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16. Abstract On February 19, 1988, an AVAir Inc. Fairchild Metro III, N622AV, operating as Air Virginia (AVAir) flight 3378, crashed in Cary, North Carolina, shortly after it departed runway 23R at Raleigh Durham International Airport (RDU), Morrisville, North Carolina, with 2 flightcrew members and 10 passengers on board. The airplane struck water within 100 feet of the shoreline of a reservoir, about 5,100 feet west of the midpoint of runway 23R. The airplane was destroyed and all 12 persons on board were killed.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew to maintain a proper flightpath because of the first officer's inappropriate instrument scan, the captain's inadequate monitoring of the flight, and the flightcrew's response to a perceived fault in the airplane's stall avoidance system. Contributing to the accident was the lack of company response to documented indications of difficulties in the first officer's piloting, and inadequate Federal Aviation Administration surveillance of AVAir.

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The safety issues examined in the report included the Fairchild Metro avoidance system, Federal Aviation oversight of AVAir, Inc., and the company's management of its operations.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

AVAIR INC., FLIGHT 3378
FAIRCHILD METRO III, SA227 AC, N622AV
CARY, NORTH CAROLINA
FEBRUARY 19, 1988

1. FACTUAL INFORMATION

1.1 History of the Flight

At 2125 eastern standard time on February 19, 1988, an AVAir Inc., Fairchild MetroIII, N622AV, operating as Air Virginia (AVAir) flight 3378, departed runway 23R at Raleigh-Durham International Airport (RDU), Morrisville, North Carolina, with 2 flightcrew members and 10 passengers on board. AVAir 3378, en route from RDU to Richmond, Virginia (RIC), was a regularly scheduled flight conducted under 14 Code of Federal Regulations (CFR) Part 135.

About 1400 the captain telephoned an AVAir flight controller, informed him that he had "upper-respiratory and flu-like" symptoms, and asked if there was a reserve captain available to take command of AVAir 3378. The captain was informed that a reserve captain would be available. The captain then told the controller that if he did not call back he would take command of AVAir 3378, as scheduled; however, if his symptoms worsened, he would inform the flight controller. The captain did not call the controller and, after flying as a passenger to RDU from his residence in Roanoke, Virginia, reported to the RDU station 1 1/2 hours before the scheduled 2040 departure time for the flight. The first officer, who resided in the RDU area, also reported for duty over 1 1/2 hours before the scheduled departure time.

Due to RDU's prevailing instrument meteorological conditions (IMC) and the proximity of its parallel runways, all flight operations were conducted on runway 23R. As a result, flights at RDU were delayed. AVAir 3378 departed about 40 minutes behind schedule.

At 2124:54 the RDU local controller cleared AVAir 3378 to taxi into position and to hold, following the departure of an American Airlines MD-80. The captain of flight 3378, who was performing all communications with air traffic control, acknowledged. According to AVAir's former manager of training, company standard operating procedure called for the nonflying pilot to perform all communications with air traffic control. At 2125:20, the local controller directed AVAir 3378 to continue to hold but to amend its original clearance from maintaining a runway heading of 230° after departure to turning right to a heading of 290". The captain acknowledged. At 2125:49 AVAir 3378 was cleared for an immediate takeoff. At 2126:33, the flight was told to "report established on the 290° heading and make that turn as soon as feasible, jet traffic to depart behind you." The captain responded "three seventy eight." This was the last transmission from the flight. (See appendix B.)

According to the local controller, he heard but could not see the American MD-80 depart. He saw the MD-80 on radar and cleared AVAir 3378 for departure. He briefly saw AVAir 3378 in the air, observed it on radar, and then cleared the Piedmont airplane to depart. In the next 3 minutes, he cleared a Cessna to land, coordinated with the departure controller, and attempted to locate AVAir 3378. At 2131:45, the RDU local controller alerted the airport crash, fire, and rescue unit.

The airplane struck water within 100 feet of the shoreline of a reservoir, at a point that was located about 5,100 feet west of the midpoint of runway 23R. The airplane was destroyed and all 12 persons on board were killed. The accident occurred during the hours of darkness at 35° 52.6' N latitude and 78° 47.3' W longitude.

1.2 Injuries to Persons

Iniuries	Crew	Passenaers	Others	Total
Fatal	2	10	0	12
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	0
Total	2	10	0	12

1.3 Damage to Aircraft

The airplane was destroyed in the accident. Its value was estimated at $3 million.

1.4 Other Damage

Several trees beyond the shoreline of the reservoir were destroyed

1.5 Personnel Information

The flightcrew consisted of a captain and a first officer. Both were properly certificated and met the requirements for a flight conducted under 14 CFR 135. (See appendix C.) AVAir 3378 was the first and only flight on the day of the accident for both the captain and the first officer. The crew was scheduled to fly six trips on February 20 and seven trips on February 21. Company records indicate that before the accident, the first officer and the captain of flight 3378 had flown together a total of 14 hours in two 2-day trips on November 19-20 and November 30-December 1, 1987. All flights were in the Metro III.

1.5.1 The Captain

The captain had been hired by AVAir (then known as Air Virginia) on June 10, 1985, and was assigned to the position of first officer on the Fairchild Metro. In July 1987, he attempted to upgrade and transition to the position of captain on the Short Brothers SD3-30 airplane. After successfully completing the ground school and after 16.9 flight hours in six flight training sessions, he left SD3-30 training and returned to the Metro. The captain's progress in transition was normal for the first four training sessions. After the fifth session, the instructor commented, "needs more time on one engine work and instrument procedures" and, after the sixth session, he wrote, "needs basic instrument work (ILS--VOR). Also needs more time before check flight." These were the only unfavorable comments in AVAir's pilot records of the captain. AVAir's former manager of training attributed the captain's leaving the SD3-30 training to the company's need to complete pilot training as quickly as possible, not to a lack of skill on his part. She stated that AVAir intended to return the captain to SD3-30 training after the initial cadre of pilots had been qualified in the airplane. However, shortly afterward, a captain's position on the Metro opened and he successfully qualified as captain on that airplane. Later, AVAir phased out the SD3-30.

The captain began training to upgrade to the position of captain on the Fairchild Metro in July 1987 and qualified as captain on July 29, 1987. At the time of the accident, the captain had accrued about 3,426 total flight hours, of which about 1,836 hours were in the Metro (II and III), with about 405 hours of those as pilot-in-command.

The captain had been off duty on February 15 and 16. He was reported to have gone to bed sometime after 2300 on February 16. On February 17, the captain reported for duty at RDU at 0820, following a flight from Roanoke, in preparation for a scheduled 0920 departure. The first officer on the flights of February 17 and 18 was a captain who had been temporarily reduced in rank after AVAir resumed operations in early February. The captain was in command of a total of nine legs on February 17 and he alternated the legs with the first officer as was customary at AVAir. The captain was reported to have retired about 2200.

On February 18, the captain met the first officer on the flights of February 17 and 18 at 0745. The captain was described as appearing normal in all respects. The crew then traveled to the airport for a scheduled 0845 departure. The captain flew both legs that morning in preparation for a required, 6-month proficiency check that was scheduled to occur during the crew's 3-hour layover in Lynchburg, Virginia. According to the examiner who administered the check, the captain performed as an "average" captain would during the l-hour 45-minute flight. The examiner described his instrument work during the check as "fine." After the check, the first officer flew the remaining three legs. The duty day ended at 2000 and the captain then returned to Roanoke.

A close friend met the captain at the Roanoke airport. According to the friend, the captain most likely went to bed shortly after 0230 on February 19. At 1000 on February 19, the friend called the captain. The captain told her that he wanted to remain in bed and that he would telephone later that day. At 1245, the captain called her and shortly thereafter, she visited him at his residence. According to the friend, during the visit, the captain indicated that "his stomach was queasy," and that this may have been related either to a sinus problem or to his having eaten too much the previous night. The friend described him as not being very sick. The friend gave the captain a bottle of Emetrol, an over-the-counter medication for the relief of nausea. According to a recent edition of the Physician's Desk Reference, Emetrol, with the primary ingredients of glucose and fructose, has no known side effects. He did not take Emetrol in her presence.

About 1700 on February 19 another AVAir captain saw the captain at the Roanoke, Virginia, airport, where the captain was waiting for an AVAir flight to RDU. The captain told him that he was not feeling well and described his symptoms as "a little bug or something" but added that he would be all right. The captain then told the pilot-in-command of the AVAir flight that he "didn't know if he felt 100 percent or not." While the pilot-in-command was loading the baggage onto the flight to RDU, the captain asked him to load his bag upright since it contained medication that could spill. A passenger who sat next to the captain on that flight and had an extended conversation with him described their conversation as "normal," the captain as alert, and without any manifestations of illness.

Several AVAir employees, who saw and talked to the captain in the company crew lounge at RDU, indicated that he appeared normal. An AVAir first officer overheard the captain tell the first officer of flight 3378 that she, the first officer, was to fly AVAir 3378 that night. The first officer responded in a positive manner. The first officer who overheard this conversation indicated that both the captain and the first officer appeared normal in all respects.

Comments from AVAir crewmembers who had flown with the captain were consistently positive. They described his style in the cockpit as relaxed and easy going, but very attentive to required flight duties and procedures. In response to the Safety Board's request of AVAir crewmembers to describe the captain's typical routine in performing certain procedures, several first officers said that, based on their experience, the captain would turn the bleed air switches on when he was the nonflying pilot. These switches, located just behind the first officer's control column (see figure 1), were to be turned on shortly after takeoff in order to pressurize the cabin. The choice as to which crewmember turned on these switches varied among AVAir captains. A pilot who flew as a first officer with the captain said that, as the nonflying pilot the captain might be looking at a checklist, "cleaning up the aircraft and might have his eyes off the instruments," while climbing through 300 feet.

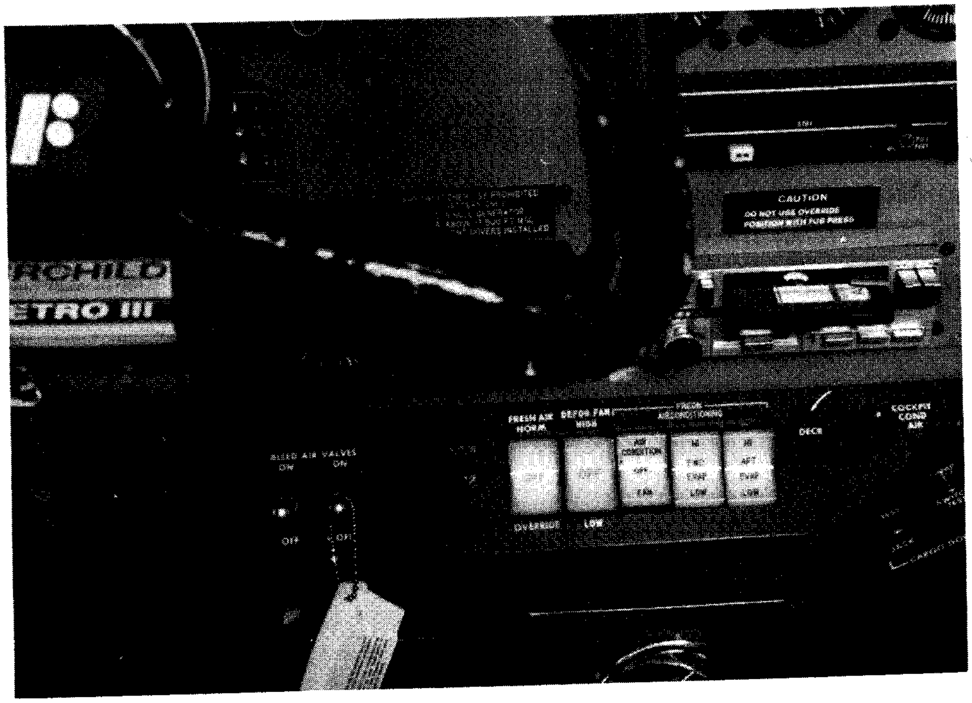
1.5.2 The First Officer

The first officer had been hired by AVAir on May 5, 1987, and was assigned to the position of first officer on the Metro. At the time of the accident, the first officer had accrued about 2,080 total flight hours, of which about 450 were in the Metro (II and III), all as second-in-command. She flew her first flight in the Metro on June 30, in a Metro III, for a total of 3.3 hours. In the 6-month period before that, she accumulated 20.1 total hours of multiengine time, all in the Piper PA 44 model, all during 9 days in April in preparation for and participation in an Air Transport Pilot's (ATP) check ride. She successfully qualified for an ATP certificate on April 17. The remainder of her flight time in that period, 244.2 hours, was in Cessna 172 airplanes. She completed AVAir 's ground training and, following 12.7 hours of flight training, was certificated to fly as a first officer the Metro III. She then began "differences" training on the Metro II and required 5.8 hours in three sessions, each with a different check airman, before qualifying on that airplane. The first check airmen wrote in the flight check form, among other remarks, that she "needs more work on landing, having trouble maintaining glide path and speed control and keeping torques matched on landing." The second check airman, who was her instructor in the Metro III, wrote "refuses to fly aircraft. . . performance unsatisfactory. . . . recommend termination." The third check airman, after observing her perform eight takeoffs and landings, qualified her as second-in-command on the Metro II.

The Director of Operations at AVAir at the time of the first officer's training stated that the check airman, who had recommended that the first officer be terminated, talked to him about his recommendation. The Director of Operations testified that:

> I didn't make it a practice of terminating anyone upon one person's recommendation . . . she had invested a lot in our company and our company had invested a lot in her, and my question to him was, within a reasonable period of time could we bring her up to the standards that AVAir demands of their first officers. His response was it would take a long time.

AVAir's Vice President of Operations said that several individuals, including a check airman, the chief pilot, and the Director of Operations, talked to him about the first officer's difficulties in qualifying in the Metro II. AVAir's manager of training at that time later testified that, while she herself had not experienced problems with the check airman who recommended terminating the first officer, "the pressure of having [the check airman] in the airplane, and [he] can be very demanding at times, could have very well have just made it so that she just simply could not function on that particular day." The former manager also characterized the second check airman as "extremely critical."



(View from right side)

(View from left side)

Figure 1.--Bleed air switches as viewed from the captain's control column

On September 15, 1987, an AVAir captain completed for the first officer a monthly captain's progress and evaluation report, which captains were encouraged to complete for probationary first officers. The first officer flew a total of 55.1 hours with this captain from August 8 through August 19, 1987. Of those hours, 41.5 were in the Metro Ill, and 5.9 were in the Metro II. The remainder, 7.7 hours, was in the Metro; however, the Safety Board was unable to determine which model of the airplane, II or II. The captain described the first officer as "behind the airplane," and wrote that she "over-controlled" it, and that she "had real problems landing." The captain also noted that the chances of her successfully completing her l-year probationary period were "questionable." After completing the progress and evaluation report, the captain discussed the first officer's performance with the chief pilot. The chief pilot told the captain that the first officer's difficulties resulted from her reaction to her mother's illness and that she should get better over time, after she "gets over these family problems " Her mother passed away in mid-November 1987.

After that captain's appraisal of the first officer's performance, the vice president of operations discussed her performance with another captain who had flown with her in the late summer, early fall period. The captain told him that while the first officer was "rough around the edges, " she had made "tremendous improvement" throughout the month that they had flown together and that she was doing fine. There is no evidence that AVAir took further action regarding the first officer's performance thereafter.

The Safety Board interviewed several AVAir captains who had flown with the first officer. Their opinions regarding her piloting abilities were generally more positive according to the time period in which they had flown with her and the amount of time that had passed since her initial training at AVAir. A captain who flew with her over a S-day period immediately after she qualified as first officer said that she had difficulty with landings and with altitude captures. He stated that she was "very much behind the airplane, much more than most previous new hires I'd flown with." However, he added that she had become "smoother" by the end of their fifth day of flying. The captain who had completed the progress and evaluation report on the first officer told the Safety Board that, in his opinion, she "didn't have a feel for the airplane," that she over controlled it, and was often "behind the airplane." Another captain said that the first officer appeared to be behind the airplane during instrument approaches and that it seemed that she did not feel as if she was in command of the airplane. A captain who had flown with her on November 26-28, 1987, at times under instrument meteorological conditions (IMC), stated that he had "no problems" with her instrument skills.

The first officer had accrued 184 hours of actual and 57.2 simulated hours of IMC time at the time of the accident. To determine the first officer's recency of actual IMC experience before the accident, the Safety Board reviewed National Weather Service (NWS) data for conditions during times when she was the second-in-command of an AVAir flight. The data indicate that on December 22, 1987, she had flown as first officer during a departure from Greenville, North Carolina, where there was a 400-foot ceiling and 1 mile visibility, and 5 days later during a departure from RDU with the same conditions. Both flights were in daylight.

