) and amount of current through a conductor.

Frame # 3022 (Current FLASH)

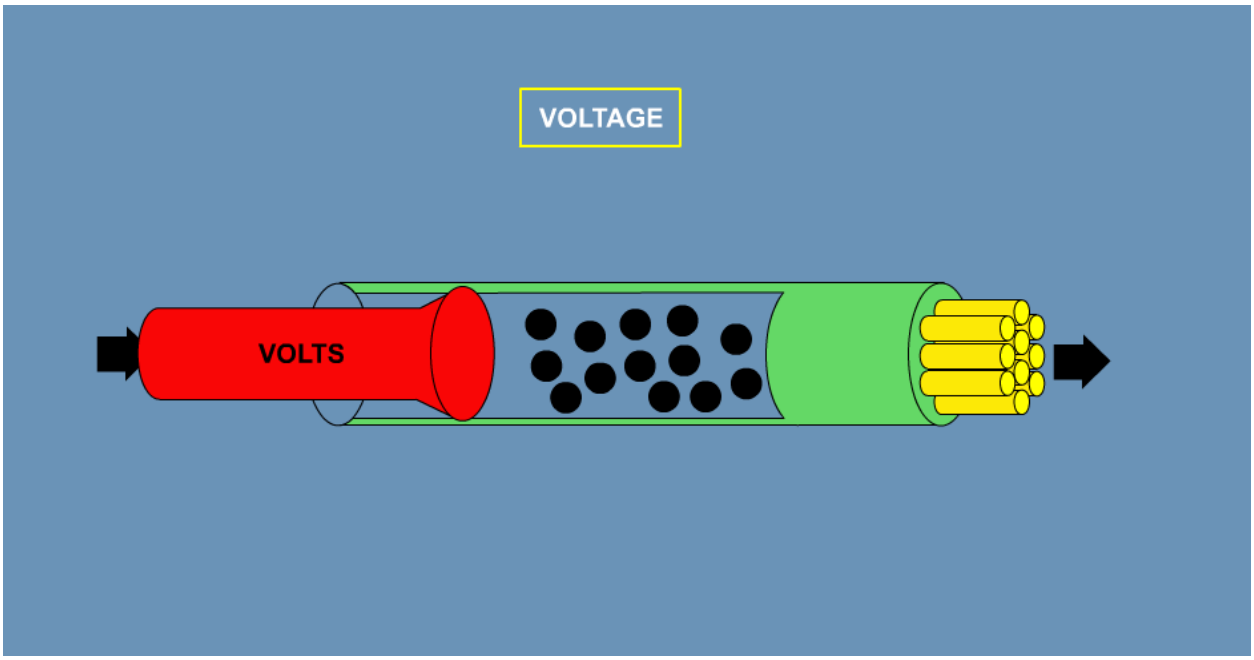


(5) Ampere - Unit of current strength.

(6) Current is the number of electrons passing a given point at a given time.

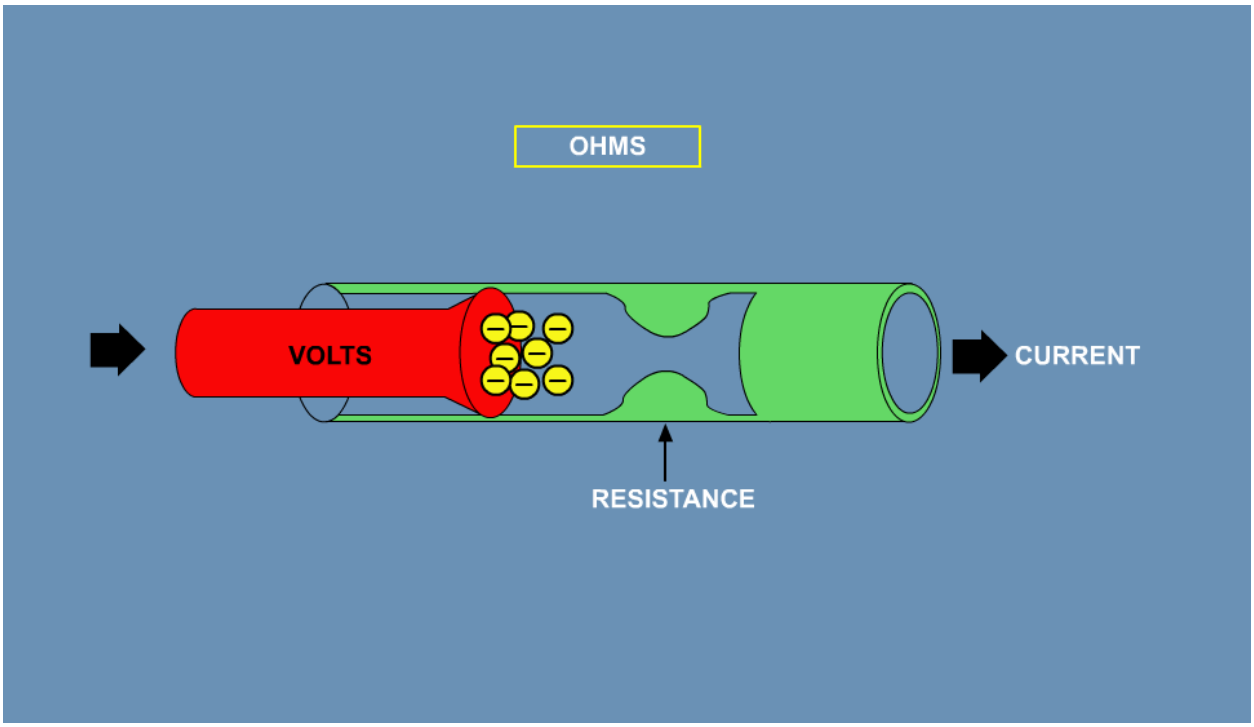
(7) Also known as electron flow.

Frame # 3023 (VOLTAGE FLASH)



(8) Voltage - Unit of electrical potential (electromotive force; pressure).

Frame # 3024 (OHMS FLASH)

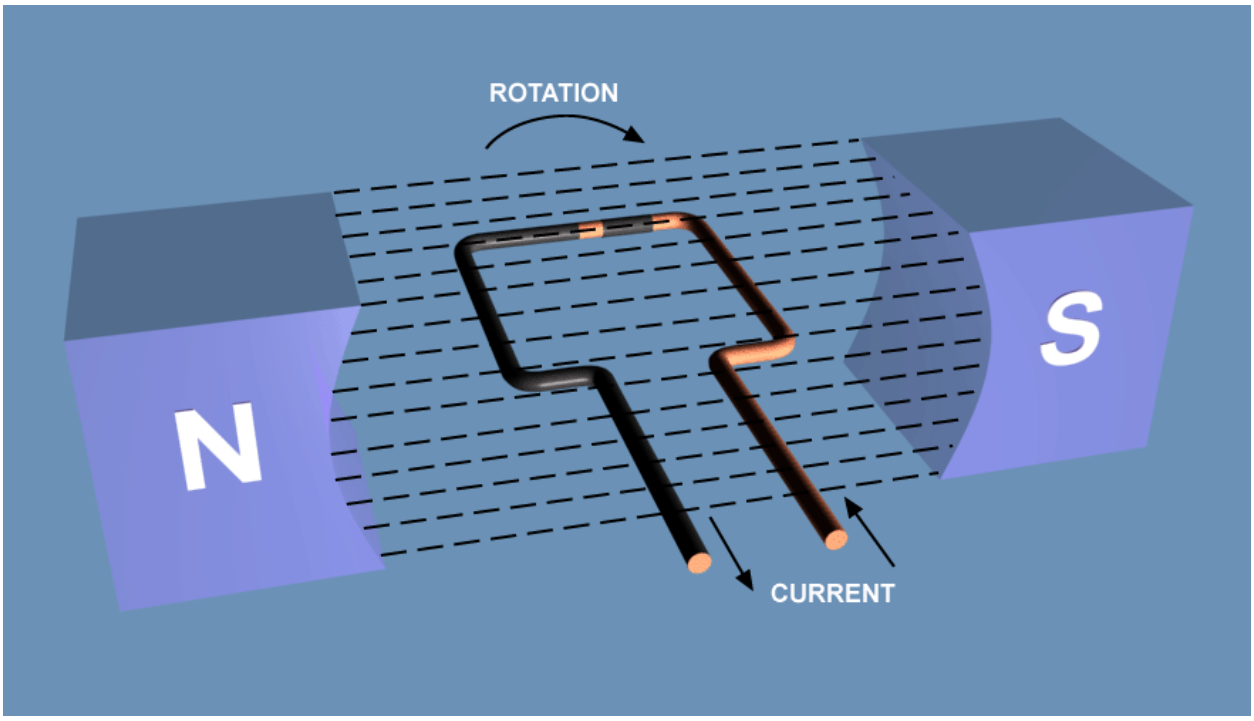


(9) Ohms - Measure of resistance to electron flow.

(10) Resistance in an electrical system is the opposition to current flow.

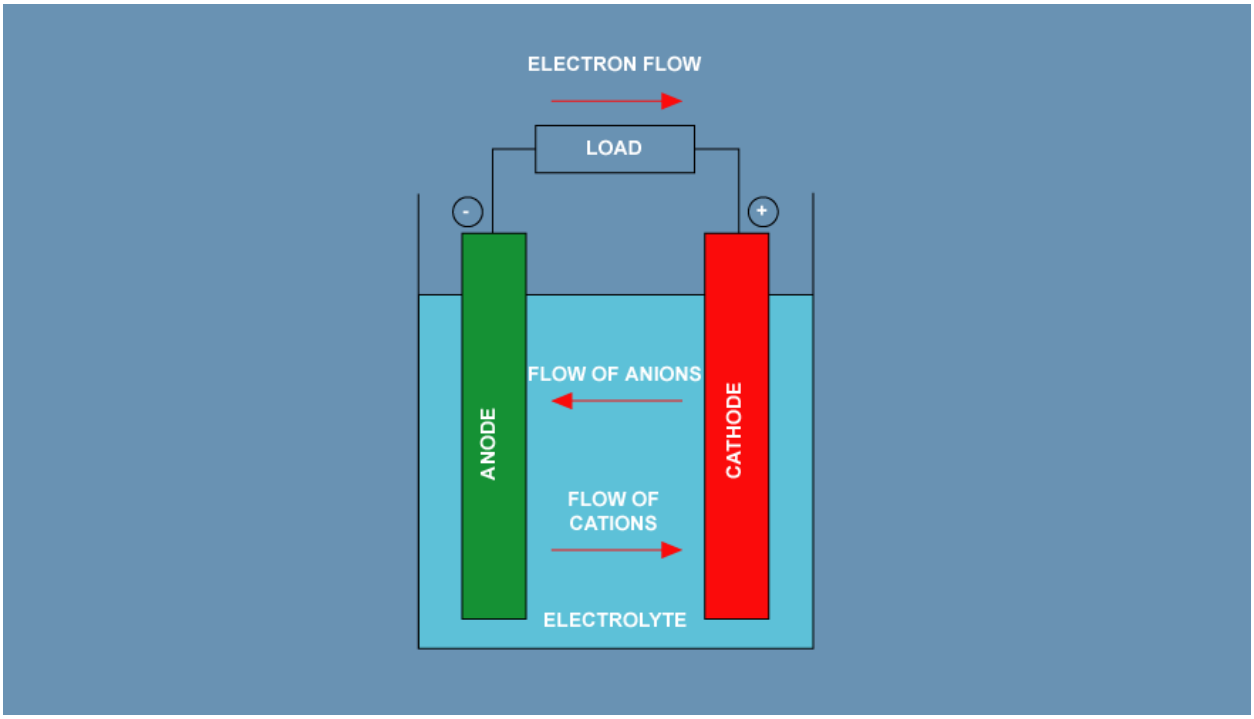
d. Ways to Produce Electricity

Frame #3025 (Ways to Produce Electricity)



(1) Magnetism/Electrical - This voltage is produced when a conductor or conductors move across a magnetic field so as to cut the lines of force, electrons within the conductor are impelled in one direction or another.

Frame #3026 (Electron Flow)

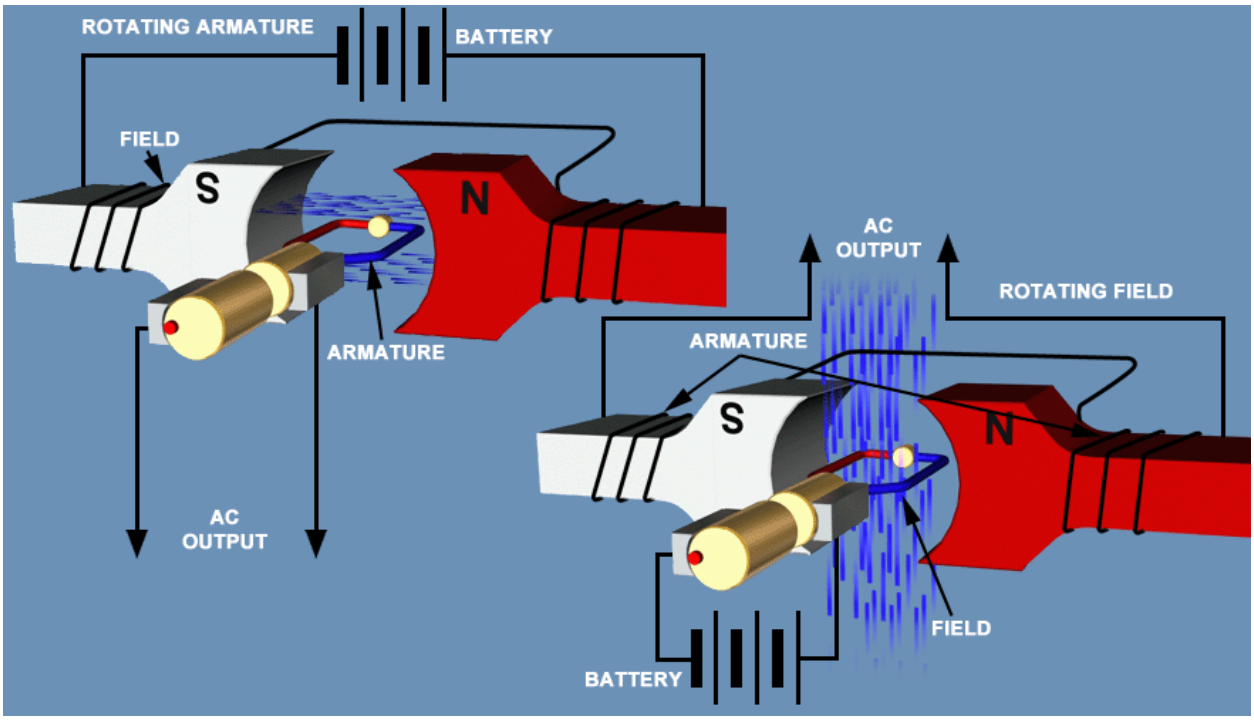


(2) Chemical - This voltage is produced when atoms are added to or taken away from a parent substance.

(3) This action will cause the parent substance to take an electrical charge either positive or negative.

e. Field Excitation

Frame #3030 (Field Excitation)



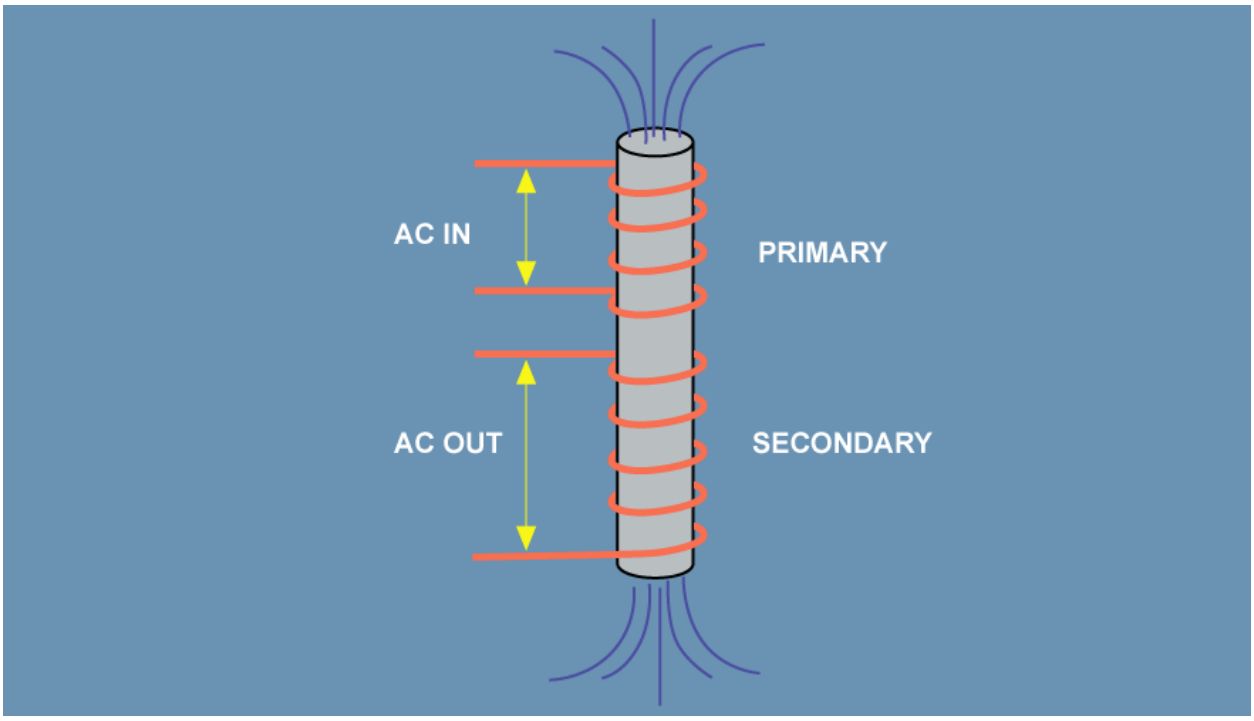
(1) The production of the electromagnetic field is called excitation or the field is excited.

(2) A generator can be separately excited by current coming from another source.

(3) Field excitation current may be carefully controlled by controlling the external excitation current.

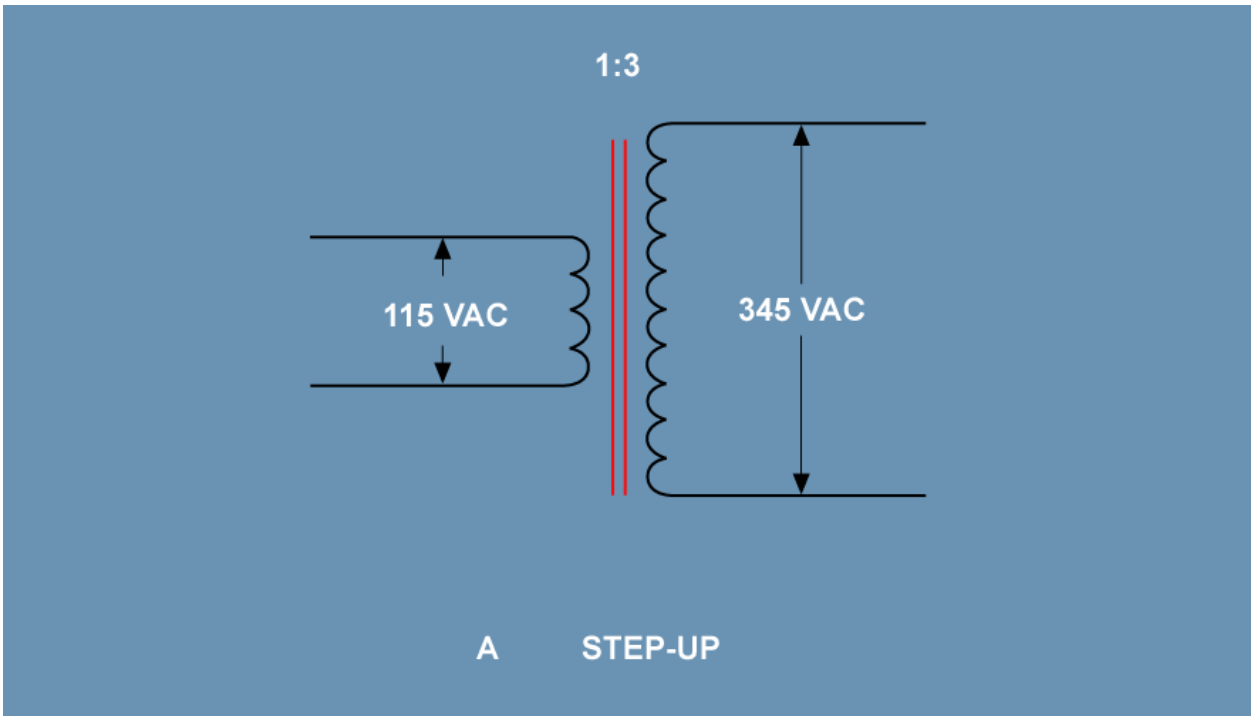
f. Transformation

Frame #3035 (Transformation)



(1) Transformation of a voltage is controlled when electricity flows into a coil, which induces a second coil to give a different output voltage.

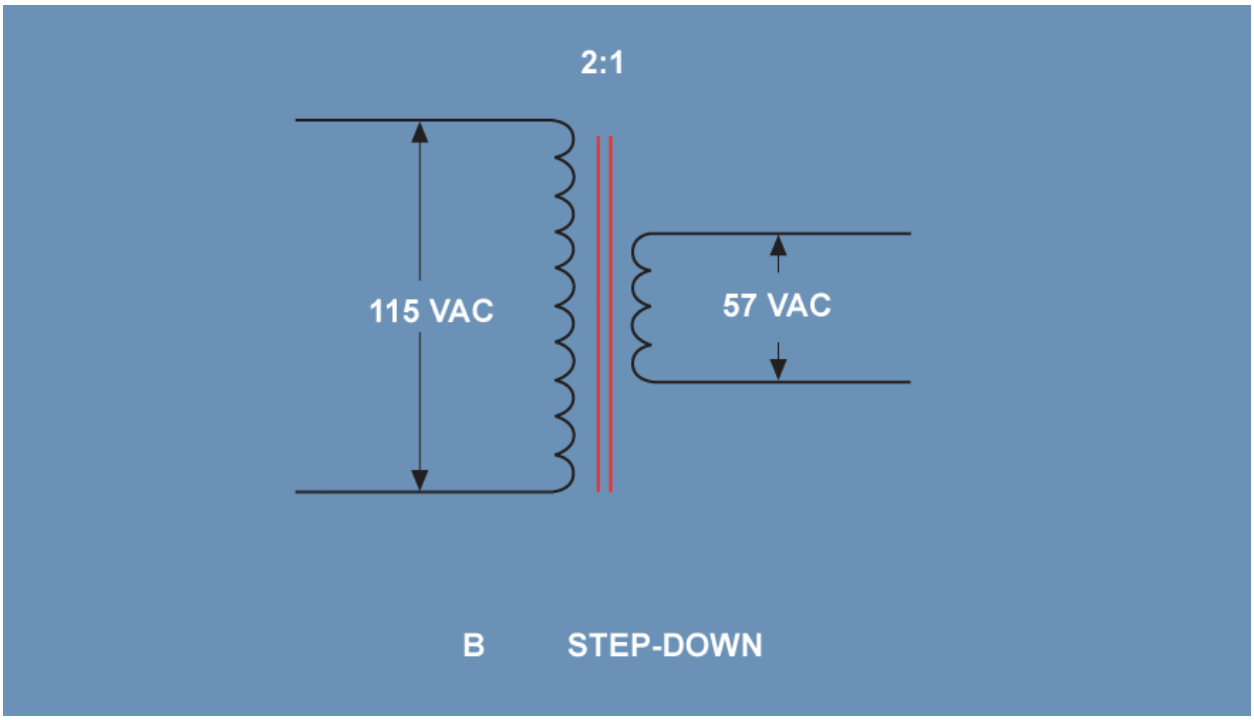
Frame #3036 (Step-up Transformation)



(a) Step-up transformation - When the input coil has less "wraps" than the output coil.

(b) This causes the voltage to increase when it leaves the transformer.

Frame #3037 (Step-down Transformation)

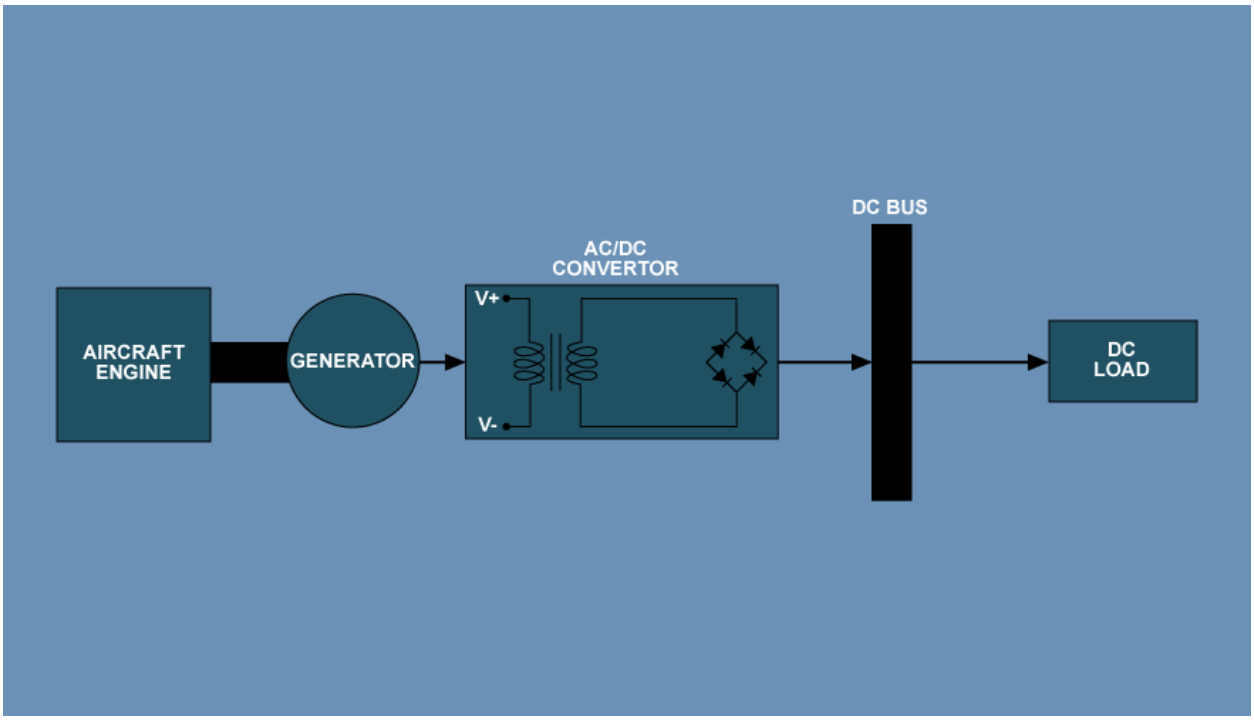


(c) Step-down transformation - When the input coil has more "wraps" than the output coil.

(d) This causes the voltage to decrease when it leaves the transformer.

g. Conversion

Frame #3040 (Conversion)

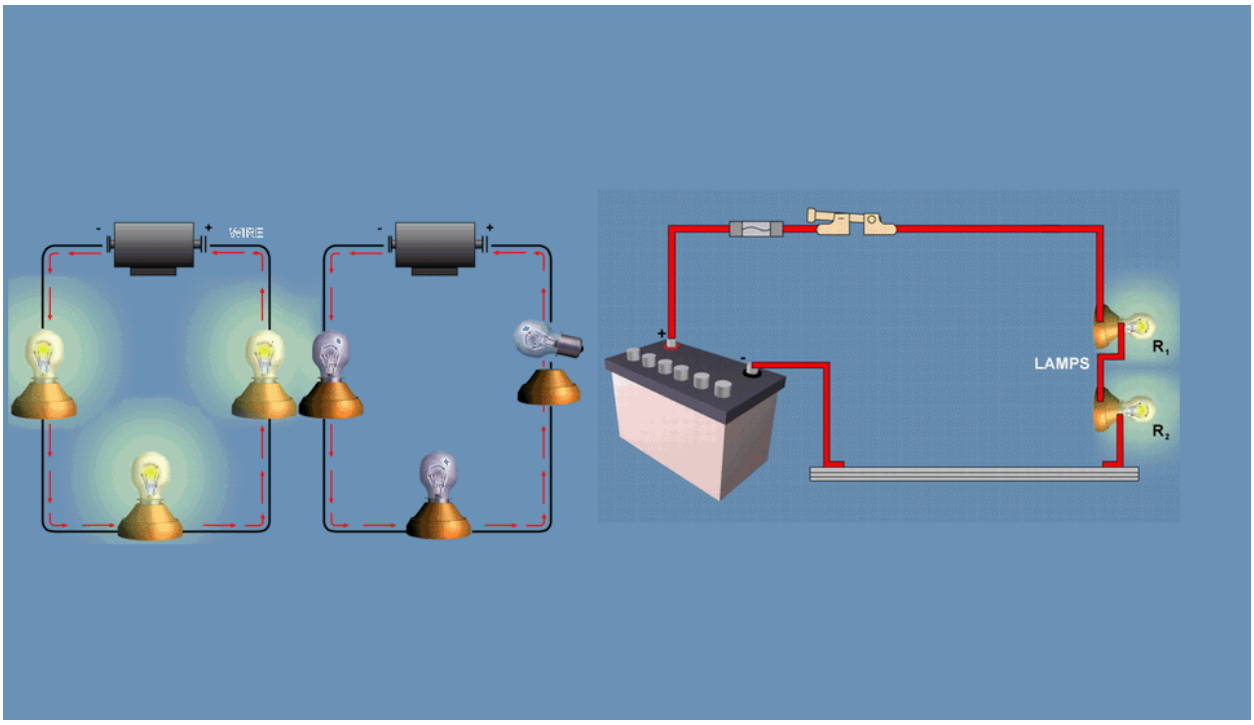


(1) The conversion of AC to DC is the modification of voltage to the phase extremes.

(2) Removing, or to "cut off" the top and/or bottom of an AC phase, results in a "one way current".

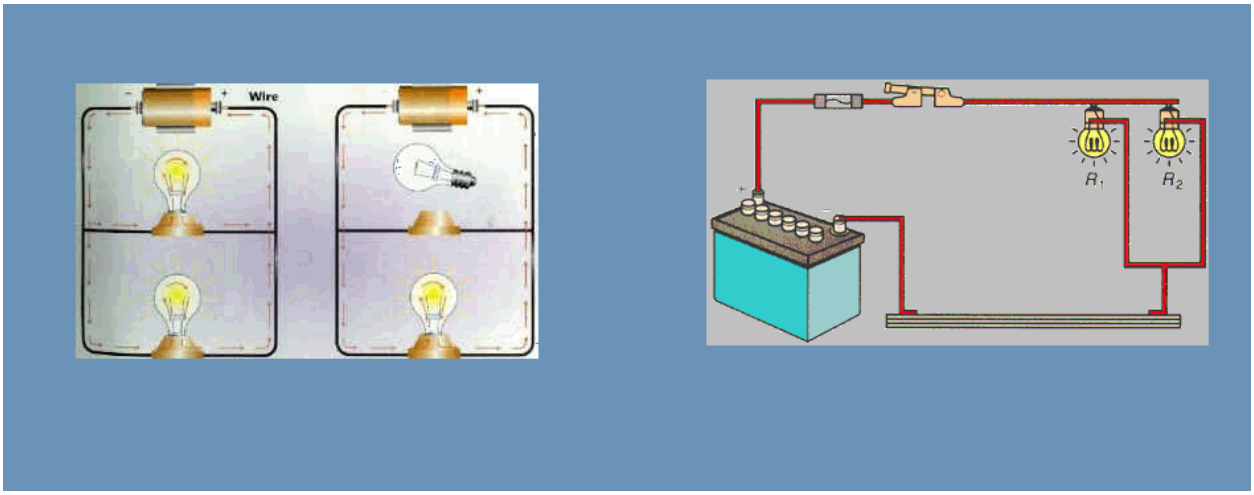
h. Electrical Circuits

Frame #3045 (Electrical Circuits)



(1) Series circuit - in a line of customers, all customers must be closed in order for voltage to pass.

Frame #3046 (Parallel Circuit)



(2) Parallel Circuit - In a line of customers, voltage is supplied to each customer individually.

CHECK ON LEARNING

1. What is the energy made available by the flow of electric charge through a conductor?

2. What is an electric current flowing in one direction only and substantially constant in value?

3. What happens to the output voltage during step-up transformation?

4. How is voltage controlled when the electricity flows into a coil causing the voltage in a second coil to have a different output voltage?

5. What is an electrical current that reverses its direction at regularly recurring intervals?

SECTION III. -SUMMARY

1. REVIEW/SUMMARIZE:

You have completed the Characteristics of Electricity topic.
The key points to remember are:

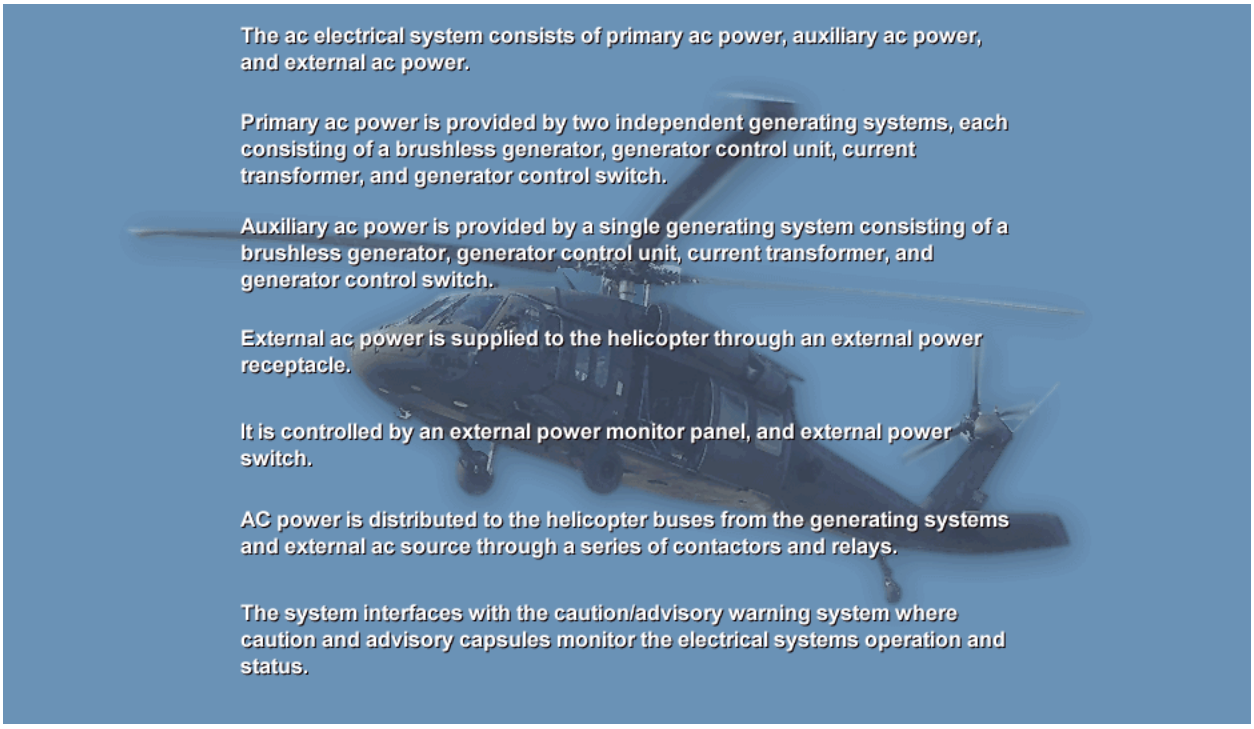
- Electricity is the energy made available by the flow of electric charge through a conductor.
- AC is an electrical current that reverses its direction at regularly recurring intervals.
- DC is an electrical current flowing in one direction only and substantially constant in value.
- Magnetism and chemical are two ways that electricity can be produced.
- Field excitation is the production of an electromagnetic field. A generator can be separately excited by current coming from another source. A field excitation current may be carefully controlled by controlling the external excitation current.
- Transformation of voltage is controlled when electricity flows into a coil, which induces a second coil, to give a different output voltage.
- Step-up transformation is when the input coil has less wraps than the output coil. This causes the voltage to increase.
- The conversion of AC to DC is the modification to the phase extremes, removing or to cut off the top and/or bottom of an AC phase results in a one-way current.
- Two types of electrical circuits are a series circuit and a parallel circuit.

B. ENABLING LEARNING OBJECTIVE ELO No. 2

ACTION: Identify the characteristics of the UH-60 AC Electrical System.
CONDITIONS: As a UH-60 Maintenance test pilot.
STANDARDS: IAW UH-60 Black Hawk TM 1 Series manuals.

a. AC Electrical System

Frame #1001 (AC Electrical System)



(1) The ac electrical system consists of primary ac power, auxiliary ac power, and external ac power.

(2) Primary ac power is provided by two independent generating systems, each consisting of a brushless generator, generator control unit, current transformer, and generator control switch.

(3) Auxiliary ac power is provided by a single generating system consisting of a brushless generator, generator control unit, current transformer, and generator control switch.

(4) External ac power is supplied to the helicopter through an external power receptacle.

(5) It is controlled by an external power monitor panel, and external power switch.

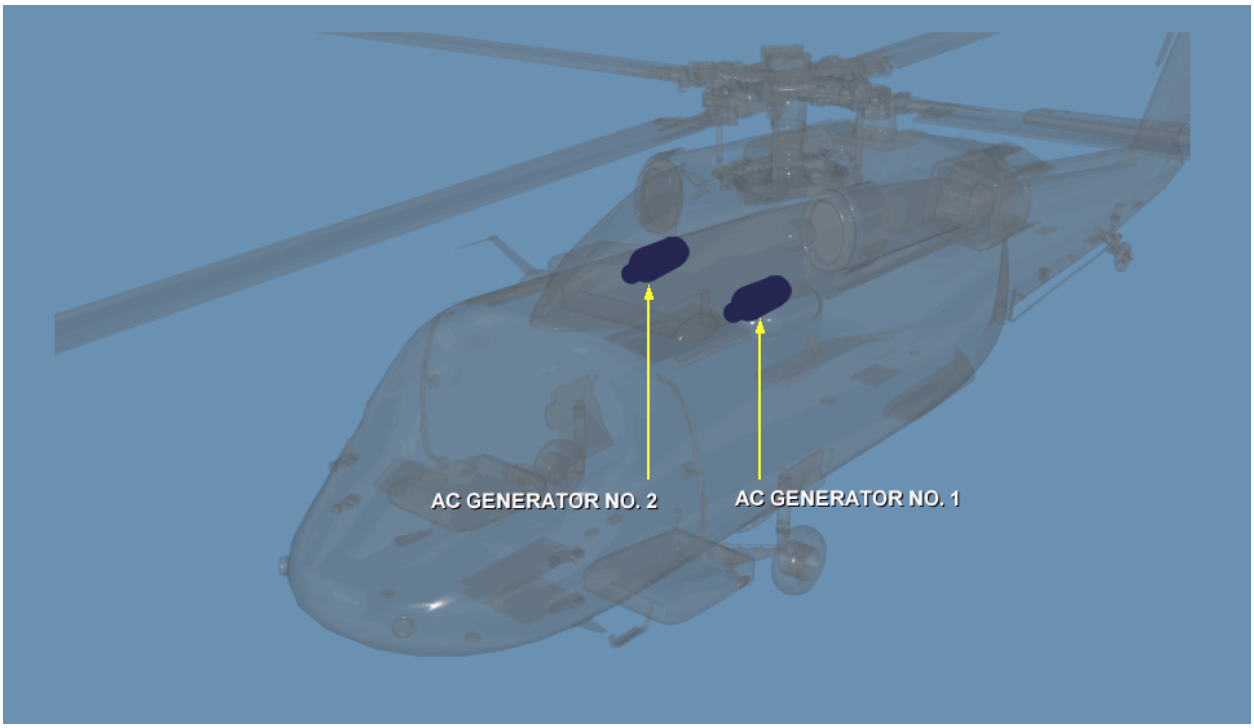
(6) AC power is distributed to the helicopter buses from the generating systems and external ac source through a series of contactors and relays.

(7) The system interfaces with the caution/advisory warning system where caution and advisory capsules monitor the electrical systems operation and status.

Frame #1005 (MENU)

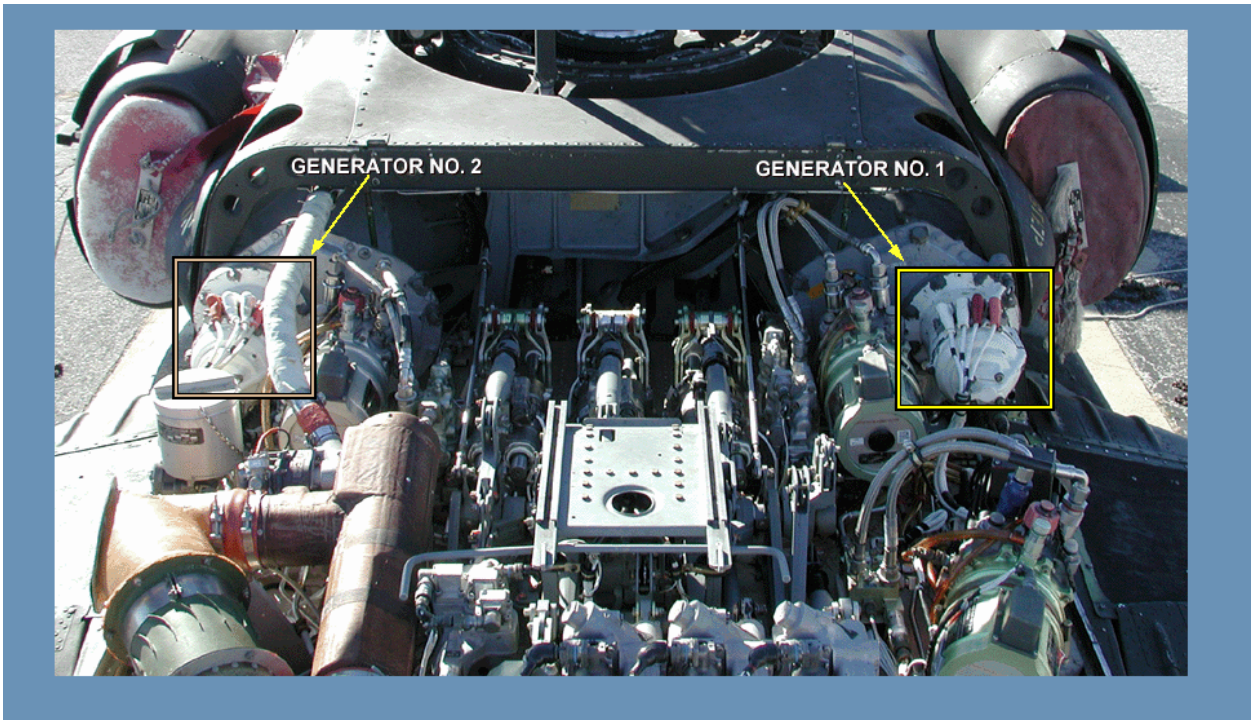
(a) AC Generator NO. 1 and NO. 2

Frame #1009 (AC Generator NO. 1 and NO. 2 Location)



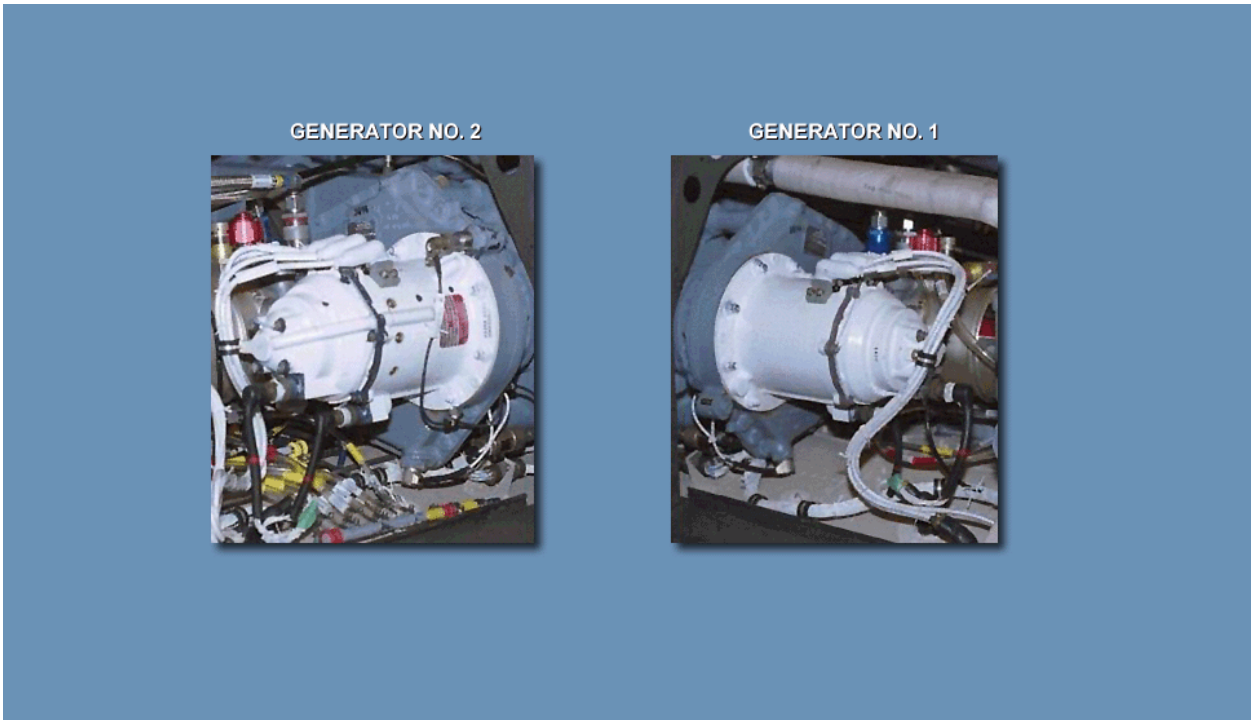
1) The No. 1 and No. 2 oil-cooled, brushless generators, mounted on the left and right accessory modules of the main gear box, are driven whenever the main rotor head is turning.

Frame #1006 (AC Generator NO. 1 and NO. 2)



2) Each generator, rated at 30/45 Kilo Volt Ampere (KVA) at 115/200 volts, is connected for a 4-wire output, with grounded neutral, furnishing three-phase alternating current.

Frame #1006 (AC Generator NO. 1 and NO. 2)



3) The generator drive shaft is normally driven at about 12,000 RPM (Revolutions Per Minute) to maintain an output frequency of 400 Hz (Hertz).

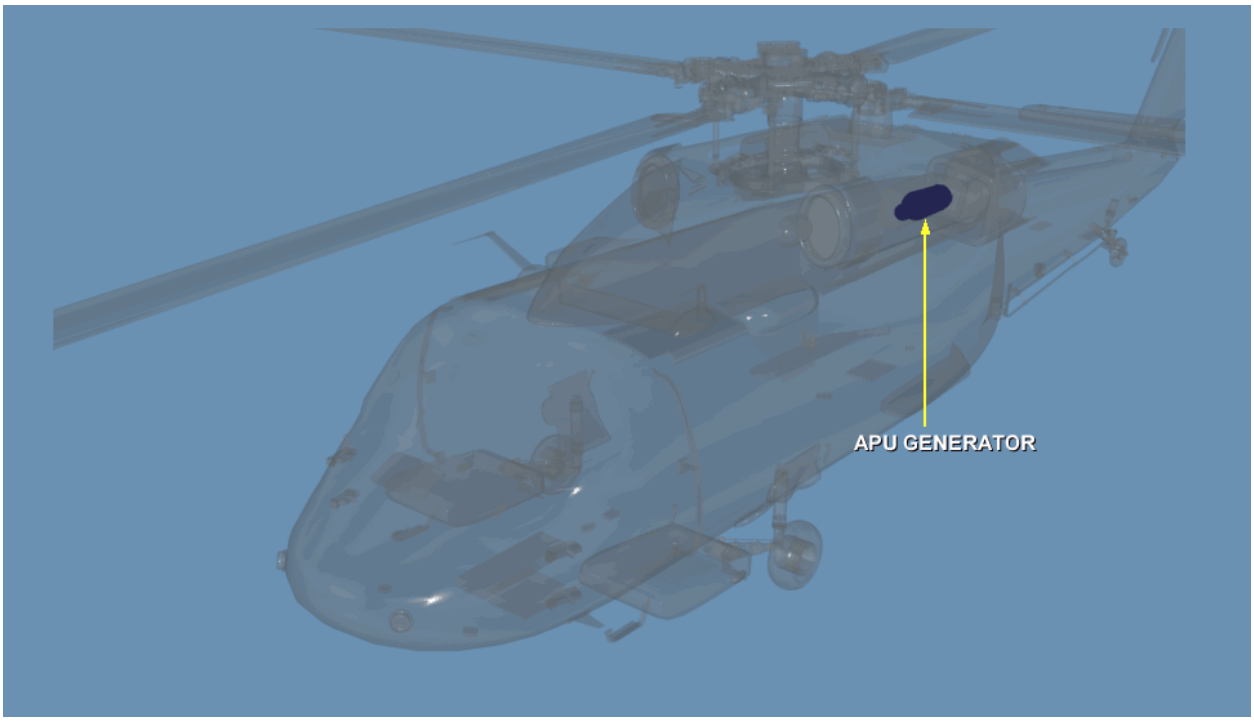
4) The generator output voltage is regulated by a voltage regulator within the generator control unit, which varies the exciter control field.

Frame #1007 (Generator Spline Adapter)

5) The Generator Spline Adapter is for shear shaft protection for the generators, and other components, from being damaged in the case of an over-torque condition, and allows the generator spline to mount to the accessory drive.

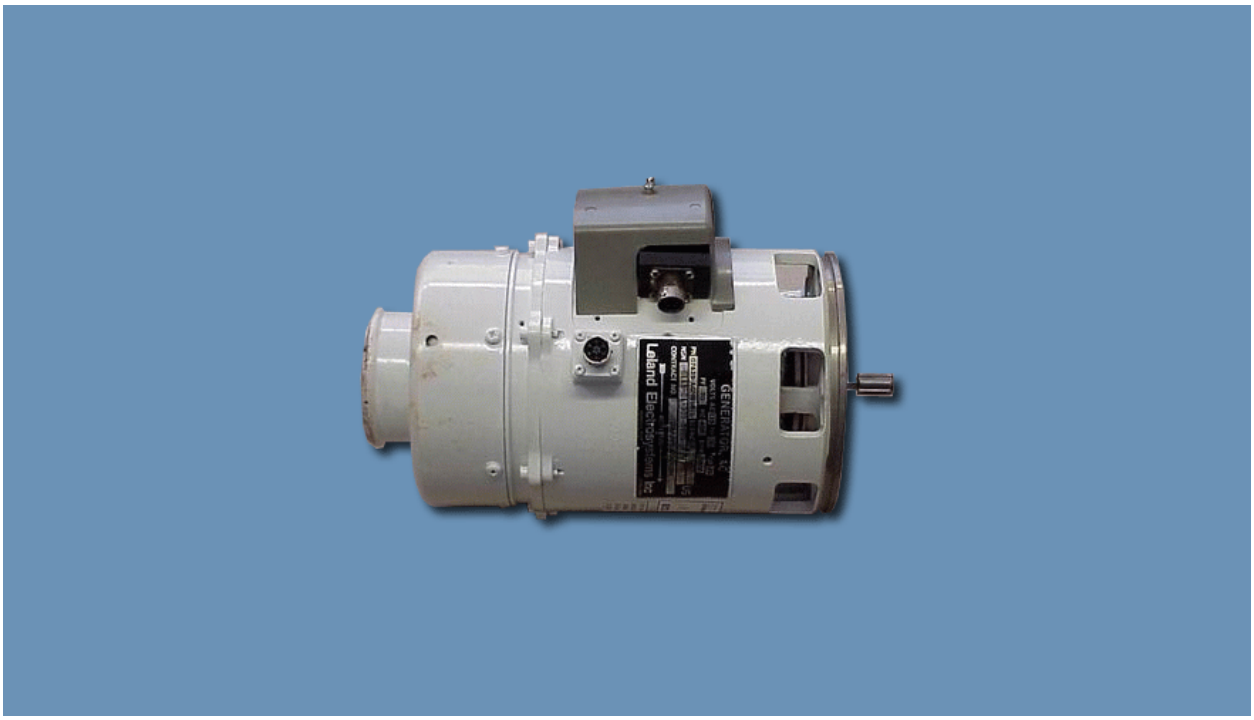
(b) APU Generator

Frame #1016 (APU Generator Location)



1) The Auxiliary Power Unit (APU) air-cooled, brushless generator, mounted on the APU, is driven whenever the APU is operating.

Frame #1008 (APU Generator)

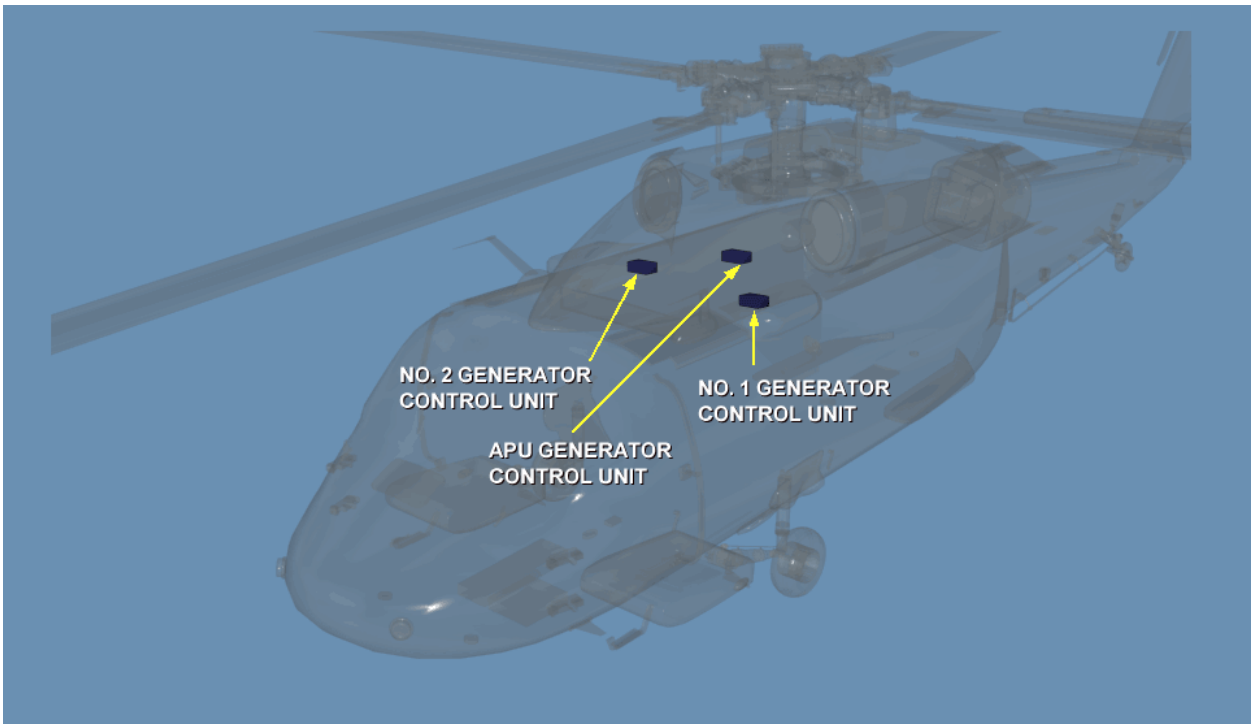


2) The generator, rated at 20/30 Kilo Volt Ampere (KVA) at 115/200 volts, is connected for a 4-wire Wye output, with grounded neutral, furnishing three-phase alternating current.

3) The generator drive shaft is normally driven at about 12,000 RPM to maintain an output frequency of 400 Hz.

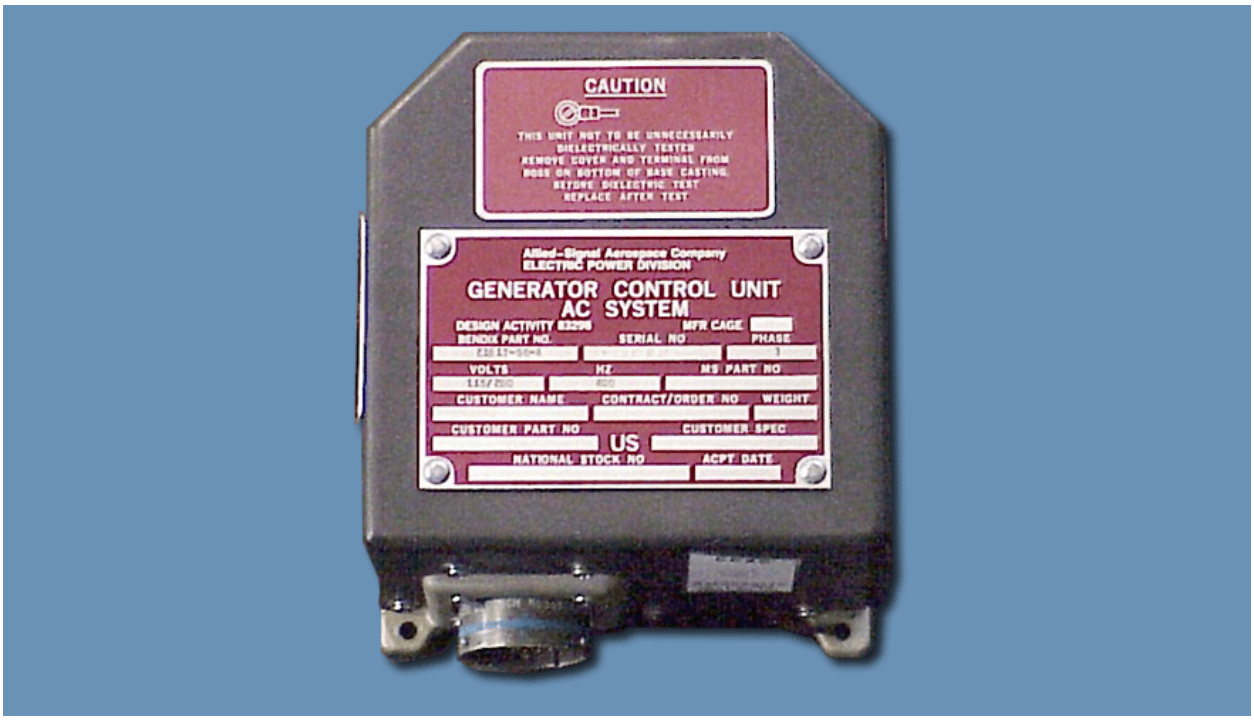
(c) Generator Control Unit

Frame #1013 (Generator Control Unit Location)



1) The No. 1 and APU generator control units is located on the upper left cabin, and the No. 2 generator control unit is located on the upper right cabin.

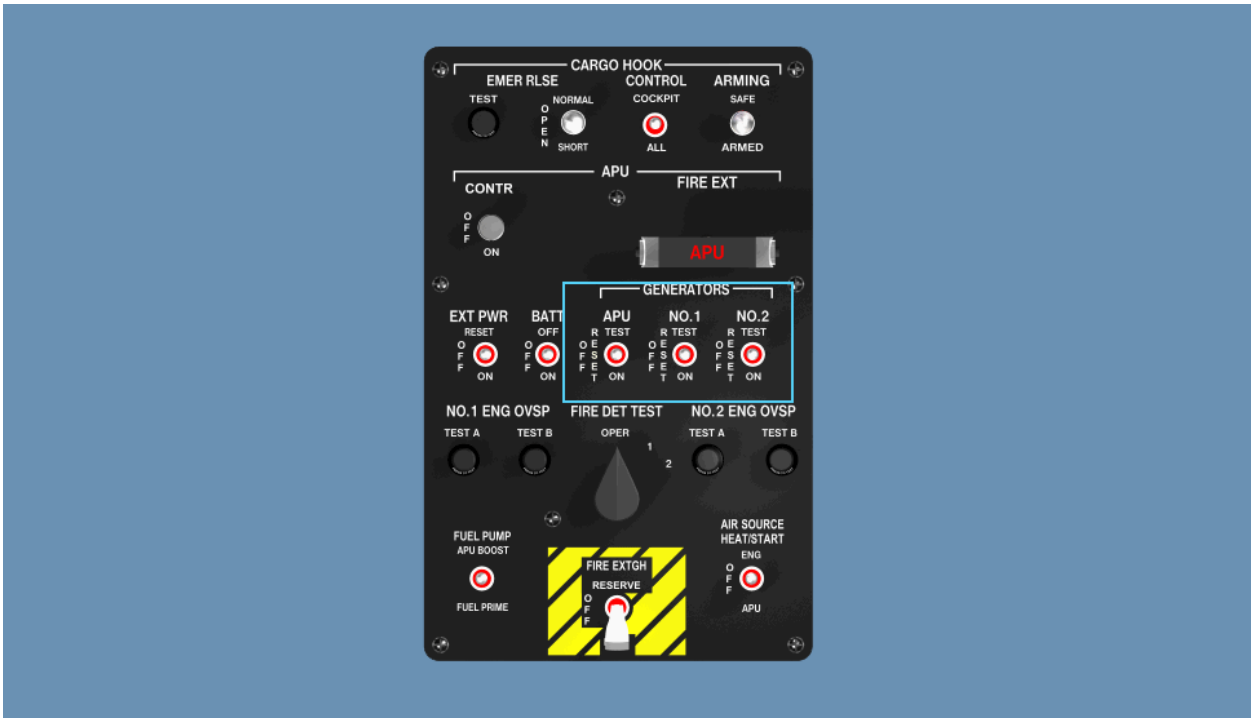
Frame #1010 (Generator Control Unit)



2) The generator control units continuously monitor and regulate generator ac output to provide voltage regulation, current regulation, over-voltage protection, under-voltage protection, feeder fault protection, and under-frequency protection.

3) Under-frequency protection by the No. 1 and No. 2 generator control units, is provided only during ground operation.

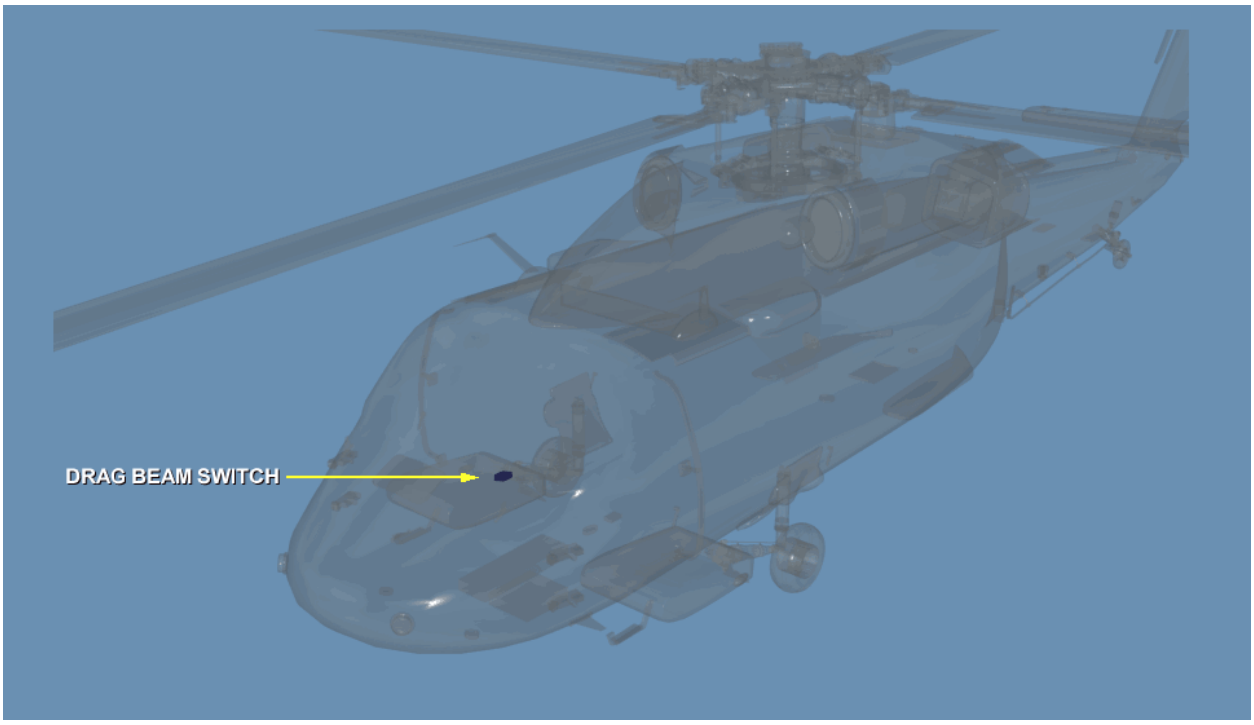
Frame #1015 (Generator Control Switches)



4) Generator outputs are connected to their associated generator control units and the AC primary bus contactors by the three-position control switches (on/t/off-reset/test) on the upper console.

(d) Drag Beam Switch

Frame #1017 (Drag Beam Switch Location)



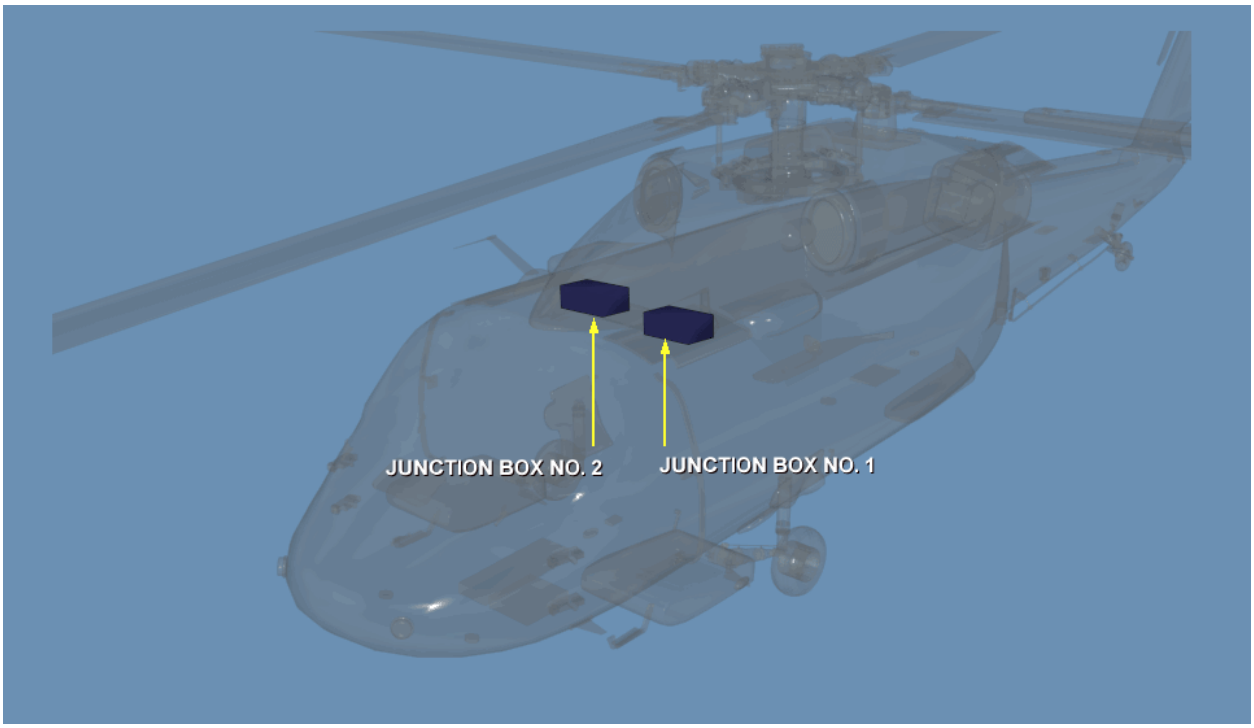
1) The drag beam switch is located on the main landing gear drag beam.

Frame #1012 (Right Drag Beam Switch)

2) The right drag beam switch provides the under-frequency disable signal.

