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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

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In reply refer to: A-97-56 through -77

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On May 11, 1996, at 1413:42 eastern daylight time, a Douglas DC-9-32 crashed into the Everglades about 10 minutes after takeoff from Miami International Airport, Miami, Florida. The airplane, N904VJ, was being operated by ValuJet Airlines, Inc., as flight 592. Both pilots, the three flight attendants, and all 105 passengers were killed. Visual meteorological conditions existed in the Miami area at the time of the takeoff. Flight 592, operating under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121, was on an instrument flight rules flight plan destined for the William B. Hartsfield International Airport, Atlanta, Georgia.

The investigation revealed that shortly before flight 592's departure from Miami, five boxes of unexpended chemical oxygen generators and three tires (two of which included wheel assemblies) were loaded into the forward cargo compartment (a class D compartment). Personnel from the SabreTech Corporation, a maintenance facility with which ValuJet had an ongoing contractual relationship for line maintenance and heavy aircraft maintenance, had loaded the boxes on flight 592 before takeoff. The oxygen generators, all of which were near or past their expiration dates, had been removed from three ValuJet MD-80s at SabreTech.

The National Transportation Safety Board determined that the probable causes of the accident, which resulted from a fire in the airplane's class D cargo compartment that was initiated by the actuation of one or more oxygen generators being improperly carried as cargo, were (1) the failure of SabreTech to properly prepare, package, and identify unexpended chemical oxygen generators before presenting them to ValuJet for carriage; (2) the failure of ValuJet to properly oversee its contract maintenance program to ensure compliance with maintenance, maintenance training, and hazardous materials requirements and practices; and (3) the failure of the Federal Aviation Administration (FAA) to require smoke detection and fire suppression systems in class D cargo compartments.

Contributing to the accident was the failure of the FAA to adequately monitor ValuJet's heavy maintenance programs and responsibilities, including ValuJet's oversight of its contractors, and SabreTech's repair station certificate; the failure of the FAA to adequately

respond to prior chemical oxygen generator fires with programs to address the potential hazards; and ValuJet's failure to ensure that both ValuJet and contract maintenance facility employees were aware of the carrier's "no-carry" hazardous materials policy and had received appropriate hazardous materials training.[1]

Propagation and Detection of Fire

The first indication of a problem during the accident flight occurred at 1410:03, approximately 6 minutes after flight 592 took off from Miami, when the cockpit voice recorder (CVR) recorded an unidentified sound, which prompted the captain to ask "What was that?" Simultaneously, an anomaly in the flight data recorder (FDR) altitude and airspeed parameters occurred consistent with a static pressure increase of about 69 pounds per square foot (psf). Within 12 seconds, the captain reported an electrical problem, and at 1410:25, there were voices shouting "fire, fire, fire" in the passenger cabin.

In the Safety Board's fire tests,[2] a main landing gear tire that had been inflated to 50 pounds per square inch (psi) ruptured 16 minutes after the first oxygen generator was activated, when the fire destroyed 9 of the 12 tire sidewall plies. Because the tires in the accident airplane were loaded just forward of the cargo door, the tires would have been located just above the set of left static ports. The FDR altitude and speed data are based on readings from the left alternate static port, indicating that the unidentified sound on the CVR and the FDR anomaly at 1410:03 were most likely caused by the rupture of an inflated tire in the forward cargo compartment after the tire was partially burned through by the fire.

Because the cargo compartment where the fire occurred was a class D cargo compartment and was not equipped (nor was it required to be equipped) with a smoke detection system, the cockpit crew of ValuJet flight 592 had no way of detecting the threat to the safety of the airplane from the in-flight fire until smoke and fumes reached the passenger cabin. Further, because the cargo compartment was not equipped (nor was it required to be equipped) with a fire suppression system, the cockpit crew had no means available to extinguish or even suppress the fire in the cargo compartment.

If the fire started before takeoff, and a smoke/fire detection warning device had activated, the flightcrew most likely would not have taken off. However, the Safety Board concludes that even if the fire did not start until the airplane took off, a smoke/fire warning device would have more quickly alerted the pilots to the fire and would have allowed them more time to land the

[1] For more detailed information, read Aircraft Accident Report—"In-flight Fire and Impact with Terrain, ValuJet Airlines Flight 592, DC-9-32, N904VJ, Everglades, near Miami, Florida, May 11, 1996." (NTSB/AAR-97/06).

[2] The tests were conducted during the Safety Board's investigation of this accident and were not designed to be an exact replication or simulation of the circumstances of this accident, but were conducted to learn about the overall nature of a fire initiated by an oxygen generator and fed with high concentrations of oxygen released from additional oxygen generators. Because the investigation could not conclusively determine the exact physical arrangement of the generators in each box, the exact size of the boxes, the exact arrangement of the boxes and tires in the cargo compartment, or how many oxygen generators were initially activated, and because of differences between the test chamber and the accident cargo compartment, the Safety Board recognizes that the test results might differ somewhat from what occurred on the accident airplane.

airplane. Further, the Safety Board concludes that if the plane had been equipped with a fire suppression system, it might have suppressed the spread of the fire (although the intensity of the fire might have been so great that a suppression system might not have been sufficient to fully extinguish the fire) and it would have delayed the spread of the fire, and in conjunction with an early warning, it would likely have provided time to land the airplane safely.

Although class D cargo compartments are designed to suppress fire through oxygen starvation, this accident and events before this accident illustrate that some cargo, specifically oxidizers, can generate sufficient oxygen to support combustion in the reduced ventilation environment of a class D cargo compartment. An in-flight fire on American Airlines flight 132, a DC-9-83, on February 3, 1988,[3] clearly illustrated the need for systems that would provide flightcrews with the means to detect and suppress fires in the cargo compartments of airplanes. As a result of its investigation of that accident, the Safety Board recommended that the FAA require fire/smoke detection and fire extinguishment systems for all class D cargo compartments (Safety Recommendations A-88-122 and -123). As recently as August 1993, although the FAA had investigated several incidents of fires that were initiated as a result of oxidizers in the cargo compartments of airplanes, the FAA responded to Safety Recommendations A-88-122 and -123 stating that fire/smoke detection and fire extinguishment systems were not cost beneficial, that it did not believe that these systems would provide a significant degree of protection to occupants of airplanes, and that it had terminated its rulemaking action to require such systems. The Safety Board concludes that had the FAA required fire/smoke detection and fire extinguishment systems in class D cargo compartments, as the Safety Board recommended in 1988, ValuJet flight 592 would likely not have crashed. Therefore, the failure of the FAA to require such systems was causal to this accident.

The crash of ValuJet flight 592 prompted the FAA to state in November 1996 that it would issue an NPRM by the end of the summer of 1997 to require, on about 2,800 older aircraft, the modification of all class D cargo compartments to class C compartments, which are required to have both smoke detection and fire extinguishment systems. The accident also prompted the Air Transport Association (ATA) to announce in November 1996 that its members would voluntarily retrofit existing class D cargo compartments with smoke detectors. As of the date of this report, the Safety Board is unaware that any airplanes have been modified and are in service.

On June 13, 1997, the FAA issued an NPRM that would require the installation of smoke detection and fire suppression systems in class D cargo compartments. According to the NPRM, the airline industry would have 3 years from the time the rule became final to meet the new standards. The FAA indicated that it anticipated issuing a final rule by the end of 1997. The Safety Board is disappointed that more than 1 year after the ValuJet crash and 9 years after the American Airlines accident at Nashville, the class D cargo compartments of most passenger airplanes still do not have fire/smoke detection or suppression equipment and there is no

[3] *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.

requirement for such equipment. The FAA's recent findings and the continued shipment of undeclared hazardous materials,[4] including oxygen generators, highlight the importance of getting the proper equipment installed as rapidly as possible. Therefore, the Safety Board believes that the FAA should expedite final rulemaking to require smoke detection and fire suppression systems for all class D cargo compartments.

