National Transportation Safety Board
Washington, D.C. 20594

Safety Recommendation

Date: MAY 31 1996

In reply refer to: A-96-29 and -30

Honorable D.K. Sharma
Administrator
Research and Special Programs Administration
Washington, D.C. 20590

On May 11, 1996, about 1415 eastern daylight time, a McDonnell Douglas DC-9-32 crashed into the Everglades swamp shortly after takeoff from Miami International Airport, Miami, Florida. The airplane, N904VJ, was operated by ValuJet Airlines, Inc., as ValuJet flight 592. Both pilots, the three flight attendants, and all 105 passengers were killed. Before the accident, the flightcrew reported to air traffic control that it was experiencing smoke in the cabin and cockpit. Visual meteorological conditions existed in the Miami area at the time of the takeoff. The destination of the flight was Hartsfield International Airport, Atlanta, Georgia. Flight 592 was on an instrument flight rules flight plan.

Although the accident is still under investigation and many facts are yet to be determined, the Safety Board has discovered sufficient factual information to raise issues needing immediate attention. Preliminary evidence indicates that five cardboard boxes containing as many as 144 chemical oxygen generators, most with unexpended oxidizer cores, and three wheel/tire assemblies had been loaded in the forward cargo compartment shortly before departure. These items were being shipped as company material (COMAT). Additionally, some passenger baggage and U.S. mail were loaded into the forward cargo compartment. The forward compartment of this aircraft was a class D compartment,[1] which had no fire/smoke detection system to alert the cockpit crew of a fire within the compartment.

[1] Title 14 CFR 25.857 defines lower fuselage cargo compartments of large passenger airplanes, i.e., not accessible to crewmembers during flight, as either class C or class D type compartments. Class C compartments must have "a separate approved smoke detector or fire detector to give warning at the pilot or flight engineering station" and "an approved built-in fire-extinguishing system controllable from the pilot or flight engineering stations." Class D cargo compartments require no fire/smoke detection or fire extinguishing systems. Instead, class D cargo compartments depend on the limited availability of oxygen in the compartment to suppress a potential fire. This is controlled by compartment size and leakage rate requirements found in Section 25.857. Further, class D compartment lining material must pass vertical and 45° Bunsen or Tirrill burner tests as outlined in Sections 25.853 and 25.855.

Shortly before the departure of flight 592, a driver from the SabreTech Inc., maintenance facility at the Miami airport delivered the COMAT (the boxes and wheel/tire assemblies) to the ValuJet lead ramp agent for transport to ValuJet facilities in Atlanta. (SabreTech operates an FAA-approved aircraft repair and maintenance facility at the Miami airport and had performed renovation work for ValuJet.) A SabreTech shipping ticket, dated May 10, 1996, for the five boxes of chemical oxygen generators, was also offered to the ramp agent. The generators were identified on the shipping ticket as "Oxy Cannisters [sic] 'Empty'."

The ramp agent, who was busy offloading the aircraft from its previous flight, signed the shipping ticket for the COMAT and instructed the SabreTech driver to place the items on an empty baggage cart. The ramp agent stated that he asked the first officer of flight 592 for approval to load the COMAT on the aircraft. After the ramp agent and the first officer estimated the weight of the COMAT, the three wheel/tire assemblies and the five boxes with the generators were loaded into the forward cargo compartment.

The chemical oxygen generators loaded on flight 592 had been removed from three MD-80 aircraft that were being renovated for ValuJet at the SabreTech's Miami facility. These chemical oxygen generators had been installed in overhead compartments[2] on the MD-80 aircraft to provide emergency oxygen for passengers but were removed because their shelf life of 12 years had expired.[3] SabreTech mechanics who placed the generators in cardboard boxes stated that shipping caps were not installed over the percussion caps, and that 15 generators or fewer had been discharged. When not installed as part of an airplane's equipment, a shipping cap must be mounted over the percussion cap to prevent accidental initiation of the generator should the pin be unintentionally pulled or jarred loose.

Chemical oxygen generators, when transported as cargo, are considered a hazardous material regulated under the Department of Transportation hazardous materials regulations (49 CFR Parts 171-180) and are classified as oxidizers. These same regulations govern the packaging, labeling, and shipping requirements for transportation of chemical oxygen generators.