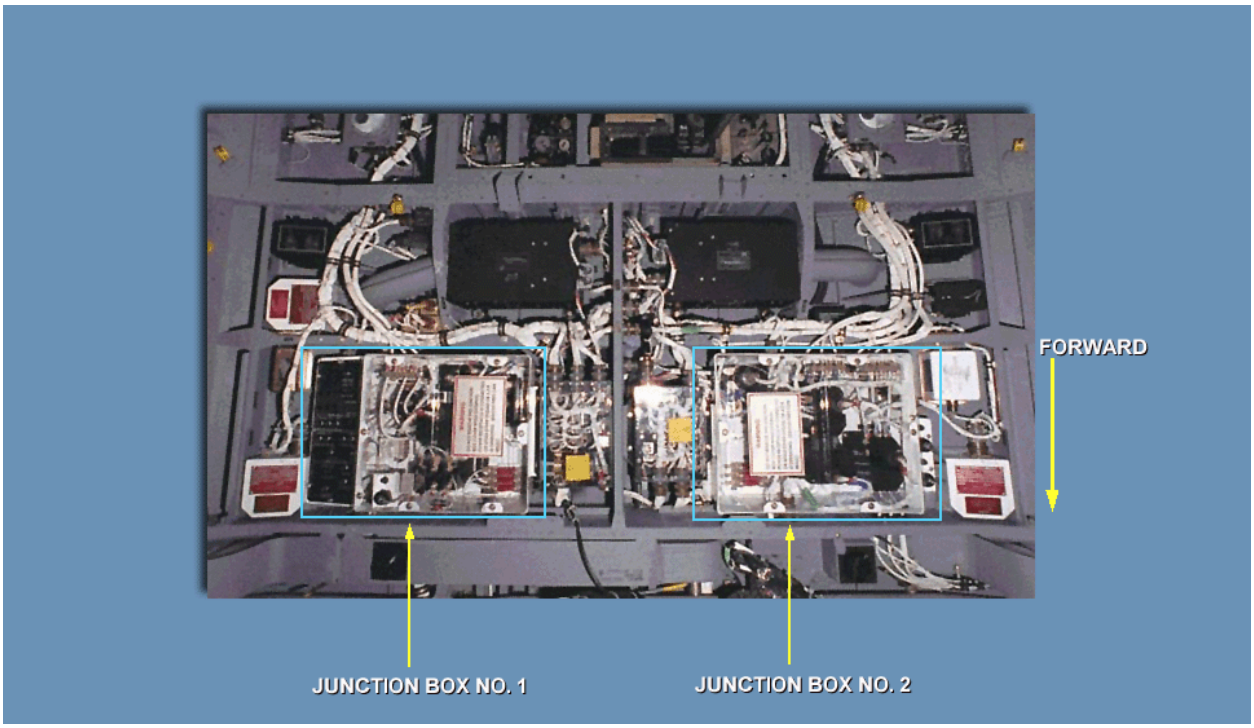
(e) Junction Box NO. 1 and NO. 2

Frame #1014 (Junction Box NO. 1 and NO. 2 Location)



1) Junction box No. 1 is located on the upper left cabin, and junction box No. 2 is located on the upper right cabin.

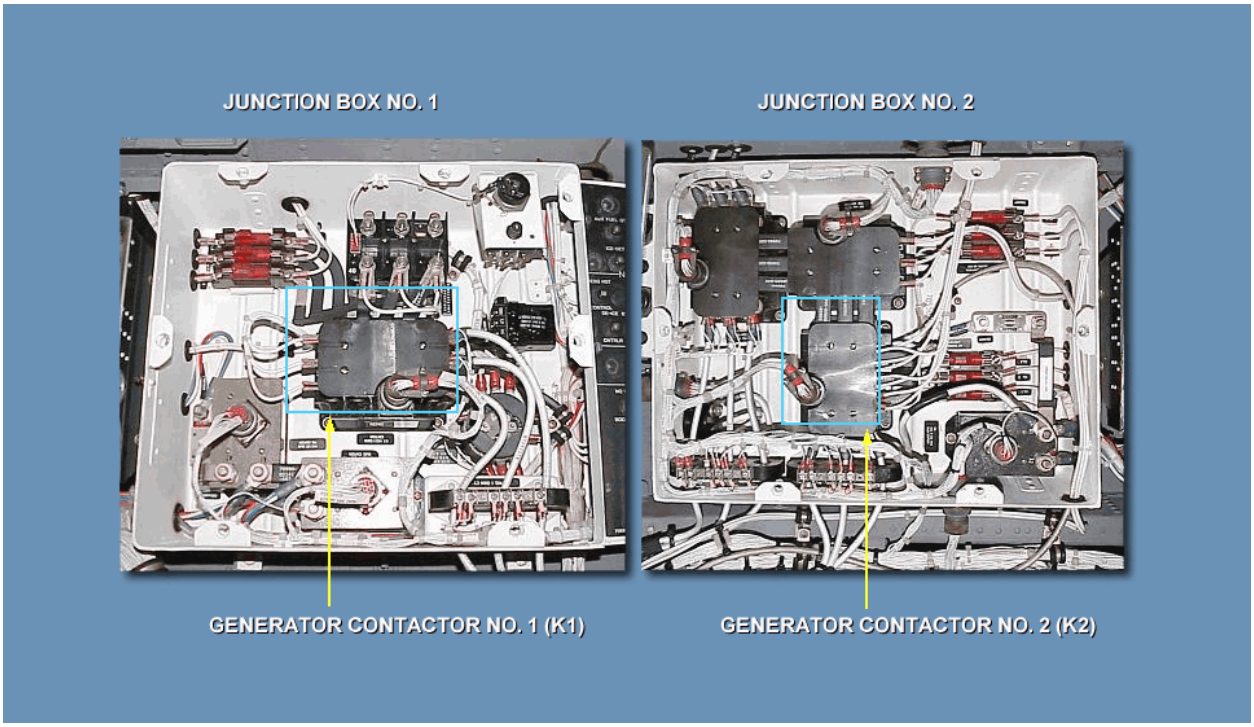
Frame #1020 (Junction Box NO. 1 and NO. 2)



2) Junction box No. 1 contains the No. 1 generator contactor (K-1), current transformer (T1), current limiters (CL4,5,6), autotransformer (T12), and one test receptacle.

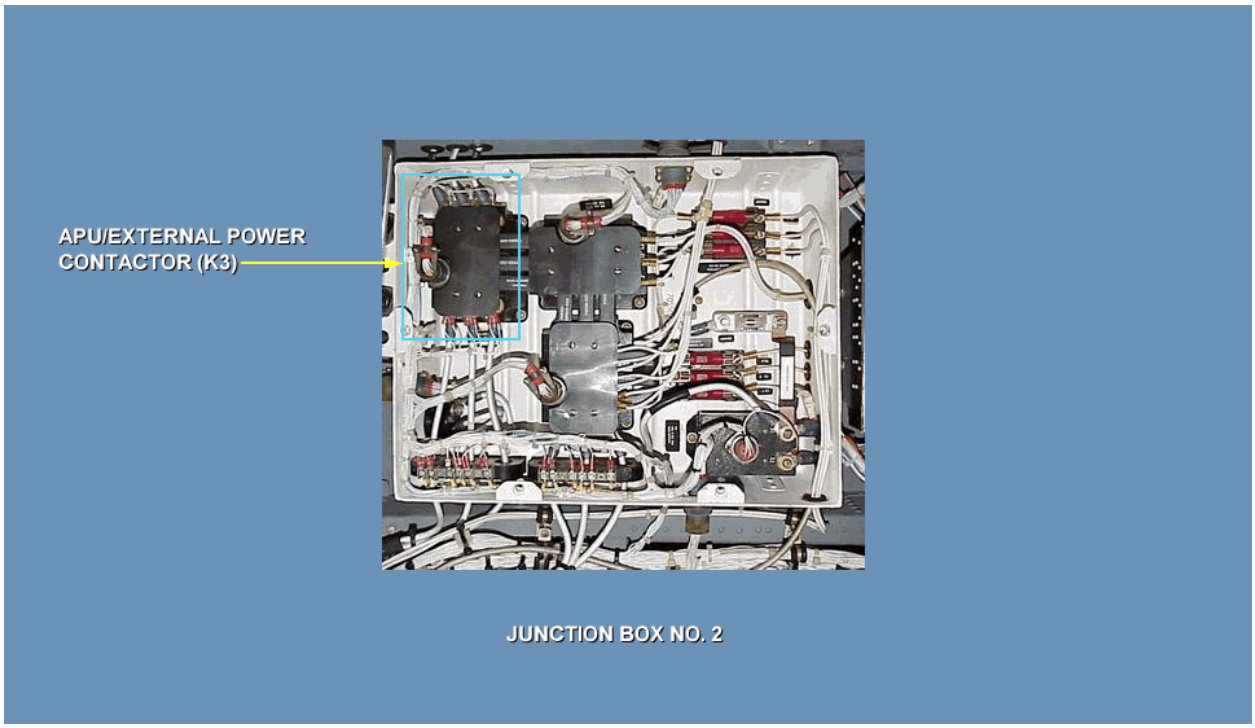
3) Junction box No. 2 contains the No. 2 generator contactor (K-2), APU/external power contactor(K-3), ac bus tie contactor (K-4), current transformers (T2), current limiters (CL1,2,3), and two test receptacles.

Frame #1025 (Generator Contactors)



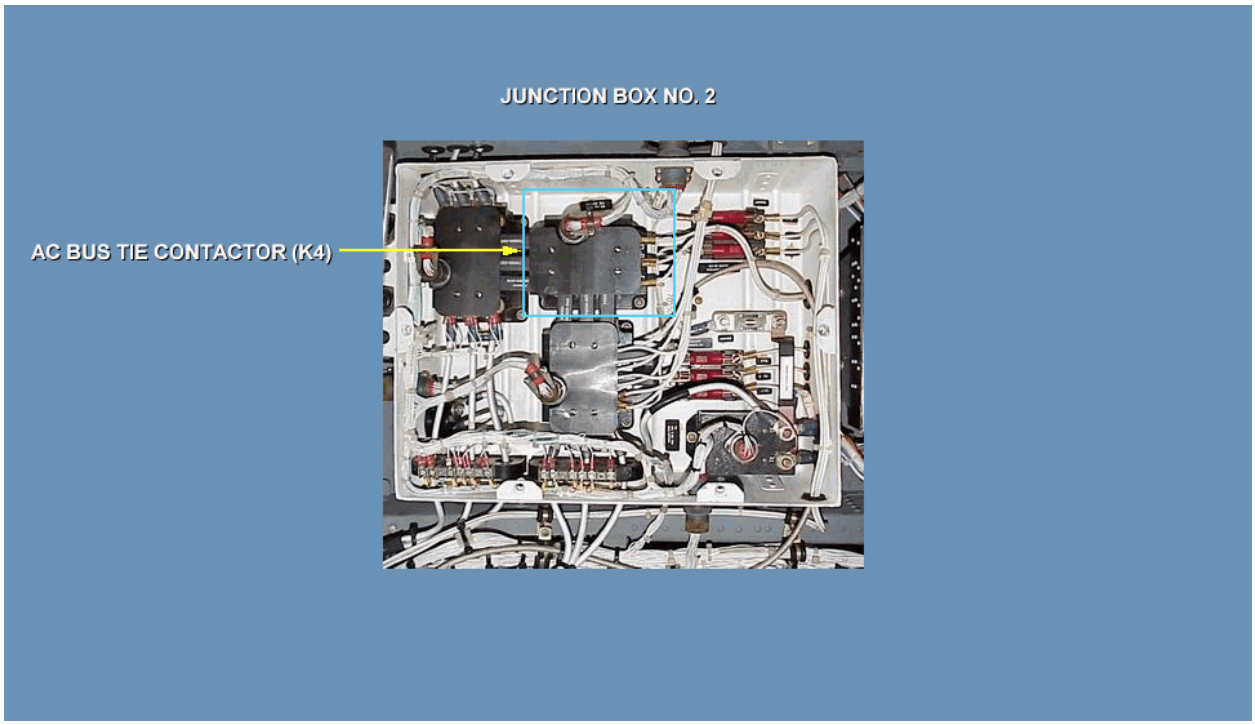
4) The No. 1 and No. 2 generator contactors (K1, K2), on junction box No. 1 and No. 2, respectively, provide connections from the No. 1 and No. 2 generator three-phase feeder lines to the No. 1 and No. 2 ac primary buses for distribution of ac power.

Frame #1030 (APU/External Power Contactor K 3)



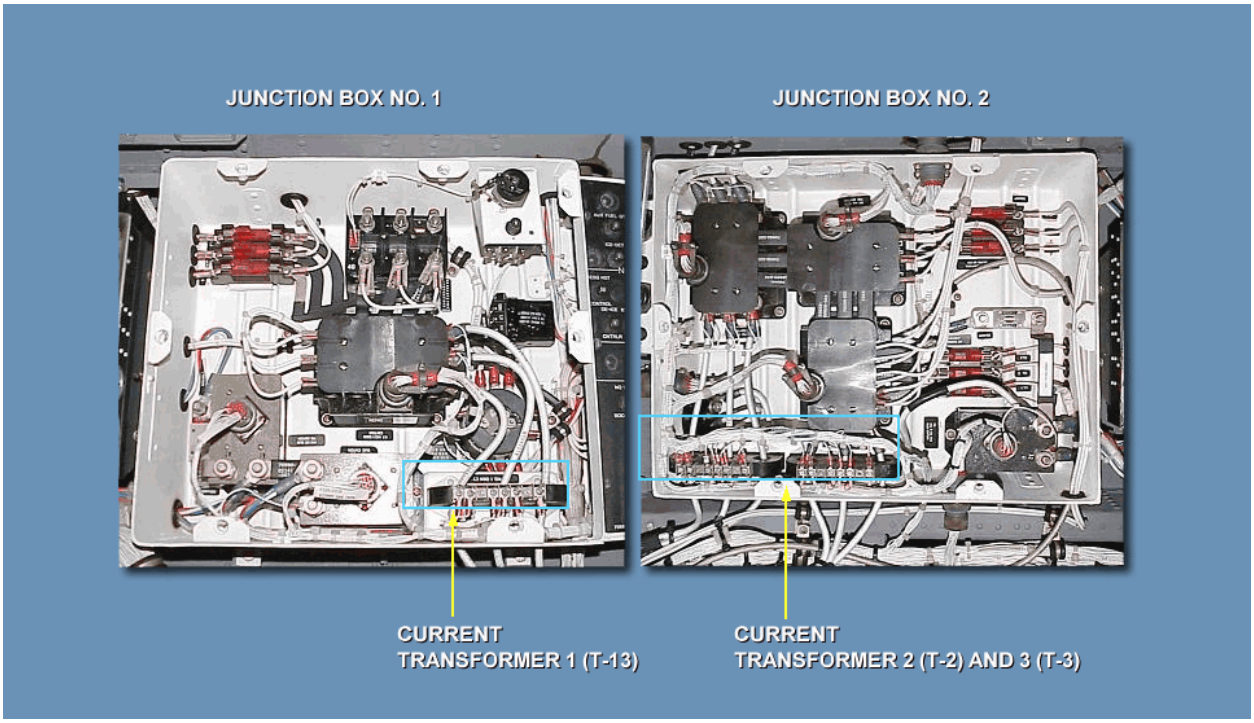
5) The APU/External power contactor (K-3), on junction box No. 2, provides connection from the APU generator three-phase feeder lines, or the ac external power receptacle to the ac primary buses for distribution.

Frame #1035 (AC BUS TIE Contactor K4)



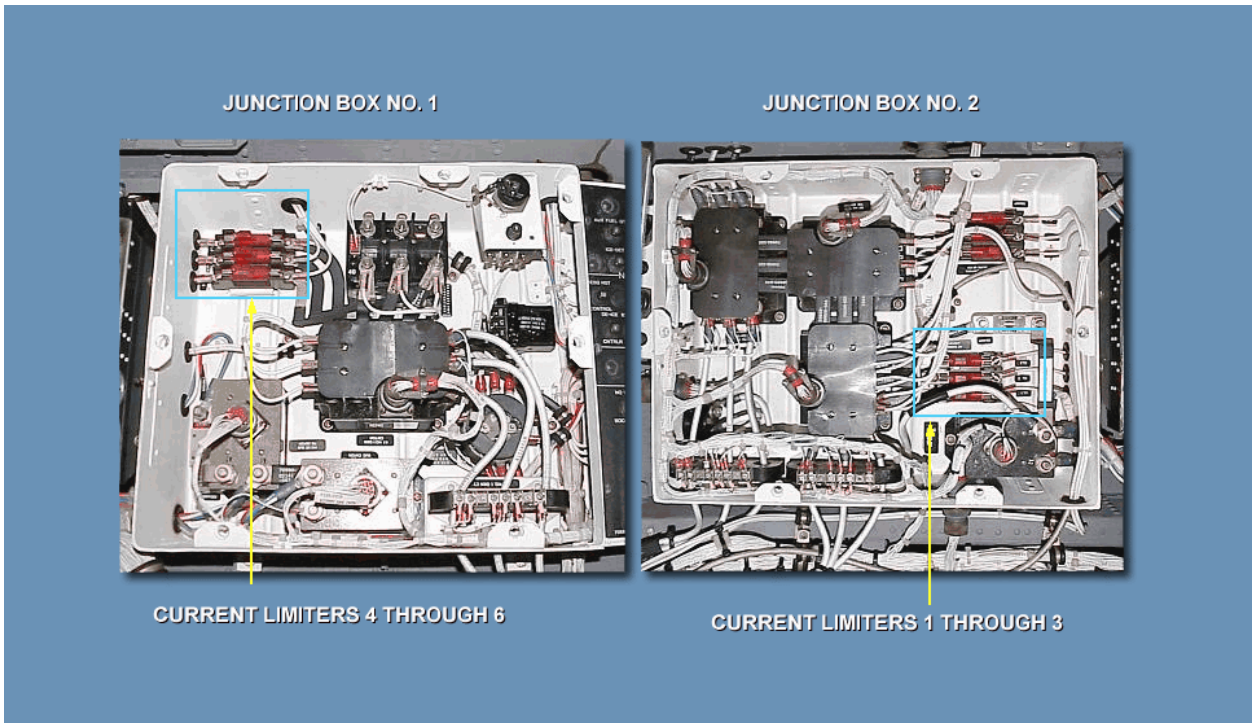
6) The ac bus tie contactor (K-4), on junction box No. 2, provides three-phase ac power from the APU generator, or external ac power receptacle, to the ac primary buses.

Frame #1040 (Current Transformer)



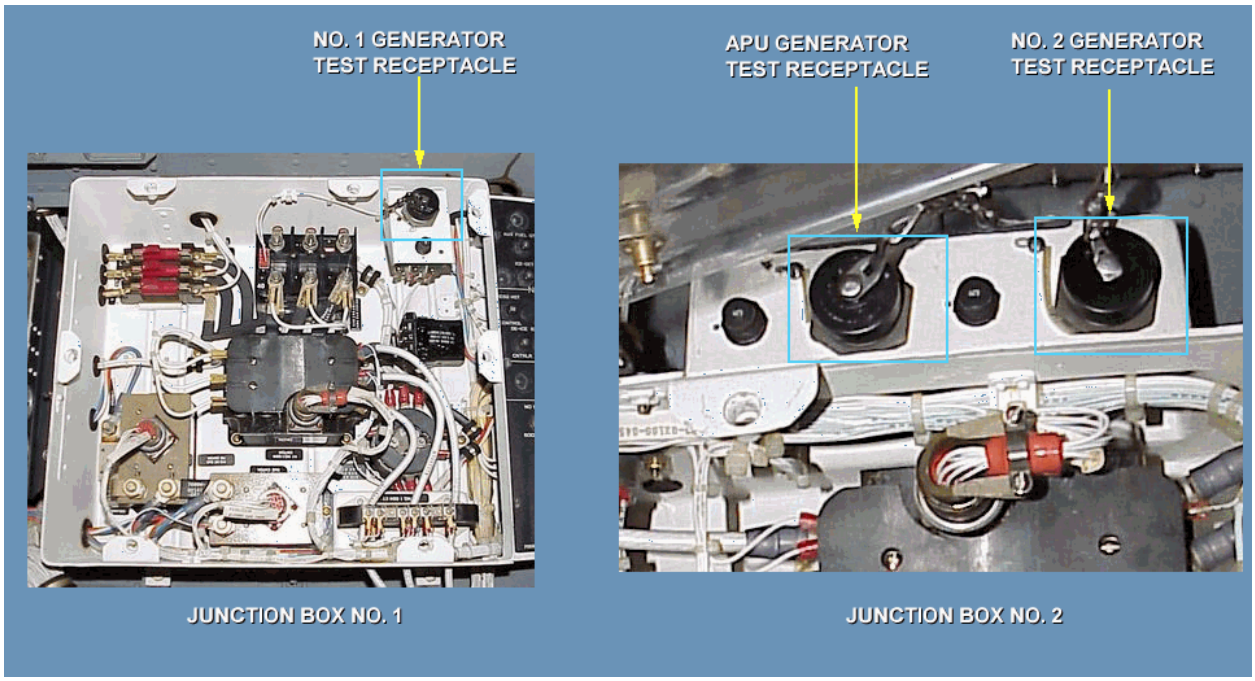
7) Three current transformers, one on junction box No. 1 and two on junction box No. 2, are installed in the output legs of each generator to monitor generator output current and to detect feeder faults.

Frame #1045 (Current Limiters)



8) Current limiters CL1 through CL3, on junction box No. 2, and CL4 through CL6, on junction box No. 1, are 60 ampere fuses protecting the operating generator from excessive overloading during transfer operations.

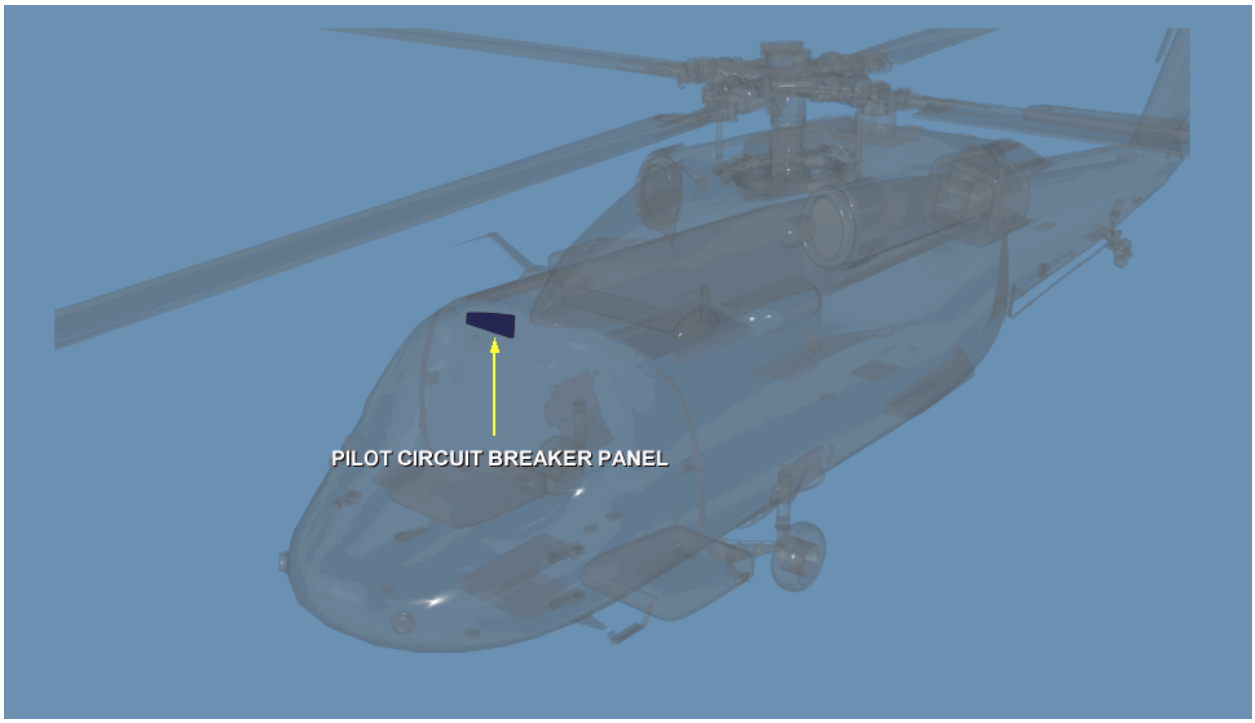
Frame #1050 (Test Receptacle)



9) The No. 1 generator test receptacle, located on junction box No. 1, and the No. 2 generator and APU generator test receptacles, located on junction box No. 2, are provided for monitoring generator three-phase ac output.

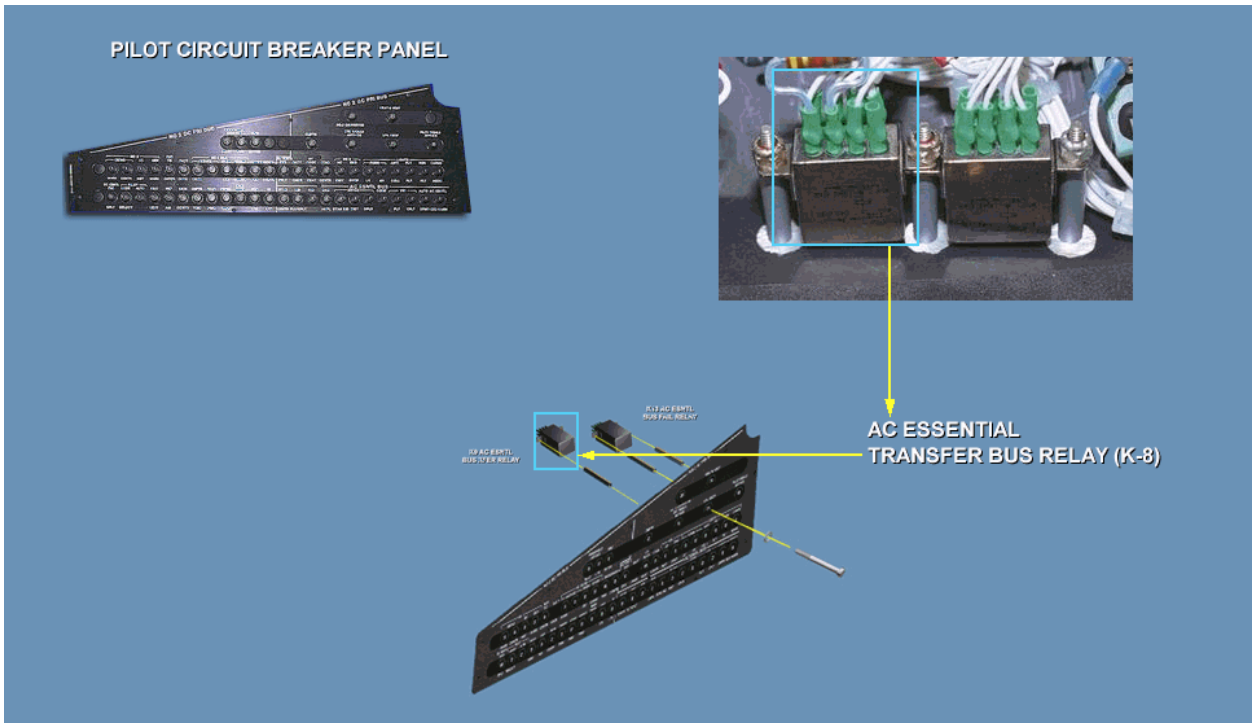
(f) Pilot Circuit Breaker Panel

Frame #1018 (Pilot Circuit Breaker Panel)



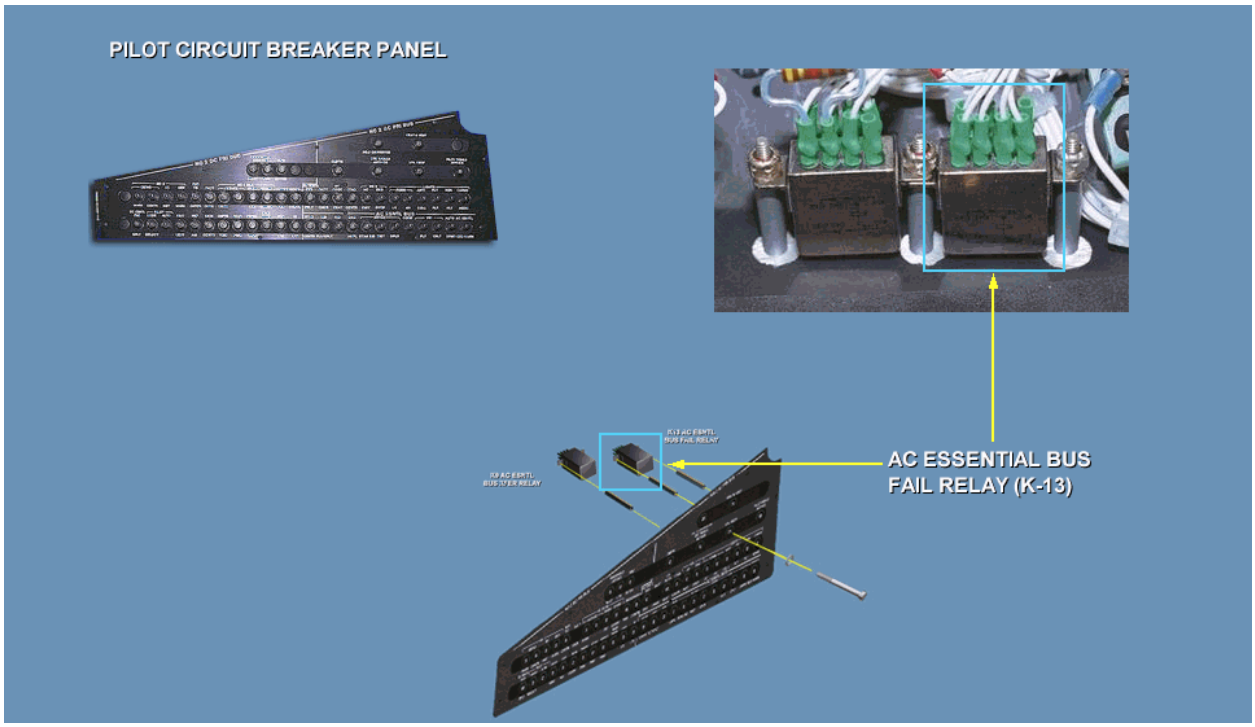
1) The pilot circuit breaker panel is located in the cockpit above the pilot seat.

Frame #1055 (AC Essential Bus Transfer Relay)



2) The AC essential bus transfer (XFER) relay (K-8), on the pilot circuit breaker panel, provides connection of 115 Vac, B phase power to the ac essential bus.

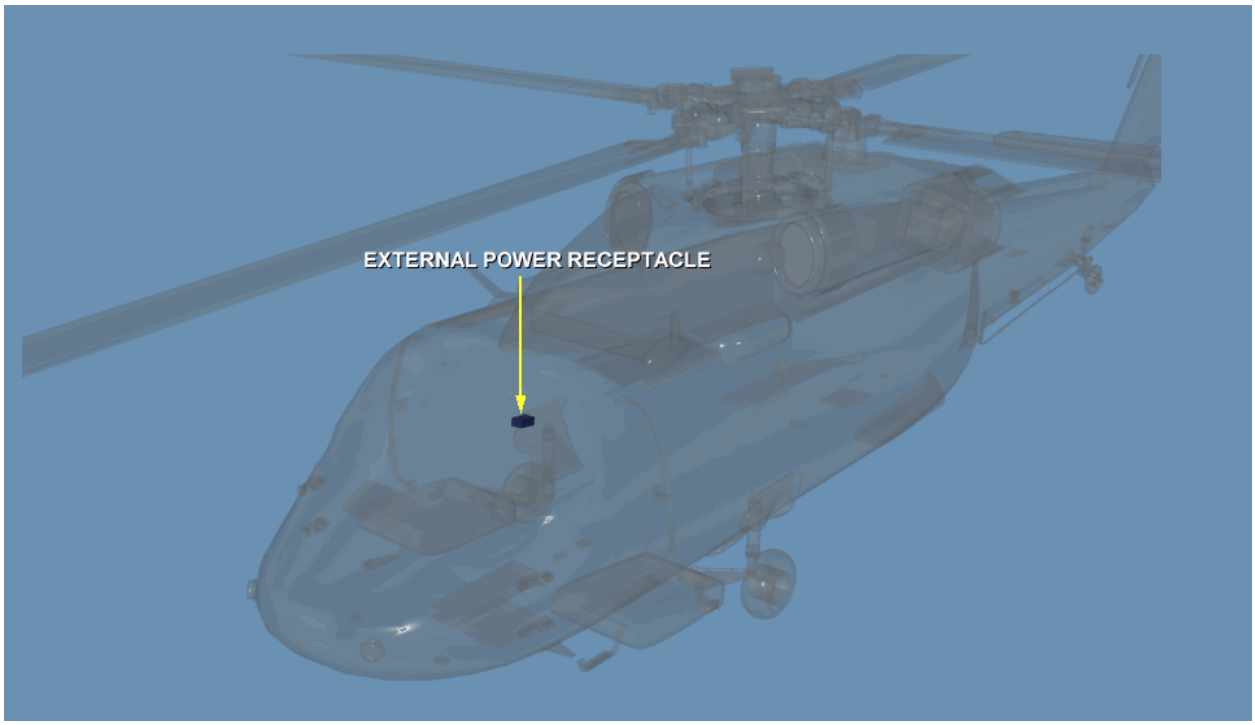
Frame #1060 (AC Essential BUS Fail Relay)



3) The ac essential bus fail relay (K-13), on the pilot circuit breaker panel, is energized when ever there is power on the ac essential bus.

