



CHAPTER 9

FIRE PROTECTION

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CHAPTER 9

FIRE PROTECTION

GENERAL

Fire protection includes those fixed and portable components which identify fire and overheat conditions, as well as provide warnings of fire, overheat, and smoke in the airplane. The fire protection system also stores the fire-extinguishing agent and applies it to all protected areas of the airplane when needed.

The fire protection system provides the ability to detect and extinguish a fire in the engine nacelles and in the auxiliary power unit (APU) compartment. An overheat detection system, in the jetpipe and pylon areas of each engine, permits the flight crew to monitor any overheat condition in those areas. The main gear wheel wells have a similar overheat detection system. The airplane is equipped with a lavatory smoke detector and an automatic built-in fire extinguisher. The cargo compartment also has detection and extinguishing systems.

Both the detection and extinguishing systems permit the flight crew to test and monitor for possible system faults.

SYSTEM DESCRIPTION

The fire protection system includes fire detection and extinguishing systems. Fire detection is provided for the following areas:

- Engine (overheat)
- Auxiliary power unit (overheat)
- Lavatory (smoke only)
- Cargo compartment (smoke only)
- Main landing gear (overheat only)



Fire extinguishing systems are provided for the following:

- Engine fire extinguishing
- APU fire extinguishing
- Portable fire extinguishing
- Lavatory fire extinguishing
- Cargo fire extinguishing

FIRE DETECTION AND EXTINGUISHING SYSTEMS

Engine and APU

The engine and APU fire/overheat detection system determines if a fire or overheat condition occurs in the engine nacelles, jetpipe and pylon areas, and the APU. Each fire and overheat detection system consists of dual heat sensing elements, designated loops A and B, which are mounted parallel to each other in the following areas (Figure 9-1):

- Left and right nacelles, zone A (fire detection)
- Left and right jetpipes and pylons, zone B (overheat detection)
- APU compartment (fire detection)

The fire-extinguishing systems store the fire-extinguishing agent and apply it to the necessary areas. Two engine fire-extinguishing bottles are in the rear fuselage equipment bay. The APU fire-extinguishing bottle is on the APU support structure in the rear fuselage equipment compartment. The bottles use Halon and are pressurized with nitrogen. A bottle pressure gage reveals bottle pressure. When the bottle pressure is low, a caution message is shown on the EICAS primary display.:



The discharge lines are interconnected to allow discharge of both bottles into one engine, if needed. The FIRE DETECTION/FIREX MONITOR panel permits the flight crew to test squib circuit continuity and monitor Firex bottle pressure.

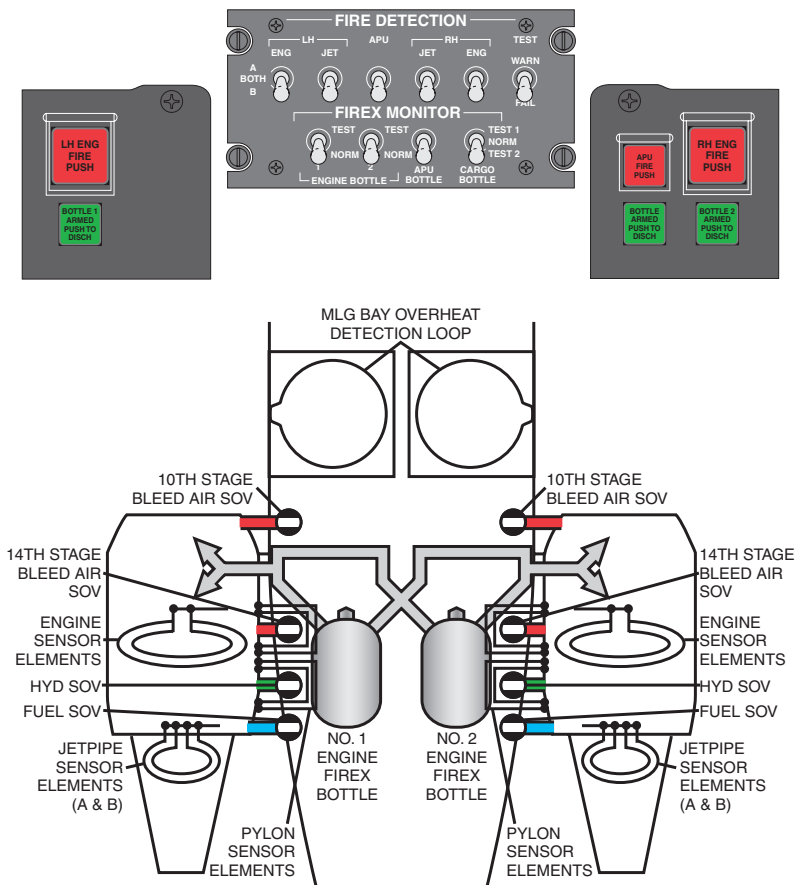


Figure 9-1 Engine Firex Monitor System



If a fire occurs while the APU is unattended on the ground, the APU fire-extinguishing detection system automatically shuts down the APU and activates the APU fire-extinguishing system. A fire warning horn, in the aft accessory section, operates when the Firex bottle squib is tested with the APU shut down or if an APU fire is detected while on the ground.

Fire and Overheat Control Unit

The fire and overheat control unit monitors two sensing element loops for a change in resistance that accompanies a heat increase. Both loops must detect a heat increase to trigger fire alerting on the EICAS. A failure of one loop is indicated by a FAIL message on the EICAS. Deselecting the affected loop enables the remaining loop to give fire and overheat alerting.

