National Transportation Safety Board
Aviation Accident Final Report

Location:	SAN DIEGO, CA	**Accident Number:**	LAX97FA189
Date & Time:	05/21/1997, 1314 PDT	**Registration:**	N198SW
Aircraft:	Embraer EMB-120	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	17 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

After suffering a total loss of power and subsequent fire of the number 2 engine, the Skywest crew made a successful emergency landing. The airplane overran the end of the runway by 1,300 feet, but no additional damage occurred and there were no injuries to the passengers or crew. Immediately prior to the accident flight, a maintenance person added 2.5 quarts of oil to the number 2 engine, when he could not determine the engine's oil level. No evidence was found of any assembly anomalies during the engine hot section inspection, which was performed about 2.3 hours prior to the accident flight. The engine fire resulted from ignition of oil that had leaked across bearing seals. Oil will back flow into the engine rather than drain overboard from the filler neck under overfull operating conditions. The elapsed time between engine shutdown and oil level determination provided by Embraer in its Maintenance Manual are inconsistent with the instructions provided by Pratt & Whitney. The Skywest mechanic may not have allowed adequate elapsed time to permit the oil to drain back into the engine reservoir prior to adding additional oil, thereby overfilling the tank. The clear color of the oil, particularly in a new engine, is difficult to see when determining oil quantity.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The failure of maintenance personnel to allow adequate time for the engine oil to drain back into the engine oil reservoir prior to adding additional oil, thereby overfilling the reservoir, which resulted in an engine fire and subsequent damage to hydraulic lines and components, including the brakes, which precluded stopping the airplane prior to overrunning the runway end. An additional factor was the confusing and insufficiently defined procedures for servicing the engine oil.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - NONMECHANICAL
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings
1. (C) FLUID,OIL - LEAK
2. (C) MAINTENANCE,SERVICE OF AIRCRAFT/EQUIPMENT - IMPROPER - COMPANY MAINTENANCE PERSONNEL
3. (F) CONDITION(S)/STEP(S) INSUFFICIENTLY DEFINED - COMPANY/OPERATOR MANAGEMENT

Occurrence #2: FIRE
Phase of Operation: CLIMB

Findings
4. FIRE EXTINGUISHER,POWERPLANT - DISCHARGED
5. ENGINE SHUTDOWN - PERFORMED - PILOT IN COMMAND

Occurrence #3: OVERRUN
Phase of Operation: EMERGENCY LANDING

Findings
6. (F) HYDRAULIC SYSTEM - FAILURE,TOTAL
7. BRAKES(NORMAL) - NOT AVAILABLE
8. BRAKES(EMERGENCY) - NOT AVAILABLE

Factual Information

HISTORY OF FLIGHT:

On May 21, 1997, at 1314 hours Pacific daylight time, Skywest Flight 724, an Embraer EMB-120, N198SW, experienced a total loss of engine power to the right engine and associated engine fire, followed by a total loss of all airplane hydraulic systems, after takeoff from San Diego International-Lindbergh Field, San Diego, California. The airplane sustained substantial damage. The 2 pilots, 1 flight attendant, and 14 passengers were not injured. Skywest Airlines, Inc., was operating the airplane as a scheduled, domestic, passenger flight under 14 CFR Part 121. The flight was destined for Los Angeles, California. It diverted to Miramar NAS, San Diego, where it landed at 1427. Visual meteorological conditions prevailed at the time, and an IFR flight plan was filed.

According to the pilots, about 2,000 feet mean sea level (msl) during the initial climb, a bang sound was heard; the airplane yawed right, and the right propeller auto feathered. Flames were observed by passengers and the cabin attendant emanating from the right engine. The crew performed the engine shutdown and fire check lists, and turned off the fuel within 1 minute of the mishap.

The cockpit crew extinguished the fire using both of the airplane's fire bottles. The cockpit crew then observed that hydraulic and rudder lights on the master alert panel were illuminated, along with the associated hydraulic lights on the overhead panel, which indicated loss of both hydraulic systems.

The crew diverted to Naval Air Station (NAS) Miramar, extended the landing gear manually, and accomplished a landing without flaps. The captain indicated that he landed within the first 2,000 feet of runway 24R. He was unable to use single engine reverse thrust to decelerate because of the loss of nose wheel steering. Additionally, the captain attempted to use the airplane's primary and emergency brakes; however, hydraulic pressure was also lost to these systems. The airplane overran the departure end of the runway and came to rest in the adjacent field. The passengers deplaned using the air stair door. There were no injuries to the passengers or crew.

PERSONNEL INFORMATION

According to the Federal Aviation Administration airman records, the captain held an airline transport pilot certificate issued on November 7, 1995. He held a first-class medical certificate issued on January 7, 1997, with a limitation requiring him to wear corrective lenses. According to the information provided on the Pilot/Operator report, the captain had 12,100 total hours of flying experience, and 182 hours in the Brasilia 120 within the last 90 days preceding the accident.

The first officer held a commercial pilot certificate with airplane single and multiengine land, instrument-airplane ratings. He held a first-class medical certificate issued on March 3, 1997, with a limitation requiring him to wear corrective lenses.

AIRPLANE INFORMATION

The airplane was an Embraer EMB 120, serial number 120120. Skywest Airlines maintained the airplane on a continuous airworthiness maintenance program. Skywest acquired the newly manufactured right engine, serial number 115655, in 1993, and it was placed into service. Most

recently, on March 31, 1997, the engine was removed from another airplane (N194SW) for routine maintenance and to replace cycle-limited parts, and comply with various service bulletins. Following completion of this work, on May 20, 1997, the engine was installed on the accident airplane. When installed, the engine's total time since new (TSN) was reported as 8,289.2 hours.

FLIGHT RECORDERS

The airplane was equipped with a Fairchild digital flight data recorder (DFDR), which was removed and read out by the National Transportation Safety Board's vehicle performance laboratory. The DFDR indicated that power was lost to the airplane's right engine approximately 1.5 minutes after initial power up during takeoff.

WRECKAGE AND IMPACT INFORMATION

The airplane came to rest on level terrain about 1,300 feet beyond the departure end of runway 24R. The airplane was examined, and fire damage was observed to the right engine nacelle, wing, and landing gear well.

The engine nacelle around the exhaust pipe was observed burned through. The right engine hydraulic system pump and tank were destroyed by fire, and a left engine hydraulic system line, which crossed through the right engine nacelle, was burned through. There was a 3- by 4-inch oval-shaped hole burned through the web of the right wing spar aft of the engine. The fire also damaged the right aileron control cables.

Regarding damage to the right engine, the right engine was disassembled, and no evidence of preexisting broken oil or fuel lines, or loose B-nuts was found. No evidence of fire damage on external components or any fuel or oil leakage from the external engine plumbing was noted. Internally, the power turbine (PT) section of the engine was observed extensively damaged. The first stage PT disk was intact, but there was a continuous sector of five blade root slots that were elongated radically outward and the respective blades were missing. The fuel system's fuel nozzles, electronic engine control, flow divider valve, hydro mechanical fuel control, and fuel pump were functionally checked, and no anomalies were noted. Oil streaking was observed on the first and second stage PT disks.

A statement received from a Skywest Airlines mechanic in San Diego indicated that, at the request of the flight crew, he had checked the right engine's oil level just prior to the airplane's departure on the accident flight. The mechanic stated that when he was unable to determine the oil level, he added a total of 2.5 quarts of oil.

The Safety Board's power plants group chairman reviewed the EMB-120 Maintenance Manual and observed two different oil servicing procedures on adjacent pages. These procedures also differed somewhat from the engine manufacturer's instructions. The three procedures listed time limits when the oil should be checked that varied between 10 and 30 minutes following engine shutdown. The time interval between engine shutdown and checking the oil level allows for the oil to drain into the oil tank.

Skywest Airlines stated they intend to operate the engine at 1 quart below the full level to preclude the engine from venting the oil overboard through the accessory gearbox (AGB) vent tube.

During the disassembly of the engine, the low and high pressure compressor impellers were observed coated with oil, the combustor liner had oil streaking on the inner diameter (ID), and

the AGB vent tube had oil leaking from the split line at the firewall and from the end of the tube at the PT case. Also, evidence of oil stains was noted in other engine locations.

Pratt & Whitney personnel reported the engine oil that was used was clear in color. Skywest personnel reported that in a new engine it is difficult to visually detect the oil quantity by reference to either the oil tank level indicator or by looking in the filler neck.

Pratt & Whitney personnel indicated that if an engine were over serviced with oil, the bearing compartments would flood because the scavenge pumps would be unable to pump the oil back into the already full oil tank. Oil would leak out past bearing compartment seals into the gas path, and also out through the AGB vent line.

During the engine disassembly, it was noted that the gas generator case aft drain valve adapter was not capped off as required by the airplane manufacturer in its power plant Buildup Manual.

TESTS AND RESEARCH

A review of the Embraer EMB-120 power plant 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. The instructions consist 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.

ADDITIONAL INFORMATION

The airplane was released to the operator on July 7, 1997.

On June 13, 1997, the Safety Board issued Safety Recommendation number A-97-38 through -40 which addressed issues related to the correct installation of the engine's gas generator case drain line and plug, and revisions to the power plant Buildup Manual.

Pilot Information

Certificate:	Airline Transport	**Age:**	39, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	**Last Medical Exam:**	01/07/1997
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	12100 hours (Total, all aircraft), 1200 hours (Total, this make and model), 10500 hours (Pilot In Command, all aircraft), 182 hours (Last 90 days, all aircraft), 56 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Embraer	**Registration:**	N198SW
Model/Series:	EMB-120 EMB-120	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	120277
Landing Gear Type:	Retractable - Tricycle	**Seats:**	33
Date/Type of Last Inspection:	05/01/1997, Continuous Airworthiness	**Certified Max Gross Wt.:**	26609 lbs
Time Since Last Inspection:	141 Hours	**Engines:**	2 Turbo Prop
Airframe Total Time:	15646 Hours	**Engine Manufacturer:**	P&W
ELT:	Installed, not activated	**Engine Model/Series:**	PW-118B
Registered Owner:	ICX CORPORATION	**Rated Power:**	1800 hp
Operator:	ICX CORPORATION	**Air Carrier Operating Certificate:**	Flag carrier (121)
Operator Does Business As:	SKYWEST AIRLINES	**Operator Designator Code:**	SWIA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	NKX, 14 ft msl	**Observation Time:**	1251 PDT
Distance from Accident Site:	0 Nautical Miles	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Scattered / 2500 ft agl	**Temperature/Dew Point:**	23°C / 16°C
Lowest Ceiling:	None / 0 ft agl	**Visibility**	7 Miles
Wind Speed/Gusts, Direction:	12 knots, 280°	**Visibility (RVR):**	0 ft
Altimeter Setting:	29 inches Hg	**Visibility (RVV):**	0 Miles
Precipitation and Obscuration:			
Departure Point:	, CA (SAN)	**Type of Flight Plan Filed:**	IFR
Destination:	LOS ANGELES, CA (LAX)	**Type of Clearance:**	IFR
Departure Time:	1310 PDT	**Type of Airspace:**	Class B

Airport Information

Airport:	MIRAMAR NAS (NKX)	**Runway Surface Type:**	Concrete
Airport Elevation:	477 ft	**Runway Surface Condition:**	Dry
Runway Used:	24R	**IFR Approach:**	Visual
Runway Length/Width:	12000 ft / 200 ft	**VFR Approach/Landing:**	Full Stop; Straight-in

Wreckage and Impact Information

Crew Injuries:	3 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	14 None	**Aircraft Fire:**	In-Flight
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	17 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	THOMAS H WILCOX	**Adopted Date:**	07/17/2001
Additional Participating Persons:	JOHN E WINFORD; SAN DIEGO, CA ROBERT VENTURELLA; SAINT GEORGE, UT ADAM MICHELS; SAN DIEGO, CA MICHEL VALLIERES; LOS ALAMITOS, CA		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		