National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation

Date: May 16, 1988

In reply refer to: A-88-61 Through -63

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On November 28, 1987, a South African Airways Boeing 747-244B, call sign Springbok 295, on a scheduled flight from Taipei, Taiwan, to Johannesburg, South Africa, with an en route stop in Mauritius, crashed into the sea about 140 miles northeast of Mauritius. All 141 passengers and 19 crewmembers on board were killed in the accident. Preliminary evidence, based on the estimated 1 percent of the wreckage that has been retrieved, and the communications between Springbok 295 and Mauritius air traffic control, suggests that an in-flight fire disabled the airplane, the flightcrew, or both.

The continuing investigation of the accident is being conducted by the Directorate of Civil Aviation of the Republic of South Africa, with the full participation of the National Transportation Safety Board representing the United States, the state of manufacture of the airplane, in accordance with the provisions of Annex 13 of the International Civil Aviation Organization. Considerable evidence remains to be obtained primarily by complex underwater recovery efforts. However, the accident has raised several issues which the Safety Board believes deserve immediate corrective action.

The Boeing 747-244B airplane was a "Combi" airplane, that is, an airplane in which a portion of the main, passenger compartment can be used to transport cargo. In the Boeing 747 Combi, the two aft cabins can be converted within hours to either passenger or cargo configurations. Federal Aviation Regulations (FAR) categorize aircraft cargo compartments into five classes, A through E, according to their volume, in-flight accessibility, air flow, and fire containment capabilities (see 14 Code of Federal Regulations (CFR) 25.857). Accordingly, the aft, main deck, cargo compartment of the Boeing 747 Combi is a class "B" compartment. Among other requirements of 14 CFR 25.857, this type of compartment must have: sufficient access to enable a crewmember to effectively reach any part of the compartment while in flight; separate smoke or fire detectors to alert flightcrew members at their stations to smoke or fire within the compartment; and the ability to prevent smoke from the compartment from entering the passenger compartment.

These requirements have hitherto been assumed to provide adequate protection from the potentially catastrophic consequences of an in-flight fire because, the Safety Board believes, the incidence of such events on transport category aircraft has been quite low. As a result, little opportunity has been available to demonstrate the effectiveness of these requirements in actual in-flight occurrences. For example, the Safety Board is aware of only five major fatal in-flight fires on board transport category aircraft in the last two decades: on July 11, 1973, near Paris, France, a fire on a Varig Airlines Boeing 707 killed 124 people; on November 3, 1973, in Boston, Massachusetts, a fire on a Pan American Airways Boeing 707 freighter killed all three crewmembers; on November 26, 1979, near Jeddah, Saudi Arabia, a fire on a Pakistan International Airlines Boeing 707 killed all 156 people on-board; on August 19, 1980, in Riyadh, Saudi Arabia, a fire which was believed to have originated in a class D compartment of a Saudia Lockheed L-1011 killed all 301 persons on-board; and on June 2, 1983, a fire on an Air Canada McDonnell Douglas DC-9 in Cincinnati, Ohio, killed 23 people.

Following the accident involving the Saudia Lockheed L-1011, the Safety Board issued Safety Recommendation A-81-13 which urged the Federal Aviation Administration (FAA) to:

> Review the certification of all baggage/cargo compartments (over 500 cu. ft.) in the "D" classification to insure that the intent of 14 CFR 25.857(d) is met.

In response to the recommendation, the FAA carried out extensive research to determine the fire containment capabilities of class C or D cargo compartments. 1/ The results of the research changed several assumptions regarding the fire containment and/or suppression capabilities of inaccessible, i.e., class C and D, cargo compartments. For example, certain cargo liner material that had been considered to be fire resistant was shown to be unable to contain a sustained fire for even several minutes. As a result, the FAA upgraded the fire-resistance standards of class C and D cargo compartment liners and revised other regulations governing fire detection, containment, and suppression in class C and D cargo compartments.

According to the final rule requiring changes in cargo liner fire resistance, 2/ the proposed changes were to be applied ". . . to all classes of cargo or baggage compartments that depend on liners for fire control," i.e., class C and D cargo compartments and not class B and E cargo compartments, which rely on crewmember access to combat a fire. Thus, aircraft manufacturers can comply with current FARs by demonstrating that class C and D cargo compartments can contain a fire and, due to their ability to restrict internal air flow, smother it with extinguishing agent, starve it through oxygen depletion, or both. Further, fire containment in ceiling and sidewall liners of

1/ Blake, D.R., and Hill, R.G., Fire Containment Characteristics of Aircraft Class D Cargo Compartments, Atlantic City, New Jersey: FAA Technical Center, 1983 (FAA/DT/CT-82/156); and Blake, D., Suppression and Control of Class C Cargo and Compartment Fires, Atlantic City, New Jersey: FAA Technical Center, 1985 (DOT/FAA/CT-84/21).

2/ Department of Transportation, Federal Aviation Administration, 14 CFR Part 25, Airworthiness Standards; Fire Protection Requirements for Cargo or Baggage Compartments, Federal Register 51, May 16, 1986.

class C and D cargo compartments is required to be demonstrated by holding a flame to them for a minimum of 5 minutes, while certification requirements specify that flames be held to liners of class B compartments for only 12 seconds. The Safety Board believes that to provide the needed fire resistance for class B cargo compartments, the FAA should establish fire resistant requirements for the ceiling and sidewall liners in class B cargo compartments of transport category airplanes that equal or exceed the requirements for class C and D compartments as set forth in 14 CFR Part 25, Appendix F, Part III.