Engine Fire Extinguishing

When fire occurs in an engine (see Figure 9-1):

MASTER WARNING and LH or RH FIRE PUSH switchlights illuminate.

- Firebell sounds.
- MASTER WARNING switchlight is pressed:
 - Firebell silences.
 - MASTER WARNING switchlight extinguishes and resets.
- Respective thrust lever is set to the SHUTOFF position:
 - Respective LH or RH FIRE PUSH switchlight remains illuminated.
- The illuminated ENG FIRE PUSH switchlight is pressed:
 - BOTTLE 1 or 2 ARMED PUSH TO DISCH switchlight illuminates.



- Squibs are armed.
- Engine fuel feed shutoff valve closes.
- Bleed-air shutoff valve closes.
- Hydraulic shutoff valve closes.
- Engine-driven generator shuts down.
- The onsite BOTTLE ARMED PUSH TO DISCH switchlight is pressed:
 - Bottle 1 or 2 squib fires.
 - Firex extinguishing agent discharges.
 - The respective ENG BOT 1 or 2 LO message appears on EICAS.

If a fire or overheat condition in the engine persists:

- LH or RH ENG FIRE PUSH switchlight remains illuminated.
- The remaining BOTTLE ARMED PUSH TO DISCH switchlight is pressed:
 - The respective bottle squib fires.
 - Firex extinguishing agent discharges.
 - The respective ENG BOT LO message appears on EICAS with MASTER CAUTION.



APU Fire Extinguishing

When fire occurs in the APU (Figure 9-2):

- MASTER WARNING and APU FIRE PUSH lights illuminate.
- Firebell sounds.
- If the airplane is on the ground, the APU fire shutoff relay is automatically energized to shut down the APU. After five seconds, the APU bottle fire-extinguishing agent

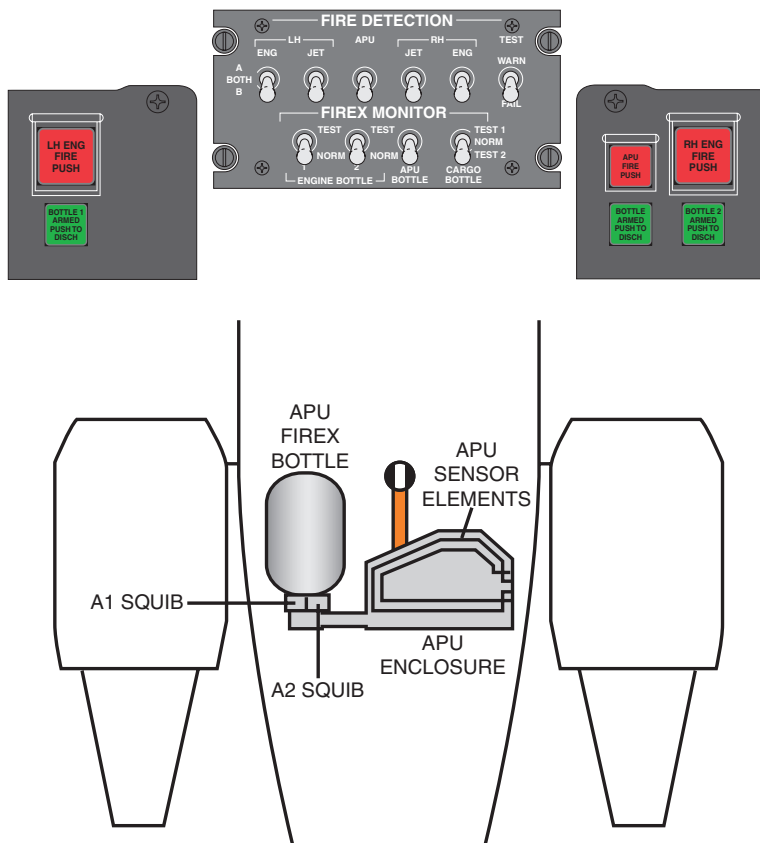


Figure 9-2 APU Firex Monitor System



automatically discharges. If the aircraft is in flight, the APU automatically shuts down.

- MASTER WARNING switchlight is pressed:
 - Firebell silences.
 - MASTER WARNING switchlight extinguishes and resets.
- APU FIRE PUSH switchlight is pressed:
 - BOTTLE ARMED PUSH TO DISCH switchlight illuminates.
 - If on the ground, the APU is shut down if the automatic shutdown was not successful.
 - If airborne, the APU shuts down.
 - APU squibs are armed.
 - APU bleed-air valve closes.
 - APU fuel valve closes.
- BOTTLE ARMED PUSH TO DISCH switchlight is pressed:
 - APU bottle squib fires.
 - Firex extinguishing agent discharges.
 - APU BTL LO message appears on EICAS with MASTER CAUTION.

Main Landing Gear

The main landing gear overheat detection system consists of single-loop sensing elements in both main landing gear bays as well as a dual-channel overheat detection unit. The overheat detection unit continuously monitors the heat-sensing elements. Any overheat condition or system fault is displayed on the EICAS with a possible accompanying aural message.



The overheat detection system is tested from the flight compartment by selectively simulating an overheat condition and a system fault condition. Test result messages are displayed on the EICAS.

Four heat-sensitive fusible plugs in each wheel release excessive air pressure caused by heat buildup in the wheel/tire assembly.

Lavatory

The lavatory fire-extinguishing system automatically extinguishes fire in the lavatory waste compartment. The system includes one sealed Firex bottle charged with Halon 1301 and pressurized with dry nitrogen. The system operates automatically when the heat in the waste compartment is more than the specified limit. The fire-extinguishing agent is directed into the lavatory waste compartment through two discharge tubes and nozzles. The discharge nozzles are sealed with heat-sensitive capsules that melt when subject to heat, permitting discharge of the extinguishing agent.

One ceiling smoke detector allows smoke detection in the lavatory. The smoke detector unit has an audible alarm horn and a red alarm indicator on the front panel. A green power indicator light, a self-test switch, and an alarm interrupt switch permit system testing and horn silencing. When smoke density exceeds a predetermined level, the smoke detector sounds the aural alarm in the lavatory and sends a signal to the EICAS. After smoke detection, the aural alarm and the EICAS caution message are reset by pressing the interrupt switch on the smoke detector. The lavatory smoke detection system is tested by pressing the self-test switch on the front panel of the lavatory smoke detector.

NOTE

Operation of mobile transceivers in close proximity to the smoke detectors may cause a false alarm.

An automatic fire extinguisher (Figure 9-3) detects heat and provides automatic fire extinguishing for the lavatory waste compartment. The extinguisher is mounted on a bracket inside the waste compartment.

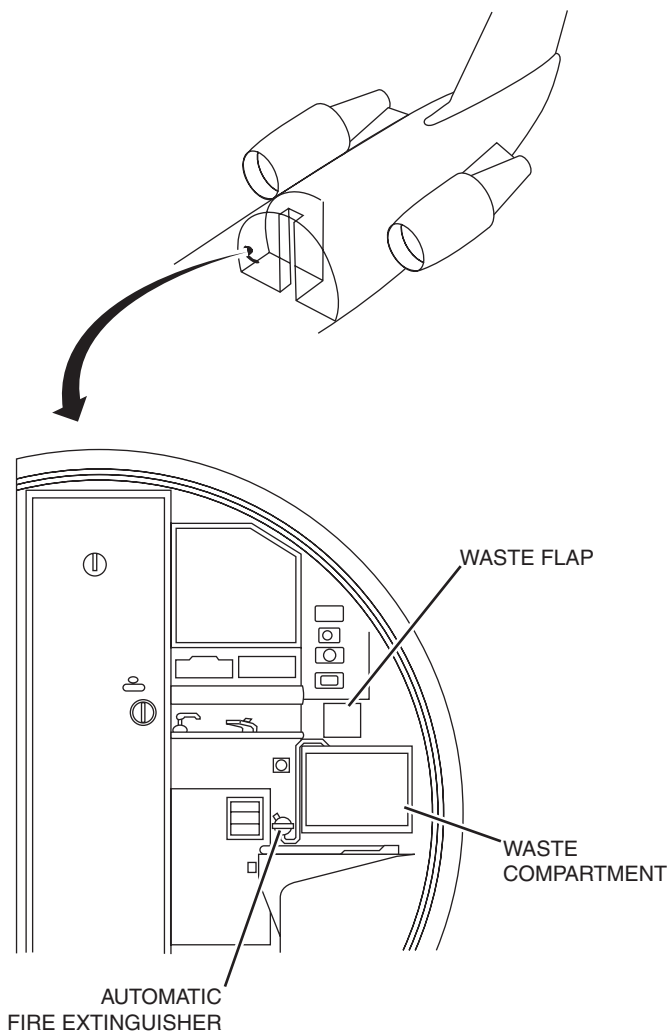


Figure 9-3 Automatic Fire Extinguishers

The extinguisher automatically discharges when the temperature reaches a specified value. A pressure gage on the top of the extinguisher provides a visual indication of bottle pressure. A service door provides access to the pressure gage.



Cargo Compartment

Two smoke detectors on the ceiling of the cargo compartment monitor the compartment for smoke. When smoke density exceeds a predetermined level, the smoke detectors send a signal to the EICAS. Power to the cargo compartment fan and heater and cargo compartment air are automatically shut off.

The cargo compartment smoke detection system is tested from the flight compartment with the test indications displayed on the EICAS.

NOTE

Operation of mobile transceivers in close proximity to the smoke detectors may cause a false alarm.

The cargo compartment extinguishing system uses two Firex fire bottles. These bottles are charged with Halon 1301 and pressurized with dry nitrogen.

Bottle 1 allows quick discharge of the extinguishing agent, followed by a slow, metered discharge of the extinguishing agent. Bottle 2 discharges at the same time as bottle 1 but is slow and metered throughout. Slow metering lasts approximately 30 minutes but give protection for 45 minutes.

Cargo Compartment Fire Extinguishing

When smoke occurs in the cargo compartment (Figure 9-4):

- MASTER WARNING and SMOKE CARGO PUSH switch-lights illuminate.
- “Smoke” aural warning sounds.