The first officer had been recalled to duty at AVAir on February 15, following their cessation of operations on January 15 (see Section 1.17.1, AVAir Operations), but because she was vacationing with a close friend in Chicago at the time, reported for duty 2 days later. On February 17, she reported for duty before a 0940 departure. The first officer alternated flying the nine legs flown that day with the captain. They went off duty at 2119. On February 18, the first officer arose in time to board an 0630 shuttle bus to the airport. The first leg of the six flights that were flown that day began at 0800. There was a 3-hour layover during the day from 1610 to 1917. The first officer was reported to have spent the layover watching television in the crew lounge of the airport. At 1953, she arrived in RDU, where she resided.

All flights on February 17 and 18 were in visual meteorological conditions (VMC), characterized as "severe clear" by the captain of those flights. He described her first landings of the 2-day trip as "rough," manifested by landing on her side of the runway, flaring too soon, or not flaring at all. However, the landings improved as the day progressed. That captain described her flying abilities as "average" and indicative of one who has been a first officer for 4 or 5 months.

On February 19, the first officer telephoned a friend at 0820 and again at 1410. The friend, and all others who saw or talked to the first officer on February 19, described her as being well rested and in a good mood. The first officer reported for duty well in advance of the scheduled 2040 departure of flight 3378, possibly as early as 1900.

1.6 Airplane Information

1.6.1 General

The airplane, serial No. AC 622, a Fairchild Metro III, was manufactured in September 1985 by the Fairchild Aircraft Corporation. It was operated by AVAir Inc. from the date its airworthiness certificate was issued, November 20, 1985. (See appendix D.)

The Metro III, SA227, is derived from the Metro and Metro II airplanes. The earlier Metro and Metro II airplanes are basically identical, except for some minor differences in appearance such as window shape. The Metro II and the Metro III have an approximate 59-foot fuselage. The wing spans are different; the wing span of the Metro II is slightly over 46 feet while the wing span of the Metro III is 57 feet. The Metro III also is equipped with higher rated Garrett engines and four-bladed propellers compared to three-bladed propellers on its predecessor airplanes. As of July 1988, 15 Metros, 156 Metro II, 10 Metro IIA, and 205 Metro III airplanes were in service worldwide.

The takeoff weight of AVAir 3378 was 12,908 pounds; its center of gravity (CG) was 24.07 percent mean aerodynamic chord (MAC). The maximum takeoff weight for the Metro III is 14,500 pounds, and its CC can range from 11 .15 to 36.00 percent MAC. Therefore, both the weight and CC of AVAir 3378 were within acceptable limits throughout the flight.

Passengers were assigned to seats on the flight. However, since no flight attendant was on board the airplane to assist in passenger seating, the actual passenger seating could not be determined.

The airplane's maintenance records were reviewed for the entire period that it was in service and no discrepancies were found. AVAir performed maintenance at preestablished intervals according to an FAA-approved program. The last service check, a Phase 3 check of the cabin, stall avoidance system (SAS) capstan and SAS servo, as well as other airplane systems and components, was completed on February 15, 1988. There were no write ups on the SAS after this date. All applicable Federal Aviation Administration (FAA) airworthiness directives (AD) had been complied with.

1.6.2 Stall Avoidance System

Metro airplanes are equipped with a SAS to warn the pilot of and take action in response to an approaching stall. According to the FAA's Aircraft Certification Service, the SAS was installed on all Metro airplanes because the certification tests of the original Metro demonstrated that the airplane was unable to comply with certain requirements during aft CG, power on, stall demonstrations, i.e., the airplane exceeded 15" of roll during recovery. As a result, the

A SAS malfunction can manifest itself in a variety of ways depending on the component that develops the fault. Perhaps the fault that could most affect the safety of flight is an inadvertent stick pusher actuation since that could affect airplane control. During the investigation, several instances of inadvertent, uncommanded actuations were reported to the Safety Board. For example, on September 14, 1986, a Metro III encountered an uncommanded actuation while on approach to Greater Cincinnati International Airport. According to the crew of that flight, they attempted to disengage the clutch but were unable to. They experienced "extreme" forward pressure on the control column, requiring both pilots to strongly pull on the column to override the nose-down forces. Subsequent investigation revealed that water had accumulated under the cockpit floor, near the SAS servo, which then entered the SAS servo electrical connector. AVAir's former manager of training and its director of operations independently testified that, while on final approach in a Metro II, each had experienced uncommanded stick pusher actuations. In both cases, the crew disengaged the clutch and completed the landing without incident. According to Fairchild, the maximum force to the control column that the stick pusher can develop ranges from 119 to 146 pounds. Forces of this magnitude result from three distinct failures involving the magnetic particle clutch, the mechanical slip clutch, and the servo motor.

Following a fatal accident in a Metro II (in which the SAS was not found to be causal to the accident), 1 incident in that model, and 14 reported instances of uncommanded nose-down SAS actuations, the Safety Board on July 11, 1984, urged the FAA to:

> <u>A-84-66</u>
>
> Review the design, the installation, and the maintenance requirements for the stall avoidance system on Fairchild Swearingen (as they were known at the time) Models SA 226 and SA 227 airplanes to verify system reliability and maintainability, and take action as needed to preclude unwarranted actuation of the system that could present hazards to airplanes.

On November 22, 1985, the FAA issued AD 85-22-06, which required the performing of additional inspections of and calibrations to the SAS computer at intervals of 600 hours in the Rosemount computer-equipped Metros and at 2,000 hours in the Conrac computer-equipped ones. Metro II airplanes were equipped with a SAS Rosemount computer, while Metro IIIs were equipped with a Conrac computer. According to Fairchild, the Conrac computer, which was more reliable and required less calibration than the Rosemount model, was installed on all Metro III airplanes and retrofitted on most Metro II airplanes. The AD also required the installation of a shield to the wire, extending from the computer to the negative side of the servo clutch, in the Conrac computer-equipped SAS. As a result of the FAA's action, the Safety Board classified Safety Recommendation A-84-66, as "Closed--Acceptable Action." N622AV was manufactured in accordance with the changes required in the AD.

The Safety Board examined the FAA's service difficulty reports (SDRs) that had been filed on the SAS in both the Metro II and Metro III airplanes, from their initial certification through March 4, 1988. The SDRs were then categorized by the type of airplane, Metro II or Metro III, according to the faults. No determination could be made as to whether the airplanes referred to in the reports had been modified in accordance with the AD pertaining to the SAS computers. In addition, the categorization was hampered by the lack of commonality among the descriptions reported in the SDRs. That is, similar faults and results of faults may have been described differently, and similar descriptions may have been applied to different occurrences. As a result, the categorizations incorporate, necessarily, some degree of subjectivity.

SAS Fault	SA 226 Metro II Total	SA 227 Metro Total
Stick pusher on takeoff	5	0
Stick pusher on climbout	3	1*
Stick pusher on descent/appch	4	10
Stick pusher intermittent inflight	7	4
Stick pusher intermittent during in-flight test	1	1
SAS i nop on ground	16	10
SAS arm light on above 140 KIAS	2	3
SAS disarms below 140 KIAS	1	0
SAS fault illuminated inflight	5	6
SAS horn in flight	9	0
SAS horn on approach	4	0
SAS vane bent/broken/out of calibration	8	1
SAS out of calibration	3	6
SAS vane heat inoperative	4	0
SAS indicator erratic inflight	11	7
SAS won't test inflight	1	0
SAS cb's popped inflight	6	2
Excessive stick pusher force on ground	2	3
Insufficient stick pusher	2	3
force--on ground	7	1
SAS system indicator inaccurate	0	1
SAS servo operates in reverse	1	0
SAS flap position connect. failed	1	0

*The narrative of the SDR stated, "on misapproach a stuck (sic) pusher activation of SAS caused A/C to loose (sic) approx 400 ft alt. Sys deactivated R/R (repair and replaced) SAS servo unit grd (ground) ck (check) ok." The Safety Board was unable to obtain additional information on the incident other than that included in the SDR.

1.6.3 Pitch Trim

The Metro airplanes are equipped with an electric pitch trim control system, independently controlled by switches located on the control column of each pilot. A trim selector switch located on the center pedestal determines whether the captain or first officer will actuate the trim. When trim is actuated, i.e., when electric power is applied to the pitch trim, an aural trim-in-motion tone will sound. An alert will also sound if the pitch trim is not within acceptable parameters before takeoff. To change the trim from end to end, either full nose up to full nose down or the reverse, requires just over 24 seconds.

The Safety Board examined the SDRs that had been filed on the pitch trim of the Metro II and Metro III airplanes from their initial certification through July 8, 1988. Fifty SDRs relating to the pitch trim had been filed on the Metro II and 49 on the Metro III. The type of report filed for each airplane was very similar, and all but a few of the reports concerned relatively insignificant difficulties, such as inoperative trim and "creeping" or "coasting" trim after the trim setting had been selected. Of the reports that directly affected flight safety, i.e., a runaway trim, five such reports--three runaway nose up, one nose down, and one unspecified--were filed for the Metro II.

Four reports were filed on the Metro III--one runaway nose up, one occasional runaway nose up, and two unspecified.

1.7 Meteorological Information

The 1900 surface weather map prepared by the NWS indicated that a large, low-pressure area was centered over the northern Great Lakes, with a trough extending southeast through western North Carolina. Secondary lows were over extreme southeastern Michigan and over the Virginia-North Carolina border, in the vicinity of Raleigh. In addition, a warm front that was moving northwesterly extended northeast from the low over the Virginia-North Carolina border, through the Delmarva Peninsula, into the Atlantic Ocean. A trough also extended east-northeast from a weak low over east-central Georgia, along the southern North Carolina coast.

The NWS's RDU Forecast Office recorded the following airport surface observations around the time of the accident:

> 2050-Surface Aviation.--Ceiling--indefinite 100 feet obscured; surface visibility--1/4 mile; tower visibility--O miles; weather--light drizzle and fog; temperature--4P F; dewpoint--47° F; wind--240" at 5 knots; altimeter--29.68 inHg.; remarks--runway 5R visual range 3,500 variable 4,500 feet, surface visibility 1/4 mile.
>
> 2136-Local.--ceiling--indefinite 100 feet obscured; surface visibility--l/8 mile; tower visibility--O miles; weather--light drizzle and fog; temperature--47° F.; dew point--47° F.; wind--220" at 5 knots; altimeter--29.68 inHg.; remarks--runway 5R visual range 2,400 feet variable 3,000 feet, surface visibility 1/8 mile; aircraft mishap.

The following runway visual range (RVR) values were recorded at RDU's runway 23R at the intervals noted:

Time	RVR Range (feet)
2115--2117	4,500
2118	6,000 +
2120--2122	3,000--3,500
2123--2125	2,400--2,800
2126--2128	2,200--2,400
2129--2135	2,200--3,000
2136--2138	2,000--2,200
2140--2145	1,600--1,800
2146--2149	2,400--3,000
2152	5,500
2155--2200	6,000 +

Light drizzle was in the area between 1635 and 2146. From 2100 to 2200, the RDU gust recorder showed a steady wind velocity of 5 knots, except for a drop to 3 knots at 2105. During the same l-hour period, the ceilometer indicated a constant 100-foot ceiling.

At 2140, the RDU Forecast Office reported observing no echoes on the local weather radar. The NWS network radar located at Volens, Virginia, also reported no echoes in the vicinity of RDU during observations carried out at 2035, 2135, and 2235.

The weather at RIC, the intended destination of AVAir 3378, around the time of the accident was reported as:

> 1950-Record Special.--ceiling--indefinite 200 feet obscured; visibility--l mile, weather--light drizzle and fog; temperature-- 47" F.; dewpoint--47° F.; wind--320" at 5 knots; altimeter--29.63 inHg.; remarks--runway 34 visual range 6,000 feet.
>
> 2050--Record Special.--ceiling--indefinite 100 feet obscured; visibility--l mile; weather--light drizzle, fog; temperature--46° F.; dew point--46° F.; wind--300" at 6 knots; altimeter--29.61 inHg.; remarks--runway 34 visual range 6,000 feet.

1.8 Aids to Navigation

There were no known difficulties with ground-based navaids at RDU at the time of the accident.

1.9 Communications

There were no known communications difficulties at the time of the accident.

1.10 Aerodrome Information

Raleigh-Durham International Airport is located 9 miles northwest of Raleigh, North Carolina. The airport elevation is 437 feet msl. It consists of three hard-surfaced runways, 5L/23R, 5R/23L, and 14/32. Runway 5L/23R is 10,000 by 150 feet, runway 5R/23L is 7,500 by 150 feet, and runway 14/32 is 4,498 by 100 feet. Both parallel runways are equipped with high-intensity runway lights; runway 5R/23L also has centerline lights. At the time of the accident, both the high-intensity runway lights and the approach lighting system lights were set to the Step 4 level, the next to brightest on the 5-step category of approach lighting system intensity. The airport maintained sufficient emergency equipment to be considered a 14 CFR Part 139 index D[7] facility.

1.11 Flight Recorders

The airplane was not equipped, nor was it required to be equipped, with either a cockpit voice recorder or a flight data recorder.

1.12 Wreckage and Impact Information

The airplane was extensively damaged and fragmented from its initial impact with the water and its more than 100-foot path through a wooded area beyond the shore of the reservoir. The wreckage path extended about 425 feet from the shoreline on a magnetic heading of about 300". (See figure 3.)

Most of the airplane's structure was found beyond the reservoir's shoreline. However, some structure was unaccounted for and was believed to have been located in the reservoir. At the request of the Safety Board, local authorities drained a portion of the reservoir to locate and to retrieve airplane wreckage. Draining of the reservoir was completed in early March 1988. Safety

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[7] The applicable index in 14 CFR 139.49 is determined by the longest aircraft operated by an air carrier user with an average of five or more departures per day, served or expected to be served by the airport. Index D applies to aircraft between 159 and 199 feet long.

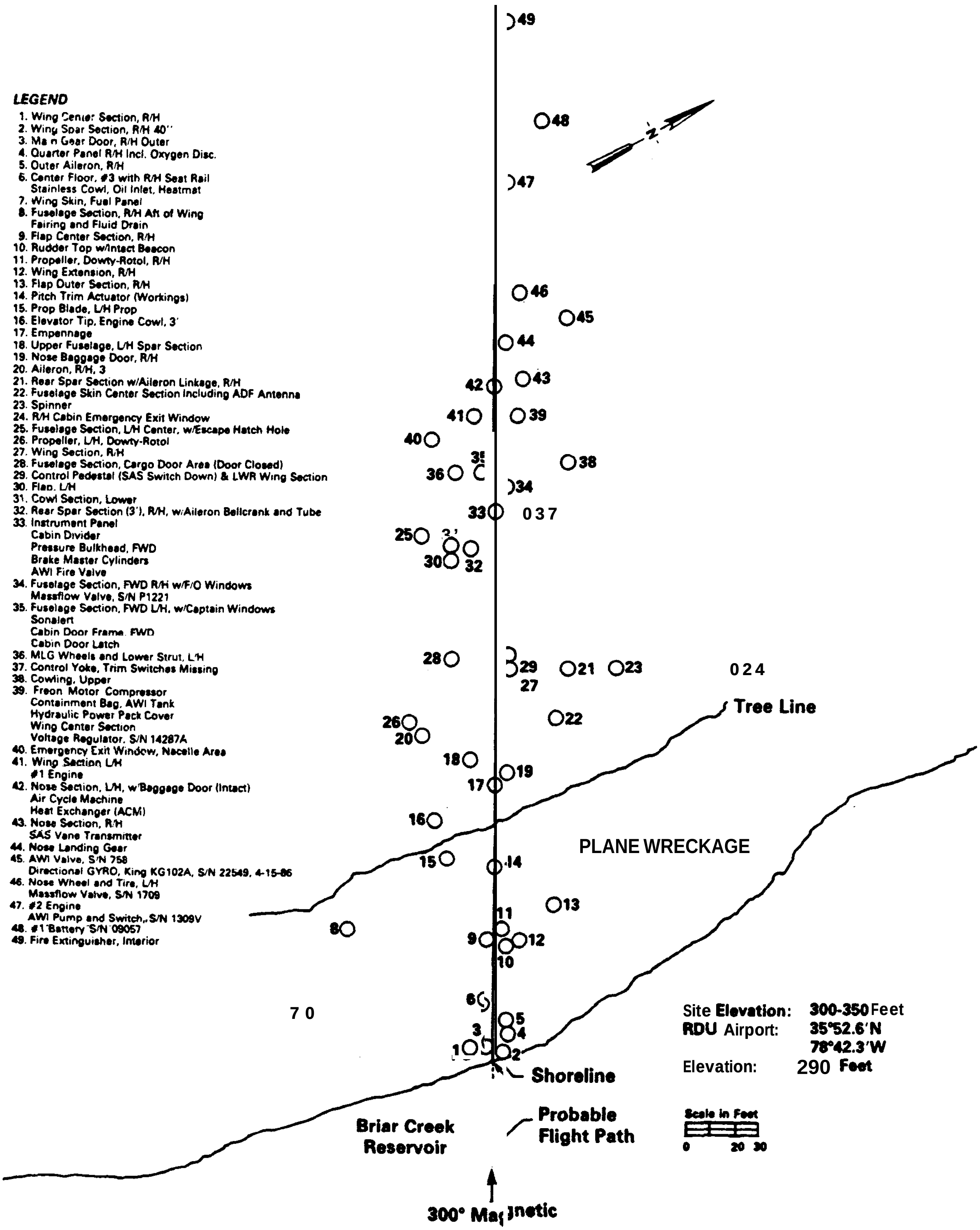


Figure 3.--Wreckage diagram

Board investigators examined and inventoried the additional wreckage which consisted mostly of small pieces, including a section of cabin seat track, a fuel boost pump, sections of hydraulic lines and pneumatic ducting, an inboard section of right wing flap, pieces of a propeller spinner, and personal effects.

The fuselage from the nose to the empennage was extensively fragmented. The tail cone, which had separated with the aft pressure bulkhead, was found intact and with minimal damage. The vertical stabilizer and horizontal stabilizers were attached to the empennage.

The left wing was extensively damaged along its entire span. Spanwise compression for most of the length of the leading edge extended 5 feet from the root to 6 feet from the tip, where there was downward bending about 10" with extensive leading edge compression. Compression buckling was found along the lower surface of the flap, and tension on the upper surface, both spanwise. The damage to the flaps indicates that the flaps were at the 1/4, or 9" position. Evidence of postcrash fire was observed on the No. 1 engine and nacelle and the areas alongside the nacelle. The No. 1 engine had separated from the firewall about 6 feet forward of the wing facing aft.

Considerable evidence of postimpact fire was found in the No. 1 engine, including soot and fire blackening, primarily to the forward portions of the engine. Impact damage to the engine was also noted, including extensive bending opposite the direction of rotation of many of the compressor section's first-stage impeller blades and ingestion and subsequent charring of a large amount of wood debris. Second- and third-stage impeller blades were rotationally rubbed. Wood debris was found in all three turbine stages. Charred wood was found in the combustion chamber. Internal damage to the engine was typical of postimpact damage; no preimpact damage was noted.

The propeller of the No. 1 engine had separated from the engine and was located just to the left of the major portion of the wreckage. All blades, except the No. 4 blade, remained attached to the hub. A 2-foot section of the No. 4 blade, including the tip, was located about 50 feet closer to the shoreline than the remainder of the assembly. The blades were bent aft to varying degrees in an approximate circular pattern. No evidence of preexisting damage to the propeller components was found following disassembly of the propeller.

The No. 2 engine was found about 200 feet beyond the major portion of the right wing section. Evidence of postcrash fire was found in the area of the engine and nacelle. A 40-inch section of the aft wing spar which had separated from the right wing was found on the shoreline. The wing upper surface was severely damaged in the spanwise direction. The inboard section of the aileron was attached; however, both the outboard section of the aileron and the flaps had separated.

A 3-foot-long, semicircular ground crater, with a maximum depth of 4 inches, was found about 30 feet aft of the location of the No. 2 engine. The forward edge of the crater exhibited a "flange" type of appearance. The engine did not show evidence of fire damage; however, some minor impact damage was noted. Wood and wire debris were found in the first-stage compressor. Components of the first- and second-compressor stages showed evidence of bending and nicking as well as foreign object damage. Rotational rubbing also was evident in the first- and second-stage compressor impellers. The firewall shutoff valves of both engines were in the open position.

The propeller of the No. 2 engine was found near the edge of the reservoir. All four blades were attached to the hub. Three of the four blades showed heavy and uniform bending in an aft direction. The fourth blade was slightly bent. Dissassembly of the components showed no evidence of preexisting damage.

The left main landing gear upper strut casting and drag braces had separated as a unit and were found aft of the nacelle wheel well area. The right main landing gear was found with the engine and nacelle. The inboard gear actuator was found in the retracted position, separated at the rod end fitting. The outboard gear actuator was found intact and in the extended position, The structure surrounding the nose landing gear was separated. The exterior skin was severely compressed and the internal formers were deformed. The gear handle in the cockpit was found in the UP position- The damage to the landing gear and the surrounding structure indicates that the gear was retracted at impact.

The left stabilizer and elevator were intact to points just short of the tip and the tip areas, respectively. Spanwise compression was found on the stabilizer leading edge for most of its length. The right stabilizer was sheared but attached by the leading edge deicer boot, about 1/3 the distance from its root. Extensive leading edge compression was found on the stabilizer. The elevator was bent downward about 90° at two locations.

The left and right aileron cables leading to the cockpit were attached to the bellcrank but separated at the center cabin break. As a result, aileron continuity could not be established. The elevator cables were found attached to the elevator bellcrank with about 20 feet of each cable trailing aft, along the wreckage path. The ends of the cables exhibited typical tensile overload type of fractures.

The pitch trim selector was broken and no determination could be made about whether it had been selected by the captain or by the first officer. Both pitch trim actuator rods were found extended 5 3/4 inches and bent. To determine the relationship of an actuator extension of this magnitude to horizontal stabilizer position, the pitch trim actuator rods of another Metro III were extended by this amount. This resulted in a nose-down trim between the bottom of the green, normal operating band on the pitch trim indicator and the lower limit of the gauge. (See Section 1.17.7, Airplane Performance Information.)

The SAS disengage switch was found in the DOWN or disengage position. The switch was then disassembled for closer examination. There was no evidence of movement of the switch after impact.

Several light bulbs, which were found with intact filaments, were removed from the annunciator panel and examined at the Safety Board's materials laboratory. One intact filament from one of the two bulbs of the SAS FAULT indication was found. The filament showed evidence of severe stretching. The filaments of both bulbs of the SAS ARM indicator were intact; neither showed evidence of stretching.

1.13 Medical and Pathological Information

The Office of the Chief Medical Examiner of North Carolina performed autopsies on the bodies of the 10 passengers and 2 crewmembers on board AVAir 3378. The cause of death for all was determined to have been massive and traumatic injuries sustained during the impact. Tissue and body fluid samples from the crewmembers were retained for further toxicologic examination by both the Medical Examiner and the Center for Human Toxicology at the University of Utah in Salt Lake City. All were found to be negative for alcohol as well as both licit and illicit drugs.

1.14 Fire

Small postcrash fires erupted around each engine and its nacelle. The fires were quickly extinguished by crash/fire/rescue (CFR) personnel who arrived at the site at 2139. The CFR personnel were directed to the site by an airport guard who observed the postcrash fire and reported its location to the rescue authorities.

1.15 Survival Aspects

The accident was not survivable due to the extensive destruction and fragmentation of the airplane.

1.16 Tests and Research

Not applicable.

1.17 Other Information

1.17.1 AVAir Operations

AVAir Inc. began scheduled service as Air Virginia in March 1979. It operated two daily flights using Piper Navajo airplanes from its Lynchburg, Virginia, headquarters to both Washington Dulles International Airport and Baltimore-Washington International Airport. In June 1979, the company obtained six additional Piper Navajos and added flights to Charlottesville, Roanoke, Richmond, and Danville, Virginia, as well as to Charlotte and Greensboro, North Carolina.

In September 1979, Air Virginia obtained the first of five Fairchild Metro II airplanes. In early 1980, it added flights to Newark, New Jersey, and to Philadelphia, Pennsylvania, and it began to phase out its Piper equipment, completing the phaseout by August 1980. By August 1983, Air Virginia had added flights to Charleston, West Virginia; Columbus, Ohio; and Washington National Airport, Washington, DC. It also obtained additional Metro airplanes and began to operate two HS 748 airplanes.

In 1984, the company experienced financial difficulties and phased out the HS 748s. In late 1984, an investor purchased the company and renamed it AVAir. On May 15, 1985, the company began a marketing affiliation with American Airlines, becoming an American Eagle carrier. In mid-1987, American Airlines opened a "hub" facility at RDU and designated AVAir as its primary feeder at the hub. At this time, AVAir was operating 7 Metro II, 15 Metro III, and 6 Short Brothers SD3-30 airplanes.

The agreement between American Airlines and AVAir gave AVAir nonexclusive use of several trademarks owned by American, including access to its computer reservations system and code sharing privileges, i.e., AVAir flights were listed in airline computer reservations systems as American Airlines flights. Responsibility for all aspects of AVAir's operations belonged to AVAir. However, American required AVAir to maintain certain standards of passenger service and retained the right to inspect AVAir's operations. In 1987, American performed two inspections of AVAir's operations and three inspections of its maintenance facilities. The operations inspections examined management's ability to maintain the standard of dispatch reliability required to be the primary feeder to American's RDU hub. Likewise, the maintenance inspections examined the quality and availability of facilities and personnel to perform the maintenance necessary to sustain AVAir's role at RDU.

During 1987, AVAir experienced both pilot and management turnover. There were three chief pilots, two Directors of Operations, and two managers of training in that year. During this period, the company assigned to the FAA-required position of chief pilot someone who had insufficient total flying time to meet FAA requirements. As a result, the person was not approved by the FAA. The company then assigned its vice president of operations, who was FAA-qualified, to serve in the chief pilot position to deal with the FAA while its initial chief pilot candidate continued to perform the company-related duties of the position. Thus, AVAir, during this period, designated one individual the "FAA chief pilot" and another, the "corporate chief pilot." According to the vice president of operations, although no "corporate chief pilot" was listed in its management structure, administratively the dual chief pilots worked effectively, once one separated the "FAA duties" from the "administrative duties."

In January 1985, AVAir employed 94 pilots. One year later it employed 112 pilots. In January 1987, AVAir employed 86 pilots. On January 16, 1988, AVAir had 184 pilots on its seniority list. About 60 percent of the pilots had been with the company less than 1 year. During the second quarter of 1987, the company hired 123 pilots, including the first officer of AVAir 3378. At this time, it initiated an intensive training effort to qualify them in AVAir airplanes. Throughout 1987, attrition was estimated at 4 to 5 pilots per month.

In late 1987, following its rapid expansion, the company again experienced financial difficulties. It furloughed pilots in the autumn and phased out its Short Brothers airplanes by the end of the year. On January 15, 1988, the company filed for Chapter 11 bankruptcy protection from its creditors and ceased operations. It resumed operations on February 3, 1988, with 15 Metro III airplanes. Eighty-five pilots were recalled at that time.

Several months after the accident, AVAir's assets were purchased by a subsidiary of AMR Corporation, the holding company which also owns American Airlines. AMR merged AVAir's operations into those of another subsidiary, Nashville Eagle, which it owned and operated from its hub in Nashville, Tennessee.

On December 17, 1987, an AVAir Metro II, on approach to Washington Dulles International Airport, experienced a dual-engine failure and made a forced landing short of the airport. The airplane was substantially damaged and one passenger was seriously injured. The company determined that the flightcrew failed to carry out proper in-flight engine anti-icing procedures during flight in icing conditions. The captain of that flight was subsequently terminated. The Safety Board determined that the following factors contributed to the cause of the accident: inadequate company oversight of its check airman, inadequate initial training of the captain, and the pilot-in-command's improper in-flight planning and decisionmaking.

AVAir procedures required pilots on climbout to retract the landing gear after establishing a positive rate of climb, retract the flaps above 115 knots, and turn on the bleed air switches "as desired." The company taught pilots to retract the flaps above 400 feet above ground level. The procedures did not specify whether the pilot flying the airplane or the pilot not flying should perform these actions.

1.17.2 FAA Surveillance

AVAir's FAA operating certificate to operate under 14 CFR Part 135 was issued and held by its RIC Flight Standards District Office (FSDO) during the period that its operations were based in Lynchburg. In July 1986, the principal operations inspector (POI) became ill and remained away from his duties for several weeks. He returned to work but, about a month later, he became ill again and subsequently retired from the FAA. His duties were assigned on an acting basis until February 1987 to an inspector in the RIC office. The POI duties were then assigned permanently to another inspector. In April 1987, AVAir informed the FAA's RIC FSDO that it intended to move its operations to RDU. On August 11, 1987, the carrier's operating certificate was transferred to the RDU office of the FAA's Winston-Salem, North Carolina, FSDO.

In the approximately 12-month period before the accident, FAA inspectors performed the following inspections of AVAir:

Inspection	Date
Main base inspection	12-12-87
Station inspection	12-12-87
Ramp inspections	10-22-87
	11-21-87
	01-12-88
Enroute cockpit check	10-15-87
Enroute cabin check	11-21-87
Training program observation	10-08-87
Crew/dispatcher records check	12-12-87
Trip records check	10-22-87

The POI from the RIC FSDO, who was permanently assigned to surveil AVAir, stated that, in the 4- to 5-month period in which he had served as POI, he was extensively involved in the company's preparation for the acquisition of the SD3-30. To this end, he attended the ground school portion of AVAir's SD3-30 instruction; observed proving runs and, later, check rides; reviewed the operations specifications and flight manual for the airplane; and oversaw the company changes required to operate the airplane under 14 CFR Part 121. In addition, he performed at least two en route inspections on AVAir's Metro airplanes. He was not type rated in either the Fairchild or the Short Brothers airplane. He often met with company personnel, at the company's training facility at Lynchburg as well as at other company locations. He stated that he neither received from nor initiated communication with the inspector from the FAA's Winston-Salem branch office at RDU who was assigned to surveil AVAir.

There is no evidence that the POI in RDU performed an en route inspection of AVAir, observed flight instruction, observed a check ride, or met with company personnel other than AVAir's Director of Operations. According to several AVAir pilots and check airmen, the first time the POI met with the chief pilot or the manager of training was during the investigation of this accident.

Safety Board personnel interviewed the POI several days after the accident. At that time, he had applied for a transfer to the FAA's office in Frankfurt, Federal Republic of Germany, and the transfer had been approved pending completion of the screening for a required security clearance. The POI told Safety Board personnel that he had known for several weeks that his application had been approved and that he was awaiting receipt of a security clearance. About 2 weeks after the accident, the POI resigned from the FAA and was employed briefly in a corporate setting. Several weeks thereafter, he resigned from the corporation, apparently as a result of his unhappiness with the type of flying he was performing. He was able to rejoin the FAA and was assigned to the FAA position in Frankfurt that he had applied for before the accident.

According to that POI, in the months before the accident, he had observed two 4-hour ground school sessions. He stated that both before and after AVAir's certificate was transferred to RDU, he had spent some time reading and reviewing company manuals, operating specifications, and other material. He explained that he did not perform en route inspections because he was not rated in the Metro airplane although it was not uncommon for POIs to not have type ratings in the airplanes of the operators they were surveilling. He said that while this put him at somewhat of a disadvantage in surveilling AVAir, an inspector at the FAA's RDU office and inspectors at other FAA offices who were type rated, performed the necessary inspections and maintained close communication with him.

The POI at the RIC office stated that the lack of a type rating in an aircraft that a POI was surveilling was not much of a problem to him since an inspector could still observe procedures and piloting technique without having extensive knowledge of the airplane. Moreover, he stated that, regardless of the presence of a type rating, such inspections are part of his job and added, "I would expect this to be the case throughout [the FAA]."

The FAA's manager of the commuter and air taxi branch, in the Office of Flight Standards, likewise stated that, regardless of whether a POI was type rated in an operator's airplane, observing flight training would be "almost. . . mandatory." Moreover, observation of instructional flights and en route inspections by nontype rated POIs "happens all the time."

The FAA provides POIs of 14 CFR Part 121 operators with indicators of financial distress to alert inspectors to the possible need for increased surveillance. These indicators include significant layoff of personnel due to loss of business, high rate of employee turnover, and sale or repossession of aircraft and other equipment. Filing "Chapter 11," or declaration of bankruptcy, as AVAir did, is a legal action which protects a corporation from its creditors while it attempts to reorganize. It is not listed by the FAA as an indicator of financial distress. While a company reorganizes under Chapter 11, it may continue its operations. Airlines which file for Chapter 11 do not lose their Department of Transportation (DOT) operating certificates, provided they do not discontinue their operations for an excessive time period. Likewise, new FAA operating certificates are not needed. No financial indicators are given to POIs of 14 CFR Part 135 certificated operators. Rather, they are advised how to process a request for a financial evaluation of the operator when they believe that an evaluation may be required.

1.17.3 AVAir Pilot Training

AVAir's pilot training manual, issued in April 1986, was approved by the FAA's General Aviation District Office (GADO) No. 16 in its Eastern Region, on June 5, 1986. The manual has been revised seven times, most recently on November 6, 1987.

AVAir required all new pilots, irrespective of previous experience, to complete an initial ground training course. The course consisted of two components: a 31 1/2-hour indoctrination training program covering company rules and procedures and 14 CFR Part 135 operations and a 50 1/2-hour airplane systems and performance program.

Pilots upgrading to captain participated in a 52 l/2-hour ground school which, in addition to the sections on airplane systems and performance which were covered in initial training, also included instruction in hazardous materials and security. Both captains and first officers were required to participate in annual recurrent training, which consisted of 39 hours of review of company and Part 135 operations and other material.

All flight training was carried out in the airplane. The amount of time required to complete flight training depended on the individual as AVAir trained its pilots to a level of proficiency, with a minimum of 4 hours of flight training required for both captains and first officers. AVAir taught three sessions of flight training in the SA 227 airplane, which lasted about 6 1/2 hours and two additional sessions to cover differences between the SA 227 and SA 226, which lasted about 3 hours. The three sessions in the SA 227 introduced the student to: (1) the airplane's handling characteristics; (2) traffic pattern work, including simulated engine failures during takeoffs and landings; and (3) training to proficiency under simulated instrument conditions with simulated engine failures included. The company used pilot "foggles," i.e., lenses which restrict most external visual cues, except those in the area in which airplane instruments are typically located, to simulate instrument conditions. The two sessions of differences training introduced the student to: (1) the cockpit layout of the SA 226 and its flight handling characteristics and (2) engine and system checks and performance computations.

The SAS was addressed in both ground and flight training. In ground training it was introduced to pilots in the initial training during the airplane systems review. The operation of the system was explained and normal and abnormal procedures were discussed. Abnormal procedures primarily addressed two conditions: an inadvertent stick pusher actuation and a SAS fault indication, as manifested by the illumination of the SAS fault on the annunciator panel. Regardless of the fault, pilots were taught to disengage the SAS clutch and pull the appropriate SAS circuit breaker. The circuit breakers were located to the left of the captain at the approximate position left of the armrest. During initial flight training, stick pusher actuation was simulated by the instructor pushing forward on the control column at a point in the flight when a safe altitude was reached and when the student pilot was not expecting it.

AVAir's chief pilot at the time of the accident estimated that about 5 percent of initial trainees failed to qualify as first officers. In addition, about 5 percent of probationary employees failed to complete the l-year probationary period.

1.17.4 AVAir Operations Specifications

The FAA-approved operations specifications allowed AVAir to perform lower-than-standard instrument takeoffs provided the pilot-in-command was qualified in accordance with 14 CFR 135.297 and 135.343, which deal with instrument proficiency and required initial and recurrent training, respectively. In addition, AVAir operations specifications considered the Metro to be a large airplane, which allowed pilots to complete takeoffs with a runway visual range (RVR) as low as 600 feet.

Before the accident, AVAir recognized that its operations specifications incorrectly classified the Metro as a large airplane, when it should have been categorized as a small airplane, with its more restrictive visibility standards for takeoffs, i.e., pilots-in-command with at least 100 hours in command of the type airplane being flown, were allowed to perform the takeoff. AVAir's director of operations at the time of the accident said that he informed the FAA's POI in the autumn of 1987 of the incorrect classification. In April 1988, the operations specifications were revised to reflect the correct classification. He also stated that AVAir's operations specifications allowed either the pilot-in-command or the second-in-command to perform a lower-than-standard takeoff, provided each had received training in lower-than-standard instrument takeoffs.

According to the manager of the FAA's commuter and air taxi branch, Office of Flight Standards, operators under Part 121 of the Federal Aviation Regulations (FARs) were permitted to have seconds-in-command perform lower than standard (visual condition) takeoffs. However, regarding operators under Part 135 of the FARs, ". . . the pilot-in-command is the only one who can handle the control (and perform the takeoff)."

Several months after the accident, the FAA began to implement operations specifications that were developed and stored in a central computer. The FAA announced its intention to require all scheduled passenger carriers and air taxi operators to use the computerized operations specifications, although no deadline for the use of the new specifications had been selected at the time of the announcement. Because they are to be centrally stored, the FM should be able to access more quickly and review more easily a carrier's operations specifications. In addition, the FAA intends for the system to simplify its ability to both review and standardize operations specifications across operators while still maintaining the flexibility to tailor them to the needs of an individual operator.

1.17.5 Human Performance Information

To determine the physical and behavioral condition of each crewmember around the time of the accident, the Safety Board examined crew records and interviewed relatives, close friends, and associates of the flightcrew of AVAir 3378.

1.17.5.1 The Captain

The Safety Board's examination of the captain's medical history indicated that the captain had various minor ailments in the years before the accident. He was treated by his personal physician nine times for various sinus-related problems between February 1980 and June 1986. Among the symptoms which he manifested during this period were those generally considered typical of an allergy or head cold, e.g., congestion, runny nose, sore throat, excessive sinus drainage. On several occasions the symptoms associated with his sinus problem were preceded by a cold. The captain's brother described the sinus problems as common to the family and likely to worsen during the winter months. In 1976, the captain was diagnosed as having "respiratory congestion and inflammation with secondary intestinal virus." A record of prescription pharmaceuticals from the captain's health insurance records with AVAir indicated that no pharmaceuticals were dispensed to him in the 5-month period before the accident.

The captain's most recent visit to his physician, who was also his aviation medical examiner (AME), was on January 29, 1988, in preparation for his application for employment with a major, turbo jet operator. The captain was concerned that his cholesterol level may have been too high to be considered for employment by a major carrier. The physician, who described the captain as "doing fine," checked the captain's cholesterol level and suggested a low-cholesterol diet.

According to friends, relatives, and acquaintances, the captain was in a good frame of mind and in good spirits around the time of the accident. Although his financial condition was described as "tight" by a relative, the captain had not reacted adversely to the absence of a salary during the 3 weeks that AVAir ceased operations.

1.17.5.2 The First Officer

At the time of the accident, the first officer was described by friends as being in good spirits. Her financial condition was considered to have been relatively unaffected by AVAir's cessation of operations.

1.17.6 AVAir's Sick Leave Policy

Before the bankruptcy, the sick leave provision of AVAir's contract with its pilots union compensated them at the rate of 2.1 hours of sick leave per month. After the resumption of operations, several pilots believed that the company was "tightening up" its allowance of sick leave. Several AVAir pilots told Safety Board investigators that their perceptions of the company's willingness to compensate pilots for sick leave at the contractual rate changed after the bankruptcy. According to the chief pilot at the time, he tried to reassure pilots that they would be paid for their sick leave and, as a result, within 2 weeks after AVAir resumed its operations, most pilots believed that they would be so paid. According to company records, both the captain and first officer had sick leave available at the time of the accident.

An AVAir captain stated that several hours before the accident the captain of flight 3378 told him that he was reluctant to call in sick because, "They'll put me on reserve tomorrow, (and) I'd rather fly tonight." According to its chief pilot, AVAir placed pilots on reserve status upon their return to duty after being on sick leave. This procedure, however, was not a written policy.

Reserve pilots were required to report to their duty station within 1 hour of being called to report to duty. Since the captain resided in Roanoke, this would have necessitated his remaining in the RDU area while he was on reserve status.

1.17.6 Airplane Performance Information

The Safety Board reviewed the recorded radar data from the FAA's RDU air traffic control (ATC) facility to examine the flight profile of AVAir 3378. In addition, the Safety Board obtained data from the airplane that departed runway 23R in advance of AVAir 3378 to determine whether the wake turbulence from that flight affected the performance of AVAir 3378.

There were four "hits" or contacts made between RDU radar and AVAir 3378 from the point at which the airplane lifted off around 2126:23 to the last contact at 2126:55. These data points, with performance data on the airplane's airspeed and altitude as well as the location of the impact, provided the information necessary to construct a profile of the flight. Due to the lack of data between each of the radar data points, several assumptions were made regarding the flight performance characteristics of AVAir 3378. With the known parameters about the flight from the radar, including Mode C altitude information, with certain physical constraints on flight performance, the range of data describing the profile was limited. (See figure 4.)

The data from the digital flight data recorder (DFDR) of American Airlines flight 1094, a McDonnell-Douglas MD-82, which preceded AVAir 3378 from RDU's runway 23R, were examined with the RDU radar data on that airplane to determine the potential effects of the wing tip vortices of the American Airlines airplane on the performance of AVAir 3378. This information, with parameters from the 2136 RDU surface weather observation, was applied to the radar data on AVAir 3378 to obtain plots of the estimates of the vortex paths and their relationships to that flight. (See appendix F.) The results indicate that under the "worst" circumstances, or the circumstances allowing the closest proximity of AVAir 3378 to wake turbulence, AVAir 3378 was above, or north, or both, of the vortices generated by American 1094.

The Safety Board applied data from the Metro III Type Inspection Report concerning the pitch trim at various airspeeds, power settings, CG conditions, and flap positions to the obtained pitch setting on AVAir 3378. Given a mid-range CG, the pitch trim position found on AVAir 3378 corresponded to an approximate 157-knot airspeed.

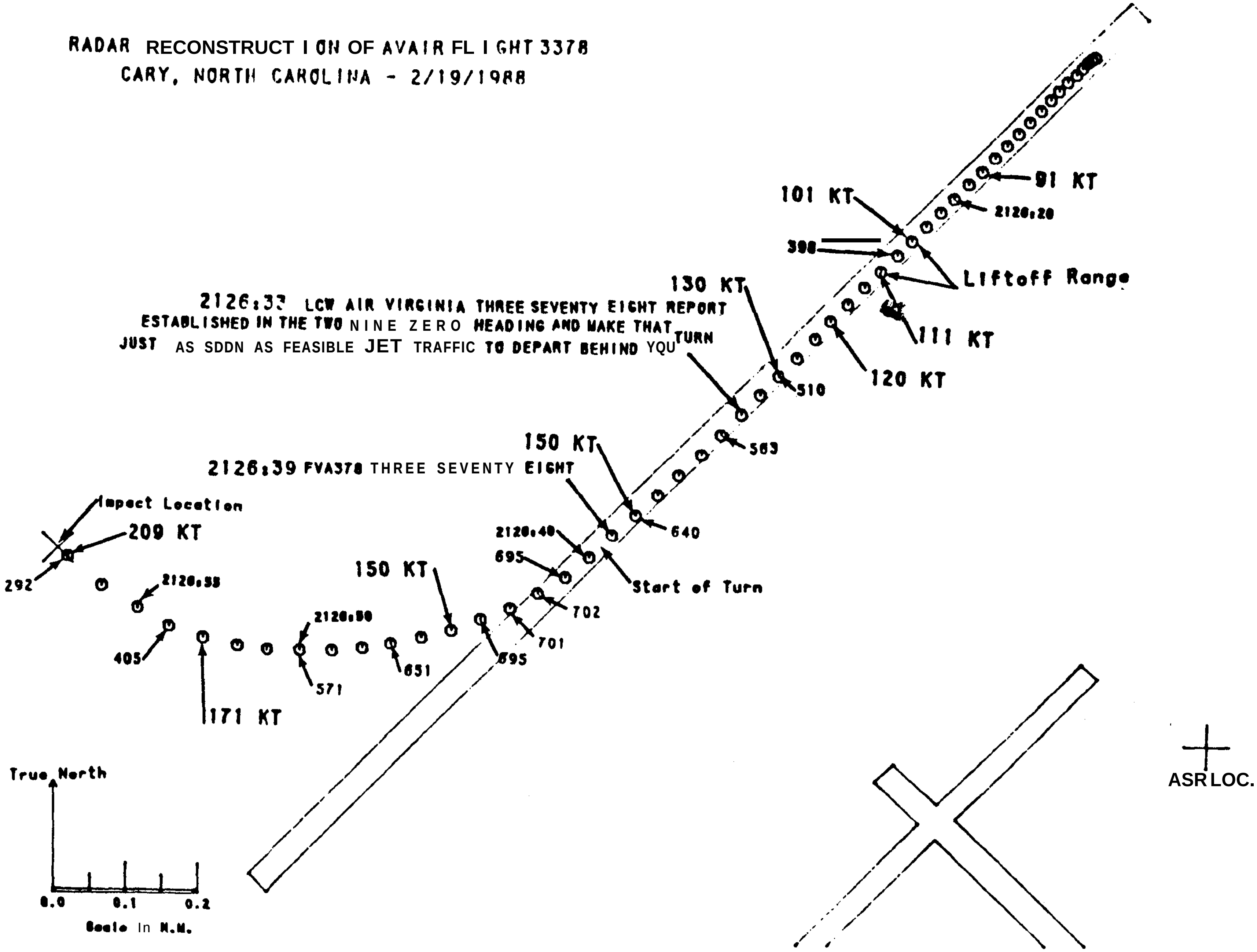


Figure 4.--Overhead view of flight of AVAir 3378
Data not identified refers to mean sea level altitude, in feet.

2. ANALYSIS

2.1 General

The flightcrew was properly certificated to perform their duties in accordance with applicable Federal aviation regulations. AVAir maintained N622AV in accordance with FAA-approved procedures. No preexisting defects were found in the airplane's structure or powerplants which could have contributed to the accident. In addition, ATC handling of the flight was found to be in accordance with applicable standards and regulations.

AVAir 3378 departed RDU's runway 23R and began its turn about 10 seconds after liftoff at an approximate height of 200 feet agl. Analysis of radar data indicates that the airplane continued to climb at an appropriate climb speed but at an excessive rate of turn and then began to descend. The data suggest the absence of abrupt maneuvers. Within 5 seconds of the 2126:39 transmission from the flight, "Three seventy eight," the airplane entered a 40" to 45" angle of bank and maintained that for at least 10 seconds. A standard rate turn would have required an approximate 22° bank angle. After 10 seconds, a roll out was initiated; however, at that time, the airplane was in a high rate of descent. The airplane was aloft for less than 1 minute.

The reduction in the airplane's vertical lift component from the excessive bank angle required additional back force on the control column to maintain level flight. The Safety Board calculated the extent of the additional back force required. A Metro III trimmed for an approximate 157-knot climb speed requires about 10 pounds of back force in a standard rate turn and about 40 pounds for a 45" angle of bank turn to maintain level flight. Applying mathematically the back force required for the standard rate turn to the flight profile of AVAir 3378, the airplane will strike the ground around the impact point. That is, the data indicate that with the over 40" angle of bank demonstrated by the radar data and the trim position found on the airplane, had the pilot exerted a back force sufficient only for a standard rate turn, the airplane would have lost altitude in a way closely resembling that observed in the radar data.

The Safety Board examined factors which may have affected the flight profile of AVAir 3378. These factors included a malfunction in the pitch trim or the SAS system and a deficiency in the crew's instrument monitoring or flight control. The Safety Board believes, as a result of AVAir's policy of the nonflying pilot performing the radio communications, with the fact that the captain was performing all radio communications, that the first officer was flying the airplane. In addition, the Safety Board examined the actions of AVAir management and FAA surveillance to determine if they contributed to the cause of this accident.

The ability to determine the potential contribution of any factor was limited by the absence of both a cockpit voice recorder (CVR) and a flight data recorder (FDR) on AVAir 3378. However, since the accident, the FAA has mandated the installation of flight recorders in such aircraft. In fact, shortly after the accident, AMR Corporation announced that it was placing CVRs and FDRs in the airplanes of the affiliated carriers that it owned in advance of the implementation of the FAA's rule. The Safety Board is pleased with the actions of AMR and encourages all regional carriers to do the same.

2.2 SAS Malfunction

The Safety Board considered the likelihood that a SAS malfunction, specifically an inadvertent stick pusher actuation, occurred in the short time that AVAir 3378 was airborne. The SAS clutch switch was found in the disengage position, and a filament in one of the annunciator panel's two SAS fault indicator light bulbs was found stretched at impact, indicating that the bulb most likely was illuminated at that time. The illuminated bulb also could be explained by the fact that disengaging the SAS clutch by itself will cause the SAS fault bulb to blink, thus, the flightcrew may have begun the flight with the switch in the "off" position. However, the Safety Board considers this unlikely since AVAir required crewmembers to test the SAS in the before taxi checklist and determine that it was engaged. Because AVAir pilots who had flown with the crewmembers of AVAir 3378 reported that both crewmembers consistently followed the checklists, the crew would have been unlikely to either allow the SAS to be disengaged before flight or to disengage the SAS without an indication of a system fault. Since it is unlikely that the crew would have continued a takeoff beyond the V1 decision speed with a SAS fault indication, the Safety Board concludes that the crew disengaged the SAS in response to what they perceived to be a SAS fault which occurred after V1.

The crew also could have mistakenly perceived a runaway nose-down trim as a malfunctioning stick pusher. Had this occurred, they would likely have responded by disengaging the SAS. However, the frequency of reported instances of Metro III runaway nose-down trim actuations in the SDRs is very low; therefore, the probability of its occurrence is low. In addition, the trim setting that was found on the airplane was appropriate for an approximate 157-knot climb with neutral control column elevator force.

In the limited visual conditions which existed at the time, the first officer would have been unlikely to visually confirm a trim setting during the climbout. Rather, she could have trimmed the airplane for a 157-knot climb speed shortly after rotation. However, if following entry into the turn, the first officer had not begun to trim nose-up to compensate for the reduction of vertical lift from a 40° to 45" bank angle, the trim could have remained in the nose-down setting that was found after the accident. However, the lack of evidence on the actual performance of the trim system prevents the Safety Board from conclusively determining how the trim setting was achieved.

The Safety Board examined the components of the SAS from N622AV that could be disassembled, but no manifestation of a SAS malfunction was evident. The evidence indicating that the SAS fault light was illuminated makes it highly unlikely that the stick pusher could have actuated. If the light was flashing, then either the servomotor had a fault which would have disabled it or the crew disabled the servomotor. Regardless, the resultant likelihood of the stick pusher inadvertently actuating would have been highly remote. If the SAS fault light had illuminated steadily, then the computer, which would have initiated the illumination of the light, would also have inhibited electrical power to the clutch, thereby preventing the stick pusher from actuating. Although an electrical short could have permitted current to flow to the clutch despite a computer command to the contrary, the evidence of an illuminated SAS fault light indicates that such a short would have occurred concurrently with the particular fault that the computer had initially sensed, a highly improbable occurrence of two simultaneous and unique faults. Thus, the likelihood of an inadvertent stick pusher, itself remote, is even more so in the presence of evidence indicating the occurrence of an illuminated SAS fault light. Further, there were no signs within the capstan of the wratcheting that occurs when a crew attempts to override a SAS stick pusher, which also indicates that there was no unwarranted and uncommanded stick pusher. However, despite this evidence, without a CVR the Safety Board was unable to determine why the crew disengaged the SAS clutch.

The type of SAS malfunction that could occur can range in severity from the annoying to the potentially catastrophic, e.g., an uncommanded and unwarranted stick pusher. The SAS malfunctions that have been reported in the Metro II and Metro III suggest that the potentially serious malfunctions occur the least often. Most reported incidents were relatively inconsequential insofar as their potential impact on the safety of flight was concerned. These included such faults as a SAS ground test failure and a SAS vane heat failure. Of the potentially serious malfunctions, in particular an unwarranted and uncommanded stick pusher actuation, only one reported instance occurred on climbout in the Metro III type airplane. The Safety Board examined information related to this type of malfunction in a Metro III that was reported to have occurred on approach to Greater Cincinnati International Airport. However, that incident appears to have been a highly unique one in which water contamination in the fuselage of the airplane provided an electrical conduit which first actuated the stick pusher, then prevented the clutch from being disengaged.

N622AV was manufactured after Fairchild incorporated an FAA-directed remedy to correct a problem which had produced such actuations, i.e., a tendency in the SAS computers of early Metro airplanes to become uncalibrated and, as a result, actuate the stick pusher at inappropriate air speeds. This remedy appears to have reduced the frequency of unwarranted stick pusher actuations. Therefore, given the flight profile of AVAir 3378, the lack of marks on the capstan of the airplane, the very low incidence of reported unwarranted and uncommanded stick pushers on climb out in the Metro III, and the indications of an illuminated SAS fault light, the Safety Board believes that AVAir 3378 did not experience an unwarranted stick pusher on takeoff.

However, the point in the flight regime during which a SAS fault occurs also can affect the severity of an occurrence which under other conditions, may have been inconsequential. For example, a fault that occurs when the airplane is close to the ground can lead to potentially more adverse consequences than one that occurs when the airplane is at altitude. Despite the fact that the required response to a SAS fault indication is relatively simple, i.e., disengaging the SAS clutch by means of the toggle switch located on the center pedestal and pulling appropriate circuit breakers, merely disengaging the clutch requires several steps. These include perceiving a fault indication, localizing the fault, recalling the response, locating and then identifying the disengage switch, and finally, moving the switch itself. These actions, which require little time to perform, could distract a crewmember from flight monitoring and control duties, particularly in certain phases of flight. If at the same time the visibility was limited and the airplane was in a high traffic environment, the consequences of that fault could be potentially serious, rather than be merely distracting.

AVAir 3378 flew in what were perhaps the most adverse conditions in which a perceived SAS fault could occur, The airplane was close to the ground, in a busy terminal area, and in IMC. As a result, the crew needed a high degree of concentration to fly the airplane solely by reference to the instruments and coordinate routine in-flight duties, such as responding to ATC clearances. At the same time, they would have been performing activities, such as retracting the gear, while attempting to respond to a perceived SAS fault.

Given these conditions, a SAS malfunction at any point in the flight of AVAir 3378, regardless of whether it actually occurred or was perceived to have occurred, could have distracted the crew when such a distraction could be least afforded. Yet, because of what the crew believed to be potential catastrophic consequences of an uncommanded and unwarranted stick pusher inherent in a perceived SAS fault, they had to take immediate action in response. The response, therefore, was required irrespective of the phase or circumstance of flight that they were in because the approved Fairchild and AVAir Metro flight manuals failed to mention that a SAS fault indicated by an illuminated warning on the annunciator panel does not require an immediate pilot response in all circumstances. Rather, because the same computer action that causes the fault light to illuminate also inhibits the SAS clutch or indicates the presence of an inhibited clutch, the likelihood of an inadvertent stick pusher actuating when a SAS fault is indicated is highly unlikely.

The Safety Board believes that an illuminated SAS fault light should properly be treated as a cautionary warning and not an emergency which requires an immediate response. Although the Safety Board agrees with the manufacturer, Fairchild, that a prudent response to a SAS fault is to disengage the system, the very probability of an inadvertent stick pusher actuation in the presence of an illuminated SAS fault light mitigates against an immediate universal response which could divert crew attention from more critical tasks. Therefore, the Safety Board believes that the FAA should review the approved flight manual of the Fairchild Metro airplane with regard to flightcrew response to an illuminated SAS fault and if necessary, revise it to reflect the cautionary, nonemergency nature of a SAS fault which requires a response after more immediate flight monitoring and control duties have been completed.

Since the crew of AVAir 3378 was, most likely, unaware of the cautionary nature of the SAS fault, they were required by the flight manual to immediately respond to the perceived fault. The Safety Board believes that, irrespective of the actual nature of the perceived SAS fault, due to the particular circumstances of this flight, a perceived SAS fault distracted the crew, compromised their ability to monitor the instruments and to control the airplane, and, as a result, contributed to the cause of the accident.

The Safety Board believes that the potential benefit the SAS provides to airplane stability in the early stages of a stall may be outweighed by the potentially adverse consequences of a system fault during critical phases of flight. Since the Metro III airplane with its larger wing span, more powerful engines, and more efficient propellers is inherently more stable than its Metro II predecessor, the need for such a system on the Metro III is questionable. Therefore, the Safety Board urges the FAA to conduct flight tests in the Metro III airplane to determine the extent to which the SAS stick pusher enhances the airplane's flight characteristics in the stall regime. If the tests fail to demonstrate the need for the stick pusher, then the stick pusher should be permanently disengaged on all Metro III airplanes.

2.3 Crew Actions

Because there was no evidence of an actual malfunction in the airplane, the focus of the investigation centered on the possible crewmember actions which could have led to the accident. The focus of this analysis will be on the the captain's monitoring of the airplane's performance and the first officer's instrument scan and control of the airplane.

The Safety Board does not consider the demands placed on a pilot performing a takeoff in the restricted visual conditions that existed in RDU on February 19 to have been beyond the abilities of a crewmember approved for 14 CFR Part 135 operations. Although visibility was severely limited, the meteorological conditions did not preclude the safe execution of the flight. Even with the additional, subtle pressure placed on the crew of AVAir 3378 by ATC's asking almost immediately after takeoff whether they had begun a turn 60" to the right and the distraction of a perceived SAS malfunction, a well trained and well coordinated crew should have been able to safely execute the maneuver. Moreover, a crew trained for and certificated to engage in revenue air transport should have effectively resisted ATC's pressure to initiate a turn at such a low altitude. Given the prevailing IMC and the high workload required during that particular phase of flight, the crew of AVAir 3378 should have climbed straight out to a safe altitude, generally 500 feet agl, retracted landing gear and flaps, and then initiated a turn as necessary. Well trained pilots should be aware that a simple "unable" response to ATC is sufficient to inform them that the crew will initiate a turn at what they consider to be a safe altitude. The Safety Board believes that the crew of AVAir 3378 should have so responded to ATC and should not have initiated a turn at the altitude that they did. However, the Safety Board believes that the crew of AVAir 3378 was faced with additional pressures, many self-induced, which limited their capabilities to perform effectively.

The captain's ability to monitor flight parameters on initial climbout may have been hampered by several factors. He may have been involved in routine posttakeoff procedures, such as retracting the landing gear and turning on the bleed air switches. While neither task was particularly demanding, he may have diverted his attention from monitoring instruments to the point where he may not have noticed a departure from the correct flight profile. In addition, it is likely that the captain's physical discomfort, although not severe according to his own statements to company personnel, was sufficient to degrade his ability to effectively monitor the flight parameters. Certainly, the sinus congestion and gastro-intestinal discomfort he said that he was experiencing could have reduced his concentration and, possibly, his reaction time, in the environment which placed the highest demands on these very skills.

The captain's discomfort may have accounted for his decision to allow the first officer to fly the airplane. He may have believed that, given his physical state, he would expend less effort by not flying.

Discussions that the captain had with other pilots demonstrate that he was aware that the first officer had experienced some difficulties flying at AVAir. However, there is no evidence that the captain was aware of the extent of those difficulties or that the first officer had most likely not made a takeoff in conditions as poor as they were on the night of the accident. Had the captain been aware of this information, perhaps he would not have allowed the first officer to perform the takeoff. Nonetheless, the Safety Board believes that, in view of the severely restricted visibility at the time, prudence should have directed the captain to perform the takeoff himself.

Given the captain's physical condition at the time, it is appropriate to examine why he reported for work that night, particularly since he was told that a reserve pilot was available to take his place. The investigation revealed that AVAir's sick leave policy required him to serve as a reserve captain upon his return to duty for the duration of the trip for which he had called in sick. This policy provided the company with a replacement for the reserve pilot who had replaced the previously sick captain. The captain thus may have concluded that, while he was not feeling well, given the cost of calling in sick, i.e., spending a day or two in RDU on reserve away from his home in Roanoke, it was in his best interest to take the flight.

The records of both crewmembers indicate that they encountered difficulties in their flying at AVAir. The captain encountered some difficulty while attempting to upgrade and transition to the SD3-30. However, due to the nature of the training, the lack of other unfavorable comments about the captain's performance, as well as the positive nature of crewmembers' comments about the captain's abilities in the Metro airplane, the Safety Board does not believe that those difficulties related to the quality of his performance in the Metro.

On the other hand, the first officer's record at AVAir indicates that her piloting abilities were deficient. Although much of the record concerned difficulties she encountered in basic aircraft control during approaches and landings, the record itself suggests a possible deficiency in basic piloting skills and abilities. AVAir's training and management personnel suggested that the difficulties she had encountered in training and early in her tenure as a line flying first officer, were characteristic of an initial trainee. They stated that her performance improved as she progressed through these initial difficulties. However, one AVAir captain reported that, notwithstanding her inexperience in both the company and the airplane, her abilities were less than what he expected of a "new hire."

Further, an examination of her difficulties suggests that her performance may have deteriorated when she was under stress. The first two check airmen, for example, with whom she attempted to qualify in differences training in the Metro II, were described as demanding pilots who could be critical and thereby, create a tense cockpit environment while administering a flight check. Although the evidence suggests that the captain of AVAir 3378 tended toward a relaxed and easy going cockpit management style, the Safety Board believes that the circumstances of the flight itself and the first officer's recent history, created a highly stressful situation for her.

Two days before the accident the first officer had returned to duty at AVAir after being off duty for 4 1/2 weeks. In the 2 days before the accident, she flew extensively, but under exclusively visual conditions. On the day of the accident, she was to fly in the most visually restrictive conditions encountered at AVAir, her only experience in scheduled passenger operations. Additional stressors to this potential stress included the last-minute change in ATC's clearance to AVAir 3378, the perceived need to initiate a right turn almost immediately after liftoff, and the knowledge that a Piedmont jet was taking off just behind them.

The Safety Board believes that a distraction, such as a perceived SAS malfunction, in the initial phases of flight increased the stress on the first officer to the point where her instrument scan deteriorated and she continued the turn but allowed the plane to descend. Given the vertigo-inducing maneuver that the first officer began almost immediately after takeoff--an accelerating, climbing turn into instrument conditions--it was imperative that she perform an adequate instrument scan to maintain appropriate flight control. The radar data portray a flight profile with no marked departure from a controlled flightpath in a turn that was initiated seconds after rotation, but with an initial climb that quickly changed to a descent. These data, with the evidence on the trim setting, indicate that with the 40" to 45" bank angle during the climb, there was insufficient back pressure to the control column to compensate for the reduction in the airplane's vertical lift component. The excessive bank angle and the insufficient control column back pressure are consistent with the evidence, a first officer who is relatively inexperienced in IMC and encountering possible vertigo in a highly stressful condition.

In summary, the Safety Board concludes that the first officer allowed the airplane to descend due to the distracting effects of a perceived SAS malfunction, possible vertigo from the climbout in IMC, a highly stressful situation, and relative inexperience in the type of instrument conditions that existed on the night of the accident. The captain failed to adequately monitor the flight instruments, possibly due to his performing routine cockpit duties and the possible degradation of his abilities caused by the combined effects of sinus and gastro-intestinal difficulties. The captain also may have been distracted by the need to respond to the perceived SAS fault.

2.3 AVAir Management

The Safety Board believes that AVAir management created extraordinary conditions for the company, from early 1987 to the time of the accident, which limited its ability to adequately oversee its operations. During that time, AVAir moved its operations base several hundred miles, experienced considerable turnover in the management of its pilot operations as well as in its pilot ranks, acquired and then phased out a new and considerably more complex aircraft type, dramatically increased its number of pilots, intensively trained pilots, furloughed pilots, significantly expanded its route structure, significantly reduced its route structure, sustained a major accident, and finally, filed for bankruptcy. These factors suggest that AVAir management significantly misjudged critical aspects of financial and operational planning. These misjudgments, the Safety Board believes, extended to oversight of the first officer.

AVAir management had been informed by its training personnel and line captains that the first officer's performance was marginal and that her potential advancement in the company was questionable. There is no evidence that the company provided her with additional training, or that it monitored her performance more carefully or more often. Rather, the evidence suggests that following some initial discussion about her difficulties in differences training, the only action the company took with regard to her performance after she had qualified to fly as first officer was to file the captain's progress and evaluation report dated September 15, 1987, that had been completed by a captain with whom the first officer had flown.

The Safety Board believes that AVAir's efforts to qualify the first officer during her training difficulties reflect positively on the company's efforts to provide its employees every opportunity to succeed. Such efforts can often result in well motivated and loyal employees which may have been the case at AVAir. However, AVAir also had both a moral and legal obligation to provide its passengers with the highest degree of safety possible. The Safety Board believes that when it received the captain's progress and evaluation report on the first officer's performance, AVAir's management should have responded in some positive manner. Its failure to respond can be accounted for, in part, by the turmoil AVAir was experiencing at that time. However, given the first officer's training history, a prudent course of action would have been for the company to determine quickly the nature of the performance difficulties and, at a minimum, provide her with remedial training and additional flight checking, as needed. This was not done. Therefore, the Safety Board concludes that the company's failure to respond adequately to the first officer's piloting difficulties contributed to the accident.

2.4 FAA Surveillance

During the time that AVAir experienced a high degree of turnover within its management, the FAA also experienced a high turnover rate among personnel from its RIC and RDU offices who were assigned to oversee AVAir. The FAA turnover was due primarily to a variety of circumstances that were largely outside the control of any individual, such as the illness of the POI who had been assigned to oversee AVAir since its inception. With the subsequent relocation of the company's operations base to RDU, the FAA transferred the responsibility for surveilling AVAir from RIC to RDU. Although this move was consistent with the FAA's policy of locating the surveilling office physically close to the operator under surveillance, the move caused further turnover in surveillance personnel. As a result, in a relatively brief period, several FAA inspectors needed time to familiarize themselves with AVAir and its operations. Unfortunately, this inconsistency in FAA's surveillance of AVAir occurred at a time when consistency was most required due to the turnover within the company's management.

Nevertheless, given the inherent limitations to the quality of the FAA's surveillance of AVAir caused by the turnover in personnel, the Safety Board believes that the efforts of the POI at the RIC FSDO to achieve a high level of surveillance were commendable, particularly since it occurred at a time when AVAir was undergoing rapid expansion and implementing intensive pilot training. The POI not only performed the routine, necessary surveillance of an expanding operator, but he also oversaw the operator's acquisition of the SD3-30 airplane and its operation under 14 CFR Part 121 rules.

On the other hand, the Safety Board believes that following the transfer of AVAir's certificate to RDU, the surveillance performance by the FAA achieved a low level in its quality and frequency. Considering the events that occurred to AVAir in just the 2 months before the accident, including a near fatal accident, bankruptcy, cessation of operations and resumption of operations, the Safety Board is at a loss to explain why there is no record that the POI performed an en route inspection of an AVAir flight, observed a flight training session or a check ride, met the chief pilot or the manager of training, or even visited the company headquarters. If the POI was unwilling or unable to perform the necessary surveillance, then his supervisor should have taken the necessary action to ensure that AVAir was receiving the level of surveillance warranted by a major 14 CFR Part 135 carrier that was undergoing significant management and operational changes.

