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15. Supplementary Notes

16. Abstract About 1750 e.d.t., July 9, 1978, Allegheny Airlines Inc., Flight 453, a British Aerospace Corporation BAC 1-11, overran the departure end of runway 28 at the Monroe County Airport, Rochester, New York, after completing a precision approach and landing in visual flight conditions. After the aircraft overran the end of the runway, it crossed a drainage ditch and came to rest 728 ft past the end of the runway threshold. Although the aircraft was damaged substantially when it hit the drainage ditch, there was no fire. There were 73 passengers and a crew of 4 on board; one passenger was injured seriously.

The landing aircraft passed over the runway threshold at 184 KIAS--61 kns above reference speed--and landed nose wheel first at a point about 2,540 ft down the 5,500-ft runway at a speed of about 163 KIAS--40 to 45 kns above the normal touchdown speed. A go-around was not attempted.

The National Transportation Safety Board determines that the probable cause of the accident was the captain's complete lack of awareness of airspeed, vertical speed, and aircraft performance throughout an ILS approach and landing in visual meteorological conditions which resulted in his landing the aircraft at an excessively high speed and with insufficient runway remaining for stopping the aircraft, but with sufficient aircraft performance capability to reject the landing well after touchdown. Contributing to the accident was the first officer's failure to provide required callouts which might have alerted the captain to the airspeed and sink rate deviations. The Safety Board was unable to determine the reason for the captain's lack of awareness or the first officer's failure to provide required callouts.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

# AIRCRAFT ACCIDENT REPORT

Adopted: February 8, 1979

## ALLEGHENY AIRLINES, INC.
## BAC 1-11, N1550
## ROCHESTER, NEW YORK
## JULY 9, 1978

## SYNOPSIS

About 1750 e.d.t., July 9, 1978, Allegheny Airlines Inc., Flight 453, a British Aerospace Corporation BAC 1-11, overran the departure end of runway 28 at the Monroe County Airport, Rochester, New York, after completing a precision approach and landing in visual flight conditions. After the aircraft overran the end of the runway, it crossed a drainage ditch and came to rest 728 ft past the end of the runway threshold. Although the aircraft was damaged substantially when it hit the drainage ditch there was no fire. There were 73 passengers and a crew of 4 on board; one passenger was injured seriously.

The landing aircraft passed over the runway threshold at 184 KIAS--61 kns above reference speed--and landed nose wheel first at a point about 2,540 ft down the 5,500-ft runway at a speed of about 163 KIAS--40 to 45 kns above the normal touchdown speed. A go-around was not attempted.

The National Transportation Safety Board determines that the probable cause of the accident was the captain's lack of awareness of airspeed, vertical speed, and aircraft performance throughout an ILS approach and landing in visual meteorological conditions which resulted in his landing the aircraft at an excessively high speed and with insufficient runway remaining for stopping the aircraft, but with sufficient aircraft performance capability to reject the landing well after touchdown. Contributing to the accident was the first officer's failure to provide required callouts which might have alerted the captain to the airspeed and sink rate deviations. The Safety Board was unable to determine the reasons for the captain's lack of awareness or the first officer's failure to provide required callouts.

# 1. FACTUAL INFORMATION

## 1.1 History of the Flight

On July 9, 1978, Allegheny Airlines Inc., Flight 453, a BAC 1-11, operated as a scheduled passenger flight from Boston, Massachusetts, to Montreal, Canada, with an en route stop at the Monroe County Airport, Rochester, New York.

About 1657 e.d.t. 1/, Flight 453 departed Boston on an instrument flight rules (IFR) flight plan to Rochester, New York, with 73 passengers and a crew of 4 on board. The flight's cruising altitude was 24,000 ft 2/, and the captain was flying the aircraft. At 1741:30, Flight 453 established radio communications with the Rochester approach control and requested "to go straight in runway 28." The captain said that runway 28 was selected because the wind was favoring runway 28 and because of a noise sensitive area off the end of runway 22. The controller told the flight to "maintain one one thousand, altimeter 29.91 in., expect vectors ILS 28 approach." At 1742:32, the flight was cleared to descend to 3,000 ft and was given a heading to intercept the localizer inbound. At 1744:26, the controller told the flight "one six miles from Breit, 3/ cleared ILS runway 28 approach, maintain two thousand one hundred and report established on the localizer." The flight acknowledged the clearance.

According to the cockpit voice recorder (CVR) tape, at 1747:12, the captain stated "this will be a two engine ILS."

At 1748:16, the flight reported their position to the tower as being "a couple outside Breit." The tower controller cleared the flight to land. During the clearance, the surface winds were reported to be from 260° at 6 kns.

At 1749:06, the captain called for the landing gear to be lowered. This call was followed by a configuration warning horn which sounds when the flaps are extended while the spoilers are deployed.

At 1749:23 the first officer stated, "yeah, it looks like you got a tailwind here." The captain agreed with the comment. This conversation was followed at 1749:28 by a ground proximity warning system (GPWS) alert after which the first officer replied, "yeah, flaps are slower than....." At 1749:44, the GPWS again sounded. This alert was followed by a reply from the first officer, "yeah, twenty-six, there you got it." This was followed by a third GPWS alert at 1749:51.

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1/ All times herein are eastern daylight time, based on the 24-hour clock.
2/ All altitudes herein are mean sea level unless otherwise specified.
3/ A position 4.5 nmi from the landing threshold of runway 28 used as an outer marker for the ILS approach.

During an initial interview on July 11, 1978, the captain stated that during the approach he stayed within the speed parameters of the flaps and stayed on the glidepath. However, he stated, "We just never could dissipate all the speed that we picked up." He indicated that the 45° flap position was selected at 800 to 850 ft. The first officer's recollection was that the 45° flap position was selected about 1,000 ft. The captain could not recall receiving any altitude, airspeed, or sink-rate calls from the first officer during the approach. Although the first officer recalled making at least the 1,000-ft call, none was recorded on the CVR. During the final portion of the approach and landing, neither of the crewmembers could recall any specific airspeed or sink rates other than that the airspeed was a little fast; they did recall that $V_{ref}$ was 123 kns. Both crewmembers recalled that, during flap extension, it took the flaps a longer-than-normal amount of time to come down. Both crewmembers indicated that other than the slightly high airspeed there was no concern that the approach was unsafe. The captain further stated that at no time during the approach or landing did he consider a missed approach or rejected landing. Both crewmembers estimated that the aircraft touched down about 1/3 of the way down the runway. The captain stated that he flew the aircraft onto the runway "three point", and made a normal attempt to stop. He said that at touchdown the spoilers were deployed and reverse thrust was selected. He further stated that, "I didn't feel that we really got a good reverse response from the engines, although we did get cockpit indications that the clam shells opened...."

On December 8, 1978, the cockpit crew was interviewed again to resolve some unanswered questions generated by the review of findings from the recorders, a performance study, and a medical examination of the captain. During his interview, the first officer stated that (1) the aircraft was within the prescribed speeds for the extension of the landing gear and the flaps; (2) he did not agree with the speeds reflected by the flight data recorder, but the speeds he could recall were "relatively high"; (3) he believed that the approach should not have continued past the outer marker because the speeds were too high; (4) he normally makes the required callouts and could not explain their absence in this case; (5) the captain made all flap selections during the approach; (6) the captain selected reverse thrust before speed brakes; (7) he considered going around many times and tried to warn the captain in subtle ways like mentioning the possibility of a tailwind and the slowness of flap extention; (8) he thought the captain understood the meaning of these remarks and would take the appropriate action; (9) he tried to take control after touchdown but the captain had both hands on the controls; and (10) after touchdown he believes he said "go Jack" to indicate the need for a go-around instead of "oh Jack", as transcribed from the CVR.

The captain's testimony was essentially the same as given during the previous interview, except that (1) he didn't interpret the tailwind remarks made by the first officer to mean that they were too fast; (2) he confirmed his reported medical history; and (3) there were no problems which prevented the approach and landing from being foremost in his mind.

According to flight data recorder (FDR) information, the aircraft crossed the runway threshold at a speed of about 184 kns indicated airspeed (KIAS)--61 kns above $V_{ref}$. About 1750:08, the aircraft's nose wheel touched down on the runway about 2,540 ft down the runway at 163 kns. This was followed by the touchdown and subsequent failure of the right main landing gear tires at a point about 3,000 ft down the runway at a speed of about 159 kns. This was followed by the touchdown and subsequent failure of the left main landing gear inboard tire about 3,960 ft down the runway at 143 KIAS.

About 7 sec after the inboard tire of the left main landing gear failed, the aircraft departed the end of the runway at a speed of about 102 kns. Following its departure from the end of the runway, the aircraft traveled about 425 ft down a gradual slope and then traversed a 35-ft-wide, 10-ft-deep drainage ditch. Impact with the drainage ditch caused the nose landing gear to collapse rearward and both main landing gear to separate from the aircraft. The aircraft continued on and came to a rest about 728 ft past the departure end of the runway, 143 ft to the left of the extended runway centerline, on a heading of 334° magnetic.

The Rochester tower ground controller stated that the ARTS III 4/ radar display showed a 190-kn groundspeed when the aircraft was 1/2 mile from the runway. Several ground witnesses, who were also pilots, saw the aircraft from the time that it crossed the runway threshold until it left the runway. These witnesses were located on a road adjacent to the airport. They stated that the approach seemed fast and the nose was low.

Another tower controller said that the aircraft touched down nose gear first at a point near taxiway "Bravo", which crosses runway 28 about 2,500 ft from the runway threshold. None of the ground witnesses saw or heard any reverse thrust application.

Passengers on board the aircraft stated that the aircraft seemed to be going very fast just before touchdown and that the aircraft's descent profile was steeper than normal. They further stated that about 3 to 4 min before landing, the spoilers were up for about 1 min. One passenger recalled hearing the noise associated with reverse thrust for about 5 sec.

The accident occurred during the hours of daylight. The coordinates of the accident site are 43°7'24"N and 77°39'22"W.

4/ Automated Radar Terminal System - In general, an ARTS displays to the terminal controller on his radar display aircraft identification, position, altitude, and groundspeed.

## 1.2 Injuries to Persons

| Injuries | Crew | Passengers | Other |
|---|---|---|---|
| Fatal | 0 | 0 | 0 |
| Serious | 0 | 1 | 0 |
| Minor/None | 4 | 72 | 0 |

## 1.3 Damage to Aircraft

The aircraft was damaged substantially.

## 1.4 Other Damage

None

## 1.5 Personnel Information

The four crewmembers were trained and certificated in accordance with current regulations. (See Appendix B.)

## 1.6 Aircraft Information

Flight 453, a British Aerospace Corporation BAC 1-11, was certificated, maintained, and equipped in accordance with Federal Aviation Administration (FAA) requirements. (See Appendix C.) The gross weight and center of gravity (c.g.) were within prescribed limits for the landing.

