



# National Transportation Safety Board

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Washington, D.C. 20594  
Safety Recommendation

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Date June 13, 1997

In reply refer to: A-97-38 through -40

Mr. Barry L. Valentine  
Acting Administrator  
Federal Aviation Administration  
Washington, D.C. 20591

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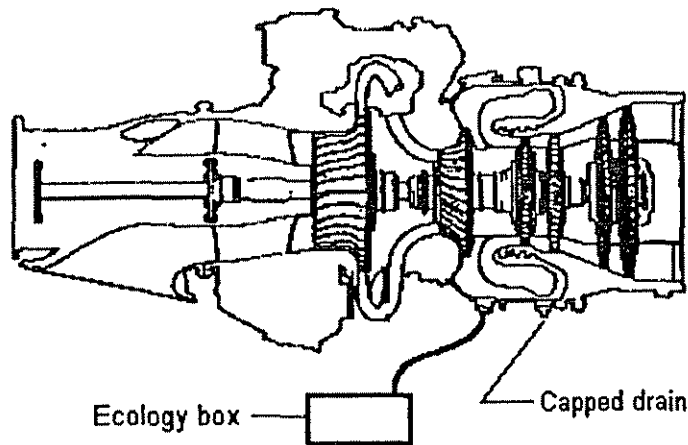
On May 21, 1997, SkyWest Airlines flight 724, an Embraer EMB-120ER airplane, equipped with Pratt & Whitney of Canada (PWC) PW118B turboprop engines, experienced a fire in the right engine nacelle following takeoff from the San Diego International-Lindbergh Field, San Diego, California. Flight 724 was operating under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121 as a regularly scheduled passenger flight from San Diego to Los Angeles, California. The 2 pilots, 1 flight attendant, and 14 passengers on board were not injured.

The flightcrew reported that after takeoff from San Diego, the right engine lost power as the airplane was climbing through 2,000 feet. The pilots stated that they had been conducting the engine failure checklist when the right engine fire warning light came on. The passengers and flight attendant reported seeing flames coming from the right engine nacelle and exhaust. The pilots said that the fire was extinguished after they discharged both of the airplane's fire extinguisher bottles. The flightcrew then observed hydraulic system malfunction warnings and saw that all pressure had been lost on both hydraulic systems. The pilots diverted the airplane to Naval Air Station (NAS) Miramar, where they executed an emergency single-engine landing with the flaps retracted and no nosewheel steering. The flightcrew was unable to use single-engine reverse thrust because of the lack of nosewheel steering, and the hydraulic brakes and the emergency braking system were inoperative. Although the airplane touched down on the first 2,000 feet of the 12,000 foot-long runway, it overran the departure end of the runway at an estimated speed of 20 to 30 knots and stopped about 1,300 feet beyond the end of the runway.

The examination of the airplane revealed extensive heat and fire damage to the right engine nacelle, wing, and landing gear well. The engine nacelle around the exhaust pipe was burned through, and a 5-foot section of the exhaust pipe was missing. The right engine hydraulic system pump and tank were destroyed by the fire, and a left engine hydraulic system line, which crossed through the right engine nacelle, was burned through. There was a 3- x 4-inch oval-shaped hole burned through the web of the right wing spar aft of the engine. The right aileron control cables were also damaged by the fire.

The Safety Board's disassembly of the engine revealed that the 1<sup>st</sup> stage power turbine (PT) disk front face had been burned by an intense oil-fed fire at the counterweight flange. The fire caused the flange to be rolled radially outboard. The disk was intact, but two blade retaining lugs were elongated coincident with a continuous sector of five 1<sup>st</sup> stage PT blades that had come out of the blade slots. All of the remaining 1<sup>st</sup> stage PT blades were fractured transversely across the airfoils just above the blade root platform. Although all of the 2<sup>nd</sup> stage PT blades were fractured across the airfoils at varying heights above the blade root platform, the blades were not burned. All of the high pressure turbine (HPT) and low pressure turbine (LPT) blades were intact and had no indications of having been burned. The lack of burning on the HPT, LPT, and 2<sup>nd</sup> stage PT blades suggests that there was not a torching effect from the fuel nozzles through the turbines that could have also burned through the exhaust pipe. The fuel and oil lines on the rear of the engine were examined visually and pressure tested, and no leaks were found. This led the Safety Board to conclude that the extensive damage observed on the right engine nacelle, wing, and landing gear well could not have been caused by the initiating oil-fed fire.

The PWC PW100 series turboprop engine gas generator case has two drain plugs, one each at the forward and rear of the case, at the 6-o'clock location,<sup>1</sup> to drain the unburned fuel from the fuel manifolds that has drained back through the lowest fuel nozzles into the gas generator case. These drains are intended to prevent internal fires or hot starts. Each drain plug has a "finger" seal, which closes to prevent any air leakage whenever the case is pressurized. After engine shutdown, the finger seal opens when the internal pressure in the case returns to ambient levels. The gas generator case has the two drain plugs to accommodate the installation requirement for the case drain line for the various airplane model installations.<sup>2</sup> One drain plug is connected to a drain line routed to the "ecology" tank,<sup>3</sup> and the other drain plug is then capped to prevent fuel leakage into the nacelle.



<sup>1</sup> All locations on the engine as referenced to the clock are as viewed from the rear, looking forward.

<sup>2</sup> PW100 turboprop engines are used on Embraer EMB-120, Aerospatiale-Alenia ATR42, deHavilland DHC-8, Dornier 328-110 and 328-120, Fokker 50, and British Aerospace Jetstream ATP airplanes.

<sup>3</sup> An ecology tank collects and stores any fuel or oil that drains or leaks from the engine rather than venting it to the atmosphere or draining it on the ground. Any fluids in the ecology tank are then drained into another container on the ground for proper disposal.

On the EMB-120, the forward drain plug has the drain line to the ecology tank and the aft drain plug is capped. During the disassembly of the engine, it was noted that the forward drain plug had the drain line that would have been routed to the ecology tank. But the aft drain plug did not have the cap attached, and the threads of the plug were not damaged. Thus, the Safety Board concluded that the cap had not been installed before the engine failure.

Therefore, when the engine failed and shut down because of the oil-fed fire, the unburned, residual fuel in the fuel manifolds would have drained back through the fuel nozzles into the gas generator case and then out through the drain plugs at the bottom of the case. Because the airplane was climbing in a nose-high attitude, the fuel would have drained rearward through the aft drain plug and onto the deck under the engine, rather than through the forward drain into the ecology tank. Although the deck area under the engine also has an overboard drain located in the forward part of the engine bay, the fuel would have flowed aft because of the airflow through the nacelle and the nose-up climb attitude. The fuel could have then been ignited by the heat from the hot exhaust pipe in the aft section of the engine nacelle.

After this finding, SkyWest Airlines inspected its fleet of 50 EMB-120 airplanes and found that two other airplanes had PW118 engines with the cap missing from the aft drain plug. SkyWest Airlines advised the Safety Board that it had immediately installed caps on the gas generator case aft drain plugs on those engines. The Safety Board staff subsequently contacted the maintenance departments of two other major domestic EMB-120 operators and requested that they also inspect their fleets to ensure that the gas generator case drain plug not connected to the drain line was capped off. Both airlines initiated fleet inspections and did not identify any airplanes with uncapped drain plugs. The Safety Board is pleased by the efforts of SkyWest and two other EMB-120 operators to ensure that the drain line and cap were correctly installed on their EMB-120 airplanes. However, the Safety Board is concerned that other PW100 series turboprop operators, domestic and foreign, may have gas generator case drain plugs missing that could cause in-flight fire hazards to the airplane. The Safety Board is aware that on June 4, 1997, Embraer issued Alert Service Bulletin No. 120-72-A005 to alert the operators that the cap should be installed on the gas generator case drain. Nevertheless, the Safety Board believes that the Federal Aviation Administration (FAA) should issue an airworthiness directive to require an immediate one-time inspection of all PWC PW100 series turboprop engines to ensure that the gas generator case drain line and the plug are correctly installed.

The Embraer EMB-120 Powerplant Buildup Manual provides the instructions on external components and parts that must be installed on a PW100 series turboprop engine before an operator installs an engine on an EMB-120 airplane.<sup>4</sup> Task 71-00-00, Subkit No. 16, of the Powerplant Buildup Manual shows the drain lines and plugs that should be installed on the engine for installation into the airplane. The instructions consist only of a single drawing that shows the drain lines and plugs and a list that identifies each part; however, no text or supplemental illustrations show where each individual line and plug should be installed on the engine. The Safety Board is concerned that without clearly defined instructions that include text and illustrations, drain lines, caps, and clamps could be installed incorrectly or not installed at all after

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<sup>4</sup> The fire occurred on the day after the engine had been installed on the airplane. The engine had accumulated 2.3 hours and 3 cycles following a hot section inspection by SkyWest in Salt Lake City, Utah.

engine maintenance by the operator, thus creating a fire hazard to the airplane. Therefore, the Safety Board believes that the FAA should require Embraer to revise the engine installation instructions in its Powerplant Buildup Manual to clearly define, with illustrations and text, where all of the required lines and plugs must be installed on PWC PW100 series engines for installation on an EMB-120 airplane.

The PW100 series engines are also installed in ATR42, DHC-8, Dornier 328, Fokker 50, and Jetstream ATP airplanes. The Safety Board is concerned that the buildup instructions for installing the drain lines and plugs on PW100 series turboprop engines in these other airplanes may also be inadequate. Therefore, the Safety Board believes that the FAA should review all of the PW100 series turboprop engine buildup instructions for installing the engine on airplanes other than the EMB-120 to ensure that the instructions are clear and unambiguous, and require the manufacturers to revise the instructions, if necessary.

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

Issue an airworthiness directive to require an immediate one-time inspection of all Pratt & Whitney of Canada PW100 series turboprop engines to ensure that the gas generator case drain line and the plug are correctly installed. (Class I, Urgent Action) (A-97-38)

Require Embraer to revise the engine installation instructions in its Powerplant Buildup Manual to clearly define, with illustrations and text, where all of the required lines and plugs must be installed on the Pratt & Whitney of Canada PW100 series engine for installation on an EMB-120 airplane. (A-97-39)

Review all of the Pratt & Whitney of Canada PW100 series turboprop engine buildup instructions for installing the engine on airplanes other than the EMB-120 to ensure that the instructions are clear and unambiguous, and require the manufacturers to revise the instructions, if necessary. (A-97-40)

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



By: Jim Hall  
Chairman