Crew's Use of Emergency Procedures and Equipment

To help assess the flightcrew's actions in response to the clear evidence of a fire on the airplane, the Safety Board evaluated the ValuJet guidance and training in fire and smoke emergencies provided to the flightcrew. ValuJet had established four emergency procedures for handling fire and smoke from electrical system and air conditioning (pressurization) system malfunctions, removing smoke from a pressurized airplane, and removing cockpit smoke from an unpressurized airplane.

Given the pilots' clear awareness of smoke and fire aboard the airplane (based on their statements recorded on the CVR), the Safety Board evaluated the effect of the flight attendants' actions on the flightcrew, the flightcrew's use of the ValuJet smoke evacuation procedures and emergency equipment, and the adequacy of that equipment.

The flight attendant first opened the cockpit door at 1410:52 to inform the crew of the emergency, and some smoke from the cabin area was likely introduced into the cockpit environment. However, during the 1 minute 42 seconds in which the CVR operated continuously after the emergency began (including the times that the cockpit door was open), the flightcrew made no comments about breathing or vision difficulties, nor were there any sounds of coughs from the crewmembers during this period. Based on the absence of comments and sounds indicating flightcrew physical impairment on the CVR, the Safety Board concludes that only a small amount of smoke entered the cockpit before the last recorded flightcrew verbalization at 1411:49, including the period when the cockpit door was open.

However, the Safety Board is concerned that if the smoke concentrations on the cabin side of the door had been severe when the flight attendant opened the door, her actions could have resulted in the introduction of incapacitating smoke into the cockpit.

In the event of a cabin fire, the cabin crew needs to immediately communicate information to the flightcrew, while maintaining a smoke barrier between the cockpit and cabin. The interphone would have been the most appropriate way to do this, but it was inoperative.[5] Based on a principal operations inspector's (POI) suggestion that an appropriate "alternate procedure" for an inoperative interphone might consist of a prearranged code for knocking on the cockpit door to gain entry, the Safety Board concludes that the current MEL requirements for the

[4] For detailed information on recent incidents involving the shipment of hazardous materials, see section 1.18.2, "Incidents Involving Chemical Oxygen Generators," of the report of this accident.

[5] According to ValuJet's FAA-approved minimum equipment list (MEL) for the DC-9, the following operational procedure was required for the interphone system: "May be inoperative provided: a) alternate normal and emergency operations procedures are established and used; and b) the passenger address system is operative."

development of an "alternate procedure" for an inoperative service interphone are inadequate for a cabin fire situation. Therefore, the Safety Board believes that the FAA should specify, in air carrier operations master MELs, that the cockpit-cabin portion of the service interphone system is required to be operating before an airplane can be dispatched.

Evidence recovered at the accident site indicates that the pilots were active in attempting to remove smoke from the cabin and cockpit before impact, and in doing so they had executed portions of the ValuJet emergency procedures for handling smoke. The soot pattern found on the outflow valve recovered in the wreckage is consistent with the flightcrew having at least partially opened the outflow valve using the manual method, which is part of the ValuJet electrical smoke/fire procedure for evacuating smoke.

The four ValuJet emergency procedures for handling smoke and fire uniformly instructed the pilots to don their oxygen masks and smoke goggles, as the first item to be performed on the emergency checklist. However, the flightcrew comments recorded on the CVR sounded unmuffled. Further, these comments were recorded on the cockpit area microphone channel of the CVR; this microphone would not have picked up verbalizations made under an oxygen mask. This indicates that neither the captain nor the first officer donned their oxygen masks during the period of the emergency in which the CVR was operative and the pilots were speaking. The last recorded verbalization by the captain was at 1410:49; the last by the first officer was at 1411:38. Because smoke goggles of the type provided to the flightcrew must be donned subsequent to the oxygen mask to have any effect, the pilots probably did not don their smoke goggles from the onset of the emergency, at 1410:07, through at least 1411:38. There is no evidence to indicate whether they donned their masks and goggles after 1411:38.

The donning of oxygen masks and smoke goggles at the first indication of smoke anywhere in the airplane can provide flightcrews with a sustained ability to breathe and see in the event of a subsequent influx of smoke into the cockpit. Although in this accident, the donning of oxygen masks and smoke goggles would not have assisted the crew in the initial stages of the emergency (because of the absence of heavy smoke in the cockpit), early donning of the smoke protection equipment might have helped later in the descent, if heavy smoke had entered the cockpit. Consequently, the Safety Board evaluated why the pilots of ValuJet flight 592 did not don their oxygen masks or smoke goggles while the emergency was in its early stages.

The training records of the captain and first officer substantiated that both pilots had received a single session of simulator training in the electrical fire and smoke emergency procedure during the ValuJet initial DC-9 qualification program (the first step of which was to don oxygen masks and smoke goggles). However, in a previous incident involving smoke in the cabin from an overheated air conditioning pack, the captain had obtained a successful outcome without donning the mask and goggles. This might have predisposed her to decide not to don an oxygen mask and smoke goggles when the emergency began on the accident flight.

In an informal survey of air carriers conducted by the Safety Board, pilots from several air carriers indicated that they would not don oxygen masks and smoke goggles for situations such as reports of galley fire, smoke in the cabin, or a slight smell of smoke in the cockpit.

Based on the circumstances of this accident and the results of its survey, the Safety Board concludes that there is inadequate guidance for air carrier pilots about the need to don oxygen masks and smoke goggles immediately in the event of a smoke emergency. The Safety Board believes that the FAA should issue guidance to air carrier pilots about the need to don oxygen masks and smoke goggles at the first indication of a possible in-flight smoke or fire emergency.

Title 14 CFR Part 121.333 requires that pilots of pressurized airplanes operating above flight level 250 be provided a "quick-donning type of oxygen mask that...can be placed on the face from its ready position, properly secured, sealed, and supplying oxygen upon demand, with one hand and within five seconds." This regulation also requires that the mask can be "put on without disturbing eyeglasses and without delaying the flight crewmember from proceeding with his assigned emergency duties." The Safety Board notes that FAA regulations do not establish any similar performance requirements for smoke goggles.[6]

Based on a Safety Board simulator evaluation of the equipment furnished to the flightcrew of ValuJet flight 592 and its informal survey of air carrier pilots, the Board concludes that the smoke goggle equipment currently provided on most air carrier transport aircraft requires excessive time, effort, attention, and coordination by the flightcrew to don. Consequently, the Safety Board believes that the FAA should establish a performance standard for the rapid donning of smoke goggles; then ensure that all air carriers meet this standard through improved smoke goggle equipment, improved flightcrew training, or both.

During its investigation of this accident, the Safety Board learned that many current installations of smoke goggles at a variety of U.S. air carriers place the goggles within sealed plastic wrapping, and this wrapping is sufficiently thick such that it cannot be easily opened (without using one's teeth to tear the plastic material or requiring the pilot to obtain and manipulate a sharp object and devote both hands to opening the bag). The Safety Board is concerned that flightcrews attempting to don these smoke goggles in an emergency might be unable to open the wrapping material quickly. The Safety Board concludes that the sealed, plastic wrapping used to store smoke goggles in much of the air carrier industry poses a potential hazard to flight safety. Consequently, the Safety Board believes that the FAA should require that the smoke goggles currently approved for use by the flightcrews of transport-category aircraft be packaged in such a way that they can be easily opened by the flightcrew.