The estimated landing weight at Rochester was about 68,600 lbs. At the time of the accident, about 6,500 lbs of Jet A-1 fuel were on board. Based on the aircraft weight, the $V_{ref}$ speed for a 45° flap approach was 123 KIAS, and landing speed was 123 to 118 KIAS.

## 1.7 Meteorological Information

The surface weather observations for the Monroe County Airport were, in part, as follows:

> 1650: clouds--estimated ceiling 5,000 ft broken, 10,000 broken, 25,000 ft overcast; visibility--10 statute miles; temperature--81°F; dewpoint--65°F; surface wind--250° at 5 kns; altimeter setting--29.93 inHg.
>
> 1753: clouds--4,500 ft scattered, 12,000 ft scattered, estimated ceiling 25,000 ft broken; visibility--10 statute miles; temperature--82°F; dewpoint--65°F; surface wind--240° at 6 kns; altimeter setting--29.92 inHg; remarks--aircraft mishap.

The flightcrew received the 1650 Rochester observation via ATIS "Information Julliet," which included the current weather observation and altimeter setting of 29.91 inHg.

The winds aloft recorded during the 1900 observation at Buffalo, New York, (the nearest reporting station) were:

| Height (Ft) | Direction °(True) | Speed (Kns) |
|---|---|---|
| 1,636 | 233 | 18 |
| 2,586 | 235 | 20 |
| 3,536 | 236 | 22 |
| 4,550 | 233 | 22 |
| 5,532 | 235 | 16 |

The difference in the horizontal wind vector from the surface to 1,000 ft (vertical wind shear) in the vicinity of Rochester Airport at the time of the accident was estimated to be 7 kns. This value corresponds to a vertical shear of 2 kns per 100 ft. Such a wind would be characterized as a light shear.

During the approach to Rochester, 59 sec after the tower controller had issued the surface winds as 260° at 6 kns, the first officer mentioned the possible presence of a tailwind. However, the pilot of Piper Commanche N7094Y, who had landed on runway 22 while Flight 453 was on final approach, stated that he did not note any changes in wind drift correction while on final approach. Additionally, the captain of United Air Lines Flight 978, who was on an approach to runway 22 when the accident occurred, stated that he did not experience any turbulence during the descent and approach to Rochester.

## 1.8 Aids to Navigation

An ILS is installed on runway 28. The localizer final approach course is 277°, and the glide slope angle is 2.95°. The Breit outer marker is located 4.5 nmi from the threshold of runway 28, at coordinates 43°7'37"N and 77°33'17"W. The frequency of the ILS is 109.5 MHz--the frequency selected on both of Flight 453's navigation receivers. The ILS Rwy 28 Jeppesen approach chart cautions that, after the glide slope intersects the runway, there is only 4,106 ft of runway remaining. There is no visual approach slope indicator installed on runway 28.

After the accident, the ILS was flight checked and found to be operational within prescribed tolerances.

## 1.9 Communications

No communication difficulties were reported.

## 1.10 Aerodrome and Ground Facilities

Monroe County Airport is located 4 mi southwest of Rochester, New York. Two runways were available for landing. Runway 4/22 is 8,000 ft long and 150 ft wide with a concrete surface. Runway 10/28 is 5,500 ft long and 150 ft wide with an asphalt surface. The runway surfaces were dry at the time of the accident. The elevation at the touchdown zone for runway 28 is 549 ft, and the airport elevation is 560 ft. Runway 28 has an upslope of 0.5 percent with a crown at the intersection of runway 22. The FAA last inspected the airport on August 11, 1977, according to 14 CFR 139.

## 1.11 Flight Recorders

The aircraft was equipped with a Sundstrand, Model FA-542 flight data recorder, serial No. 4359. The flight recorder and foil recording medium were not damaged, and all parameters had been recorded.

The aircraft was also equipped with a Collins Radio Company, Model 642 cockpit voice recorder. The recorder was not damaged, and the final 8 min were transcribed.

The final 3.8 min of the FDR recording was examined and the data were plotted. The data showed that the airspeed decreased smoothly from about 235 kns as the flight descended through 2,100 ft (the outer marker crossing altitude) to about 184 kns at 799 ft (decision height). The altitude data showed high rates of descent between 2,100 ft and the airport elevation of 549 ft. The average rate of descent was 1,240 fpm during the final 4.8-mile segment of the final approach. Peak descent rates reached 1,630 fpm, 2,100 fpm, and 2,375 fpm when the aircraft was 1,325 ft, 700 ft, and 510 ft above the ground, respectively. (See Appendix D.)

An additional readout was made of altitude and airspeed traces beginning where the aircraft descended through 10,750 ft. For the times indicated, the following altitudes and airspeeds were recorded:

| Time (Approximate) | Altitude (Ft) | Airspeed (Kns) |
|---|---|---|
| 1742:15 | 10,750 | 325 |
| 1743:30 | 10,750 | 288 |
| 1744:00 | 10,000 | 270 |
| 1745:09 | 6,900 | 267 |
| 1745:27 | 6,250 | 250 |
| 1746:55 | 3,925 | 223 |
| 1748:52 | 2,100 | 235 |

Because the captain recalled seeing the FDR-failure indicator light illuminate during the flight, a detailed examination was made of the recorder. A recorder malfunction could not be substantiated.

Additionally, readouts were made of the two previous flights made by N1550, and the airspeed and altitude traces were determined to be accurate.

Although the quality of the cockpit voice recording was only fair because of a high signal to noise ratio, an accurate readout of the recorder was made. In addition to the voices of the crew, it contains various sounds associated with cockpit activity and aircraft systems. (See Appendix E.)

### 1.11.1 Time-Distance Correlation

FDR and CVR data were used to determine the relationship of the following relative to the runway threshold: Aircraft position, altitude, airspeed, time, and major events recorded by the CVR. (See Appendix F.)

The FDR-indicated airspeeds were corrected for density altitude effects to yield true airspeeds. The density altitude was based on an altimeter setting of 29.91 inHg. and a surface temperature of 82°F. The 5.7-kn headwind component of the steady 6-kn surface wind was then subtracted from true airspeed to determine groundspeed. The resultant groundspeeds were then integrated for each 1-sec interval while the aircraft was on the runway to obtain the relationship between aircraft position on the runway and times and events recorded by the CVR. This interval was increased to 5 sec for the preceding 2-min period while the aircraft descended on final approach.

The comparison between the aircraft headings, recorded by the FDR, and the tire skid path on the ground established that the aircraft departed the end of runway 28 on a heading of 246° and at an airspeed of 102 kns. Time and distance data were compared to the CVR transcript to determine the aircraft's speeds and altitudes and the positions where the tires failed, where altitude alerts and GPWS alerts sounded, and where other events occurred. Before these analyses could be made, it was necessary to correlate data from these four independent data sources: CVR, FDR, altitude alerter, and GPWS. CVR and FDR data were correlated by relating the changes in aircraft ground track, determined from actual measurements on the runway, to the FDR heading trace and the CVR-recorded tire failures. Additionally, the radio transmission times, as indicated by the binary marks on the FDR foil, and the radio transmissions, as recorded on CVR, were compared. Finally, the times of the two CVR-recorded altitude alerts and the times of those altitudes recorded by the FDR were correlated. (See Appendix F.)

The results of the analyses of airspeeds, altitudes, and rates of descent were compared to their respective maximum limit as specified by the Allegheny Airlines flight manual. (See Appendix G & H.)

The flight profile shows that the aircraft followed the glide slope closely but greatly exceeded the maximum prescribed airspeeds by as much as 60 kns. During the approach between the outer and middle markers, the airspeed was about 50 to 60 kns above the maximum flap speed and above the stabilized airspeed limits specified by company procedures, and 40 to 45 kns above these limits at touchdown. The aircraft crossed the outer marker on the glide slope while descending about 1,000 fpm at an airspeed of 238 kns. While descending through 1,700 ft at 230 kns, the captain called for landing gear extension. The average rate of descent between the outer and middle markers was 1,240 fpm. Peak values of over 2,000 fpm were recorded within 2 nmi of the runway threshold. Coinciding with the peak rates of descent was the captain's comment on the CVR, "We'll make it, gonna have to add power." Ten seconds later the rate of descent decreased to 1,000 fpm and 20 sec later the rate of descent decreased to 500 fpm. The airspeed at the middle marker and at the threshold was 184 kns. The altitude at the threshold was about 50 ft above the elevation of the runway touchdown zone. Based on a witness statement that the aircraft first touched down on the nose gear opposite taxiway B, the touchdown speed was calculated at 163 kns; 2,960 ft of the 5,500-ft-long runway would have remained. The right main gear touched down at 159 kns with 2,490 ft of runway remaining. The tires on the right main landing gear blew out as the aircraft decelerated through 150 kns with 2,070 ft of runway remaining. With 1,540 ft of runway remaining and at 143 kns, the left inboard tire on the main landing gear blew out. The aircraft decelerated through 113 kns--$V_2$ speed--with about 500 ft of runway remaining.

During the 6-sec interval between the aircraft's crossing the threshold and nose-gear touchdown, the aircraft decelerated from 184 kns to 163 kns--a rate of 3.5 kns per sec. The British Aerospace Corporation determined that this airborne rate of deceleration was possible for 45° flaps, idle thrust, and fully extended speed brakes during the landing maneuver. If speed brakes were not used, BAC determined that 9.5 sec would be required to decelerate 21 kns. However, considering the tolerances of airspeed and FDR timing data, the use of speed brakes during the landing maneuver could not be substantiated.

## 1.12 Wreckage and Impact Information

The aircraft overran the departure end of runway 28 at the left corner. The aircraft traveled about 425 ft down a slope, where it traversed a 35-ft-wide, 10-ft-deep ditch. When the aircraft hit the ditch the nose landing gear collapsed rearward into the lower fuselage and both main landing gear assemblies separated from their upper attachments.

Before the aircraft came to rest, the left main landing gear was propelled over the fuselage. It impacted the top fuselage skin and came to rest adjacent to the left side of the aircraft. (See Appendix I.) The fuselage was creased and buckled in several areas. However, the empennage was not damaged.

The wing-to-fuselage attach points were not damaged, and the main wing assemblies were relatively intact. The wingtips and structure between the main spars were undamaged, except where the left and right main landing gears were torn away. All spoiler panels and both ailerons were intact and undamaged. All of the wing flap jackscrews were found fully extended. The fuel tanks did not rupture and fuel did not spill.

The No. 1 tire remained inflated, but exhibited ridges on the treads with the highest point of the ridges on the center and inboard treads. There were scuff marks on the inboard side of the tire between the sidewall at right angles to the tread. There was no evidence of milling (flat spots) and the treads were in good condition. The No. 1 wheel had been loosened on the axle when the axle sleeve was flaired by the inboard bearing spacer.

The No. 1 brake assembly appeared to be worn beyond limits. It was not disassembled and examined on scene, but was retained for further testing and examination.