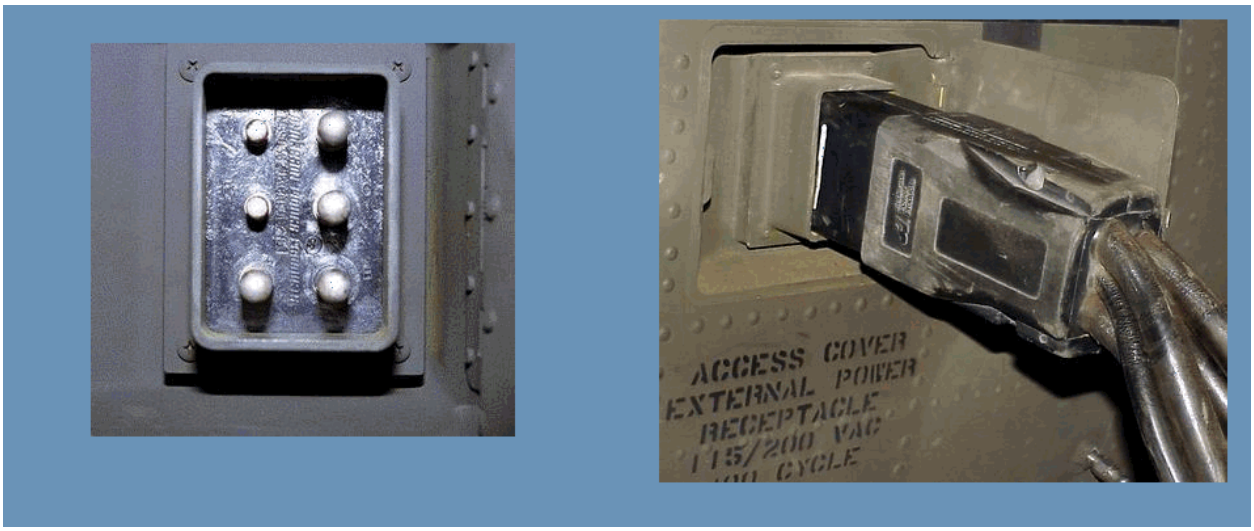
(g) External Power Receptacle

Frame #1021 (External Power Receptacle Location)



1) The external power receptacle is located on the front right-hand cabin fuselage.

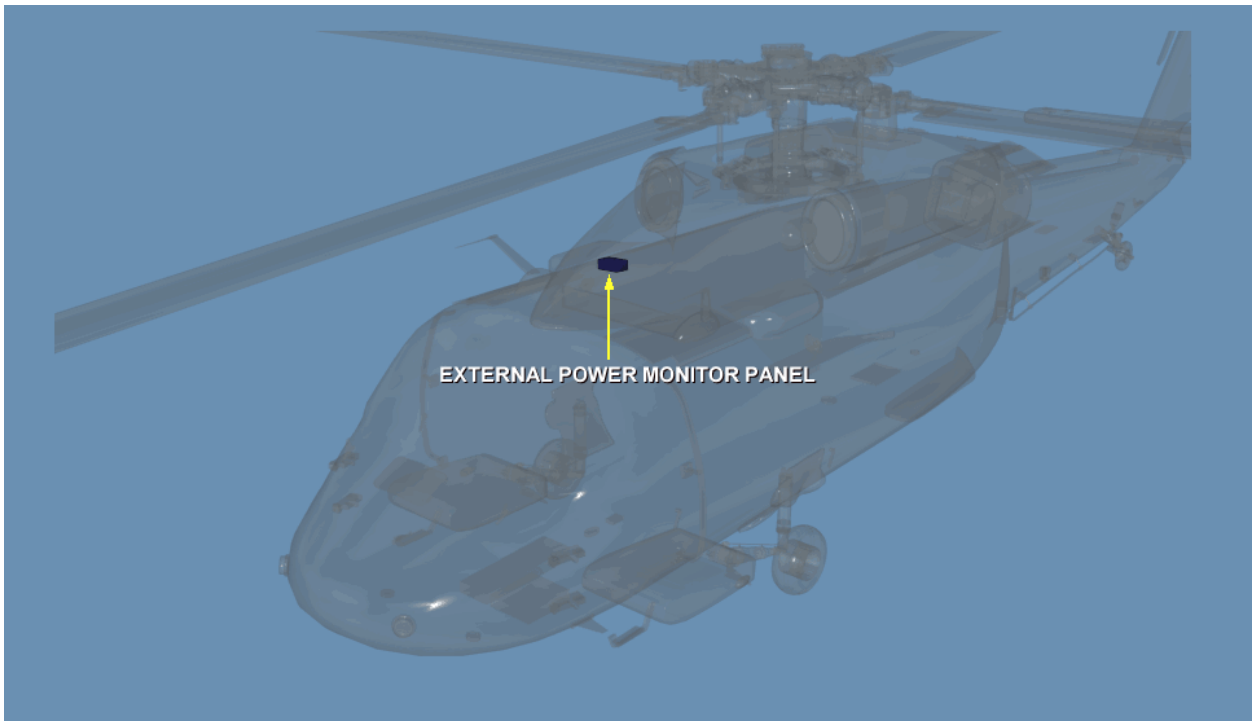
Frame #1065 (External Power Receptacle)



2) The external power receptacle permits three-phase ac power, from an external power cart, to be applied to the helicopter electrical system during ground operations.

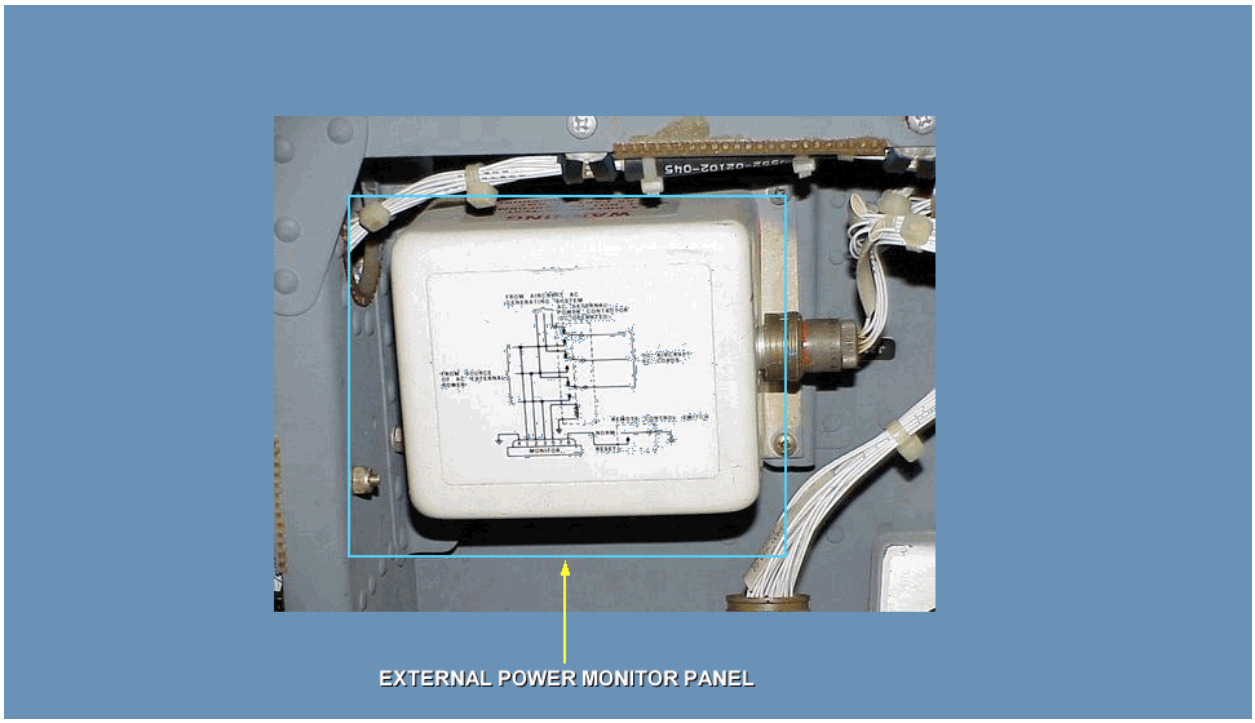
(h) External Power Monitor Panel

Frame #1022 (External Power Monitor Panel Location)



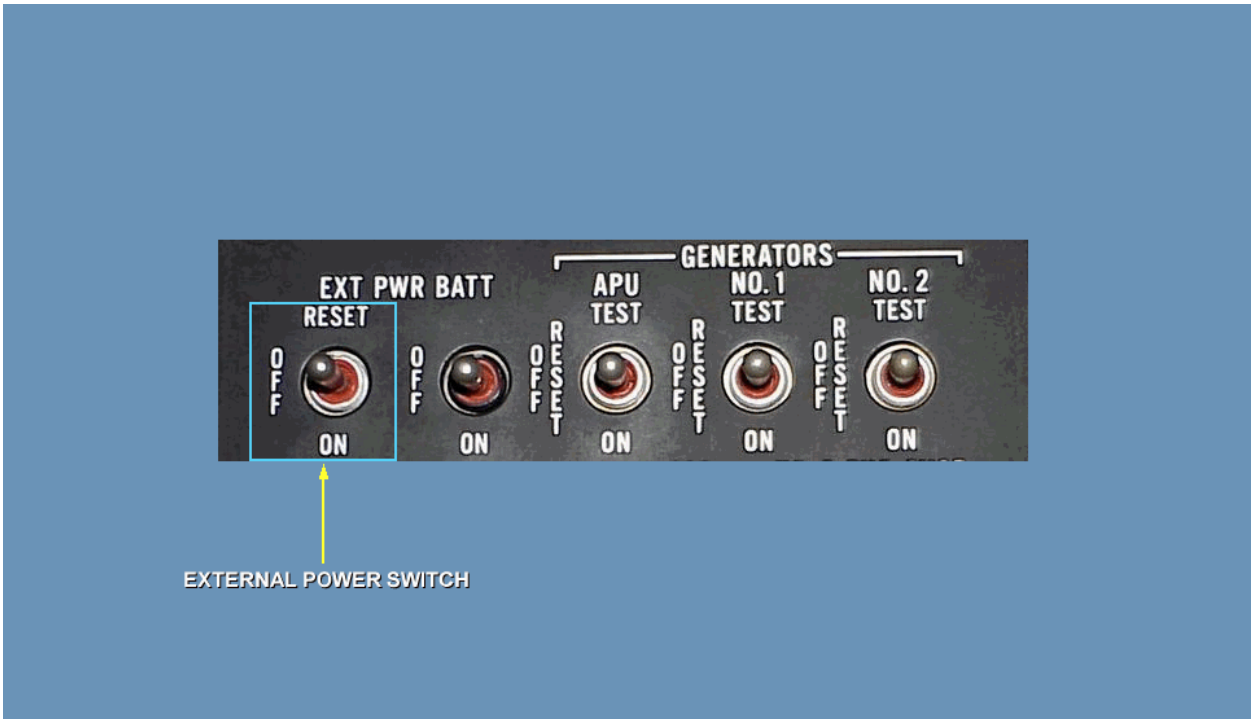
1) The external power monitor panel is located on the upper right-hand cabin.

Frame #1070 (External Power Monitor Panel)



2) The external power monitor panel monitors the external ac input for under-voltage, over-voltage, under-frequency, over-frequency, and correct phase rotation conditions.

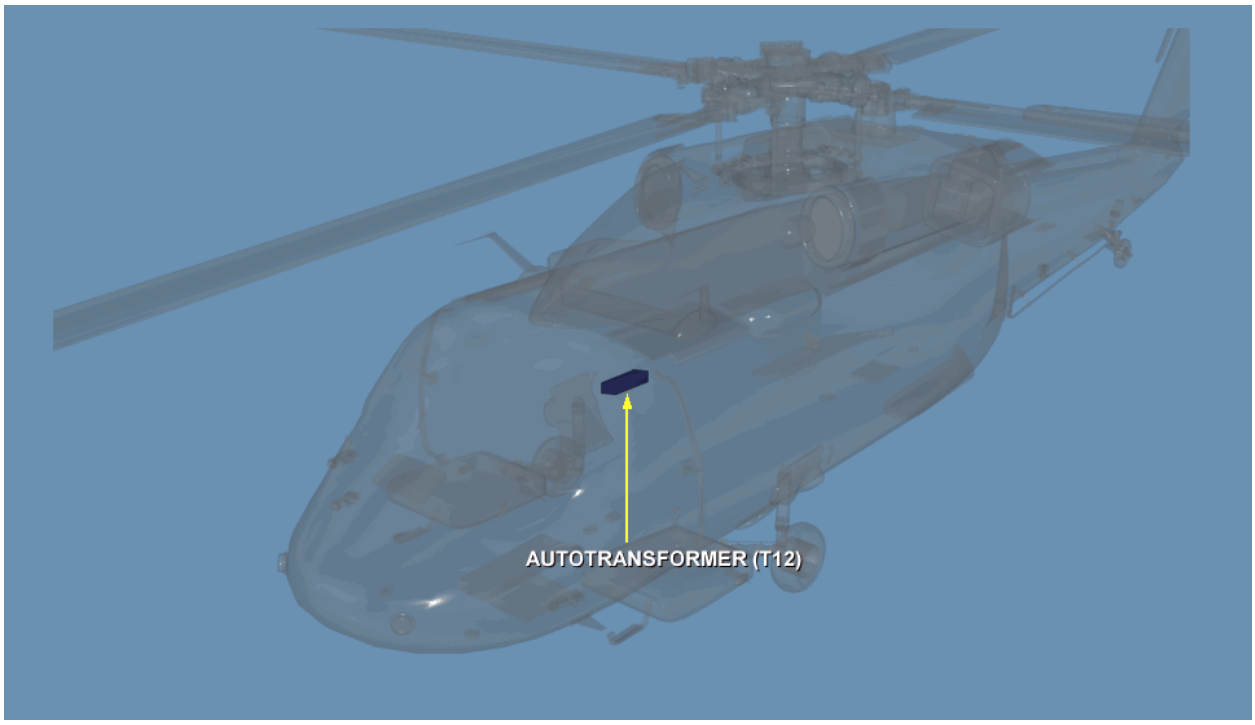
Frame #1075 (External Power Control Switch)



3) The external power control switch, on the upper console, is a three-position switch used to apply external power to the helicopter ac buses.

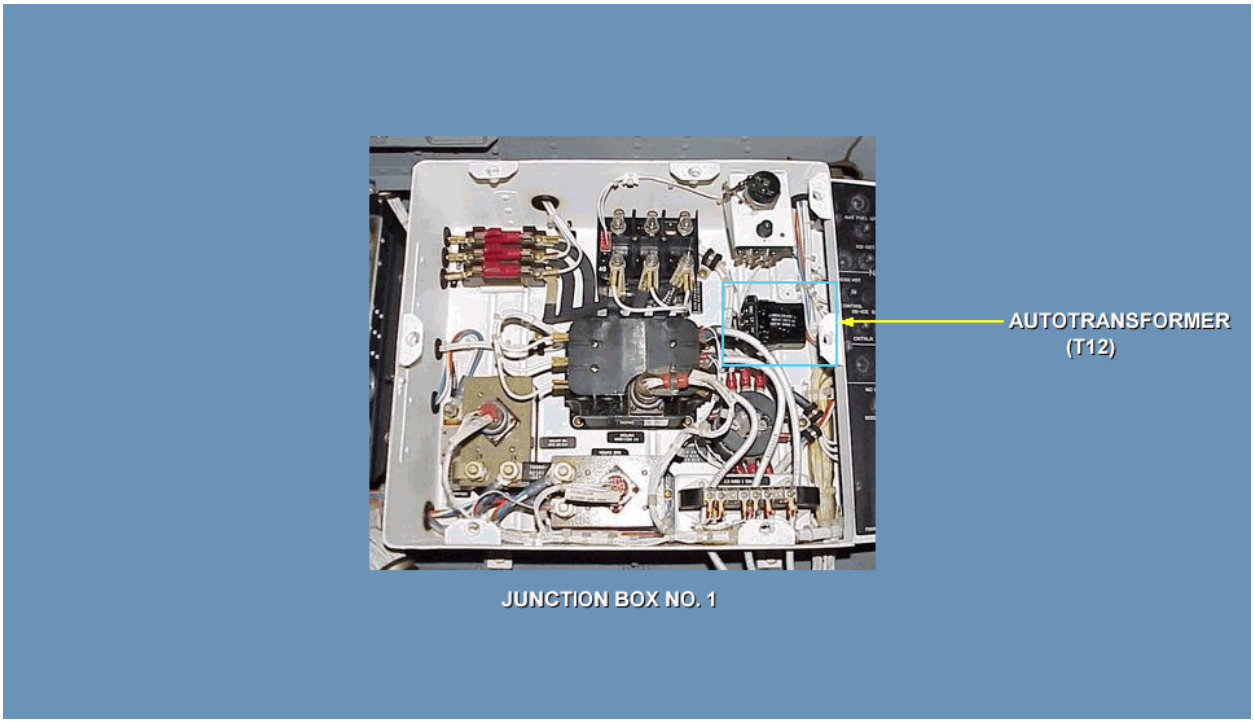
(i) Autotransformer

Frame #1023 (Autotransformer (T12) Location)



1) The autotransformer (T12) is located inside junction box No. 1.

Frame #1066 (Autotransformer T 12)



2) An autotransformer is a transformer having one continuous tapped winding.

3) The tap may either be fixed or variable. All or only a portion of the winding can serve as the primary, with the remaining tapped portion as the secondary.

4) The transformer is used to change the value of voltage or current in an electrical system.

CHECK ON LEARNING

1. How many independent generating systems provide primary ac power to the UH-60?

2. What APU generator output parameters does the APU Generator Control Unit monitor?

3. What components does the No.1 Junction Box contain?

4. What is the purpose of the 60 ampere current limiters?

5. What external ac inputs does the external power monitor panel monitor?

SECTION IV. -SUMMARY

1. REVIEW/SUMMARIZE:

You have completed the characteristics of the UH-60 AC electrical system topic. The key points to remember are:

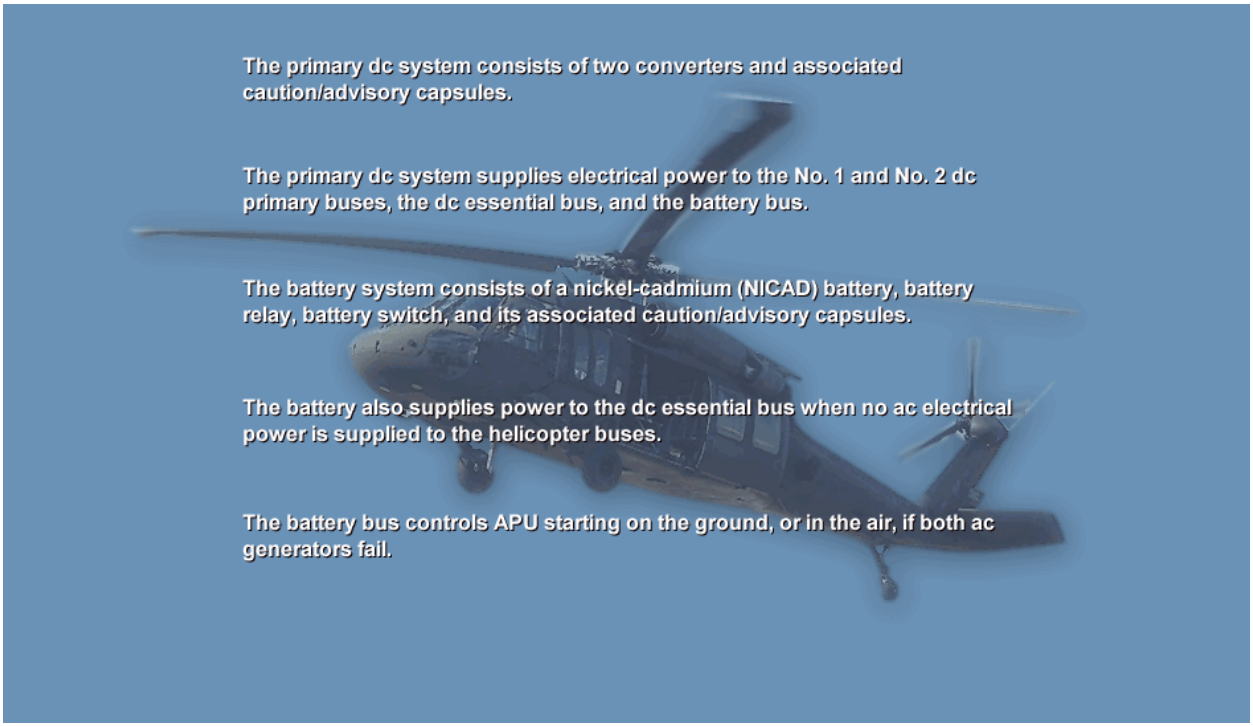
- The ac electrical system consists of primary ac power, auxiliary ac power, and external ac power.
- The No. 1, No. 2, and the APU generator control units continuously monitor and regulate generator output to provide voltage regulation, current regulation, over-voltage protection, under-voltage protection, feeder fault protection, and under-frequency protection.
- The ac bus tie contactor (K-4) provides three-phase ac power from the APU generator, or external ac power receptacle, to the ac primary buses.
- The current limiters are a 60 ampere fuses protecting the operating generator from excessive overloading during transfer operations.
- On the pilot circuit breaker panel the AC essential bus transfer (XFER) relay (K-8) provides connection of 115 V ac, B phase power to the ac essential bus.
- The external power monitor panel monitors the external ac input for under-voltage, over-voltage, under-frequency, over-frequency, and correct phase rotation conditions.
- The No. 1 junction box contains the No. 1 generator contactor (K-1), current transformer (T13), autotransformer (T12), current limiters (CL 4,5,6), and one test receptacle.

C. ENABLING LEARNING OBJECTIVE ELO No. 3

ACTION: Identify the characteristics of the UH-60 DC electrical system.
CONDITION: As a UH-60 Maintenance Test Pilot.
STANDARD: IAW UH-60 Black Hawk TM 1 Series manuals.

a. DC Electrical System

Frame #2005 (DC Electrical System Overview)



(1) The primary dc system consists of two converters and associated caution/advisory capsules.

(2) The primary dc system supplies electrical power to the No. 1 and No. 2 dc primary buses, the dc essential bus, and the battery bus.

(3) The battery system consists of a nickel-cadmium (NICAD) battery or a Sealed Lead Acid Battery (SLAB), battery relay, battery switch, and its associated caution/advisory capsules.

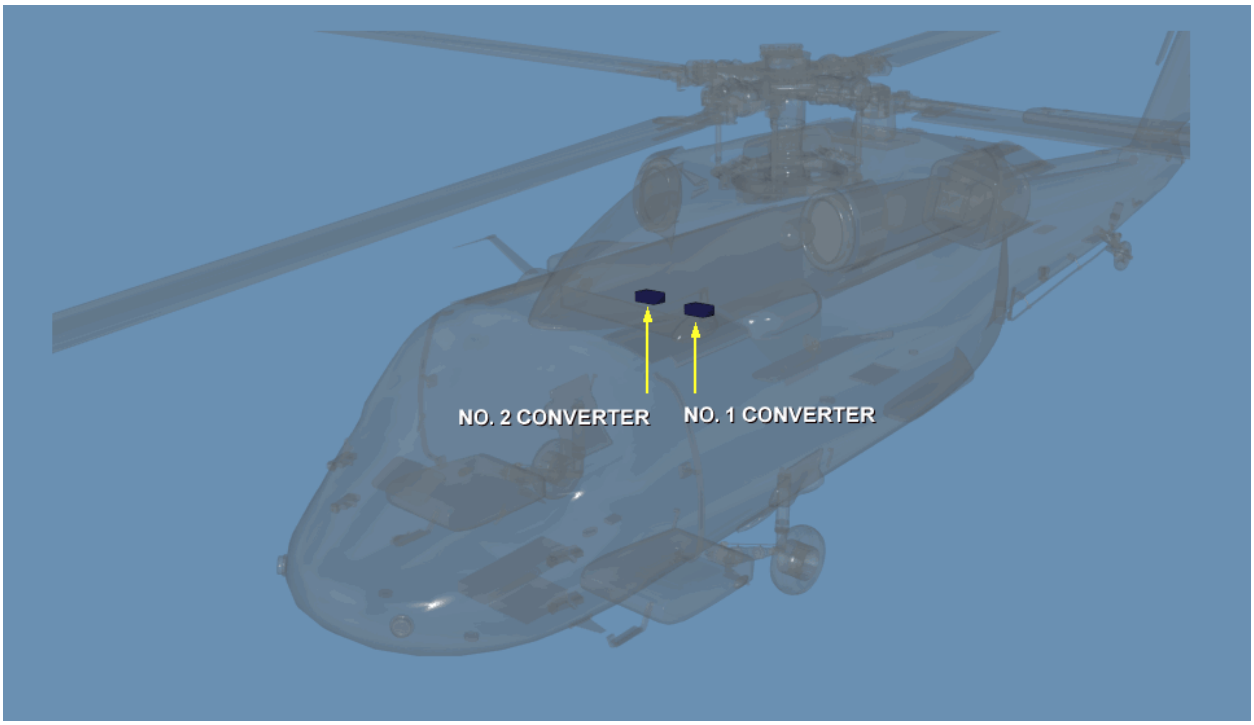
(4) The battery also supplies power to the dc essential bus when no ac electrical power is supplied to the helicopter buses.

(5) The battery bus controls APU starting on the ground, or in the air, if both ac generators fail.

Frame #2010 (DC Power MENU)

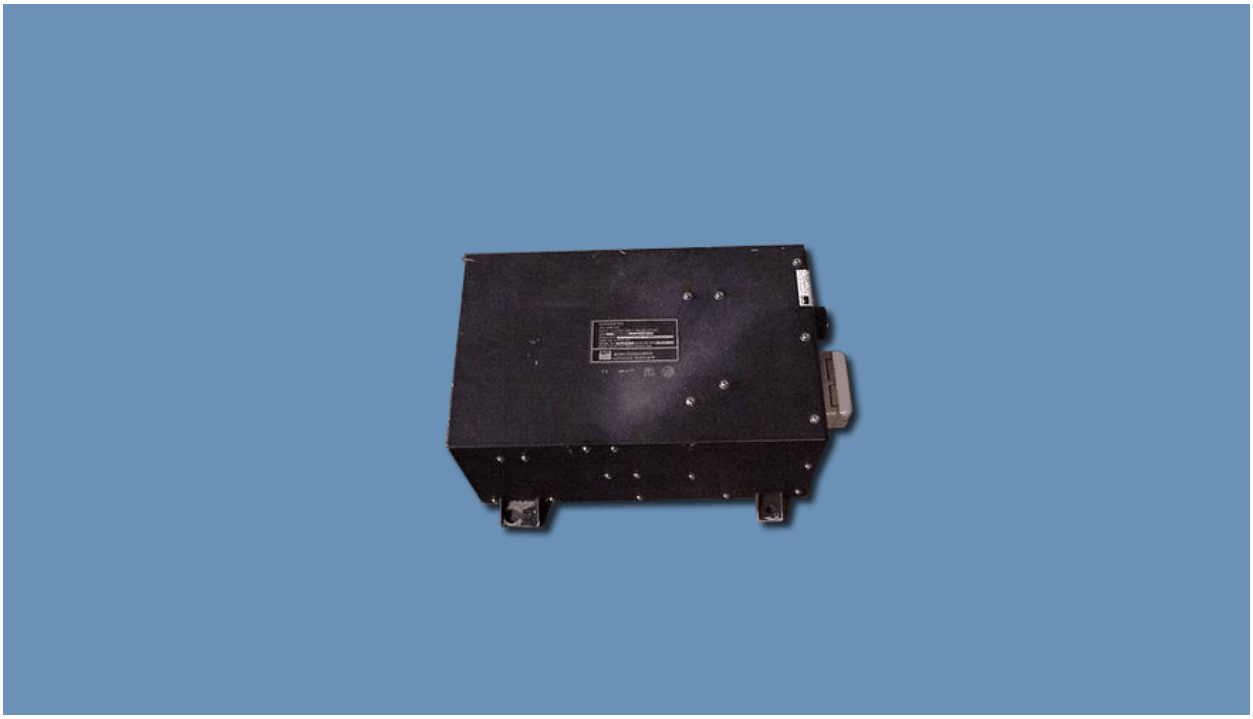
(a) Converter

Frame #2016 (Converter Location)



1) The No. 1 converter is located on the upper left-hand cabin and the No. 2 converter is located on the upper right-hand cabin.

Frame #2015 (Converter)



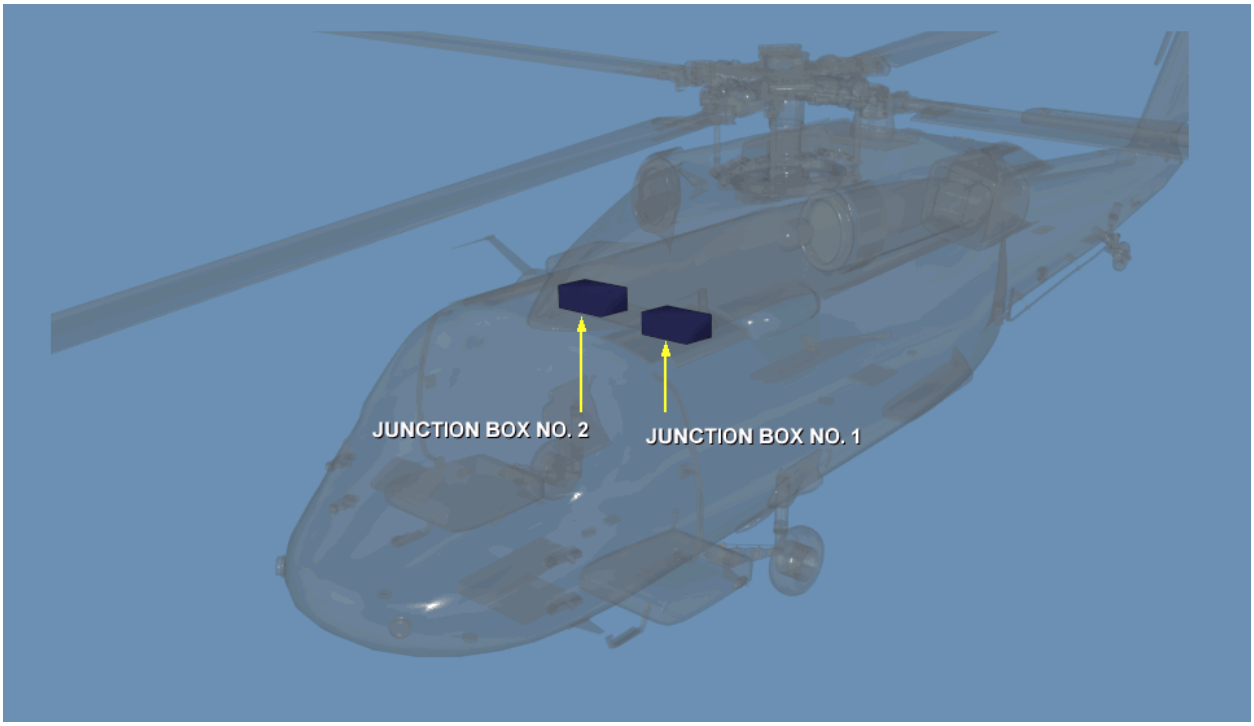
2) The No. 1 converter and the No. 2 converter provide dc power for helicopter equipment.

3) The converters take 115/200 V ac, three-phase, 400 Hz power and convert it to 31 V dc at no load to 25 V dc at 200 amperes.

4) The converters are cooled by internal fans.

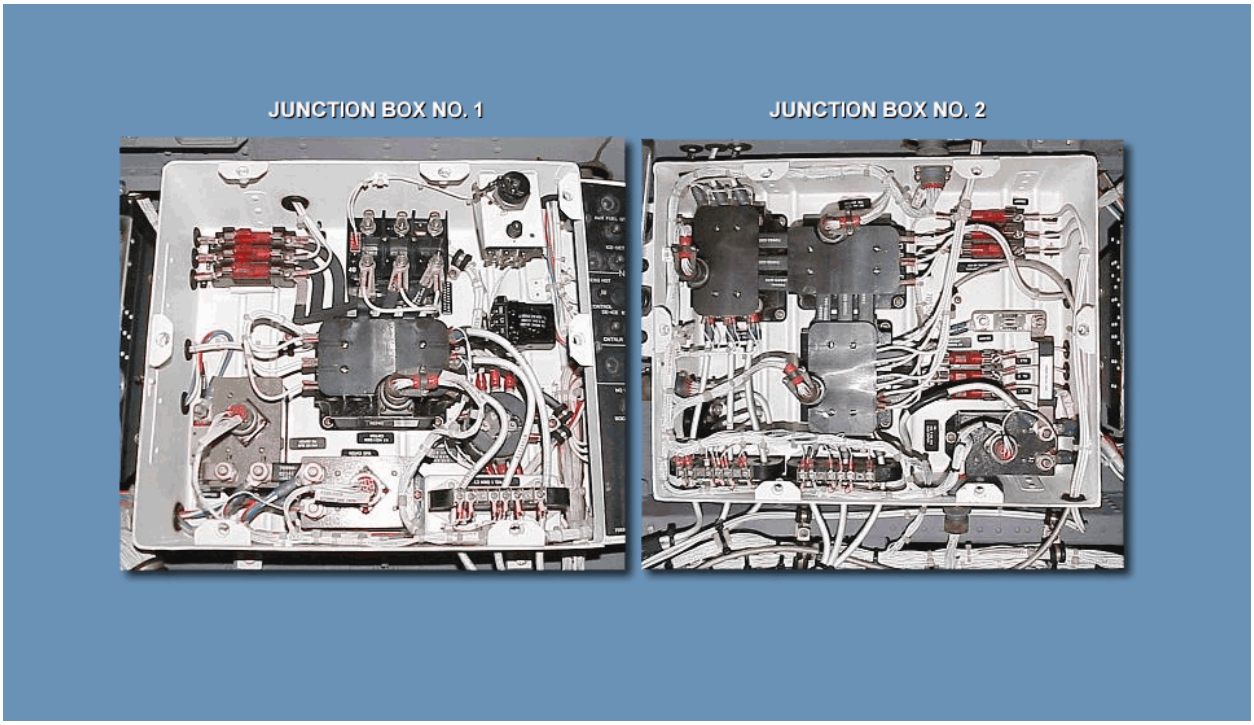
(b) Junction Boxes

Frame #2021 (Junction Box Location)



1) Junction box No. 1 is located on the upper left-hand cabin, and the junction box No. 2 is located on the upper right-hand cabin.