The generators,[4] which were manufactured by Scott Aviation, Inc., produce oxygen when a pin is pulled releasing a spring-loaded firing mechanism that strikes a percussion cap starting a chemical reaction in the solid oxidizer core of the generator. The chemical decomposition reaction of the oxidizer is exothermic (releases heat) and the heat of reaction can result in external shell temperatures up to 547 °F. (Manufacturer measurements of external shell temperature on oxygen generators during operational testing indicated maximum shell temperatures between 450 and 500 °F.) The oxidizer core is primarily sodium chlorate mixed with less than 6 percent barium peroxide and potassium perchlorate, and trace amounts of

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[2] Chemical oxygen generators are designed to function safely when properly installed in aircraft.

[3] The MD-80 maintenance manual specifies that after a generator is removed from an airplane because it has passed its expiration date, it should be initiated (discharged) and the oxidizer core fully expended.

[4] A generator is about the size of a can of spray paint (a cylinder 2.75" by 6.75").

other materials. The reaction produces oxygen for at least 15 minutes. Discharged oxygen generators must be disposed of as hazardous waste.

Although the origin of the in-flight fire on board flight 592 has not been determined to date, the presence of the chemical oxygen generators in the forward cargo compartment of the aircraft created an extremely dangerous condition. The chemical decomposition reaction of an oxidizer such as sodium chlorate in a confined space will generate heat, and the oxygen resulting from the reaction will sustain and intensify a fire. Also, the ignition temperature of ordinary materials is lowered in an oxygen-rich environment.

On May 24, 1996, the Research and Special Programs Administration (RSPA) issued an interim final rule[5] that prohibits the transportation of chemical oxygen generators on passenger aircraft until January 1, 1997, and the FAA issued an emergency notice[6] that any person who offers for transportation or transports oxygen generators as cargo aboard passenger aircraft will be subject to swift enforcement action. The Safety Board supports these actions but believes that further action can and should be taken. Because chemical oxygen generators are not reusable and must be discharged before disposal, the Board believes that there is no need to transport expired and undepleted chemical oxygen generators as cargo on board any passenger or cargo aircraft. Therefore, the Safety Board believes that the RSPA, in cooperation with FAA, should permanently prohibit the transportation of chemical oxygen generators as cargo on board any passenger or cargo aircraft when the generators have passed their expiration dates and the chemical core has not been depleted.

The Safety Board also believes urgent action is needed to prevent the shipment of undeclared or inappropriately packaged hazardous materials. The failure to properly identify and properly package hazardous materials has resulted in other accidents and incidents.

On November 3, 1973, a Pan American World Airways, Inc., Boeing 707-321C crashed at Logan International Airport, Boston, Massachusetts, killing all three crewmembers. Thirty minutes after this cargo flight departed John F. Kennedy Airport, New York, the flightcrew reported smoke in the cockpit, and the flight was diverted to Logan, where it crashed short of the runway. The Safety Board determined that dense smoke in the cockpit seriously impaired the flightcrew's vision and ability to function effectively during the emergency. Although the source of the smoke could not be established conclusively, the Board believed that spontaneous chemical reaction between leaking nitric acid (a corrosive and oxidizing material), which was improperly packaged and stowed, and the improper sawdust packing surrounding the acid's package, initiated the accident sequence. A contributing factor was found to be a general lack of compliance with existing regulations governing the transportation of hazardous materials and the

[5] *Temporary Prohibition of Oxygen Generators as Cargo in Passenger Aircraft*, Docket HM-224, at 61 FR 26418 on May 24, 1996.

[6] *Emergency Notice of Enforcement Policy* at 61FR 26422 on May 24, 1996.

inadequacy of government surveillance. Further, the Safety Board concluded that most personnel handling the hazardous material shipment were inadequately trained.

On August 10, 1986, a McDonnell Douglas DC-10-40, operating as a nonscheduled flight from Honolulu, Hawaii, to Chicago, Illinois, with an en route stop in Los Angeles, California, arrived without incident at Chicago's O'Hare International Airport. After the passengers and crew had deplaned, a fire, which was found to have initiated in a cargo compartment, burned through the cabin floor, spread rapidly throughout the entire cabin, and destroyed the airplane.