The No. 1 antiskid drive shaft was disconnected from the drive cover. The unit was operational when spin tested. The wheel bearings were also checked and found to be in good condition.

The No. 2, No. 3, and No. 4 tires had milled away to the point of failure in one area of the tread. All three tires remained on the wheel assemblies, and there was no evidence that the wheels contacted the runway surface.

All three brake and wheel assemblies were serviceable. All three antiskid drive shafts were in place, and spin tests were satisfactory. All of the wheel bearings were in good condition, except for the No. 2 inboard bearing, which had indentations on two rollers.

Both tire and wheel assemblies on the nose landing gear remained intact and inflated. The tread on both tires was in good condition. Part of the rim of the left tire had been torn away.

Both engines remained attached to the aft fuselage, and the nose cowls had been damaged by impact.

The reverser system on each engine was functionally checked. The cockpit controls were used during the test along with an outside air tank, which was charged to 25 psi, providing 20 cubic-ft-per-minute of air. The right engine reverser was found to open or close in 1.5 sec. The left engine reverser opened or closed in 2.5 sec. According to the Allegheny Airlines engine shop, the reverser will normally open or close in 2.0 sec. The fuel scheduling to the engine during the reverser checks was found to be satisfactory.

The spoiler system could not be functionally checked but the spoiler control examination and the satisfactory spoiler operation during the flight indicated that the system was capable of satisfactory operation during the landing.

## 1.13 Medical and Pathological Information

Only one of the occupants of the aircraft was seriously injured. An elderly woman sustained a compression fracture of the first lumbar vertebra. Eight other passengers and a flight attendant were injured slightly. Their injuries included sprains, contusions, lacerations, and bruises. The one serious injury and eight minor injuries resulted either from the collapse of the overhead passenger service units or from the evacuation.

An examination of the captain's medical records disclosed that during the previous 1 1/2 years, his distant visual acuity had deteriorated from 20/20 to 20/200. Additionally, he had been issued a First-Class medical certificate on January 24, 1978, without the required waiver. A demonstrated ability waiver is required when the distant visual acuity is less than 20/100. In cooperation with the Safety Board's investigation of the accident the captain submitted to a complete eye examination. The examination disclosed that his distant visual acuity was near normal. During the examination the following medical history was disclosed:

> "The patient has difficulty with close vision. This was first noted about six years ago. More recently, he has worn bifocals. His last glasses change was three years ago. He states that he has difficulty following words on a line and needs to use his finger to keep his place. The patient has had a problem with photophobia when he awakens at night. Sometimes it takes about an hour until the eyes are comfortable. He has a sensation of the lids being stuck to the eyes and a gritty feeling in the eyes. Sometimes, when he looks in the rear-view mirror and then looks forward again, there is difficulty adapting to the new position and, also, there is sometimes a problem in orienting his vision to a view after looking in another direction.
>
> The patient states that he is generally in good health. Five years ago, he developed a problem with a sensation of sudden nausea and light-headedness which lasts about twenty seconds and occurs about one or two times per day. The cause was not discovered. The patient states that he has been followed for this by Dr. Jules Friedman in Dr. Strang's office at Boston University. The patient has forty percent hearing loss in the right ear."

During the interview of December 8, 1978, the captain stated that the periods of sudden nausea and light-headedness have not abated; however, he has never experienced them in flight.

## 1.14 Fire

There was no fire.

## 1.15 Survival Aspects

This was a survivable accident. The evacuation of the aircraft was completed in about 90 sec. The cockpit crew and the 2 flight attendants successfully evacuated all 73 passengers. The aircraft fuselage remained intact. None of the seats or seatbelts failed. Twenty-seven overhead passenger service units, including reading lights, oxygen panels, and flight attendant call buttons, failed and swung down in front of seated passengers; these units partially blocked egress from some seats. A passenger's cane caught between the galley door and slide; a flight attendant was able to free it.

The main passenger entry door jammed and could be opened only 8 inches because of deformation. However, the captain was able, after some delay, to open the door. Finally, the nylon webbing on the passenger entry door slide failed during the evacuation, but the captain was able to leave the aircraft and hold the slide in place. The nylon webbing had worn with age and was no longer capable of withstanding the evacuation forces.

The control tower sounded the crash alarm at 1755; simultaneously, the crash-fire-rescue (CFR) team prepared for departure to the crash scene. The control tower also contacted the airport manager and the city fire dispatcher. The city fire dispatcher then notified appropriate agencies. The first firetruck arrived at 1758; the first ambulance arrived at 1800 and the last at 1805. The Rochester Police, who arrived at 1800, and the Airport Security personnel secured the accident site.

## 1.16 Tests and Research

### 1.16.1 Cockpit Instruments

The Safety Board tested both altimeters, both airspeed indicators, and both vertical speed indicators. Although some minor discrepancies were noted during the tests, all of the instruments, except for the first officer's altimeter, were within manufacturer's tolerances. His altimeter was out of tolerance by 10 ft at 1,000 ft and 20 ft at -1,000 ft.

### 1.16.2 No. 1 Brake System Tests

The No. 1 brake modulation valve was tested and found to be serviceable. The No. 1 brake assembly was tested and disassembled for examination. During hydraulic testing, the brake functioned satisfactorily and did not leak. Examination of the assembly components disclosed that all components were serviceable.

### 1.16.3 The Altitude Alert and Ground Proximity Warning System

The CVR recorded two altitude alerts and three GPWS alerts ("whoop, whoop, terrain--whoop, whoop, terrain"). An altitude alert would sound at the upper altitude (3,050 ft) and lower altitude (1,800 ft) limits for the altitude selected (2,100 ft). This selected altitude was the glideslope intercept altitude and the altitude that ATC had specified in the approach clearance. The upper and lower altitude alerts were recorded as the aircraft descended through 2,900 ft and 1,750 ft, respectively, indicating proper performance of the altitude alert system and acceptable correlation between the CVR and FDR data.

Based on the aircraft performance data and the GPWS operating specifications, the Safety Board determined that the GPWS alerts were mode 1, excessive rate of descent, for the first alert, and mode 4, flap handle less than 26° with landing gear extended and excessive rates of descent, for the second and third alerts. (See Table 1.) BAC estimated that flap extension from 18° to 26° at 192 kns would require 1.3 sec and that flap extension from 18° to 45° at 192 kns would require 4.1 sec. Thus, the third alert would not have sounded had the flap handle been moved when the first mode 4 alert sounded.

Table 1.--Ground Proximity Warning System GPWS and Aircraft Performance Data

| Seconds Before Touchdown | GPWS Mode | Altitude (ft) | | Rate Of Descent (Ft/min.) | Distance From Runway (Nmi) | KIAS |
|---|---|---|---|---|---|---|
| | | msl | agl | | | |
| 40 | 1 | 1,350 | 800 | 1,700 | 2.2 | 212 |
| 24 | 4 | 890 | 340 | 1,100 | 1.1 | 196 |
| 17 | 4 | 800 | 250 | 750 | 0.7 | 186 |

### 1.16.4 Performance Derived From ATC Radar Data

The Safety Board used position and altitude data recorded by the Cleveland Air Route Traffic Control Center (ARTCC) to verify the FDR airspeed and altitude data. The Cleveland Center NAS Stage-A computer recorded the position, altitude, and time for Flight 453 every 30 sec. The last recorded data coincided with the threshold of runway 28. At that point, the aircraft was shown descending through 600 ft, 40 ft agl.

Based on ATC data the average rate of descent between 1,900 ft and 600 ft was 1,280 fpm. This rate agreed with the 1,240-fpm rate determined from the FDR altitude data recorded between 2,100 ft and 550 ft.

The ATC altitude recorded at 1.03 nmi outside the outer marker was 2,500 ft; the altitude recorded at 0.98 nmi inside the outer marker was 1,900 ft. Based on these data, the altitude calculated for the outer marker was 2,192 ft. This derived altitude closely agrees with the altitude recorded on the FDR and agrees with the minimum published altitude for the outer marker.

The average flightpath angle between 1,900 ft and 600 ft was 3.5°. In order to maintain such an angle with a 1,280-fpm rate of descent, groundspeed must average 207 kns. This groundspeed converts to an indicated airspeed of 213 kns--the same as recorded by the FDR.

### 1.16.5 Analysis of BAC 1-11 Stopping and Go-Around Performance

BAC provided the Safety Board with estimated aircraft stopping and go-around performance which was based on flight test data. The stopping distance data were based on five touchdown speeds assuming various combinations of engine thrust reversers, wheel brakes, and speed brakes. (See Table 2.) The highest demonstrated touchdown speed was 135 kns. However, BAC estimated that the highest touchdown speed would be 150 kns, 9 kns less than the main gear touchdown speed of Flight 453; therefore, the stopping distance from 159-kn was extrapolated from the 150-kn and lower speed data.

Table 2.--BAC 1-11 Minimum Stopping Distance
(Corrected To Flight 453 Conditions)

| Touchdown Speed | STOPPING DISTANCE | |
|---|---|---|
| | Required (Using All Stopping Devices) | Available To Flight 453 |
| (Kns) | (Ft) | (Ft) |
| 159 | 2,500 | 2,400 |
| 150 | 2,140 | 2,100 |
| 135 | 1,680 | 1,280 |
| 121 | 1,280 | 800 |
| 106 | 950 | 280 |
| 102 | 880 | 0 |
| 92 | 690 | - |

Extrapolation of the BAC minimum stopping data to 159 kns, the main gear touchdown speed of Flight 453, resulted in a minimum stopping distance estimate of 2,500 ft, which exceeded the 2,400-ft value available to Flight 453 for stopping. For the 150-kn case, the estimated minimum stopping distance was 2,140 ft, 100 ft more than Flight 453 had available for stopping at 150 kns when the two right tires failed.

BAC provided go-around performance data using Flight 453's weight, the density altitude, and the surface wind conditions. Full reverse thrust and full landing flaps were assumed to be present when a go-around decision was made. The BAC analyses show that a successful go-around from the runway was possible at any point during the landing roll between 159 kns and 134 kns; these speeds occurred just after the left main tire failed. Had a go-around been initiated at 159 kns, the aircraft would have been airborne in 3 sec with 1,740 ft of runway remaining. Had a go-around been initiated at 150 kns, the aircraft would have become airborne in 5 sec with 1,300 ft of runway remaining. In both cases, the aircraft would have become airborne in a nose-level attitude with flaps at 45°.

## 1.17 Other Information

### 1.17.1 Excerpts from 14 CFR 91

§ 91.70 Aircraft Speed.

(a) Unless otherwise authorized by the Administrator, no person may operate an aircraft below 10,000 feet MSL at an indicated airspeed of more than 250 knots (288 m.p.h.).

(b) Unless otherwise authorized or required by ATC, no person may operate an aircraft within an airport traffic area at an indicated airspeed of more than--

Paragraph (b) of this section does not apply to any operations within a Terminal Control Area. Such operations shall comply with paragraph (a) of this section.

