NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Aviation Engineering Division
Washington, DC 20594

December 22, 2008

AIRWORTHINESS GROUP CHAIRMAN'S FACTUAL REPORT

A. **ACCIDENT:** DCA08MA076

LOCATIONS: San Francisco International Airport, California

DATE/TIME: June 28, 2008, approximately 10:15 pm local time

AIRCRAFT: Boeing 767-281SF, N799AX

B. GROUP MEMBERS:

Chairman: Robert L. Swaim
Washington, DC

Member: Susan Letcher
Federal Aviation Administration (FAA)
Seattle, Washington

Member: Bob Hettman
Federal Aviation Administration
Seattle, Washington

Member: Samuel Ifergan
Israel Aircraft Industries, Ltd. (IAI)
Ben Gurion Int'l Airport, Israel

Member: Joe Freese
ABX Air, Inc.
Wilmington, Ohio

Member: Matthew Anglin
Boeing Commercial Airplane
Seattle, Washington

C. SUMMARY:

On June 28, 2008, about 2215 Pacific daylight time (PDT),[1] an ABX Air Boeing 767-200, registration N799AX, operating as flight 1611 from San Francisco International Airport (SFO), San Francisco, California, experienced a ground fire before engine startup. The fire was located in the supernumerary area,[2] so the two pilots had to egress the airplane through the cockpit windows. No injuries were reported, and the airplane was substantially damaged. The cargo flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121. At the time of the fire, the airplane was parked near the DHL loading facility and all of the cargo had been loaded.

D. DETAILS OF THE INVESTIGATION:

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[1] All times in this report are PDT based on a 24-hour clock unless otherwise noted.
[2] The supernumerary area is the portion of the airplane that is located directly aft of the cockpit and forward of the main deck cargo compartment. This area is where the lavatory, galley, and three non-flight crew seats are located.

DETAILED SUMMARY

The pilots reported that as they prepared to operate as cargo flight 1611 they reported hearing a loud “pop” and “hissing” while performing the engine start checklist. The first officer got out of his seat to check on what may have caused the noise and found smoke and fire in the supernumerary area that was behind the cockpit. He described observing red flames at the ceiling, generally between the galley and right edge of the 3 supernumerary seats, as well as thick brown smoke that he said made breathing difficult.[3] The area where the fire had first been seen contained components of the supplemental oxygen system. The Maintenance Records group found that the oxygen system needed abnormally frequent refills since a maintenance check (C-Check) had been performed and galley lighting was changed above the ceiling.

The two pilots went through the fire and evacuation checklist before both flight crew members exited the airplane through the cockpit windows. The airport rescue and fire fighting unit (ARFF) extinguished the fire rapidly, but not before the crown burned through and the mounting structure for the tail-related control cables had fallen to the floor from over the ceiling. Damage to the aircraft was subsequently determined to be beyond what could economically be repaired.

The airplane was examined in San Francisco on June 30-July 5, 2008, and again on August 5, 2008. Pressure testing the remaining cockpit supplemental oxygen system revealed no significant leaks forward of the supernumerary compartment. The supernumerary supplemental oxygen system regulators were tested and disassembled at Avox Systems (formerly Scott) on August 5, 2008, where they had been manufactured; no faults were found. Undamaged plastic valve seats from the regulators indicated to manufacturing personnel that the regulators had not passed high pressure oxygen into the low pressure sections of the cockpit or supernumerary supplemental oxygen systems. Flexible PVC[4] oxygen hoses from the accident airplane and other ABX airplanes were examined and passed pressure tests at Hydraflow Corporation on August 7, 2008, where they had been manufactured.

The investigation found that the complete (cockpit and supernumerary) oxygen system was grounded to the airplane structure through a flexible high pressure convolute metal hose and through wire spring material within some flexible PVC hoses at the individual mask boxes. The conductive hoses were found only at the supernumerary and right cockpit extra crewmember stations. The majority of the supply tubing between these hoses was rigid stainless steel, and of the stainless tubing found, no evidence was found of electrical contact. Not all of the rigid tubing was found for examination. Three points

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3 Supernumerary occupants are not the pilots of the airplane and at ABX require training in use of the supplemental oxygen system, as well as other aspects of the compartment and flight operation. More detailed descriptions of the supernumerary requirements and provisions are contained in the applicable sections of this report and in Appendix B.

4 PVC is an acronym for poly vinyl chloride.

of contact between wiring and the conductive tubing were found in other ABX 767 airplanes. These findings prompted ABX and Israeli Aircraft Industries (IAI-Bedek, where the airplanes were modified from passenger to freight configuration) to have all of the other 767 freighter conversion airplanes inspected.

Records of previous PVC hose failures were examined, and two were related to electricity passing through the internal wire spring (302 CRES stainless steel), melting through the PVC plastic wall. Boeing issued a Service Bulletin on September 2, 1999, which called for hose replacements with non-conductive hoses. Three of the four cockpit hoses had been replaced in N799AX, with one remaining conductive hose in the cockpit. The hose end remnants recovered from the supernumerary area were of the conductive type.

The ABX inspections also found a potential point of arcing at a light in the cabinet that had contained the supernumerary oxygen mask boxes.

D.1 STRUCTURE:

The airplane was manufactured by Boeing as line number 145 and assigned serial number 23432. FAA records show the first flight on June 26, 1986 as N6005C. The airplane was operated in Japan as a passenger airplane from July 8, 1986 to August 15, 2003, when it was acquired by ABX Air. Israeli Aircraft Industries (IAI-Bedek) converted the airplane to a full-cargo configuration at Ben Gurion International Airport in Israel. The airplane was re-registered as N799AX and had an airworthiness date of November 22, 2004.

The airplane had two supplemental type certificates (STCs) covering the conversion of the passenger to the all-cargo configuration. The main STC for the conversion was developed by IAI-Bedek as ST01433SE. The Civil Aviation Authority of Israel (CAAI) issued an STC for the conversion, and then the FAA issued a corresponding STC via the type design validation process, in accordance with the bi-lateral agreement between the United States and Israel. The cargo loading system had been developed by AAR Corporation and was installed by IAI-Bedek.

The worst of the heat damage was in the area of the supernumerary compartment, although the fire penetrated the upper aft cockpit wall. Large holes had perforated the top of the fuselage above the supernumerary compartment and in the left sidewall, next to where the lavatory oxygen bottle had been located. The fire department had used a truck-mounted penetrating water nozzle, called a “snozzle,” and holes typical of snozzle were found, such as forward of a burn-through that was next to the L1 door.

The flight control cables for the rudder, stabilizer trim, and First Officer side of the elevator system had passed over the supernumerary compartment. The Captain’s side of the dual elevator control system was routed along the left sidewall of the airplane. Following the fire the cables and pulley assemblies that had been routed over the supernumerary compartment were found on the floor of the main deck, allowing the flight control cables to be slack. The fire did not affect the routing of the Captain's elevator control path.

The heat affected area extended between FS 260 and FS 434, from about the floor on the left side of the fuselage to the top of the R1 door. (See Figures 1 through 3)

The following fire damage was found to the primary structure:

1) Most of the skin, stringers, and frames between stations 266 to station 360 and from stringer 7-Left to stringer 6-Right had been consumed, melted, or had been heavily damaged.
2) Frames & stringers from station 266 to station 390 below stringer 6 on the left and right hand side up to the floor level had been heat-damaged and distorted.
3) Frames and stringers from station 360 aft to station 434 in the crown area had been distorted.
4) Holes were in the left side of the fuselage where frames and stringers had been outboard of the lavatory. This damage extended from station almost FS 270 forward to the cockpit partition, and above roughly 30 inches above the floor level.
5) The non-metallic materials in most of the 9-G cargo restraint (net) had burned away.
6) The structural center portion of the aft cockpit wall was missing from about 5 feet above floor level.

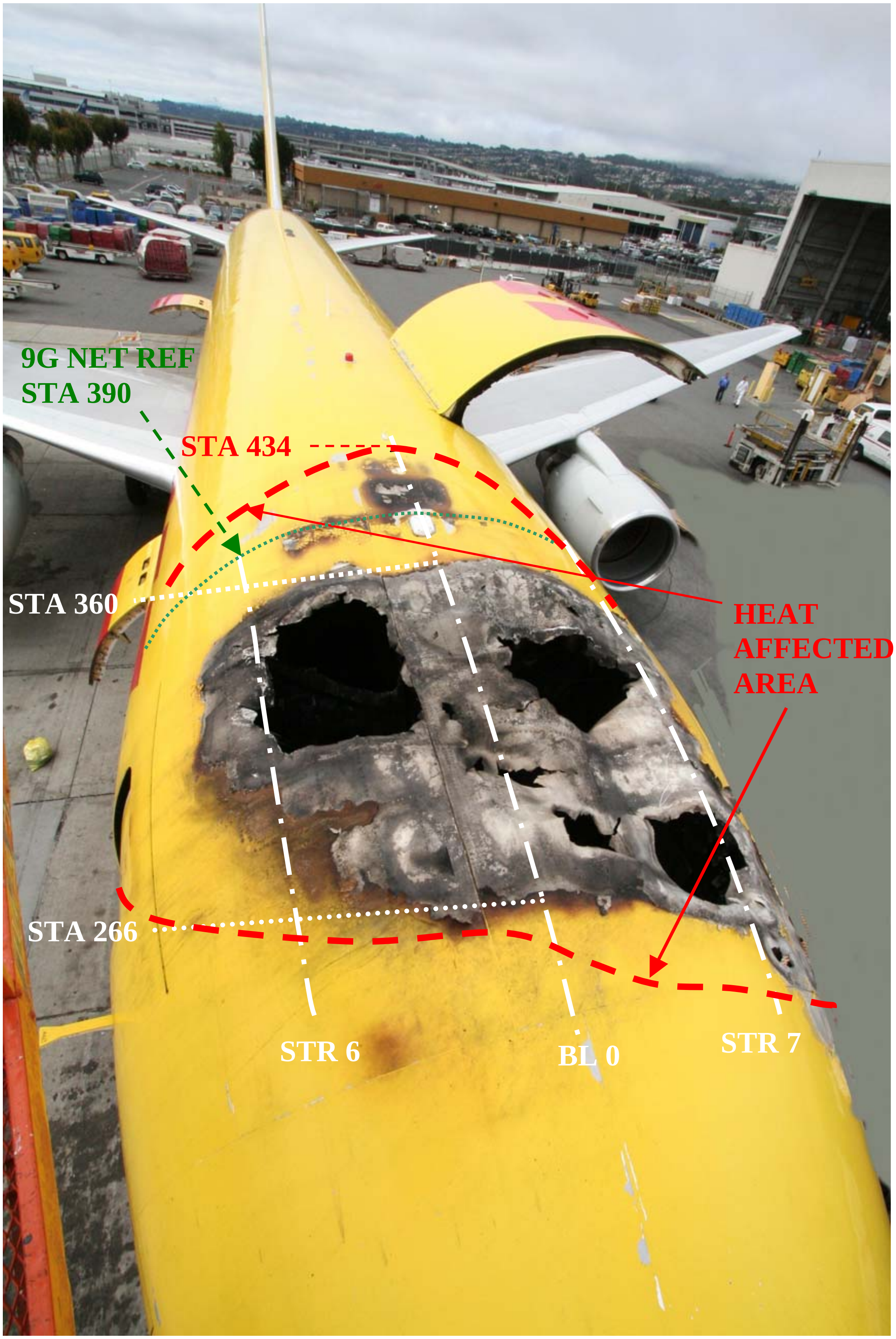

Figure 1. The general areas of heat damage to the top of the fuselage.

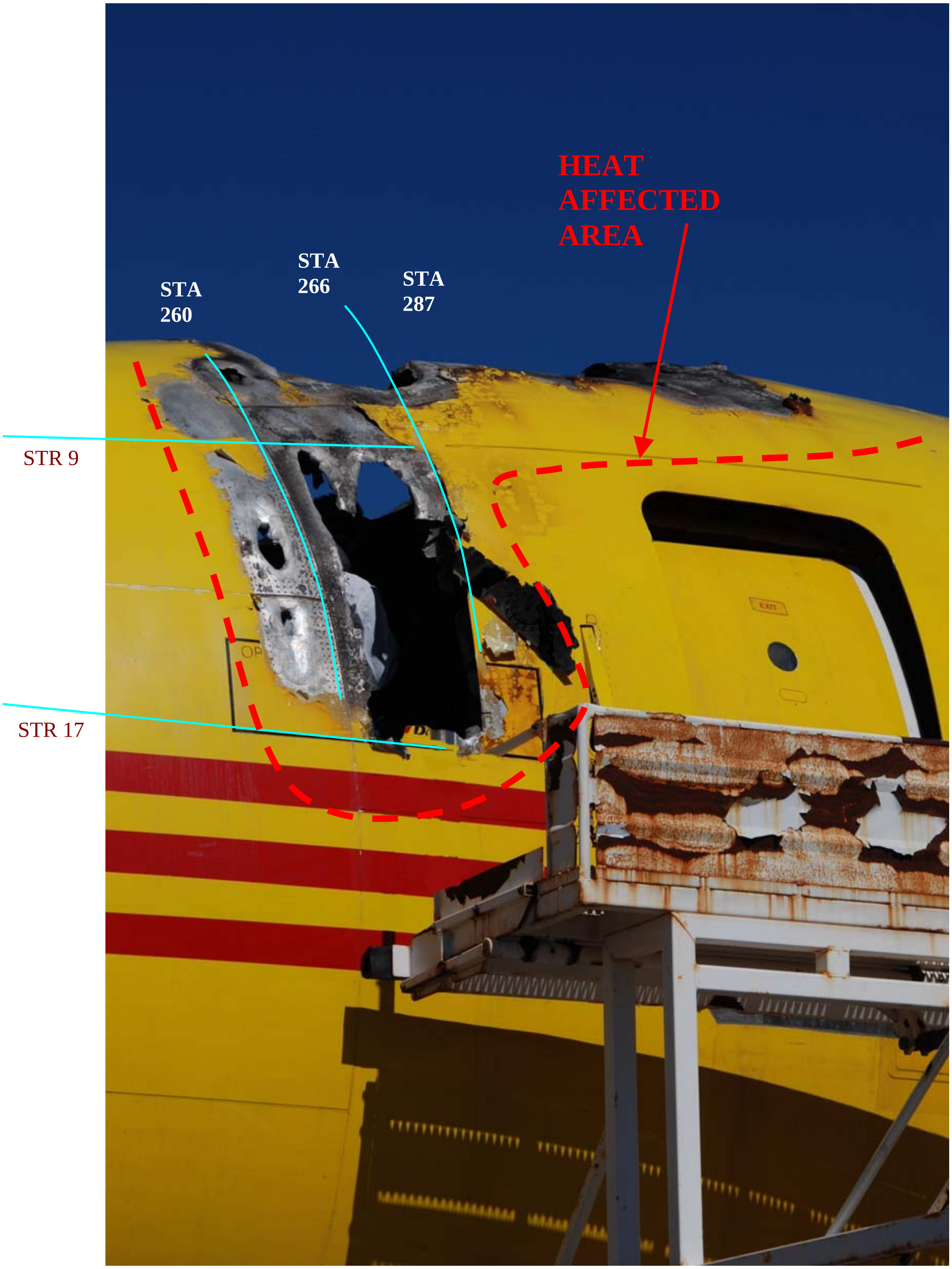

Figure 2. Externally visible heat damage to the left side of the fuselage, ahead of the L1 door. The underlying structure had extensively more damage than can be seen.

Figure 3. Heat damage to the right side of the fuselage, above the R1 door.

The smoke wall that had separated the occupied spaces from the cargo compartment split vertically at or near butt-line zero, where a modified aluminum T-section connected the left and right panels. The panels had been held together by metal clips installed in slots that had been milled through the T-strip. (See Figure 4)

Figure 4. Photo of the aft side of the smoke wall in an exemplar aircraft. The supernumerary compartment and cockpit would be to the left of this wall. The net is the 9-G cargo barrier and the tail is to the right of this photo. The arrows show clips installed through T-strip in a similar airplane, holding the left and right smoke wall panels together. The center-wall clips and T-section had been consumed in the accident aircraft.

A reinforced aluminum wall had existed between the cockpit and supernumerary compartment. Another wall had been between the supernumerary and the cargo compartments. The top of the cockpit to supernumerary wall had been breached by the fire. (See Figure 5)

Figure 5. As viewed aft and up from the Captain's seat in N799AX, this view shows where fire breached the wall that had separated the cockpit from the supernumerary compartment. The sky is visible through the holes that had penetrated the top of the supernumerary compartment. The supplemental oxygen tubing and wiring that were not found for inspection had been in this missing area.

A hand-held GPS provided the following coordinates at the nose of the airplane:

N 37° 37.465'
W 122° 23.893'

The First Officer's forward windshield had a large vertical crack with numerous smaller cracks radiating outward, and it was reported that during firefighting efforts, an attempt was made to use the snozzle penetrator on the windshield.

D.2 SUPERNUMERARIES - GENERAL:

Under FAA design requirements, transport category airplanes configured for all cargo operation that are equipped with Class E cargo compartments, as defined in 14 CFR Part

25.857(e), can not carry passengers. Airplane occupancy is limited to flight crew. However, the FAA has granted exemptions to some design approval holders, such as Israel Aircraft Industries, to allow for the carriage of certain kinds of individuals on all-cargo airplanes, and these individuals are known as supernumeraries. These individuals are not revenue passengers and must meet certain requirements associated with fitness and training. Certain passenger-related requirements are not applied to supernumeraries because they are trained and more familiar with the airplane systems than typical passengers. Examples of supernumeraries include airline employees and individuals specifically associated with the cargo, such as animal handlers, specialists in cargo loading, military couriers, and security personnel. The FAA operational requirements contained in Part 121 allow for such individuals, and Section 121.583 provides a further listing.

The FAA granted IAI-Bedek an exemption to certain Part 25 requirements to allow for the carriage of up to three supernumeraries for the supplemental type certificate (STC) installed on N799AX. Specific relief was provided for sections 25.810(a)(1), 25.857(e), and 25.1447(c)(1), based on the specific training and capabilities of the supernumerary to be carried. Under the exemption, escape slides normally required for passenger airplanes could be replaced by crew-type escape devices. Oxygen masks normally required to be automatically presented in the event of a decompression were not required to be automatically presented. Rather, the supernumerary trained in use of the more complex crew-type masks could be instructed to don the masks by the pilots.

The supernumerary area in N799AX was located aft of the cockpit and forward of the main deck cargo. The supernumerary compartment was generally considered to be aft of STA 275 and forward of the cargo compartment smoke wall. (See Figures 6 through 8)

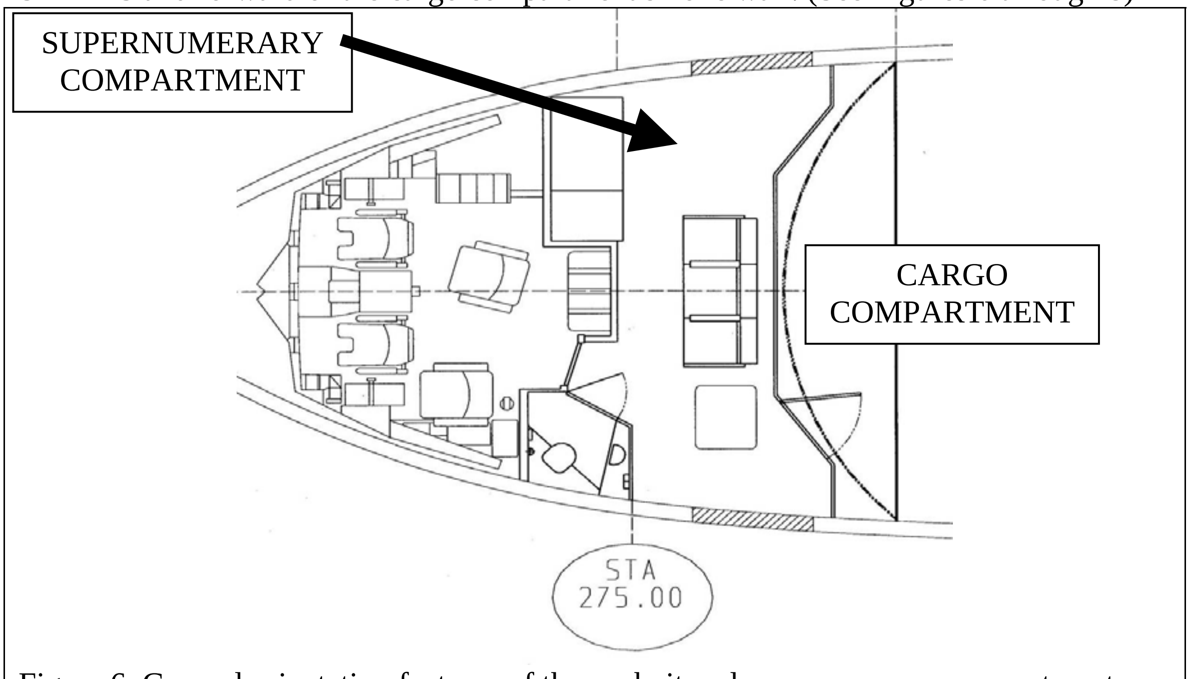

Figure 6. General orientation features of the cockpit and supernumerary compartment from above.