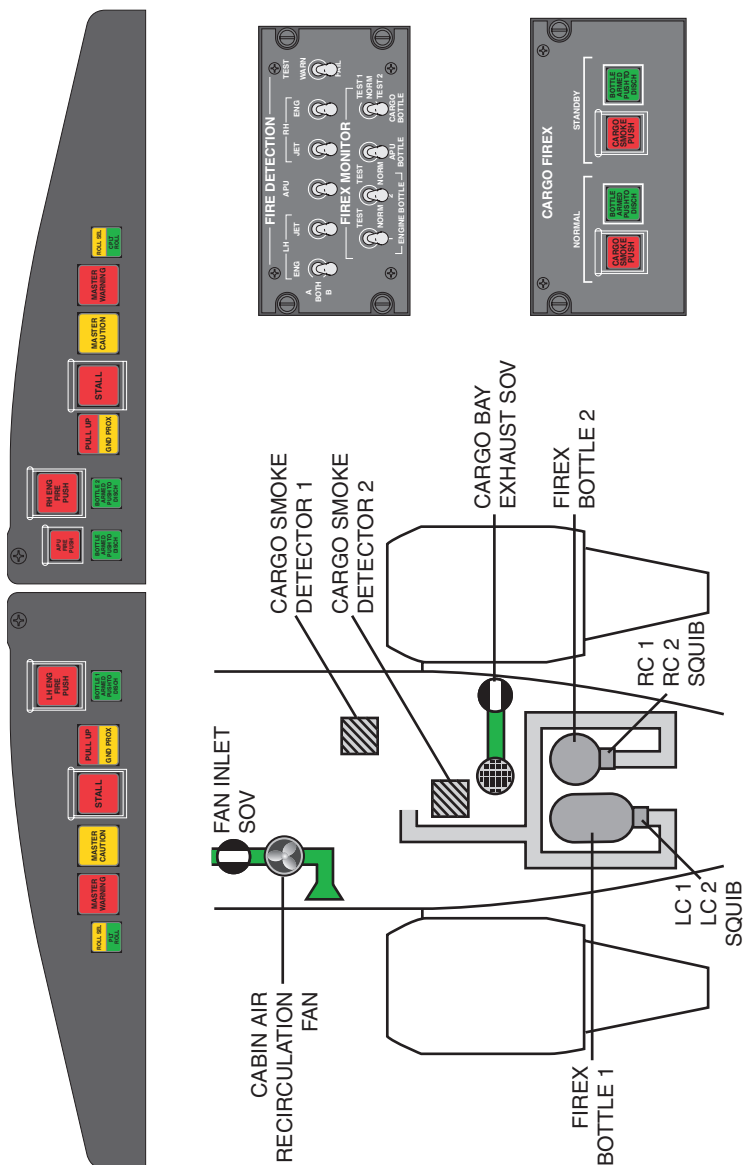


Figure 9-4 Cargo Compartment Firex Monitor System



- The MASTER WARNING switchlight is pressed:
 - “Smoke” aural warning silences.
 - MASTER WARNING switchlight extinguishes and resets.
- The NORMAL/STANDBY CARGO SMOKE PUSH switchlight is pressed:
 - NORMAL/STANDBY BOTTLE ARMED PUSH TO DISCH switchlight illuminates.
 - Cargo bottle squibs are armed.
- The BOTTLE ARMED PUSH TO DISCH switchlight is pressed:
 - Cargo bottle squibs fire.
 - Firex extinguishing agent discharges.
 - CARGO BTL LO message appears on EICAS with MASTER CAUTION.

Portable Equipment

The airplane has three portable fire extinguishers: one in the flight compartment and two (one forward and one aft) in the cabin (Figure 9-5). The fire extinguishers are held in mounting brackets with quick-release straps.

The flight compartment fire extinguisher is on the bulkhead behind the copilot’s seat. The forward cabin fire extinguisher is in the left wardrobe next to the passenger door. These extinguishers are hand-held bottles containing Halon. Pressure gages on the top of the bottles show if the extinguishers are within serviceable limits.

The aft cabin fire extinguisher is on the bulkhead near the lavatory, on the right side of the airplane. The extinguisher is a liquid-type, Class A, hand-held bottle. The discharge time is between 30 and 45 seconds at 70° F. The discharge stream covers a minimum range of 20 feet (6.1 meters).



Portable Fire Extinguishing

Operation of the portable Halon fire extinguisher includes the following steps:

- Unsnap “quick release” mounting strap and remove from the bracket.
- Hold the extinguisher upright.