The Safety Board is aware that emergency cockpit vision technology exists that might be applicable to improving flightcrews' ability to see in the event of smoke in the cockpit. Based on the absence of flightcrew comments about smoke early in the sequence, the light sooting within the cockpit indicated by recovered wreckage, the likelihood that the flightcrew did not don smoke goggles (which need to be used with the emergency cockpit vision device), and the likelihood of severely degraded airplane controllability later in the sequence, the use of

[6] The Safety Board has expressed its concerns to the FAA about the performance of smoke goggles beginning in 1974, as a result of its investigation of the Pan American World Airways B-707 freighter accident at Boston and in 1983, as a result of the Air Canada DC-9 accident at Cincinnati. The Board recognizes that the FAA currently has design requirements for smoke goggles in 14 CFR Part 25.1439 and Technical Standard Order (TSO) C99. However, none of these requirements establishes minimum performance standards for donning time or difficulty.

emergency cockpit vision technology would not have prevented this accident. Further, the Safety Board is concerned that flightcrews encountering a smoke emergency might devote valuable time and attention to rigging an emergency cockpit vision device, to the exclusion of the timely donning of their oxygen masks/smoke goggles and their execution of smoke removal procedures. However, the Safety Board concludes that emergency cockpit vision devices might have potential safety benefits in some circumstances. Therefore, the Safety Board believes that the FAA should evaluate the cockpit emergency vision technology and take action as appropriate.

As a result of its investigation of an Air Canada DC-9 that forced the flightcrew to make an emergency landing on June 2, 1983, at the Greater Cincinnati Airport (the interior materials of the airplane's cabin continued to burn after the landing; five crewmembers and 18 passengers were able to evacuate the burning cabin; the remaining 23 passengers died in the fire), the Safety Board recommended that the FAA "expedite the research at the Civil Aero Medical Institute necessary to develop the technology, equipment standards, and procedures to provide passengers with respiratory protection from toxic atmospheres during in-flight emergencies aboard transport category airplanes" (Safety Recommendation A-83-76). Based on the development of a joint international standard for passenger protective breathing equipment (PBE), the Safety Board classified this safety recommendation "Closed—Acceptable Action" on March 6, 1995.

The Safety Board acknowledges that there are a variety of concerns about providing PBE to passengers (primarily based on the possibility that an emergency evacuation would be delayed while passengers don this equipment). Further, the Safety Board notes the emergence in recent years of potential alternative technologies for protecting passengers from a toxic cabin atmosphere caused by fires. The Safety Board is also aware that the National Aeronautics and Space Administration (NASA) has undertaken a new research program focused on mitigating the severity of survivable accidents.

The Safety Board concludes that emerging technology, including research being conducted by NASA, might result in improvements in the potential to provide passenger respiratory protection from toxic cabin atmospheres that result from in-flight and post-crash fires. Therefore, the Safety Board believes that the FAA should evaluate and support appropriate research, including the NASA research program, to develop technologies and methods for enhancing passenger respiratory protection from toxic atmospheres that result from in-flight and post-crash fires involving transport-category airplanes.

Emergency Procedures for Smoke Removal

Although ValuJet adopted the DC-9 procedures developed by Douglas for clearing smoke from the cockpit (including, as a last resort for smoke originating in the cockpit, depressurizing the airplane and opening a cockpit side window to remove the smoke),[7] ValuJet did not adopt a procedure developed by Douglas for the evacuation of smoke from the passenger cabin. This

[7] The Douglas procedure states that the open cockpit window produces a loud noise level in the cockpit that renders communications impossible if airspeed exceeds 165 knots. Because there was no such noise recorded on the CVR, it is apparent that the flightcrew did not open the cockpit side window when the CVR was operating.

procedure calls for partially opening the right forward service door at the front of the cabin, then opening the passenger aft (tailcone) entrance door. According to Douglas, if these doors are opened, the "airflow will sweep smoke forward [to the open service door]" and the procedure is effective in clearing smoke from both the cabin and cockpit area. This procedure has been adopted by some operators of the DC-9, and similar procedures have been adopted by some operators of Boeing 747 airplanes, but the procedure has not been adopted by most U.S. carriers.

The Douglas procedure was examined by the Safety Board in 1983 during its investigation of the Air Canada DC-9 in-flight fire accident. In that examination, the Board recognized the efficacy of the procedure in removing cabin smoke (based on flight test results provided by Douglas). Noting concerns expressed by some air carriers and fire protection experts (but not by the manufacturer, which disagreed) that the procedure could intensify a fire, the Safety Board stated that the outcome of using this procedure during the Air Canada accident sequence was highly uncertain.

In this accident, the Safety Board concludes that because of the rapid propagation of the oxygen-fed fire and the resulting damage to the airplane's control cables and structure, the use of the Douglas smoke evacuation procedures would likely not have affected the outcome. The Safety Board also recognizes that airlines that have not adopted these procedures might have what they believe to be legitimate safety reasons for that decision. Nevertheless, the Safety Board also concludes that the Douglas DC-9 procedures involving partial opening of cabin doors for in-flight evacuation of smoke or fumes from the passenger cabin and similar procedures adopted by some operators of other transport-category airplanes might clear smoke sufficiently in the cabin (and prevent entry into the cockpit) to prolong the occupants' survival time during some fire and smoke emergencies. Therefore, the Safety Board believes that the FAA should evaluate the usefulness and effectiveness of the Douglas DC-9 procedures involving the partial opening of cabin doors and similar procedures adopted by some operators of other transport-category airplanes for evacuating cabin smoke or fumes and, based on that evaluation, determine whether these or other procedures should be included in all manufacturers' airplane flight manuals and air carrier operating manuals.

Guidance for the Removal and Disposition of Chemical Oxygen Generators

Because the majority of oxygen generators removed from the MD-80s had exceeded their life limits, they were neither salvageable nor repairable and should have been stored or disposed of in accordance with the MD-80 maintenance manual procedures. Although the Douglas MD-80 maintenance manual contains procedures for removal and actuation of oxygen generators, the manual does not specify that the generators should be actuated before they are transported. Based on incidents after the ValuJet accident, the Safety Board is concerned that the potential clearly still exists for expired generators to be transported before they are actuated. The Safety Board concludes that given the potential hazard of transporting oxygen generators and because oxygen generators that have exceeded their service life are not reusable, they should be actuated before they are transported. Therefore, the Safety Board believes that the FAA should require airplane manufacturers to amend company maintenance manuals for airplanes that use chemical oxygen generators to indicate that generators that have exceeded their service life

should not be transported unless they have been actuated and their oxidizer core has been depleted.

Adequacy of Information on Routine Work Card 0069[8]

Execution of work card 0069 required a signature by a mechanic to confirm the completion of each step in the removal and installation of the chemical oxygen generators. The card also required that a supervisor sign the card confirming that all of the mechanic blocks had been signed off once the entire job was completed. However, it did not require the signature of an individual to confirm that the work of the mechanic had been inspected. Inspection of work performed is a critical step in the maintenance process, particularly maintenance that involves the handling of hazardous materials. The Safety Board concludes that because work card 0069 did not require an inspector's signoff at the completion of each task, and there was no requirement for it to do so, there might have been no inspection of the maintenance work related to the removal of the chemical oxygen generators. The Safety Board further concludes that had work card 0069 required an inspector's signoff, one of the inspectors involved with the two airplanes might have noticed that safety caps had not been installed on any of the generators.