Note: Not shown in Figures 6-8 was a computer that had been mounted on the smoke barrier wall to the right (outboard) of the right-most supernumerary seat. An edge of the computer can be seen in the lower left corner of Figure 12, behind the person's elbow.

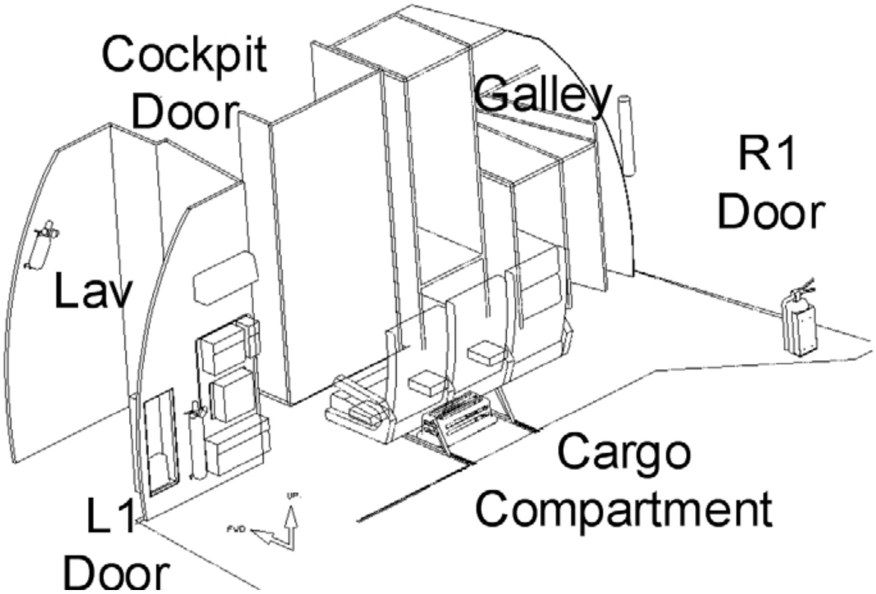

Figure 7. General orientation features of the supernumerary compartment from the aft left, facing toward forward right.

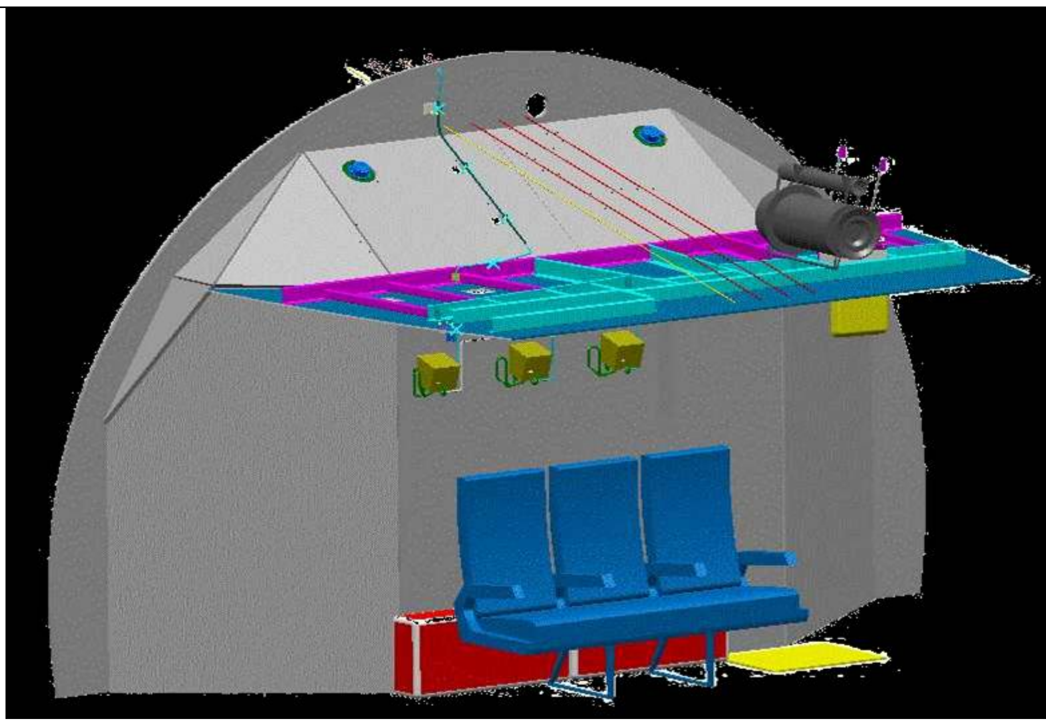

Figure 8. General orientation features of the smoke wall (gray), supernumerary seats, ceiling, and locations of the supplemental oxygen mask assemblies (three yellow boxes) above each seat. The view is toward the aft left and omits features such as the cabinet which contained the mask boxes and reading lights.

D.3 SYSTEMS:

D.3.1 OXYGEN SYSTEM, GENERAL INSTALLATION:

The airplane was provided with a supplemental oxygen system for the pilots and supernumerary occupants. Each of the two compartments had been supplied by a separate 115 cubic foot pressurized metal cylinder. The two 1850 psig (nominal) cylinders, their associated manual shut-off valves, and the pressure regulators were located to the right of the nose landing gear. This location was beneath the main deck floor, under the area of the co-pilot and to the right of the nose landing gear in a space shared with the electronic equipment center (E/E compartment). To permit the pilots to draw from the supernumerary supply and to prevent potential leakage in the supernumerary area from depleting the available supply of oxygen for the pilots, the system included a check valve between the two supply bottles.

To supply oxygen to the supernumerary seats, rigid stainless steel metal tubing at a nominal 70 psi was routed from the pressure regulators near the cylinders, upward between the galley and aft right cockpit, then inboard above the main deck ceiling. The routing then was aft, slightly outboard of the supernumerary heating outlet and inboard of the forward R1 door track, then inboard to follow the forward station of the smoke wall. The metal line bent downward to a “T” fitting to service the right-most supernumerary installation, and branched to the center and left supernumerary installations. Directly above and slightly behind each of the supernumerary seats was a box-mounted, crew-type oxygen mask. The mask assemblies were generally similar to those provided for the pilots, although in the case of the supernumerary, the microphone wiring integral to the masks were not connected. (See Figures 9A, 10, and 11)

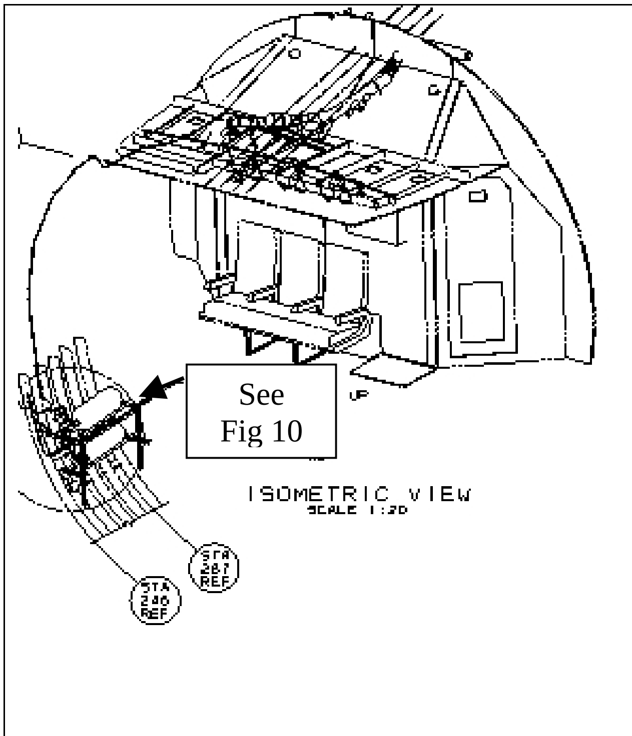

Figure 9. As viewed from the front left of the airplane, the drawing shows the routing of the supernumerary supplemental oxygen supply from the below-deck oxygen cylinders. The three supernumerary seats are shown.

Figure 10. N799AX. The green oxygen bottles circled in Figure 9A are shown from the rear. The upper bottle supplied the supernumerary oxygen system. The top of this compartment is the cockpit floor and the nose landing gear compartment was to the left of this photo.

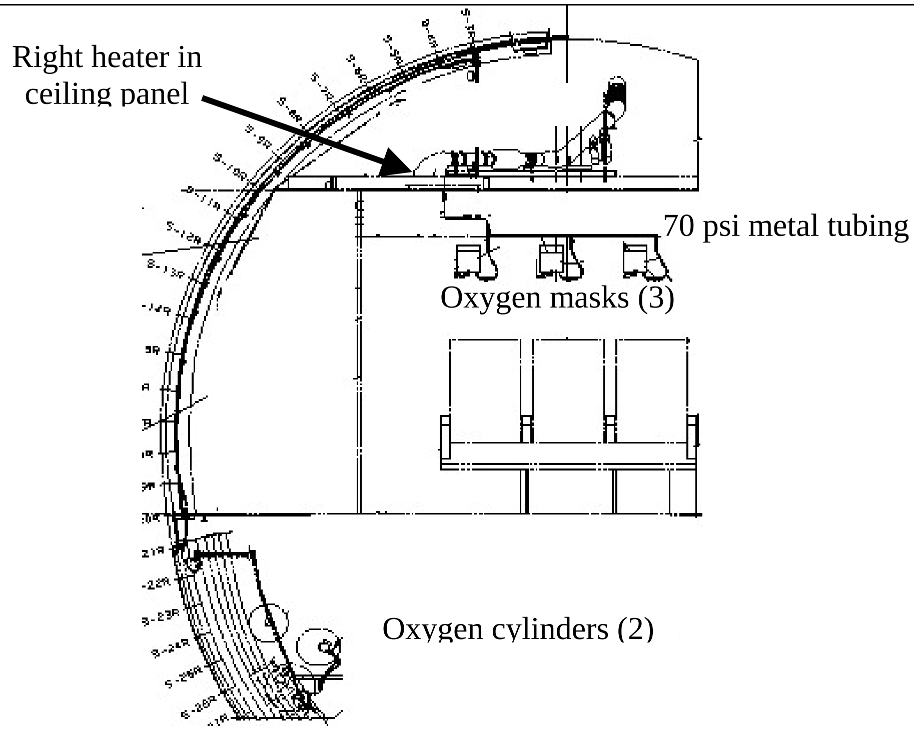

Figure 11. View of oxygen bottles below the main cabin floor and oxygen mask locations above each supernumerary seat. View looks aft.

In the event of overpressure in the high pressure portion of the system, a green disc would open to vent the cylinder(s) overboard at 2850 psi. The vent had been located to the right of the nose landing gear and below the oxygen cylinders and would vent overboard. In the event of an internal regulator failure, each regulator was designed to open at 160 psi, releasing the cylinder contents into the atmosphere shared with the E/E compartment. Neither vent in N799AX was found with evidence of having been opened by a discharge.

D.3.1.1CABINET ENCLOSURES AND LIGHT ASSEMBLIES:

Above the supernumerary seats was an enclosure for the horizontal portion of the metal supply tube, the mask box assemblies, the gasper tubes, reading lights, and reading light switches. The air to each gasper was routed through orange hoses from above the ceiling. The enclosure was made of fiberglass facial panels and composite or aluminum honeycomb cores. In other aircraft a gap existed between the enclosure and the ceiling. The width of the gap seen in two other airplanes varied between about 1/8-inch and 5/8-inch. (See Figures 12 and 13)

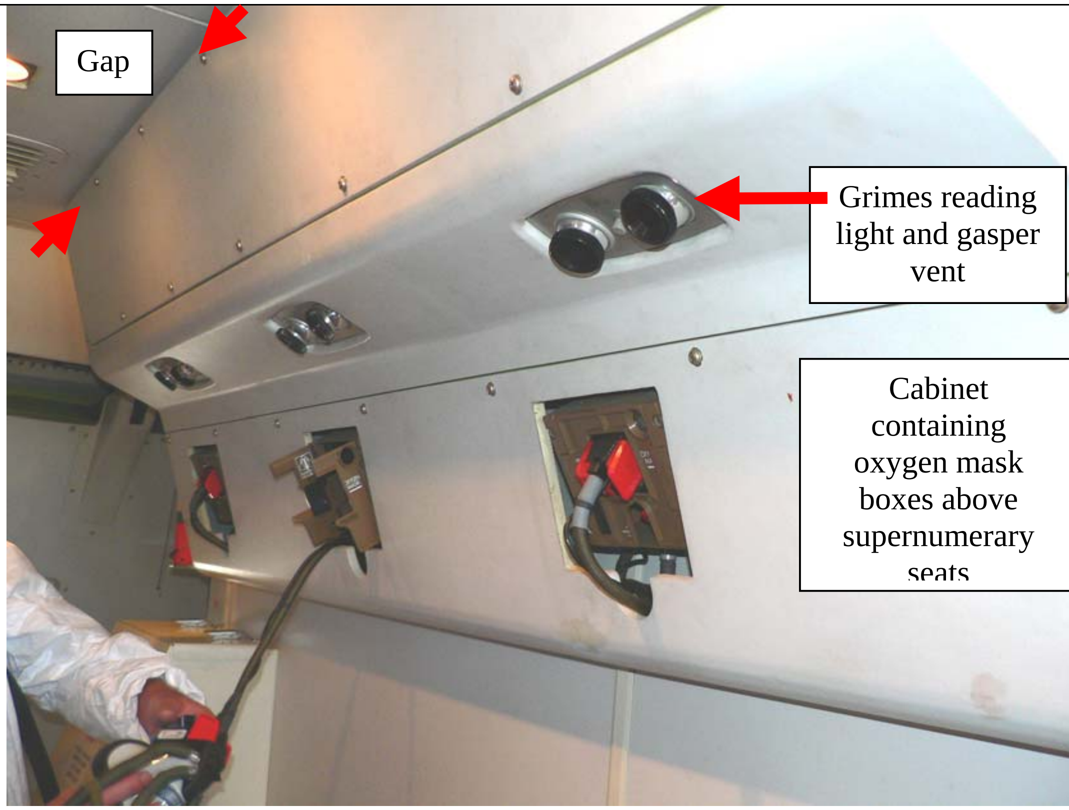

Figure 12. The cabinet over the three supernumerary seats in an exemplar 767 containing the oxygen mask assemblies, the gaspers, and reading lights. The gap between the enclosure and ceiling is visible at the upper left. The First Officer described first seeing the fire near the left arrow. Figure 16 shows the same area with the upper panel removed.

Note: The next topic and the following four Figures describe the concealed side of a light and vent (a.k.a. gasper) assembly. Three of the Grimes passenger service unit (PSU) light and gasper assemblies are visible above the mask boxes in Figure 12.

The Grimes Aerospace Company Component Maintenance Manual (CMM) for the PSU, Part Number 10-0026, stated that:

> The reading light provides area illumination for passenger seats. It consists of a light assembly, a gasper assembly [fresh air outlet] and an escutcheon plate assembly on a mounting plate assembly.

ABX inspected the fleet of 767 freighter airplanes after the fire and found that many were missing rubber boots that isolated electrical parts of light assemblies. When the lights were rotated, the light switch in the center of the assembly was able to contact the grounded light housing. (See Figures 13 and 14) The ABX personnel were able to produce visible sparks by contacting the electrical components.

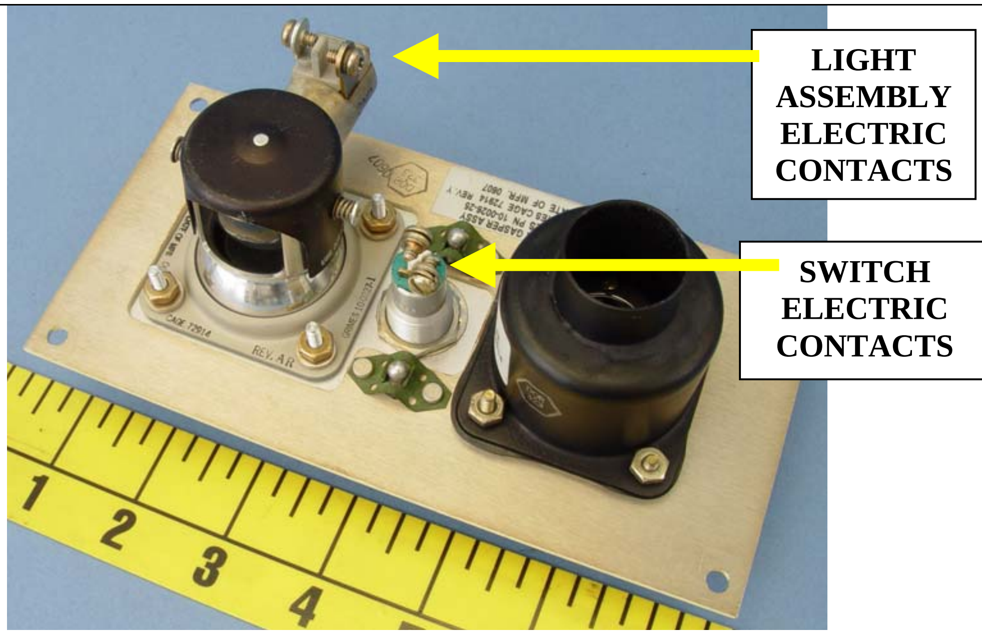

Figure 13. Light assembly from an exemplar aircraft (left) in an unrotated orientation. A pushbutton switch is in the middle and the electrical connection screws are visible. An orange fresh air (gasper) hose would be connected to the black housing on the right.

Figure 14. The same light assembly after rotating until the lighting shell contacted a potentially powered screw at the light switch.