Frame #2020 (Junction Boxes)

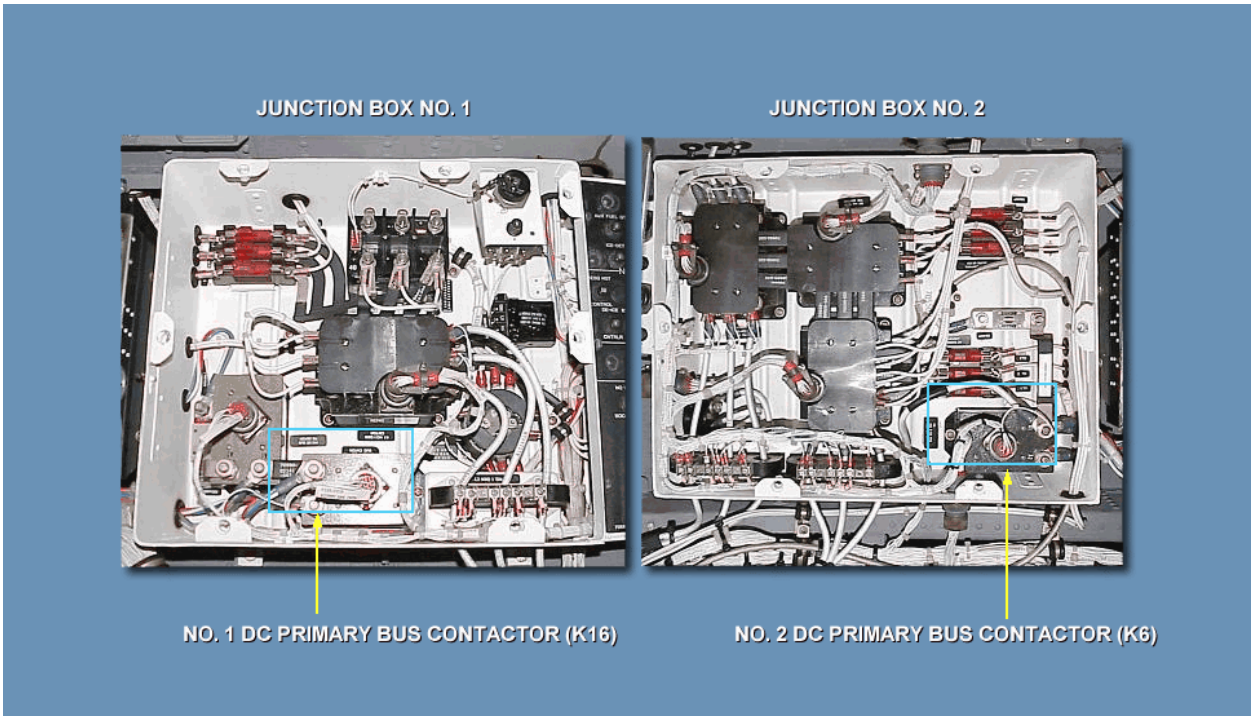


2) The No. 1 and No. 2 junction boxes provide mounting space for dc power system components.

3) The No. 1 junction box, located on the upper left-hand cabin overhead, contains the No. 1 dc primary bus contactor (K16), the dc bus tie contactor (K15), and a 100 amp current limiter.

4) The No. 2 junction box, located on the upper right-hand cabin overhead, contains the No. 2 dc primary bus contactor (K6).

Frame #2025 (DC Primary BUS Contactors)

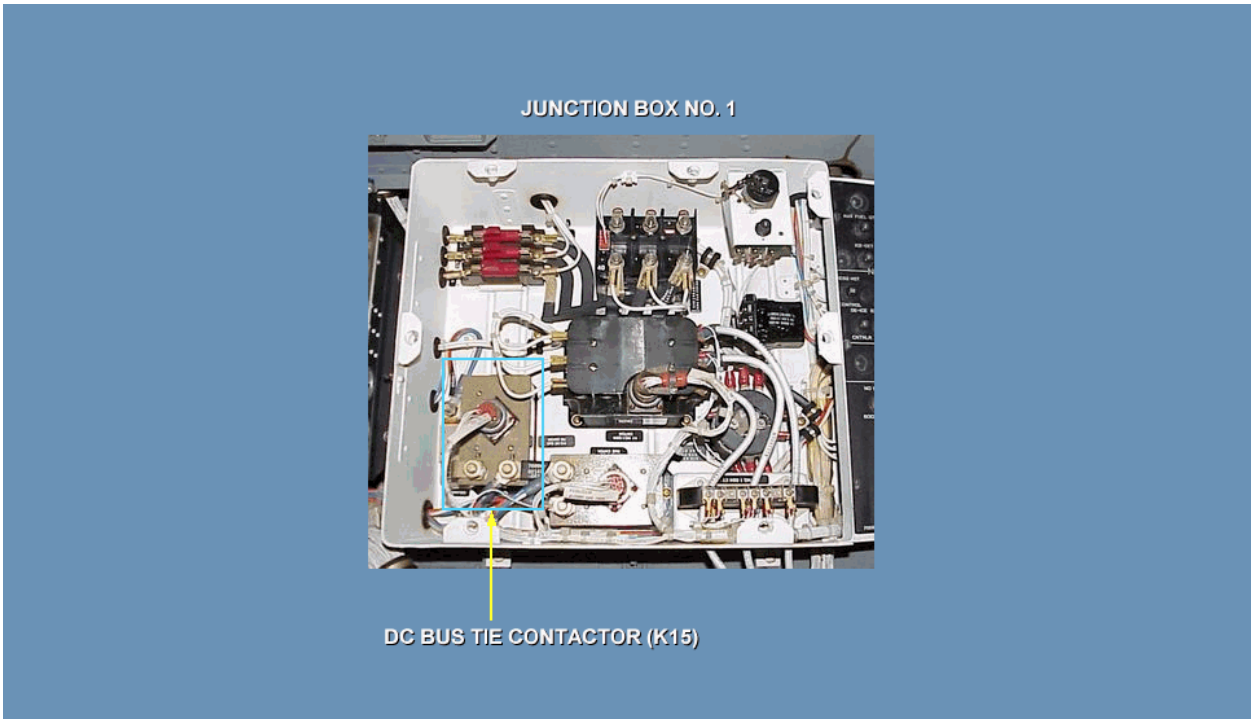


5) The No. 1 and No. 2 dc primary bus contactors (K16,K6), on junction box No. 1 and junction box No. 2, respectively, provide connections from the No. 1 and No. 2 converters to the No. 1 and No. 2 dc primary buses.

6) With the converters operating, their dc outputs energize the contactor solenoids and supply the dc primary buses.

7) When energized, one set of contactor auxiliary contacts open the path to the battery relay to prevent the battery from supplying power to the dc essential bus.

Frame #2030 (DC BUS TIE Contactor K15)

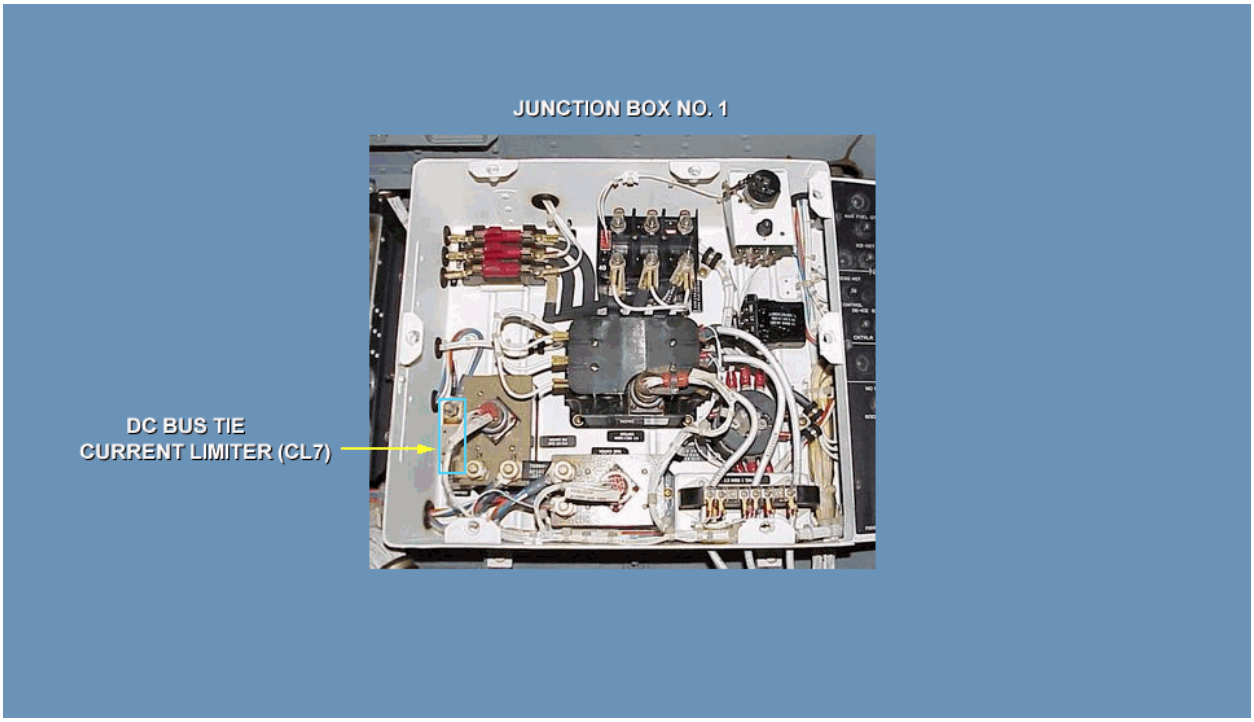


8) The dc bus tie contactor (K15), in junction box No. 1, provides a connection between the No. 1 and No. 2 dc primary buses.

9) If one converter fails, the path is closed from the primary bus of the operating converter to energize the solenoid of the dc bus tie contactor (K15).

10) The energized contactor connects the primary bus of the operating converter to the primary bus of the failed converter.

Frame #2035 (DC BUS TIE Current Limiter 100 AMP CL)

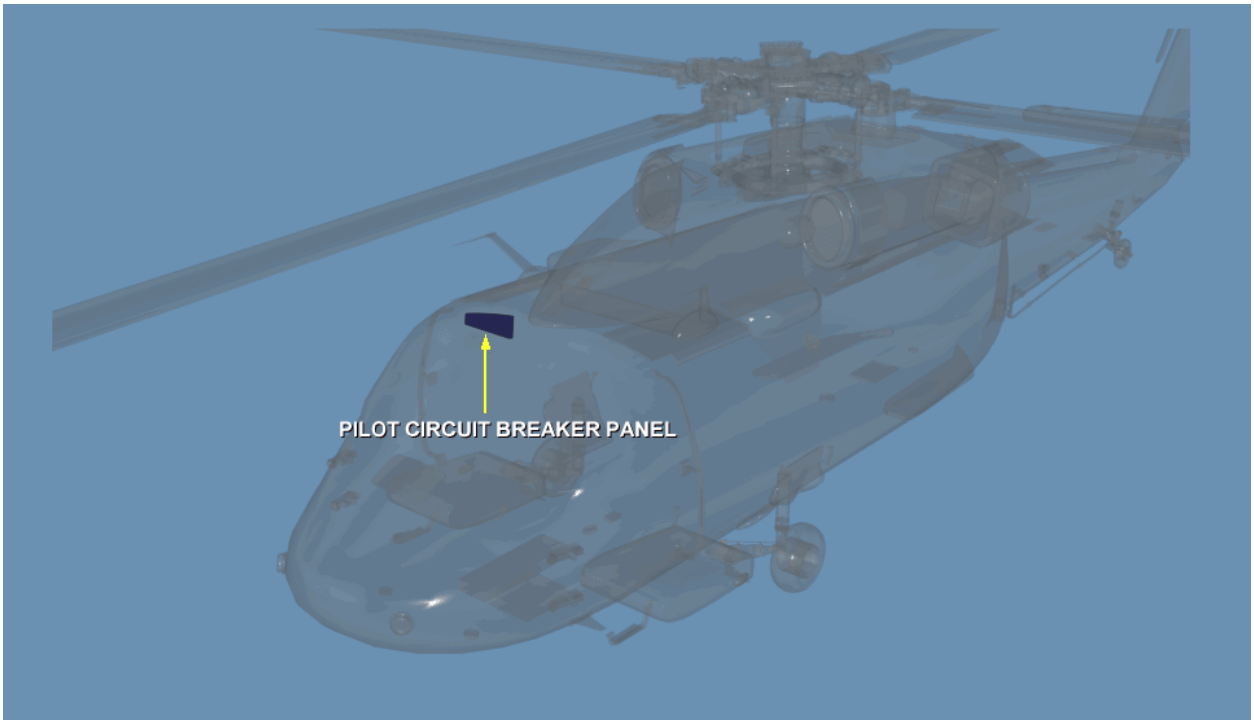


11) The DC bus tie current limiter (100 AMP CL), in junction box No. 1, is a 100-ampere fuse protecting the operation.

12) This current limiter operates when one dc primary bus is supplying the other dc primary bus as a result of a converter failure caused by a load short-circuit.

(c) NO. 1 DC Essential Bus Supply Relay (K10)

Frame #2041 (NO. 1 DC Essential Bus Supply Relay (K10) Location)



1) The No. 1 dc essential bus supply relay (K10) is located behind the pilot circuit breaker panel.

Frame #2040 (NO. 1 DC Essential BUS Supply Relay K10)

2) The No. 1 dc essential bus supply relay (K10) connects the dc essential bus to the No. 1 dc primary bus when energized, or the dc essential bus to the No. 2 dc primary bus, or the battery bus, when de-energized.

3) When the converters are operating, power from the No. 1 dc primary bus energizes the solenoid of the No. 1 dc essential bus supply relay (K10).

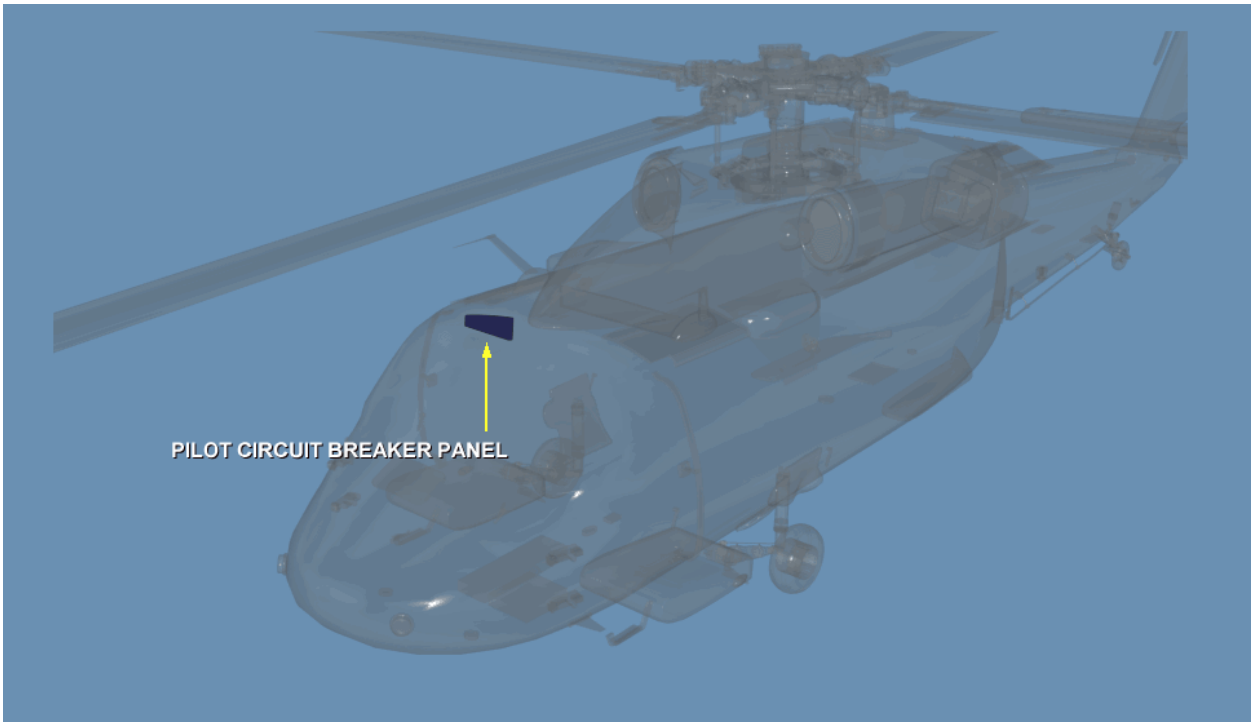
4) This power is applied through the energized relay contacts to supply the dc essential bus.

5) If power is lost on the No. 1 dc primary bus, the relay is de-energized and power from the No. 2 dc primary bus is applied through the normally closed relay contacts to supply the dc essential bus.

6) When the converters are off and the BATT switch is ON, power from the battery bus is applied through the normally closed contacts of the No. 1 dc essential bus supply relay to supply the dc essential bus.

(d) NO. 2 DC Essential BUS Supply Relay (K9)

Frame #2046 (NO. 2 DC Essential BUS Supply Relay (K9) Location)



1) The No. 2 dc essential bus supply relay (K9) is located behind the pilot circuit breaker panel.

Frame #2045 (NO. 2 DC Essential Bus Supply Relay K9)

2) The No. 2 dc essential bus supply relay (K9) connects the dc essential bus to the battery bus when energized, or the dc essential bus to the No. 2 dc primary bus when de-energized.

3) When the converters are off, the BATT switch is ON, and the battery is more than 35% charged, the path is closed from the battery utility bus, through the battery analyzer/conditioner, to energize the solenoid of the No. 2 essential bus supply relay (K9).

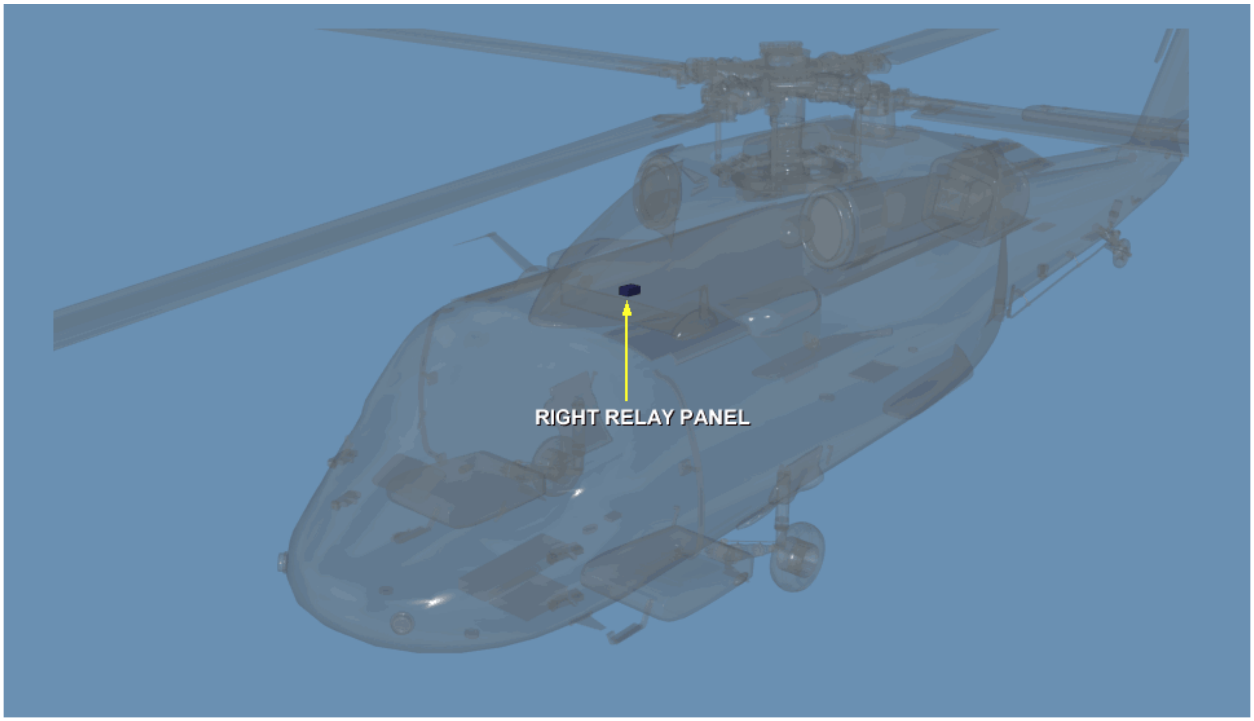
4) Power from the battery bus is applied through the energized relay contacts to supply the dc essential bus.

5) If the battery charge falls to 35%, the path through the analyzer/conditioner to the relay solenoid is opened and the relay de-energizes.

6) The path from the battery bus to the dc essential bus is opened and the dc essential bus is dropped.

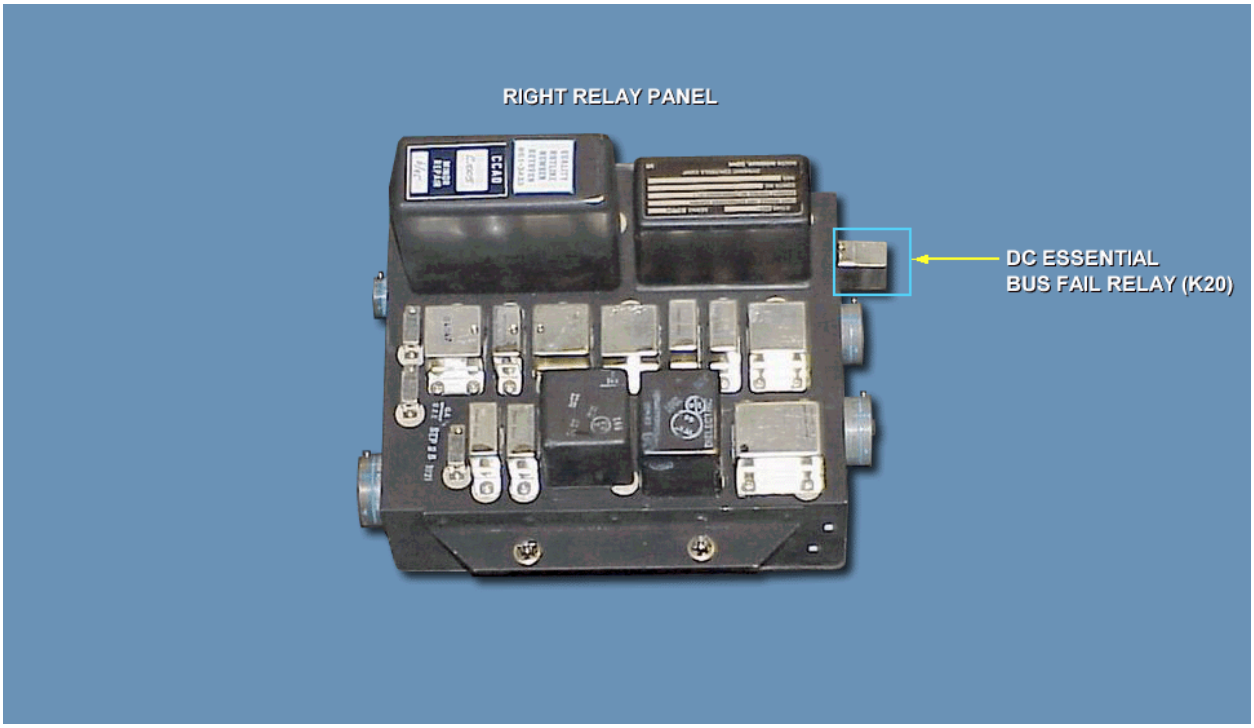
(e) DC Essential BUS Fail Relay (K20)

Frame #2051 (DC Essential BUS Fail Relay (K20) Location)



1) The dc essential bus fail relay (K20) is located on the right relay panel in the upper cabin.

Frame #2050 (DC Essential BUS Fail Relay K20)



2) The dc essential bus fail relay (K20) provides a path to illuminate the caution/advisory panel DC ESS BUS OFF capsule.

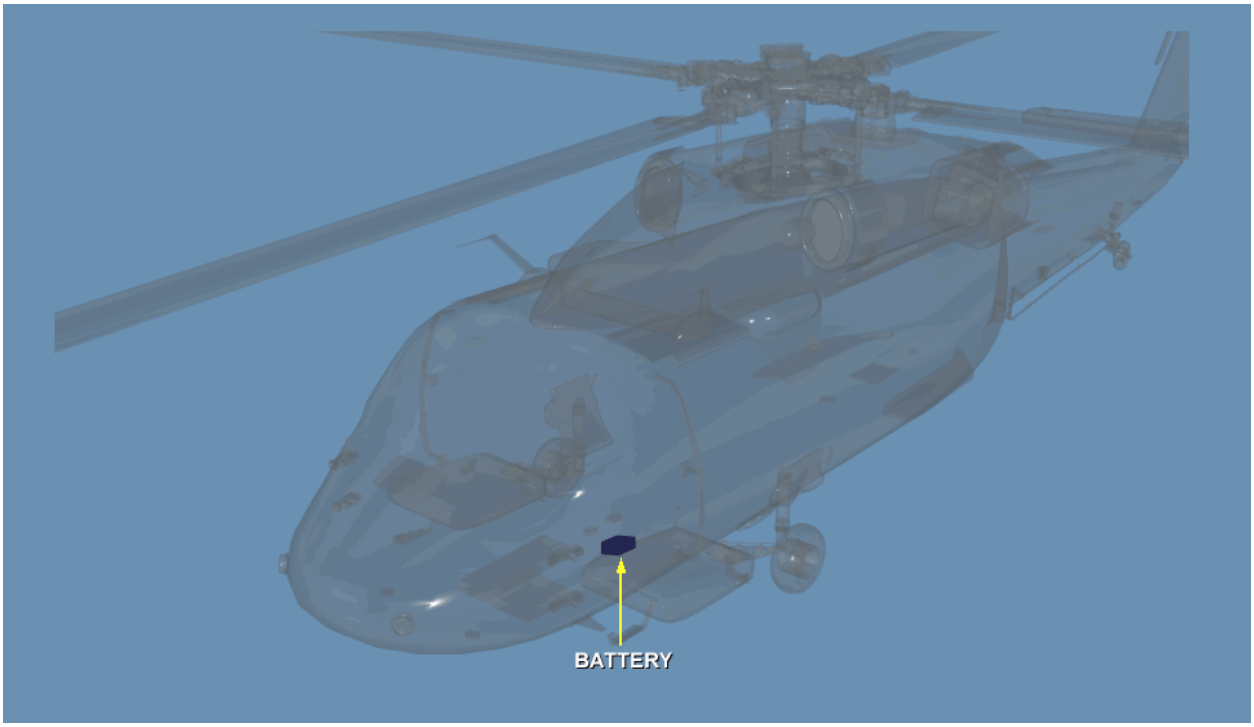
3) Power from the dc essential bus energizes the relay solenoid and the path is opened between the battery bus and the caution/advisory panel capsule.

4) When the charge of the battery supplying the dc essential bus falls to 35%, the bus is dropped.

5) The relay is now de-energized and the normally closed relay contacts close the path from the battery bus to illuminate the DC ESS BUS OFF capsule.

(f) Battery

Frame #2056 (Battery Location)



1) The battery is located on the front cabin floor behind the copilot.

Frame #2057 (Battery)

2) A Sealed Lead Acid Battery (SLAB) is installed in the UH-60L 96-26723-SUBQ UH60Q HH-60L.

3) Most UH-60A,L,Q prior to 96-26723 will receive the SLAB Batt as MWO 50-77 .

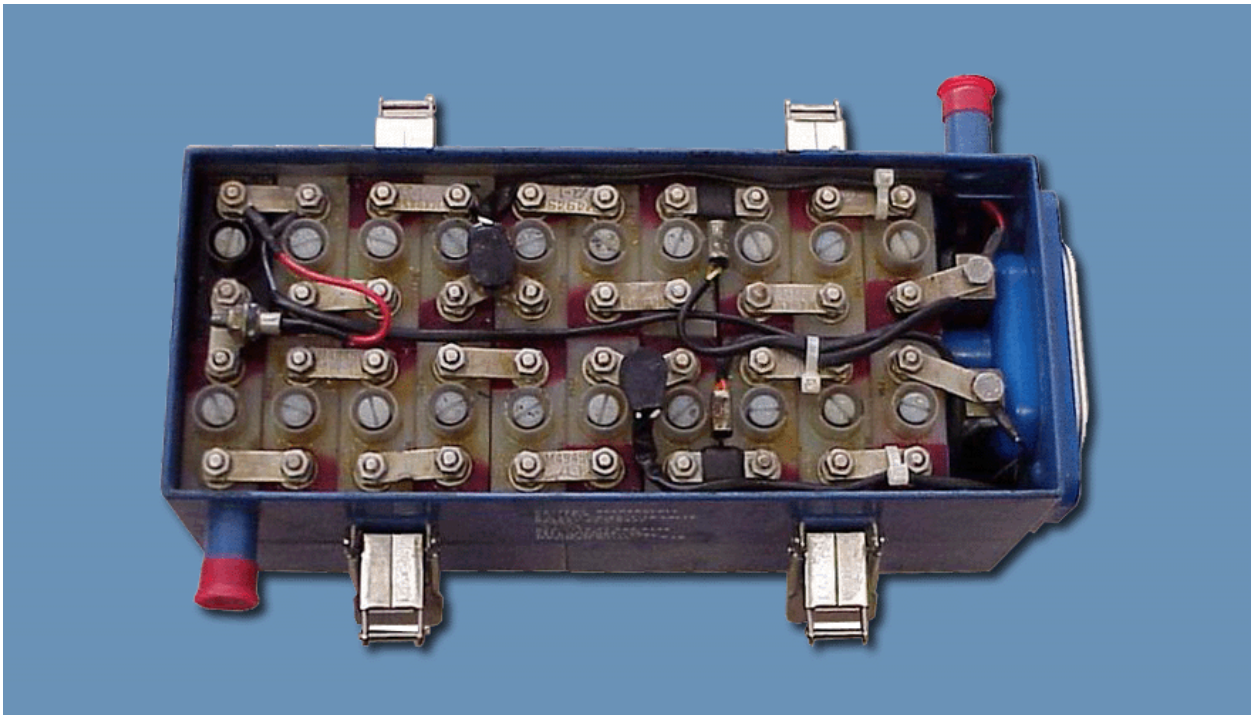
4) The sealed lead acid battery has a capacity of 10 ampere-hours, based on a 1-hour discharge rate at 24 ° C ambient temperature to a cutoff voltage of 18 volts.

5) The battery supplies power to the battery bus.

6) The battery also supplies power to the dc essential bus when no ac electrical power is supplied to the helicopter buses.

7) The battery bus controls APU starting on the ground, or in the air if both ac generators fail. If battery voltage drops to less than 23 V dc, the BATT LOW CHARGE capsule will light.

Frame #2055 (Battery)



8) The nickel-cadmium battery has a capacity of 5.5 ampere-hours.

9) It provides power for the dc essential bus on the ground when neither the engines nor the APU are operating.

10) It also provides power for controlling APU starting on the ground, or in the air if both ac generators fail.

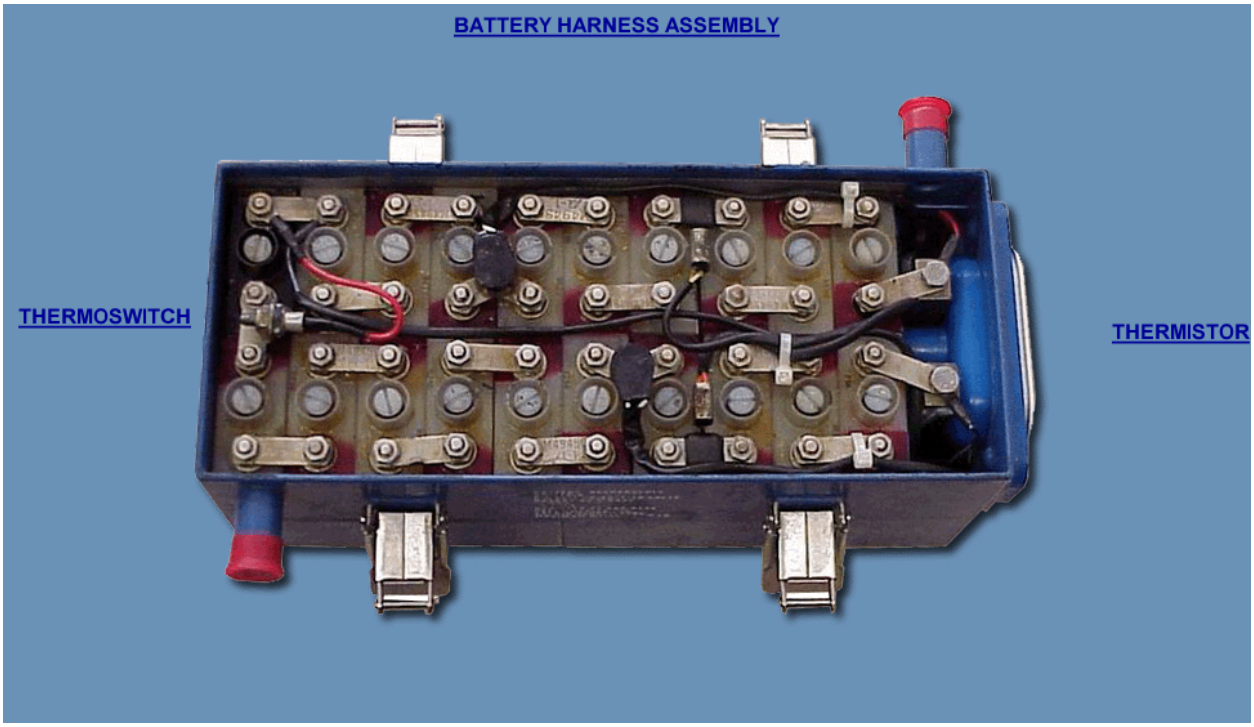
11) The battery has a total of 20 cells; 19 interchangeable cells and one low-capacity sense cell.

12) The low-capacity sense cell provides information to the battery analyzer/conditioner as to the percent of charge of the battery.

13) Two temperature sensors provide continuous signals to the analyzer/conditioner to compensate for voltage changes as a result of battery temperature variations during charging and discharging.

14) An over-temperature switch in the battery opens when the battery temperature increases to 160 °F during charging, disabling the analyzer/conditioner charging circuit to prevent thermal runaway.

Frame #2060 (Battery Harness Assembly)



a) Battery Harness Assembly

1 The Battery Harness Assembly contains the wiring for the Thermistor and the Thermoswitch.

a Thermoswitch

i) Thermoswitch operates the FAULT LIGHT. If there is an unbalance in the cell voltage, due to an overcharge condition, the thermoswitch will illuminate the FAULT LIGHT and disconnect the battery charger analyzer.

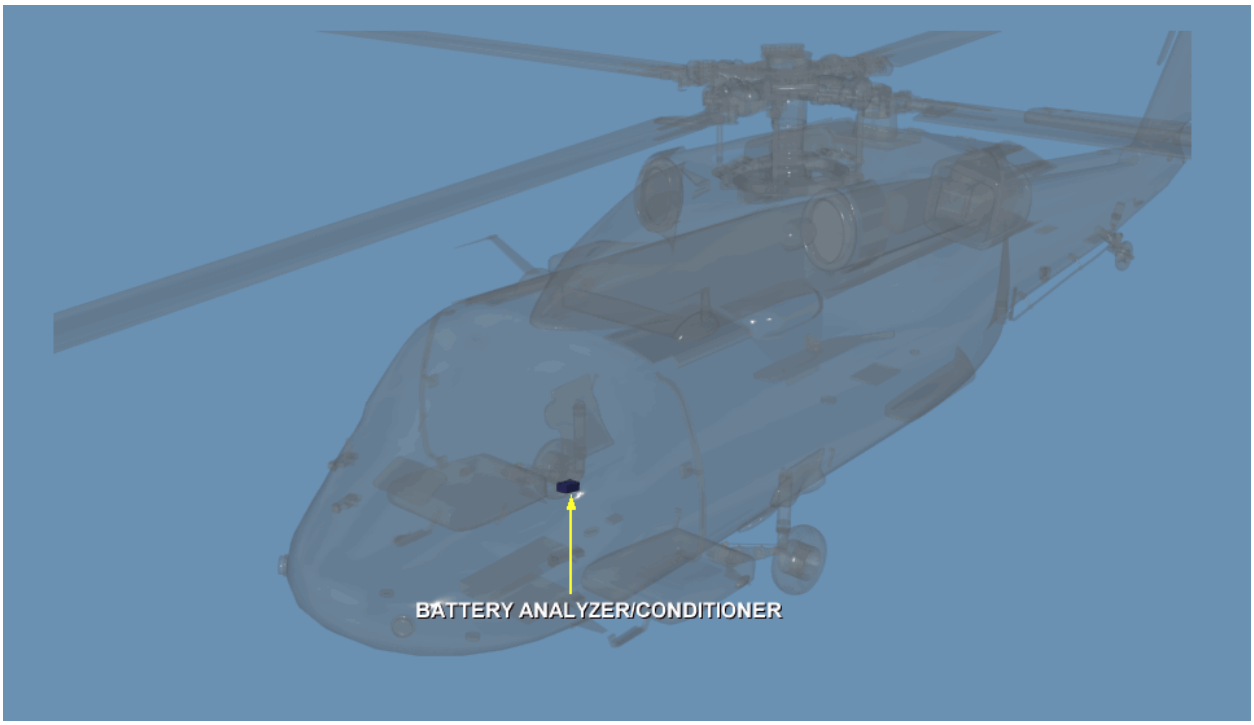
b Thermistor

i) A thermistor compensates for voltage variations with a change in temperature.

ii) If the battery temperature exceeds 160 degrees, you should get a BATTERY fault light located on the caution/advisory panel and the battery should be disconnected from the charger analyzer through relay K-7

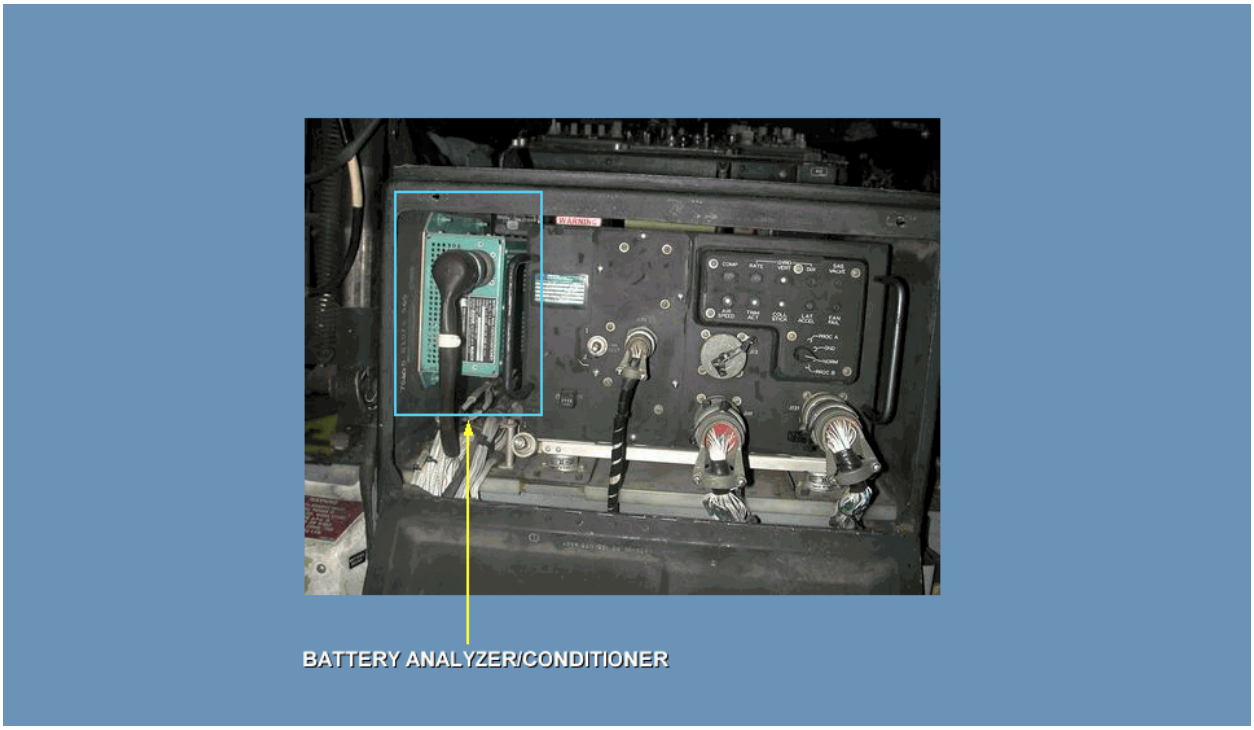
(g) Battery Analyzer/Conditioner

Frame #2067 (Battery Analyzer/Conditioner Location)



1) The battery analyzer/conditioner is located on the rear cockpit floor inside the lower console.

Frame #2065 (Battery Analyzer/Conditioner)



2) The battery analyzer/conditioner continuously monitors battery voltage and temperature condition and contains a charging circuit for battery charging.

3) When the battery is supplying the dc buses, the analyzer/conditioner monitors battery capacity.

4) When the battery capacity falls to 40%, a low cell voltage detector in the analyzer illuminates the caution/advisory panel BATT LOW CHARGE capsule.

5) When capacity falls to 35%, a battery low disconnect circuit disconnects the dc essential bus loads to make sure that enough charge remains on the battery for APU starting.

Frame #2066 (Battery Analyzer/Conditioner)

6) The analyzer voltage detector circuit also receives temperature information to compensate for voltage changes as battery temperature varies.

7) When the converters are operating and the battery switch is ON, the charging circuit of the analyzer/conditioner receives ac and dc power to charge the battery.

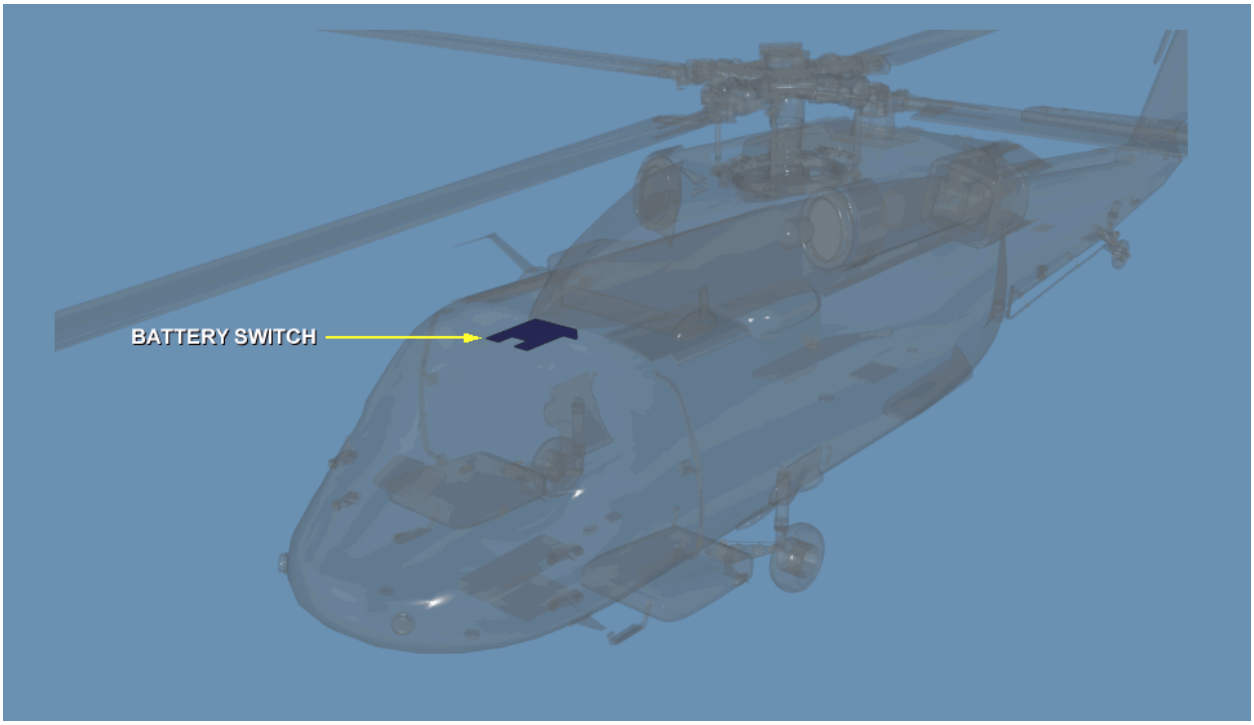
8) Battery output voltage and temperature are monitored by the charging circuit to regulate the charging current to the battery.

9) The charging circuit is automatically disabled when the analyzer/conditioner fault indication circuit senses a battery over temperature or overcharge condition.

10) The fault indication circuit illuminates the caution/advisory panel BATTERY FAULT capsule to indicate the fault condition.

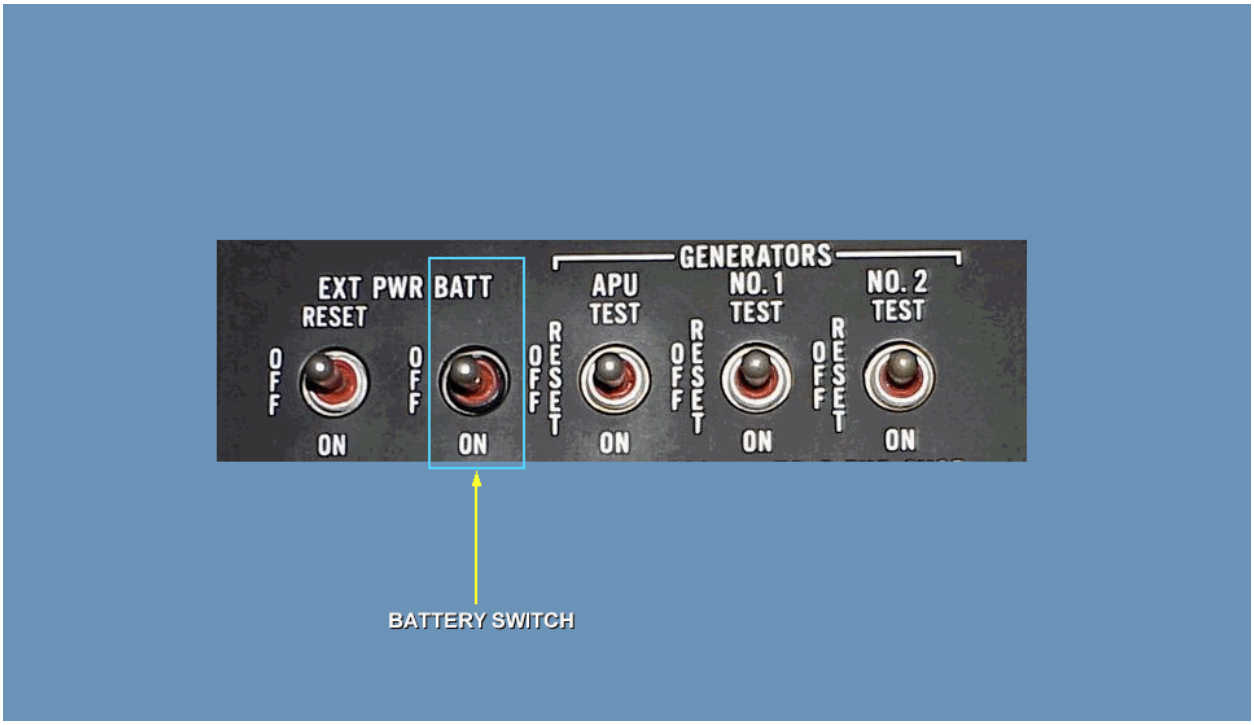
(h) Battery Switch

Frame #2076 (Battery Switch Location)



1) The two-position Battery (BATT) switch is located on the upper console.

Frame #2075 (Battery Switch)



2) The two-position Battery (BATT) switch controls battery system operation.

3) Placing the switch to ON permits the battery to supply the battery and dc essential buses when the converters are off, or the battery to be charged by the analyzer/conditioner when the converters are on.

4) Placing the switch to OFF disables all battery system operation except supply of the battery utility bus.

(i) Battery Relay (K7)

Frame #2071 (Battery Relay (K7) Location)

1) The battery relay (K7) is located on the lower front cabin bulkhead left-hand side.

Frame #2070 (Battery Relay K7)

2) The battery relay (K7) connects the battery to the battery bus when energized or the dc essential bus to the battery bus when de-energized.

3) When the converters are off and the BATT switch is ON, the path is closed and the battery utility bus energizes the solenoid of the battery relay.

4) The energized contacts of the battery relay apply power from the battery to the battery bus.

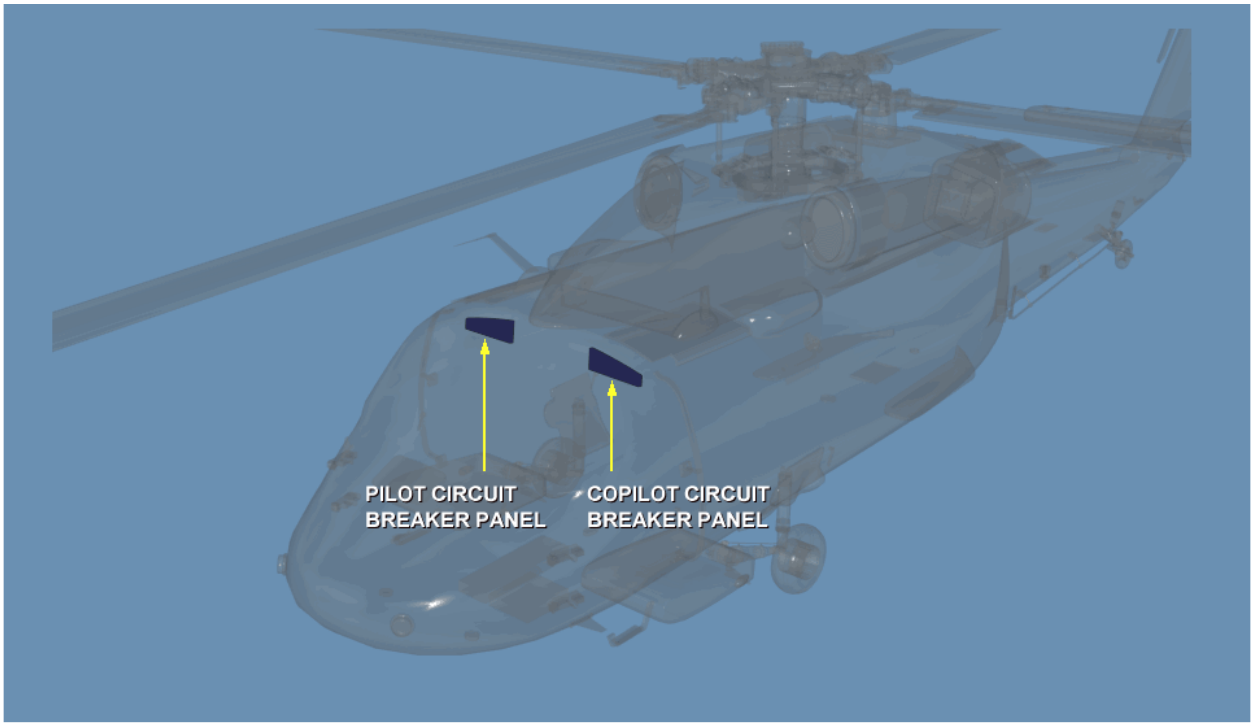
5) When the converters are operating, the normally closed contacts of the battery relay, apply power from the dc essential bus to the battery bus.

6) When the converters are operating the BATT switch is ON, the battery relay is de-energized.

7) Normally closed relay contacts connect the battery to the analyzer/conditioner to allow the battery to be charged.

(j) Pilot and Copilot Circuit Breaker Panel

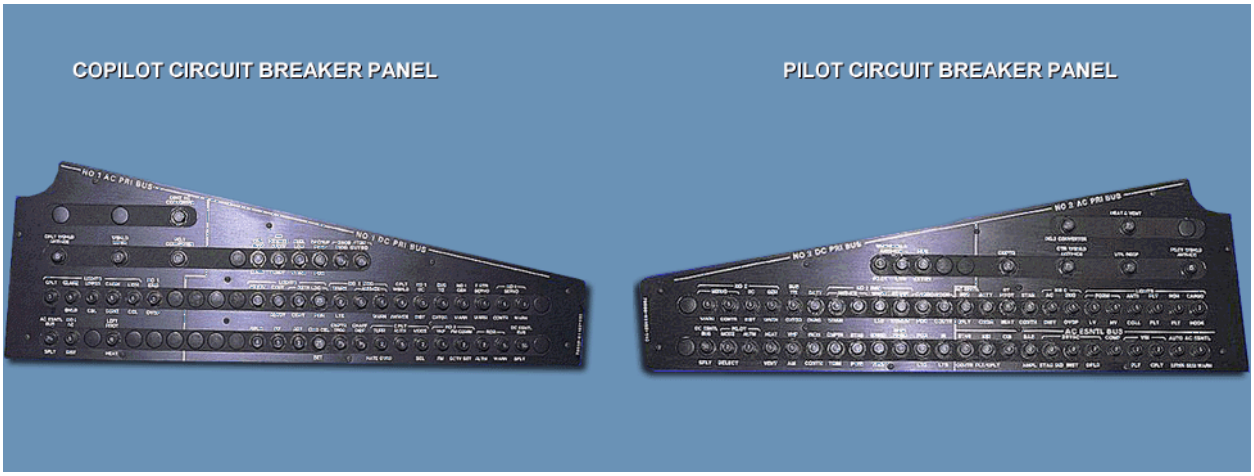
Frame #2086 (Pilot and Copilot Circuit Breaker Panel Location)



1) The pilot circuit breaker panel is located in the cockpit above the pilot seat.

2) The copilot circuit breaker panel is located in the cockpit above the copilot seat.

Frame #2085 (Pilot and Copilot Circuit Breaker Panel)

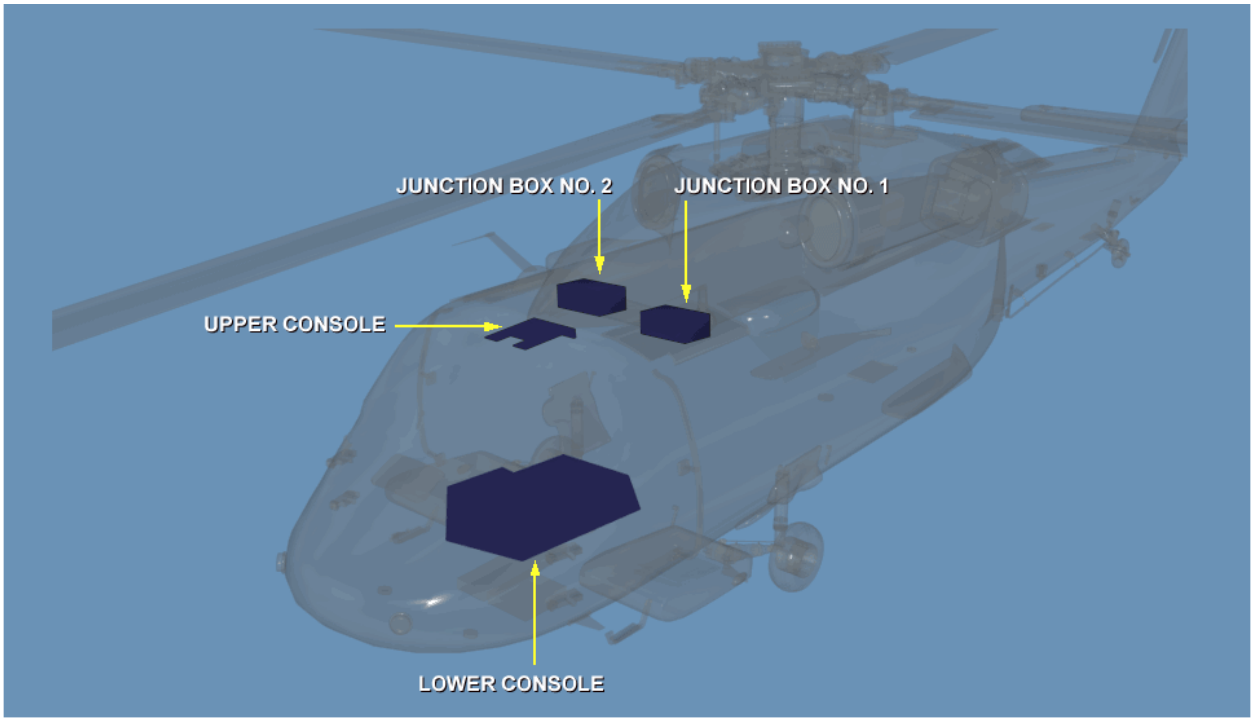


3) Pilot Circuit Breaker Panel contains No. 2 AC and DC Primary Bus.

4) The Copilot Circuit Breaker Panel Contains the No. 1 AC and DC Primary Bus.

(k) Miscellaneous Circuit Breaker Panels

Frame #2081 (Miscellaneous Circuit Breaker Panels)

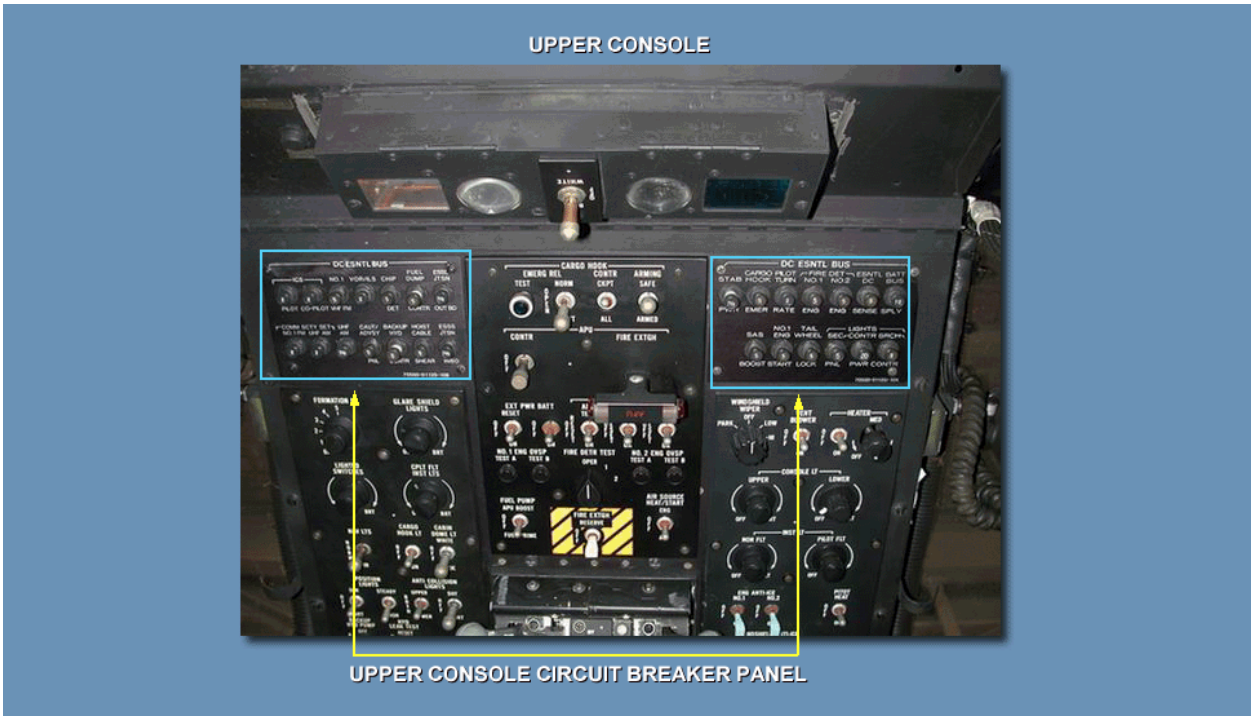


1) The Upper Console Circuit breaker panels L/H and R/H are located on the upper console.

2) The Lower Console Circuit Breaker Panel is located on the rear portion of the lower console.

3) The Mission Readiness Circuit Breaker panel is located on Junction Box No. 1.

Frame #2080 (Upper Console)



4) The Upper Console Circuit Breaker Panel contains the DC Essential Bus.

Frame #2082 (Mission Readiness Circuit Breaker Panel)

MISSION READINESS CIRCUIT BREAKER PANEL

5) The Mission Readiness Circuit Breaker Panel contains the No. 1 and No. 2 AC and DC Primary Bus.

Frame #2083 (Lower Console Circuit Breaker Panel)

6) The Lower Console Circuit Breaker Panel contains the Battery Bus, Battery Utility Bus, APU Bus and the AC and DC Essential Bus.

CHECK ON LEARNING

1. What component supplies power to the dc essential bus when no ac electrical power is supplied to the helicopter buses?

2. What component provides connection between the No. 1 and the No. 2 dc primary buses?

3. What is the percentage of charge in the battery that allows the DC ESS BUS OFF capsule to illuminate?

4. What parameters does the Battery Analyzer/Conditioner not monitor?

5. What component provides primary dc power for helicopter equipment?

SECTION V. -SUMMARY

1. REVIEW/SUMMARIZE:

You have completed the characteristics of the UH-60 DC electrical system topic. The key points to remember are:

- The primary dc system consists of two converters, supplied from the ac power system, and associated caution/advisory capsules.
- The converters operate from 115/200 Vac, three-phase, 400 Hz power and provide outputs of 31 Vdc at no load to 25 Vdc at 200 amperes.
- The dc bus tie contactor (K15), on the No. 1 Junction box, provides a connection between the No. 1 and No. 2 primary buses.
- The dc bus tie current limiter (CL7), in the No. 1 junction box, is a 100 ampere fuse that protects the connection between the No. 1 and the No. 2 primary dc buses.
- The current limiter (CL7) operates when one primary dc bus is supplying the other dc primary bus as a result of a converter failure caused by a load short-circuits.
- The DC ESS BUS OFF capsule is illuminated when the charge of the battery supplying the dc essential bus falls to 35% and the bus is dropped off line.
- The battery analyzer/conditioner continuously monitors battery voltage and temperature condition and contains a charging circuit for the battery.
- The battery supplies power to the dc essential bus when no ac power is supplied to the helicopter buses.

D. ENABLING LEARNING OBJECTIVE ELO No. 4

ACTION: Identify the characteristics of the UH-60 Electrical System using system diagrams.
CONDITION: As a UH-60 Maintenance test pilot.
STANDARD: IAW UH-60 Black Hawk TM 1 Series manuals.

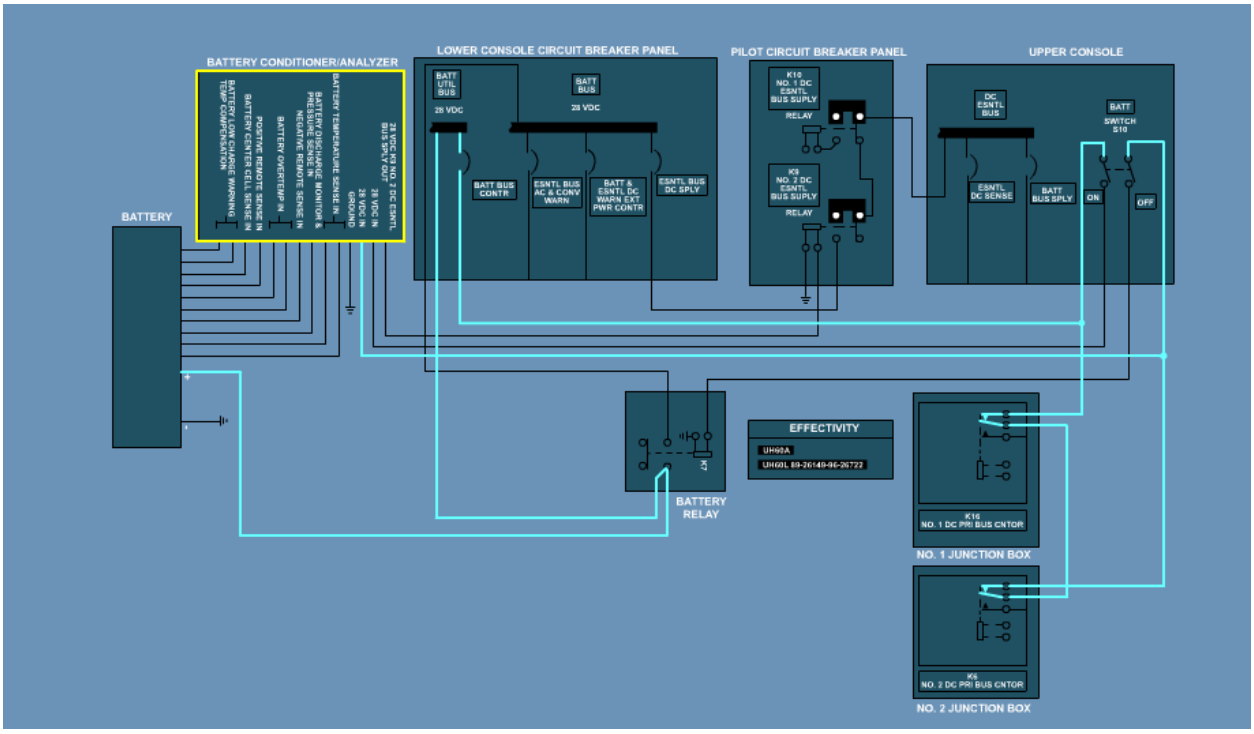
a. Schematic Menu

Frame #4001 (Schematic Menu)

(1) DC Schematics

(a) Battery Operation

Frame #4005 (Battery Operation FLASH)



1) The battery always supplies the battery utility bus.

2) The battery analyzer/conditioner continuously monitors battery voltage and temperature condition and contains a charging circuit for battery charging.

3) Dc power from the battery utility bus is applied through the BATT BUS CONTR circuit breaker, the normally closed auxiliary contacts of No. 1 and No. 2 dc primary bus contactors K16 and K6, and to the BATT switch.

4) When the battery switch is placed to the on position, dc power is routed from the battery switch to battery relay K7, and also to the battery conditioner/analyzer.

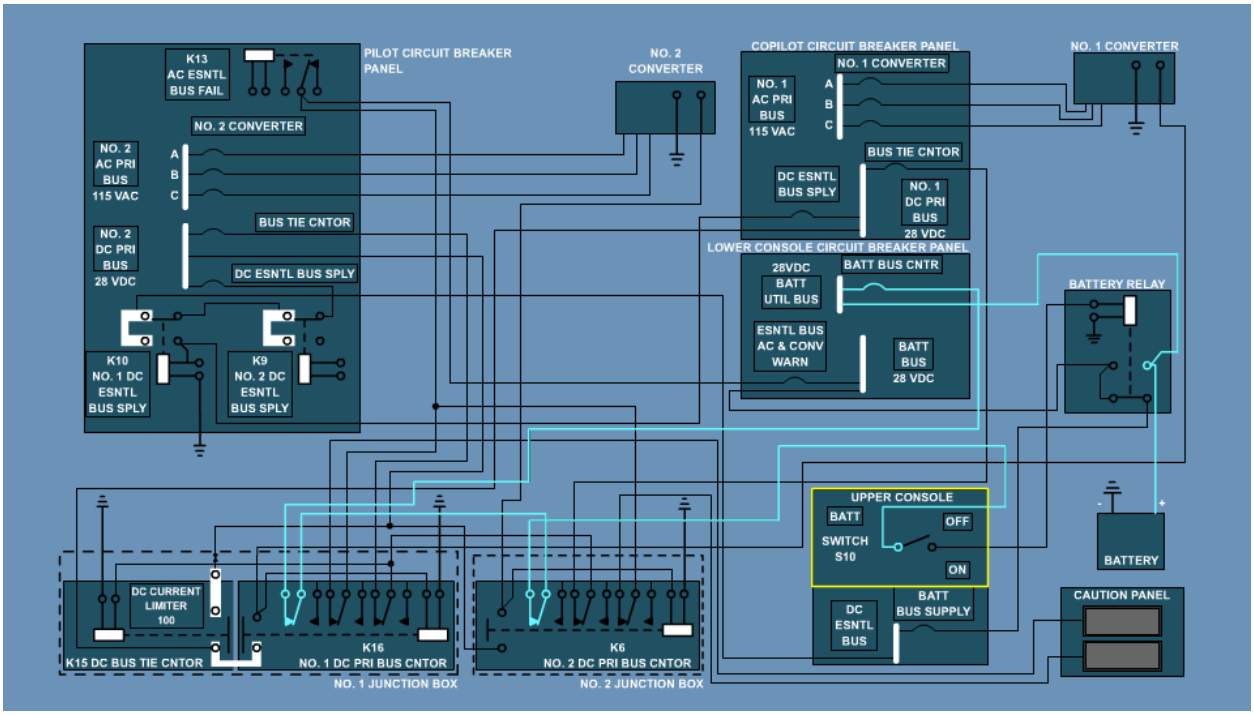
5) DC power is applied to the Battery Bus through the energized contacts of the battery relay (K7).

6) DC power from the battery bus is applied through the ESNTL DC SPLY circuit breaker to the contacts of relay K9.

7) DC power from the battery conditioner/analyzer is applied to the No. 2 DC Essential bus supply relay K9. Dc power then flows through the energized contacts of relay K9, and the normally closed contacts of No. 1 dc essential bus supply relay K10, to supply the dc essential bus.