Although work card 0069 warned about the high temperatures produced by an activated generator, it did not mention that unexpended generators required special handling for storage or disposal, that out-of-date generators should be expended and then disposed of, or that the generators contained hazardous substances/waste even after being expended; further, the work card was not required to contain such information. Although these issues are addressed in the Douglas MD-80 maintenance manual given the relative simplicity of the task and the removal instructions already outlined on the work card, and the lack of any reference on the work card to this section of the maintenance manual, the mechanics likely completed the removal of the generators without referring to this section of the maintenance manual.

In contrast, at the time of the accident, another air carrier's work card for the same task included a clear warning about the hazardous nature of the unexpended generator, and clear instructions to dispose of the generators in a specific manner. This air carrier's work card called for the discharge of all removed generators, and included instructions about the method for discharging them. It also clearly identified the discharged generators as hazardous waste. The card also stated specifically that the expended generators must be held at the location where they were removed, and directed the individuals performing the removal task to "immediately notify the environmental affairs manager."

Thus, the mechanics who removed the oxygen generators from the MD-80s were not made fully aware, by reading only work card 0069, of the hazardous nature of the generators or of the existence of an approved, uncomplicated procedure for expending the generators that

[8] A routine work card is a pre-printed step-by-step listing of the key steps for a particular maintenance task; mechanics are to sign by each step to indicate completion of the task. ValuJet's work card 0069 was taken from a McDonnell Douglas-generated work card for that task and was part of the maintenance package ValuJet purchased from McDonnell Douglas. The contents of the work card had not been changed by ValuJet, nor had ValuJet used the work card before the removal of the oxygen generators from the MD-80 airplanes at SabreTech

required no unusual equipment. Some of the mechanics acknowledged that they had (both intentionally and unintentionally) activated some of the generators, and thus they must have been somewhat familiar with the process and the heat generated by the activated generators. However, the Safety Board concludes that had work card 0069 required, and included instructions for, expending and disposing of the generators in accordance with the procedures in the Douglas MD-80 maintenance manual, or referenced the applicable sections of the maintenance manual, it is more likely that the mechanics would have followed at least the instructions for expending the generators.

In view of the above, the Safety Board believes that the FAA should require that routine work cards used during maintenance of Part 121 aircraft (a) provide, for those work cards that call for the removal of any component containing hazardous materials, instructions for disposal of the hazardous materials or a direct reference to the maintenance manual provision containing those instructions, and (b) include an inspector's signature block on any work card that calls for handling a component containing hazardous materials.

Lack of Hazardous Materials Labels on the Removed Generators

The expired generators did not have labels or markings on them warning of the high temperatures generated during activation, or any emblems indicating that the generators were a hazardous material. Although generators manufactured by Scott Aviation since 1988, including those that were delivered to SabreTech for installation on the ValuJet MD-80s, have labels warning of the high temperatures generated during activation, the Safety Board is concerned that they do not adequately communicate the significant dangers posed if the canisters are not handled properly after removal from aircraft. Many of the mechanics who removed the generators recognized that the canisters generated heat, but apparently did not fully understand the severity of the dangers posed by unexpended generators. Therefore, the Safety Board concludes that had a warning label or emblem clearly indicating the significant danger posed been affixed to each generator, personnel handling the generators, including the personnel in shipping and stores who prepared them for shipment to Atlanta, might have been alerted to the need to determine how to safely handle and ship the generators. Had they done so, they might have learned of the need for (and acquired) safety caps and they might also have learned that unexpended generators demand special packaging and identification requirements (and taken appropriate actions). Even if they did only one of these actions, the accident would not likely have occurred.

Further, in light of a recent incident involving unauthorized transportation of oxygen generators (removed during airplane maintenance) aboard a Continental Airlines passenger flight, and other incidents involving the improper transport of chemical oxygen generators, the Safety Board concludes that the existing prohibition against transporting oxygen generators on passenger aircraft has not been completely effective, and improper handling of oxygen generators could be reduced by affixing an effective warning label or emblem on all existing and newly manufactured chemical oxygen generators to clearly identify the dangers and hazards of unexpended generators and the severe consequences that can occur if mishandled. Therefore, the Safety Board believes that the FAA should require manufacturers to affix a

warning label to chemical oxygen generators to effectively communicate the dangers posed by unexpended generators and to communicate that unexpended generators are hazardous materials. The FAA should further require that aircraft manufacturers instruct all operators of aircraft using chemical oxygen generators of the need to verify the presence of (or affix) such labels on chemical oxygen generators currently in their possession. The Safety Board is concerned that other hazardous aircraft components might not be identified or handled properly. Therefore, the Safety Board believes that the FAA should require all air carriers to develop and implement programs to ensure that other aircraft components that are hazardous are properly identified and that effective procedures are established to safely handle those components after they are removed from aircraft.

Lack of Safety Caps

The Safety Board concludes that although the installation of safety caps would not likely have prevented the oxygen generators from being transported on board flight 592, it is very likely that had safety caps been installed, the generators would not have activated and the accident would not have occurred. Based on a Aircraft Maintenance Service Agreement between ValuJet and SabreTech, the safety caps that were required to be installed on the chemical oxygen generators removed from N802VV and N803VV were considered "peculiar" expendables because they were not routinely carried in SabreTech's inventory. It appears from the service agreement that ValuJet was responsible for supplying peculiar expendables to SabreTech.

However, even if under the terms of the service agreement ValuJet was responsible for providing the safety caps, SabreTech should have ensured that the safety caps were installed on the removed generators. Work card 0069 clearly specified that safety caps were to be installed on any generator that had not been expended after it was removed from an airplane. Although the work cards were signed off by SabreTech mechanics and supervisory personnel indicating that all steps on the work cards had been completed, safety caps were never installed on the oxygen generators. The investigation revealed that some SabreTech supervisory personnel were advised by mechanics of the need for safety caps, but they took no action to acquire them, and that the mechanics who brought this matter to the attention of the supervisory personnel did not follow up to assure that the safety caps were acquired. Further, one of the mechanics who discussed with his supervisor the need for safety caps later carried some of the open boxes of uncapped generators to the SabreTech shipping and stores area and left them there without informing anyone in that area of what the items were, or of their hazardous nature. Moreover, one of the SabreTech inspectors who signed the "final inspection" block on the non-routine work card for one of the airplanes knew that the generators needed safety caps, but signed the card anyway relying on representations by supervisory personnel that this would be "taken care of" in the shipping and stores department, yet he never verified that this had been done.

The Safety Board is alarmed at the apparent willingness of mechanics and inspectors at the SabreTech facility to sign off on work cards indicating that the maintenance task had been completed, knowing that the required safety caps had not been installed, and at the willingness of those individuals and other maintenance personnel (including supervisors) to ignore the fact that the required safety caps had not been installed. The Safety Board has long been concerned about

false maintenance entries, and their sometimes catastrophic implications.[9] As a result of the investigation of the accident involving Tower Air flight 41 on December 20, 1995, (which revealed that contrary to representations in company maintenance records, a required functional test of the FDR had not been accomplished), the Safety Board recommended in Safety Recommendation A-96-160 that the Federal Aviation Administration

> Reassess inspectors' methods of evaluating maintenance work, focusing on the possibility of false entries through selective detailed analysis of records and unannounced work site inspections.

In its letter dated February 25, 1997, the FAA responded that it "conducts unannounced work site inspections and analysis of records as part of its oversight methods," and indicated that "[t]he FAA believes that these methods are adequate to ensure effective oversight," to identify false records. However, as this accident and others demonstrate, false maintenance entries continue to go undetected and more effective oversight techniques are needed.

