Thomas K. Dodt
Chief Engineer
Air Safety Investigation
Commercial Airplanes

The Boeing Company
P.O. Box 3707 MC 67-PR
Seattle, WA 98124-2207

12 May 2009
66-ZB-H200-ASI-18449

Ms. Lorenda Ward
Investigator In Charge
National Transportation Safety Board
Via e-mail: wardl@ntsb.gov

BOEING

Subject: Boeing Submission for ABX Air 767-200 Freighter N799AX Ground Fire at San Francisco, California 28 June 2008

Reference: NTSB Tech Review Telecon Meeting, 14 April 2009

Dear Ms. Ward:

As discussed during the reference technical review, please find enclosed a copy of The Boeing Company's submission on the subject fire.

We would like to thank the NTSB for giving us the opportunity to make this submission. If you have any questions, please contact Lori Anglin at 206-852-1476, or via e-mail at lori.m.anglin@boeing.com.

Best regards,

[redacted]

Thomas K. Dodt
Chief Engineer
Air Safety Investigation
Org. B-H200, MC 67-PR
Phone (425) 237-1386
Fax (425) 237-3327

Enclosure: Boeing Submission to the NTSB for the subject accident

Submission to the

National Transportation Safety Board

for the

ABX Air
767-200 Freighter N799AX
Ground Fire at San Francisco, California
28 June 2008

The Boeing Company
12 May 2009

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INTRODUCTION

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.[3]

SUBMISSION ABSTRACT

- The Boeing Company, as the airplane's manufacturer, is acting as a technical advisor to the National Transportation Safety Board (NTSB) in this investigation.
- The conclusions presented in this submission are based on factual information, Boeing expertise and a methodical investigation process.
- Based on the factual evidence gathered during this investigation, Boeing believes the most likely cause of the fire is a breech of the supernumerary oxygen system, which allowed oxygen to come in contact with an ignition source.
- The investigation did not reveal any anomalies with the airplane or its systems, other than the aforementioned supernumerary oxygen system components installed by the supplemental type certificate (STC) that most likely contributed to the accident.

[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.

BOEING ASSISTANCE WITH THIS INVESTIGATION

The National Transportation Safety Board (NTSB) led the investigation into this ABX Air 767 accident. Assisting the NTSB in their investigation are the Federal Aviation Administration (FAA), ABX Air, Teamsters - Airline Professionals Association, Boeing, and other designated parties.

As the manufacturer of the 767 airplane, Boeing's specific role in this investigation has been to provide technical information regarding the airplane design and common-use components to assist the NTSB.

Furthermore, the NTSB allows all parties to make a submission of findings from the evidence gathered during the course of the investigation. Boeing has responded to the NTSB request with this document, which:

- Provides an assessment of the evidence and other pertinent data.
- Identifies knowledge gained from the investigation.
- Identifies conclusions and recommendations supported by the knowledge gained from the investigation.

EVIDENCE ASSESSMENT

The Boeing assessment of the evidence is based upon observations of the airplane at the accident site, post-accident examination of airplane components, exemplar airplanes and flight crew interview reports.

AIRPLANE HISTORY

The airplane was manufactured by The Boeing Company and was delivered in a passenger configuration to a different operator in July, 1986. ABX Air, Inc. purchased the airplane from Marubeni Aerospace Corporation on September 22, 2003. The airplane had 40,088.12 total hours and 36,626 total cycles at the time of the purchase.[4]

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.[5]

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.[6] The supernumerary area, including the supernumerary oxygen system, of the accident airplane was designed and installed as part of the STC installation.

The airplane had 47,068 total hours with 38,708 total cycles at the time of the accident.[7]

EVENT DESCRIPTION

When the flight crew arrived at the airplane, the cargo doors were closed and the airplane was already loaded. The First Officer completed a walk-around prior to entering the airplane. Both crew members entered the flight deck and completed their paperwork.

A short time later, "The first officer closed the L1 door, checked the lavatory to make sure nobody was in there, perhaps turned the galley light on, went into the cockpit, closed the cockpit door, sat down in his seat and buckled up. He heard a pack valve noise, or something, cycling. It sounded different but not bad. The captain was talking to the person on the ground. About 30 to 45 seconds after he sat down, he heard a "muffled bang," immediately followed by the sound of air flowing. It "crescendoed" up loud, like something banging together. He thought it might have been a ruptured duct. He looked up at the pneumatic panel and the captain turned off the packs. The noise was coming from behind them and it did not go away.