The CMM showed that a p/n 60-2517-1 silicone boot should be installed over the switch assembly. A second silicone boot of the same p/n or a 60-2636-1 cable nipple was placed over the screws of the electrical contact at the lighting socket assembly. (See Figure 15)

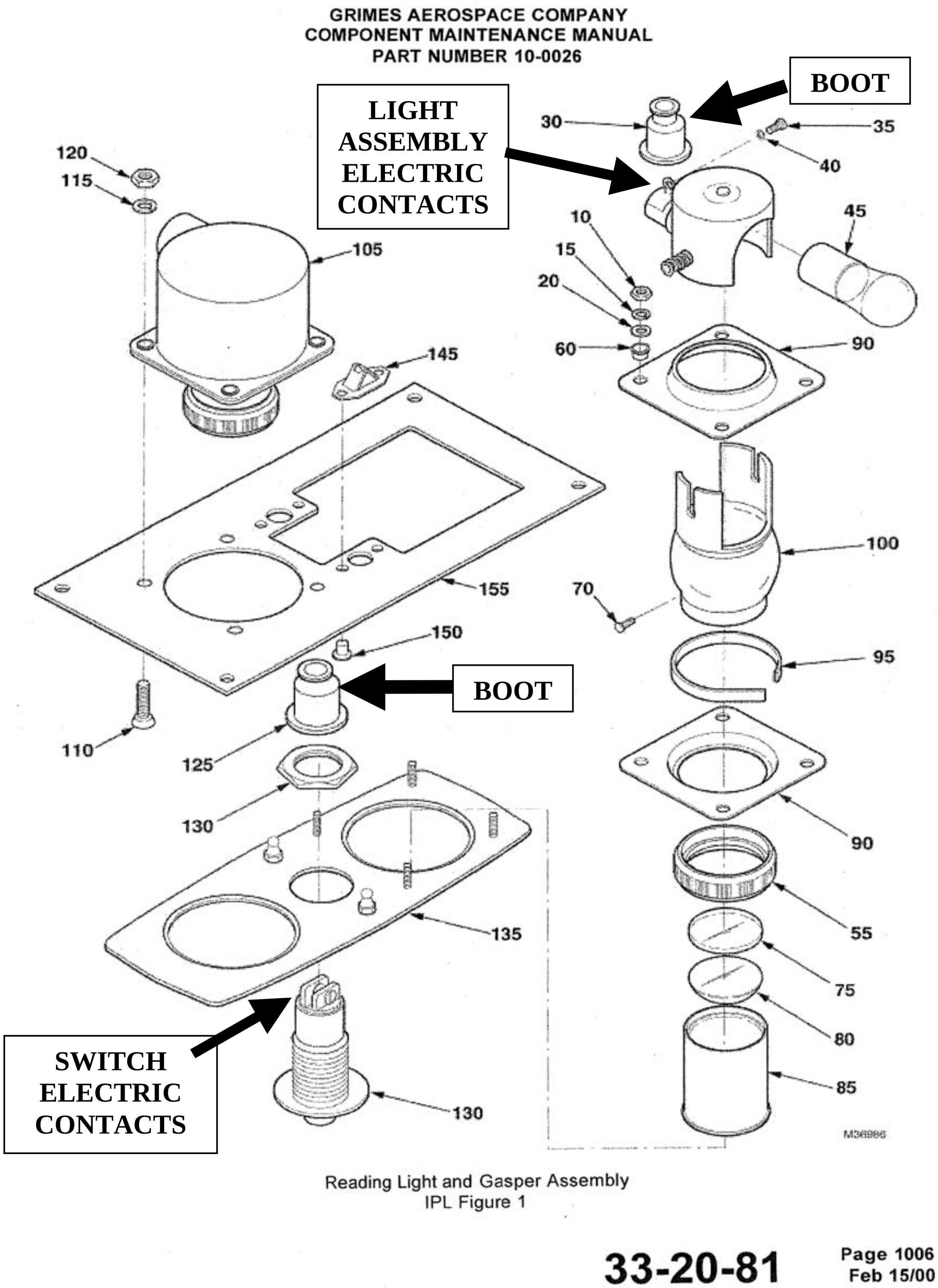

Figure 15. Grimes Component Maintenance Manual illustration showing the missing rubber boots, with added text in boxes. Items numbered 30 and 125 (see "BOOT") are listed in the CMM as a p/n 60-2517-1 silicone boot and cover the electrical connections. As an alternative, item #30 could have been a p/n 60-2636-1 cable nipple.

The boots were found inconsistently installed between the ABX airplanes examined, although the boots had been required in each location. Some airplanes had the boots installed in both locations, some in one location and others with no boots installed. At least one was found with black tape protecting the switch contacts. (See Figure 16) The operator decided to deactivate the lights on the ABX and the ATI 767 freighter airplanes until the assemblies were modified to prevent the light assembly in the unit from being able to rotate into contact with the switch terminals, with or without the boots. The ABX modification to the PSU installed insulated stand-offs to prevent the light socket terminals from rotating far enough to contact the terminals of the light switch (Ref. ABX Drawing M08858). When the work was accomplished to modify the lights for incorporation of the change, the wire insulating boots were also inspected and corrected where necessary.[5]

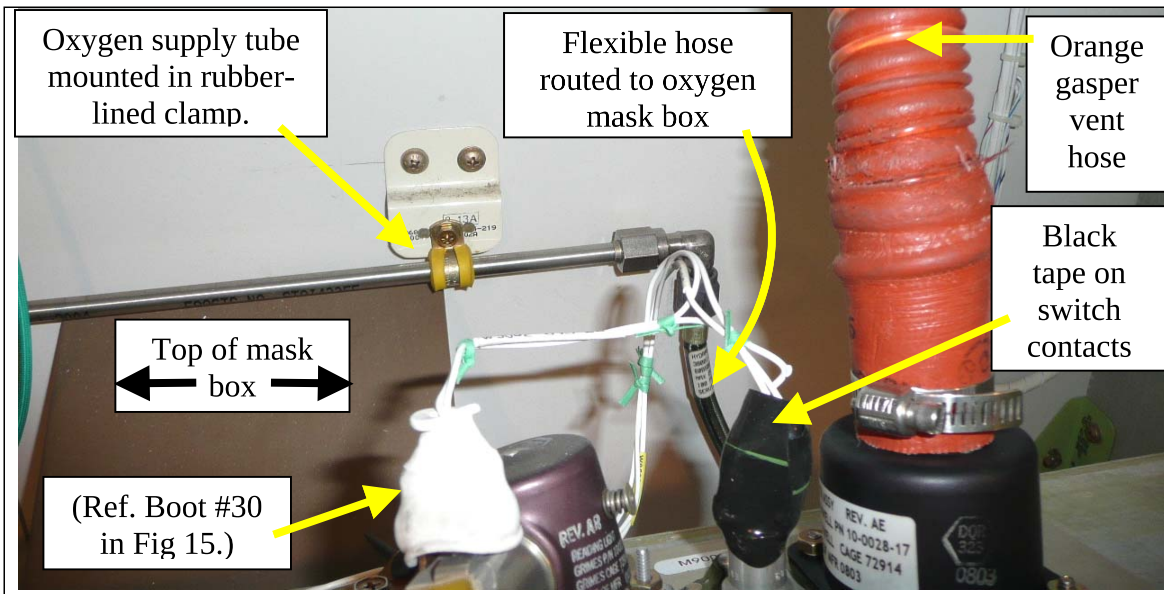

Figure 16. Exemplar airplane. Proximity of the oxygen supply tube located above the supernumerary seat to the gasper hose (orange). This was above the left-most seat and a typical installation for component proximity above each of the three seats. Figure 17 shows a the same installation from below.
The white boot is Item #30 in Figure 15 and was missing in some airplanes. The switch contacts in this airplane were covered with black tape, rather than having a similar white boot (Ref. Figure 15 Item #125). Figure 12 shows the same area with the upper panel installed. The supplemental oxygen mask box was mounted beneath the Grimes passenger service unit.

The ABX Wiring Diagram 702517 showed that the power to the reading lights was 28 VAC, from a right-side electrical bus (2.5A) circuit breaker at the P11-6 panel. At least one wire at the switch terminals would have been energized as long as the bus was energized.[6]

5 ABX owned 18 of the 35 IAI-converted 767 airplanes. IAI-Bedek asked the other three operators of the converted 767 freight airplanes to check the rubber boots and the inspection results were not available.
6 The Grimes CMM showed the light to be 28VDC, rather than 28 VAC.

To examine whether an electrical transient may have been involved in creation of an arc, the pre-start checklist was examined. The ABX 767 Fleet Chief Pilot noted that the normal checks that would have been accomplished by the crew at the time of the fire, such as checking for standby power, would not turn the RH 28V AC Bus off and on again.[7] At about the point in the pre-departure routine in which the fire began, the pilots typically switch power from an external source to the auxiliary power unit (APU) or vice versa. This action for starting the engines could momentarily interrupt power to the buses and then restore the electrical power. The Chief Pilot related that in most cases the APU would be on and running prior to the crew arriving, then the APU would need to be disconnected as part of the departure.

Also attached to each PSU, orange gasper hoses were routed near the oxygen supply tubing in the enclosure above the supernumerary seats. Wiping the inside of the hoses with a finger or white tissue revealed nothing in most cases, although one had a light film of oily residue. The source of air for the hoses (indirectly) was the engine bleed air system.

The flexible orange gasper vent hoses used by IAI-Bedek were made to SAE specification AS4804 and typically came from one of the following two sources: (1) Flexfab LLC of Hastings, Michigan, and (2) Senior Aerospace BWT (formerly Baxter Woodhouse and Taylor) in the United Kingdom. The Flexfab catalog entry for the FLX 4008 orange gasper hose material contained the following description: "Lightweight air handling hose and ducts for low positive pressure and high negative pressure applications and low to high temperature applications. Flexible lightweight material, reinforced with external helically-wound nylon. Resistant to oils, solvents, ozone, fungus, alkalis and water per SAE AS1501."

D.3.1.2OXYGEN HOSE INSTALLATIONS:

The IAI-Bedek design of the modification routed the nominal 70-psi supply of oxygen through the rigid stainless supply tubing to a point near the mask box above each seat. A flexible hose with a Boeing part number then connected the oxygen supply to a short stainless steel tube that was attached to each of the mask boxes. The stainless sections connected to a blue anodized aluminum fitting in the bottom of the mask box. Markings on the flexible hoses showed that each had been manufactured by Hydraflow Corporation. (See Figure 17)

7 The crew could isolate the buses with the Bus Transfer Breaker, but nothing was found to indicate that this was accomplished, nor was it part of the company procedures.

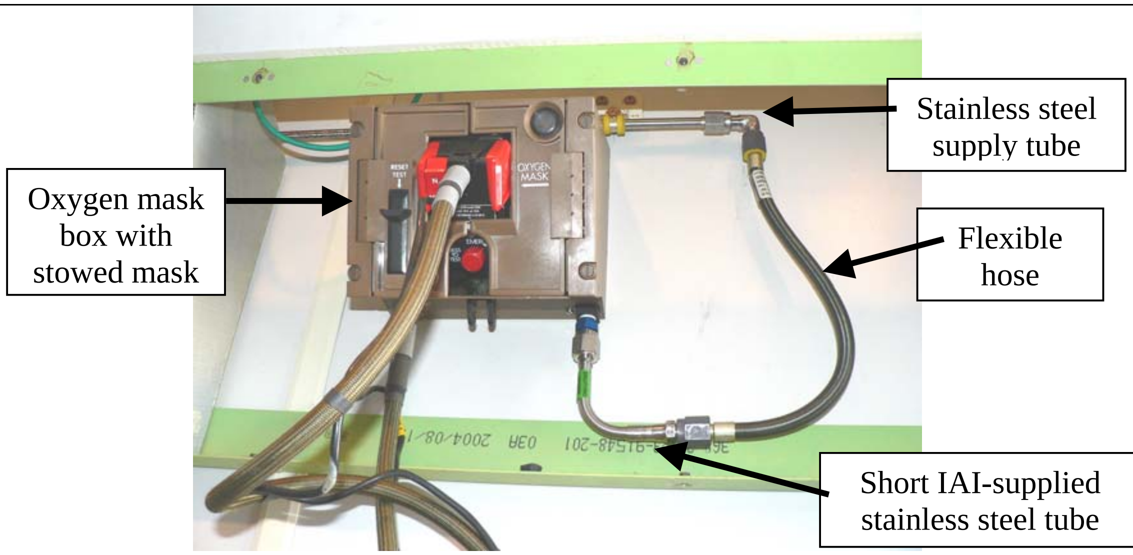

Figure 17. Exemplar airplane, showing the same supply tube and flexible hose visible in Figure 16. (Figure 16 was downward onto the components in this Figure.) This supernumerary mask assembly view was achieved by removing the front panel of the cabinet.

The nominal 70-psi supply to the mask arrives in the metal tube above the mask assembly box, then was routed to a Boeing part numbered flexible hose with stainless steel connectors. When the front of the enclosure was in place, the hose hanging at the bottom of the photo was laid in the box to not interfere with the person sitting in the supernumerary seat.

The short section of stainless steel tubing was a difference between the Boeing installations that investigators saw in the cockpit and the IAI-Bedek design in the supernumerary compartment. The Boeing installations found in the cockpit connected the flexible hose directly to the mask box. (See Figure 18)

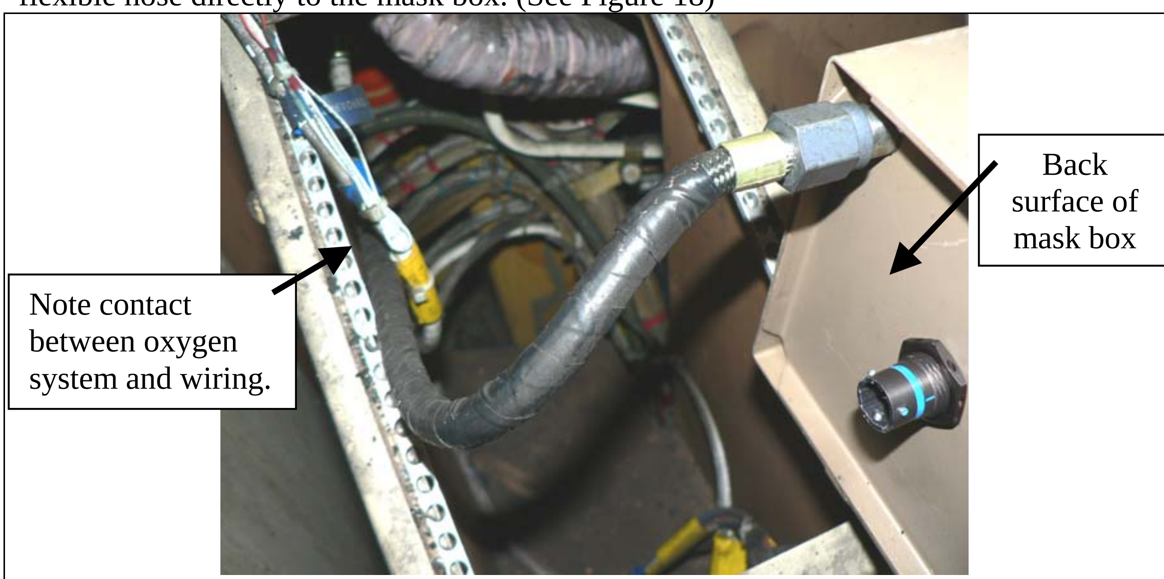

Figure 18. The PVC hose connecting the N799AX left observer's cockpit supplemental oxygen mask box and the stainless steel supply tube. The stainless supply tube at the hidden end of this PVC hose is not visible. This tube had been

wrapped in PVC black tape and a wear pattern was seen on structure that this hose had rested against. (The protective over-wrap of tape was described in Boeing SB 767-35A0034). The open electrical connector in the lower right corner of the photo was a provision for the oxygen mask microphone assembly. Note co-routed electrical wiring.

The supernumerary mask boxes (Part Number MXP-106-02) had been provided by Intertechnique-Eros.[8] The Captain's mask box had been manufactured under license from Intertechnique-Eros by Scott Aviation. The routing to the Scott-manufactured mask assembly box was less complex than those of the Eros assemblies. The flexible supply hose in the Scott-manufactured assembly attached directly to a fitting at the base of the mask box. In the Eros assembly, the stainless nut on the hose was routed to a stainless fitting on one end of the stainless elbow. The end of the elbow near the box had an aluminum nut to attach to a blue-anodized aluminum fitting. The fitting had an AN-flare at the end which attached to the elbow and a compression thread (also known as a pipe thread) at the end which attached to the box assembly. Rather than attaching directly to the hose assembly within the box, the Eros assembly used a square-shaped black-anodized fitting at the wall of the box and the hose assembly within the box connected to the black fitting. Teflon tape had been used on each of the three blue-anodized compression thread fittings. (See Figure 19)

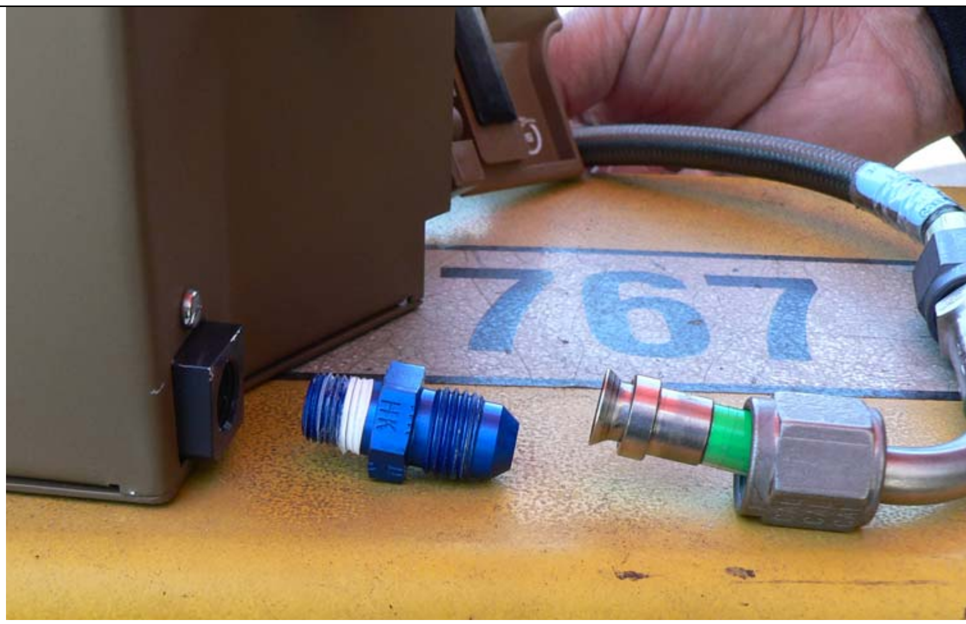

Figure 19. N799AX: Parts required to connect the oxygen supply to the Eros mask box, as used in the supernumerary compartment.

The hose assemblies routed to each mask box in two other airplanes were examined and the hose was found routed tightly in one installation, to displace the stainless elbow upward, pulling on the bottom of the flexible hose. (See Figure 20)

[8] The Eros masks were Part Number MC10-25-101.

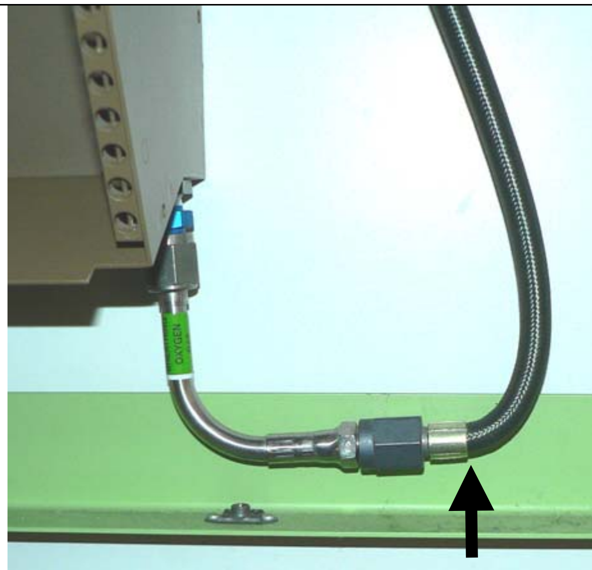

Figure 20. The arrow shows where an improper routing placed tension on the PVC flexible hose, where it entered the fitting at the bottom of the oxygen mask box assembly. Photo taken in N798AX before deactivation and removal.

The oxygen supply metal tube fitting which had been located above the center supernumerary seat was different than the fittings for the hoses that had been connected to the other two oxygen mask assemblies. The difference was that the fitting for the hose connecting to the center seat flexible hose assembly had resolidified aluminum in the fitting threads. (See Figure 21)

Figure 21. N799AX: Resolidified aluminum filled the threads of the center supernumerary seat threads. The flexible hose to the mask box would have hung from this fitting.

D.3.1.3N799AX SUPPLEMENTAL OXYGEN SYSTEM:

Maintenance personnel on-scene provided the pressures of the oxygen bottles from pre-flight as 1580 psi for the supernumerary cylinder and 1700 psi for the crew cylinder, and related that they had turned the valves to off after the fire.[9] When the group inspected the cylinders, the supernumerary cylinder was empty and the crew cylinder was 1700 psi. (See Figure 22)

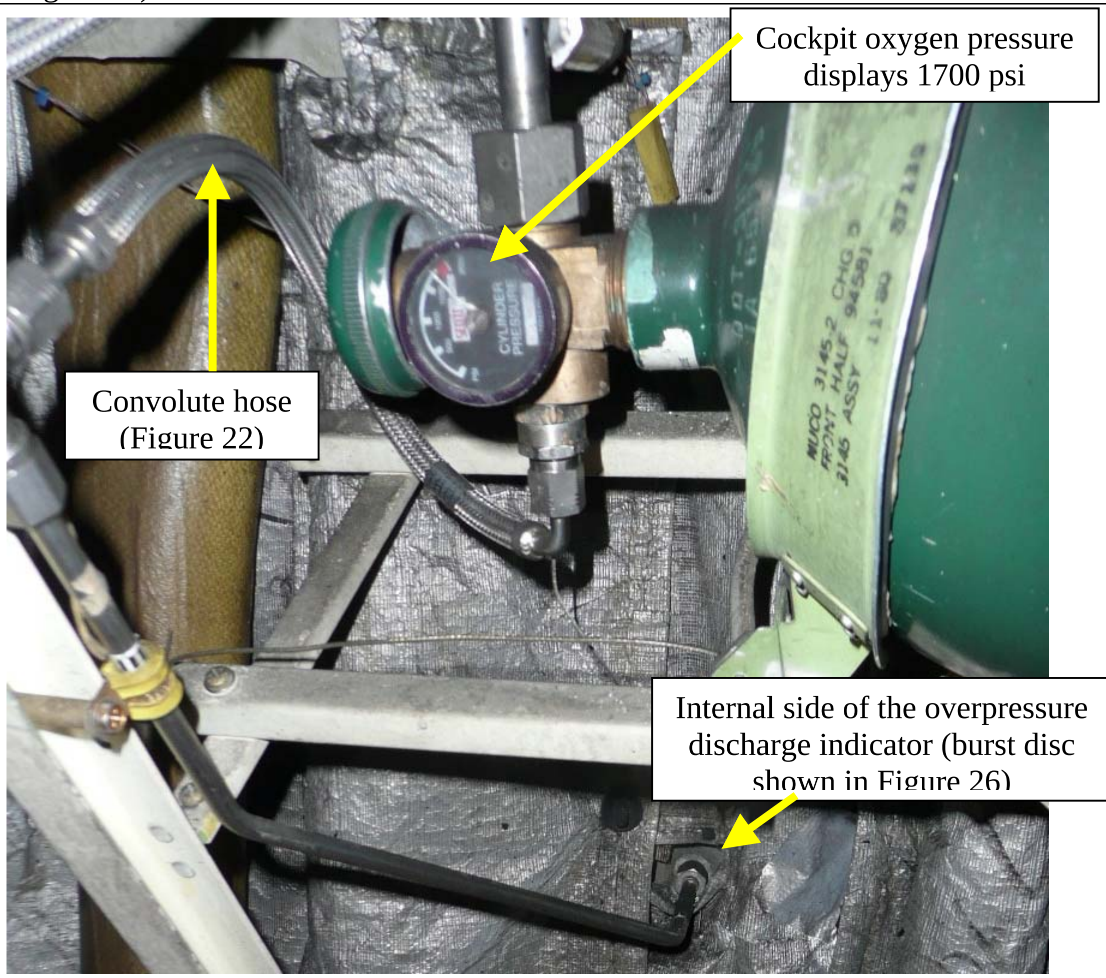

Figure 22. N799AX: Cockpit supplemental oxygen supply pressure as-found displayed 1700 psi. The convolute hose found to be an electrical path to ground for the oxygen system at the overpressure indicator (burst disc) is also shown.

Because the crew used oxygen to test the masks and in some operations, the maintenance personnel related that the normal practice at ABX was to refill the cylinders to 1800-1850 psi when the pressure indication was found approaching 1300 psi. The green overpressure disc on the lower right exterior of the airplane was intact.

[9] The pressure values shown are from conversations directly with the mechanics at the airplane.

The metal oxygen supply tube in the supernumerary area was found intact, with each of the fittings that had been above the supernumerary seats. The fittings were tight and no penetrations of the tube were found. The recovered rigid stainless steel tubing was removed for detailed inspection with a 3X magnifying glass and no punctures or damage was found. (See Figure 23)

Figure 23. N799AX: The metal oxygen tube remained intact in the supernumerary compartment. The R1 door is in the background.

The supplemental oxygen system was pressure tested for leaks with shop air at about 110 psig. This test required plugging the tube to the previously removed supernumerary system and plugging the missing area of tubing, aft of the circuit breaker panels in the cockpit. When soapy water was sprayed onto each of the fittings, the pressure test revealed one minor leak. The leak was in a heat-damaged area, where the PVC hose connected to the back of the right observer mask box. Specifically, the foaming was between the B-nut and swaged fitting, not between the PVC hose and the swaged fitting. No sound could be heard and the leak created only an extremely slow foaming at the fitting. (See Figure 24)

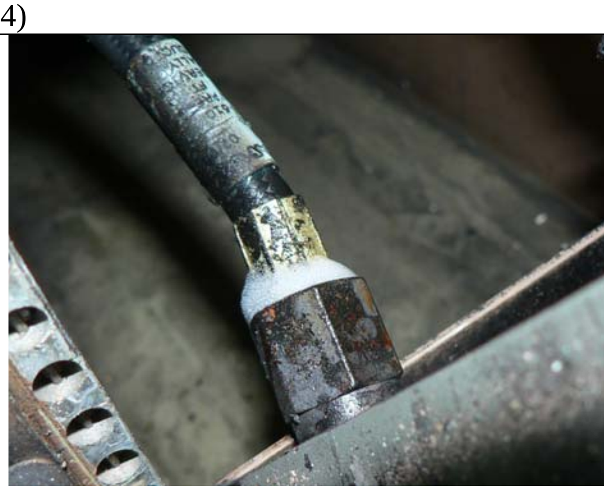

Figure 24. N799AX: Slight foaming at the right observer station hose. This slow foaming action required about a minute to produce.

The same hose fitting (after removal from the airplane) did not leak during testing at Hydraflow. The Hydraflow engineering staff noted on several occasions that they had experienced such leakage due to the deformation of the mating surface, which in this case was still on the airplane. The mating surface was designed to be a bulb seal and they had seen fittings in which maintenance or installation personnel had over-torqued and deformed the shape of the bulb seal.

D.3.1.4 OXYGEN SYSTEM GROUND PATHS:

Inspections of operational ABX 767 freighters were initially conducted to aid in orientation of components that had been in the fire-damaged N799AX. Electrical wires were found that crossed the routing of the metal oxygen tube, above the ceiling panels. In two airplanes, the wiring was routing beneath the oxygen tube or was securely clamped with significant spacing from the oxygen. In one airplane, wire bundles were found in two locations not clamped or clamped in such a way that the wires could contact the oxygen tube. (See Figure 25)

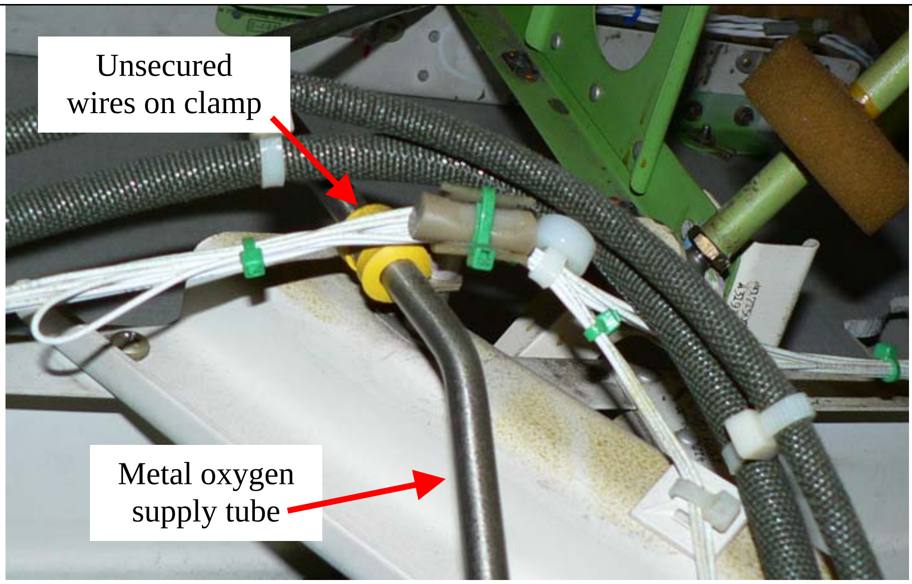

Figure 25. Exemplar airplane: Above ceiling of similar airplane, this photo shows an electrical bundle lying on a yellow clamp which supports the metal oxygen tube.

Electrical resistance between the supplemental oxygen system and the structure of the N799AX airplane was measured and the path of least resistance was found to be through a convolute high pressure oxygen hose (See Figure 22). No grounding straps were found between the supplemental oxygen system components and the airframe.

In the event of overpressure in the high pressure portion of the system, a green disc would open to vent the cylinder(s) overboard at 2850 psi. The vent had been located to the right of the nose landing gear and below the oxygen cylinders. The convolute hose in the path to the housing of this green disc was Titeflex high pressure convolute oxygen hose p/n 96431-11, Boeing p/n 60B50060-11. (Ref. Figures 22, 26, 27)

Figure 26. N799AX: The exterior view of the overpressure disc, located to the right of the nose landing gear. The Titeflex convolute hose shown in Figure 22 was part of the routing to the interior of this port.

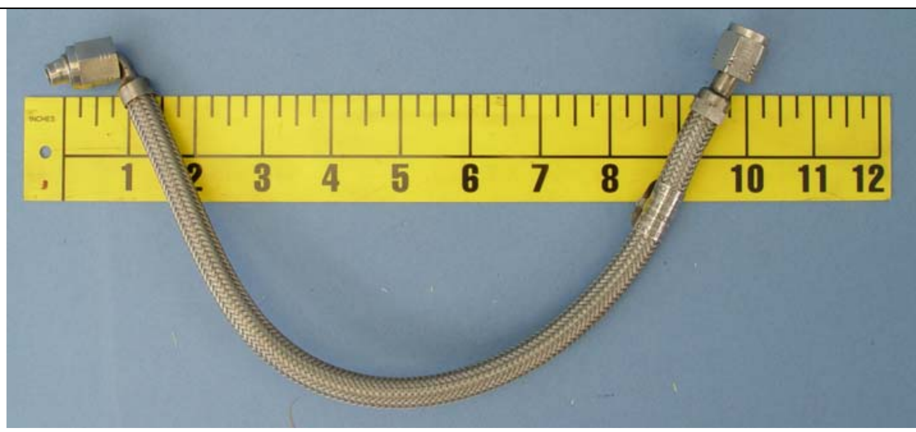

Figure 27. Detail of the Titeflex convolute hose from N799AX. (See Figure 22) The hose had an outer braid of stainless steel wire and welded end fittings.

The convolute hose from N799AX had a metal tag with the following markings:

Titeflex[10]
96431-11
60B50060-11
OPER PRESS 3000PSIG
OXYGEN S/N 0081

Without the convolute hose connection to structure in N799AX, the electrical resistance between the stainless oxygen supply tubes and structure was typically about 3 mega-

10 Titeflex, 603 Hendee Street, Springfield, MA 01139.

ohms. With the convolute hose installed, the resistance was 0.3 ohms through the tube and oxygen regulators.[11]

The path (as opposed to electrical resistance values) of electrical continuity through each of the cockpit hoses was found to be similar in N799AX.[12] The supply end of each hose was found connected to stainless steel supply tubing that was routed from the oxygen cylinders. An end of each hose attached to a short section of stainless steel at each box containing a supplemental oxygen mask. In the cockpit, each AVOX or Scott[13] supplemental oxygen mask box was held to structure by quick-release (1/4-turn) fasteners. (Visible in Figure 18) In the supernumerary compartment, screws in each box fastened to hard-points in the aft compartment wall. The potential ground path routes observed included through the hard-points contacting grounded aluminum at the panel edges, through the aluminum core of honeycomb (where used), or where in contact, between the short sections of stainless tubing and the bottom flange of the cabinet. (See Figure 20)

The PVC supplemental oxygen hoses from the cockpit were removed and the electrical resistance was measured between the ends of each hose. Each of the hoses marked "ELECTRICALLY NONCONDUCTIVE" were found to be an open circuit. The resistance in hoses without the marking could vary in a single hose between single ohms and totally open circuits.[14] The resistance of any individual hose could be changed by slight manipulation of the hose at either end and mega-ohm measurement displays could be found for some orientations. The reason for the intermittent variations in conductivity and resistance was found to be the how the internal steel wire spring reinforcement hooked into a hole in the steel fitting at each end of the hose.

D.3.1.4.1 OTHER WIRE / OXYGEN SYSTEM INTERFERENCE:

The Safety Board issued Safety Recommendations A-98-1 and –2 to the Administrator of the Federal Aviation Administration on January 15, 1998. Following an in-flight fire aboard a Cessna Citation Model 650 (Citation III), arcing was found between 115 VAC electrical wiring and a hydraulic tube. The letter also contained details about additional incidents involving inadequate clearance between electrical wiring and adjacent components, such as in a Delta Air Lines 767 on June 25, 1996, involving flight controls and a similar Lan Chile Airlines incident that followed days later. These led to a Telegraphic AD for a fleetwide inspection to ensure that at least one inch of clearance existed between flight control cables and electrical wiring. The letter referred to one

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11 All electrical measurements were made with a Fluke Model 73 Multimeter, following installation of a fresh battery for this activity.

12 Boeing labels the observer seats as primary and secondary. To prevent confusion, the group and this document referred to the observer seats as simply left and right.

13 AVOX Systems is a part of the Aircraft Systems Segment of Zodiac, originally was Uniloy Accessories Corporation, and later Scott Aviation. The manufacturer is at 225 Erie Street, Lancaster, NY

14 This resistance was measured with a Fluke volt-ohmmeter at the airplane. Further electrical resistance test results and other descriptions for each of the individual hoses is documented in the section titled HYDRAFLOW OXYGEN HOSES.

incident involving an oxygen system in a 1995 Japan Air Lines 767, where inadequate clearance led to arcing between wires and an oxygen line fitting near the Captain's oxygen mask.[15] The Japanese incident was followed by a Boeing Service Bulletin and an FAA AD mandating the installation of protective sleeving over the wiring within two inches of the oxygen lines. After the summary of interference-related incidents, the NTSB recommended that the FAA:

> Review the design, manufacturing, and inspection procedures of aircraft manufacturers, and require revisions, as necessary, to ensure that adequate clearance is specified around electrical wiring, in accordance with published FAA guidelines. (A-98-1).
>
> Review the existing designs of all transport-category airplanes to determine if adequate clearance is provided around electrical wiring, in accordance with published FAA guidelines. If deviations are found, require that modifications be made to ensure adequate clearance. (A-98-2)

The letter referred to a Safety Board review of FAA guidelines for safe wire routing practices and cited Advisory Circular (AC) 43-13-1A, "Acceptable Methods, Techniques, and Practices – Aircraft Inspection And Repair," and AC 65-15, "Airframe and Powerplant Mechanics Airframe Book." These references state that no electrical wire should be located within ½ inch of any combustible fluid or oxygen line, and if the separation is less than 2 inches, back-to-back clamps or a polyethylene sleeve should be installed to ensure positive separation. The letter noted that the original design of the 767 flightcrew oxygen mask stowage box allowed for electrical wiring to be within 2 inches of oxygen lines, but that protective sleeving was required after the 1995 JAL incident.

Note that Figure 18 shows contact between wires and the oxygen system components that led to the observer position that had been behind the Captain in N799AX.

Inspections found chafes of Boeing 747 wiring on oxygen lines, which led to Boeing SB 747-35-2035, dated 7 January 1983. Finding additional chafes led to Boeing Alert Service Bulletin (ASB) 747-35A2035, Revision 1, dated 22 July 1999. The FAA mandated adoption of this ASB by issuing Airworthiness Directive 2001-24-29, effective January 16, 2002. This AD required a onetime inspection for chafing between the hose for the passenger oxygen system (hereinafter called the ``oxygen hose'') and adjacent electrical wire bundles at certain passenger service units, and corrective actions, if necessary. This AD also required rerouting or reorienting the oxygen hose to ensure sufficient clearance between the hose and electrical wire bundles. This action was described as "necessary to prevent chafing between the oxygen hose and adjacent electrical wire bundles, which could result in arcing of a chafed electrical wire bundle and consequent burnthrough of the oxygen hose. If this occurs when the oxygen system is pressurized, such arcing could represent a potential ignition source in an oxygen enriched environment." The ASB called for a minimum of 2 inches clearance between the oxygen hose and electrical wire bundle.

The FAA also issued AD 2004–22–16 on November 4, 2004, for certain Gulfstream Model GV and GV–SP series airplanes to require a one-time general visual inspection for contact or insufficient clearance between the crew oxygen bottle/supports and any wiring harness, related investigation, and corrective actions if necessary. This AD also required adjusting the wiring harness to obtain a minimum clearance between the oxygen system components and wiring, applying Teflon sheeting in certain cases, and reworking certain wiring bundles.

D.3.1.5HYDRAFLOW OXYGEN HOSES:[16]

IAI personnel related that at least the original hoses for the STC conversion had been made by Hydraflow and had the Boeing part number.[17] The Hydraflow hose construction was of polyvinyl chloride (PVC), with an internal corrosion resistant steel spring to prevent kinking the hose, and an outer Nomex braid that supplied heat and chafe protection. The weave of the Nomex was oriented to control the growth of the hose when pressure was applied.

The change in design that led to later hoses with the "ELECTRICALLY NONCONDUCTIVE" marking placed a plastic insert between the internal spring wire and each end fitting, rather than hooking the spring wire directly to the end fitting.[18] A minimum engineering requirement for electrical resistance tests at the factory was one mega-ohm, but the minimum value was not a drawing requirement.

Boeing Alert Service Bulletin (SB) 767-35A0034 had been issued to recommend replacement of the –94 hose assemblies with non-conductive hoses.[19] The SB related that the –94 hose contained a metal reinforcement wire spring and that in two airplanes, a 737 and a 757, an electrical current had reached the hose wire springs, heating the stainless steel wire springs and causing a melt-through of the PVC hose sidewall, allowing oxygen to leak.

Federal Aviation Regulation 25.1309 states that:

(a) The equipment, systems, and installations whose functioning is required by this subchapter, must be designed to ensure that they perform their intended functions under any foreseeable operating condition.
(b) The airplane systems and associated components, considered separately and in relation to other systems, must be designed so that--
(1) The occurrence of any failure condition which would prevent the continued safe flight and landing of the airplane is extremely improbable, and

16 Hydraflow, 1881 W. Malvern Avenue, Fullerton, Cal

17 The original conductive hose call-out was for Hydraflow p/n 38001-94, which was Boeing p/n 60B50059-94. The equivalent size of the conductive replacement hose had a "-608" to replace the "-94" dash number.

18 The internal springs can be seen in Figures 28-30, with Figures 29 and 30 showing the looseness of how the wire hooked to the end fittings of the earlier hoses.

19 Original released on September 2, 1999. Revision 1 released June 22, 2000.

(2) The occurrence of any other failure condition which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions is improbable.

Although the failures had occurred in similar installations in two airplanes and short circuits are not considered to be extremely improbable, the FAA did not issue an airworthiness directive to require implementation of Alert SB 767-35A0034. Although nearly identical installations were found after the fire in other Boeing models of airplane and airplanes from other manufacturers, the FAA had not issued airworthiness directives for any other airplanes, either.[20] The FAA reported on December 4, 2008, that an AD to require incorporation of the service bulletin is in process with an expected publication in the Spring of 2009. The AD will be model specific and address several aircraft.

The FAA routinely issues airworthiness directives that refer to service bulletins as the means of compliance for removal of parts from service. The IAI-Bedek installation was similar to the original Boeing design in many aspects and called for original Boeing equipment in many locations. The investigation found that modifications created a route by which parts could remain in service after the FAA and manufacturers required replacement. The FAA regularly issues airworthiness directives that require accomplishment of a service bulletin that calls for parts to be replaced. When the same parts are installed in a new installation as part of an approved post-production modification, the service bulletins would not address the new use of the part.

IAI-Bedek also issued a Service Bulletin to call for hose replacements on September 3, 2008, then released a revision on September 21, 2008. In addition to calling for replacement of the conductive style of hoses, Service Bulletin 368-35-094 also asked operators to conduct fleet inspections to ensure that hose routings did not place a hose in tension.