The Safety Board believes that, at a minimum, FAA surveillance should have been increased as a result of the rapid expansion of AVAir, as well as the subsequent financial distress of the company. The FAA provides POIs of 14 CFR Part 121 operations with manifestations of financial distress that indicate when additional surveillance may be warranted. Unfortunately, no such indicators are distributed to POIs of 14 CFR Part 135 operators. Additionally, indicators of rapid growth are not distributed to any POIs. AVAir displayed several indices of rapid growth and financial difficulty that should have been manifest to its POI. It began to furlough pilots, it phased out airplanes shortly after it had acquired them, and it contracted its route structure having just completed a major route expansion. The Safety Board believes that aviation safety would be enhanced if the FAA provided POIs of operators under 14 CFR Parts 135 and 121 with similar indicators of financial and rapid growth which suggest when increased surveillance of those operators is warranted.

Had FAA surveillance of AVAir been adequate, it is possible that this accident would not have occurred. Increased surveillance could have indicated to the FAA that AVAir was operating its Metro airplanes under inappropriate operations specifications which did not prohibit seconds-in-command from performing the takeoff in those conditions. Then, the captain would have been required to perform the takeoff. Perhaps more important, effective surveillance could have resulted in an improved AVAir management that responded appropriately to reports about the first officer's piloting abilities. Effective FAA surveillance also could have resulted in a thorough examination of AVAir's training program, which the Safety Board believes was warranted after the accident at Washington Dulles International Airport. Because FAA surveillance was inadequate, these actions did not occur. Therefore, the Safety Board concludes that inadequate FAA surveillance of AVAir contributed to the accident.

The Safety Board believes that the FAA's efforts to standardize operations specifications among domestic air carriers should prevent the FAA from approving improper operations specifications. The Safety Board is pleased that the FAA is taking positive action in this regard and hopes that this will prevent ambiguity in the prohibition against seconds-in-command performing takeoffs in less-than-standard minimum visual conditions.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was properly certificated for the flight.

2. The airplane was properly maintained for the flight.

3. There was no evidence of preexisting damage to the airplane structure or powerplants that could have contributed to the accident.

4. The air traffic control handling of AVAir 3378 was in accordance with applicable standards and regulations.

5. AVAir 3378 took off in lower than standard minimum instrument takeoff conditions caused by the low prevailing visibility. This condition should not have precluded the safe operation of the flight.

6. The company did not take positive action in response to documented indications of difficulties in the first officer's piloting.

7. The crew responded to a perceived malfunction in the stall avoidance system (SAS) by disengaging the SAS clutch.

8. Because of possible deficiencies in the SA 226 and SA 227 operating procedures, the crew was not informed that a perceived SAS malfunction does not require an immediate response.

9. The airplane's flightpath indicated an excessive angle of bank initiated at an altitude that was too low.

10. The first officer was at the controls of AVAir 3378 and allowed the airplane to descend due to a deficient instrument scan.

11. The captain should have performed the takeoff due to the restricted visibility at the time.

12. The captain did not effectively monitor the flight instruments, possibly because of his response to a perceived SAS fault and the possible degradation of his monitoring capabilities due to his physical discomfort.

13. FAA surveillance of AVAir was deficient and inadequate.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew to maintain a proper flightpath because of the first officer's inappropriate instrument scan, the captain's inadequate monitoring of the flight, and the flightcrew's response to a perceived fault in the airplane's stall avoidance system. Contributing to the accident was the lack of company response to documented indications of difficulties in the first officer's piloting and inadequate FAA surveillance of AVAir.

4. RECOMMENDATIONS

As a result of its investigation, the Safety Board recommendeds that the Federal Aviation Administration:

> Review the approved flight manual of the Fairchild Metro airplane with regard to flightcrew response to an illuminated stall avoidance system fault, and revise it, as appropriate, to reflect its cautionary nature. (Class II, Priority Action) (A-88-153)
>
> Conduct a special airworthiness review of the Metro III airplane and determine the necessity of the stall avoidance system stick pusher. If the tests fail to demonstrate the need for the stick pusher, then the stick pusher should be permanently disengaged on all Metro III airplanes. (Class II, Priority Action) (A-88-154)
>
> Provide principal operations inspectors of operators under 14 CFR Parts 135 and 121 with similar indicators of financial distress and rapid growth which suggest when increased surveillance of those operators is warranted. (Class II, Priority Action) (A-88-155)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Acting Chairman

/s/ Jim Burnett
Member

/s/ Lemoine V. Dickinson, Jr.
Member

John K. Lauber, Member, *filed* the *following concurring and* dissenting statement:

Because of the lack of cockpit voice and flight data recorder data, it is impossible to determine with any degree of confidence what happened to AVAir 3378. Based on analysis of recorded radar data, we can state with a reasonably high degree of confidence that the aircraft entered a steeply banked (45°) right turn at a low altitude (approximately 200 feet above the ground) about 10 seconds after liftoff. We also know that the aircraft started to descend shortly after the turn was initiated. We also can state with a fair degree of confidence that some time after takeoff, the crew disabled the stall avoidance system, which has an established history of uncommanded actuations. We know that the first officer had limited recent instrument flight experience and had not flown for nearly a month due to being furloughed; she had flown only in VFR conditions in the 2 days prior to the accident. We know the captain was not feeling well the night of the accident. We know from training records that both pilots had experienced performance difficulties at various stages of their careers at AVAir and, from other records, that AVAir was experiencing serious destabilizing effects due to financial distress and that the FAA's surveillance of AVAir was abysmal.

What we cannot state with any degree of confidence is how these factors, and perhaps others, conspired to result in this accident. We cannot state conclusively that an uncommanded stick pusher actuation did or did not occur. We can speculate, but not conclude, that the captain's monitoring was inadequate, that one or both pilots experienced vertigo, or that the first officer's instrument scan was deficient. We simply do not have enough evidence to elevate these factors, or others, from possible causes to probable causes.

Accordingly, I believe the Probable Cause should read:

> The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew to maintain a proper flightpath in response to an actual or perceived fault in the airplane's stall avoidance system. Contributing to the accident were ineffective management and supervision of flightcrew training and flight operations, and ineffective FAA surveillance of AVAir.

Joseph T. Nall, Member, *filed the following concurring and dissenting statement:*

Based on an analysis of recorded data and airplane performance we have determined that immediately after departure the airplane entered a nonstandard-rate right turn which would have required a bank angle of approximately 45°. The airplane then began a descent until it crashed nearly wings-level at an elevation some 100 feet below the runway elevation. Examination of the wreckage revealed that the stall avoidance system (SAS) clutch switch was found in the "off" position, a position which should only be used to manually deactivate the system should a fault occur. Also, the annunciator bulb for the SAS was found to have been illuminated at impact. No other system discrepancies were found. Therefore, the evidence of record supports that this flight was flown outside the normal flightpath parameters during departure and that the SAS clutch switch was intentionally disabled by the flightcrew at some point.

The deviation from a normal flightpath may be attributed to several factors which include overcontrol by the flying pilot, deficient instrument monitoring by both pilots, and a distraction to both pilots caused by a perceived fault in the SAS.

For the reasons stated above, I am in concurrence with Member Lauber's conclusion that the probable cause of this accident should read:

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the flightcrew to maintain a proper flightpath in response to an actual or perceived fault in the airplane's stall avoidance system. Contributing to the accident were ineffective management and supervision of flightcrew training and flight operations, and ineffective FAA surveillance of AVAir.

December 13, 1988

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident about 2210 eastern standard time on February 19, 1988. An investigative team was dispatched from its Washington headquarters to the scene the following morning. Investigative groups were established for operations, air traffic control, meteorology, structures, systems/maintenance records, powerplants, survival factors, human performance and aircraft performance. Parties to the investigation were: the FAA; AVAir, Inc.; Garrett Engine Division, Allied Signal Corporation; Fairchild Aircraft Corporation; Raleigh-Durham Airport Authority; Dowty Aerospace Corp.; and the Airline Pilots Association.

2. Public Hearing

There was no public hearing. A deposition of Richmond and Winston-Salem based FAA personnel involved in the oversight of AVAir and a headquarters-based individual involved in flight standards was held on May 4, 1988. Depositions of AVAir pilot training and flight operations management personnel was held on May 5, 1988.

APPENDIX B

AIR TRAFFIC CONTROL TRANSCRIPT

U.S. Department of Transportation
Federal Aviation Administration

Memorandum

Subject: INFORMATION: Transcription concerning the accident involving FVA378 a Swearingen Metroliner on February 20, 1988 at 0226 UTC

Date: February 24, 1988

Reply to Attn. of

From: Hugh E. Sawyer, Jr., Air Traffic Manager, Raleigh ATCT

To

This transcription covers the time period from 0146 UTC to 0231 UTC on February 20, 1988.

Agencies Making Transmissions	Abbreviation
Raleigh ATC Tower, Clearance Delivery	CD
Piper Cherokee N9222K	N9222K
Piper Cherokee N4945F	N4945F
American 1038	AAL1038
Air Virginia 378	FVA378
American 1040	AAL1040
Raleigh Radar Approach Control, East Arrival	EAR
Raleigh Flying Service Fuel Truck 53	RFS53
Raleigh ATC Tower, Ground Control East	GCE
American 1094	AAL1094
Unknown	UNKNOWN
Piedmont 8907	PAI8907
Delta 757	DAL757
Raleigh ATC Tower, Local Control West	LCW
Piedmont 374	PAI374
American 884	AAL884
American 868	ML866

American 1066	AAL1066
American 1052	AAL1052
Piedmont 508	PAI508
Cessna N755AB	N755AB
Raleigh Radar Approach Control, North Departure	NDR
November 322 bravo echo	N322BE
Air Virginia 338	FVA338

1 HEREBY CERTIFY thst the following is a true transcription of the *recorded* conversations pertaining to the subject aircraft accident:

Preston L. Williams

Plans and Procedures Specialist

Raleigh Airport Traffic Control Tower

This portion of the transcription concerns communications at the Clearance Delivery position from 0146 UTC to 0154 UTC on February 20, 1988.

(0146)

(0147)

(0148)

0148:29	N9222K	Raleigh clearance Cherokee nine triple two kilo with quebec
0148:33	CD	Cherokee nine triple two kilo Raleigh go ahead

0151:24	AAL1038	Clearance delivery it's American ten thirty eight
0151:28	CD	American ten thirty eight ah standby 1'11 be right with you
0151:32	AAL1038	Ah standby I can hardly hear you hold on
0151:35	C D	Okay the aircraft calling clearance standby I'll be right with you as soon as I can
0151:48	FVA378	Raleigh clearance Air Virginia's three seventy eight quebec Richmond
0151:52	C D	All aircraft this frequency stand by
(0152)		
0152:12	C D	Use caution deer activity reported on and in the vicinity of the air
0152:41	AAL1040	Raleigh clearance American ten forty Charlie five to ah Detroit with quebec
0152:45	C D	American tan forty you're number three standby
0152:56	CD	Ha romeo's current
0152:58	EAR	Romeo thank you
(6153)		
0153:05	CD	Okay American ah ten thirty eight I believe you were thefirst one that called ah go ahead
0153:10	AAL1038	Yeah 1 was just gonna ah say that we were monitoring here ah you guys and ah if it they

		change our departure time for Philly there ah could you give us a little bit of warning then we can get the people on
0153:21	C D	Okay sir they just ah called a while ago they extended for everybody ah to hold all traffic for ah Philadelphia for an additional thirty minutes but your time exceeded that so that was riot a factor but I had called and confirmed yours so it's still valid
0153:36	AAL1056	Okay all right
0153:38	CD	Kay the ah Air Virginia aircraft that called number two say your call sign
0153:42	FVA378	Air Virginia three seventy eight to Richmond
0153:45	CD	Virginia three seventy eight is cleared to the Richmond airport as filed after departure fly runway heading maintain five thousand expect one one thousand one zero minutes after departure departure frequency one three two point three five squawk four six four seven
0153:59	FVA378	As filed runway heading five thousand eleven in ten one thirty two thirty five four six four seven on ths squawk for three seventy eight
(0154)		
0154:08	C D	Air Virginia three seventy eight that is correct ah information romeo is now current ground point niner
0154:12	FVA378	Yeah we'll get romeo

This portion of the transcription concerns communications at the Ground Control East position from 0211 UTC to 0217 UTC on February 20, 1588.

(0211)

0211:06	RFS53	Raleigh ground Raleigh flying service fifty three like to cross Charlie and delta
0211:12	GCE	Raleigh flying service fifty three give way to the Piedmont Boeing jet and than ah taxi correction proceed as requested
0211:18	RFS53	Roger
0211:34	AAL1094	And ground American ah ten ninety four ah we're number two behind this seven ah two for delta
0211:42	GCE	American ten ninety four Raleigh ground taxi ah via foxtrot left Charlie right bravo follow your company two three right
0211:46	AAL1094	American ten ninety four

(0212)

(0213)

0213:04	UNKNOWN	Ground twenty nine fifteen
0213:06	GCE	Twenty nine fifteen Raleigh ground
0213:10	UNKNOWN	Roger we're located on the cargo ramp and off of alfa
0213; 12	GCE	Thank you sir

(0214)

0214:12	PAI8907	And ah Raleigh ground Piedmont ah eighty nine zero seven we're pushed back we're getting ready to start engines ah be in gate ten here
0214:18	GCE	Piedmont eighty nine oh seven Raleigh ground roger

(0215)

0215:30	DAL757	Delta seven five seven to push at alfa three
0215:42	GCE	Delta seven fifty seven Raleigh ground roger on your push advise ready to taxi
0215:46	DAL4 57	Roger

(0216)

0216:16	FVA378	Air Virginia Three seventy eight's coming up on delta at fox eight
0216:21	GCE	Air Virginia three seventy eight Raleigh ground taxi to runway two three right use foxtrot
0216:27	FVA378	Three right three seventy eight
0216:34	PA18907	And Raleigh ground Piedmont eighty nine oh seven's ready to taxi
0216:36	GCE	Piedmont eighty nine oh seven Raleigh ground taxi to runway two three right turn left on charlie right on bravo
0216:43	PA18907	Two three right right on charlie right on bravo

0216:46 GCE Left on charlie

0216:48 PAI8907 Ah left on Charlie

(0217)

This portion of the transcription concerns communications at the Local Control West position from 0217 UTC to 0231 UTC on Fatruary 20, 1988

0217:18	LCW	Piedmont three seventy four let me know when you have the Boeing traffic on short final--- and he's past you
0217:20	PA1374	Ah three forty seven's got the ah boeing on final
0217:22	LCW	Okay has he paza ah passed up the approach end
0217:27	PA1374	He's just crossing it now
0217:28	LCW	Piedmont three seventy four two three right position and hold
0217:30	PA1374	Position and hold Piedmont three seventy four
0217:45	LCW	Two three right and I see what you got as far as traffic any special activity
0217:48	LCW	Ah eight eighty four's rolling out
0217:49	LCW	Uh huh
0217:51	LCW	I don't see him yet but he's coming up on b five just a moment anyway American eight eighty four rolling out on the right side Piedmont's going into position two three right five oh eight's been cleared to land two three right

		Piedmont
0218:00	LCW	R d
0218:01	LCW	J d
0218:09	LCW	American eight eighty four turn left off the runway lat me know what exit you use
0218:14	AAL884	Can eight eight four we'll turn left ah bravo three
0218:15	LCW	Okay
0218:24	AAL884	Those ah runway lights are awfully bright is there any way you can keep the approach lights up and turn the runway lights down
0218:27	LCW	Yeah
0218:35	LCW	Eight eighty four are you clear yet
0218:36	AAL884	Eight eighty four's clear
0218:37	LCW	Piedmont three seventy four runway two three right cleared for takeoff
0218:44	PAI374	Three seventy four cleared to go
(0219)		
0219:04	LCW	American eight sixty eight runway two three right taxi into position and hold be reedy for immediate
0219:08	AAL868	Position and hold we'll be ready American eight sixty eight

0219:20	LCW	American eight sixty eight runway two three right cleared for takeoff
0219:23	AAL868	Cleared to go we're rolling American eight sixty tight
0219:29	LCW	Piedmont thrae seventy four contact Raleigh departure so long to you
0219:31	PAI374	Three seventy four good day now
0219:54	AAL1066	And Raleigh tower American ten six six with you at ten out ah intercepting
0219:58	LCW	American ten sixty six roger runway two three right cleared to land wind two four zero' at four the r v r four thousand
(0220)		
0220:04	AAL1066	Cleared to land two three right American ten six six
0220:25	LCW	American eight sixty eight as soon as feasible start *your* left turn heading of two one zero contact Raleigh departure so long
0220:30	AAL868	Right sixty Eight we're turning now good day
0220:38	LCW	American ten fifty two traffic just should of crossed the approach lights verify that
0220:39	AAL1052	Yes sir he's coming over the numbers now
0220:41	LCW	Ten fifty two give way to him *runway two* three right taxi into position and hold be ready when called