The Safety Board concludes that improper maintenance activities and false entries pose a serious threat to aviation safety and must be curtailed. Thus, the Safety Board believes that the FAA should evaluate and enhance its oversight techniques to more effectively identify and address improper maintenance activities, especially false entries. Therefore, Safety Recommendation A-96-160 is classified "Closed—Unacceptable Action Superseded," to be replaced by a new recommendation

Lack of Communication About Items Left in Shipping and Stores Area

Personnel in the shipping and receiving department were not informed about the generators when they were placed in the ValuJet customer hold area. According to the stock clerk, the boxes were already in the hold area one morning when he arrived at work. SabreTech had no formal procedure in place that required an individual leaving items in the shipping and receiving area to inform anyone in that area of what the items were, or that they were hazardous. The stock clerk said that no one told him anything about the generators or the hazardous nature of the generators. Had SabreTech had a system requiring that items delivered to its shipping and receiving department be properly identified and classified as hazardous or non-hazardous, and if that system had included procedures for tracking the handling and disposition of hazardous materials, it is likely that the hazardous nature of the generators would not have been overlooked, and that they would not have been improperly packaged and delivered to the accident flight.

The Safety Board notes that although the Aircraft Maintenance Service Agreement between ValuJet and SabreTech clearly indicated that SabreTech would retain any material that had been removed from an airplane and was not to be reinstalled until ValuJet authorized disposal of such material in writing, and that although the director of logistics at SabreTech

[9] See NTSB/AAR-92/04, "Britt Airways, Inc., d/b/a Continental Express Flight 2574, In-flight Structural Breakup, Emb-120RT, N33701, Eagle Lake, Texas, September 11, 1991" and NTSB/AAR-96/04, "Runway Departure During Attempted Takeoff, Tower Air Flight 41, Boeing 747-136, N605FF, JFK International Airport, New York, December 20, 1995."

clearly understood this provision, SabreTech personnel shipped the generators to ValuJet without having ValuJet's permission.

The Safety Board concludes that the lack of a formal system in SabreTech's shipping and receiving department, including procedures for tracking the handling and disposition of hazardous materials, contributed to the improper transportation of the generators aboard flight 592. Although this problem is no longer relevant to SabreTech's Miami facility in light of the surrender of its repair station certificate, the Safety Board is concerned that air carriers and other Part 145 repair facilities performing heavy maintenance for air carriers might have similar deficiencies. Accordingly, the Safety Board believes that the FAA should review the adequacy of current industry practice and, if warranted, require that Part 121 air carriers and Part 145 repair facilities performing maintenance for air carriers develop and implement a system requiring items delivered to shipping and receiving and stores areas of the facility to be properly identified and classified as hazardous or non-hazardous, and procedures for tracking the handling and disposition of hazardous materials.

Human Factors in the Maintenance Environment

Many of the shortcomings discussed above (including the SabreTech mechanics' failure to install safety caps, their improper maintenance entries, and the inadequate communications between the maintenance shop floor and stores department) result from human failures that might have been avoided if more attention were given to human factors issues in the maintenance environment. Although it is unclear whether it may have played a role in this accident, the Safety Board is also concerned that the SabreTech mechanics did not follow a consistent procedure for accomplishing shift changes or for tracking which specific tasks were performed during each shift. The Safety Board has addressed this issue previously[10] and continues to believe that emphasis should be placed on proper procedures.

The Safety Board recognizes that the FAA has conducted workshops and sponsored research into the human factors issues relevant to air carrier maintenance. However, based on previous accidents involving deficiencies in the performance of maintenance tasks,[11] and the circumstances of this accident, the Safety Board concludes that some aspects of air carrier maintenance programs do not adequately reflect the human factors issues involved in the air carrier maintenance environment. Therefore, the Safety Board believes that the FAA should include, in its development and approval of air carrier maintenance procedures and programs, explicit consideration of human factors issues, including training, procedures development,

[10] See NTSB/AAR-92/04, "In-flight Structural Breakup, Britt Airways, Inc., d/b/a Continental Express Flight 2574, EMB-120RT, N33701, Eagle Lake, Texas, September 11, 1991."

[11] See NTSB/AAR-96/03, "Uncontained Engine Failure/Fire, ValuJet Airlines Flight 597, Douglas DC-9-32, N908VJ, Atlanta, Georgia, June 8, 1995"; NTSB/AAR-92/04, "In-flight Structural Breakup, Britt Airways, Inc., d/b/a Continental Express Flight 2574, EMB-120RT, N33701, Eagle Lake, Texas, September 11, 1991"; NTSB/AAR-96/06, "In-Flight Loss Of Propeller Blade Forced Landing, And Collision With Terrain, Atlantic Southeast Airlines, Inc., Flight 529, Embraer Emb-120RT, N256AS, Carrollton, Georgia, August 21, 1995"; and NTSB/AAR-96/04, "Runway Departure During Attempted Takeoff, Tower Air Flight 41, Boeing 747-136, N605FF, JFK International Airport, New York, December 20, 1995."

redundancy, supervision, and the work environment, to improve the performance of personnel and their adherence to procedures.

Further, the Safety Board notes that the regulations of 14 CFR Part 121.377 establish limitations on duty time for individuals performing maintenance on Part 121 airplanes, including those working at a Part 145 repair station. This regulation requires that these individuals be relieved from duty for "24 consecutive hours every seven consecutive days, or the equivalent thereof within any one calendar month." However, because this regulation may result in mechanics working for as many as 26 consecutive days (with all of the required days free from duty being provided consecutively at the end of a month), the Safety Board concludes that the maintenance duty time limitations of 14 CFR Part 121.377 may not be consistent with the current state of scientific knowledge about factors contributing to fatigue among personnel working in safety-sensitive transportation jobs. Accordingly, the Safety Board believes that the FAA should review the issue of personnel fatigue in aviation maintenance; then establish duty time limitations consistent with the current state of scientific knowledge for personnel who perform maintenance on air carrier aircraft.

Guidance and Procedures for Transporting Hazardous Materials

The Safety Board recognizes that air carriers routinely need to move aircraft equipment items around their route systems. Air carriers that have an approved program for accepting and transporting hazardous materials can and likely would choose to transport hazardous company materials (COMAT) themselves, pursuant to that program. Air carriers that have no such approved program, such as ValuJet, might transport some aircraft equipment items under FAA-approved special procedures that are documented in manuals, that comply with the hazardous materials regulations, and for which their personnel are specially trained. Or, they might use other approved air carriers or ground transportation.

Guidance issued by ValuJet to its flight operations and station operations personnel in the company's general operations manual and stations operations manual explicitly stated, "ValuJet will not engage in transportation of hazardous materials." Further, both manuals cited the applicable Federal regulations that listed items exempted from the hazardous materials regulations and, therefore, could be carried. Of these exempted items, tires were the only items of aircraft equipment. However, the former senior vice president of operations of ValuJet said in a postaccident interview that he was "led to believe" that the air carrier was authorized to carry internal shipments of certain hazardous items, such as aircraft batteries. A November 28, 1995, internal memorandum from the ValuJet maintenance training manager identified the need to train mechanics at company out-stations on how to "properly ship company hazardous materials." The memorandum stated, "this problem is not just with the out-stations as IAD [Washington Dulles International Airport] has the most activity of improperly shipping hazardous materials." Moreover, the ValuJet dispatcher on duty at the time of the accident stated that he believed the airline was authorized to transport hazardous equipment items. He referred to standard practice 8228, a recently added provision in ValuJet's general maintenance manual (GMM). Standard practice 8228 specifically listed several hazardous aircraft equipment items that ValuJet apparently believed it was authorized to carry pursuant to 49 CFR 175.10(a)(2) and provided

instructions for preparing and packaging those items. ValuJet indicated to the FAA in a memo dated May 20, 1996, that the publication of standard practice 8228 was an attempt to "ensure that [ValuJet] complies with its duty to ensure that authorized items of [hazardous] company material are labeled, marked and packaged in the appropriate manner."