The recovered Hydraflow hoses from N799AX were subjected to pressure testing at the manufacturer, either in water for the leakage test (observing for bubbles), or filled with water for testing the burst strength. Each of the hoses passed a 250 psig leakage test requirement. The hoses would move as the pressure was increased and each was noticeably stiffer when pressurized. The burst test required each hose to be pressurized to 500 psi for at least 3 minutes and each hose passed this requirement, as noted below. The Hydraflow engineering personnel noted that the preferred method of ultimate failure for a hose would be for the hose to fail prior to failure of the fitting at either end of the hose, and this was how each hose failed. (See Figure 28)

20 For example, hose 60B50059-70 is a low pressure hose assembly installed on 727, 747, 757, and 767 airplanes. Nearly identical hoses are also used in the 737 series of airplanes.

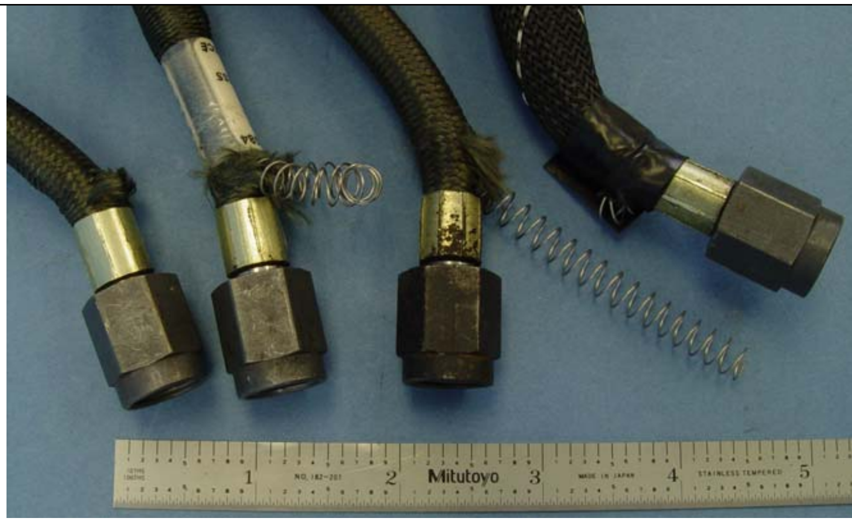


Figure 28. The photo shows the results of pressure testing four hoses to ultimate failure. From left to right, the photo shows the hoses of the N799AX Captain station, left observer station, right observer station, and First Officer station.

The following individual observations and markings were noted for the Hydraflow hoses which had been removed from N799AX:

Captain. This hose was removed during the first airplane examination and was found in braided chafe protection sleeve and had the following markings on an identification tag that had a blue tint:

> HYDRAFLOW 24984 02/00
> 38001-605
> 60B50059-605
> MAX OPER PRESS 100 PSIG FTE
> OXYGEN SERVICE – ELECTRICALLY NONCONDUCTIVE

First Officer. The actual burst pressure was 1100 psig. The hose was found in braided chafe protection sleeve and had the following markings on an identification tag that had a blue tint:

> HYDRAFLOW 24984 02/00
> 38001-606
> 60B50059-606
> MAX OPER PRESS 100 PSIG FTE
> OXYGEN SERVICE – ELECTRICALLY NONCONDUCTIVE

Left Observer. The hose had been wrapped with black PVC electrical tape. The tape was removed and no damage was found to the exterior of the underlying braid. The actual burst pressure was 1250 psig.

HYDRAFLOW 24984
38001-70
60B50059-70
4/98 FTE
MAX OPER PRESS 100 PSIG
OXYGEN SERVICE

When the left observer hose was tested for electrical conductivity on a Fluke Multimeter at the manufacturer, the resistance could be changed by manipulating the hose. Separate measurements between the ends of the hose were 502 ohms, no resistance, an open circuit, 122 ohms, and an unstable reading that varied from 300 to 600 ohms.

Right Observer. The actual burst pressure was 975 psig. The hose fitting was replaced and the hose was pulled at a right angle to the opposite fitting with a force of about 30-35 pounds. With the side load, the hose failed the second burst test at 880 psig. The hose had been routed through an area which had sustained heat damage and the blue tinted data tag was partially blackened and obscured.

HYDRAFLOW 24984 02/00
38001-610
60B50059-610
MAX OPER PRESS 100 PSIG FTE
OXYGEN SERVICE – ELECTRICALLY NONCONDUCTIVE

Following the fire, ABX accelerated the hose replacements in their fleet and provided a group of the replaced hoses to the investigation for consumption in burst and other testing. One of the hoses was found to have an end fitting sleeve that had a smooth inner surface. This contrasted with the internal serrations that gripped the PVC in other hose fitting assemblies. The date on the 27 year-old hose was seven months prior to the first flight of the first Boeing 767. The part number for the hose applicable to the 727, 747, 757, and 767 programs.[21] Hydraflow records indicated that the style of fittings changed at that time.

[21] The first Boeing 727 flew in 1963, predating the 767 program. The first 747 flew in 1969, also pre-dating the 767.

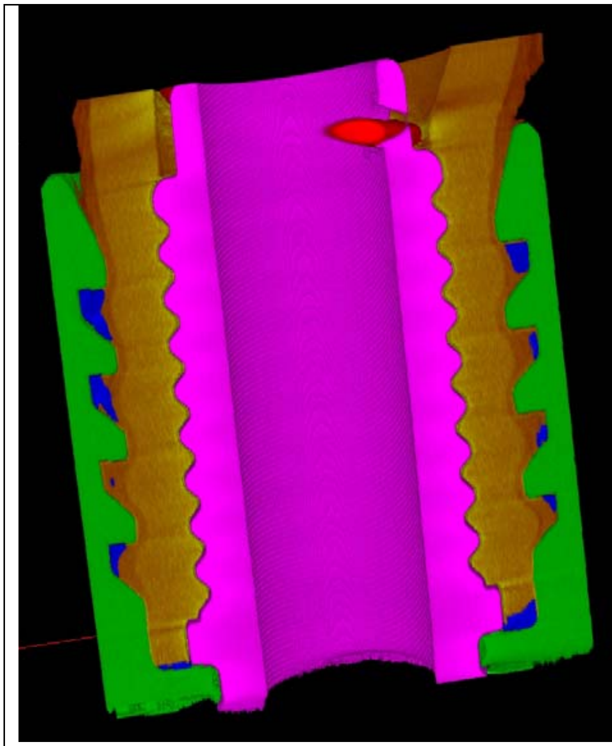


Figure 29. Exemplar airplane: Computerized tomography image of the sleeve on a typical hose end. This sleeve (green) is representative of all but one, in that it had serrations which were pressed into the pvc material (orange).

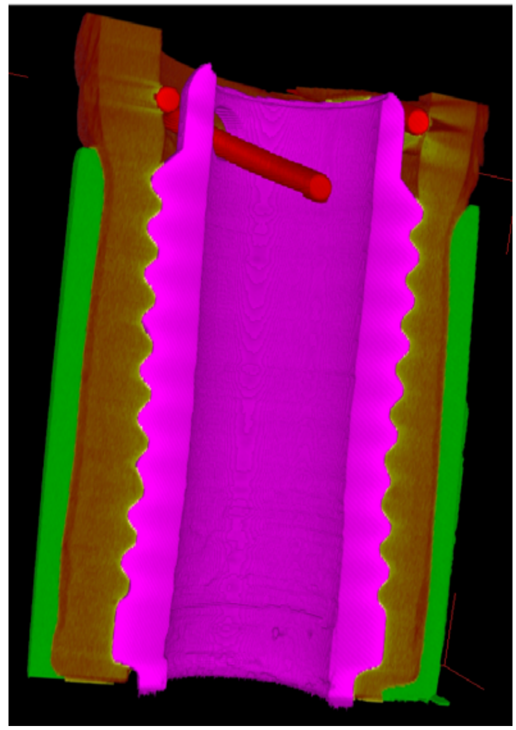


Figure 30. Exemplar airplane: Computerized tomography image of the older style sleeve that was found with no internal serrations.

Notes:

1. The above images also show the inconsistency of electrical contact between the internal stainless steel wire spring (shown in red and also visible in Figure 28) and the hole in the inner steel (pink) component that the wire spring hooked into.
2. Refer to the Computed Tomography Specialist Factual Report for additional illustrations and details.

After the tests at Hydraflow, a slight difference between the stiffness of various hoses was noticed and subjectively the oldest hoses had a slightly stiffer feel. To be less subjective and as a comparative test of flexibility, the end fitting of four hoses was mounted to a horizontal coupling and the distance was measured to where each hanging hose crossed a horizontal line that had been drawn 3.5 inches below the coupling.[22]

The newer hoses crossed the horizontal line closest to the coupling, with the newest manufacturing date (12/00, representing December 2000) at 2.5 inches. The oldest hoses (02/81 and 12/82) extended the furthest along the line, crossing at 3.7 and 3.9 inches, respectively. Hoses that had been installed with tension (localized pressure) to one side, as shown in Figure 21, retained a bend at the fitting even after removal. As a second test

[22] This test was not performed to a laboratory standard or with a sample of hoses large enough to be statistically significant.

for flexibility and to remove any potential influence that such bends could induce in the measurements, the middle of each hose was clamped in a vertical orientation and a one-pound weight was hung from the upper end of the hose. The results were similar to those of the first test, in that the bend radius of the older hoses was larger and the difference was about the same. The oldest hose was almost more than 27 years old and a literature search revealed that heat and pressure over time could affect polyvinyl chloride (PVC) plastic, the major material in the hose construction.

D.3.1.6ADDITIONAL SUPPLEMENTAL OXYGEN ISSUES:

In addition to the Boeing Alert Service Bulletin (SB) 767-35A0034 had been issued to recommend replacement of the –94 hose assemblies with non-conductive hoses:

1. A 747-300 operator reported a flight diversion on 22 January 2006 after the rupture of a Hydraflow (PN 38001-606) oxygen supply hose that had been routed to the first observer's oxygen mask box.[23] The rupture resulted in loss of pressure in the crew oxygen system. It was determined that the hose separated from the end fitting due to loss of clamping strength on the tube. The hose supplier concluded that the hoses failed due to inadequate crimp as a result of a change in crimp tooling between 07/1997 and 12/2000. The service related problem was closed based on the release of Boeing Alert Service Bulletin 747-35A2120 on 8 February 2007, calling for inspection of the flight deck oxygen box supply hoses to replace the affected hoses.

2. On July 17, 2008, All Nippon Airways notified ABX that a plastic fitting had been found cracked at the mask connection to the mask box. This applied to airplanes manufactured prior to 1986, which included the accident airplane. The same P/N masks are used in the cockpit and supernumerary area. An ABX fleet campaign to inspect all aircraft is currently in process.

3. On November 11, 2008, ABX reported the results of pressure testing a leaking O2 mask box that had been removed from a supernumerary seating position, due to maintenance troubleshooting for system leakage. The test found that the Pneumatic "ON-OFF" Valve leaked in the closed position (depressed). The valve was designed to open when the crewmember opened the left door of the box, permitting oxygen to flow to the mask. A piston should shut the oxygen supply when the door was shut and the piston reset. The valve only leaked when the valve piston was in the closed position (depressed into the valve), so that when the left door was closed and reset the valve would leak. If the door was open or closed and not reset, the valve did not leak. This had not been found in any other ABX airplane.

   The manufacturer, Intertechnique, had previously issued a modification to prevent leakage of the valve. The ABX valve had been of the post-modification style, according to ABX. The Intertechnique modification was 4PEE45504AC, Issue 2, identified in Intertechnique Service Bulletin MXP100-35-57, of May 15, 1996.

[23] Boeing Service Related Problem 747-SRP-35-0038 report of 1 February 2006.

D.3.1.7 N799AX OXYGEN REGULATORS:

The AVOX (formerly Scott) regulators for the oxygen cylinders had been removed during the first inspection of N799AX. The regulators were pressure tested and disassembled at the manufacturer, AVOX (formerly Scott Aviation).[24]

SUPERNUMERARY REGULATOR:

Part number 27660-08 and S/N 6686 were found on the regulator and were applicable to the valve assembly, which is what was present. Part number 803127-01 and S/N 4595 were marked on the assembly to denote the complete assembly of supplemental oxygen system regulator, transducer, and coupling.

When at N799AX, investigators had attached the supernumerary nipple to the cockpit oxygen cylinder and the nipple had not leaked with cylinder pressure of about 1580 psig. (The test was performed outside of the airplane.) At AVOX, the supernumerary oxygen cylinder nipple was examined and found to have scratches which appeared minor, but which could be felt with a fingernail and seen. (See Figure 31)

Figure 31. Scratches were found on the rounded wear area of this nipple from the supernumerary supplemental oxygen system of N799AX.

During examination of the regulators at AVOX, the service history documentation for the sub-assemblies was reviewed. The supernumerary regulator had been overhauled in November 2007 after receipt from Delta Airlines, due to leakage at the nipple which had

[24] The test data sheet for the regulators was AVOX Component Maintenance Manual (CMM) 35-16-30, TEST DATA SHEET B, [for] 27660 Series Oxygen Regulator Assembly, Page 1009, Revision 20071207. The test data sheet for the overpressure relief valve test was AVOX Component Maintenance Manual (CMM) 35-16-60, TEST DATA SHEET A, [for] 27660 Series Oxygen Regulator Assembly, Page 1008, Revision 20071207.

been connected to the cylinder.[25] The technician performing the work for the examination of August 4, 2008, was the same person who had worked on the regulator in 2006.The AVOX technician noted that maintenance-related damage at the nipple was a common finding when discrepancies described leakage at the oxygen cylinder fitting. A new coupling nipple had been installed by AVOX and following overhaul, the regulator assembly had been shipped back to Delta on November 27, 2006, then shipped to ABX Air as an exchange part.

Following the procedural steps of the CMM, a 150 psi low pressure test revealed no internal leakage and the pressure responses to varying flow rates were within allowable specifications. A soapy water leak test at 150 psi found no leakage.

At an inlet pressure of 1800 psi, the application of soapy water as a leak test revealed no leakage. The pressure settings held steady, without variance or creep that would indicate internal leakage. A flow test was within specification at varying flow rates, as described by the test data sheet.

At an inlet pressure of 1580 psi, the pressure settings held steady, without variance or creep that would indicate internal leakage. The outlet pressure was 74 psi. A soapy water leak test at1580 psi revealed no leakage.

The CMM showed that the overpressure valve should begin to open at 100-110 psi. The part began to open at 110 psi and re-seated at 90 psi.

Failure modes were discussed. From previous experience, the company personnel noted that the poppet would go into a resonance and destroy itself if the overpressure valve were to flow at high pressures, such as more than 140 psig for more than about 10 seconds. Overpressure valves which had experienced this typically could not subsequently meet the CMM parameters and the overpressure valves from the airplane met the CMM parameters. As a validation of the statements, a new check valve was subjected to 140 psi for about 30 seconds. After disassembly, a worn and dark annular ring was clearly visible in the white plastic seat. This test seat was clearly different than the appearance of another new plastic seat and both of the overpressure valves from the airplane. (Ref. Figures 32 and 33)

[25] The nipple from the cockpit regulator was serial 126 and from the supernumerary cylinder was serial number 1183.

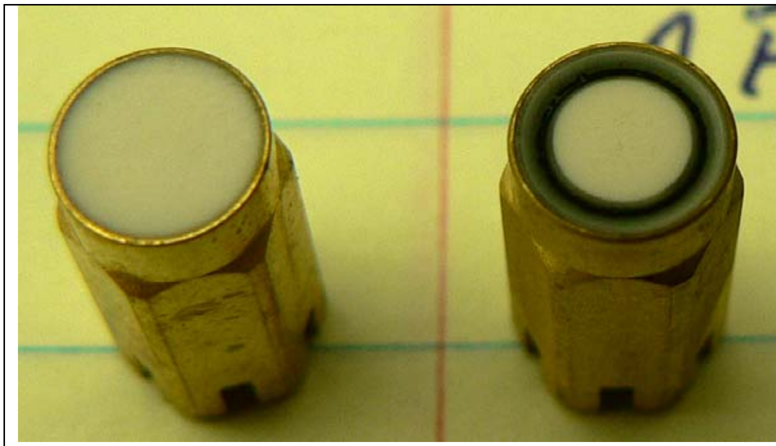


Figure 32. N799AX: New overpressure valve poppet on left. On the right is an overpressure valve poppet which was subjected to 140 psig for about 30 seconds and a darkened annular ring is visible.

Figure 33. N799AX: The overpressure valve poppet from the supernumerary regulator

After disassembly, the interior area and components were clean and found to function freely against the spring assembly. The dark green/gray diaphragm had an ink-stamped manufacturing date of September 26, 2006, and the spring seat had a slip ring (plastic washer).

Engineering documents showed that the slip ring was added in October 1999 and the diaphragm material change from the previous light gray material was in June 2000. (Ref. Figure 34)

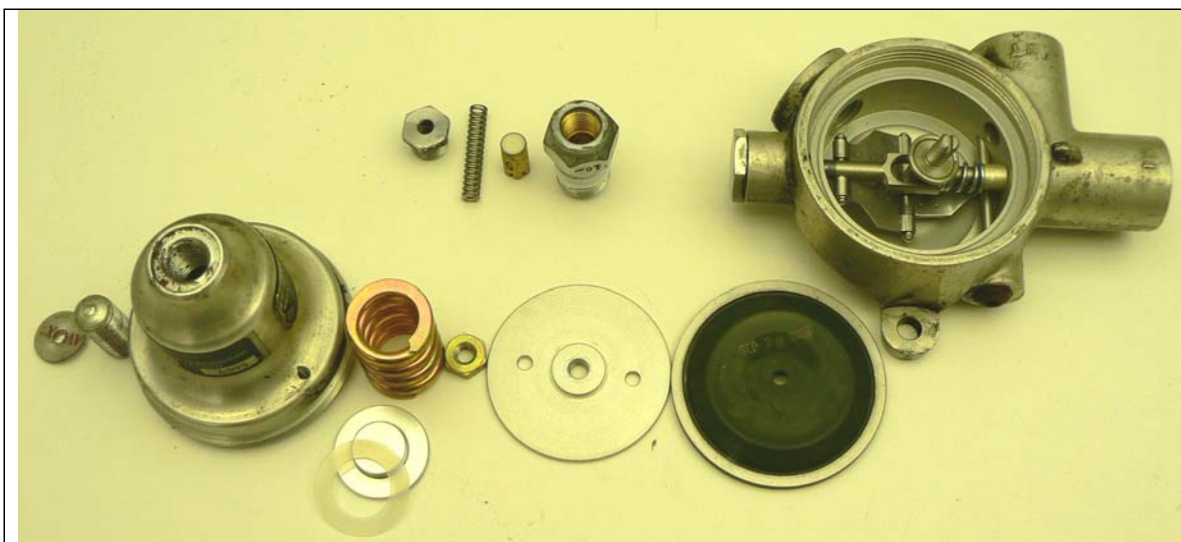


Figure 34. N799AX: Components of the regulator from the supernumerary supplemental oxygen system.

CREW REGULATOR

Part number 27660-08 and S/N 767 were found on the regulator and were applicable to the valve assembly, which is what was present. Part number 803127-01 and S/N 215 were marked on the assembly to denote the complete supplemental oxygen system assembly of regulator, transducer, and coupling.

The service records indicated that the crew regulator had not been overhauled by AVOX and there were no service marks or tags from other shops. This regulator had been manufactured in 1985.

The regulator passed the same low and high pressure soap-water leak tests and the functional tests as the supernumerary regulator. At the CMM-specified low pressure test of 150 psi at the inlet, the output pressure was 78 psi. The settings held steady, without variance or creep that would indicate internal leakage.

The overpressure valve began to release at about 100 psi, which was at/within the low specification limit, and re-seated at 90 psi. When disassembled, the plastic seat had a slight annular wear mark and several flecks of dark dust-like material which had not affected the performance. (See Figure 35)

Figure 35. N799AX: Slight annular wear mark and dark flecks of dust-like material on the face of the overpressure poppet from the crew regulator.

After disassembly, the interior area and components were clean and functioned freely against the spring assembly. The diaphragm appeared to the AVOX personnel to be the light gray color which would have been used in 1985.

D.3.2. N799AX SUPERNUMERARY COMPARTMENT HEATING SYSTEM:

The design of the supernumerary compartment provided heat from two electrical heaters that were located in ducts mounted above the ceiling. The core element from an electric heater was found approximately beneath where the left heater had been installed. The thin heating wires had no stretching, typically associated with damage while being hot. The heater also had no localized blackened areas or damage.

The panel that had contained the control knob assembly for the electric heater system was in an area of intense heat, immediately inboard of the L1 door. Most of the panel components had been consumed by the fire, including the control knob. Electrical contacts from within the knob assembly were found attached to loose wires.

D.3.3. N799AX FLIGHT CONTROLS:

The flight control cables for the rudder, stabilizer trim, and First Officer side of the elevator system had passed over the supernumerary compartment. The Captain's side of the dual elevator control system was routed along the left sidewall of the airplane. Following the fire the cables and pulley assemblies that had been routed over the supernumerary compartment were found on the floor of the main deck, allowing the flight control cables to be slack. The fire did not affect the routing of the Captain's elevator control path. (See Figure 36)

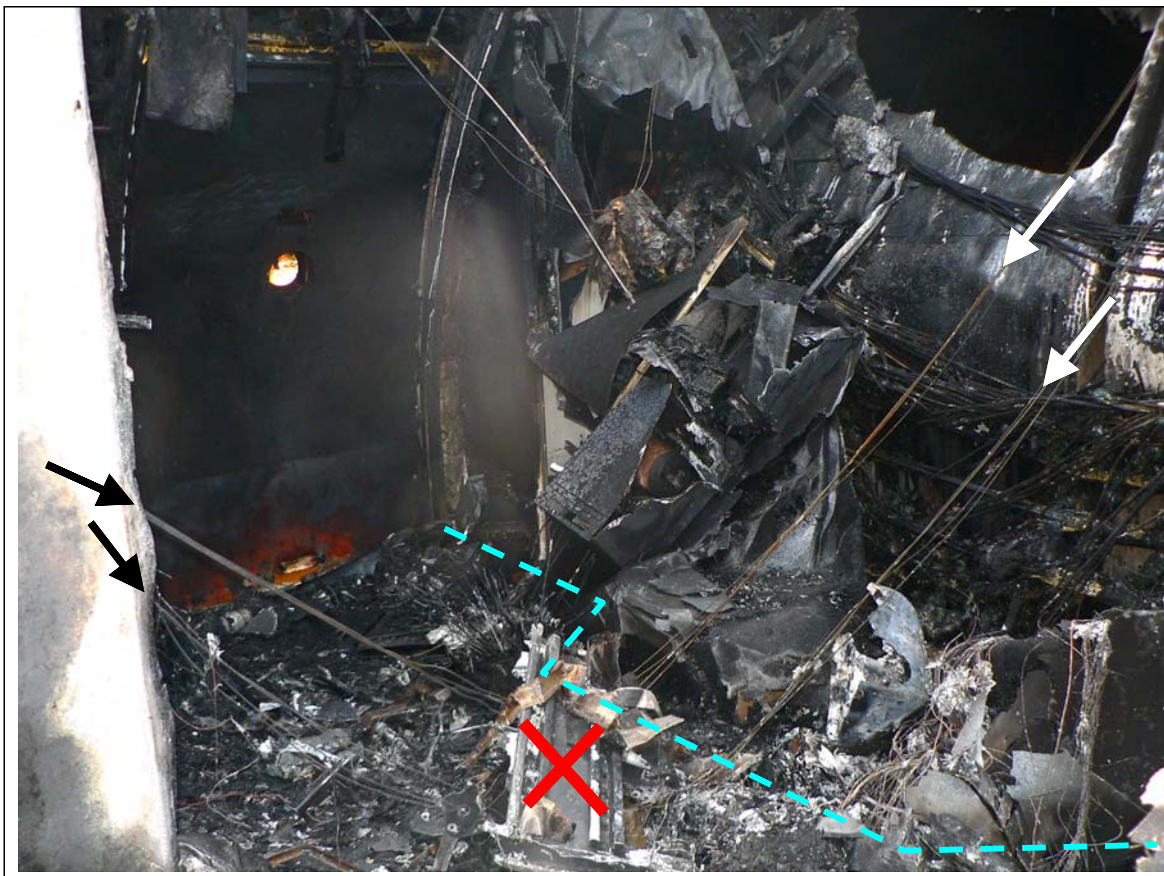


Figure 36. N799AX: The mounting for the control pulleys found on the floor of the supernumerary compartment were from the rudder, stabilizer trim, and First Officer side of the elevator system. The mounting is indicated by the red "x" at the bottom of the photograph. The arrows at the left and upper right point to the control cables. The view in this photo is from the forward left toward the aft right from the lavatory. The approximate base of the smoke wall is traced with the dashed blue line.

The aileron flight control components routed beneath the main deck were not affected.

The wing and tail-mounted flight controls of the airplane were not in the heat-affected areas and were only examined to look for exterior damage.

D.3.4. N799AX COCKPIT CONTROLS AND INDICATORS:

The microphone selectors were both switched to BOOM and not to OXY, the Captain had the INT selected and the First Officer had PA selected.

The #1 VHF radio showed 121.8 as active and 135.10 as standby. The #2 VHF radio had both selectors black. The #3 was selected to 131.62 on the active side and 130.80 on the standby side.

The Captain's speaker selections were for the left VHF comm. radio, right VHF comm. Radio, and interphone. The rotational positions of the knobs varied.

The First Officer's speaker selections were for the left VHF comm. Radio and right ADF radio. The rotational positions of the knobs varied.

The TCAS/ATC on transponder #1 was at the STBY selection.

The weather radar was set to TEST.

Both engine fire handles were extended, with the left handle turned toward #2 and the right handle turned to #1. The APU fire handle was in the extended position and rotated forward.

The parking brake handle was extended.

Both stabilizer trim handles were at the mid-range white marks.

The speed brake handle was in the stowed position.

Both throttles were fully aft, with the reverser handles in the stowed positions.

The flap handle was fully up.

Both fuel control knobs were in the CUT OFF positions.

The magnetic compass showed a heading of about 328 degrees.

The Captain's clock is electronic and no time was shown.

The brake pressure indicator showed zero pounds of pressure.

The overhead panels had facial heat damage and some had resolidified plastic drips hanging from them. None of the lettering was legible and some control knobs had melted. Many of the circuit breakers had tripped and their internal springs were on the cockpit floor.

The panel for control of the electrical system had the following buttons in the latched-in positions: APU GEN, L BUS TIE, R BUS TIE, L UTILITY BUS, R UTILITY BUS, L GEN CONT, R GEN CONT, both BUS OFF selectors were extended. The STBY POWER selector was at AUTO.

The pneumatic control panel had the following selectors latched in: the L ISO valve, the R ISO valve, CTR ISO valve. The APU valve selector was not in the latched position. The left and right engine (spar) valves were found in the latched position.

The fuel control panel only had the center tank's right pump in the latched position.

The hydraulic control panel had all three selector knobs at OFF. The L ENG and R ENG hydraulic pump buttons were found in the latched position.

D.3.5 N799AX DOORS:

The cockpit windows were open and functioned normally after the accident.

The L1 and R1 doors were similar in design and damage. Each was designed to be manually unlatched from the inside or outside of the airplane by movement of a single lever. The doors each had a canister-type of counterbalance containing springs and a counterbalance cable that was routed to the peak of the aircraft crown.

The L1 and R1 doors were several inches above the closed positions, with the L1 door higher than the R1. The exterior handles were ajar and not in the closed orientations. The tracks for the L1 and R1 doors were found twisted along the upper portions of the doors and melted away, higher than about 8-12 inches above each door. Two control rods for the L1 door mechanism had been consumed by fire. The counterbalance spring canisters had come apart and the canister for the L1 door was lying at the cockpit entrance. The pulleys for the doors that had been at the crown of the airplane were partially consumed and were in the fire debris near the floor, allowing the counterbalance cables to become slack. (See Figures 37 and 38)

Figure 37. Exemplar airplane: Photograph of the door when raised to the top of the tracks. The left arrow points to a track and the right arrow points to the counterbalance pulley.

Figure 38 N799AX: The top of the L1 door, with the upper arrow pointing to the remaining end of the door track and the lower arrow pointing to the slack counterbalance cable.

The cockpit door was fire damaged, especially on the supernumerary surface, but remained intact and the paper documents on the cockpit side had not gotten hot enough to be illegible.

The upper third of the cargo compartment door from the supernumerary area was still in place and the fiberglass skins of the upper door were hanging.

The main deck cargo door (MDCD) was aft of the heat damage (other than cosmetic) and was manually actuated to permit removal of the main deck cargo containers.

The MDCD depressurization vents were found in the open positions due to aircraft mechanics attempting to open the MDCD after the fire and while securing the airplane. The mechanics had been told to stop opening the MDCD.

The window to the left over-wing exit had been broken by firefighting efforts.

The aft main deck doors are normally non-operational and remained closed throughout the investigation.

D.3.6 N799AX EMERGENCY EQUIPMENT:

The airplane was equipped with emergency equipment for the pilots and non-flying occupants. (See Figure 39)

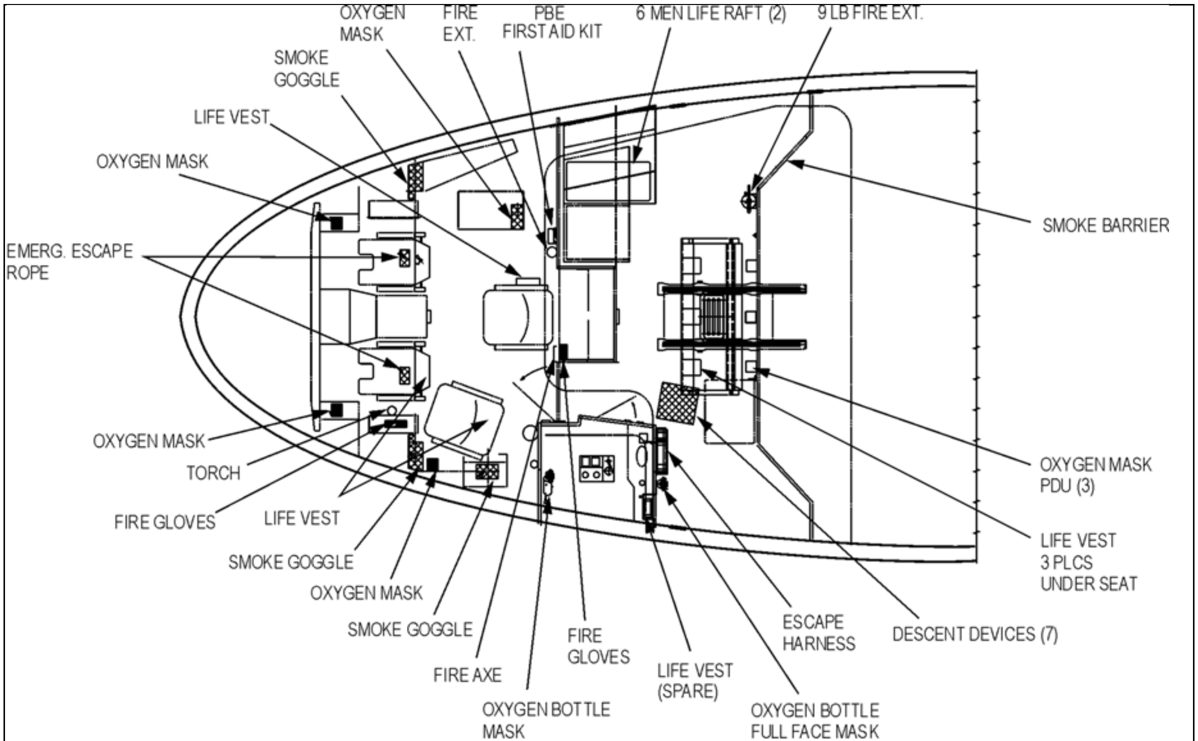


Figure 39. Emergency provisions for the STC conversion in the cockpit and supernumerary areas. The figure is generic and some items were slightly different than shown.

Smoke detectors were found in the cargo compartment and the lavatory. Each was separated from the supernumerary compartment when the cargo and lavatory doors were shut. There were no provisions for smoke detection in the unoccupied supernumerary compartment.

The lower forward cargo compartment contained four spherical fire bottles. Both engine fire-extinguishing bottles had been discharged and both bottles for the lower deck fire (in-flight) extinguishers were found full. Fire suppression for the Class E main deck cargo compartment is to depressurize the airplane. The Class E compartment is not required to have a fire extinguishing system and did not.

(The presence of the lavatory trash compartment fire extinguisher was documented by the Fire Group.)

The Captain’s escape rope was in the closed compartment and could be normally accessed after the fire. The First Officer’s escape rope was found hanging from the right cockpit window. A tag on the First Officer’s rope was labeled:

Western Filament Inc
P/N 232T4108-17
Boeing P/N 232T4108-17
LANYARD ESCAPE ASSY FOR 767T
P.O.# PA-531889-8137E
1 EACH
LOT # 990702, DOM 3999

The seven supernumerary compartment escape devices were found stowed in the metal box.

Two 15 pound Halon fire extinguishers were found in their mounting brackets. One was inside the cockpit door, behind the left observer seat, and showed a full charge. The second was near the R1 door and the discharge indicator had been melted, not allowing the state of charge to be determined. Neither fire extinguisher was weighed during the investigation.

The smoke goggles for the Captain’s seat were in a pouch and located in the bin to the left of his seat. The smoke goggles from the First Officer’s side of the airplane were found in the pouch on the ground.

The walk-around oxygen bottle from the L1 door was on the floor at the base of the door and the regulator portion had extensive fire damage.

The portable oxygen container for the lavatory was found in the toilet, directly under the mounting location.

A portable emergency locator transmitter (ELT) was found on the floor near the R1 door. The full length of the ELT existed, but half of the upper portion along one side had been consumed by fire. The batteries in the lower section were fire damaged consistent with the surrounding structure. Examination of a similar ELT in another airplane showed that it had been supplied by Dayton Grainger as a Dolphin with the part number 750056 when using the 760011-2 battery pack. The type of battery pack was labeled as lithium manganese.

The aircraft ELT continued to transmit until the antenna was removed from the top of the airplane. The on/off wiring to the cockpit switch had been routed through the supernumerary area which had been consumed by fire. The ELT transmitter had been mounted above the main deck cargo containers and was inaccessible until the main deck cargo was unloaded.

Rafts, life vests, and other emergency provisions were found heat damaged.

D.3.7 OTHER N799AX SYSTEMS COMPONENTS:

The outflow valve was in the fully open position.

All of the wiring, which had been above the floor of the main deck, was destroyed by the fire, lying in tangled groups and without insulation. One wire that had been routed near the L1 door was found with a beaded end, and no orientation for the installed purpose was found.

The wing fuel tanks had been de-fueled to secure the airplane after the fire.

APPENDIX A. REGULATORY REVIEW

Introduction

Most large transport airplanes are equipped with supplemental oxygen for the passengers to use in the event of decompression for protection from the harmful effects of hypoxia. The systems provided in passenger airplanes generally provide between 12 to 20 minutes of supplemental oxygen to cover the time period required for the airplane to descend to an altitude where the supplemental oxygen is no longer needed for most passengers, generally 10,000 feet above sea level. Cargo-only airplanes with Class E cargo compartments are designed to control fires detected in the cargo compartment by depressurizing the airplane and remaining at an altitude of about 25,000 feet for the remainder of the diversion to an emergency landing. The remainder of the flight could require several hours, especially in operations over the sea. Because the 12 to 20 minute supplies provided by typical passenger supplemental oxygen systems would be expended, the supernumerary in this application were provided with a longer-duration system and crew-type masks for the diversion and trained in the use of the masks to prevent hypoxia.

The group reviewed the Supplemental Type Certificate, the IAI-Bedek specification describing the freighter conversion, the applicable regulations for the supernumerary area, the exemptions granted to the regulations, and the substantiation document that had been submitted to the FAA in conjunction with issuance of the Supplemental Type Certificate (STC). The following provides a summary of most regulations and compliance associated with FAA certification of the supernumerary area, per the IAI – Bedek STC. Due to other structural and systems in the area, this is not a complete regulatory review or list of regulations.

FAR 25.810 Emergency provisions

This regulation establishes requirements for escape routes and emergency exits. IAI, the Supplemental Type Certificate (STC) holder for the passenger to cargo conversion of the ABX airplane, petitioned for and was granted an exemption to FAR 25.810(a)(1) by the FAA to allow for use of escape devices, such as ropes, in lieu of normal passenger escape provisions, such as slides. The escape devices are the same type used by the flight crew, and the exemption was granted considering the capabilities and training that would be provided to the supernumeraries in the use of the equipment.

FAR 25.853 Compartment interiors

This regulation establishes flammability requirements for airplane interiors. Interior materials and design in the supernumerary area was certified to these requirements. These requirements are not intended to address cases in which pressurized oxygen or an oxidizing agent are involved in the fire.

FAR 25.854 Lavatory fire protection

FAR 25.854 requires lavatories to incorporate a smoke detection system to provide warning to the cockpit in the event of a fire in the lavatory, or to provide an aural or visual warning in the cabin if it can be readily detected by a flight attendant. Per this regulation, the lavatory trash receptacle must also be equipped with a built in fire extinguisher to automatically extinguish a fire if one occurs therein. The FAA considered that the design incorporated on the ABX airplane met these requirements. Note that the door to the lavatory was typically closed during flight, so the detection system in the lavatory would not likely detect and annunciate a fire that occurred in the supernumerary area until the fire had grown significantly.

FAR 25.857(e) Cargo compartment classification

This regulation identifies the requirements associated with cargo compartment fire control. The ABX airplane was equipped with both Class C and Class E compartments. The two lower lobe compartments were Class C compartments, which are required to be equipped with fire detection and suppression systems per FAR 25.857(c). For these compartments, fire suppression is provided by flooding the compartment with fire extinguishing agent in the event that a fire is detected. The main deck cargo compartment on the airplane was a Class E compartment, which must also incorporate a fire detection system, but the primary means to suppress a fire in this compartment is to depressurize the airplane at about 25k feet to starve the fire of ambient oxygen. Note that this approach to fire suppression necessitates installation of supplemental oxygen for the supernumeraries in sufficient quantities to protect them from the harmful effects of hypoxia for the duration that the airplane could potentially need to divert in a depressurized state for an emergency landing, which could be several hours. In both kinds of compartments, hazardous quantities of smoke and fumes from the compartment in the event of a fire must be excluded from occupied areas of the airplane, which would include the supernumerary area. Testing was conducted to demonstrate this.

FAR 25.858 Cargo or baggage compartment smoke or fire detection systems

This regulation provides requirements for cargo compartment fire detection systems. The FAA approved the design of the cargo compartments implemented on the ABX airplane as meeting this standard. However, neither the main deck or lower lobe compartment systems would be capable of detecting a fire in the supernumerary area until enough smoke were produced to migrate into a protected cargo compartment, or fire damage allowed the fire/smoke to directly enter the cargo compartment.

FAR 25.869 Fire protection – systems
(Prior to 2004, contained in 25.1451)

Per 25.869(c)(1) and (2), oxygen equipment and lines must not be located in any designated fire zone, and must be protected from heat generated in or that could escape from a designated fire zone.

Per 25.869(c)(3), the oxygen equipment and lines must be installed so that escaping oxygen cannot cause ignition of grease, fluid, or vapor accumulations that are present in normal operation or as a result of failure or malfunction of any system. The FAA review of the design incorporated in the ABX airplane would indicate that this requirement had been met. Except in the cabinets where potential sparks from the PSU light assemblies were found, oxygen equipment and lines were generally located in relatively open areas that would not likely result in accumulation of dangerous oxygen concentration levels in the event that a leak occurred.

Grease and oil was found near some areas of the oxygen system installation. Similar airplanes examined during the investigation had visible grease on the R1 forward door track. The oxygen supply for the supernumerary area was routed about six inches beneath the door track. The orange tubing connected to a gasper vent in one airplane had an oily film on the surface.

FAR 25.1439 Protective breathing equipment

Per this regulation, the ABX airplane must be equipped with protective breathing equipment (PBE) for use by the appropriate crewmembers. In addition, PBE must be installed in each separate compartment of the airplane where crewmember occupancy is permitted during flight. The crew supplemental oxygen system provides PBE capability for the flight crew when seated at their stations in the event that smoke or fumes are present in the cockpit. With PBE donned, the crewmembers are able to conduct their flight deck duties, including piloting the airplane, navigation, and communication. This PBE is generally not intended to be worn while firefighting within the cockpit since it would limit the user’s mobility. Because the airplane was equipped with a Class E cargo compartment, additional PBE for firefighting was required and generally installed in the cockpit in the vicinity of the required portable fire extinguisher. This PBE could be in the form of a smoke hood, or it could be a portable oxygen bottle fitted with a mask that provides PBE protection.

At least one PBE for firefighting had been installed in the supernumerary area in the vicinity of the hand held fire extinguisher. Although not specifically required by FAR 25.1439, the supernumerary oxygen masks were of the same type as crew oxygen masks and had PBE capability by setting the mask regulator in the emergency position. The FAA would not normally require the supernumeraries to be provided with PBE protection because per FAR 25.857, hazardous quantities of smoke and fumes must be excluded from occupied areas, like the supernumerary area.

FAR 25.1441 Oxygen equipment and supply

This regulation covers several requirements as they relate to the supernumerary area on the ABX airplane.

Per FAR 25.1441(b), the supplemental oxygen system must be free from hazards in itself. Areas of particular concern typically reviewed in evaluating compliance with this regulation are separation of oxygen lines from to other components, such as structure and wiring. In addition, use of established engineering practices associated with oxygen system design is reviewed, particularly considering the fire hazards associated with localized concentrations of oxygen due to leakage and fire hazards associated with design and cleanliness of system components. In similar airplanes, the oxygen lines associated with the supernumerary area were generally separated from structure and wiring. The gasper hose was routed near the oxygen line in the cabinet above the supernumerary's seats, one case of wire contact with an oxygen line was noted, and in one case a wire to a light was found inadequately secured.

Per FAR 25.1441(c), there must be a means for the crew to readily determine, during flight, the quantity of oxygen available in each source supply, which would include the oxygen supply provided for the supernumeraries. This capability was provided by the IAI STC design in the EICAS display.

FAR 25.1443 Minimum mass flow of supplemental oxygen

This regulation establishes the minimum mass flow of supplemental oxygen required for crew and passengers. The less stringent passenger mass flow requirements are generally applied to supernumeraries, although the kind of equipment that can be used to provide them with oxygen may not necessarily be as intuitive as passenger equipment, based on the consideration that supernumeraries are provided appropriate training in the use of the equipment installed. Typically, the duration of protection provided by passenger supplemental oxygen equipment is on the order of 12 to 22 minutes to address most in flight decompression situations, in which the airplane would be expected to descend to a breathable altitude within a short time. The unique aspect of the supplemental oxygen system provided for the supernumeraries on cargo airplanes is the duration of oxygen supplied, which must be considerably longer than passenger equipment. This is because the means to suppress a fire in the Class E cargo compartment of a cargo airplane, such as the ABX airplane, is to depressurize the airplane to a cabin altitude on the order of 24k feet, limiting the amount of ambient oxygen available to the fire. As such, the supplemental oxygen system provided for the supernumeraries must provide protection for the duration of the flight at this cabin altitude, which could be several hours, to prevent injury due to hypoxia

FAR 25.1445 Equipment standards for oxygen distributing system

Per this regulation, if a common oxygen supply is provided for crew and passengers, there must be a means to separately reserve the minimum supply required by the flight crew on duty. The crew oxygen supply and the supernumerary oxygen supply were provided by separate oxygen bottles, although these bottles were plumbed together with a valve that would allow crew use of the supernumerary supply, but would prevent supernumerary use of the crew supply. Inspections of other airplanes in the ABX fleet found that seven of eighteen had leakage through the check valve intended to provide this isolation.

FAR 25.1447 Equipment standards for oxygen dispensing units

Per FAR 25.1447(a), an individual oxygen dispensing unit must be provided for each occupant, and must be designed to cover the nose and mouth with a means to secure it to the face. Crew style oxygen masks were provided for each supernumerary to meet this requirement.

Per FAR 25.1447(c), the oxygen equipment must provide oxygen to each occupant wherever seated, and oxygen equipment must be installed in each lavatory. Per this regulation as it applies to the ABX airplane, the oxygen equipment must be automatically presented to the occupant in the event of a decompression, and that a means is provided for the flight crew to manually make the masks available in the event that the automatic system failed. The design used in the ABX airplane is equipped with oxygen for each supernumerary for use while seated, and oxygen equipment is also available in the lavatory. The supernumerary masks are not automatically presented if a decompression occurs. They are located on the wall above each supernumerary seatback, and supernumeraries are expected to retrieve them if they are alerted that oxygen use is required. A means for the flight crew to manually make the masks available for the supernumeraries is not provided.

Because these aspects of the design would not comply with FAR 25.1447(c), the STC holder, IAI, petitioned for and received an exemption from the FAA for this requirement, which allowed for acceptance of the mask configuration based on the fact that an automatic alerting system would inform the supernumeraries of the need to don oxygen masks, and the operator (ABX) would provide appropriate training to them in procedures and use of the masks.

FAR 25.1449 Means for determining use of oxygen

Per this regulation, a means must be provided to allow the crew to determine if oxygen is being delivered to the oxygen dispensing equipment. Means are provided at each supernumerary station by the crew type oxygen box used to house the mask when not in use, the same as provided to the flight crew at their stations. A flight crew member could easily determine that oxygen is flowing at each supernumerary mask by observing the indicator located on the box.

FAR 25.1453 Protection of oxygen equipment from rupture

This regulation requires that oxygen tanks, lines, and shut-off means be protected from unsafe temperatures and located where the probability and hazards of rupture in a crash landing are minimized. The FAA had concluded that the supernumerary oxygen system installation met these requirements and the design was consistent with past installations on other model airplanes.

FAR 121.583

This is an operational rule. This regulation specifies cases for carriage of individuals for which the airline does not need to specifically comply with passenger carrying requirements. This provides an overview of individuals who could be considered as supernumeraries.

APPENDIX B. ABX AIR DOCUMENTS:

APPENDIX 4: *Jumpseat Travel*

1. Jumpseat Travel On Company System

A. The following persons are authorized travel aboard ABX Air, Inc. aircraft:

(1) A Crewmember or licensed aircraft Dispatcher employed by ABX Air, Inc.

(2) An FAA Inspector, or an authorized representative of the National Transportation Safety Board, who is performing official duties.

(3) Any ABX Air, Inc. Employee whose travel is directly related to the performance of a function associated with the safe operations of ABX Air, Inc. (i.e. aircraft maintenance, engineering and support, operational training, operational auditing). Employees authorized under this paragraph will be issued special company identification, which will identify them as "*JUMPSEAT AUTHORIZED".* These approved functions include:

(a) Operations (Business Travel Only)

1 Aircraft Performance Personnel

2 Aircraft Flight Simulator Technician/Engineers

3 Ground School Instructors

4 Tower Controllers

5 Loadmasters

6 Regional, Sort, and Ramp Compliance

7 Ground Trainers/Auditors

8 Safety Personnel

9 Professional Loadmasters

10 Operations Technical Support Personnel

(b) Maintenance (Business Travel Only)

1 Aircraft Maintenance/Engineering

2 Maintenance Training

3 Maintenance Technical Services

4 GSE/MHE Support

5 Airport Planning and Property Support

6 Aircraft Support Inventory Personnel/Auditors

(4) An ABX Air, Inc. Director or above (also including Vice Presidents, President) traveling on company business. Employees authorized under this paragraph will be issued special company identification which will identify them as *"JUMPSEAT AUTHORIZED".*

(5) A person who has permission of the pilot in command, an appropriate management official, and the Administrator; and

(a) Is an employee of --

1 The United States, or

2 An aeronautical enterprise certificated by the Administrator and whose duties are such that admission to the flight deck is necessary or advantageous to safe operation.

(6) An ABX Air, Inc. employee (other than those described in paragraph 3 and 4 of this section) who has the permission of the pilot in command, an appropriate management official, and the administrator.

(a) For the purpose of this paragraph, "appropriate management officials" include the following

1 President of ABX Air Inc.

2 Sr. Vice President of Flight Operations

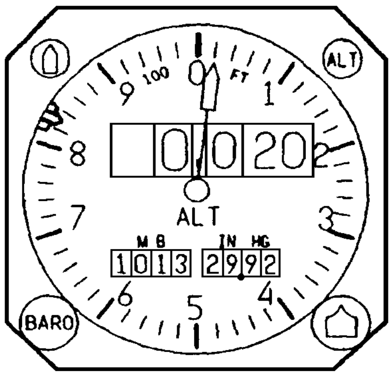
3 Sr. Director of Crew Operations

4 Vice President of Regulatory Compliance and Government Affairs

B. Employees on Medical Leave of Absence of any kind (industrial or non-industrial) are not eligible to travel on the system.

C. No person shall be admitted to occupy a jumpseat on board ABX Air, Inc. aircraft if, within the previous five years, that person has been convicted of, or found not guilty by reason of insanity of, any violent crime or crime involving the interference with commercial aircraft or airport operations.

D. A Passenger Safety Briefing and Evacuation training video has been distributed for all individuals authorized to ride on ABX Air, Inc. aircraft. This video will be viewed before riding on an ABX Air, Inc. jumpseat, but does not replace the mandatory aircraft safety briefing required by the FARs to be given by the Flight Crew. Individuals who have not viewed the video will not be allowed on the jumpseat.



767GR006/05-08-98

Figure 5.2-38 Altimeter bug settings for takeoff.

Altimeter bugs will be set for takeoff as follows.

Reference altitude marker (inner/ outer) set to minimum flap retract height (normally 800 AGL).

DEPARTURE BRIEFING

The Captain should brief the expected taxi route and any hold short lines to the runway before taxi. Both Crewmembers should have the Jeppesen Airport Diagram 10-9 Chart readily available during taxi.

The Departure Briefing should be given after the airspeed bugs and thrust management computer have been set. If accomplishing the briefing at this time will cause a delay in pushback or engine start, the takeoff briefing will be given during the Before Takeoff Checklist.

The Takeoff Briefing will be accomplished by the pilot who is to perform the takeoff. Additional items, e.g., use of airfoil ice protection after takeoff, may be included as applicable. A full Takeoff Briefing will be accomplished prior to every takeoff.

Refer to Chapter 5, Section 11; Departure Briefing, for items to be included.

PASSENGER BRIEFING

Passengers will be briefed prior to engine start. Briefing items will include items found on the passenger briefing card; in addition, the passengers will be handed the briefing card for further review (see B767 Safety Briefing Guide).

REQUIRED PAPERS

Papers required to be onboard the aircraft are:

Flight Release
Weather: Sequence Reports, Forecasts, Winds aloft, Notams and Sigmets (if applicable)
Load Plan
Weight Data Record and Tape
Hazardous Material Notification
General Declaration (international flights)
Custom Papers (international flights)

Manual Flight Release

Should a normal computer release be unavailable, the flight crew shall fill out the Manual Flight Release form.

APU START PROCEDURES

APU selector ....START, release to ON

Hold selector in the START position for 3 to 5 seconds, then slowly release back to ON. Do not allow the APU selector to spring back to the ON position. (This step is to prevent failed starts due to Start Switch contact “bounce”.)

Observe starter duty cycle of 3 start attempts within a 60-minute period.

The APU should be started fifteen (15) minutes prior to scheduled departure to ensure that the aircraft systems will function/operate properly on ships power.

The APU shall be used for all normal engine starts (Starts Before/During/ After Pushback or Starts without a Pushback). The external pneumatic aircart shall be used only in the event the APU is deferred or for training situations by a company Check Airman.

The APU may be started by Maintenance personnel prior to scheduled departure. In the event the APU is not running when the Flight Crew arrives, the Flight Crew shall start the APU no later than 15 minutes prior to departure. Once the APU is verified running, the Crew will confirm APU Pneumatics are available. If APU Pneumatics are not available, shut down the APU, then restart the APU and verify APU Pneumatics are available. If they are still not available, contact Maintenance Control.

After the APU is supplying power to the aircraft, select EXT PWR switch to OFF.

If calculator printing is in progress, delay the transfer of power until the printing process has been completed. The ground marshaller shall then be advised *"CLEARED TO DISCONNECT EXTERNAL POWER"*.

The APU should not be left running unattended by the Flight Crew without a qualified ABX maintenance person in the area of the aircraft.

GROUND MARSHALLING

Standard ground marshalling signals will be provided to the flight crew to direct the aircraft into and out of ramp locations. The Captain has final authority as to the safe operation of the aircraft. Should the Captain believe unsafe clearance exists from following marshalling instructions, aircraft movement will be stopped, until in the Captain's judgment, adequate safety exists.

B767 SAFETY BRIEFING GUIDE PC

NO SMOKING: Smoking is strictly prohibited during all operation. This includes in and around all ABX aircraft. Smoking is prohibited in the aircraft lavatory.

SEAT BELTS AND SHOULDER HARNESS: Seat belts and shoulder harness shall be fastened at all times for taxi, takeoff, and landing. Once in flight, with the Captain's permission, you may move about the aircraft. After landing, seat belts and shoulder harness shall remain fastened until all engines are shut down.

ENTRY AND EXIT: Entry and exit is accomplished through the main entry door (forward left side of fuselage). If the crew stairs are not available, emergency egress is possible by opening the main entry door and allowing the evacuation slide to inflate (see diagram below). In an emergency, if the main entry door is not accessible, exit (at a Crewmember's guidance) through the side cockpit windows. Ropes are attached and housed in a storage compartment above each pilot seat. In addition, you may be instructed to utilize the inertial reel escape ropes, located above the passenger seats. This device will automatically lower you to the ground.

RETURN TO SEAT INDICATION: While in the main cabin area or in the lavatory - an emergency return to seat indication is provided in the following areas by:

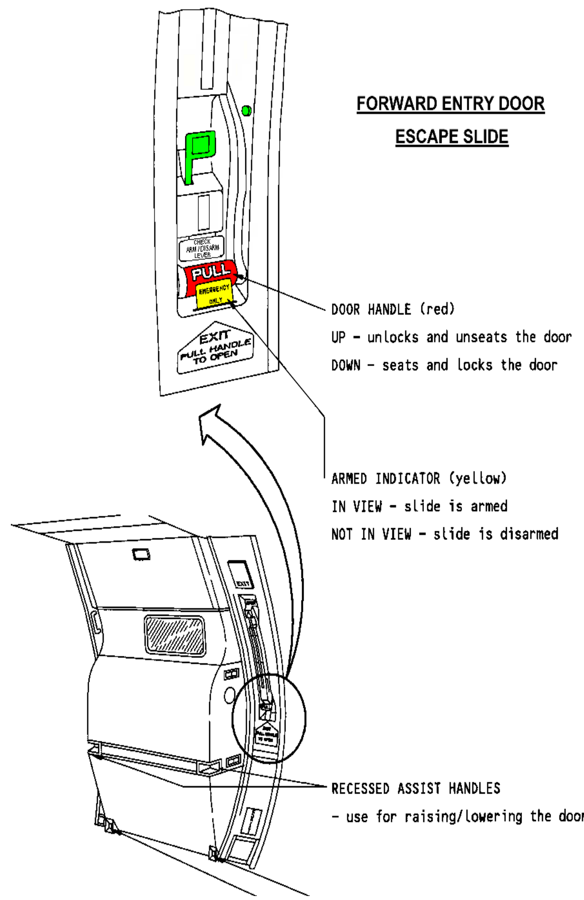
Main Cabin Area

1. Flashing overhead lights

Lavatory

1. Flashing overhead light
2. A red "Return to Seat" sign
3. Aural warning "buzzer"

If any of the above signals are indicated, immediately return to your seat and fasten your seat belt.



TALKING (Sterile Cockpit): Talking is not allowed between ground level and 10,000 feet. This applies to all phases of flight between those altitudes. Remember these are critical phases of flight for crewmember communications.

TRASH: Place all trash in the trash bag located in the cockpit.

ELECTRONIC DEVICES: With the exception of calculators, the use of all electronic devices is prohibited, Example: Radios, tape player, CD players, cellular telephones, video games, and laptop computers.

FIREARMS, ETC.: Except as authorized by the Flight Operations Manual, the Federal Aviation Administration (FAA) prohibits anyone from carrying a firearm, knife, mace product, or electronic protection device in any aircraft.

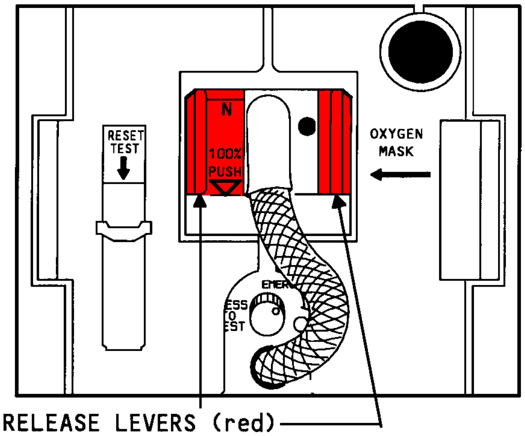
AIRCRAFT LOADING: For your own safety, avoid the cargo compartment during loading and unloading operations

SUPPLEMENTAL OXYGEN:

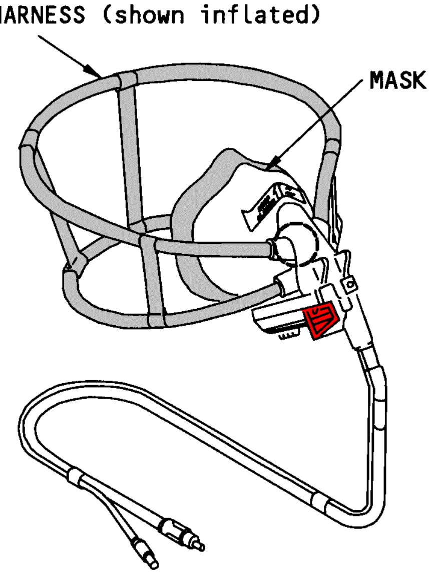
LOCATION: Adjacent to each seat.

USE:

- Use the supplemental oxygen when directed by one of the pilots.
- Squeeze and pull the red release levers and mask from the stowage box (see diagram).
- Continue to squeeze and hold the red levers; place the inflated harness (see diagram) over your head.
- Release the red release levers and the harness will secure itself to your head.
- Place the mask over your nose and mouth and breathe normally.
- The oxygen is already on and will be available immediately.
- Keep the oxygen mask on until told to remove it by one of the pilots.



SQUEEZE AND PULL - releases mask from stowage box
- oxygen turns on when stowage box doors open
- inflates mask harness when right lever is squeezed



PORTABLE OXYGEN BOTTLE:

LOCATION:

- The portable oxygen bottle is located in the lavatory. It is for emergency use only.

USE:

- Remove cylinder from bracket.
- Turn yellow knob counterclockwise to release oxygen to regulator.
- Apply mask to face and hook strap to mask. Slip over head and adjust mask to face.
- With mask in place, return to cockpit. Fasten seatbelt; utilize supplemental oxygen adjacent to seat. Discard portable oxygen bottle.

FIRST AID KIT: **LOCATION**:

- Left rear side of the cockpit, adjacent to cockpit door.

LIFE VEST: **LOCATION**:

- In the respective seat back pockets of the forward cockpit seats and adjacent to the two rear seats (see diagram).