The Safety Board concluded that the fire had been initiated as a result of a mechanic's improper handling of a chemical oxygen generator associated with a seatback temporarily stored in the compartment. The Safety Board learned as a consequence of this incident that some air carriers were not aware that solid-state passenger supplemental oxygen generators were capable of generating high temperatures and were classified as hazardous materials when carried as company material in cargo compartments. Consequently, some air carriers were not taking the required precautions when shipping oxygen generators in their airplanes. Following this incident, the FAA promptly notified all domestic air carriers and foreign airworthiness authorities of the circumstances of the incident and reminded them that oxygen generators are oxidizers and therefore are classified as hazardous materials, which should be packaged and stowed securely.

On February 3, 1988, American Airlines flight 132, a DC-9-83, had an in-flight fire while en route to Nashville Metropolitan Airport, Tennessee, from Dallas/Fort Worth International Airport, Texas.[7] As the aircraft was on a final instrument landing system approach, a flight attendant and a deadheading first officer notified the cockpit crew of smoke in the passenger cabin. The Safety Board found that hydrogen peroxide solution (an oxidizer) and a sodium orthosilicate-based mixture had been shipped and loaded into the midcargo compartment of the airplane. The shipment was improperly packaged and it was not identified as a hazardous material. After the hydrogen peroxide leaked from its container, a fire started in the class D cargo compartment. The fire eventually breached the cargo compartment, and the passenger cabin floor over the midcargo compartment became hot and soft. The aircraft landed without further incident, and the 120 passengers and six crewmembers safely evacuated the aircraft.

As a result of the accident on American Airlines flight 132, the Safety Board stated that in addition to proper packaging of hazardous materials, the safe transportation of hazardous materials depends on sufficient information to identify the materials and the hazards presented during transportation. Accordingly, the Board noted that both shippers and carriers had a responsibility to determine if materials offered for transportation were hazardous and in proper condition to ensure their safe transportation.

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[7] *In-Flight Fire, McDonnell Douglas DC-9-83, N569AA, Nashville Metropolitan Airport, Nashville, Tennessee, February 3, 1988*, Hazardous Materials Incident Report NTSB/HZM-88/02. National Transportation Safety Board. Washington, D.C. 1988.

The Board noted that although the American Airlines procedures for accepting packages that contain declared hazardous materials were thorough and American would likely have rejected the fiber drum containing the oxidizer had it been properly identified, American Airlines procedures for accepting ordinary freight packages were not adequate. These procedures did not include routine inquiries about the possibility that hazardous materials may be included but not identified as such. The Board urged American Airlines to develop checklist procedures and questions designed to help freight clerks to identify undeclared hazardous materials offered by general freight shippers who are unaware of Federal hazardous materials transportation safety regulations. Further, the Board noted that industry had also recognized that undeclared hazardous materials present a problem. The International Air Transport Association dangerous goods regulations (Section 1.6.3) addressed precautionary measures against hidden hazards in cargo and baggage. Also, following a series of misdeclarations of freight, Swissair imposed new requirements on shippers who describe consignments in generic terms—shipping descriptions must include the phrase "not restricted." Unless the additional description is included with the shipping name, the cargo is assumed to contain hazardous materials. The Safety Board is concerned, based on the facts developed during the ValuJet flight 592 accident investigation, that the practices, procedures, and training of the personnel involved in the identification and handling of hazardous materials remain inadequate.

Further, when investigating the accident on American Airlines flight 132, the Safety Board noted that because the cargo compartment was not equipped with fire or smoke detection systems, the cockpit crew had no way of detecting the threat to the safety of the airplane until smoke and fumes reached the passenger cabin. After smoke was detected in the passenger cabin, the cockpit crew had no means to identify the location of the fire. Previously, on August 8, 1984, the FAA had issued a notice of proposed rulemaking, Notice 84-11, that addressed the problem of fire containment in cargo compartments by specifying a new test method for determining the flame penetration resistance of compartment liners. When the Board provided comments on the rulemaking on October 9, 1984, it advised the FAA that while proposed flame penetration tests were more stringent than previous ones, a fire should not be allowed to persist in any state of intensity in an airplane without the knowledge of the flightcrew, and that a fire detection system should be required in class D cargo compartments.