(1) In the case of a reciprocating engine aircraft, 156 knots (180 m.p.h.); or

(2) In the case of a turbine-powered aircraft, 200 knots (230 m.p.h.).

(c) No person may operate an aircraft in the airspace underlying a terminal control area, or in a VFR corridor designated through a terminal control area, at an indicated airspeed of more than 200 knots (230 m.p.h.)

However, if the minimum safe airspeed for any particular operation is greater than the maximum speed prescribed in this section, the aircraft may be operated at that minimum speed.

## 1.17.2 Excerpts from the Allegheny BAC 1-11 Pilot's Handbook

### Speed Limitations

#### Wing Flaps Extended Speed

"The maximum permissible speed for extending or retracting the wing flaps, and for flight with the flaps extended are:

Beyond 0° to not more than 18°--220 kns IAS
Beyond 18° to not more than 26°--180 kns IAS
Beyond 26° to not more than 45°--170 kns IAS

NOTE: Allegheny maximum speed for extending 26°-45° flaps is 160 kns IAS. Other flap settings should also normally be extended at less than the maximum speeds.

"The maximum permissible speed for extending the wing flaps in emergency, using the DC hydraulic pump, is 180 kns IAS.

The flaps must not be extended above 15,000 ft."

#### Landing Gear Extended Speed

"The maximum permissible speed for extending and retracting the landing gear is 220 kns IAS, but when the gear is fully extended and the doors are closed, the maximum is Vmo/Mmo (operating limit speed). If any gear has been lowered by free-fall, or if any landing gear door is not closed and locked, the maximum speed is 220 kns IAS."

#### Stabilized Approach Factors

"The stabilized approach requires the aircraft in landing configuration at proper airspeed and sink rate by 500-800 ft above the ground on a straight-in approach, by 300 ft on a circling approach.

"Approach procedures must be standardized as much as is possible consistent with existing conditions. Following are definitions and explanations of approach components:

| | |
|---|---|
| Stabilized Approach | Stabilized airspeed, stabilized sink rate, and a constant profile. |
| Normal Sink Rate | 500-700 fpm |

| | |
|---|---|
| Reference Speed ($V_{ref}$, or "bug" speed). | The 1.3 Vs speed. As certificated, the airplane is assumed to be at this speed 50 ft above the runway threshold in landing configuration. This speed value from the V-chart is placed under bug on the airspeed indicator, as are mechanical types of speed additives, such as when landing with hydraulic failure (3rd elevator). During strong and/or gusty wind conditions, certain increments are added as wind additives but they are not placed under the bug. |
| Initial Maneuvering | 18° |
| Approach Flap | 26° |

"During maneuvering to final approach, target airspeed is the maneuver speed for the appropriate flap setting from the V-chart.

| | |
|---|---|
| Landing Flap | 45° (26° single engine) |
| Gust | Difference between reported wind and peak gusts. Example: wind 320° at 20K with gusts to 30K. Gust equals 10K. |
| Gust Factor | One half (1/2) of gust = 5 kns. |
| Headwind Component | Effective headwind (steady state). Example: Runway heading 260° wind 320° at 20 kns, gust to 30 kns. Headwind component, 10 kns. |
| Headwind Factor | One half (1/2 of headwind component = 5 kns. |
| Final Approach Speed | $V_{ref}$ (bug) speed plus 5 kns plus wind (headwind and gust) additives. Minimum speed is normally bug plus 5 kns, maximum speed is normally bug plus 15 kns. Abnormal approaches (zero flap, significant wind shear reported or suspected, etc.) may require modification of these values. |

"The MINIMUM final approach speed should not be less than $V_{ref}$ plus 5 kns on a normal 45° flap (or a 26° flap single engine) approach. The MAXIMUM total additives should not normally be greater than 15 kns. Dissipate additives in the final portions of the approach, retaining only bug plus the gust additive (minimum 5 kns) until in the target flare speed envelope.

| | |
|---|---|
| Target Flare Speed | The target flare speed envelope is the transition sector, when reducing speed from stabilized approach speed to touchdown. When reducing descent rate prior to touchdown, target speed is $V_{ref}$ (bug) plus any gust factor, with a minimum of bug plus 5 kns. |
| Touchdown Target | 1,000 ft from approach end of runway, speed something less than $V_{ref}$ (such as -5 kns)." |

ILS Approach Procedures

"The appropriate ILS frequency should be selected well in advance of its intended use, 10 minutes if possible. Monitor for station identification and normal operation, checking the flag alarm system as well as other indications. All other instruments and cockpit components which are to be used during the approach should be checked.

"The appropriate approach plate should be referred to and all applicable supplementary aids tuned and identified. Outbound, procedure turn, and inbound headings and altitudes should be studied. The appropriate minimums and pull-up procedure should be noted.

"Prior to starting the approach, the PRELIMINARY LANDING checklist shall be accomplished and the airplane slowed to the approach speed as outlined in the pilot's Handbook. This will enable the flightcrew to give undivided attention to tracking the localizer and glide path during approach.

"On being cleared for descent or an approach (or outbound from the outer marker), the airspeed should be slowed between a maximum of 200 kns and chart maneuver speed for 18° flaps, the preliminary checklist completed, and approach discussed. Normally, the aircraft should intercept the final course at least five miles from the outer marker. Proper interception of the localizer and glideslope simplify and increase the accuracy of the ILS approach.

After intercepting the localizer and at 1 1/2 dots below the glideslope, lower the gear DOWN, call for final LANDING checklist. At 1/2 dot below the glideslope, extend 26° flaps. At final fix inbound extend 45° flaps. Allow the airspeed to bleed to $V_{ref}$ plus 5 kns, plus necessary wind additives. Stabilize final approach speed by 500-800 ft above field elevation.

"Monitor speed and rate of sink closely. Regardless of whether approach is being made with raw information, the integrated instrument system, or the autopilot coupler, the localizer needle and glideslope pointer are the main indicators to be monitored. These are the end result; other instruments and aids are only a means of obtaining this result. All instruments and indications must be continually cross-checked. Significant deviations of planned sink rate, speed or power may indicate wind shear."

1.17.3 Excerpts From Allegheny Flight Operations Manual

Crew Coordination Procedures During Approach

"Duties of the pilot not flying the aircraft during the descent and approach (Pilot flying should make any call out the other pilot is not able to make):

"He should monitor engine instruments, cross check flight instruments, re-set radio frequencies as necessary, and be ready for gear, flap, and other commands.

"He should be ready, in the event of a missed approach, to assist with the pull up (power, flaps, gear, etc.) and subsequent execution of the missed approach procedure.

"Call out approaching 18,000 ft as a reminder to reset altimeters.

"Call out 10,000 ft.

"At 1,000 ft above airport elevation, call out 1,000 ft. (Both VFR and IFR)

"In VFR Conditions

"At 500 ft above airport elevation call out 500 ft, then call out airspeed and rate of descent. (Examples: 120, sink six or, in aircraft so equipped Bug plus five, sink six.) Thereafter, call out any deviations of altitude, airspeed and/or rate of descent from normal, programmed rates.

"In IFR Conditions

"At 500 feet above airport elevation, call out 500 ft, then call out airspeed, rate of descent, and No flags as appropriate. Thereafter, throughout the approach, call out any deviations of altitude, airspeed and rate of descent from normal, programmed rates.

"NOTE: The pilot not flying should check altitude, airspeed, sink rate, and for flag alarms on his own instruments. The pilot flying, upon hearing the call outs, should check his own flight instruments for comparison and for correct operation."

<u>Responsibility of Pilots</u>

<u>Captains</u>

Captains are directly responsible to the Vice President-Flying, or to his designee.

Captains are responsible for compliance with all Federal Aviation Regulations, Company regulations, scheduling policy, etc., applicable to their duties.

The Captain is, during flight time, in full command of the aircraft and crew, and is responsible for the efficient conduct of the flight. He is responsible for the safety of the aircraft and crew, passengers and cargo.

The Captain is responsible for the exercise of judgement and discretion in planning the flight, and is responsible for taking all pertinent factors into consideration.

The Captain, when enroute, is responsible for the proper servicing of the aircraft, but actual refueling is done by a responsible person or agency, and the Captain may delegate a certificated airman to ascertain that servicing is properly performed.

The Captain is responsible for all flight records kept in the cockpit, but may delegate the responsibility to a qualified person.

The Captain is responsible for preparation of reports on irregularities or incidents with regard to aircraft damage, flight irregularity, etc.

He is responsible for the conduct and for the proper performance of duties of other crew members.

The Captain is responsible for his flight time limitations. He shall also be responsible for maintaining his qualifications with reference to route and airports, aircraft, and his physical requirements, and shall be responsible for notifying the Company of changes in such qualifications.

In case of aircraft malfunction or emergency, the Captain will designate the person responsible for flying the aircraft. That person will be responsible for navigation, ATC instructions, and aircraft control.

First Officer

The First Officer is designated as second in command, is directly responsible to the Captain, and would assume command if the Captain should become incapacitated.

First Officers are responsible for compliance with all Federal Aviation Regulations, Company regulations, Scheduling Policy, etc., applicable to their duties.

The First Officer has the responsibility of aiding the Captain in the safe and efficient conduct of the flight, from flight pre-planning through termination duties. He is instrumental in helping to maintain a high degree of crew coordination and cockpit discipline.

He should constantly strive towards becoming proficient in the duties and exercise of judgement as required of a Captain.

The First Officer is responsible for his own flight time limitations, and for maintaining his qualifications with reference to aircraft and physical requirements. He shall be responsible for notifying the Company of changes in his qualifications.

Crew Coordination

All cockpit crew members shall assist the Captain in monitoring and crosschecking instruments, mode selectors, bug settings, assigned altitudes and headings, control positions including flaps, spoilers, landing gear, stabilizer position, etc., during all flight regimes.

All crew members must realize that the Captain is in complete command of the airplane and his orders are to be obeyed, even though they may be a variance with written instructions. Any potential or actual emergency situation should be immediately called to his attention. If the First Officer is actually manipulating the controls at this time the Captain shall assume complete command. Only he shall initiate such emergency procedures as engine shutdown, engine extinguishant discharge, aborted take-off, rejected landing, go-around, etc. (If the Captain must be absent from the cockpit, the First Officer is in command and must make the necessary decisions.)

To insure continuous and positive control in the event of aircraft malfunction or emergency, the Captain shall ensure that either he or the First Officer is responsible for flying the aircraft. The person flying in the aircraft must not allow himself to become distracted by the emergency or incident that is occupying the other crewmembers and must understand what is expected of him as far as control of the aircraft is concerned.

## 2. ANALYSIS

The aircraft was certificated, equipped, and maintained according to applicable regulations. The gross weight and c.g. were within prescribed limits. Meteorological conditions did not adversely affect the flight. Visual flight conditions were excellent during the entire flight. The Safety Board believes that the vertical shear was too light to be a factor in this accident.