However, standard practice 8228 was inconsistent with the company's operations and stations manuals and had never been approved by the FAA. The Safety Board recognizes that standard practice 8228 was withdrawn by ValuJet shortly after the accident and that the FAA has participated with ValuJet in reviewing and revising many of its manuals and procedures in connection with its resumption of operations. However, the Safety Board found that the manuals of other operators not authorized to accept hazardous materials contained a variety of provisions for the handling of hazardous aircraft equipment items as COMAT, at least some of which do not appear to comply with the hazardous materials regulations. Further, RSPA's Associate Administrator for Hazardous Materials Safety testified at the Safety Board's public hearing that at a recent industry seminar that had explored issues surrounding COMAT, the meaning of 49 CFR 175.10(a)(2) had been discussed at length. On December 13, 1996, in response to concerns raised at the Safety Board's public hearing, RSPA issued guidance "to clarify the application of [49 CFR 175.10(a)(2) and the hazardous materials regulations] and to overcome a number of apparent misunderstandings of them." The guidance makes clear that the hazardous materials regulations apply even to items of replacement for hazardous aircraft equipment being carried pursuant to the limited exceptions in 49 CFR 175.10(a)(2).

However, the Safety Board is concerned that air carriers might not have been made aware of, or applied this guidance to the existing procedures for transporting hazardous aircraft components as COMAT and that the FAA has not required air carriers to do so. Based on the Board's review of air carrier manuals and the incidents involving COMAT that continue to occur, the Safety Board concludes that the procedures of many air carriers for handling hazardous COMAT are not fully consistent with the hazardous materials regulations and the guidance provided on December 13, 1996, by RSPA on the transport of COMAT by air carriers. Therefore, the Safety Board believes that the FAA should issue guidance to air carriers on procedures for transporting hazardous aircraft components consistent with RSPA requirements for the transportation of air carrier COMAT. The Safety Board further believes that the FAA should then require POIs to review and amend, as necessary, air carrier manuals to ensure that air carrier procedures are consistent with this guidance.

The investigation revealed that employees at SabreTech's Miami facility had never received guidance or training from SabreTech or ValuJet regarding ValuJet's policy on the transportation of hazardous materials. Although ValuJet had developed a hazardous materials recognition training program for its employees, this training was not provided to SabreTech, and SabreTech had not developed for its employees a formal training program for recognition or shipping of hazardous materials in air transportation. The Safety Board concludes that it is equally important that employees of both the air carrier and of relevant subcontractors be thoroughly versed and trained on the handling of hazardous materials and on the air carrier's authority to transport hazardous materials. The Safety Board recognizes that maintenance subcontractor employees, particularly employees in the shipping department of a subcontractor

maintenance facility, might simultaneously be doing work for several air carriers. It might be useful, therefore, to provide, in conjunction with training, air carrier-specific checklists setting forth the hazardous materials authority and items permitted to be carried by each air carrier.

The Safety Board further concludes that had ValuJet implemented a program to ensure that its subcontractor maintenance facility employees were trained on the company's lack of authority to transport hazardous materials and had received hazardous materials recognition training, SabreTech might not have mishandled the packaging and shipment of the chemical oxygen generators that were loaded on flight 592. Given the circumstances of this accident, the Safety Board is concerned that employees at other subcontractor maintenance facilities might also not be adequately trained in hazardous materials recognition, labeling, packaging, and shipment procedures with respect to the specific items of hazardous materials that are handled by each air carrier's maintenance functions. Further, the Safety Board notes that air carriers currently are not required to provide this training to their own maintenance personnel. Therefore, the Safety Board believes that the FAA should require air carriers to ensure that maintenance facility personnel, including mechanics, shipping, receiving, and stores personnel, at air carrier-operated or subcontractor facilities, are provided initial and recurrent training in hazardous materials recognition, and in proper labeling, packaging, and shipment procedures with respect to the specific items of hazardous materials that are handled by the air carrier's maintenance functions.

FAA's Oversight of ValuJet

The surveillance conducted by the Atlanta flight standards district office (FSDO), up to and including special emphasis inspections in February 1996, identified many specific problem areas within ValuJet's flight operations and in-house maintenance functions. The Atlanta FSDO reacted properly in targeting ValuJet for more intensive surveillance, based on its surveillance findings and the air carrier's accident/incident record through the beginning of 1996. The FSDO devoted more of its limited inspection resources to ValuJet surveillance, resulting in a decrease by the FSDO in its surveillance of other air carriers. This additional surveillance of ValuJet resulted in conclusions by the FAA at the local FSDO level that certain system functions of ValuJet (such as the maintenance reliability program) were performing inadequately. Finally, in February 1996, the FSDO attempted to correct the deficiencies it had identified at ValuJet with a systemic remediation—it halted the growth of the air carrier.

As extensive as they were, the FAA surveillance programs did not take into account the extent to which ValuJet had contracted out its operations and maintenance functions. From the time ValuJet received its initial certification until the accident, the ValuJet principal maintenance inspector (PMI) did not complete an inspection of the SabreTech facility. At one point during that period, he arrived at the facility to participate with ValuJet in an inspection, but left after only about 3 hours to attend to other business. Further, the FAA surveillance of ValuJet conducted before the accident, including the RASIP, the NASIP, and the special emphasis program, did not include any surveillance of ValuJet's heavy maintenance contractors, such as SabreTech, and did not recognize the potential problems inherent in the air carrier conducting only limited oversight of its maintenance subcontractors. After the accident, FAA surveillance

during the special emphasis inspection program identified several deficiencies in ValuJet's auditing and oversight of maintenance subcontracting; that these deficiencies were identified by the FAA only after the accident indicates the inadequacy of the FAA's pre-accident surveillance of ValuJet's maintenance subcontracting activities.

The Safety Board concludes that before the accident, the FAA's oversight of ValuJet did not include any significant oversight of its heavy maintenance functions. This is especially disturbing given that by February 1996 the FAA had determined that there were problems serious enough at ValuJet (including in maintenance)[12] to warrant more than the normal level of surveillance. Had the FAA subjected the Miami facility of SabreTech to the same level of surveillance as it did ValuJet itself, it might have discovered the deficiencies later uncovered in the special FAA inspection of that facility after the accident, which led to the surrender of the facility's operating certificate.[13] Further, FAA headquarters should have responded specifically to the concerns expressed in an Federal Aviation Administration headquarters summary report (which recommended consideration of "an immediate FAR-121 re-certification" of the airline).

The Safety Board is concerned that a repair station that was performing significant heavy maintenance for ValuJet was never subjected to a complete FAA inspection by ValuJet's PMI from a Part 121 perspective and that the FAA's National Flight Standards Work Program Functions document (FAA Order 1800.135), which establishes the requirements for airworthiness surveillance of Part 121 air carriers, did not instruct a PMI to conduct such an inspection.

In Airworthiness Bulletin (HBAW) 96-05(B), in addition to the requirements imposed on carriers, the FAA required that the FAA Certificate Management Office (CMO) "perform adequate on site inspection of the air carriers substantial maintenance providers to allow it to validate that the air carrier's contracting system is performing satisfactor[ily]." However, FAA officials have told the Safety Board that this only imposes on the PMI a one-time inspection requirement, and is not a requirement for the PMI to conduct continuing surveillance of contract maintenance facilities.[14] Moreover, the level of detail contemplated by the one-time inspection requirement is not made clear from the bulletin. Further, the Part 121 PMI might not have the benefit of findings made and entered into the program tracking and reporting system (PTRS) by the Part 145 PMI.[15] The Safety Board concludes that the continuing lack of an explicit

[12] A February 29, 1996, letter to ValuJet from its three principal inspectors indicated, "we have some concerns regarding ValuJet's maintenance. The first concern is the quality of maintenance inspections performed, and second, the management of repetitive discrepancies." Further, a February 14 summary report prepared by FAA headquarters based its recommendation for an immediate re-certification of ValuJet on "such known safety related issues as the absence of adequate policies and procedures for the maintenance personnel to follow."

[13] This report addresses the FAA's surveillance of SabreTech only in the context of that facility's role as a heavy maintenance provider to ValuJet. This issue will be further addressed in the Safety Board's upcoming special study on Part 145 repair stations.

[14] The FAA has recently added to the PTRS guidelines a requirement that PMIs inspect the internal audit programs used by their carriers to inspect and oversee maintenance subcontractors. There is still no requirement, however, for PMIs to personally inspect or surveil these subcontractor facilities.

[15] As the FAA noted in its 90-day safety review, deficiencies found by a Part 145 repair station's PMI might not be "coded" in the PTRS system to connect these entries to the air carrier for which the work is being performed.

requirement for the PMI of a Part 121 operator to regularly inspect or surveil Part 145 repair stations that are performing heavy maintenance for their air carriers is a significant deficiency in the FAA's oversight of the operator's total maintenance program. Therefore, the Safety Board believes that the FAA should ensure that Part 121 air carriers' maintenance functions receive the same level of FAA surveillance, regardless of whether those functions are performed in house or by a contract maintenance facility.

Reviewing the workload of both the maintenance and operations inspectors assigned by the Atlanta FSDO to the ValuJet certificate, it appears to the Safety Board that the staffing levels for the surveillance by FAA of ValuJet's operations and airworthiness failed to keep pace with the rapid growth of the air carrier. In contrast, the FAA Southern Region's staffing model for FSDO staffing levels indicated, at the same time ValuJet was growing rapidly, that the Atlanta FSDO was overstaffed. It was on the basis of this model that the Southern Region denied the requests of the Atlanta FSDO manager for additional inspector resources. The Safety Board concludes that the manner in which the FAA's Southern Region applied the results of the FSDO staffing level models was not sufficiently flexible to account for a rapidly growing and complex air carrier and resulted in an inadequate level of inspector resources in the Atlanta FSDO. This issue was addressed in the FAA's 90-day safety review that followed the accident, and resulted in an internal recommendation to "[d]evise a new Flight Standards staffing model which...respond[s] more timely to changes in workload and productivity and...express[es] field office needs as a holistic requirement." It was also recommended, "[a]s an interim measure, [the FAA should] issue policy and guidelines on the authority of regions to adjust field office staffing based on 'spikes' which occur due to operator growth and other unanticipated workload changes." The Safety Board is encouraged by these recommendations and supports their implementation.

As a result of its investigation of the December 20, 1995, runway departure during attempted takeoff of Tower Air flight 41, the Safety Board issued Safety Recommendation A-96-163 to the FAA. This safety recommendation requested that the FAA develop, by December 31, 1997, standards for enhanced surveillance of air carriers based on rapid growth, change, complexity, and accident/incident history; then revise national flight standards surveillance methods, work programs, staffing standards, and inspector staffing to accomplish the enhanced surveillance that is identified by the new standards.

On February 25, 1997, the FAA replied to the Safety Board and cited the initiatives in progress as a result of the FAA's 90-day safety review; specifically, the Surveillance Improvement Project that addresses reengineering the FAA surveillance process. The FAA also stated that it was developing additional surveillance requirements for new entrant air carriers, establishing an analytical unit within the Flight Standards Service to target surveillance based on the air carriers' relative risk levels, and developing a new flight standards staffing model to respond to changes in inspector workload in a more timely manner. The Safety Board will monitor the FAA's response to its internal recommendations, generated as a result of the FAA's 90-day safety review.

An additional, potential source of FAA surveillance for ValuJet's heavy maintenance program was the PMI assigned to the oversight of SabreTech's Miami facility. However, based on the substantial workload from his assignment to oversight of 30 other certificate-holding entities, including an additional 20 Part 145 repair stations, the Safety Board concludes that the PMI assigned to oversight of the SabreTech facility in Miami was unable to provide effective oversight of the ValuJet heavy maintenance operations conducted at that facility. Based on the circumstances of this accident, the Safety Board believes that the FAA should review the volume and nature of the work requirements of its PMIs assigned to 14 CFR Part 145 Repair Stations that perform maintenance for Part 121 air carriers, and ensure that these inspectors have adequate time and resources to perform surveillance.

Undeclared Hazardous Materials

As a result of the February 3, 1988, accident on American Airlines flight 132, the Safety Board stated that the safe transportation of hazardous materials depended 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.

The Board noted after the 1988 American Airlines accident that the procedures for accepting packages that contain declared hazardous materials were thorough and American would likely have rejected the fiber drum containing the oxidizer (the hazardous material in the accident) had it been properly identified; however, American Airlines' procedures for accepting ordinary freight (not declared as hazardous materials) were not adequate. These procedures did not include routine inquiries about the possibility that hazardous materials might be included but not identified as such.

The American Airlines flight 132 accident also focused attention on the issue of undeclared hazardous materials being placed on aircraft through the U.S. mail. Efforts to address this issue have been hindered by the apparently limited authority of Postal Service employees to ask questions of customers about the contents of their packages and the lack of authority for FAA inspectors to open mail bags or packages carried in the U.S. mail without a U.S. postal inspector present. Also, because of the 1990 Public Law 101-615, which specifically excludes the DOT from regulating hazardous materials in the U.S. Postal Service, the FAA's efforts to monitor hazardous materials on airplanes have been further hindered. Additionally, because the U.S. Postal Service has only criminal enforcement authority to address willful violations, and does not have civil authority, the Postal Service is limited in dealing with unintentional shipments of hazardous materials. In contrast, DOT's civil enforcement authority is one of the primary tools used by the FAA in dealing with unintentional shipments by air of hazardous materials discovered during investigations.

The Safety Board concludes that the limited authority of the U.S. Postal Service and the FAA to inspect and thus successfully identify undeclared hazardous materials in U.S. mail loaded on airplanes creates a situation in which undeclared shipments of hazardous materials can

readily find their way on board passenger airplanes. Although the shipper endorsement requirements for non-U.S. mail shipments issued under 14 CFR Part 109 might help to reduce the number of undeclared hazardous materials shipments by shippers and freight forwarders, this action does not help to identify undeclared hazardous materials in the U.S. mail. Additional measures to focus on air passengers and postal patrons are needed given the significant number of packages that are transported by aircraft. Therefore, the Safety Board believes that the FAA, in cooperation with the U.S. Postal Service and the ATA, should develop programs to educate passengers, shippers and postal customers about the dangers of transporting undeclared hazardous materials aboard aircraft and about the need to properly identify and package hazardous materials before offering them for air transportation. The programs should focus on passenger baggage, air cargo, and mail offered by U.S. Postal Service customers.

ValuJet's Procedures for Boarding and Accounting for Lap Children

The Safety Board is concerned that one passenger aboard the accident flight, an unticketed passenger who was boarded by ValuJet as an under-2-year-old lap child (but who was actually 4 years old), was not immediately accounted for postaccident by ValuJet. The child was not listed on the passenger manifest for the accident flight or on any other record maintained by ValuJet. However, 14 CFR 121.693(e) requires that the load manifest maintained by an air carrier for each flight must contain, in part, "names of passengers, unless such information is maintained by other means by the air carrier." The FAA has made it clear in Air Carrier Operations Bulletin (ACOB) 8-91-2 that the word "passenger," as used in this regulation, means any passenger, regardless of age.

ValuJet used an open seating policy and controlled passenger boarding with numbered, plastic cards. The Safety Board learned that some time after the air carrier began operations, ValuJet management had expressed concern about boarding control of lap children, and that in response to this concern, the air carrier implemented a procedure in which the adult associated with each lap child was issued an unnumbered plastic boarding card at the time of check-in. This card was to be collected at the time of boarding, thus providing the air carrier with a post-departure record of the number of passengers (including lap children) aboard the flight. Based on the failure of the ValuJet passenger manifest and other post-departure records to account for the lap child on the accident flight, the Safety Board concludes that ValuJet did not follow its internal procedures for boarding and accounting for lap children. Further, the Safety Board notes that although 14 CFR 121.693(e) requires airlines to maintain a list of the names of all passengers aboard its flights, the procedures established by ValuJet did not call for recording the names of lap children aboard its flights.

The Safety Board recognizes that the manifesting of lap children by name is a challenge for the entire air carrier industry, because adults traveling with infants might not always provide the names of the infants to the airline or travel agent making the reservation. Despite this challenge, the Safety Board concludes that it is essential that air carriers maintain easily accessible and accurate records of the names of both ticketed and unticketed passengers aboard

their flights for retrieval in the event of an accident or other emergency.[16] Therefore, the Safety Board believes that the FAA should instruct POIs to review their air carriers' procedures for manifesting passengers, including lap children, and ensure that those procedures result in a retrievable record of each passenger's name.

Therefore, as a result of the investigation of this accident, the National Transportation Safety Board makes the following recommendations to the Federal Aviation Administration:

Expedite final rulemaking to require smoke detection and fire suppression systems for all class D cargo compartments. (A-97-56)

Specify, in air carrier operations master minimum equipment lists, that the cockpit-cabin portion of the service interphone system is required to be operating before an airplane can be dispatched. (A-97-57)

Issue guidance to air carrier pilots about the need to don oxygen masks and smoke goggles at the first indication of a possible in-flight smoke or fire emergency. (A-97-58)

Establish a performance standard for the rapid donning of smoke goggles; then ensure that all air carriers meet this standard through improved smoke goggle equipment, improved flightcrew training, or both. (A-97-59)

Require that the smoke goggles currently approved for use by the flightcrews of transport-category aircraft be packaged in such a way that they can be easily opened by the flightcrew. (A-97-60)

Evaluate the cockpit emergency vision technology and take action as appropriate. (A-97-61)

Evaluate and support appropriate research, including the National Aeronautics and Space Administration research program, to develop technologies and methods for enhancing passenger respiratory protection from toxic atmospheres that result from in-flight and post-crash fires involving transport-category airplanes. (A-97-62)

[16] The "Aviation Disaster Family Assistance Act of 1996" (Public Law 104-264, October 9, 1996) states that the National Transportation Safety Board's Director of Family Support Services has the responsibility "to request, as soon as practicable, from the air carrier or foreign air carrier involved in the accident, a list, which is based on the best available information at the time of the request, of the names of the passengers that were aboard the aircraft involved in the accident." The Act also requires the establishment of a task force to develop recommendations and guidelines to the airlines on a number of issues, including steps that air carriers would have to take to ensure that an accurate list of passengers on board the aircraft would be available within 1-3 hours after the accident. The task force is working on the manifest issues, including the subject of lap children. A report from the Secretary of Transportation is due to Congress by October 8, 1997.

Evaluate the usefulness and effectiveness of the Douglas DC-9 procedures involving the partial opening of cabin doors and similar procedures adopted by some operators of other transport-category airplanes for evacuating cabin smoke or fumes and, based on that evaluation, determine whether these or other procedures should be included in all manufacturers' airplane flight manuals and air carrier operating manuals. (A-97-63)

Require airplane manufacturers to amend company maintenance manuals for airplanes that use chemical oxygen generators to indicate that generators that have exceeded their service life should not be transported unless they have been actuated and their oxidizer core has been depleted. (A-97-64)

Require that routine work cards used during maintenance of Part 121 aircraft (a) provide, for those work cards that call for the removal of any component containing hazardous materials, instructions for disposal of the hazardous materials or a direct reference to the maintenance manual provision containing those instructions and (b) include an inspector's signature block on any work card that calls for handling a component containing hazardous materials. (A-97-65)

Require manufacturers to affix a warning label to chemical oxygen generators to effectively communicate the dangers posed by unexpended generators and to communicate that unexpended generators are hazardous materials; then require that aircraft manufacturers instruct all operators of aircraft using chemical oxygen generators of the need to verify the presence of (or affix) such labels on chemical oxygen generators currently in their possession. (A-97-66)

Require all air carriers to develop and implement programs to ensure that aircraft components that are hazardous (other than chemical oxygen generators) are properly identified and that effective procedures are established to safely handle those components after they are removed from aircraft. (A-97-67)

Evaluate and enhance its oversight techniques to more effectively identify and address improper maintenance activities, especially false entries. (A-97-68)

Review the adequacy of current industry practice and, if warranted, require that Part 121 air carriers and Part 145 repair facilities performing maintenance for air carriers develop and implement a system requiring items delivered to shipping and receiving and stores areas of the facility to be properly identified and classified as hazardous or non-hazardous, and procedures for tracking the handling and disposition of hazardous materials. (A-97-69)

Include, in its development and approval of air carrier maintenance procedures and programs, explicit consideration of human factors issues, including training, procedures development, redundancy, supervision, and the work environment, to

improve the performance of personnel and their adherence to procedures. (A-97-70)

Review the issue of personnel fatigue in aviation maintenance; then establish duty time limitations consistent with the current state of scientific knowledge for personnel who perform maintenance on air carrier aircraft. (A-97-71)

Issue guidance to air carriers on procedures for transporting hazardous aircraft components consistent with Research and Special Programs Administration requirements for the transportation of air carrier company materials; then require principal operations inspectors to review and amend, as necessary, air carrier manuals to ensure that air carrier procedures are consistent with this guidance. (A-97-72)

Require air carriers to ensure that maintenance facility personnel, including mechanics, shipping, receiving, and stores personnel, at air carrier-operated or subcontractor facilities, are provided initial and recurrent training in hazardous materials recognition, and in proper labeling, packaging, and shipment procedures with respect to the specific items of hazardous materials that are handled by the air carrier's maintenance functions. (A-97-73)

Ensure that Part 121 air carriers' maintenance functions receive the same level of Federal Aviation Administration surveillance, regardless of whether those functions are performed in house or by a contract maintenance facility. (A-97-74)

Review the volume and nature of the work requirements of principal maintenance inspectors assigned to Part 145 repair stations that perform maintenance for Part 121 air carriers, and ensure that these inspectors have adequate time and resources to perform surveillance. (A-97-75)

Develop, in cooperation with the U.S. Postal Service and the Air Transport Association, programs to educate passengers, shippers and postal customers about the dangers of transporting undeclared hazardous materials aboard aircraft and about the need to properly identify and package hazardous materials before offering them for air transportation. The programs should focus on passenger baggage, air cargo, and mail offered by U.S. Postal Service customers. (A-97-76)

Instruct principal operations inspectors to review their air carriers' procedures for manifesting passengers, including lap children, and ensure that those procedures result in a retrievable record of each passenger's name. (A-97-77)

Also as a result of this investigation, Safety Recommendation A-97-78 was issued to the Research and Special Programs Administration; Safety Recommendations A-97-79 through -81 were issued to the U.S. Postal Service; and Safety Recommendation A-97-82 was issued to the Air Transport Association.

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

By: Jim Hall
Chairman