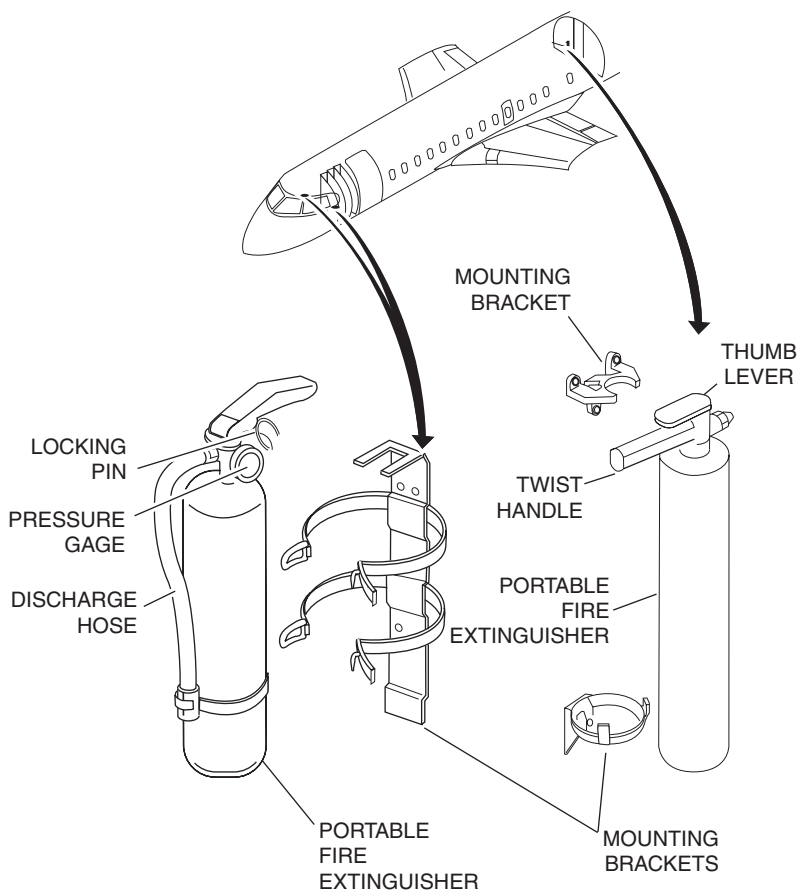


Figure 9-5 Portable Fire Extinguishers



- Pull the locking pin, breaking the nylon tie.
- Stand at least six feet away from the fire and aim the discharge hose at the base of the flame.
- Squeeze the lever and use a sweeping motion from side to side at the base of the fire.
- Move closer as the fire is being extinguished.
- Ensure the fire is completely extinguished and watch for “flashback.”
- Ventilate as promptly as possible by notifying the flight crew so that the cabin pressure can be adjusted to evacuate the smoke through the outflow valve.

The fire extinguisher in the rear cabin compartment contains carbon dioxide (CO₂) in a cartridge in the twist handle at the top of the container. When the handle is turned clockwise, the cartridge is punctured by a pin. This releases the CO₂, which pressurizes the fire-extinguishing agent. The pressurized agent remains in the cylinder until the thumb lever is pushed.

The Halon and liquid-type, Class A extinguishers operate in a vertical position with the locking pin pulled. The fire-extinguishing agent is properly aimed at the base of the flame from a distance of over six feet. The lever should be squeezed and the discharge hose swept from side to side at the base of the fire.

NOTE

The portable fire extinguishers must be recharged after use. Partial discharge may cause the bottles to leak



CONTROLS AND INDICATIONS

FIRE PANEL

The fire panel (Figure 9-6) is on the left overhead panel in the flight compartment. It is divided into two sections: FIRE DETECTION for detection controls and FIREX MONITOR for testing the extinguishing system.

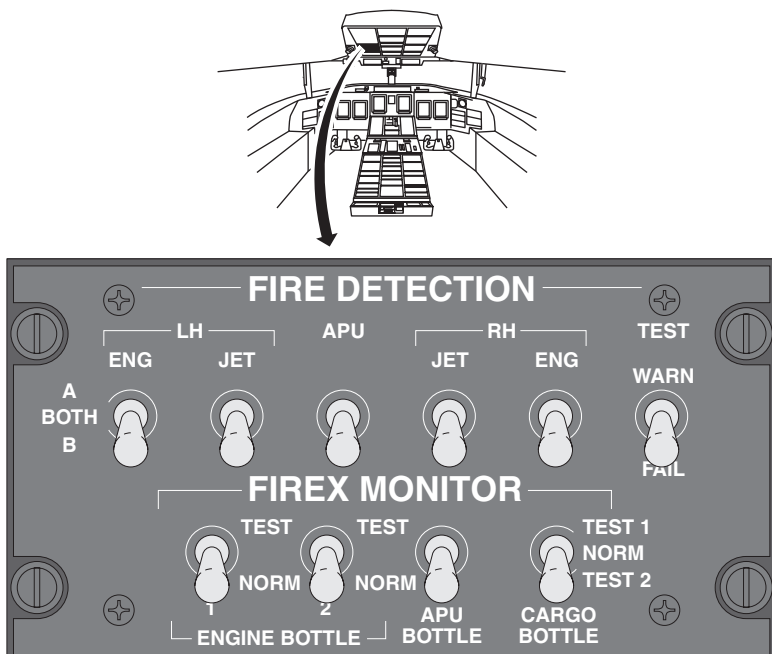


Figure 9-6 Fire Panel

FIRE DETECTION Section

LH and RH ENG Switches

The LH and RH ENG switches select engine fire detection through loop A, loop B, or BOTH (for normal operation).



LH and RH JET Switches

The LH and RH JET switches select jetpipe and pylon overheat detection via loop A, loop B, or BOTH (for normal operation).

TEST WARN–FAIL Switch

WARN—This switch grounds the loops to simulate a fire or overheat condition. If the test is good, the following messages appear:

- Firebell rings.
- Warning messages L and R ENG FIRE, APU FIRE, and L and R JETPIPE OVHT appear.
- “Jetpipe overheat” aural message activates.
- After 10 seconds, caution messages HYD SOV 1 or 2 OPEN, L or R ENG SOV OPEN, and APU SOV OPEN (if APU is operating) appear.
- Switchlights LH or RH ENG FIRE PUSH, APU FIRE PUSH, BOTTLE 1 and 2 ARMED PUSH TO DISCH, and APU BOTTLE ARMED PUSH TO DISCH illuminate.

FAIL—Simulates a short on the selected loops (A or B) with the following indications:

- Caution messages L or R FIRE FAIL, APU FIRE FAIL, and L or R JET OVHT FAIL appear.

FIREX MONITOR Section

ENGINE BOTTLE 1 and 2 Switches

TEST—Applicable Firex bottle squib circuit continuity is checked. The L or R ENG SQUIB 1 or 2 green advisory message is displayed if the test results are successful.



NORM—Selects normal operation. The switches are spring-loaded to this position.

NOTE

If a **CARGO BOTTLE** test is conducted with the **CARGO** switch selected to **FAN** or **COND AIR**, a **CARGO FAN FAIL** status message will come on.

APU BOTTLE Switch

TEST—APU Firex bottle pressure and squib circuit continuity are checked. The **APU SQUIB 1** and **2** green advisory message is displayed if the test results are successful.

NORM—Selects normal operation. The switches are spring-loaded to this position.

CARGO BOTTLE Switch

TEST 1—Simulates a smoke condition on the No. 1 detector with the following indications:

- “Smoke” aural message activates.
- **SMOKE CARGO** warning message appears.
- **CARGO SQUIB 1** advisory message appears (continuity check of squib 1).
- **CARGO FIREX** panel switchlight indications:
 - Red **NORMAL CARGO SMOKE PUSH**
 - Red **STANDBY CARGO SMOKE PUSH**
 - Green **NORMAL BOTTLE ARMED PUSH TO DISCH**

TEST 2—Simulates a smoke condition on the No. 2 detector with the following indications:

- “Smoke” aural message activates.
- **SMOKE CARGO** warning message appears.



- CARGO SQUIB 2 advisory message appears (continuity check of squib 2).
- CARGO FIREX panel switchlight indications:
 - Red NORMAL CARGO SMOKE PUSH
 - Red STANDBY CARGO SMOKE PUSH
 - Green STANDBY BOTTLE ARMED PUSH TO DISCH

CARGO FIRE PANEL

The CARGO FIREX panel is on the right center pedestal in the flight compartment (Figure 9-7).

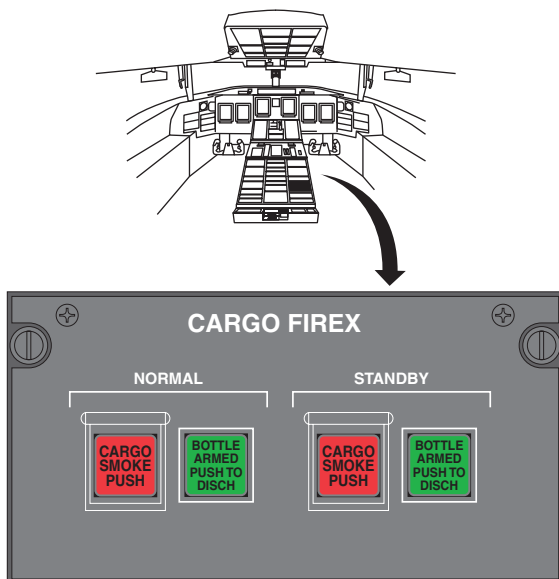


Figure 9-7 Cargo Fire Panel



NORMAL and STANDBY CARGO SMOKE PUSH Switchlights

Both CARGO SMOKE PUSH switchlights illuminate red when smoke is detected in the cargo compartment. The switchlights have identical functions and serve as backup to each other during switch malfunction.

IN—All squibs of cargo compartment Firex bottle are armed.

OUT—All squibs of cargo compartment Firex bottle is disarmed.

NORMAL and STANDBY BOTTLE ARMED PUSH TO DISCH Switchlights

The respective BOTTLE ARMED PUSH TO DISCH switchlight illuminates green once the respective CARGO SMOKE PUSH switchlight is pressed. This indicates the squibs are armed in both Firex bottles.

IN—Squibs fire. Green light extinguishes once the Firex bottle is discharged.

NOTE

BOTTLE ARMED PUSH TO DISCH switchlight will extinguish when the CARGO BTL LO caution message appears. The CARGO BTL LO caution message may take up to 20 minutes before it appears on EICAS, as the cargo Firex bottle gradually discharges.



LH AND RH ENG FIRE PUSH SWITCHLIGHTS

These guarded switches on the glareshield illuminate red when a fire is detected in the respective engine. These switches also illuminate during system testing.

IN—Accomplishes the following:

- Squibs on both engine Firex bottles are armed.
- Fuel valve closes.
- Bleed-air valve closes.
- Hydraulic valve closes.
- Engine-driven generator shuts down.

OUT—All affected systems operate normally and fire alerting is armed.

GLARESHIELD

BOTTLE 1 and 2 ARMED PUSH TO DISCH Switchlights

The BOTTLE 1 and 2 ARMED PUSH TO DISCH glareshield switchlights illuminate green to indicate the applicable Firex bottle squib is armed (Figure 9-8). During a test of the fire warning system, illumination of these switchlights confirms that the applicable squib is operational.

IN—Fires the squib to discharge the applicable engine Firex bottle.

APU FIRE PUSH Switchlight

The APU FIRE PUSH switchlight on the copilot's glareshield illuminates red when a fire is detected in the APU compartment. The switch also illuminates red during APU fire testing.

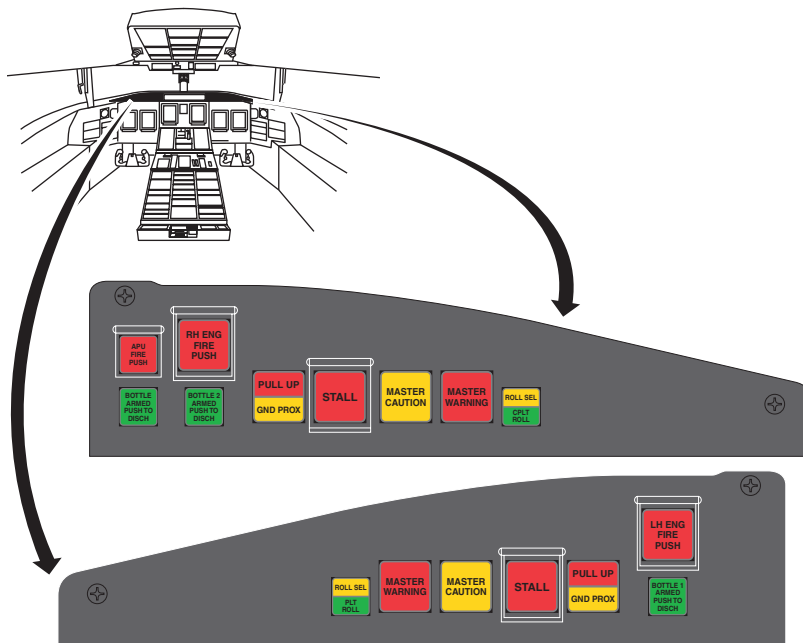


Figure 9-8 Glareshield

IN—Accomplishes the following:

- APU Firex bottle squib is armed.
- APU shutoff valve closes.
- APU is shut down.
- APU bleed-air valve closes.