The flightcrew was properly certificated and qualified in accordance with company and FAA requirements and regulations.

The Nos. 2, 3, and 4 tires had been milled away in one spot, and the No. 1 tire had not. Therefore, either the Nos. 2, 3, and 4 antiskid units were inoperative, or the brakes were applied before the main landing gear touched down. Based on witness observations, crew testimony, runway marks, and wreckage examination, the Safety Board concludes that the nosegear touched down before the main landing gear and that the brakes were applied before the main landing gear touched down. Therefore, since the antiskid system did not have the required tire spinup before the main gear touched down with locked brakes, the tires blew. Since the No. 1 tire did not fail, the No. 1 wheel probably had sufficient spinup for the antiskid unit to operate properly. The No. 1 tire had time for spinup because only the No. 2 tire contacted the runway at touchdown. Examination and testing of the No. 1 brake indicated that it was capable of functioning normally. Since the right landing gear tires had failed and the No. 1 tire had deflected slightly, the right wing dropped to a point where only the No. 2 tire was in contact with the runway surface while the brakes were locked. Because the No. 2 tire failed about 150 ft after it touched down, the Safety Board concludes that at some point just before or after the No. 2 tire failed, the pilot recycled the brakes and the No. 1 tire started to spin up. When the brakes were reapplied, the No. 1 antiskid unit functioned to protect the tire. The fact that the No. 1 tire only contacted the runway surface on the center and inboard treads, causing the inboard bearing spacer to flare the axle sleeve, substantiates this conclusion.

The entire reverser systems of both engines were functionally tested and both reversers and associated engine fuel scheduling operated satisfactorily. Although the spoiler system could not be functionally checked because of impact damage, witness observations of speed brake activation and crew statements that speed brakes were used during the descent, support a conclusion that the spoilers were operational before impact. Additionally, a review of aircraft records disclosed no recent malfunctions or abnormalities that might have lead to a malfunction of either of these systems. Although the captain stated that he deployed the spoilers and selected reverse thrust after touchdown, the extent of use of either of these systems could not be determined.

In view of the foregoing, the Safety Board concludes that the the aircraft's airframe, systems, powerplants, and components were not factors in this accident.

The Safety Board's investigation revealed that the captain's conduct of Flight 453 was deficient in several aspects.

The captain allowed the aircraft to exceed the maximum airspeed limitations for operations in the National Airspace System. Federal Regulation 14 CFR 91.70 requires that aircraft be operated at indicated airspeeds of 250 kns or below at altitudes below 10,000 ft. The regulation further specifies that the maximum indicated airspeed is 200 kns for turbine-powered aircraft within a 5 statute-mile radius of the center of the airport and up to, but not including, 3,000 ft above the airport. FDR data reveal that during the descent the aircraft exceeded 250 KIAS until it reached an altitude of 6,200 ft, and that the indicated airspeed on the final approach was above 200 kns until the aircraft was within 2 statute miles of the center of the airport.

Except for altitude control, the entire approach was unstabilized and exceeded by a significant margin both the airspeed and rate of descent limitations prescribed by Allegheny Airlines. Additionally, the gear and flaps were extended at speeds above those authorized by the company.

Allegheny flight manual procedures for airspeed management for an ILS approach specify at least seven locations along the 7-mile final approach and landing path at which specified maximum airspeeds should not be exceeded. (See Appendix G.) The procedures specified that a stabilized airspeed of 138 kn ($V_{ref}$ + 15) be achieved between 800 ft and 500 ft above the ground. For this speed, the rate of descent would have been 730 ft per minute at the point where the first officer (pilot not flying) was required to call out deviations from target descent rates and bug speed ($V_{ref}$ + additives). However, the first officer did not make any altitude calls, descent rate deviation calls, or airspeed deviation calls even though the actual rates of descent did not stabilize and exceeded the maximum descent rate of 1,000 fpm, which required a go-around. (See Appendix H.)

The dangerously high rates of descent of over 2,000 fpm within 2 miles of the threshold and the first GPWS alert should have indicated to the crew that the approach was improper and that a missed approach was necessary. None of the three GPWS alerts caused the crew to take the necessary corrective action even though company procedures dictated otherwise.

There were no flap callouts recorded on the CVR. The captain stated that, when the configuration warning sounded, the flaps were at 18°. The CVR recorded this warning when the aircraft's airspeed was 222 kns, its altitude was 1,100 ft, and it was 3.0 nmi from the threshold. At this point, flaps should have been 45° and speed should have been below 160 kns and decreasing during the next 1.4 nmi to no more than the maximum stabilized airspeed of 138 kns ($V_{ref}$ + 15).

The only evidence to indicate where the 45° landing flaps were selected is the captain's statement that they were set at 850 ft (290 ft a.g.l.) and the first officer's statement that they were selected at 300 ft. At these altitudes the aircraft would have been 0.8 nmi from the runway threshold and at an airspeed of 188 kns. This speed exceeds Allegheny's airspeed limit for 45° flaps by 28 kns. Moreover, the selection altitude was below the 1,000-ft limit established by Allegheny. The captain stated that he did not look at his airspeed over the threshold, but estimated it to be a little fast by a "seat of the pants" feeling. When the aircraft crossed the landing threshold at 184 kns ($V_{ref}$ + 61 kns), the captain's decision to continue to a landing must be considered highly unusual.

The captain was obviously not fully cognizant of the excessive deviations from stabilized parameters because of a breakdown in crew coordination and inadequate monitoring of cockpit instruments by both he and his first officer. Such excessive deviations from a normal approach would have caused an alert and prudent captain to execute a missed approach. Yet, when questioned, the captain stated that he never considered such an action. The far end of the runway end was visible when the flight was airborne, and cues were available for assessing the amount of runway remaining. Even after the brakes were locked, the captain had sufficient airspeed to go around. He had only to advance the power, select 18° flaps, and rotate the aircraft; yet he did not. Based on aircraft performance calculations using full reverse thrust, full ground spoilers, and maximum braking, the aircraft could not have been stopped on the remaining runway after touchdown.

Since the captain's awareness level during the approach was well below that expected, the question arises as to why an experienced captain would make such a grossly improper approach and continue to a landing when a missed approach could have been successfully accomplished even after touchdown. The only plausible reasons for the captain's substandard performance involve physiological or psychological factors. After the accident, the Safety Board reviewed the captain's recent FAA medical examination and found that his distant visual acuity was decaying rapidly. This finding led to a complete ophthalmological examination, which disclosed that the captain's distant visual acuity was near normal. Additionally, the captain's medical history showed that he had experienced problems in light accommodation and distant to near visual accommodation, and 5 years before the accident he had experienced problems with sudden nausea and light-headedness. No physiological basis was found for these reported symptoms, and examining physicians agree that these symptoms may not have had a physiological basis.

The captain has recently undergone neuropsychiatric evaluation at the request of Allegheny and has been found psychiatrically fit to return to flying. This evaluation was performed by a psychiatrist well qualified in the aviation field and currently a psychiatric consultant to the Federal Aviation Administration. The results of this evaluation did not indicate the reason for the substandard performance of the captain.

It should be noted that the ophthalmological and neuro-ophthalmological examinations have been performed through the efforts of the Safety Board; however, since there is no authority to require such examinations of surviving crewmembers, the evaluations were not timely and contributed little to the investigation other than to rule out the presence of detectable preexisting organic disease.

While the ultimate responsibility for decisions affecting the safety of the passengers, the crew, the cargo, and the aircraft rests with the pilot-in-command, the crew concept dictates that the pilot not flying assist the flying pilot in the performance of the latter's duties to insure that the cockpit workload remains at an acceptable level throughout an approach and landing.

The Board believes that the captain may have controlled his approach more successfully had the first officer performed the duties required by the company for the pilot not flying. Specifically, the CVR disclosed that the first officer did not make any of the required altitude, descent rate, or airspeed callouts during the approach. His failure placed added workload on the captain during the most critical period of the flight--the approach and landing. This accident again illustrates the importance of disciplined crew coordination and emphasizes the need for flightcrew members to continue to make required, as well as meaningful, callouts, including excessive descent rates and airspeeds.

The Safety Board is concerned with the first officer's failure to call the captain's attention to the excessive deviations from approach speeds and rates of descent and to take corrective action when he recognized that a dangerous situation was developing. The first officer's flight experience and particularly his experience in the BAC 1-11 should have led him to more actively monitor the approach's progress and should have led him to recognize the need for immediate corrective action when he saw the aircraft's excessive speed during the approach. As the Board stated in a previous Allegheny accident at New Haven, Connecticut, on June 7, 1971:

> "The concept of command authority and its inviolate nature, except in the case of incapacitation, has become a tenet without exception. This had resulted in second-in-command pilots reacting diffidently in circumstances where they should perhaps be more affirmative. Rather than submitting passively to this concept, second-in-command pilots should be encouraged under certain circumstances to assume a duty and responsibility to affirmatively advise the pilot-in-command that the flight is being conducted in a careless or dangerous manner. Such affirmative advice could very well result in the pilot-in-command's reassessing his procedures.
>
> The regulations prescribe that the pilot-in-command, during flight time, is in command of the aircraft and is responsible for the safety of the passengers, crewmembers, cargo and airplane. In this regard, he has full control and authority in the operation of the aircraft.
>
> The second-in-command is an integral part of the operational control system in-flight, a fail-safe factor, and as such has a share of the duty and responsibility to assure that the flight is operated safely. Therefore, the second-in-command should not passively condone an operation of the aircraft which in his opinion is dangerous, or which might compromise safety. He should affirmatively advise the captain whenever in his judgment safety of the flight is in jeopardy."

## 3. CONCLUSIONS

### 3.1 Findings

1. The aircraft was certificated and maintained in accordance with approved procedures.

2. There is no evidence that the aircraft structure, systems, flight controls, or powerplants were involved in the causal area of this accident.

3. Visual meteorological conditions existed at the time of the accident. Although there was a light wind shear, it was not significant and had no influence on the approach and landing.

4. The flight data recorder functioned normally during the flight.

5. All crewmembers were certificated and qualified for the flight.

6. During the descent for the approach to Rochester, the flight's airspeed exceeded 250 kns below 10,000 ft.

7. The crew did not comply with checklist procedures during the approach and landing in that no callouts were made and cockpit instruments were not monitored.

8. The crew failed to comply with recommended approach and landing airspeeds.

9. The approach was not made according to prescribed procedures and was not stabilized.

10. The captain applied brakes before the main landing gear was on the runway.

11. The captain's decision to land was improper and causal.

12. The right main landing gear contacted the runway 3,010 ft from the landing threshold at 159 kn and the left main landing gear initially contacted the runway about 3,800 ft from the threshold at 140 kn.

13. The aircraft left the runway at 102 KIAS.

14. A successful go-around could have been accomplished as late as 4,200 ft down the runway.

15. The aircraft could not have been stopped on the runway at the speed and distance past the threshold that it landed.

### 3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the captain's complete lack of awareness of airspeed, vertical speed, and aircraft performance throughout an ILS approach and landing in visual meteorological conditions which resulted in his landing the aircraft at an excessively high speed and with insufficient runway remaining for stopping the aircraft, but with sufficient aircraft performance capability to reject the landing well after touchdown. Contributing to the accident was the first officer's failure to provide required callouts which might have alerted the captain to the airspeed and sink rate deviations. The Safety Board was unable to determine the reason for the captain's lack of awareness or the first officer's failure to provide required callouts.

## 4. SAFETY RECOMMENDATIONS

None.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

February 8, 1979

# 5. APPENDIXES

## APPENDIX A

## INVESTIGATION AND HEARING

### 1. Investigation

At 1816 e.d.t. on July 9, 1978, the National Transportation Safety Board, Washington, D.C. office was notified of the accident. The investigation team went immediately to the scene. Working groups were established for Operations/ATC/Weather, Structures/ Systems/Powerplants, Human Factors, Witnesses, Maintenance Records, Flight Data Recorder, and Cockpit Voice Recorder.

Participants in the investigation included representatives of the Federal Aviation Administration, British Aerospace Corporation, Allegheny Airlines, Inc., International Association of Machinists, Air Line Pilots Association, and the Association of Flight Attendants.

### 2. Public Hearing

A public hearing was not held.

## APPENDIX B

## CREW INFORMATION

### Captain John Robert Johansson

Captain Johansson, 46, holds Airline Transport Pilot Certificate No. 1372029 with type ratings in BAC 1-11, and Fairchild F-27/227 aircraft. He received his checkout in the BAC 1-11 as a captain on February 9, 1973. He held a First-Class medical certificate issued on January 24, 1978, with a limitation that he must wear glasses while flying.

Captain Johansson satisfactorily passed his last proficiency check (training in lieu of check) on December 18, 1977. His last BAC 1-11 simulator proficiency check was on July 25, 1977. His last line check was on January 30, 1978. At the time of the accident he had 13,461 flight-hours, 7,008 of which were in the BAC 1-11 aircraft.

### First Officer James C. Reid, Jr.

First Officer Reid, 37, holds commercial Pilot Certificate No. 1629281 with airplane single-engine land, airplane multiengine land, and instrument ratings. He was checked out in the BAC 1-11 as a first officer on May 25, 1969. He held a First-Class medical certificate with no limitations which was issued on October 18, 1977.

First Officer Reid satisfactorily passed his last simulator proficiency check on October 3, 1977. At the time of the accident, he had 8,746 flight-hours, 4,687 of which were in the BAC 1-11 aircraft.

### Flight Attendants

The two flight attendants were qualified in the BAC 1-11 aircraft in accordance with applicable regulations and had received the required emergency evacuation training.

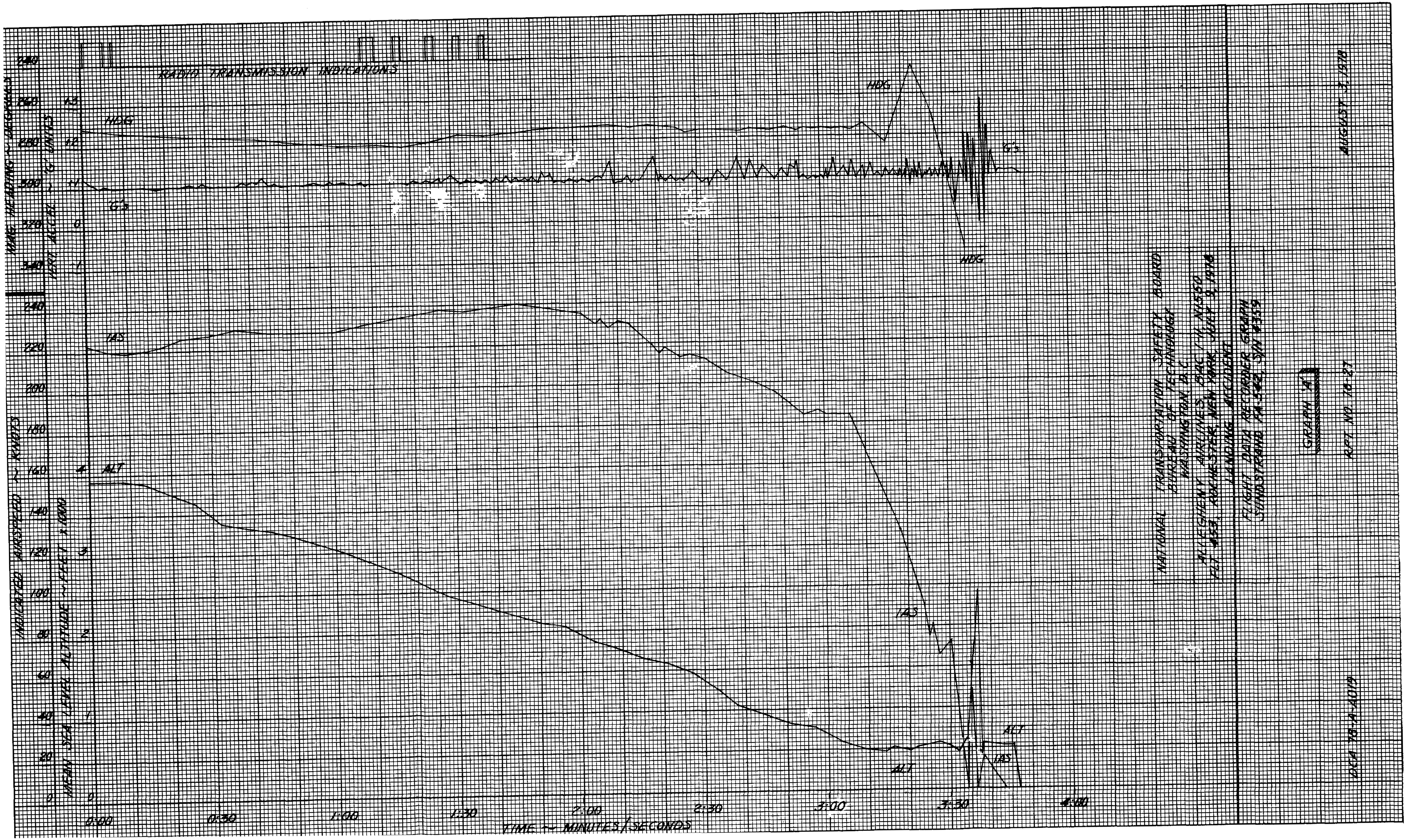
# APPENDIX C

## AIRCRAFT INFORMATION

The aircraft, N1550, was a British Aerospace Corporation, BAC 1-11 type 203AE, serial No. 044. It was purchased new from the British Aerospace Corporation by Braniff Airlines on May 10, 1965. The aircraft was subsequently purchased from Braniff by Allegheny Airlines on March 29, 1972. The aircraft total airframe hours since new was 33,693 with a total of 48,215 landing cycles. The last block overhaul was accomplished on July 25, 1977. The airframe time since the block overhaul was 2,443 hrs. The last airframe and engine inspection was C-5 check which was accomplished on May 16, 1978.

The aircraft was powered by two Rolls Royce Spey 506-14D engines. Pertinent engine data follows:

| Position | Serial No. | Total Time (hrs.) | Total Cycles | Total time since last shop visit (hrs.) |
|---|---|---|---|---|
| 1 | 6533 | 18,319 | 28,107 | 3,183 |
| 2 | 6544 | 18,718 | 28,358 | 685 |


RADIO TRANSMISSION INDICATIONS
MAG. HEADING ~ DEGREES
VERT. ACCEL. ~ 'G' UNITS
INDICATED AIRSPEED ~ KNOTS
MEAN SEA LEVEL ALTITUDE ~ FEET x 1000
HDG
G'S
IAS
ALT
TIME ~ MINUTES / SECONDS
0:00
0:30
1:00
1:30
2:00
2:30
3:00
3:30
4:00
NATIONAL TRANSPORTATION SAFETY BOARD
BUREAU OF TECHNOLOGY
WASHINGTON, D.C.
ALLEGHENY AIRLINES, BAC 1-11, N1550
FLT 453, ROCHESTER, NEW YORK, JULY 9, 1978
LANDING ACCIDENT
FLIGHT DATA RECORDER GRAPH
SUNDSTRAND FA-542, S/N 4359
GRAPH 4
AUGUST 3, 1978
RPT NO. 78-27
DCA 78-A-A019

APPENDIX E

TRANSCRIPT OF A COLLINS 642 COCKPIT VOICE RECORDER
REMOVED FROM THE ALLEGHENY BAC-111 WHICH WAS INVOLVED
IN AN ACCIDENT AT ROCHESTER, NEW YORK, ON JULY 9, 1978

## LEGEND

| | |
|---|---|
| CAM | Cockpit area microphone voice or sound source |
| RDO | Radio transmission from accident aircraft |
| -1 | Voice identified as Captain |
| -2 | Voice identified as First Officer |
| -? | Voice unidentified |
| TWR | Rochester Tower |
| APP | Rochester Approach |
| AL 224 | An aircraft |
| WS | An aircraft |
| WJ | An aircraft |
| 655 | An aircraft |
| CO | Company |
| * | Unintelligible word |
| # | Nonpertinent word |
| ( ) | Questionable text |
| (( )) | Editorial insertion |
| --- | Pause |
| Note: | All times are expressed in eastern daylight savings time. |

| INTRA-COCKPIT | | AIR-GROUND COMMUNICATIONS | |
|---|---|---|---|
| TIME & SOURCE | CONTENT | TIME & SOURCE | CONTENT |
| CAM-2 | Ah, you want me to get the pre, Jack? | 1742:53 RDO | ((Information jouliet received)) |
| 1742:55 CAM-1 | Yup | | |
| CAM-2 | Twenty-nine ninety-one | | |
| CAM-1 | Check | | |
| CAM-2 | Fuel | | |
| CAM-1 | Checks | | |
| CAM-2 | Hydro | | |
| CAM-1 | Check | | |
| CAM-2 | Twenty-three | | |
| CAM-1 | Check | | |
| CAM-2 | Shoulder harness | | |
| 1743:05 CAM-1 | On | | |
| | | APP | # |
| CAM-2 | I got a DME, I'll put it on over here if you want me to * | | |
| CAM-1 | (Just hold it for me) * * | | |

| INTRA-COCKPIT TIME & SOURCE | INTRA-COCKPIT CONTENT | AIR-GROUND COMMUNICATIONS TIME & SOURCE | AIR-GROUND COMMUNICATIONS CONTENT |
|---|---|---|---|
| CAM-? | Yeah | 1743:15 APP | UAL 978 # |
| | | 1744:26 APP | Allegheny four fifty-three, one six miles from Breit, cleared ILS runway two eight approach, maintain two thousand one hundred and report established on the localizer |
| | | 1744:34 RDO-2 | Cleared for the approach two point one will comply four five three |
| | | APP | 673 # |
| | | APP | 938 # |
| | | APP | 5HC # |
| | | APP | 673 # |
| 1746:03 CAM-1 | Coming down on that cabin pretty good are we? | | |
| CAM-2 | Yeah, it's doing good, Jack | | |
| CAM-1 | Looks like we're getting it now | | |