He then unbuckled his seatbelt and opened the cockpit door. Dark smoke was coming down from the ceiling. He could see the back of the supernumerary area. There was a glow on the upper side of the area (airplane right) in the same plane as the PSION[8] computer (used by

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[4] NTSB Maintenance Records Factual Report, dated January 16, 2009, page 4

[5] NTSB Airworthiness Group Chairman's Factual Report, dated December 22, 2008, page 4

[6] NTSB Airworthiness Group Chairman's Factual Report, dated December 22, 2008, page 4

[7] NTSB Maintenance Records Factual Report, dated January 16, 2009, page 4

ground personnel for weight and balance). He peeked around the corner and then closed the door. He told the captain that we have a fire. Smoke entered the cockpit, not a great deal, but some. He sat down in his seat to make it easier to open his sliding window. He reached for the escape rope, fumbling around but getting it in a few seconds, tugged on it and then he threw it out the window. He also got a couple breaths of fresh air out the window. The smoke was pungent. He called ground control to report the fire but he did not declare an emergency. He told ground control that he needed "CFR" [Crash Fire Rescue]. He talked to the captain about getting out of the airplane."[9]

The First Officer successfully exited the airplane via the right hand sliding window, using the escape rope installed above his seat, and the Captain successfully exited the airplane via the left hand sliding window onto mobile stairs that personnel on the ground had positioned under the Captains side window for his egress.

AIRPLANE INVESTIGATION

The fire was located in the supernumerary area[10] and destroyed all definitive evidence of what initiated the fire. However, after examining the damaged airplane, and exemplar airplanes,[11] the most likely cause of the fire is a breech of the oxygen system that supplies the supernumerary area, which allowed oxygen to come in contact with an ignition source. The supernumerary area, including the oxygen system, was installed as part of the Cargo conversion STC.

Taking into account information provided by the flight crew and an understanding of the supernumerary area configuration from the exemplar airplanes, a number of possible scenarios are viable. Two are noted here:

- The 'muffled bang' sound heard by the crew could have been one of the flex hoses becoming unsecured from either of its end connections[12]. The sound of air flowing heard by the crew could have been oxygen escaping from this loose connection. Because the oxygen components are contained in a closed area, it's possible that the area became oxygen enriched, came in contact with an ignition source and a fire ensued. One possible ignition source is a spark from the light assembly due to a missing boot.[13] The gap along the top edge of the oxygen component area[14] could have allowed the fire to expand outside of the contained area and could explain why the First Officer saw a "glow on the upper side of the area" or,

- The 'muffled bang' sound could have been one of the flexible oxygen hoses failing due to being subjected to an electrical current passing through it. This electrical grounding

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[9] Operations Group Chairman's Factual Report, Attachment 1, no date, page 1-4

[10] NTSB Airworthiness Group Chairman's Factual Report, Dated December 22, 2008, page 2

[11] ABX airplanes that had the same STC Cargo Conversion installed.

[12] Figure 17, NTSB Airworthiness Group Chairman's Factual Report, Dated December 22, 2008, page 22

[13] NTSB Airworthiness Group Chairman's Factual Report, Dated December 22, 2008, page 16

condition may have caused the hose to melt or burn allowing oxygen to escape producing the reported sound of air flowing.[15]

GASEOUS OXYGEN SYSTEM FIRE MITIGATION DESIGN CRITERIA

"Fires occur in oxygen systems when oxygen, fuel, and heat[16] combine to create a self-sustaining chemical reaction. Although oxygen, fuel, and ignition source are present in almost all oxygen systems, fire hazards can be mitigated by limiting the propensity for a chemical reaction to occur. Controlling the risk factors associated with the oxygen, fuel, or heat, in turn, will prevent the chemical reaction."[17]

To mitigate fire resulting from a gaseous oxygen system, Boeing design requirements were developed to meet or exceed industry standards. An ignition mechanism is simply a source of heat that under the right conditions can lead to ignition of the materials of construction or contaminants in a system.[18] During inspection and documentation of the ABX exemplar airplanes, several oxygen component installation configurations were noted that differed from Boeing design criteria. Note that these observations are made from inspecting an airplane, and not the installation drawings. Therefore, the configuration differences could be due to a combination of the design and/or to installation practices. Two representative differences are:

1) To avoid grounding through the system, Boeing electrically isolates the oxygen system by maintaining a minimum of 2 inches positive separation, usually via clamping, between any electrical wiring.