(b) Converter Operation

Frame #4010 (Converter Operation FLASH)



1) Prior to the application of 115 V ac, the Battery switch is placed to the ON position, which allows 28 V dc from the battery through the energized contacts of the Battery relay (K7).

2) This allows 28 V dc to the Battery Bus. Power then flows through the de-energized contacts of the No. 1 and No. 2 DC Primary Control Contactors (K16, K6) from the No. 2 Essential AC and Converter Warning Circuit Breaker, turning on the Caution/Advisory Panel converter capsules.

3) The No. 1 and No. 2 converters receive three-phase ac power from the No. 1 and No. 2 ac primary buses.

4) With both converters operating normally, the No. 1 converter supplies the No. 1 dc primary bus and the No. 2 converter supplies the No. 2 dc primary bus.

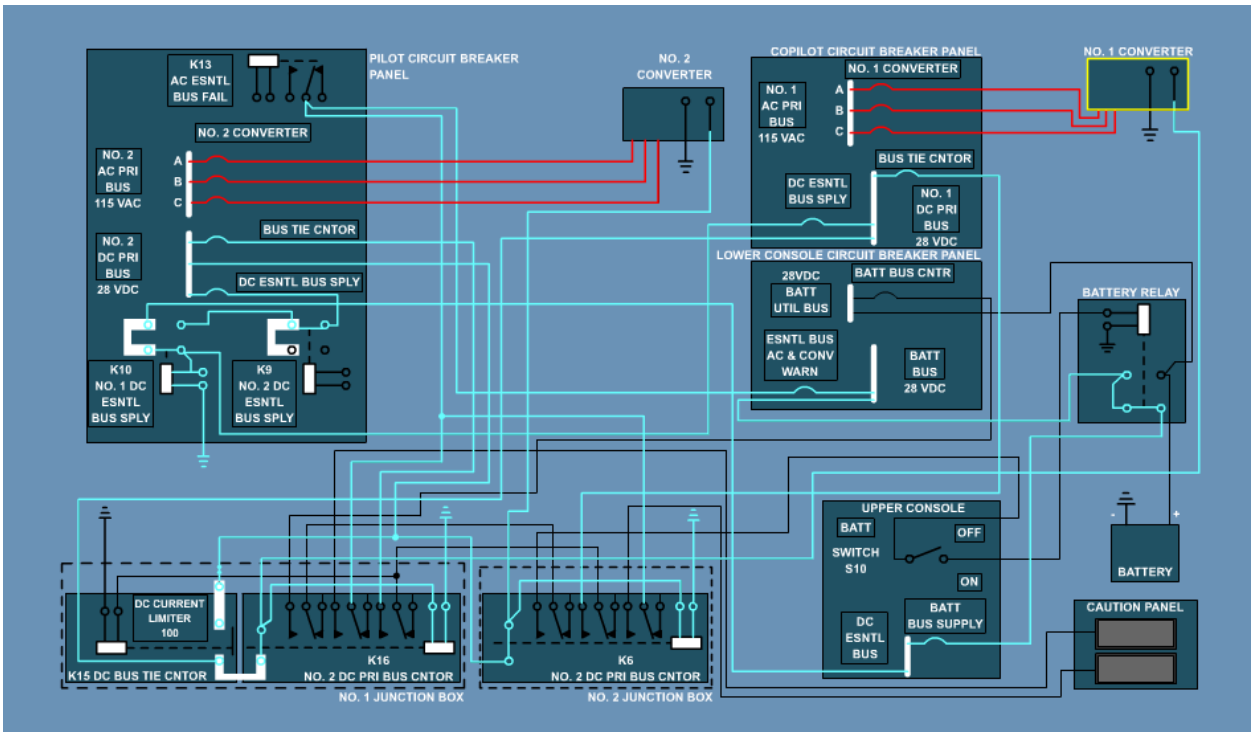
5) The dc output of the No. 1 (or No. 2, as applicable) converter energizes No. 1 (or No. 2) dc primary bus contactor K16 (or K6) and is applied through the energized main contacts of contactor K16 (or K6) to supply the No. 1 (or No. 2) dc primary bus.

6) DC power from the No. 1 dc primary bus, through the DC ESNTL BUS SPLY circuit breaker, energizes No. 1 dc essential bus supply relay K10 and is applied through the energized contacts of relay K10 to supply the dc essential bus.

7) The dc essential bus supplies dc power, through the BATT BUS SPLY circuit breaker and the normally closed contacts of battery relay K7, to the battery bus.

(c) NO. 1 Converter Fail

Frame #4015 (NO. 1 Converter Fail FLASH)



1) If the No. 1 converter fails and its output drops to zero, No. 1 dc primary bus contactor K16 de-energizes.

2) DC power from the No. 2 DC Primary Bus flows through the normally closed contacts of No. 2 DC Essential Bus Supply Relay (K9) and the No. 1 DC Essential Bus Supply Relay (K10).

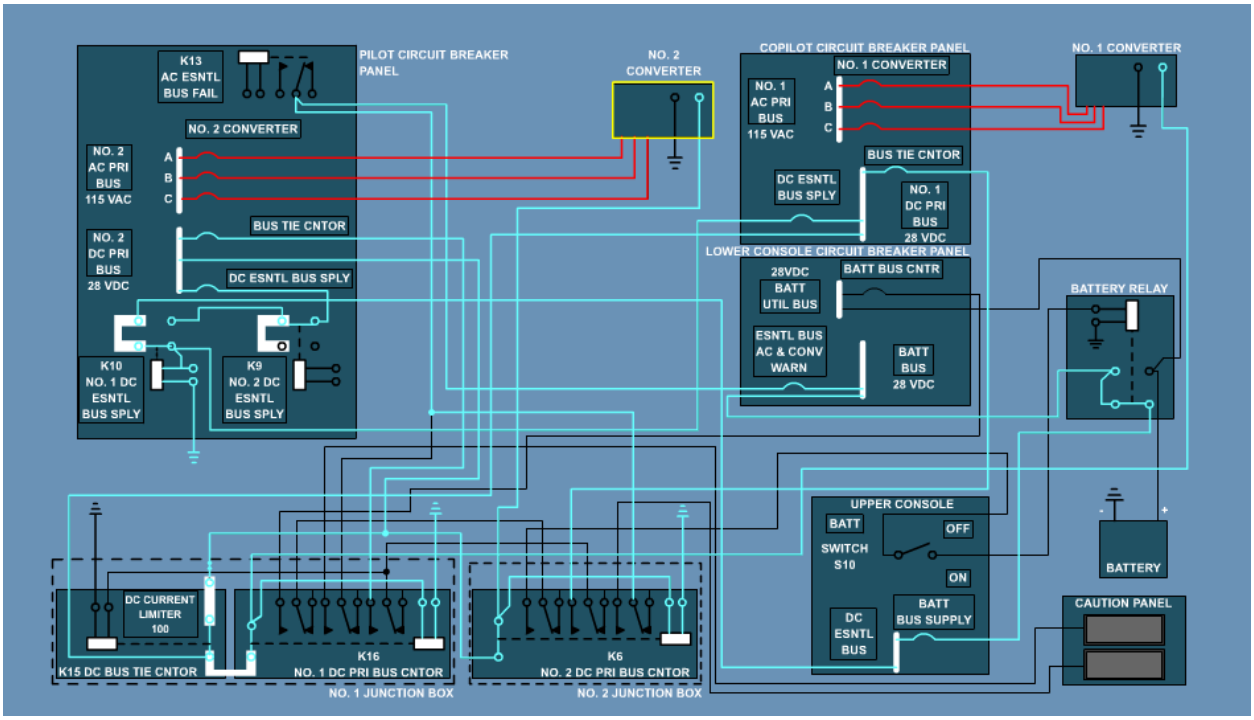
3) It is then applied through the ESNTL BUS AC & CONV WARN circuit breaker and normally closed auxiliary contacts of contactor K16 to light the caution/advisory panel #1 CONV capsule.

4) DC power from the No. 2 dc primary bus is applied through the normally closed auxiliary contacts of contactor K16 to energize dc bus tie contactor K15.

5) With contactor K15 energized, dc power from the No. 2 dc primary bus is applied through the 100 amp current limiter to supply the No. 1 dc primary bus.

(d) NO. 2 Converter Fail

Frame #4020 (NO. 2 Converter Fail FLASH)



1) If the No. 2 converter fails and its output drops to zero, No. 2 dc primary bus contactor (K6) de-energizes.

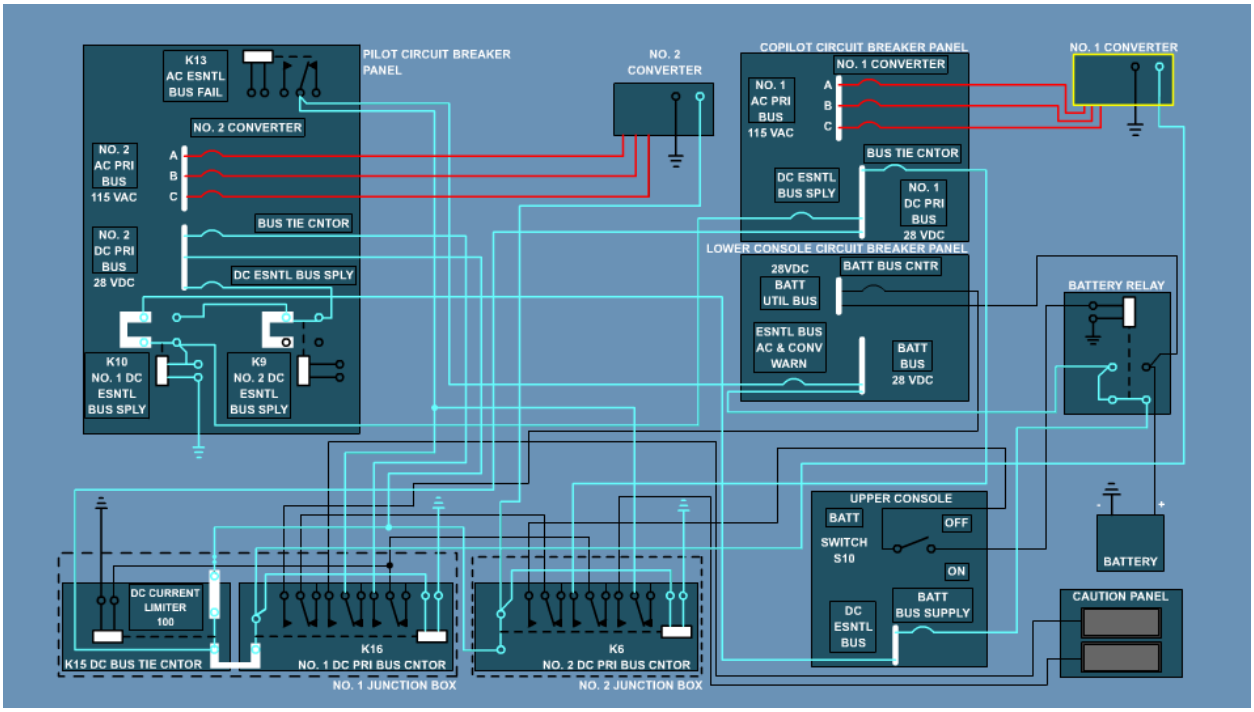
2) DC power from the battery bus is applied through the ESNTL BUS AC & CONV WARN circuit breaker and normally closed auxiliary contacts of contactor K6 to light the caution/advisory panel #2 CONV capsule.

3) DC power from the No. 1 dc primary bus is applied through the BUS TIE CNTOR circuit breaker and normally closed auxiliary contacts of contactor K6 to energize dc bus tie contactor K15.

4) With contactor K15 energized, dc power from the No. 1 dc primary bus is applied through the 100 amp current limiter to supply the No. 2 dc primary bus.

(e) NO. 1 Converter and 100 AMP Current Limiter Fail

Frame #4025 (NO. 1 Converter and 100 AMP Current Limiter Fail FLASH)



1) If a short circuit causes the No. 1 converter to be disabled and the 100 amp current limiter (CL7) to open, all power is lost on the No. 1 dc primary bus.

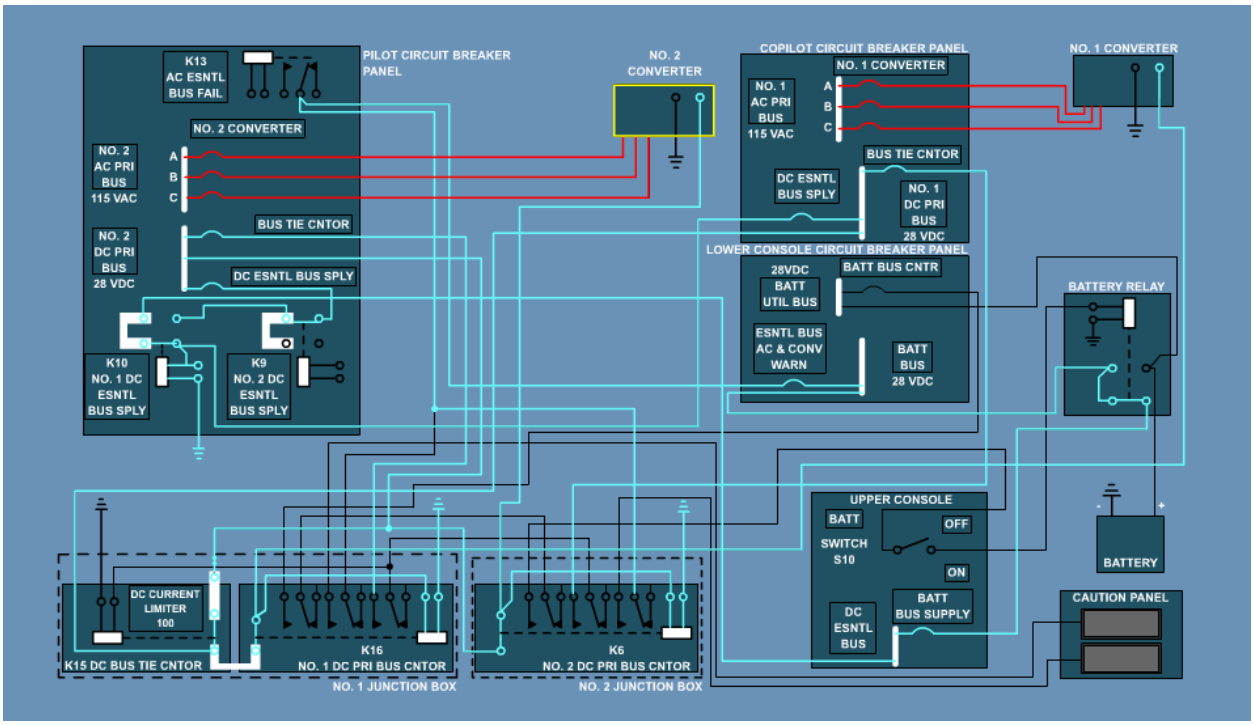
2) If this occurs, No. 1 dc essential bus supply relay (K10) de-energizes.

3) DC power from the No. 2 dc primary bus is applied through the DC ESNTL BUS SPLY circuit breaker and normally closed contacts of relay K10 to supply the dc essential bus.

4) This allows the power to illuminate the NO. 1 CONVERTER capsule on the Caution/Advisory panel.

(f) NO. 2 Converter and 100 AMP Current Limiter Fail

Frame #4030 (NO. 2 Converter and 100 AMP Current Limiter Fail FLASH)



1) If a short circuit causes the No. 2 converter to be disabled and the 100 amp current limiter (CL7) to open, all power is lost on the No. 2 dc primary bus.

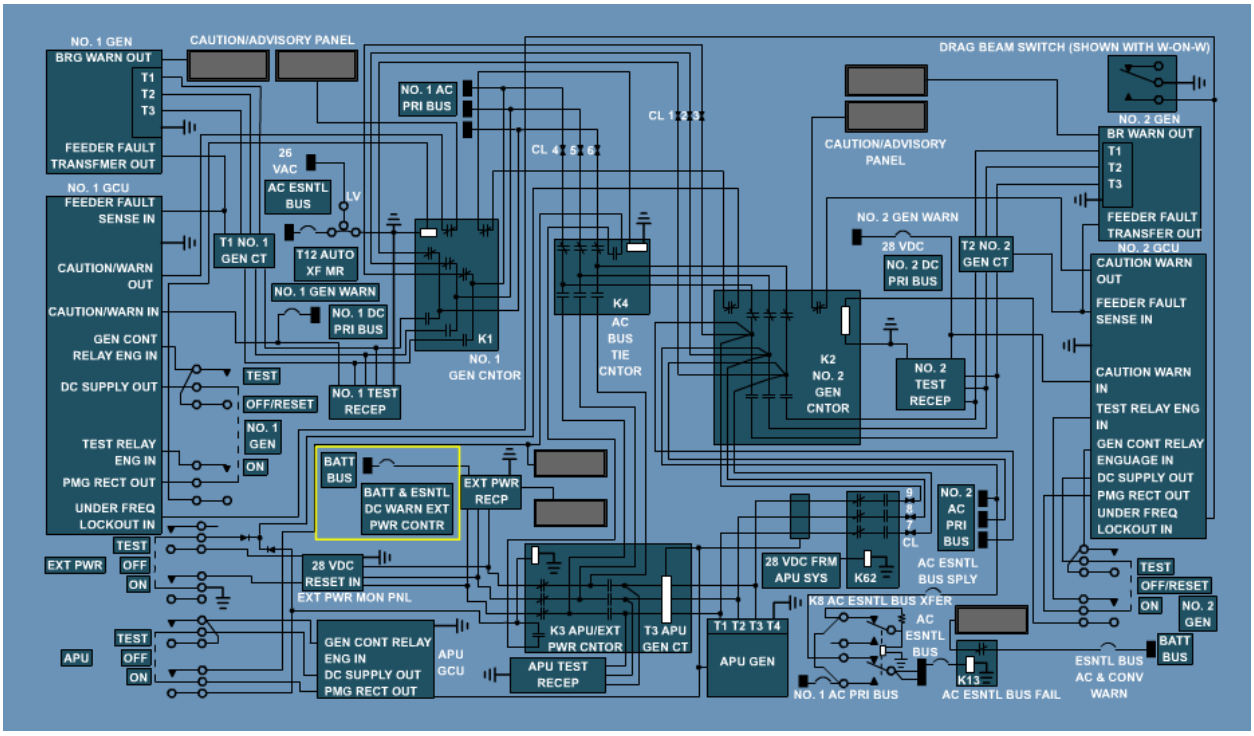
2) DC power from the No. 1 dc primary bus is applied through the DC ESNTL BUS SPLY circuit breaker and energized contacts of relay K10 to supply the dc essential bus.

3) This allows the power to illuminate the NO. 2 CONVERTER capsule on the Caution/Advisory panel.

(2) AC Schematics

(a) External Power Operation

Frame #4035 (External Power Operation FLASH)



1) With the No. 1, No. 2, and APU generators off, an external power source can be connected to supply all ac buses a source of 115 Vac, three-phase power through the external power receptacle.

2) With a battery installed in the helicopter and the BATTERY switch ON, the battery supplies power to the battery bus.

3) DC voltage from the battery bus is applied through the power receptacle and jumpered pins in the external power cart plug to light the caution/advisory panel EXT PWR (External Power) CONNECTED capsule.

4) When you place the EXTERNAL POWER switch ON, the dc voltage is applied through a blocking diode and the normally closed auxiliary contacts of contactors K2 and K1, to energize ac bus tie contactor (K4).

5) The blocking diode prevents 28 V dc from being applied to the EXT PWR switch when the APU generator is on.

6) The three-phase ac power is applied from the external power receptacle through the normally closed main contacts of contactor K3, the energized main contact of contactor K4, and the normally closed main contacts of contactor K2, to supply the No. 2 ac primary bus.

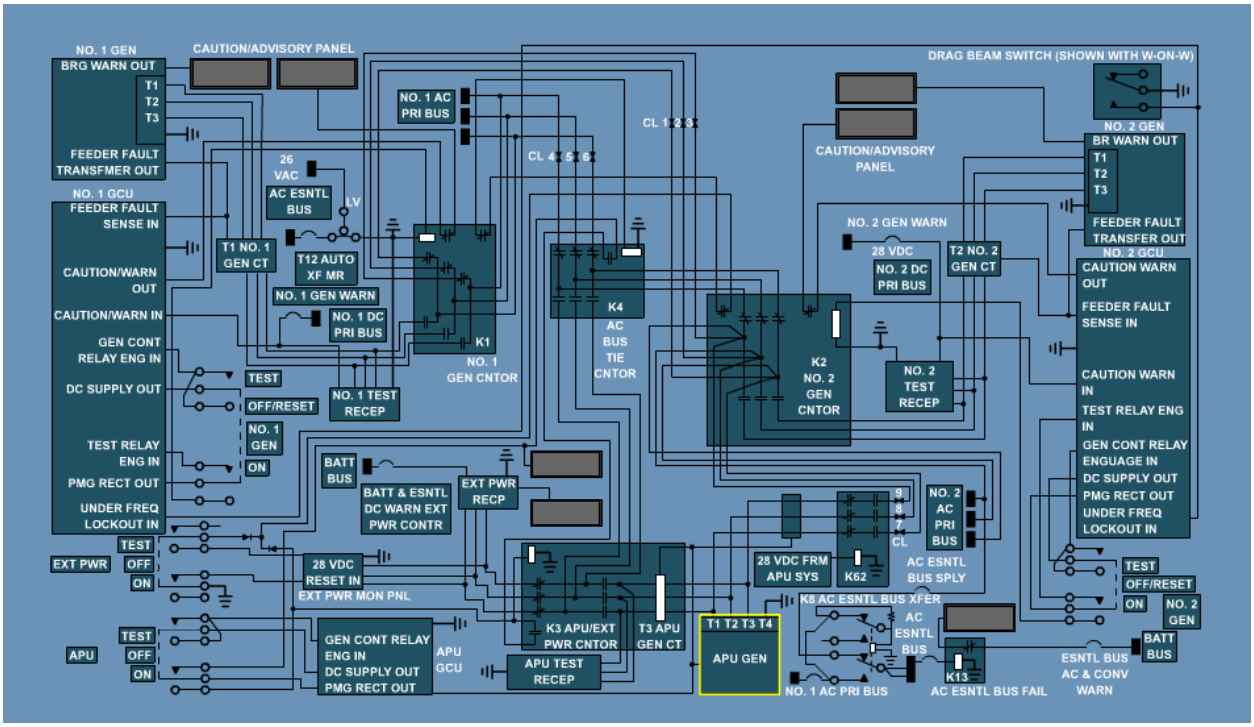
7) The No. 1 ac primary bus is supplied through current limiters. CL1, CL2, CL3, and the normally closed main contacts of contactor K1.

8) The No. 1 ac primary bus supplies 115 Vac, B phase power, through the AC ESSENTIAL BUS SUPPLY circuit breaker, to the coil and contacts of ac essential bus XFR relay (K8).

9) With relay K8 energized, and 115 Vac, B phase power is supplied to the ac essential bus, the ac essential bus applies 115 Vac, B phase power to an autotransformer (T12) that supplies 26 V ac to navigation instrument loads.

(b) APU Operation

Frame #4040 (APU Operation FLASH)



1) Auxiliary ac power is supplied by the APU generator.

2) When the No. 1 and No. 2 ac generators are off and the APU generator output is acceptable, the dc voltage from the APU generator control unit is applied to the control switch to energize the APU/external power contactor (K3) solenoid.

3) With the APU GENERATOR switch to TEST, APU/external power contactor (K3) remains de-energized and the APU generator output is applied only to the test receptacle.

4) The dc voltage from the Generator Control Unit (GCU) Permanent Magnet Generator (PMG) rectifier is applied through the TEST position of the switch to light the caution/advisory panel APU GEN (Generator) ON capsule.

5) With the No. 1 and No. 2 generators OFF and the APU generator operating at its rated value, APU/external power contactor (K3) is energized.

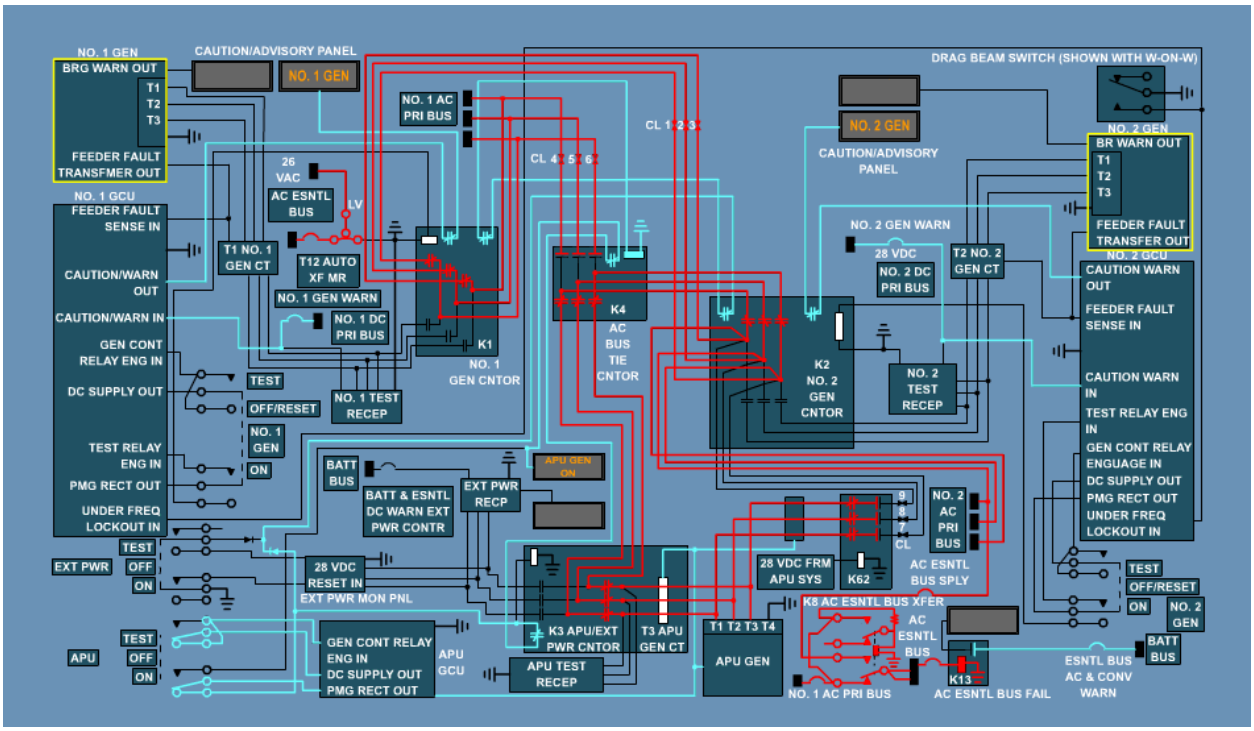
6) DC voltage is applied through a blocking diode and the normally closed auxiliary contacts of No. 2 and No. 1 generator contactors (K2 and K1), to energize ac bus tie contactor (K4).

7) The three-phase ac output of the APU generator is applied through the energized main contacts of contactors K3 and K4, and the normally closed main contacts of contactor K2, to supply the No. 2 ac primary bus.

8) The No. 1 ac primary bus is supplied through current limiters (CL1,2,3) and the normally closed main contacts of contactor K1.

(c) NO. 1 and NO. 2 Generator Operation

Frame #4045 (NO. 1 and NO. 2 Generator Operation FLASH)



1) With the left and right accessory gearbox modules driving the generators at rated speed, each generator's 12-pole permanent magnet generator (PMG) applies three-phase ac voltage to the PMG rectifier in the generator control unit (GCU).

2) The PMG rectifier rectifies and filters the ac voltage and applies a dc voltage to the No. 1 and No. 2 GENERATOR switches and to a regulated dc power supply that supplies the GCU sensing circuits.

3) When either generator control switch is placed ON, dc voltage from the PMG rectifier is applied through the contacts of No. 2 and No. 1 GENERATORS switches to energize No. 2 and No. 1 generator contactors (K2 and K1), respectively.

4) With the generators operating at rated value, the three-phase ac output of the No. 2 and No.1 generator is applied to the test receptacles for monitoring, and through the energized main contacts of K1 and K2 to supply the No. 1 and No. 2 ac primary bus.

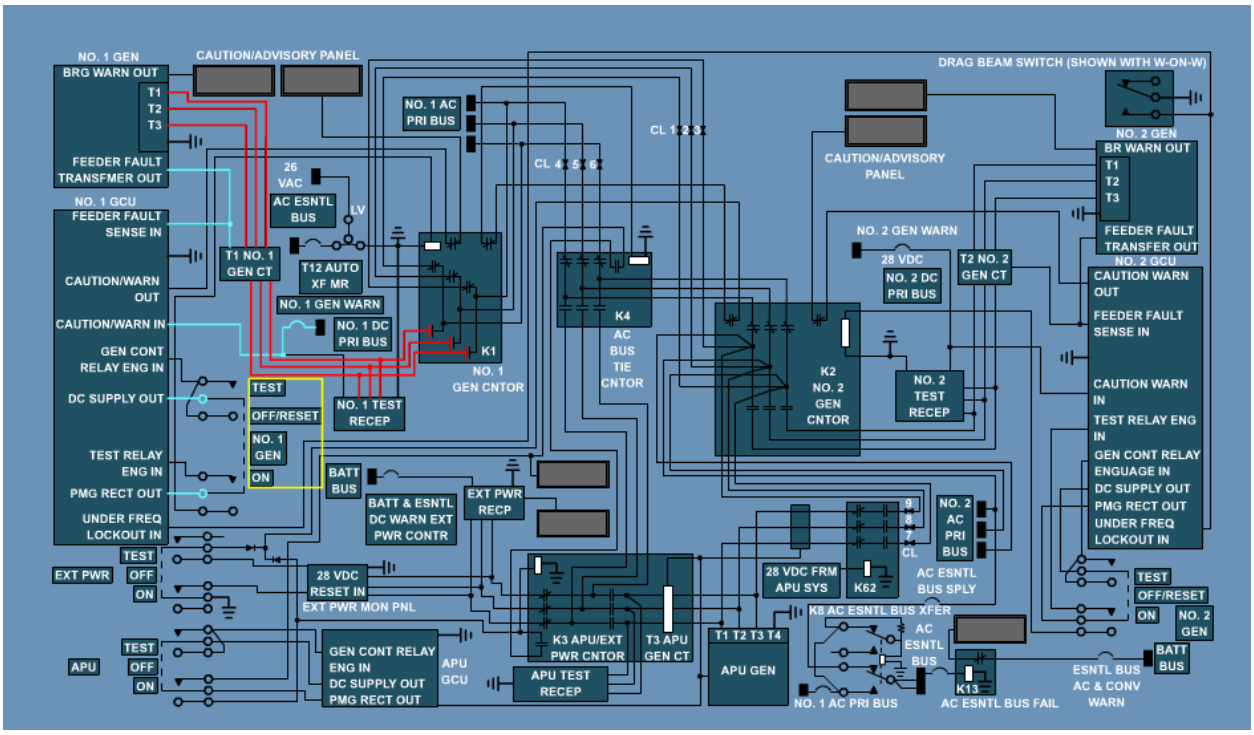
5) The No. 1 ac primary bus supplies 115 V ac, B phase power, through the AC ESNTL BUS SPLY circuit breaker, to the coil and contacts of ac essential bus XFR relay (K8).

6) With relay K8 energized, the 115 V ac, B phase power is supplied to the ac essential bus.

7) The ac essential bus applies 115 V ac, B phase power to an auto navigation instrument loads.

(d) NO. 1 Generator in Test Position

Frame #4050 (NO. 1 Generator in Test Position FLASH)



1) When the generator control switch is placed to TEST, system operation is the same as for the ON position, except that generator contactor (K1) remains de-energized.

2) Power from the GCU flows through the normally closed contacts of K1 to illuminate the No. 1 Generator capsule on the Caution/Advisory Panel.

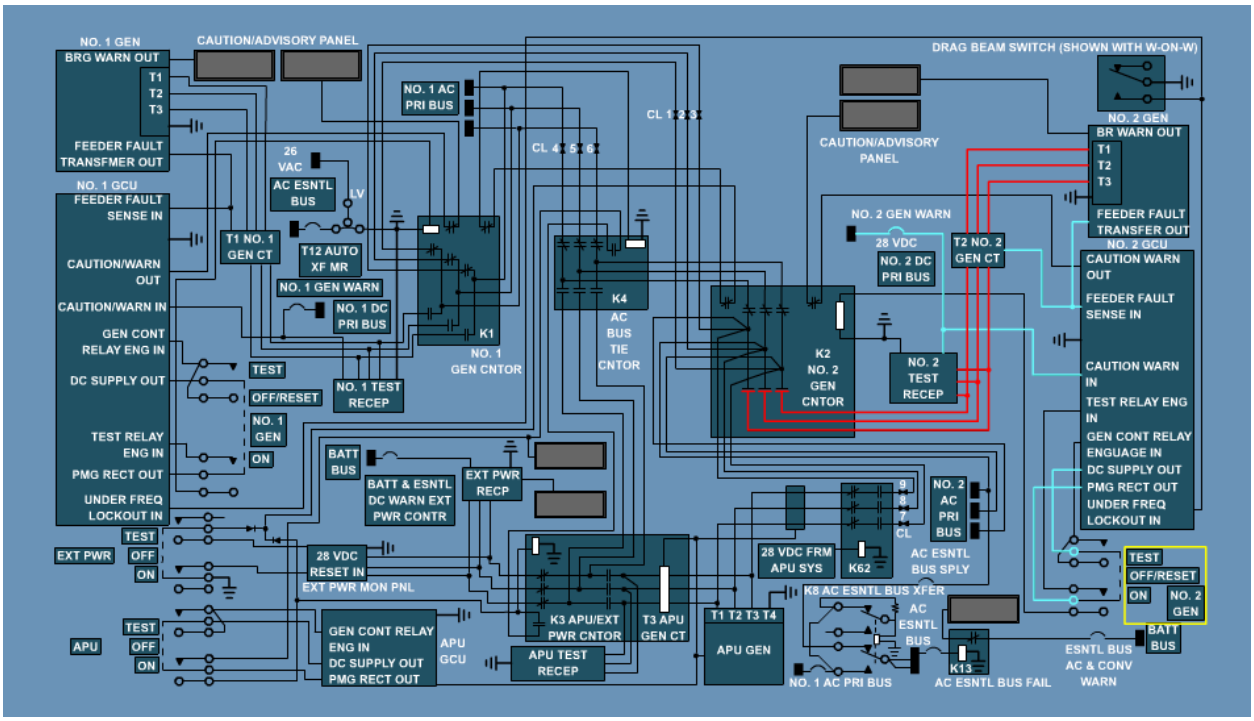
3) The GCU test relay, which is located inside the GCU, is energized.