On May 16, 1986, the FAA issued a final rule to amend fire safety standards for cargo or baggage compartments. The final rule adopted more stringent cargo liner burn-through tests and smaller class D cargo compartments, but rejected a requirement for fire detection systems in class D cargo compartments.

Further, the FAA's cargo compartment fire protection research and testing did not consider what effect hazardous materials involvement in a cargo fire could have on the capability of a cargo compartment to contain an in-flight fire. The FAA concluded in its final rule that the effects of hazardous materials were beyond the scope of its rulemaking notice. However, the Safety Board subsequently noted that the incident aboard flight 132 clearly demonstrated that hazardous materials involvement in a cargo compartment fire

must be considered in all cargo compartment fire penetration safety standards, and that hazardous materials determined to present unacceptable threats should be prohibited.

As a result of the accident on American Airlines flight 132, the Safety Board on October 24, 1988, urged the FAA to:

> Require fire/smoke detection systems for all class D cargo compartments. (A-88-122)
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> Consider the effects of authorized hazardous materials cargo in fires for all types of cargo compartments, and require appropriate safety systems to protect the aircraft and occupants. (A-88-127)

On August 10, 1993, the FAA responded to Safety Recommendation A-88-122 by stating that it did not believe that fire/smoke detection systems would provide a significant degree of protection to occupants of airplanes and that it had terminated its rulemaking action to require such systems. On October 14, 1993, Safety Recommendation A-88-122 was classified "Closed—Unacceptable Action." On April 19, 1993, after no response to a final follow-up letter to the FAA, Safety Recommendation A-88-127 was classified "Closed—Unacceptable Action."

The Safety Board is currently reviewing two other incidents reported by the FAA that involved fires associated with chemical oxygen generators that were shipped by air. One incident occurred on November 6, 1992, in Los Angeles, California, and the other on September 23, 1993, in Oakland, California. Information obtained to date indicates that neither shipment of oxygen generators was declared to be a hazardous material.

Several of these occurrences have involved oxidizing materials that were transported as cargo and were not declared or properly packaged. The Safety Board stressed in its report of the American Airlines incident the importance for air carriers to have effective policies, practices, and training to screen passenger baggage and freight shipments for undeclared or unauthorized hazardous materials that are offered for transport. However, acceptance of undeclared and unauthorized shipments of hazardous materials continues to pose a significant threat to passenger and cargo aircraft. Also, the Safety Board asserted, in issuing Safety Recommendations A-88-122 and -127, the importance of having fire/smoke detection systems and other safety systems that would provide early warning to the flightcrew of an in-flight fire and protection to the aircraft and occupants. Consequently, the Safety Board believes that the FAA should evaluate the practices of all air carriers, including training, for accepting passenger baggage and freight shipments (including company material) and for identifying undeclared or unauthorized shipments of hazardous materials, and require air carriers to revise their procedures as necessary. Because of the involvement of oxidizing materials in previous incidents, and the dangers they present by reacting to generate heat and oxygen, the Safety Board also believes that the RSPA, in cooperation with the FAA, should prohibit the transportation of

oxidizers and oxidizing materials (e.g., nitric acid) in cargo compartments that do not have fire or smoke detection systems.

Therefore, the National Transportation Safety Board recommends that the Research and Special Programs Administration:

> In cooperation with the Federal Aviation Administration, permanently prohibit the transportation of chemical oxygen generators as cargo on board any passenger or cargo aircraft when the generators have passed expiration dates, and the chemical core has not been depleted. (Class I, Urgent Action) (A-96-29)

> In cooperation with the Federal Aviation Administration, prohibit the transportation of oxidizers and oxidizing materials (e.g., nitric acid) in cargo compartments that do not have fire or smoke detection systems. (Class I, Urgent Action) (A-96-30)

Also as a result of its ongoing investigation, the Safety Board issued Safety Recommendations A-96-25 through -28 to the Federal Aviation Administration.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman