

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was properly certificated and had received the appropriate training and off-duty time prescribed by the Federal regulations.
2. There was no evidence that any preexisting medical condition affected the flightcrew's performance.
3. The flight attendants had completed ValuJet's Federal Aviation Administration-approved flight attendant training program.
4. Weather was not a factor in the accident.
5. The accident airplane was equipped and maintained in accordance with Federal regulations and approved procedures, and there was no evidence of preexisting mechanical malfunctions or other discrepancies in the airplane structure, flight control systems, or powerplants that would have contributed to the accident.
6. The activation of one or more chemical oxygen generators in the forward cargo compartment of the airplane initiated the fire on ValuJet flight 592. One or more of the oxygen generators likely were actuated at some point after the loading process began, but possibly as late as during the airplane's takeoff roll.
7. 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 airplane.
8. 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.
9. Had the Federal Aviation Administration 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.
10. Given the information available, the ramp agents' and flightcrew's acceptance of the company materials shipment was not unreasonable.
11. ValuJet's failure to secure the cargo was not unreasonable.

12. The loss of control was most likely the result of flight control failure from the extreme heat and structural collapse; however, the Safety Board cannot rule out the possibility that the flightcrew was incapacitated by smoke or heat in the cockpit during the last 7 seconds of the flight.
13. Only a small amount of smoke entered the cockpit before the last recorded flightcrew verbalization at 1411:38, including the period when the cockpit door was open.
14. The current minimum equipment list requirements for the development of an “alternate procedure” for an inoperative service interphone are inadequate for a cabin fire situation.
15. 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.
16. The pilots did not don (or delayed donning) their oxygen masks and smoke goggles, and in not donning this equipment, they were likely influenced by the absence of heavy smoke in the cockpit and the workload involved in donning the type of smoke goggles with which their airplane was equipped.
17. The smoke goggle equipment currently provided on most air carrier transport aircraft requires excessive time, effort, attention, and coordination by the flightcrew to don.
18. The sealed, plastic wrapping used to store smoke goggles in much of the air carrier industry poses a potential hazard to flight safety.
19. Emergency cockpit vision devices might have potential safety benefits in some circumstances.
20. Emerging technology, including research being conducted by the National Aeronautics and Space Administration, 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.
21. 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 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.
22. 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.

23. 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. 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.
24. 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.
25. 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.
26. 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.
27. 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.
28. Improper maintenance activities and false entries pose a serious threat to aviation safety and must be curtailed.
29. Although the use of the wrong parts tag was an additional failure of SabreTech to perform maintenance activity in accordance with prescribed maintenance procedures, it probably did not contribute to the mishandling of the generators that ultimately led to the generators being loaded into the forward cargo compartment on flight 592.
30. 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.
31. 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.

32. The failure of SabreTech to properly prepare, package, and identify the unexpended chemical oxygen generators before presenting them to ValuJet for carriage aboard flight 592 was causal to the accident.
33. Some aspects of air carrier maintenance programs do not adequately reflect the human factors issues involved in the air carrier maintenance environment.
34. Contrary to its authority, ValuJet's practices before the accident might have included the shipment of hazardous aircraft equipment items aboard company airplanes.
35. The procedures of many air carriers for handling hazardous company materials (COMAT) are not fully consistent with the hazardous materials regulations and the guidance provided on December 13, 1996, by the Research and Special Programs Administration on the transport of COMAT by air carriers.
36. 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.
37. 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.
38. ValuJet failed to adequately oversee SabreTech and this failure was a cause of the accident.
39. Before the accident, the Federal Aviation Administration's (FAA) oversight of ValuJet did not include any significant oversight of its heavy maintenance functions. The FAA's inadequate oversight of ValuJet's maintenance functions, including its failure to address ValuJet's limited oversight capabilities, contributed to this accident.
40. The continuing lack of an explicit requirement for the principal maintenance inspector 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 Federal Aviation Administration's oversight of the operator's total maintenance program.
41. The manner in which the Federal Aviation Administration's Southern Region applied the results of the Flight Standards District Office (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.
42. In part because he was responsible for so many operators, the principal maintenance inspector assigned to oversee the SabreTech facility in Miami was unable to provide effective oversight of the ValuJet heavy maintenance operations conducted at that facility.

43. Had the Federal Aviation Administration responded to prior chemical oxygen generator fires and allocated sufficient resources and initiated programs to address the potential hazards of these generators, including issuing follow-up warnings and inspecting the shipping departments of aircraft maintenance facilities, the chemical oxygen generators might not have been placed on flight 592.
44. The limited authority of the U.S. Postal Service and the Federal Aviation Administration 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.
45. Because of the lack of information regarding products approved for transportation by the Bureau of Explosives, Research and Special Programs Administration cannot adequately ensure that these products are being packaged and shipped safely in the transportation environment.
46. ValuJet did not follow its internal procedures for boarding and accounting for lap children.
47. 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.

3.2 Probable Cause

The National Transportation Safety Board determines 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.