- On ABX exemplar airplanes - Electrical wires were found that crossed the routing of the metal oxygen tube, above the ceiling panels. 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.[19]

2) To ensure proper handling and installation of oxygen system components, all Boeing mechanics that work on or with the oxygen system must be certified to our internal requirements[20] to ensure they understand the interaction of oxygen with ignition sources.

- 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

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[15] As noted in Boeing Service Bulletin (SB) 767-35A0034, *SUBJECT: OXYGEN - Crew Oxygen - Crew Oxygen System Low Pressure Flex Hose Replacement.* Originally issued on September 2, 1999: Revision 1- dated June 22, 2000, an electrical grounding condition can cause the (conductive) hose to melt or burn. Note that the SB was written to address the use of these hoses in Boeing designed and delivered configurations only.

[16] Also referred to as an ignition source or an ignition mechanism

[17] NASA/TM-2007-213740 Guide for Oxygen Compatibility Assessments on Oxygen Components and Systems, dated March, 2007, page 1

[18] NASA/TM-2007-213740 Guide for Oxygen Compatibility Assessments on Oxygen Components and Systems, dated March, 2007, page 4

[19] NTSB Airworthiness Group Chairman's Factual Report, Dated December 22, 2008, page 26

[20] Boeing Specification Support Standard 7602, PERSONNEL CERTIFICATION FOR OXYGEN SYSTEMS,

the grounded light housing. (See Figures 13 and 14) The ABX personnel were able to produce visible sparks by contacting the electrical components.[21]

ABX AIRPLANE MAINTENANCE

The oxygen system was experiencing chronic write-ups. Out of the 50 oxygen services[22] that took place from January of 2007 to June 2008 only 3 leaks were found and corrected by mechanics.[23] Leaks are one means of allowing contaminants to enter the oxygen system and can be an indication of improper maintenance practices and/or installation. It is possible for contaminants inside the system to become ignition sources.[24]

KNOWLEDGE GAINED DURING THE INVESTIGATION (Findings)

The following summarizes knowledge gained that is pertinent to drawing conclusions:

- The investigation did not reveal any anomalies with the airplane or its systems, other than the components installed by the STC that contributed to the accident.
- The Flight Crew heard a 'muffled bang' and then the sound of air flowing a very short time prior to becoming aware of the fire in the supernumerary area.
- On exemplar ABX airplanes, electrical wires were found that crossed the routing of the metal oxygen tube, above the ceiling panels. 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.
- Because some light assemblies were noted as missing their required rubber boots that provide isolation, ABX personnel were able to produce visible sparks (in a close proximity area of oxygen components) by contacting the electrical components together. This becomes an ignition source in an oxygen enriched environment.

CONCLUSIONS

Boeing believes the evidence suggests that the most likely cause of the fire is a breech of the supernumerary oxygen system which allowed oxygen to come in contact with an ignition source.

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[21] NTSB Airworthiness Group Chairman's Factual Report, Dated December 22, 2008, page 16

[22] Either refilling of the oxygen system or oxygen system repairs.

[23] NTSB Maintenance Records Factual Report, dated January 16, 2009, page 12

[24] NASA/TM-2007-213740 Guide for Oxygen Compatibility Assessments on Oxygen Components and Systems

RECOMMENDATIONS

Boeing makes the following recommendations based on the knowledge gained:

- Design and installation practices of a gaseous oxygen system should meet or exceed industry standards.
- ABX maintenance practices should be reviewed and/or revised to ensure chronic maintenance items are corrected in an appropriate time frame.
- Consideration should be given to special training / certification for personnel servicing and/or installing oxygen systems
- STC holders that use the same conductive type hoses noted in SB 767-35A0034, and the regulatory agencies that approve them, should evaluate whether their configuration may produce an electrical grounding condition through the hose. If an electrical grounding condition is foreseeable, the installation should be modified to prohibit the grounding condition.