0220:46	AAL1052	Kay we'll position and hold American ten fifty two
0220:50	LCW	American ten sixty six one maybe two dapartures prior to your arrival your speed looks good: continue I'll keep you advised
0220:56	AAL1066	American ten six six
(0221)		
0221:06	LCW	Piedmont five oh eight ah--turn left at ah bravo four
0221:14	PA1508	Five oh eight ah left at bravo four
0221:16	LCW	Piedmont five oh eight that's correct left at b four let me know when you're turning
0221:21	PAI508	Five oh eight we'll do that
0221:30	PAI508	Five oh eight's ah exiting at bravo four
0221:31	LCW	American ten fifty two cleared for takeoff
0221:35	AAL1052	Ten fifty two cleared for takeoff
0221:36	LCW	Piedmont five oh eight contact Raleigh departure thanks a lot er correction Raleigh ground control one two one point nine
0221:42	PAI508	To ground Piedmont five oh eight thank you
0221:50	LCW	American ten sixty six only one of them will go you're cleared to land runway two three right
0221:55	AAL1066	Cleared to land two three right American ten

		six six
0221:58	LCW	American ten ninety four be a momentary delay due to intrail spacing ah you and the other jets both going over South Boston
(0222)		
0222:04	AAL1094	Ah American ten ninety four---and we're holding short
0222:05	LCW	Roger
0222:41	LCW	American ten fifty two contact Raleigh departure
0222:44	AAL1052	Fifty two good day
0222:45	LCW	Good day
0222:51	N755AB	(Noise) Seven five five ALFA BRAVOS with you just outside bodly
0222:55	LCW	Five five ALFA BRAVO Raleigh Tower roger
0223:00	LCW	The r v r for runway two three right ah just decreased r v r two, thousand eight hundred touchdown midpoint ah four thousand five hundred roll out two thousand eight hundred
0223:10	N755AB	Roger
0223:25	LCW	American ten ninety four traffic's on a short final m d eighty let me know when he crosses the numbers
0223:29	AAL1094	Ok we got him in sight now we'll call him across the numbers

0223:32	LCW	Thank you
0223:43	AAL1094	And ah he's crossing the numbers now for ten ninety four
0223:45	LCW	American ten ninety four runway two three right taxi into position and hold
0223:48	AAL1094	Position and hold for two three right American ten ninety four
0223:58	LCW	Cessna five alfa bravo runway two three right cleared to land wind two one zero at three
(0224:00)		
0224:03	N755AB	Cleared to land alfa bravo
0224:09	LCW	American ten sixty six turn left at b four let me know when youre turning
0224:12	AAL1066	Left at b four American ah ten sixty six
0224:44	AAL1066	Ah ten sixty six is clear at this time
0224:46	LCW	Ten sixty six ground point seven
0224:48	AAL1066	Sixty six
0224:49	LCW	American ten ninety four runway two three right cleared for takeoff
0224:52	AAL1094	Cleared for takeoff American ten ninety four
0224:54	LCW	Air virginia three seventy eight ah reference the m d eighty runway two three right taxi into position and hold

0224:59	EVA378	Three seventy eight
(0225)		
0225:04	NDR	Yes
0225:07	LCW	Just wanted to see who this was
0225:09	NDR	All right
0225:10	LCW	You ready
0225:11	NDR	Yeah I'm ready come on
0225:12	LCW	You got a little one
0225:13	NDR	Come on
0225:20	LCW	Air Virginia three seventy eight continue ah holding runway ah two three right amend your departure instructions turn right heading of two nine zero after departure maintain two thousand
0225:30	FVA378	Two nine zero two thousand for three seventy eight
0225:49	LCW	Air Virginia three seventy eight cleared for immediate takeoff
0225:53	FVA378	Three seventy eight's rolling
(0226:00)		
0226:01	LCW	American ten ninety four contact Raleigh Departure

0226:06	AAL1094	American ten ninety four good day
0226:08	LCW	Piedmont eight nine oh seven runway two three right taxi into position and hold be ready when called
0226:09	PA18507	Kay Piedmont eighty nine oh seven we'll be ready
0226:14	LCW	Cessna five alfa bravo one departure prior to your arrival now Boeing seven thirty seven taking the runway for departure
0226:19	N655AB	Roger
0226:33	LCW	Air Virginia three seventy eight report established in the two nine zero heading and make that turn just as soon as feasible jet traffic to depart behind you
0226:39	FVA378	Three seventy eight
(0227)		
0227:02	LCW	Air Virginia you in the turn'?
0227:07	LCW	Air Virginia three seventy eight arc: you in the turn
0227:16	LCW	Piedmont ah eighty nine oh seven cleared for immediate takeoff
0227:20	PAI8907	Eighty nine oh seven on the roll
0227:30	LCW	Piedmont eighty nine oh seven are you rollin?
0227:32	PA18907	Yes sir we are

0227:33	LCW	Thank you
0227:34	LCW	Cessna five alfa bravo caution wake turbulence for the departing boeing seven thirty seven
0227:38	N755AB	Ok
0227:40	LCW	Air Virginia three eighty seven how do you hear er three seventy eight Raleigh how do you hear me
0227:45	NDR	Yeah
0227:45	LCW	Are you talking to Air Virginia three seventy eight
0227:48	NDR	No I am not
0227:50	LCW	All right
0227:53	LCW	Air Virginia three seventy eight Raleigh
0227:57	LCW	Yeah
0227:59	NDR	I've lost radar with him too
(0228:00)		
0228:00	LCW	Okay I got Piedmont rollin behind him
0228:01	N9322BE	Raleigh niner three two two bravo echo's with you outside the marker and ah wind check if you get a chance
0228:05	LCW	Piedmont. eighty nine oh seven as soon as feasible start a left turn heading two on6 zero

0228:08	PAI8907	Okay hurry over to two one oh Piedmont ah eighty nine: oh seven
0228:12	LCW	Cessna five alfa bravo have you landed yet
0228:17	N755AB	(Err ah)* we're touching down now
0228:18	LCW	Five alfa bravo roper
0228:20	LCW	Air Virginia three seventy eight Raleigh
0228:27	LCW	Piedmont eighty nine oh seven contact Raleigh Departure
0228:30	PAI8907	Eighty nine oh seven by
0228:30	NDR	Yeah
0228:31	LCW	Piedmonts on a two ten heading I turned him I dont know where Virginia is
0228:34	NDR	I don't either I did'nt I did'nt even get the strip
0228:35	PAI8907	Raleigh departure Piedmont eighty nine oh seven is with you ah
0228:37	N322BE	Three two two bravo echo's with you eight miles out
0228:39	LCW	Air Virginia three seventy eight Raleigh how Jo you hear me
0228:44	LCW	Cessna five alfa bravo turn left first available taxiway let me know when you clear the runway

0228:48	N755AB	Ok we're clear at ah I think its b 8
0228:55	LCW	Air Virginia three thirty eight Raleigh you number one
0228:58	FVA338	We're number one ready to go three thirty eight
0228:55	LCW	Air Virginia three thirty eight roger
(0229:00)		
0229:04	LCW	Air Virginia three seventy eight Raleigh how do you hear me?
02..9:09	NDR	Yeah
0229:12	LCW	Anything
0229:13	NDR	No not I I have no radar either
0229:14	LCW	Ok call Ed
0229:15	NDR	I did I think he went I I think we: lost him
0229:17	LCW	I do too
0229:18	NIX	I do too I think I think we've lost
0229:25	N322BE	Raleigh Tower three two two bravo echo
0229:29	LCW	Three two bravo echo continue expect ah maybe a low approach 1'11 let you know in justa minute
0229:34	N322BE	Expect possible low approach bravo echo

0229:51	LCW	Go ahead
0229:52	NDR	1 think we've lost him
0229:53	LCW	Ok
(0230:00)		
0230:13	DAL'724	Tower Delta seven twenty four's thirteen notheast
0230:16	LCW	Calling Raleigh standby
0230:39	N322BE	How about an update for bravo echo
0230:41	LCW	Two bravo echo Raleigh I'm going to have to send you around turn right heading three two zero climb and maintain two thousand
0230:45	N322BE	Three two zero two thousand bravo echo
0230:53	LCW	I'm sending bravo echo around three twenty and two
0230:58	EFR	Say again
0230:59	LCW	1'111 sending bravo echo around three twenty and two

This portion of the transcription concerns communications at the North Departure Radar position from 0221 UTC to 0231 UTC on February 20, 1988.

(0221)

(0222)

APPENDIX C

PERSONNEL INFORMATION

Walter R. Cole Jr., Captain

The captain, 38, was employed by AVAir, Inc., on June 10, 1985. He held airline transport pilot certificate No. 2088066 with SA227 and airplane multiengine land type ratings. His first-class medical certificate, dated November 6, 1987, contained no waivers or limitations.

At the time of the accident, the captain had accrued approximately 3,426 total flight hours, of which about 1,836 were in the Fairchild Metro II and Metro III airplanes, with about 405 of those as pilot-in-command. In the previous 90 days, 30 days, and 24 hours, the captain had flown 137.1, 98.7 and 4.8 hours respectively.

Kathleen P. Diaan, First Officer

The first officer, 28, was employed by AVAir, Inc., on May 5, 1987. She held airline transport pilot certificate No. 0444622989 with an airplane multiengine land rating. Her first-class medical certificate, dated March 24, 1987, contained no waivers or limitations.

At the time of the accident, the first officer had accrued about 2,080 total flight hours, of which about 450 were in the Fairchild Metro II and Metro III airplanes. In the previous 90 days, 30 days, and 24 hours, the first officer had flown 153.7, 11, and 0 hours, respectively.

APPENDIX D

AIRCRAFT INFORMATION

The airplane, a Fairchild SA227 AC, Metro III, United States Registry N622AV, was manufactured in September, 1985 and placed into service by AVAir in November 1985. At the time of the accident, the airframe had accrued 4,222.3 total hours.

The airplane was powered by two Garrett TPE 331-11U-611G engines, each with a Dowty Rotol R321/4-82-F/8 four-bladed propeller. The engines were rated at 1,100 equivalent shaft horsepower at sea level, given standard atmospheric conditions.

Enaines	No. 1	No. 2
Serial No.	P-44353	P-44345
Date Installed	1 O-8-87	9-12-87
Total Time	4351.6	3730.9
Total Cycles	6162	5262

Propellers	No. 1	No. 2
Serial No.	105145	105383
Date Installed	5-3 l-87	11-14-87
Total Time	4,671.4	2,686.7
Date of Last Overhaul	S-9-85	1 l-27-85
Time Since Overhaul	3442.5	1810.5
Total Cycles	2213.1	934.3

APPENDIX E

FM INFORMATION ON STALL AVOIDANCE SYSTEM

U.S. Department
of Transportation
Federal Aviation
Administration

800 Independence Ave S.W.
Washington, D C 2059:

0 4 AUG 1988

Hr. Barry Strauch, Investigator-In-Charge, AI-30
National Transportation Safety Board
800 Independence Avenue, SW
Washington, DC 20594

Dear Mr. Strauch:

Enclosed is the information you requested on the certification of the Stall Avoidance System **(SAS)** on the Fairchild SA-227AC aircraft.

Sincerely,

Don Elam
Air *Safety Investigator*

U.S. Department of Transportation
Federal Aviation Administration

Memorandum

Subject: INFORMATION: Stall Avoidance System (SAS) on the Fairchild Metro III (SA227-AC) Airplane

Date: JUL 27 1988

From: Manager, Rotorcraft Directorate, Aircraft Certification Service, ASW-100

Reply to Attn. of:

To: Manager, Accident Investigation Division, AAI-100

This memorandum is in response to requests made by letter dated July 1, 1988, from Mr. Barry Strauch, NTSB, to Hr. Don Elam of ASF-100 and made by telephone to this office. Hr. Strauch made four requests as indicated beiow:

a. The reason for the FAA requirement for the SAS to be on the SA227-AC.

b. The data required by the FAA on ine reliability of the SAS for certification on the SA227-AC.

c. The data that Fairchild supplied the FAA in response to b above.

d. A copy of the flight test report showing the SA227-AC stall characteristics. (This request was made by telephone to Ms. Michele Owsley of ASW-150.)

In answer to these requests, we submit the following:

a. The SAS is required on all Fairchild (formerly Swearingen) SA226 and SA227 series aircraft because of aerodynamic stall characteristics that are unable to meet the CAR 3/FAR 23 requirement that "during the recovery part of the maneuver, it must be possible to prevent. more than 15 degrees of roll or yaw by normal use of the controls." (This requirement is FAR 23.203 for the SA227-AC's certification basis.) The aircraft sharply rolls to left or right at the stall and the pilot is unable to hold this roll to within the 15 degree requirement until the stall is broken by nose-down application of the pitch control.

This characteristic was first identified on the initial certification of two predecessor aircraft, the SA226-TC and SA226-T. These aircraft were certificated concurrently and their type certificates were issued on June 11, 1970, and July 27, 1970, respectively. A decision was made during these programs to apply the equivalent safety provisions of FAR 21.21 in installing the SAS to provide artificial nose-down pitching moment prior to encountering the undesirable roll characteristics associated with the aerodynamic stall. This system also provided

2

artificial stall warning through activation of a horn at appropriate angles of attack prior to stick pusher activation and provided angle of attack indication on an indicator. Additionally, on the SA226-T (and subsequent "short-body" Fairchilds), the system provides artificial longitudinal stability augmentation by producing an increasing nose-down control column force proportional to increasing angle of attack below 180 knots indicated airspeed. This augmented nose-down control column force increases to approximately 20 lbs. at $1.4V_s$ and then remains constant until increased to thr full stick pusher force of approximately 65 lbs. at $1.0V_s$. Thus, on these aircraft, the system is designated a SAS^2 (stall avoidance and stability augmentation) system. This system (SAS^2) is not required on the SA227-AC since it is a "long-bodied" Fairchild, which exhibits greater aerodynamic longitudinal stability. The basic SAS system on the SA227-AC is essentially a carry-over from that certified on the SA226-TC with modifications.

b. The "data" required by the FAA addressing the reliability issue was initially provided by a document entitled "Criteria Applicable to Systems Installed on Civil Aircraft Type Certificated under SFAR 23 and *CAR* 3 to Prevent Hazardous Conditions in the Stall Regime of the Airplane ." These criteria were provided to Swearingen Aircraft on March 11, 1970, as an acceptable means under which an equivalent level of safety may be shown with the applicable regulations for certification of the SA226-T and SA226-TC aircraft. These criteria were later modified somewhat in agreements between FAA and Swearingen, generally in the area of the requirements for dual *system* components. A copy of these criteria is attached to this memorandum.

Additionally, the SAS *system* was thoroughly evaluated by FAA flight test personnel during the original SA226-T and SA226-TC certification programs and subsequent follow-on model certifications including the SA227-AC. Essentially, the basis for the finding of equivalent safety with CAR 3.120 (later changed to FAR 23.203 for the SA227-AC) was that the single strand (no redundancy) SAS system could be relied upon to prevent the aircraft from reaching an angle of attack where undesirable stall characteristics were encountered. Should the system fail, however, the aircraft was shown to be recoverable from the aerodynamic stall. Thus, the aircraft was shown to meet the criteria for "airplane recoverable" of current Advisory Circular 23-8, paragraph 86d(2)(i). Conversely, should the *SAS* (stick pusher) activate at some lower, inappropriate angle of attack in *a* normal flight *regime*, this event was shown to be easily controlled (overridden) by the pilot while he deactivated the SAS clutch to remove the unwanted push. This was shown through numerous intentional hardovers performed in all regimes of fiight, including takeoff and landing, with time delays applied where appropriate during the SA226-TC, SA226-T, SA227-AC, and other Fairchild aircraft type certification programs. The system has an airspeed switch which disarms the SAS above a speed (140 ±5 KIAS for the SA227-AC) appropriate for each aircraft to prevent inadvertent activations at higher airspeeds where negative accelerations could be imposed on the aircraft shouid the pilot delay more than 3 seconds in preventing further nose-down elevator movement.

c. The data supplied by Fairchild in response to the requirements of b above is proprietary, and thus is not releasable by the FM for publication or for public viewing. Further, it is quite voluminous. It consists of various Fairchild reports, SAS vendor reports, and *FM* type inspection reports concerning all the Garrett-engined SA226 and SA227 aircraft certificated from the time of the SA226-TC certification to present. All of these aircraft have used a similar SAS system that has evolved with numerous changes, including changes in the manufacturer, but which all operate essentially the same way.

The initial SAS system was manufactured by Honitair Corporation. They submitted specification and qualification data for all the SAS components for the SA226-T and SA226-TC certification programs. This data consists largely of system specifications, environmental qualification data, some reliability data, and system fault-tree analyses and was submitted in response to the previously mentioned criteria attached to *this* memorandum. Additional data was requested of Swearingen by FAA concerning component reliability.

Subsequently, Rosemount Corporation took over manufacture of the Monitair SAS system certified on the SA226-T and SA226-TC aircraft. Later, a replacement system, manufactured by Conrac Corporation, was certificated on the SA226-T(B) aircraf t. This is the system that was certificated on the SA227-AC and was installed on AC-622 that was involved in the accident to which Mr. Strauch referred in his letter.