4) With the GCU test relay energized, its contacts open and the caution/advisory panel GEN capsules go off.

5) The generator outputs are not applied to the ac buses, but are applied to the test receptacles for monitoring.

(e) NO. 2 Generator in Test Position

Frame #4055 (NO. 2 Generator in Test Position FLASH)



1) When the generator control switch is placed to TEST, system operation is the same as for the ON position, except that generator contactor (K2) remains de-energized.

2) Power from the GCU flows through the normally closed contacts of K2 and illuminates the No. 2 Generator capsule on the Caution/Advisory Panel.

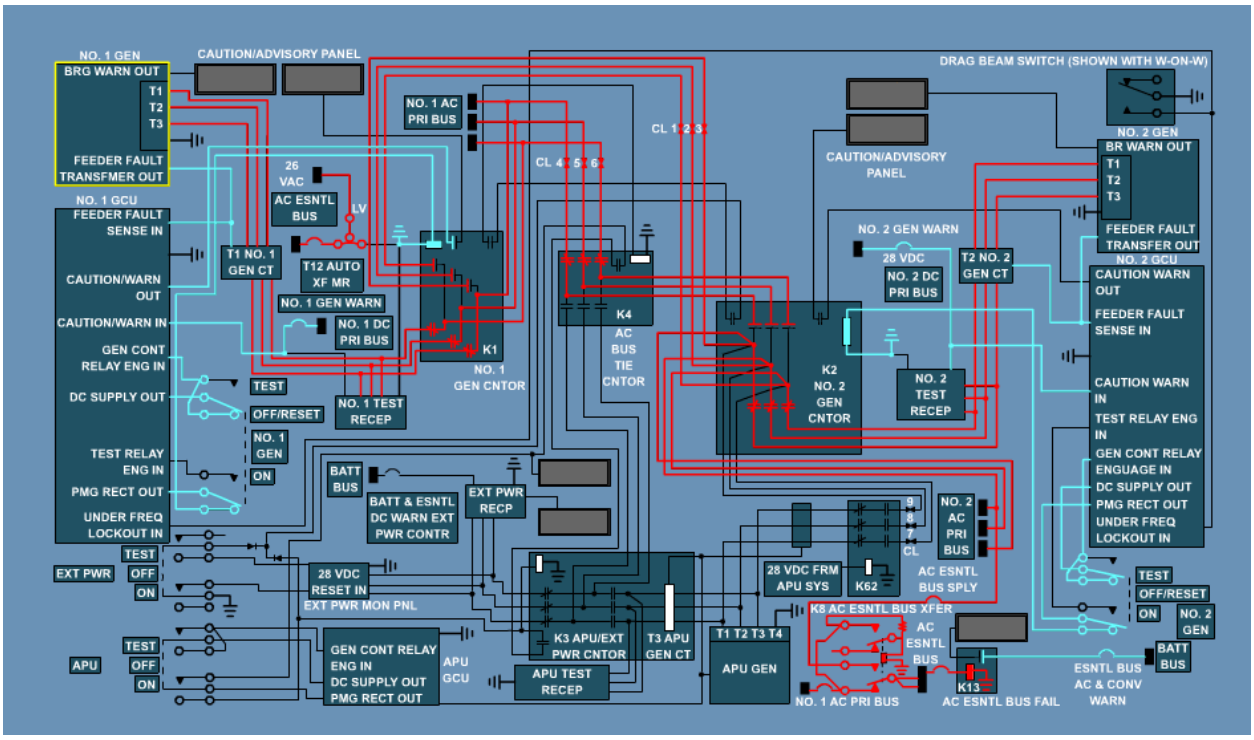
3) The GCU test relay, which is located inside the GCU, is energized.

4) With the GCU test relay energized, its contacts open and the caution/advisory panel GEN capsules go off.

5) The generator outputs are not applied to the ac buses, but are applied to the test receptacles for monitoring.

(f) NO. 1 Generator Failure

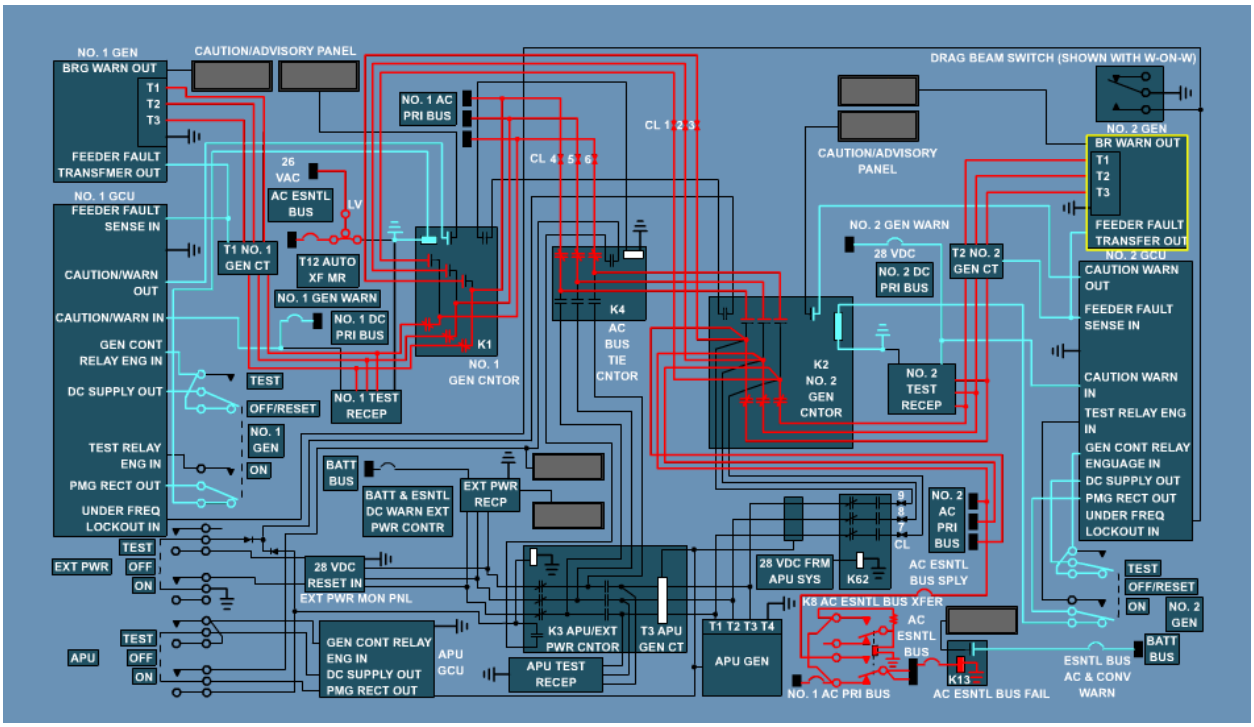
Frame #4060 (NO. 1 Generator Failure FLASH)



1) If the No. 1 generator fails, the No. 2 generator supplies the No. 1 ac primary bus through current limiters (CL1,2,3) and the normally closed main contacts of No. 1 generator contactor (K1).

(g) NO. 2 Generator Failure

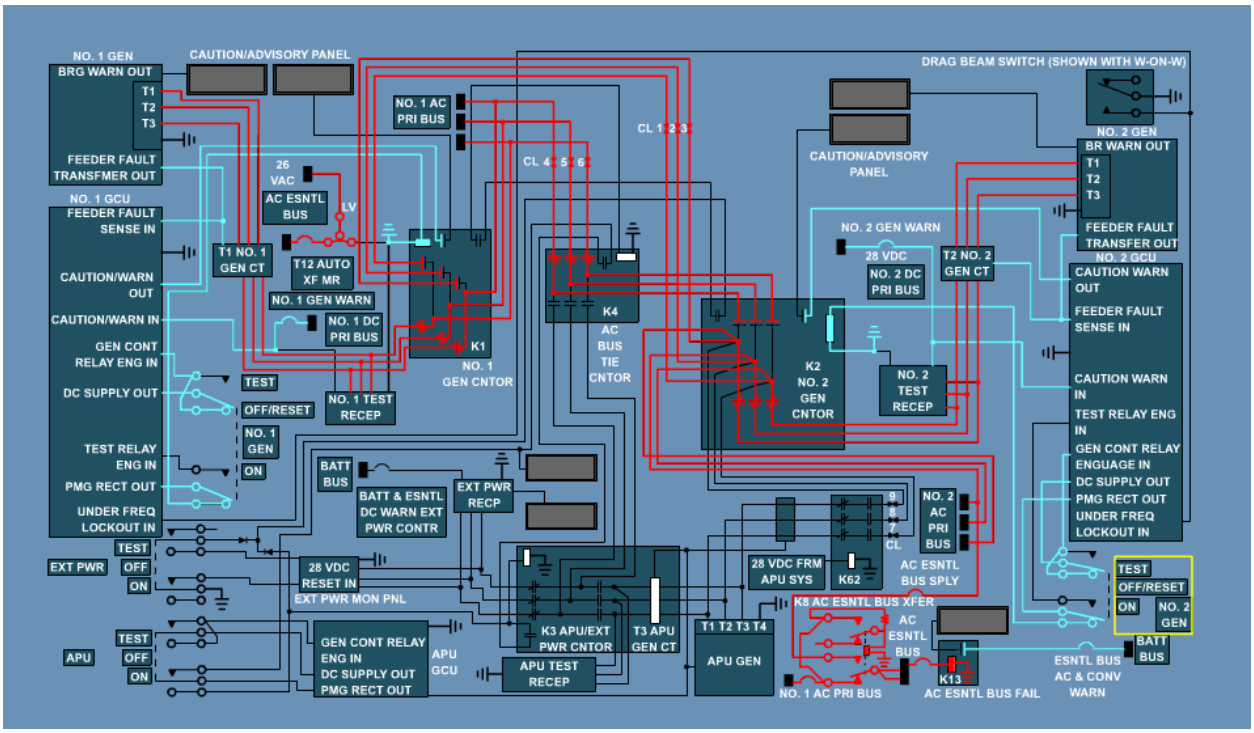
Frame #4065 (NO. 2 Generator Failure FLASH)



1) If the No. 2 generator fails, the No. 1 generator supplies the No. 2 ac primary bus through current limiters (CL4,5,6) and the normally closed main contacts of ac bus tie contactor (K4) and No. 2 generator contactor (K2).

(h) NO. 1 GEN SW ON, NO. 2 GEN SW OFF, and CL 4,5,6 Fail

Frame #4070 (NO. 1 GEN SW ON, NO. 2 GEN SW OFF, and CL 4,5,6 Fail FLASH)



1) With No. 2 GENERATORS switch OFF, the No. 2 generator output does not build up.

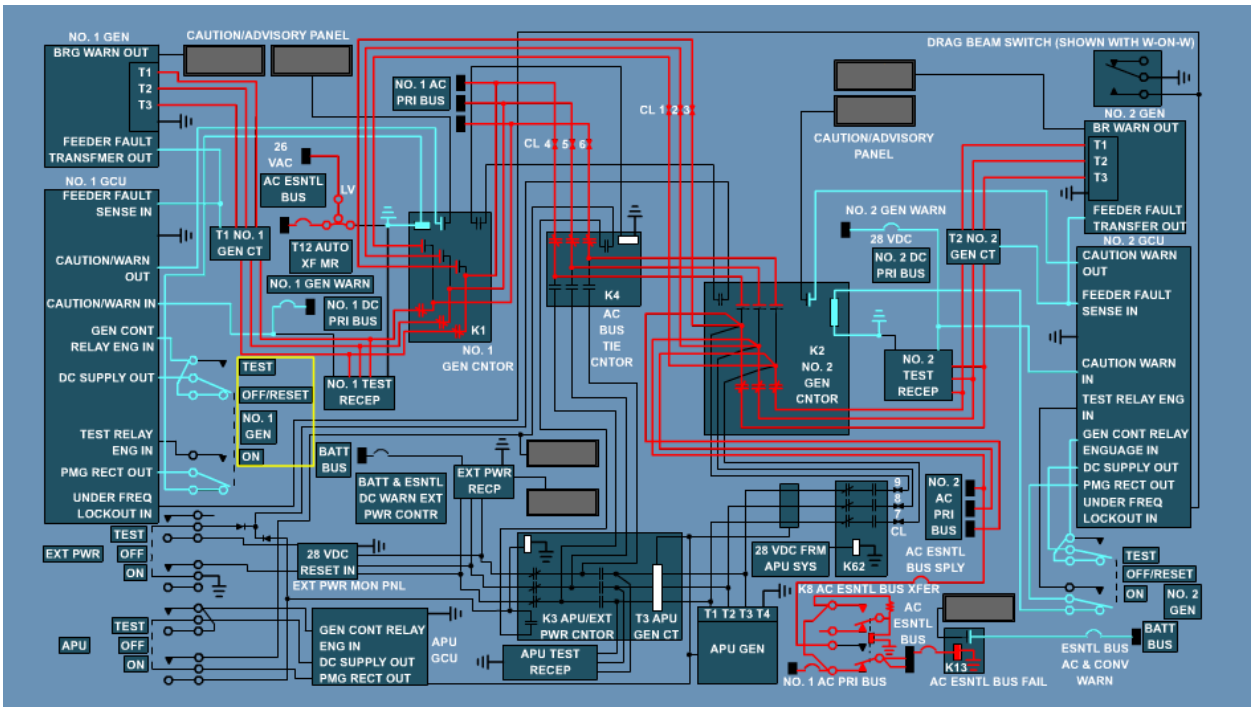
2) No. 2 generator contactor (K2) is de-energized, the path between the No. 2 dc primary bus and the caution/advisory panel #2 GEN capsule is closed through normally closed auxiliary contacts of K2, and the capsule is on.

3) The three-phase output of the No. 1 generator is applied from the No. 1 ac primary bus, through current limiters CL4, 5, and 6, and through the normally closed main contacts of ac bus tie contactor (K4) and No. 2 generator contactor (K2), to supply the No. 2 ac primary bus.

4) With the failure of the current limiters 4,5, and 6, voltage is unable to flow from the No. 1 AC Primary Bus to supply the No. 2 AC Primary Bus.

(i) NO. 2 GEN SW ON, NO. 1 GEN SW OFF, with CL 1,2,3 Fail

Frame #4075 (NO. 2 GEN SW ON, NO. 1 GEN SW OFF, with CL 1,2,3 Fail FLASH)



1) With the No. 1 GENERATOR switch OFF, the No. 1 generator output does not build up.

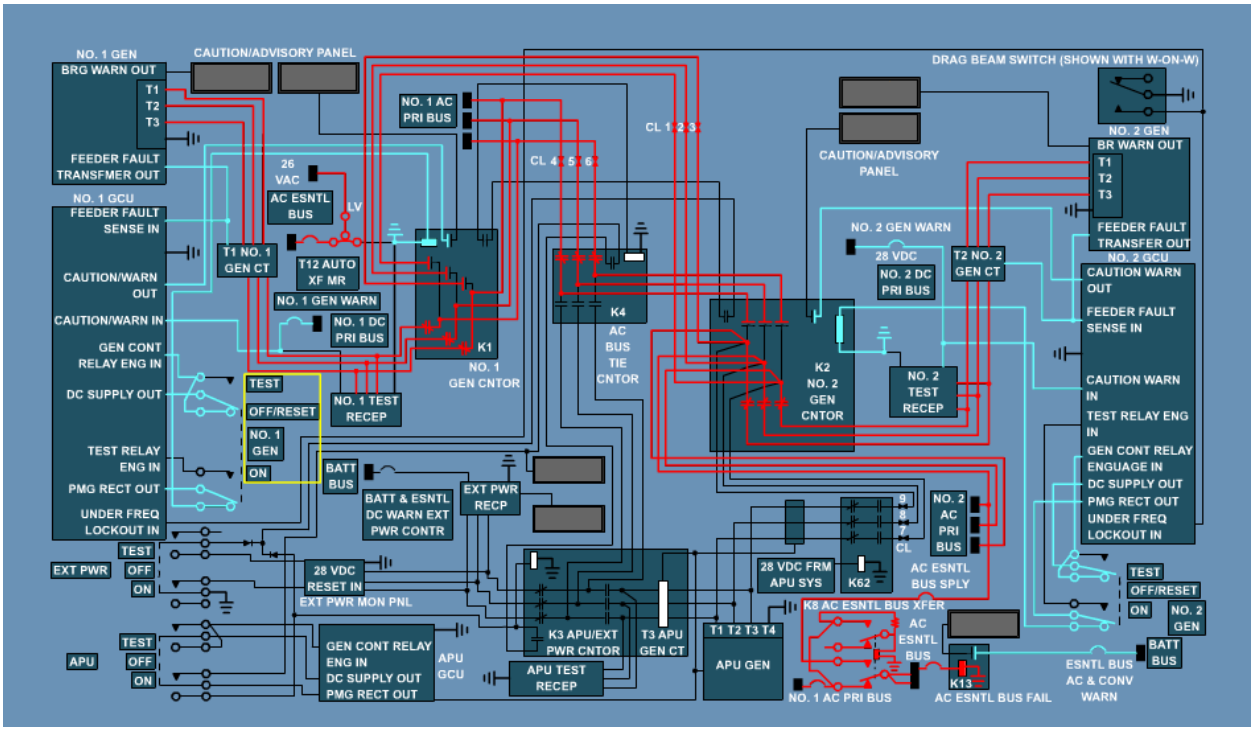
2) The No. 1 generator contactor (K1) is de-energized, and voltage flows through the normally closed auxiliary contacts of K1 to illuminate the No. 1 GEN capsule on the caution/advisory panel.

3) The three-phase output of the No. 2 generator is applied from the No. 2 ac primary bus, through current limiters CL1, 2, and 3, and through the normally closed main contacts of the No. 1 generator contactor (K1), to supply the No. 1 ac primary bus.

4) With the failure of the current limiters 1, 2, and 3, voltage is unable to flow from the No. 2 AC Primary Bus to supply the No. 1 AC Primary Bus.

(j) NO. 2 GEN SW ON, NO. 1 GEN SW OFF, and Current Limiters 1 and 3 Fail.

Frame #4080 (NO. 2 GEN SW ON, NO. 1 GEN SW OFF, CL 1 and 3 Fail. FLASH)



1) With No. 1 GENERATORS switch OFF, the No. 1 generator output does not build up.

2) The No. 1 generator contactor (K1) is de-energized, and voltage flows through the normally closed auxiliary contacts of K1 to illuminate the No. 1 GEN capsule on the caution/advisory panel.

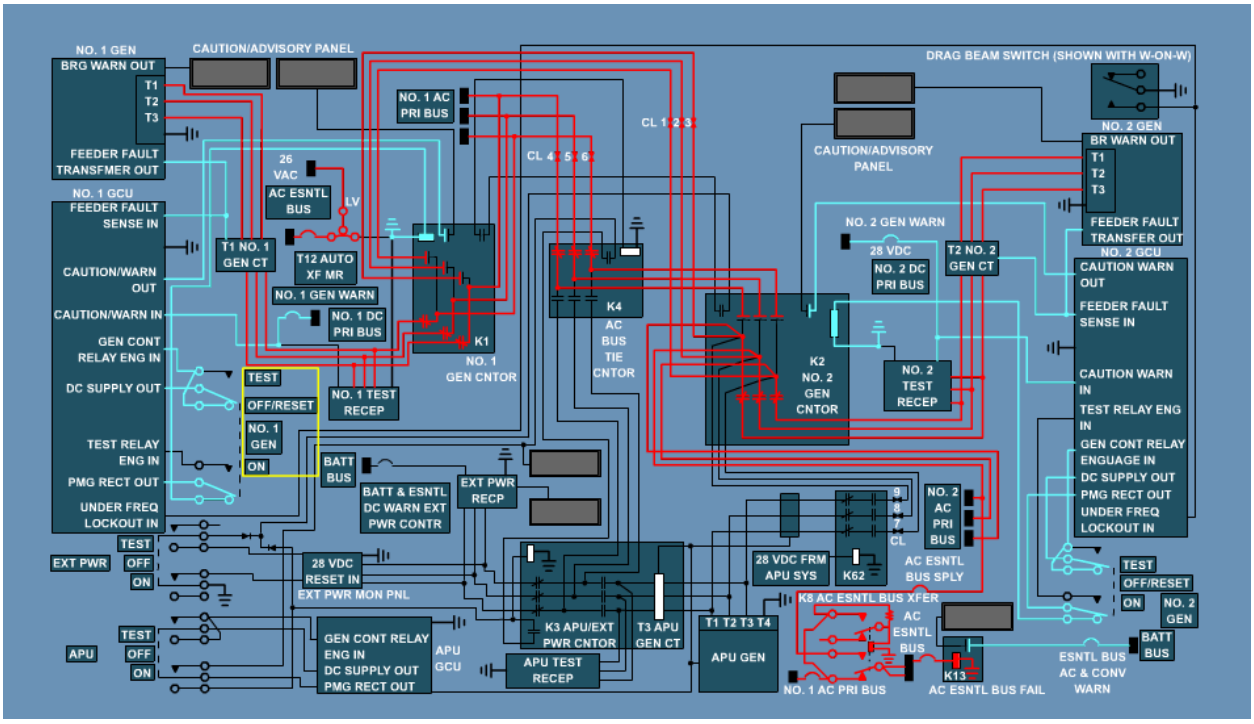
3) The three-phase output of the No. 2 generator is applied from the No. 2 ac primary bus, through current limiters CL 1, 2, and 3, and through the normally closed main contacts of K1, to supply the No. 1 ac primary bus.

4) If a failure of the current limiters 1 and 3 occurs, voltage is unable to flow from the No. 2 AC Primary Bus to supply the No. 1 AC Primary Bus.

5) Power for the AC Essential Bus will not be affected.

(k) NO. 2 GEN SW ON, NO. 1 GEN SW OFF, and Current Limiter 2 Fail

Frame #4085 (NO. 2 GEN SW ON, NO. 1 GEN SW OFF, CL 2 Fail FLASH)



1) With No. 1 GENERATORS switch OFF, the No. 1 generator output does not build up.

2) The No. 1 generator contactor (K1) is de-energized, and voltage flows through the normally closed auxiliary contacts of K1, to illuminate the No. 1 GEN capsule on the caution/advisory panel.

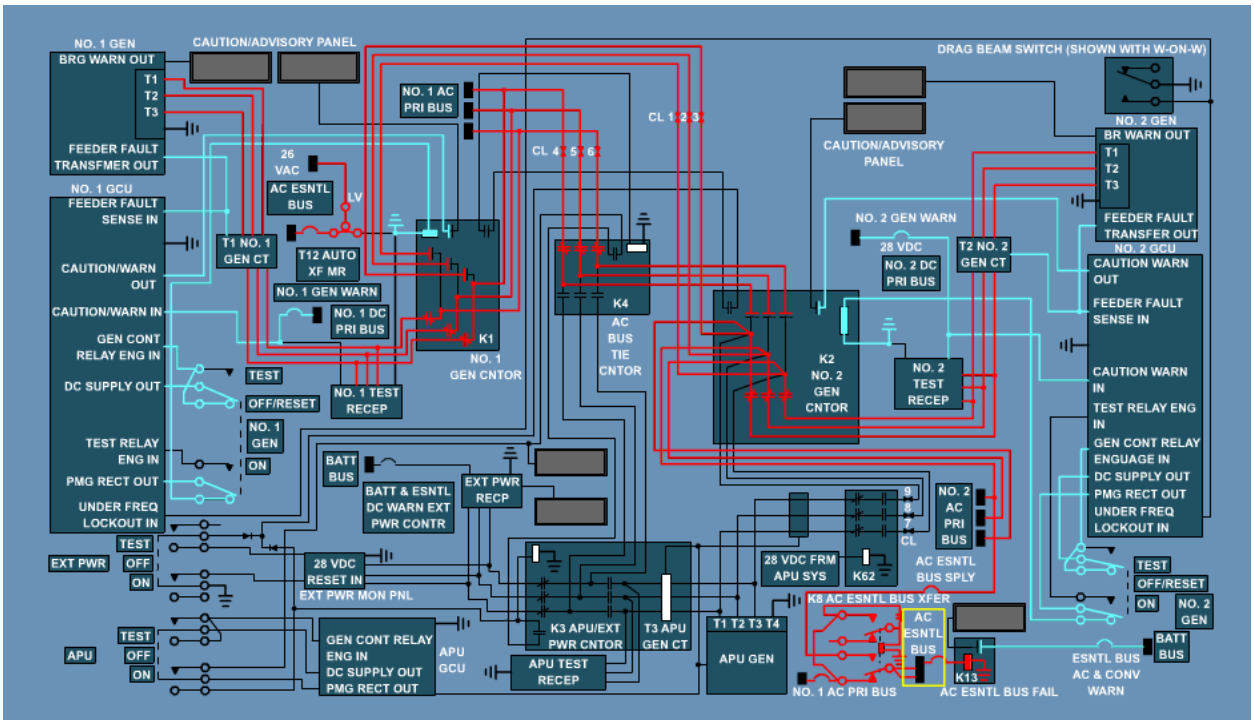
3) The three-phase output of the No. 2 generator is applied from the No. 2 ac primary bus, through current limiters CL 1, 2, and 3, and through the normally closed main contacts of K1, to supply the No. 1 ac primary bus.

4) If a failure of current limiter 2 occurs, voltage is unable to flow from the No. 2 AC Primary Bus to supply the No. 1 AC Primary Bus.

5) Power for the AC Essential bus will be supplied from phase B of the No. 2 AC Primary Bus, through the de-energized contacts of the AC Essential Bus Transfer relay (K8).

(l) AC Essential Bus Failure

Frame #4090 (AC Essential Bus Failure FLASH)



1) If a failure occurs to the ac essential bus, the AC ESS BUS OFF capsule on the caution/advisory panel will light.

2) Also, voltage will be removed from the 26 V ac bus.

CHECK ON LEARNING

1. What component provides Primary DC voltage if the No. 1 converter fails?

2. What component provides Primary AC voltage for the No. 1 AC buses if the No. 1 Generator fails?

3. What bus will be affected if there is a failure to the AC Essential Bus?

4. What provides power to the ac essential bus if CL 2 fails, with No. 2 generator switch on, No. 1 generator switch off?

5. What component allows the No. 1 generator capsule to go off, with the No. 1 generator switch placed in the test position, after the test is complete?

SECTION VI. -SUMMARY

1. REVIEW/SUMMARIZE:

You have completed the UH-60 electrical system using system schematics topic. Key points to remember are:

- The battery always supplies the battery utility bus. The battery analyzer/conditioner continuously monitors battery voltage and temperature condition and contains a charging circuit for battery charging.
- The No. 1 and No. 2 converters receive three-phase ac power from the No. 1 and No. 2 ac primary buses. With both converters operating normally, the No. 1 converter supplies the No. 1 dc primary bus and the No. 2 converter supplies the No. 2 dc primary bus.
- If the No. 1 converter fails and its output drops to zero, No. 1 dc primary bus contactor (K16) de-energizes. DC power from the No. 2 dc primary bus is applied through the normally closed auxiliary contacts of contactor K16 to energize dc bus tie contactor (K15). With contactor K15 energized, dc power from the No. 2 dc primary bus is applied through the 100 amp current limiter to supply the No. 1 dc primary bus.
- The three-phase ac power is applied from the external power receptacle through the normally closed main contacts of contactor K3, the energized main contact of contactor K4, and the normally closed main contacts of contactor K2 to supply the No. 2 ac primary bus. The No. 1 ac primary bus is supplied through current limiters. CL1, CL2, and CL3 and the normally closed main contacts of contactor K1. The No. 1 ac primary bus supplies 115 V ac, B phase power, through the AC ESNTL BUS SPLY circuit breaker, to the coil and contacts of ac essential bus XFR relay K8. With relay K8 energized, and 115 V ac, B phase power is supplied to the ac essential bus. The ac essential bus applies 115 V ac, B phase power to an autotransformer that supplies 26 V ac to navigation instrument loads.
- With the No. 1 and No. 2 generators OFF and the APU generator operating at its rated value, APU/external power contactor (K3) is energized. DC voltage is applied through a blocking diode and the normally closed auxiliary contacts of No. 2 and No. 1 generator contactors (K2 and K1), to energize ac bus tie contactor (K4). The three-phase ac output of the APU generator is applied through the energized main contacts of contactors K3 and K4, and the normally closed main contacts of contactor K2, to supply the No. 2 ac primary bus. The No. 1 ac primary bus is supplied through current limiters and the normally closed main contacts of contactor K1.
- When the generator control switch is placed to TEST, system operation is the same as for the ON position, except that generator contactor K1 remain de-energized. Power from the GCU flows through the normally closed contacts of K1, to illuminate the No. 1 Generator capsule on the Caution/Advisory Panel. The GCU test relay, which is located inside the GCU, is energized. With the GCU test relay energized, its contacts open and the caution/advisory panel GEN capsules go off. The generator outputs are not applied to the ac buses, but are applied to the test receptacles for monitoring.
- If the No. 1 generator fails, the No. 2 generator supplies the No. 1 ac primary bus through current limiters and the normally closed main contacts of No. 1 generator contactor (K1).

- With No. 1 GENERATORS switch OFF, the No. 1 generator output does not build up. The No. 1 generator contactor (K1) is de-energized, and voltage flows through the normally closed auxiliary contacts of K1 to illuminate the No. 1 GEN capsule on the caution/advisory panel. The three-phase output of the No. 2 generator is applied from the No. 2 ac primary bus, through current limiters CL1, 2, and 3, and through the normally closed main contacts of the No. 1 generator contactor (K1), to supply the No. 1 ac primary bus. With the failure of the current limiters 1, 2, and 3, voltage is unable to flow from the No. 2 AC Primary Bus to supply the No. 1 AC Primary Bus.
- If a failure occurs to the ac essential bus, the AC ESS BUS OFF capsule on the caution/advisory panel will light. Also, voltage will be removed from the 26 V ac bus.

APPENDIX A

ILLUSTRATION LISTING

FRAME #	FRAME TITLE
3005	Menu
3010	Definition of Electricity
3015	Definition of a Conductor
3020	Characteristics of Electricity FLASH
3021	Alternating Current FLASH
3022	Current FLASH
3023	Voltage FLASH
3024	OHMS FLASH
3025	Ways to Produce Electricity
3026	Electron Flow
3030	Field Excitation
3035	Transformation
3036	Step-up Transformation
3037	Step-down Transformation
3040	Conversion
3045	Electrical Circuits
3046	Parallel Circuit
1001	AC Electrical System
1005	Menu
1009	AC Generator No. 1 and No. 2 Location
1006	AC Generator No. 1 and No. 2
1007	Generator Spline Adapter
1016	APU Generator Location
1008	APU Generator
1013	Generator Control Unit Location
1010	Generator Control Unit
1015	Generator Control Switches
1017	Drag Beam Switch Location
1012	Right Drag Beam Switch
1014	Junction Box No. 1 and No. 2 Location
1020	Junction Box No. 1 and No. 2
1025	Generator Contactors
1030	APU/External Power Contactor
1035	AC BUS TIE Contactor
1040	Current Transformer
1045	Current Limiters
1050	Test Receptacle
1018	Pilot Circuit Breaker Panel
1055	AC Essential Bus Transfer Relay
1060	AC Essential BUS Fail Relay
1021	External Power Receptacle Location
1065	External Power Receptacle
1022	External Power Monitor Panel Location
1070	External Power Monitor Panel
1075	External Power Control Switch
1023	Autotransformer Location
1066	Autotransformer
2005	DC Electrical System Overview
2010	DC Power MENU
2016	Converters Location

2015	Converter
2021	Junction Box Location
2020	Junction Boxes
2025	DC Primary BUS Contactors
2030	DC BUS TIE Contactor
2035	DC BUS TIE Current Limiter
2041	No. 1 DC Essential BUS Supply Relay Location
2040	No. 1 DC Essential BUS Supply Relay
2046	No. 2 DC Essential BUS Supply Relay Location
2045	No. 2 DC Essential BUS Supply Relay
2051	DC Essential BUS Fail relay Location
2050	DC Essential BUS Fail Relay
2056	Battery Location
2055	Battery
2056	Battery
2057	Battery
2060	Battery Harness Assembly
2067	Battery Analyzer/Conditioner Location
2065	Battery Analyzer/Conditioner
2066	Battery Analyzer/Conditioner 2
2076	Battery Switch Location
2075	Battery Switch
2071	Battery Relay Location
2070	Battery Relay
2086	Pilot and Copilot Circuit Breaker Panel Location
2085	Pilot and Copilot Circuit Breaker Panel
2081	Miscellaneous Circuit Breaker Panel
2080	Upper console
2082	Mission Readiness Circuit Breaker Panel
2083	Lower Console Circuit Breaker panel
4001	Schematic Menu
4002	DC Schematic Menu
4003	AC Schematic Menu
4005	Battery Operation FLASH
4010	Converter Operation FLASH
4015	No. 1 Converter Fail FLASH
4020	No. 2 Converter Fail FLASH
4025	NO. 1 Converter and 100 AMP Current Limiter Fail FLASH
4030	NO. 2 Converter and 100 AMP Current Limiter Fail FLASH
4035	External Power Operation FLASH
4040	APU Operation FLASH
4045	NO. 1 and NO. 2 Generator Operation FLASH
4050	NO. 1 Generator in Test Position FLASH
4055	NO. 2 Generator in Test Position FLASH
4060	NO. 1 Generator Failure FLASH
4065	NO. 2 Generator Failure FLASH
4070	NO. 1 GEN SW ON, NO. 2 GEN SW OFF, and CL 4,5,6 Fail FLASH
4075	NO. 2 GEN SW ON, NO. 1 GEN SW OFF, and CL 1,2,3 Fail FLASH
4080	NO. 2 GEN SW ON, NO. 1 GEN SW OFF, and Current Limiters 1 and 3 Fail. FLASH
4085	NO. 2 GEN SW ON, NO. 1 GEN SW OFF, and Current Limiter 2 Fail FLASH
4090	AC Essential Bus Failure FLASH

APPENDIX B

TEST AND TEST SOLUTIONS

1. This appendix is only used when the test and solutions are internal to the POI file.

2. When the test and solutions are internal to the POI file, then the POI file becomes a FOR OFFICIAL USE ONLY document.