| INTRA-COCKPIT | | AIR-GROUND COMMUNICATIONS | |
|---|---|---|---|
| TIME & SOURCE | CONTENT | TIME & SOURCE | CONTENT |
| 1746:15 CAM-1 | Oh boy been hazier than # the last couple of days worse than than this | | |
| | | APP | 978 # |
| CAM-2 | * it's good | | |
| | | 1746:53 RDO-2 | Rochester four five three, there was a lot of interference when I talked to you before, say the gate again |
| | | CO | Yeah gate four |
| | | RDO-2 | Okay good |
| CAM-2 | Gate four, Jack | | |
| 1747:12 CAM-1 | Ah this will be a two engine ILS | | |
| CAM-2 | Yeah, it's great for a * * | | |
| | | 1747:27 APP | 938 # |
| CAM-2 | Who was supposed to give you the ride? | | |
| CAM-1 | I don't know * * | | |
| 1747:32 CAM-1 | Got the letter in the mail | | |
| CAM-? | (How about the control * *) | | |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENT |
|---|---|
| 1748:03 CAM | ((Sound of altitude alert)) |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENT |
|---|---|
| 1747:46 APP | U78 # |
| 1747:58 APP | Allegheny four fifty-three, contact the tower one one eight point three |
| 1748:00 RDO-2 | Okay, good day sir, thanks for your help |
| 1748:07 RDO-2 | Rochester tower, Allegheny four fifty-three is about eight out |
| RDO-? | # |
| 1748:13 TWR | Rochester tower, say again |
| 1748:16 RDO-2 | Allegheny four five three is a couple outside Breit |
| 1748:20 TWR | Okay four fifty-three Rochester tower, clear to land runway two eight, wind two six zero at six |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENT |
|---|---|
| 1748:51<br>CAM-1 | Oh hum |
| 1749:06<br>CAM | ((Sound of altitude alert)) |
| CAM-1 | Gear down |
| 1749:10<br>CAM | Beep, beep, beep, beep<br>((sound of configuration warning)) |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENT |
|---|---|
| RDO-2 | Clear to land four five three |
| 1748:26<br>AL 224 | Hello Allegheny two twenty four, with you at seventeen thousand |
| RDO-? | Three ninety-one |
| 1748:31<br>RDO-2 | I did that once myself |
| 1748:35<br>RDO-? | Nine six |
| RDO-? | Would # |
| RDO-2 | Wrong button |
| WS | Rochester tower # |
| TWR | 4WS # |
| RDO | ((Stewardess public address)) |
| TWR | # |

| INTRA-COCKPIT TIME & SOURCE | INTRA-COCKPIT CONTENT | AIR-GROUND COMMUNICATIONS TIME & SOURCE | AIR-GROUND COMMUNICATIONS CONTENT |
|---|---|---|---|
| 1749:12<br>CAM-1 | Yeah, I'm pulling plenty * * | WJ | I'm looking |
| CAM-? | (Six when you move the tail it drops) | | |
| CAM-1 | Yeah ((between tail and dropped)) | | |
| 1749:23<br>CAM-2 | Yeah, it looks like you got a tailwind here | | |
| CAM-1 | Yeah | | |
| CAM-? | Yeah moves awfully # slow * | | |
| 1749:28<br>CAM | ((Sound of GPWS just before "slow" above)) Whoop whoop terrain, whoop, whoop terrain | | |
| 1749:31<br>CAM-2 | Yeah, the # flaps are slower than a # | | |
| 1749:34<br>CAM-1 | We'll make it, gonna have to add power * | | |
| CAM-2 | I know | | |
| CAM | ((Sound of clicks, similar to trim)) | | |

| INTRA-COCKPIT TIME & SOURCE | INTRA-COCKPIT CONTENT | AIR-GROUND COMMUNICATIONS TIME & SOURCE | AIR-GROUND COMMUNICATIONS CONTENT |
|---|---|---|---|
| 1749:44 CAM | Whoop, whoop, terrain, whoop, whoop terrain | | |
| CAM-2 | Yeah * twenty six, there, you got it | | |
| 1749:51 CAM | Whoop, whoop, terrain, whoop, whoop terrain | | |
| | | 1749:55 655 | Cherokee six five five downward two five touch and go |
| | | 1750:06 TWR | Six five five cleared for a touch and go two five |
| 1750:10 CAM-2 | Oh Jack! | 1750:10 655 | six five five |
| 1750:14 CAM-? | * * * | | |
| 1750:14 CAM | ((Bang bang)) | | |
| 1750:16 CAM | ((Bang)) | | |
| 1750:20 CAM-? | ((Sound of a gasp)) | | |

| INTRA-COCKPIT | | AIR-GROUND COMMUNICATIONS | |
|---|---|---|---|
| TIME & SOURCE | CONTENT | TIME & SOURCE | CONTENT |
| 1750:23 CAM-? | ((Sound of another gasp)) | | |
| 1750:24 CAM | ((Sound of aircraft breaking up)) | | |
| 1750:34 CAM | ((Sound of Klaxon)) | | |
| 1750:41 CAM | ((Sound of electrical system slowdown and recorder stopping)) | | |

APPENDIX F

**NATIONAL TRANSPORTATION SAFETY BOARD**

**WASHINGTON, D.C.**

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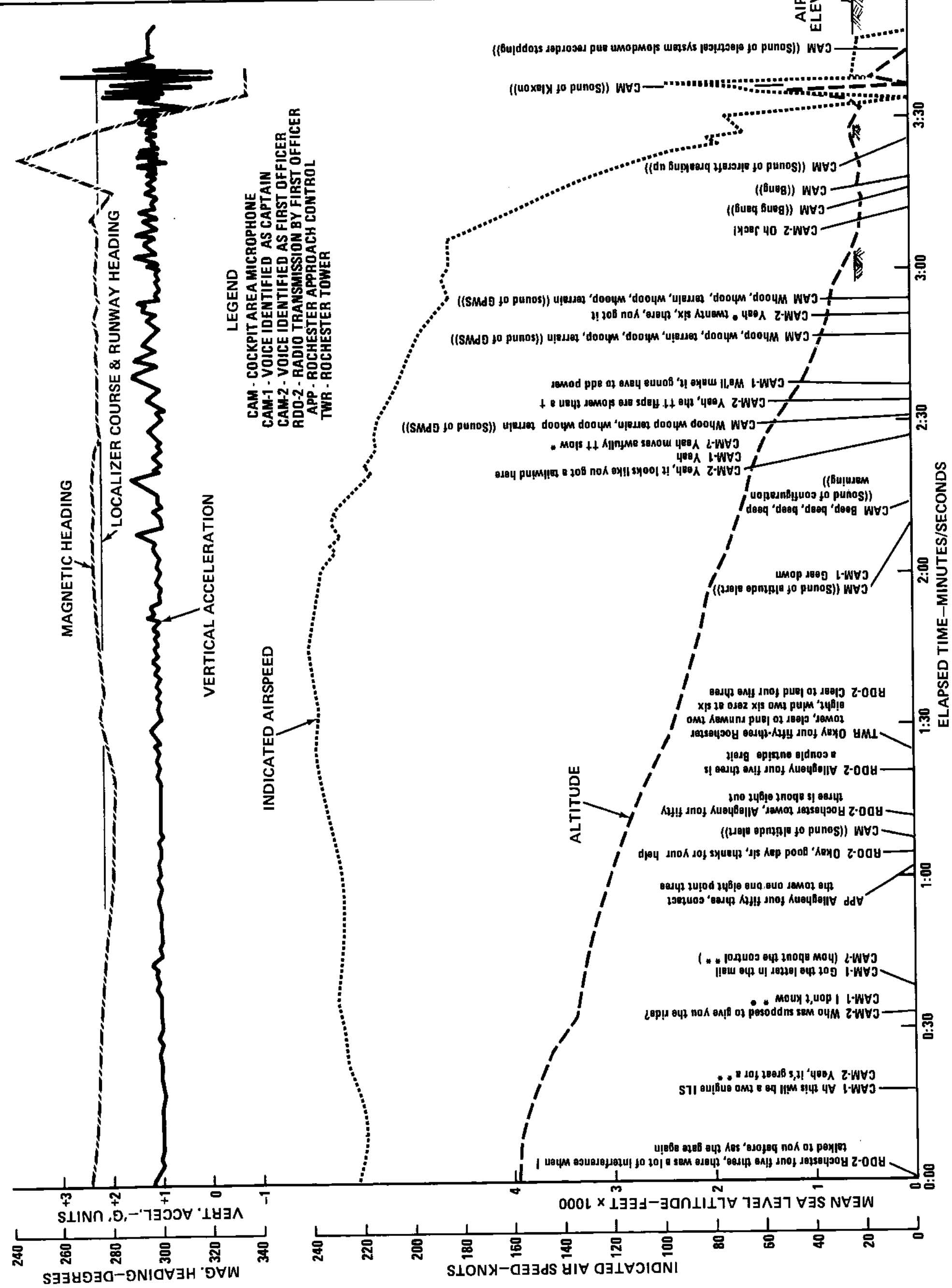
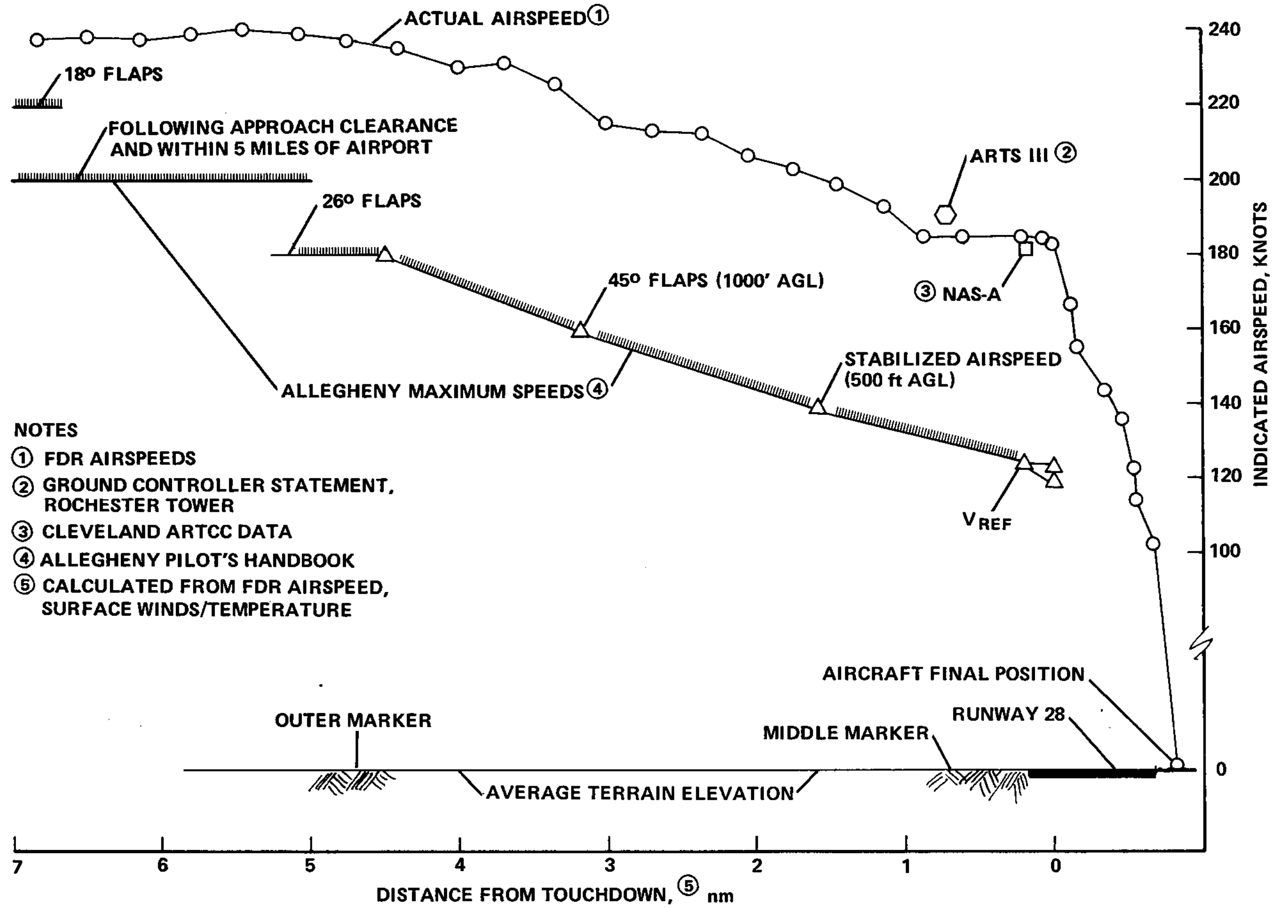
**PLOT OF FLIGHT DATA AND COCKPIT VOICE RECORDER DATA**

**ALLEGHENY AIRLINES, BAC 1-11, N1550**
**FLT. 453, ROCHESTER, NEW YORK, JULY 9, 1978**



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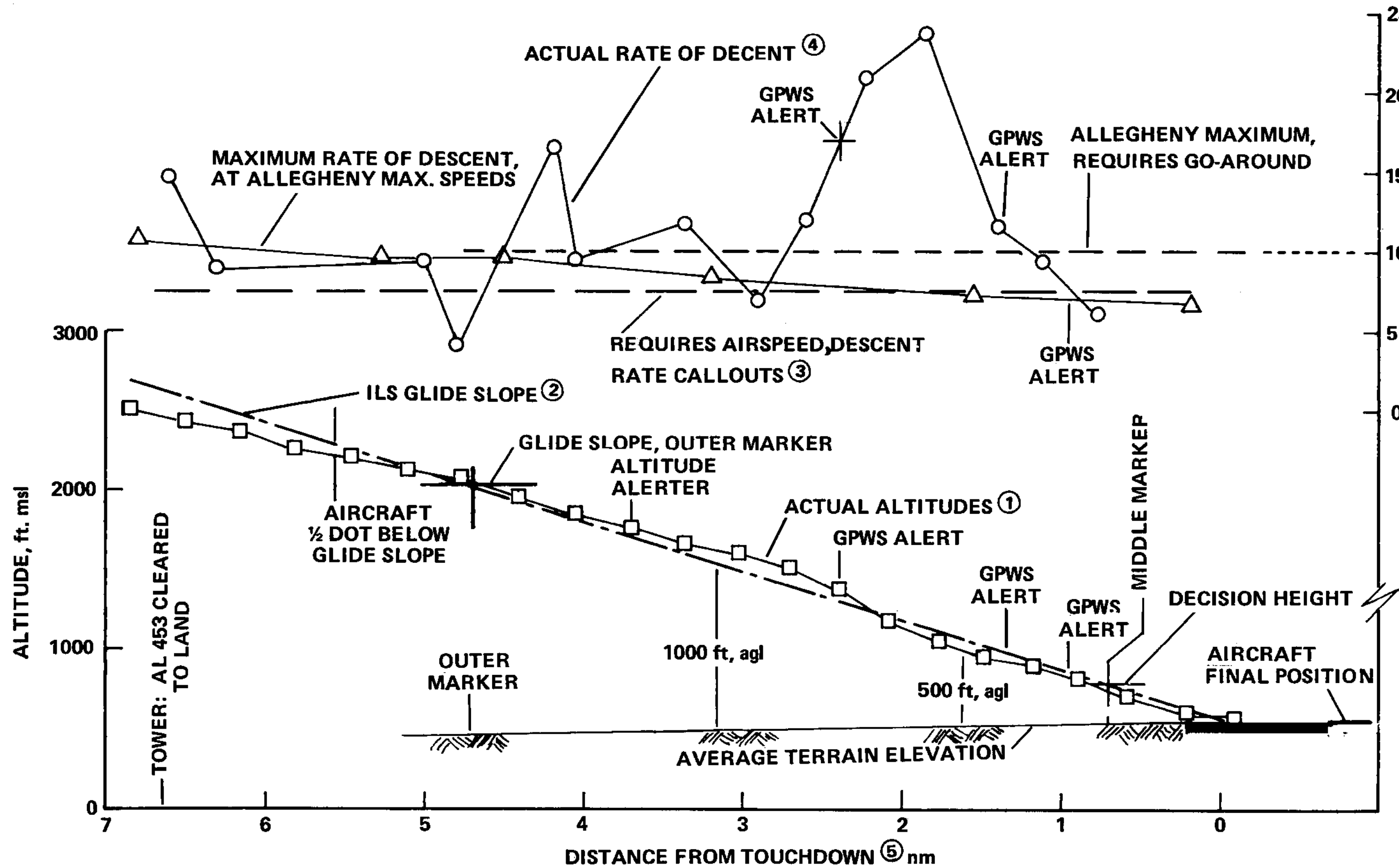
**COMPARISON OF AL-453 AIRSPEEDS WITH ALLEGHENY MAXIMUM SPEEDS**
**ALLEGHENY AIRLINES, BAC 1-11, N1550**
**ROCHESTER, NEW YORK**
**JULY 9, 1978**




NOTES

① FDR ALTITUDES
② 2.95 DEGREE GLIDESLOPE
③ ALLEGHENY PILOT'S HANDBOOK
④ CALCULATED FROM FDR ALTITUDE DATA
⑤ CALCULATED FROM FDR AIRSPEED, SURFACE WINDS/TEMPERATURE

**NATIONAL TRANSPORTATION SAFETY BOARD**
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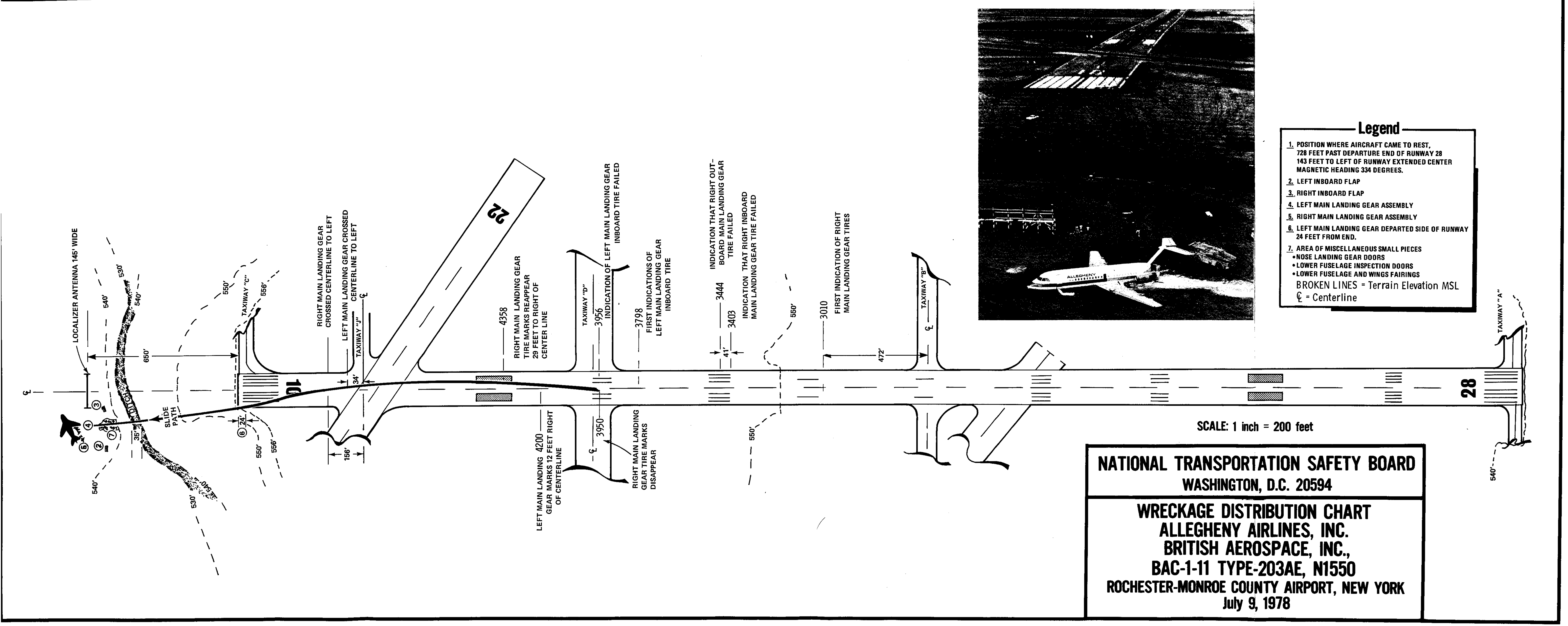
**COMPARISONS OF AL-453 ALTITUDES AND RATES OF DESCENT WITH ALLEGHENY AIRLINES, MAXIMUM LIMITS ALLEGHENY AIRLINES, BAC 1-11, N1550**
**ROCHESTER, NEW YORK, JULY 9, 1978**




**NATIONAL TRANSPORTATION SAFETY BOARD**
**WASHINGTON, D.C. 20594**

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**ALLEGHENY AIRLINES, INC.**
**BRITISH AEROSPACE, INC.,**
**BAC-1-11 TYPE-203AE, N1550**
**ROCHESTER-MONROE COUNTY AIRPORT, NEW YORK**
**July 9, 1978**