The principle of operation of the Conrac System is the same as that of the Wonitair System. The principal difference is that the angle of attack vane is mounted on the fuselage rather than the wing. This eliminated the need for the wing leading edge blanket heater and reduced the likelihood of handling damage to the vane. Both these changes improved reliability and decreased maintenance problems. All of the system components previously supplied by Honitair (Rosemount) were now supplied by Conrac. There were many detail differences, most of which were designed to improve reliability, such as the change from a wire-wound potentiometer for flap position sensing to a “precision potentiometer.” Ultimately, however, reliability problems with the SAS continued to be experienced in the field, and this resulted in the issuance of AD 85-22-06 on November 22, 1985. This AD applies to all of the SAS systems on Fairchild aircraft manufactured to that *date*. It requires compliance with several Fairchild service bulletins which consist of inspection and calibration procedures for each of the various SAS systems. Further, replacement of components found through these procedures to be defective is required.

On-going service difficulty reports concerning the SAS systems have resulted in the generation of new Failure Modes and Effects Analysis reports by Conrac Corporation. These reports are presently undergoing *FAA* and Fairchild scrutiny and consequent revision. However, the certification basis for this system remains the same on the current SA227-AC and SA227-AT. The system is required by AFM limitation for all operations. *A* pre-flight check of the system is part of the AFM Normal

Procedures prior to each flight. Should the system malfunction in flight, AFM emergency procedures are provided. The aircraft has been shown to be recoverable from any stall maneuver required for certification with the SAS inoperative. Further, the aircraft has been shown to be controllable to a safe landing without requiring exceptional pilot skill should an inadvertent SAS activation (hardover or unwanted push) occur in any regime of flight including takeoff and landing.

d. The flight test report showing SA227-AC stall characteristics consists of the manufacturer's flight test report and the FAA type inspection report. Both of these contain proprietary data that is not releasable by FAA for public viewing. Essentially, the stalling characteristics of the SA227-AC aircraft are the same as for the SA226-TC and all other Fairchild "long-bodied" aircraft. Both forward and aft c.g. stalls. as defined by the stick pusher, are very benign, easily controllable in roll and yaw, and result in a nose-down pitch of 10 to 30 degrees and altitude loss of approximately 300 to 800 feet depending on power, configuration, and attitude of entry when conducted as required for aircraft certification. Much less nose-down pitch-and altitude loss will result if the pilot arrests the stall earlier and uses maximum available power to "fly out the stall" as is taught in type rating training. The aerodynamic stall usually results in a roll-off on one wing or the other. Bank angles may reach 60 degrees or greater during the recovery, again depending on power, configuration, and attitude at entry. However, there is no undue spinning tendency, and once the stall is broken by the release of back elevator pressure recovery from the resultant banked, nose-down attitude is easily accomplished with normal use of the controls.

If we may be of further assistance, please contact me or Hr. Ron Filler, ASW-150, FTS 734-5157.

J. L. B. Andriesen

Attachment

CRITERIA APPLICABLE TO SYSTEMS INSTALLED ON CIVIL AIRCRAFT TYPE CERTIFICATED UNDER SFAR 23 & CAR 3 TO PREVENT HAZARDOUS CONDITIONS IN THE STALL REGIME OF THE AIRPLANE

1. PURPOSE. These criteria set forth acceptable means, but not the ● oh means, under which equivalent level of safety may be shown with the applicable portions of the referenced regulations in accordance with FAR 21.21 by the use of a ● yrtr to prevent hazardous conditions in the stall regime of the airplane.

2. DEFINITION. A system installed in accordance with the ● bovr purpose is defined ● o a combination of a reliable warning system and a stick pusher. This system should provide adequate warning and preclude hazardous conditions associated with flight in the stall regime of the airplane.

3. REFERENCE REGULATIONS.

FAR 21.21	Issue of Type Certificates
FAR 23.21	Proof of Compliance (CAR 3.61)
FAR 23.49	Stalling Speed (CAR 3.82, CAR 3.83)
FAR 23,141	General (Flight Characteristics) (3.105)
FAR 23.173	Static Longitudinal Strbllity (CAR 3.114, 3.115) (SFAR 23.9)
FAR 23.201	Stall Demonstration (CAR 3.120, 3.121, 3.122)
FAR 23.203	Stall Characteristics (CAB 3.120, 3.121, 3,122)
FAR 23.205	One-Engine-Inoperative Stalls (CAR 3.123)
FAR 23.201	St.11 Warning (CAR 3.120) (SFAR 23.10)
FAR 23.671	General (Control Systems) (CAR 3.333)
FAR 23.687	Spring Devices (CAR 3.347)
FAR 23.1301	Function ● d Installation (CAR 3.631, 3.652) (SFAR 23.59)
FAR 23.1329	Automatic Pilot System (CAR 3.667)

4. ACCEPTABLE MEANS OF COMPLIANCE. For safe operation, it is essential that hazardous flight condition@ be prevented. In addition to automatic and reliable systems to provide the pilot(r) with adequate warning in order to take corrective action, an automatic and reliable system to preclude hazardous conditions in the stall regime may have to be provided. The airplane shall comply with the stalling requirements of FAR 23 up to the point of actuation of the stick pusher ● The system must be investigated for structural ● ffoctb on the airplane, reliability, and the effects of failure and malfunction. Flight tests shall be conducted to determine that the intended function of the required items of equipment for type certification is performed. This uy be ● co&iohrd under the ● quivalent level of ● 4f8ty provisions FAR 21.21 subject to the following:

a. General

(1) The equipment, systems, and installation rhould insure that the intended function is performed reliably under all reasonably foreseeable operating conditions, including environmental • ffecto.

(2) The equipment, • ystems, and installations • ra designed to reasonably preclude inadvertent operation, and to safeguard against hazards to the airplane in the event of malfunction or failure.

(3) All applicable margins of safety criteria used in determining tho airplane performance and flight characteristics should bo based on the stall speeds as determined with the stick pusher system switched on.

(4) Dual components may be shared between the warning And stick pusher systems.

(5) Power failure indications should be provided for the warning • d stick pusher systems.

(6) Means should be provided to check proper functioning of the • ystem(s) prior to flight.

(7) Any rela ted normal and emergency operating limitations and procedures, together with any information found necessary for safety during operation *of* these system(s), should be included in the airplane flight manual and • uppbented by • Ueh markings and placards • 8 deemed necessary.

b. Warning System. The warning portion of the system should have a high degree of reliability, and should actuate in • ch • manner • 8 to give an unmistakable warning to the pilot(s) with A satisfactory margin prior to actuation *Of* the stick pusher system in turning flight, and in accelerated and unaccelerated level flight for all airplane configurations.

c. Stick Pusher System

(1) The stick pusher portion Of the system should incorporate components which insure a high degree of reliability. Single rather than duplicate components uy be used in the • tfck pusher system when it is shown that any single failure in no way affects the operation of the stall warning system. Mechanical parts of the stick pusher • ystem need mot be duplicated if their failure or jamming is considored to be remote.

3

(2) The system should be designed to preclude inadvertent operations or hazardous conditions from occurring during its operation in all airplane configurations and flight conditions.

(3) A means to quickly deactivate the stick pusher system should be provided and be made readily available to the pilot(s).

(4) The characteristics of the system should be such as to prevent inadvertent overpowering, yet not such that overpowering is not achievable or maintainable during malfunction prior to manual deactivation of the system.

(5) Malfunction of the system should not cause the airplane to exceed its structural limits.

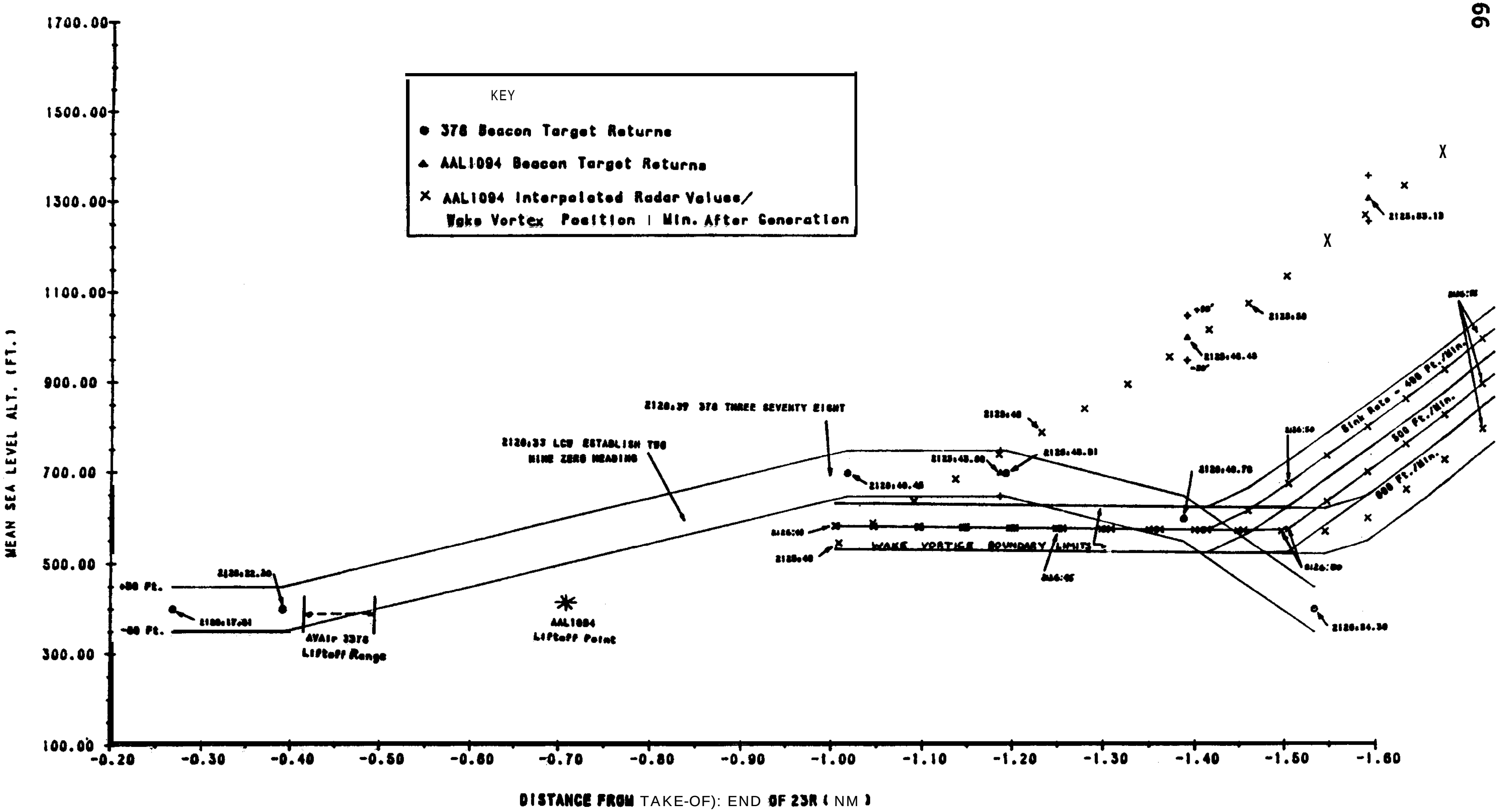
(6) After system actuation, the angle of attack should be automatically decreased to an angle which will provide a satisfactory recovery to normal flight regime without excessive loss of altitude or exceptional degree of skill, alertness, or strength on the part of the pilot(s).

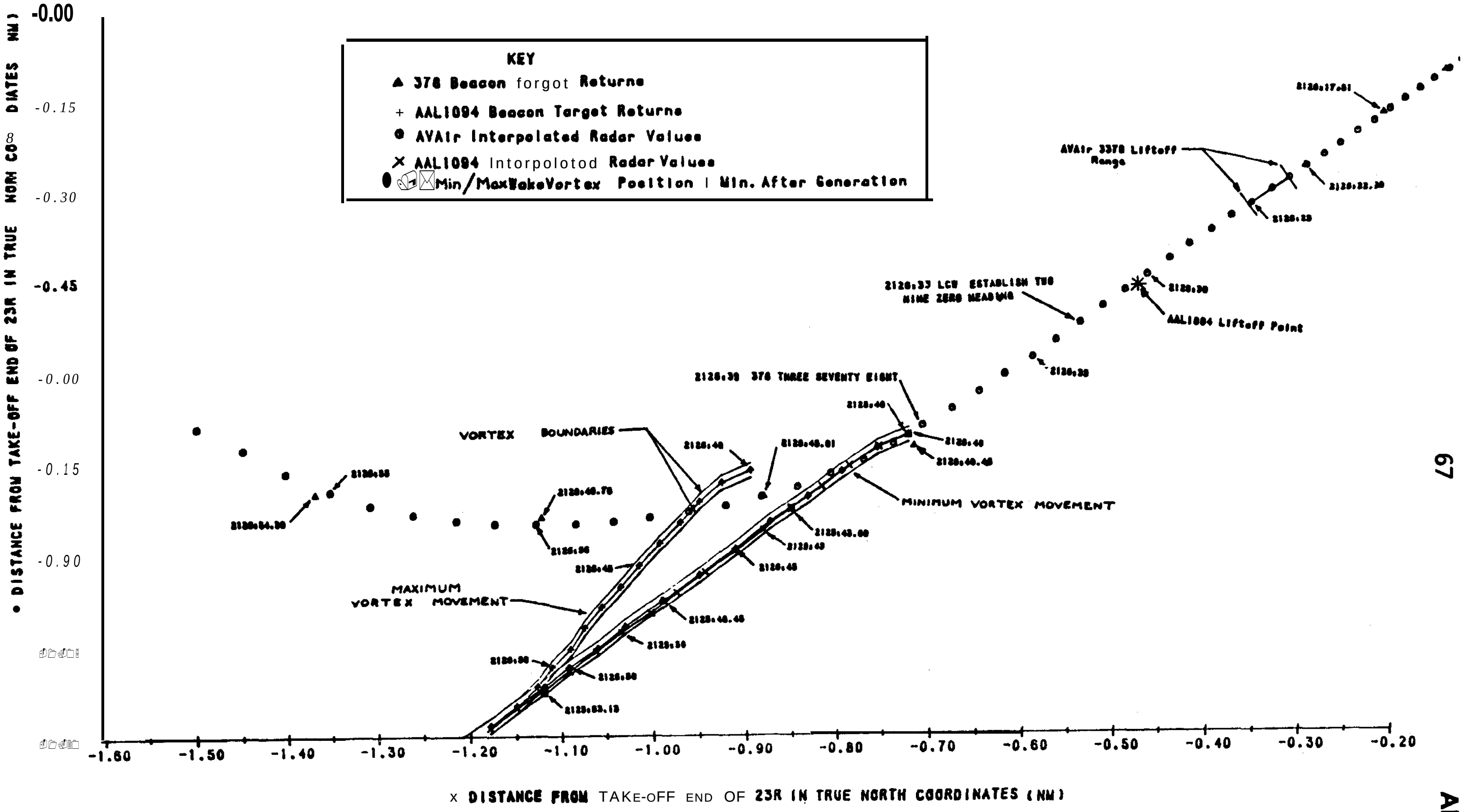
(7) Satisfactory operation of the stick pusher system during turning flight and accelerated and unaccelerated level flight for all airplane configurations should be provided.

(8) The system should not produce hazardous deviations from the flight path during flight in turbulence for all regimes of flight, i.e., climb, cruise, descent, holding, approach and landing. (The term turbulence has no definition here; however, flights should be conducted in areas of turbulence. In addition, appropriate analysis should be made to determine that encounters with severe turbulence will not result in actuation such as to create a problem in continuing controlled flight through turbulent areas.)

APPENDIX F

WAVE VORTEX POSITIONS




KEY
▲ 378 Beacon forgot Returns
+ AAL1094 Beacon Target Returns
● AVAir Interpolated Radar Values
✕ AAL1094 Intorpolotod Radar Values
Min/Max Wake Vortex Position I Min. After Generation
VORTEX BOUNDARIES
MAXIMUM VORTEX MOVEMENT
MINIMUM VORTEX MOVEMENT
AVAir 3378 Liftoff Range
AAL1094 Liftoff Point
378 THREE SEVENTY EIGHT
-0.00
-0.15
-0.30
-0.45
-0.00
-0.15
-0.90
-1.60
-1.50
-1.40
-1.30
-1.20
-1.10
-1.00
-0.90
-0.80
-0.70
-0.60
-0.50
-0.40
-0.30
-0.20
X DISTANCE FROM TAKE-OFF END OF 23R IN TRUE NORTH COORDINATES (NM)
Y DISTANCE FROM TAKE-OFF END OF 23R IN TRUE NORTH COORDINATES (NM)

ERRATA

THESE CORRECTIONS SHOULD BE MADE TO THE PREVIOUSLY PUBLISHED REPORT IDENTIFIED AS FOLLOWS

AIRCRAFT ACCIDENT REPORT

USAIR, INC., FLIGHT 183
McDONNELL DOUGLAS DC9-31, N964VJ
DETROIT METROPOLITAN AIRPORT
DETROIT, MICHIGAN
JUNE 13, 1984

NTSB/AAR-85/01 (PB85-910401)

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