OUT—The APU operates normally and fire alerting is armed.



APU BOTTLE ARMED PUSH TO DISCH Switchlight

The BOTTLE ARMED PUSH TO DISCH switchlight on the copilot's glareshield illuminates green to indicate the APU Firex bottle squib is armed. This switchlight also illuminates during APU fire testing.

IN—Fires the squib to discharge the APU bottle.

LANDING GEAR CONTROL PANEL

The landing gear control panel (Figure 9-9) is on the center pedestal in the flight compartment

MLG BAY OVHT Test Switch

Placing the switch in the up position simulates an overheat condition in the main landing gear bay. An aural “gear bay overheat” warning and MLG BAY OVHT annunciation on the EICAS occur. The switch is spring-loaded to the normal position.

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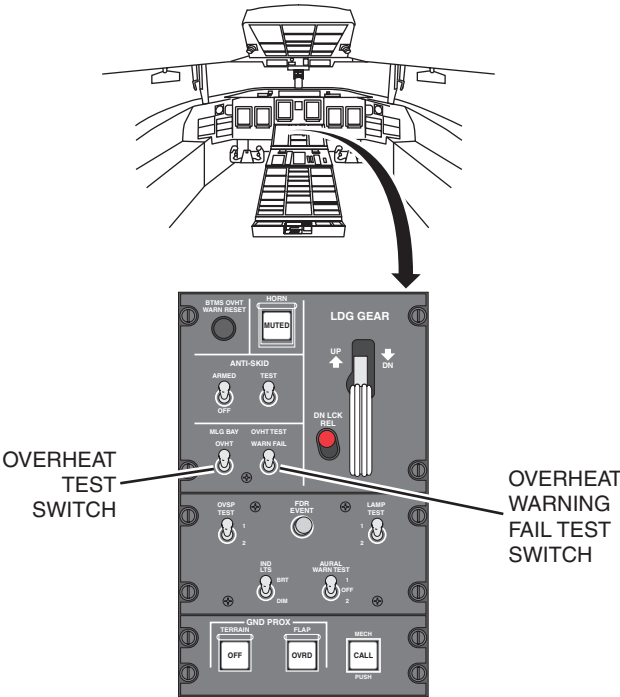


Figure 9-9 Landing Gear Control Panel



OVHT WARN FAIL TEST Switch

Placing the switch in the up position simulates a failure in the main landing gear bay overheat detection system. An accompanying MLG OVHT FAIL annunciation appears on the EICAS. The switch is spring-loaded to the normal position.

LAVATORY SMOKE DETECTOR

The lavatory smoke detector is in the ceiling of the lavatory (Figure 9-10).

Power Light

The power light indicates green when the unit is powered.

Interrupt Pushbutton

When the alarm is activated, pressing the interrupt pushbutton resets the smoke detector and cancels the aural and visual alarms. If the aural alarm and alarm light activate again when the interrupt switch is released, the smoke condition still exists.

Test Pushbutton

When the test pushbutton is pressed in, the aural alarm sounds, the alarm light illuminates, and the SMOKE TOILET caution message is displayed on the EICAS.

Alarm Light

The alarm light illuminates red when there is smoke in the lavatory. It works in conjunction with the aural alarm.

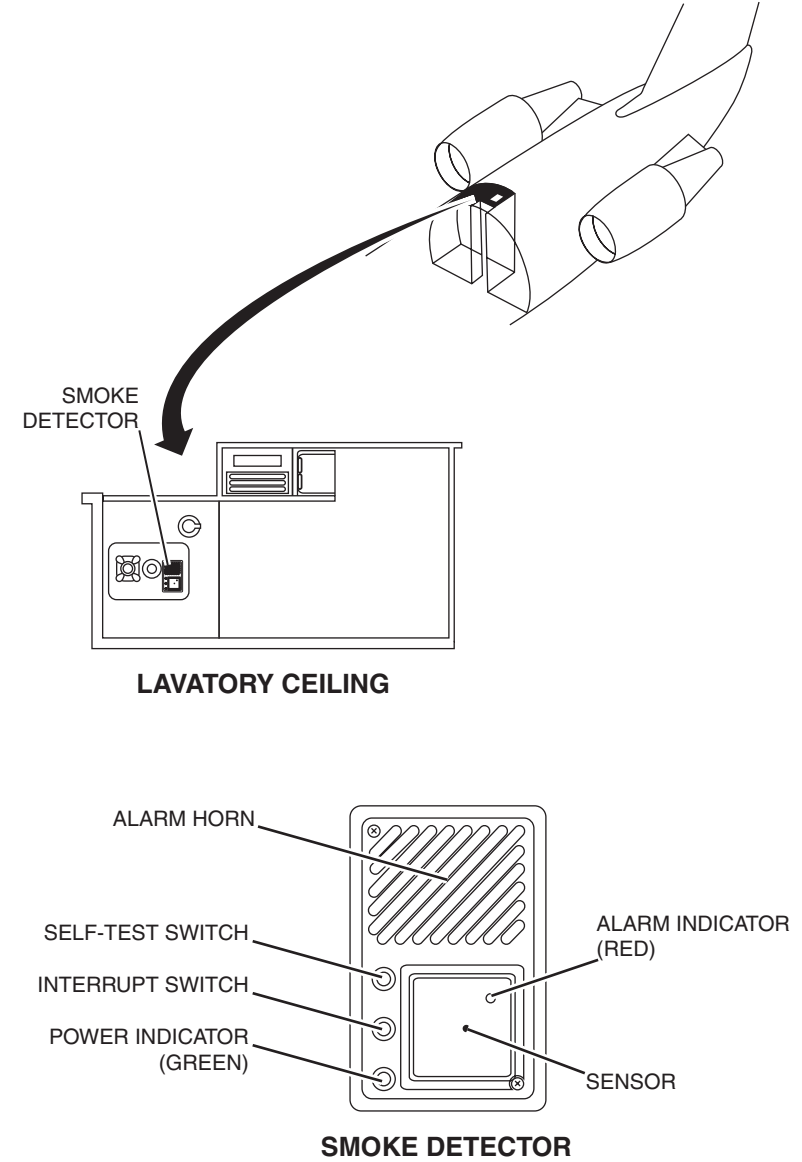


Figure 9-10 Lavatory Smoke Detector



EICAS INDICATIONS

Fire and Smoke Indications

Table 9-1 shows the combinations of EICAS messages, aural warnings, and switchlight annunciations.

Table 9-1 FIRE AND SMOKE ALERTING INDICATIONS

CONDITION	EICAS VISUAL MESSAGE	AURAL WARNING	SWITCHLIGHT ANNUNCIATIONS
Left engine fire	Red L ENG FIRE	Firebell sounds	MASTER WARNING LH ENG FIRE PUSH
Right engine fire	Red R ENG FIRE	Firebell sounds	MASTER WARNING RH ENG FIRE PUSH
APU fire	Red APU FIRE	Firebell sounds (on ground)	MASTER WARNING APU FIRE PUSH
Left jetpipe or engine pylon overheat	Red L JETPIPE OVHT	“Jetpipe overheat”	MASTER WARNING
Right jetpipe or engine pylon overheat	Red R JETPIPE OVHT	“Jetpipe overheat”	MASTER WARNING
Main landing gear bay overheat	Red MLG BAY OVHT	“Gear bay overheat”	MASTER WARNING
Smoke in cargo compartment	Red SMOKE CARGO	“Smoke”	MASTER WARNING
Smoke in lavatory or lavatory self-test switch is pushed	Amber SMOKE TOILET		MASTER CAUTION



Table 9-1 FIRE AND SMOKE ALERTING INDICATIONS

CONDITION	EICAS VISUAL MESSAGE	AURAL WARNING	SWITCHLIGHT ANNUNCIATIONS
Left engine fire-sensing loops failure	Amber L FIRE FAIL		MASTER CAUTION
Right engine fire-sensing loops failure	Amber R FIRE FAIL		MASTER CAUTION
APU fire-sensing loops failure	Amber APU FIRE FAIL		MASTER CAUTION
Left jetpipe overheat sensing loops failure	Amber L JET OVHT FAIL		MASTER CAUTION
Right jetpipe overheat sensing loops failure	Amber R JET OVHT FAIL		MASTER CAUTION
Main landing gear bay sensing-loop failure	Amber MLG OVHT FAIL		MASTER CAUTION
No. 1 fire bottle low charge	Amber ENG BTL 1 LO		MASTER CAUTION
No. 2 fire bottle low charge	Amber ENG BTL 2 LO		MASTER CAUTION
APU fire bottle low charge	Amber APU BTL LO		MASTER CAUTION
Cargo fire bottle low charge	Amber CARGO BTL LO		MASTER CAUTION



Table 9-1 FIRE AND SMOKE ALERTING INDICATIONS

CONDITION	EICAS VISUAL MESSAGE	AURAL WARNING	SWITCHLIGHT ANNUNCIATIONS
Left Firex bottle 1 or 2 is operative	Green L ENG SQUIB 1 or 2		
Right Firex bottle 1 or 2 is operative	Green R ENG SQUIB 1 or 2		
The respective squib element is operative	Green APU SQUIB 1 or 2		
The respective squib element is operative after cargo Firex bottle test	Green CARGO SQUIB 1 or 2		



CIRCUIT BREAKERS

Table 9-2 lists all circuit breakers protecting the power supply for fire protection system components. The table also includes circuit-breaker location and source of power.

**Table 9-2 POWER SUPPLY AND
CIRCUIT-BREAKER SUMMARY**

SUB-SYSTEM	CB NOMENCLATURE	BUS BAR	CB PANEL	CB LOCATION
Fire detector loops	FIRE DET LOOP A	DC BAT	1	N1
	FIRE DET LOOP B			N2
	FIRE DET TEST			N3
Engine bottles	FIRE EXT 1 R ENG	DC EMER	1	R1
	FIRE EXT 1 L ENG			R2
	FIRE EXT 2 R ENG			R3
	FIRE EXT 2 L ENG			R4
APU bottle	APU FIRE EXT A			R5
	APU FIRE EXT B			R6
Cargo compartment	CARGO FIREX 1	DC BAT	1	P1
	CARGO FIREX 2	DC BUS 1	1	G1
Waste compartment/lavatory	SMOKE DET	DC BUS 1	1	K1



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