Class B cargo compartment certification standards specify that a fire be detected rapidly and, following detection, that a crewmember can then, within 5 minutes, leave his or her station, don protective equipment, enter the cargo compartment, locate the fire extinguisher, attach an extension nozzle to it, and point it at the fire. In the certification of the Boeing 747 Combi, the manufacturer demonstrated that all required actions could be accomplished well within the allowable interval.

Yet, while the certification requirements of the Boeing 747 Combi's class B cargo compartment were met, the Safety Board is unaware of any data which can support the effectiveness of the fire detection and suppression techniques against an actual fire in a class B cargo compartment. Moreover, while the effectiveness of fire suppression techniques relies on rapid detection, examination of the certification of the fire detection in the Combi's main deck cargo compartment brings into question the rapidity with which a fire can actually be detected due to several factors. All certification demonstrations used a smoke generator from which the smoke was directed vertically toward the compartment ceiling where the smoke collectors are located. No tests were carried out with smoke generated horizontally at the floor level. Further, all tests were conducted in an empty compartment, and, as a result, smoke detection was not measured in the environment in which an actual fire would be likely to occur, i.e., a compartment containing cargo, as Springbok 295 was. Moreover, the cargo pallets on board Springbok 295 were wrapped with polyethylene covers to protect them from weather during loading and unloading. Such covers could prevent smoke generated from within the pallets from rising up to the ceiling during early stages of a fire. The smoke would probably exit the pallets at the floor level. As a result, only after sufficient smoke had exited the pallet and the thermal energy of that smoke had exceeded the force of the downward air current within the compartment would smoke rise to the collectors and be detected. By this time, the material in the pallet could be preheated to a point where very rapid fire growth would result.

Moreover, based upon an examination of the wreckage that has been retrieved from Springbok 295, the air traffic control communications between it and Mauritius control, and a review of the in-flight firefighting procedures of several operators, the evidence suggests that once a fire propagates in a class B cargo compartment, the effectiveness of the crewmember assigned to combat the fire would, under the most ideal circumstances, be limited. First, the crewmember would be required to find the source of the fire, a difficult task if sufficient smoke had been generated to reduce the visibility within the compartment, or if the fire was deep-seated within a cargo pallet. Second, should the crewmember expend the fire extinguishing agent, which requires only 12 or 14 seconds for the commonly used 16-pound Halon unit, without suppressing the fire, it is highly unlikely that the agent would remain sufficiently concentrated within the compartment to suppress the fire. The air flow to the Boeing 747 Combi's main deck, aft cargo compartment cannot be shut off, and the constant air flow within the compartment would dilute the agent to the point where it would no longer be effective. Therefore, no other means would be available to contain or extinguish a fire and ensure the safety of flight. The only available option would be to land at the nearest airport.

Yet, as the accident involving Springbok 295 demonstrates, for many long, overwater flights flown by present generation transport category aircraft, the nearest airport may be several hours away. Perhaps even more significant, the next generation of transport aircraft, such as the Boeing 747-400 which also will be available in a Combi version, will have considerably more range than its predecessors and, as a result, will be capable of flying longer overwater routes than current aircraft.

The Safety Board concludes that the present regulations regarding certification of fire detection and suppression capabilities of class B cargo compartments are based on inadequate and limited data and assumptions that may be inappropriate, and, thereby may pose an immediate threat to the safety of the flying public. Therefore, until such time as research can be conducted to actually demonstrate the effectiveness of the fire detection and suppression techniques against class B cargo compartment fires, the Safety Board believes that, as an interim measure, all cargo in class B compartments of United States registered aircraft should be transported only in fire-resistant containers. FAA-sponsored research 3/ has demonstrated the effectiveness of such containers to smother cargo fires and to prevent their propagation outside the containers. The Safety Board further urges the FAA to conduct research to establish the effectiveness of the fire detection and suppression methods needed to protect transport category airplanes from catastrophic fires in class B cargo compartments.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Until fire detection and suppression methods for class B cargo compartment fires are evaluated and revised, as necessary, require that all cargo carried in class B cargo compartments of United States registered transport category airplanes be carried in fire resistant containers. (Class I, Urgent Action) (A-88-61)

Conduct research to establish the fire detection and suppression methods needed to protect transport category airplanes from catastrophic fires in class B compartments. (Class II, Priority Action) (A-88-62)

Establish fire resistant requirements for the ceiling and sidewall liners in class B cargo compartments of transport category airplanes that equal or exceed the requirements for class C and D compartments as set forth in 14 CFR Part 25, Appendix F, Part III. (Class II, Priority Action) (A-88-63)

BURNETT, Chairman, KOLSTAD, Vice Chairman, and LAUBER and NALL, Members, concurred in these recommendations.

By: Jim Burnett
Chairman

3/ Blake, D., Evaluation of Fire Containment of LD-3 Cargo Containers. (DOT/FAA/CT-TN83/38) Atlantic City, New Jersey: FAA Technical Center, 1983.