FIRE EXTINGUISHERS: **LOCATION**:

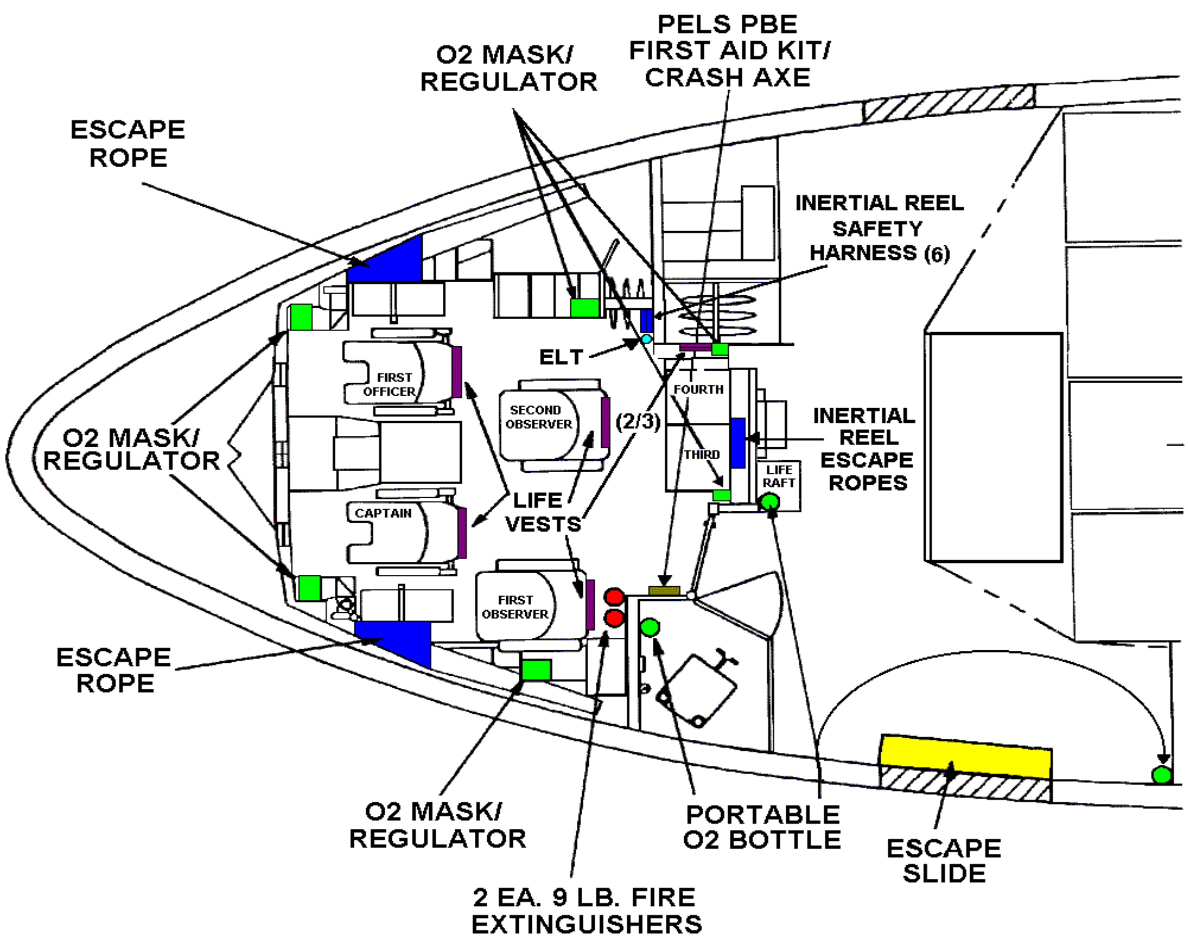
- Left side of the cockpit behind the first observer's seat.

SMOKE GOGGLES:

- Adjacent to O2 Mask Regulator.

INERTIAL REELS:

- Located high on aft cockpit wall and six safety harnesses next to coat closet wall.



*Smoke goggles are located adjacent to O_2 mask regulator.

B-767 SAFETY BRIEFING CARD GUIDE SF

NO SMOKING:

Smoking is strictly prohibited during ALL operations in and around the aircraft. Smoking is prohibited in the aircraft lavatory.

SEAT BELTS AND SHOULDER HARNESS:

Seat Belts and Shoulder Harness (if installed) shall be fastened at all times for taxi, takeoff, and landing. Once in flight, with the Captain's permission and the Fasten Seat Belt Sign extinguished, you may move around the aircraft. If the Fasten Seat Belt Sign illuminates, return to your seat and fasten your seat belt. After landing, seat belts and shoulder harness (if installed) shall remain fastened until all engines are shut down.

RETURN TO SEAT INDICATION

An Emergency "Return to Seat" indication is provided in the following areas:

Supernumerary Compartment:
1. Flashing Overhead Lights.
2. Fasten Seat Belt Illuminated.
3. Aural chime.

Lavatory:
1. Flashing Overhead Light.
2. Red "Return to Seat" Sign illuminated.
3. Aural chime.

Main Deck Cargo Area:
1. Flashing Overhead Lights.

If any of the above signals are indicated, immediately return to your seat and fasten your seat belt.

Access to the cargo area aft of the smoke barrier during flight is prohibited.

ENTRY AND EXIT:

Entry and exit is accomplished through either main entry door (forward left or right side of the fuselage).

FIRST AID KIT:

Located in the closet at the rear of the cockpit, adjacent to the cockpit door.

LIFE VEST:

Located in the respective seat back pockets of the cockpit observer seats and under the seats in the supernumerary compartment. A demonstration/ spare life vest is stored in a stowage box near the L1 entry door.

LIFE RAFTS:

Two (2), 8-man life rafts are located in a container below the galley, if required for over water flight operations.

FIRE EXTINGUISHERS:

One is located on the left side of the cockpit behind the first observer's seat. Another one is located in the supernumerary area aft of the galley mounted on the smoke barrier wall adjacent to the right entry door.

TALKING (STERILE COCKPIT):

If occupying a Cockpit Observers seat, talking is not permitted after engine start until climbing thru 10,000 feet. Talking is not permitted after descending thru 10,000 feet for landing until the aircraft is parked. Remember, these are critical phases of flight for crewmember communications.

TRASH:

Place all trash in the supernumerary compartment in the Galley Trash Receptacle. If seated in the cockpit, place all trash in the cockpit trash bag.

ELECTRONIC DEVICES:

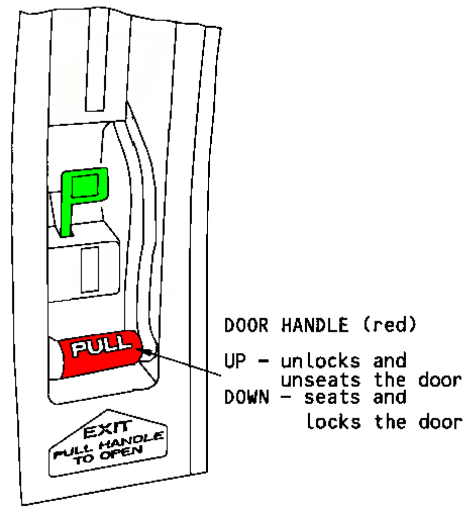
With the exception of calculators, the use of all electronic devices is prohibited: e.g., Radio's, Tape Player, CD Player, Cellular Telephones, Video Games, and Laptop Computers.

FIREARMS, ETC:

Except as authorized by the Flight Operations Manual, the Federal Aviation Administration (FAA) prohibits anyone from carrying a firearm, knife, mace product, or electronic protection device in any aircraft.

AIRCRAFT LOADING:

For you own safety; avoid the cargo compartment during loading and unloading operations.



CREW ENTRY DOOR

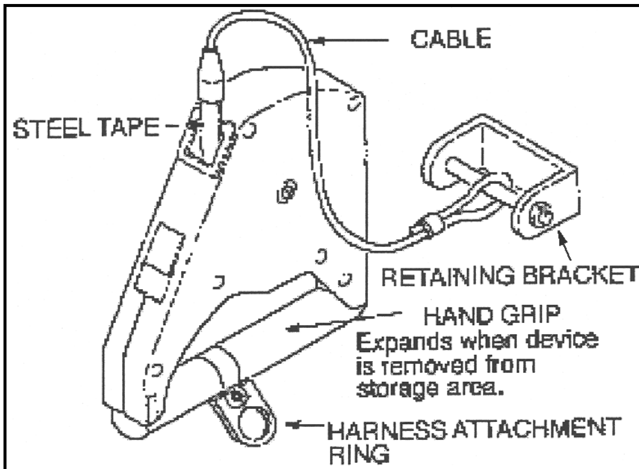
INERTIA REELS (EMERGENCY DESCENT DEVICE): LOCATION

Inertia reels are stored in a box located on the ceiling just aft of the flight deck door.

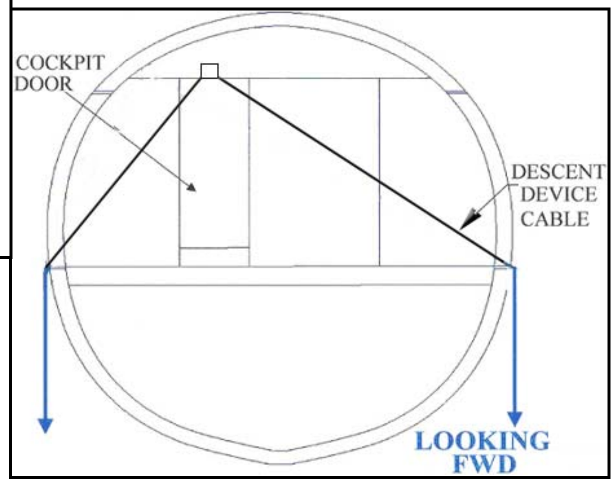
Seven safety harnesses are mounted below the Forward Attendant's Light Control panel in 2 storage pouches. A third pouch holds a spare/demonstration safety harness.

EMERGENCY EGRESS:

Emergency egress is possible by opening either main entry door and using an inertia reel emergency descent device. **Caution: Use only ONE device per person.** This device will automatically lower you to the ground as you egress either entry door hanging on to the device. If required, safety harnesses are located below the Forward Attendant Panel and may be used in conjunction with the inertia reel descent device.



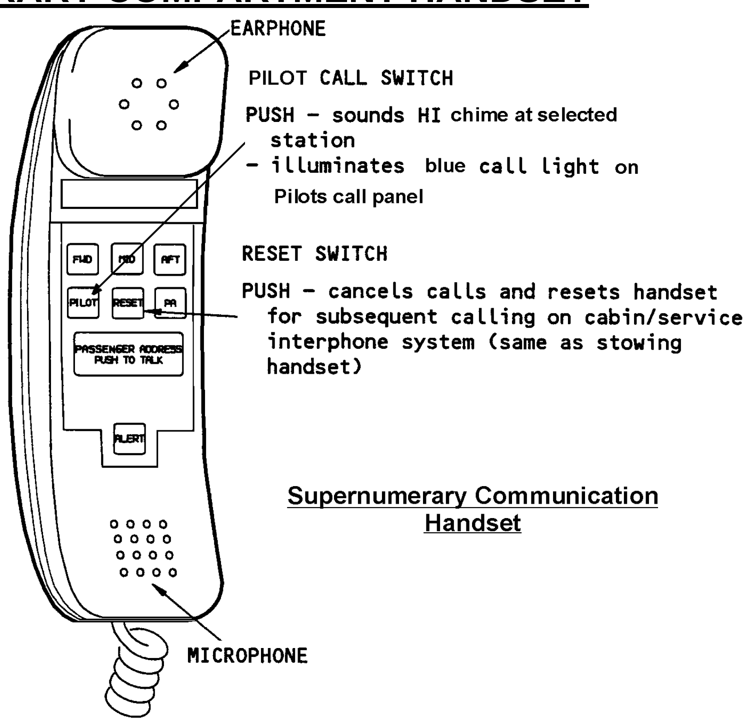
FORWARD ENTRY DOORS VIEW
(INERTIA REELS DEPLOYED)



COMMUNICATIONS:

Communications with the flight deck can be established through the use of the handset located on the aft wall.

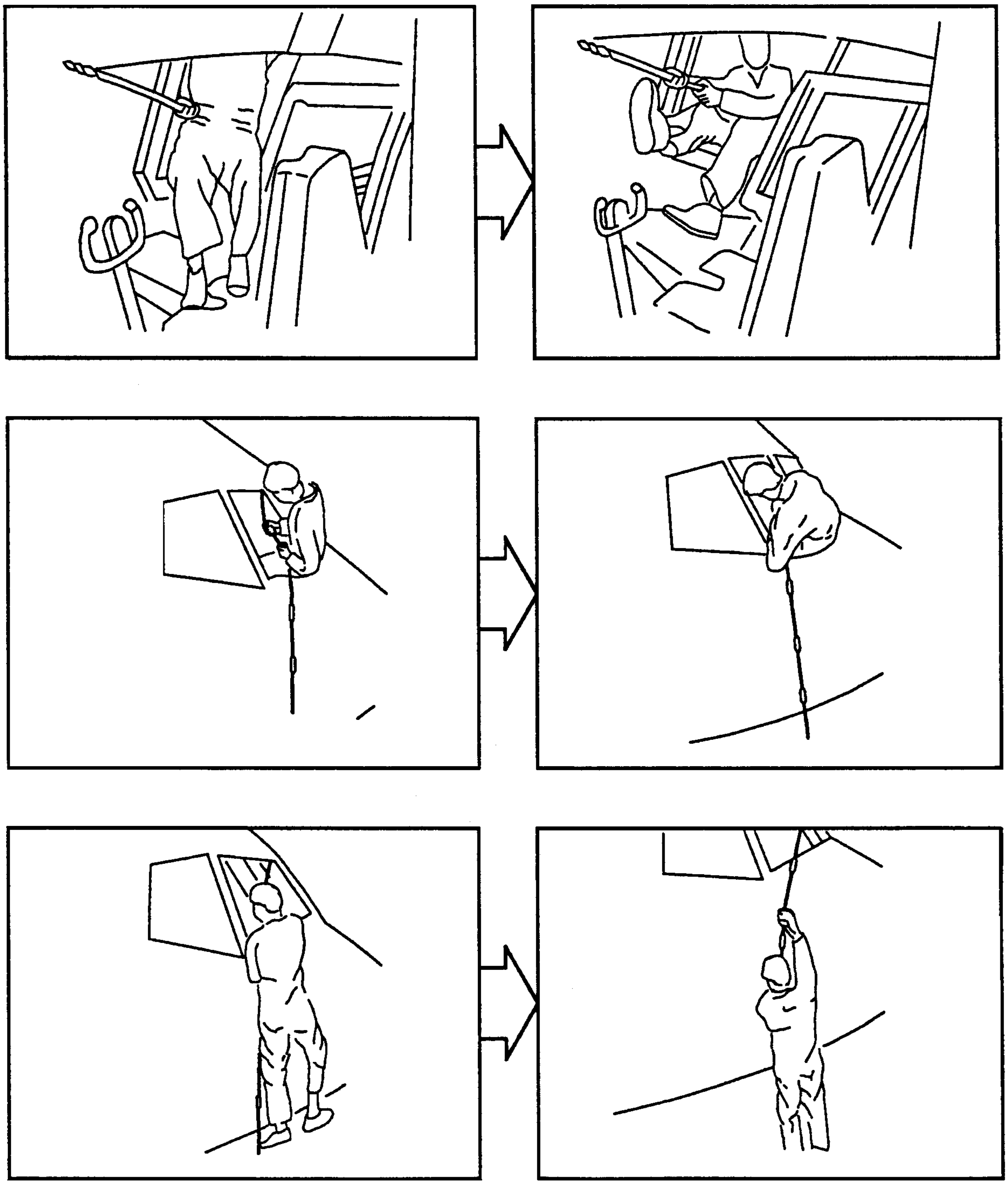
SUPERNUMERARY COMPARTMENT HANDSET



Supernumerary Communication Handset

EMERGENCY EGRESS

In an emergency, if the main entry doors are not accessible, exit (at crewmember's guidance) through the cockpit side windows. Ropes are attached and housed in a storage compartment above each pilots seat.



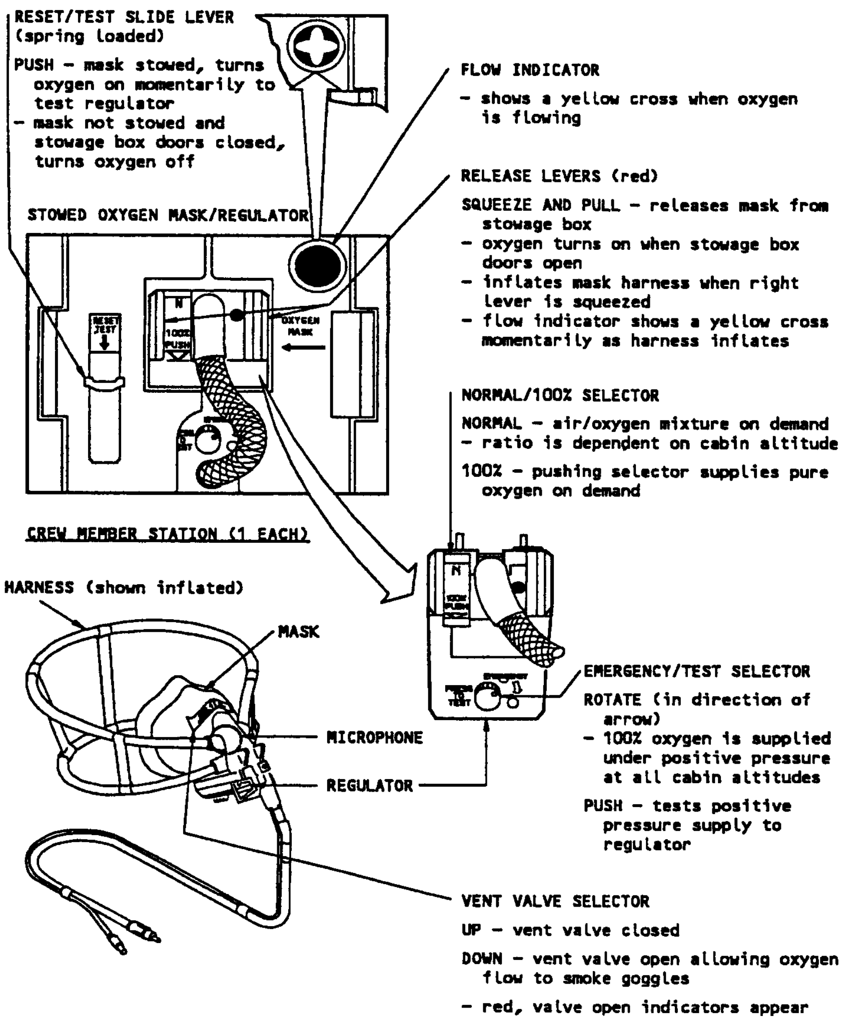
B767-200SF SAFETY BRIEFING CARD

SUPPLEMENTAL OXYGEN: A Supplemental Oxygen Mask is located adjacent to each cockpit observer's seat and above each supernumerary compartment seat in the passenger service unit.

Use:

- Use the supplemental oxygen when directed by one of the pilots or when the "USE OXYGEN" Alert light is illuminated.
- "USE OXYGEN" Alert lights are located on the supernumerary compartment and lavatory ceilings.
- Squeeze and pull the red release levers and mask from the stowage box (see below).
- Continue to squeeze and hold the red levers; place the inflated harness (see below) over your head.
- Release the red release levers and harness will secure itself to your head.
- Place the mask over your nose and mouth and breathe normally.
- The oxygen is already on and will be available immediately.
- Keep the oxygen mask on until instructed to remove it by one of the pilots.

  Note: The mask microphones do not function in the supernumerary masks.



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PORTABLE OXYGEN BOTTLES:

A portable oxygen bottle equipped with a full-face mask is located in the supernumerary compartment near the L1 entry door. This bottle is for emergency use only and is primarily used by a flight crewmember to inspect the Main Deck Cargo Compartment.

A second portable oxygen bottle is located in the lavatory. It is for emergency use only.

Use:

- If the "USE OXYGEN" Alert light on the lavatory ceiling iluminates.
- Remove cylinder from bracket.
- Turn yellow knob counterclockwise to release oxygen to regulator.
- Apply mask to face and hook strap to mask. Slip over head and adjust mask to face.
- With the portable oxygen mask in place; return to the cockpit if an official observer, or your supernumerary seat. Fasten seatbelt and shoulder harness and utilize supplemental oxygen adjacent to seat. Stow portable oxygen bottle.

SMOKE GOGGLES: Located adjacent to the O2 Mask Regulator. Smoke Goggles are only furnished for Flight Deck crew and observers.

EMERGENCY EQUIPMENT LOCATION: