June 29, 1999

Mr. Timothy Monville
National Transportation Safety Board
Miami

Dear Mr. Monville:

In accordance with the Board's rules, the Air Line Pilots Association submits the following comments concerning the accident involving USAirways Flight 861 which occurred on February 26, 1998 at Birmingham AL. ALPA appreciates the opportunity to have participated as a party to the investigation and hopes the following comments and recommendations will be of assistance as the Board concludes its investigation.

The inadequate lightning protection of the F-100 aircraft, in conjunction with a latent hardware failure, resulted in this runway veeroff accident. There was no post accident fire, and the crew prevented any post accident passenger injuries by making an informed decision not to conduct an emergency evacuation.

Summary

On February 26, 1998 at about 1728 CST, a Fokker F.28 Mark-0100 ('F-100', N867US) being operated as USAirways Flight 861, skidded off the runway after landing at Birmingham International Airport (BHM). The aircraft had departed Charlotte, North Carolina (CLT) and was struck by lightning while descending for landing at Birmingham, the destination airport.

Post landing examination revealed that a single lightning protection bonding strap failed, and lightning current arced to two hydraulic lines. This caused a loss of fluid and failure of both hydraulic systems. At this point, the aircraft was still controllable, with certain operational and performance limitations. The flight crew legitimately expected that the landing would be routine in most ways, and that the only difficulty would be that they would have to be towed to the gate. However, upon landing, a latent failure of another hydraulic system component caused three main landing gear (MLG) tires to blow out after locking up, resulting in the runway veeroff.

Flight 861 had declared an emergency with ATC, and had requested the Airport Rescue and Firefighting (ARFF) equipment to be standing by for the landing. ARFF response was excellent, and the aircraft was rapidly surrounded by emergency equipment and personnel once it came to rest. No fire occurred, and the captain was personally notified by a firefighter that the aircraft was fire safe while the flight crew was still performing the Emergency Evacuation checklist. Based on this face-to-face report, their contacts with the cabin crew, and the conditions outside the aircraft, the flight crew decided that an orderly deplaning would ensure the continued safety of the passengers. All passengers were deplaned in a calm and orderly fashion, and there were no injuries.

Adverse Weather Detection and Avoidance

The evidence indicates that the crew conducted their adverse weather avoidance maneuvering in accordance with applicable procedures and good operating practices. However, inherent limitations in both on-board and ground-based weather information-

gathering and dissemination equipment and systems prevented this flight crew from developing a completely accurate assessment of the weather in the terminal area.

Discussion

Thunderstorms were forecast in the BHM area, and this information was included in the flight's dispatch paperwork. The flight crew used their onboard radar at various ranges and tilts to remain clear of buildups. They stated that they deviated to keep a line of storms approximately 20 nm off the left (south) side of the aircraft. The crew also stated that they remained clear of cloud enroute, but descended into cirrus clouds at TOD, and stayed IMC approximately until the overflight of BHM.

The flight crew saw no lightning until the aircraft took the strike. The lightning strike occurred as the aircraft was descending through approximately 12000' and the crew was using their onboard radar to deviate for weather. The aircraft did not take any additional lightning strikes, nor did the crew make any other comments on the CVR or in post-accident interviews indicating that the flight operated too close to the adverse weather. They encountered only light rain and occasional light chop.

Paragraph 7-1-25e of the AIM states that "lightning can strike aircraft flying in the clear in the vicinity of a thunderstorm", while paragraph 7-1-26a(5) advises avoiding "by at least 20 miles any thunderstorm identified as severe or giving an intense radar echo." USAirways training and flight manuals also recommend the 20 mile separation from intense echoes.

A review of the ATC tapes for the duration of the flight did not reveal any ATC vectoring of USAirways 861 or any other aircraft for weather avoidance. On most of the frequencies, the communication traffic was very heavy, with nearly constant activity. This level of activity, combined with the weather information and detection equipment available to controllers, essentially precludes ATC from providing weather avoidance vectoring to aircraft. In general, air traffic controllers do not have the means, ability or time to provide aircraft with accurate and appropriate levels of weather avoidance information. This condition reinforces the need to develop a satisfactory methods of getting accurate, detailed and timely weather information to the place it is needed the most, the cockpit.

Corroborating the crew statements, ground based WSR-88D imagery shows that the aircraft passed approximately 10 miles to the north of the VIP level 4 and 20 miles north of the VIP level 5 returns near its altitude. However, this radar also shows that the area that the aircraft was transiting when it was struck by lightning was indicating only VIP level 1 returns. Also, the WSR-88D imagery shows level 3 returns below the flight path; this weather could not be detected by the aircraft radar due to attenuation and tilt angle limitations.

It is well known that airborne weather radar is subject to attenuation when the aircraft is operating in precipitation. Attenuation values can be on the order of 15 dB, which roughly translates to a one-color shift on the typical three-color aircraft display. This 15 dB downward shift would mean that an area of precipitation that would normally be displayed as 'red' could appear as 'yellow' on the display of an aircraft operating in precipitation. Since the actual attenuation is a function of the precipitation that the airborne weather radar is penetrating, it is impossible for the crew to accurately assess the impact of any attenuation on their display.

Proper operation and interpretation of airborne radar is dependent on flight crews having full understanding of its capabilities and limitations. An NTSB review of information obtained from the NASA Aviation Safety Reporting System (ASRS) and several accident investigations has given the Safety Board a renewed concern about usage and limitations of airborne weather radar. The Safety Board found widespread differences among air carriers in the amount and quality of the training provided to flight crews to use weather radar to identify, interpret, evaluate and avoid hazardous weather.

Further, during these investigations the Safety Board compared the severe weather avoidance policies of various air carriers and found inconsistencies among carriers. Finally, the Safety Board reviewed the FAA's *Aviation Safety Inspector's Handbook*, (8400.10) and found no specific guidance for air carrier inspectors to apply when evaluating the existence and adequacy of severe weather avoidance policies of air carriers.

The NTSB is convinced that there is "ample evidence that present-generation airborne weather avoidance radar is subject to limitations that can hamper flight safety" and believes that "today's technology promises improvements to overcome these shortcomings." The Air Line Pilots Association fully concurs with these conclusions.

At present, the most promising solution to providing flight crews with accurate and timely weather information is to data-link ground-based products to the aircraft. An ACARS weather data-link called Terminal Weather Information for Pilots (TWIP) is currently operational, and has been available for a few years. The TWIP information may be accessed at any terminal area where Terminal Doppler Weather Radar (TDWR) information and Integrated Terminal Weather Information Systems (ITWS) are being provided by ATC. However, it should be noted that TWIP is not available at most airports, including BHM. TWIP transmits a character graphics map plus a text message portraying the existence and movement of micro-burst, wind-shear, gust front, and thunderstorm activity in the terminal area. The system utilizes a request/reply format through the ARINC supported ACARS, and the messages are developed automatically by algorithms that sort and interpolate information from the TDWR and ITWS at each terminal. TWIP is a rudimentary system compared to the data-link technology expected eventually available, but it is superior to airborne radar alone.

For about 5 years, there has been an effort under way through RTCA Special Committee 169 – Working Group 3, to develop Minimum Operational Performance Standards (MOPS) for weather data-link, and significant progress has been made. Several types of data link connections are possible, including request-reply, continuous broadcast, and automatic information up-link and down-link. Each of those types may transfer alpha-numerics, character graphics, straight graphics, or combinations of each. Most RTCA participants agree that combinations heavy in graphics, portrayed on multi-function cockpit displays, will be the weather data-link of the future. RTCA MOPS for some of the above possibilities have already been published, and the remaining data-link MOPS are expected to be published by the end of 1999. The associated hardware and software are currently in various stages of development, prototype and demonstration.

If the research and development continues at its current pace, the industry can expect to have production systems available and operational in 2-3 years. Clearly, this will require the continued industry (including FAA Research, Engineering and Development (R,E&D) R,E & D) support in order to accomplish this within the given timeline.

Flight Crew Performance

This flight crew exhibited excellent Crew Resource Management (CRM) and decision-making practices. Following the loss of the hydraulic systems, they maintained their situational awareness, correctly conducted the appropriate checklists, and continually evaluated their options. In addition, they maintained good communication and coordination with each other, with ATC, and with the cabin crew.

Discussion

The #1 hydraulic system lost pressure about 90 seconds after the #2 system, while the crew was still conducting the checklist for loss of the #2 system. Within 20 seconds of this additional failure, the issue of whether BHM was still a suitable destination airport was raised. Within four more minutes, the crew had notified ATC and initiated actions to determine the conditions at BHM and other nearby airports, all while continuing to fly the aircraft and conduct the appropriate checklists. Six minutes after the initial problem, the crew recognized that they would require additional time to adequately assess their condition and options, and requested an overflight of BHM.

As US861 overflew BHM, the flight crew observed that the weather was better than reported, and they decided that BHM should remain their destination. The crew made these intentions known to ATC, requested that the ARFF equipment be standing by, informed ATC that they would be unable to taxi clear of the runway, and suggested that ATC might want to land some aircraft ahead of them. Subsequent to this, the flight crew fully briefed the cabin crew on the situation and what they could expect. As US861 was vectored around for its approach into BHM, the crew completed all applicable checklists and procedures for the manual reversion approach and emergency landing. CVR transcripts and interview summaries show that the flight crew was well aware of the operational and performance limitations imposed by the dual hydraulic failure.

Touchdown was smooth and initially uneventful, occurring in the touchdown zone and on the runway centerline. However, once the tires failed, directional control of the aircraft was lost. Although the captain applied the appropriate corrective control inputs, control authority was hindered by the blown tires and lack of nosewheel steering. His efforts met with only limited success, and the aircraft departed the left side of the runway.

As soon as the aircraft came to rest, the flight crew began shutting down the aircraft in preparation for a possible emergency evacuation. In his post accident interview, the first officer noted that the flight and cabin crews' actions were well coordinated and that the cabin attendants were "calm and professional."

F-100 Lightning Protection:

ALPA is concerned that the aircraft was susceptible to losing both aircraft hydraulic systems due to a lightning strike. It is incumbent upon the designers and certificating agencies of the F-100 and all other commercial transport aircraft to ensure that these aircraft meet or exceed both the regulatory requirements and recognized standards for lightning protection.

Discussion

Per the Type Certificate Data Sheet, the certification basis for the Fokker F-100 is FAR Part 25 (through Amendment 60) with no exemptions. FAR 25.581 requires that "the airplane must be protected against catastrophic effects from lightning", while FAA Advisory Circular

(AC) 20-53A presents the expected lightning-induced electrical current values for the different surfaces and components of the aircraft.

As part of an aircraft's lightning protection, flexible connectors called 'bonding straps' are used to provide electrically conductive pathways between certain components. By design, the F-100 has only a single electrical bonding strap connecting the horizontal stabilizer to the vertical tail structure. However, the Fokker Illustrated Parts Catalog (IPC) erroneously depicts two. On the accident aircraft, this strap was found broken, with discoloration & melting consistent with an electrical overload. It is unknown whether this strap failed on the accident flight or on some previous flight. It is also unknown whether this strap had been previously weakened due to flexing, vibration or previous lightning strikes.

According to the FAA's National Resource Specialist on Lightning, this strap "has a possibility of failing when subjected to lightning currents at or below the AC 20-53A" specifications. He also notes that two straps would provide the necessary current carrying capability.

Several stainless steel elevator hydraulic lines are routed in the rudder-vertical stabilizer cove on the aft face of the vertical stabilizer rear spar. Of these, the System 1 elevator pressure line and the System 2 elevator return line had lightning-caused holes in them. From this evidence, it is apparent that the lightning current exceeded the capability of the single bonding strap, and it failed. Lacking any other path, the current then arced to the noted hydraulic lines and burned holes in them. These holes caused the depletion of the fluid from the two normal hydraulic systems & reservoirs, rendering the systems inoperative.

Latent Failure of Parking Brake Shutoff Valve:

ALPA is concerned that a latent failure with such potentially serious consequences could and did exist, and that existing maintenance procedures were inadequate in addressing, detecting and eliminating this condition.

Discussion

An inoperative parking brake shutoff valve caused the MLG wheels to lock up on brake application, which resulted in tire failure and loss of directional control of the aircraft. On scene investigation revealed that the cannon plug of the parking brake shutoff valve was not fully engaged, and that in this condition, the valve was not electrically connected to the aircraft. Under normal conditions (both hydraulic systems operative) the functionality of this valve is transparent to the flight crew.

Maintenance records indicated that this parking brake shutoff valve was replaced in August 1995. These records showed no hydraulic system failures or any activity which required removal of the cannon plug; thus this improper connection remained as a latent failure until the accident. In addition, the existing maintenance procedures did not anticipate, warn against, or provide for detection of this latent failure mode.

Passenger Deplaning

The captain made a prudent and informed decision when he determined that the continued safety of his passengers would be better served by conducting an orderly deplaning of the aircraft rather than ordering an emergency evacuation.

Discussion

Once the aircraft came to a stop, the flight crew began performing their Emergency Evacuation checklist. Before they got to the point in this checklist which called for the evacuation order to be given (if required), the crew was interrupted by Fire Chief 2 at the captain's open side window. Chief 2 spoke with the Captain via the open window in a normal voice and advised him that the airplane was "fire safe", and that there was no fuel leakage or fire. In a post accident interview with the NSTB, Chief 2 was asked to clarify the term 'fire safe', and he cited the following conditions: "No fuel leakage", "no tire/wheel burning", "no hydraulic leakage", and "brakes warm but not glowing." Although the flight crew was not familiar with the term 'fire safe', and it is not referenced in any USAirways training document, operations manual or FAA document pertaining to pilots, they had no question regarding the term's implications.

Following an aircraft incident, evacuated passengers are exposed to a number of potential hazards. Once outside the aircraft, the passenger is in unfamiliar surroundings and frequently becomes individually responsible for his or her own safety. Potential hazards include other aircraft, rapidly responding ARFF vehicles, sharp and/or jagged wreckage, leaking flammable and/or caustic fluids, adverse weather, unfamiliar terrain and darkness.

In an accident situation, strong command and control of evacuees is required to minimize their potential for physical and psychological injury, and gaining control of the evacuees is a challenge to the flight crew, cabin crew and ARFF personnel. Airline crews are acquainted with and trained in these issues.

Given the captain's knowledge that the aircraft was safe from fire, that the cabin attendants were standing by at the emergency exits, that the passengers were under control, and that potential hazards existed outside the aircraft, the captain acted prudently by deciding not to conduct an emergency evacuation. Consequently, within approximately 10 minutes of the accident, the passengers began deplaning in an orderly fashion and boarded buses for the terminal. Positive control of the passengers was maintained throughout the incident, and as a result no passengers suffered any post-event injuries.

Safety Recommendations

Based upon information gained during the investigation of this accident, the Air Line Pilots Association proposes the following safety recommendations:

To the FAA

Review the design of the bonding strap installation at the horizontal stabilizer hinge of the Fokker F.28 aircraft (all models) and require operators to modify their airplanes to increase the lightning strike protection at that location. (NTSB Recommendation A-99-19)

Require that the design and operational configurations of the Fokker F.28 aircraft (all models) be modified to ensure that the aircraft conforms to or exceeds the lightning protection standards set forth in FAA Advisory Circular 20-53A.

Require a one time fleet inspection of all U.S. registered Fokker F.28 aircraft (all models) to ensure that the parking brake shutoff valve cannon plugs are fully engaged and electrically connected.

Require that air carrier pilot and dispatcher initial and recurrent ground training provide sufficient detail to explain proper airborne weather avoidance radar operations, interpretation and limitations, including gain usage and tilt management, and a discussion of the different types of attenuation, including precipitation-induced attenuation.

Develop and publish in the *Aviation Safety Inspector's Handbook*, (8400.10) a standard that can be used by air carrier inspectors when evaluating the existence and adequacy of an air carrier's severe weather avoidance policies.

Require that principal operations inspectors (POIs) ensure that air carriers under their surveillance are in compliance with the severe weather avoidance standards referenced in the previous recommendation, once those standards have been established and published.

Ensure that FAA Research, Engineering and Development (R,E&D) continues to provide the support necessary for the development of weather information data-link systems at the current pace, which should enable production systems to be available and operational in 2-3 years.

Coordinate the efforts of manufacturers and the aviation industry to pursue current and new technology to aid flight crews to identify, interpret, evaluate and avoid hazardous weather.

<u>To Fokker Aircraft</u>

Ensure that the as-designed, as-installed, Maintenance Manual, and Illustrated Parts Catalog configurations of electrical bonding straps on the Fokker F.28 aircraft (all models) are all congruent for each specific aircraft model.

Review and modify (as necessary) the Maintenance Manual for all model Fokker F.28 aircraft. Ensure procedures are included to prevent similar latent failures of the parking brake shutoff valve, particularly following any maintenance activity affecting or involving that valve.

Sincerely,
//s//
Dan Sicchio
Party Coordinator
Air Line Pilots Association

Cc:
NTSB Big Board guys (Hall, Black, Francis, Hammerschmidt, Goglia
NTSB regl director Jorge Prellezo
Loeb (5 copies)
Haueter

Sweedler
CRA & Midway CASC & CAI
AAA ax team (Cox, Bill Weeks, Sumwalt,Kleissas
Parties:

FAA-Bud Donner
Fokker Frans Th. Van de Pol
USAirways- George Snyder