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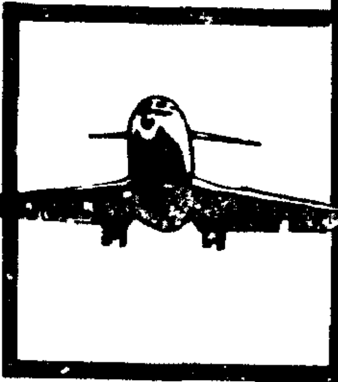
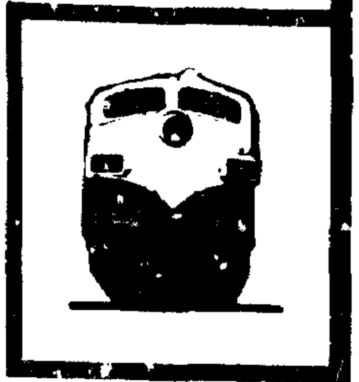
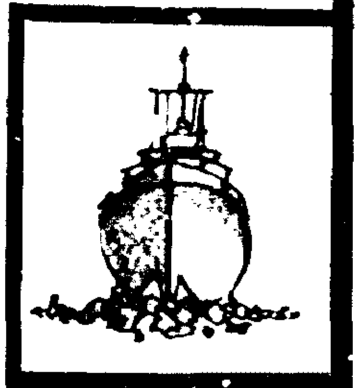


NATIONAL TRANSPORTATION SAFETY BOARD

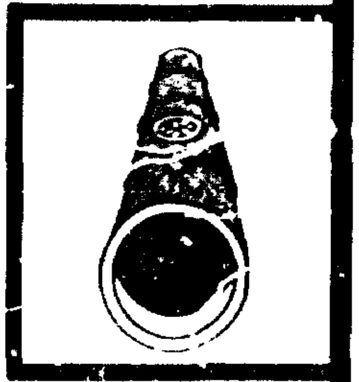


WASHINGTON, D.C. 20594



AIRCRAFT ACCIDENT REPORT

EASTERN AIR LINES, INC.,
BOEING 727-225, N8838E
RALEIGH, NORTH CAROLINA
NOVEMBER 12, 1975



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15. Supplementary Notes

16. Abstract About 2002 e.s.t. on November 12, 1975, Eastern Air Lines, Inc., Flight 576 struck the ground about 282 feet short of runway 23 at the Raleigh-Durham Airport, Raleigh, North Carolina, bounced and touched down on the runway, then slid to a stop off the right side of the runway 4,150 feet past the runway threshold. The accident occurred during an instrument landing system approach when the airplane encountered unexpectedly heavy rain while 100 feet above the ground. The airplane was damaged substantially. Of the 139 persons aboard the airplane, eight were injured; one was injured seriously.

On May 19, 1976, the National Transportation Safety Board adopted the accident report and probable cause of the accident. On October 3, 1978, the Air Line Pilots Association submitted a petition for reconsideration of probable cause of the probable cause that was adopted in the original accident report. As a result of the Air Line Pilots Association's petition, the accident report and the probable cause have been revised.

The National Transportation Safety Board determines that the probable cause of the accident was an encounter with heavy rain and associated downdrafts and wind shear during the final stages of landing when the airplane was less than 100 feet above the ground. The sudden onset of the meteorological conditions did not allow sufficient time for the captain to perceive and react to the effect of the downdraft and wind shear on the airplane's performance to stop the airplane's increased rate of descent and for the airplane to respond before striking the ground short of the runway.

17. Key Words

Instrument approach, heavy rain, wind shear, illusions, downdraft, loss of forward visibility, VASI survivable accident, FDR, CVR

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594
REVISED
AIRCRAFT ACCIDENT REPORT

Adopted: September 7, 1983

EASTERN AIR LINES, INC.
BOEING 727-225, N8838E
RALEIGH, NORTH CAROLINA
NOVEMBER 12, 1975

SYNOPSIS

About 2002 e.s.t. on November 12, 1975, Eastern Air Lines, Inc., Flight 576 struck the ground about 282 feet short of runway 23 at the Raleigh-Durham Airport, Raleigh, North Carolina, bounced and touched down on the runway, then slid to a stop off the right side of the runway 4,150 feet past the runway threshold. The accident occurred during an instrument landing system approach when the airplane encountered unexpectedly heavy rain while 100 feet above the ground. The airplane was damaged substantially. Of the 139 persons aboard the airplane, eight were injured; one was injured seriously.

The National Transportation Safety Board determines that the probable cause of the accident was an encounter with heavy rain and associated downdrafts and wind shear during the final stages of landing when the airplane was less than 100 feet above the ground. The sudden onset of the meteorological conditions did not allow sufficient time for the captain to perceive and react to the effect of the downdraft and wind shear on the airplane's performance to stop the airplane's increased rate of descent and for the airplane to respond before striking the ground short of the runway.

1. INVESTIGATION

1.1 History of the Flight

On November 12, 1975, Eastern Air Lines, Inc., Flight 576, a Boeing 727-225, N8838E, operated as a scheduled passenger flight from Miami, Florida, to Washington, D.C., with intermediate stops at Atlanta, Georgia, and Raleigh, North Carolina.

Flight 576 departed from Atlanta at 1848 1/ with 139 persons, including 8 crewmembers, aboard. It was cleared to the Raleigh-Durham Airport in accordance with a computer stored instrument flight rules (IFR) flight plan. The flight was uneventful until it approached the Raleigh-Durham area, where several deviations from course were required to circumnavigate heavy precipitation areas southwest of the airport depicted on the airplane's weather radar. No areas of heavy precipitation or thunderstorm activity in the immediate vicinity of the Raleigh-Durham Airport were observed by the flightcrew, either visually or on the airplane's radar.

1/ Unless otherwise indicated, all times herein are eastern standard time, based on the 24-hour clock.

During the en route descent for landing, the flightcrew received the Airport Terminal Information Service (ATIS) 2/ report as follows:

> Raleigh-Durham Information Oscar, 2253 Greenwich Weather; estimated ceiling, 2,000 overcast; visibility 7; light rain; temperature, 69; dewpoint, 65; wind, 170° at 4; altimeter, 29.75. Expect ILS approach landing runway 23. Stage 3 departures advise clearance delivery on 120.1 of intended heading and altitude. Advise you have 'Oscar'.

At 1956:06, Raleigh-Durham approach control gave Flight 576 the following revised weather: ". . . 1,000 scattered, measured ceiling 2,000 overcast, visibility - 4 miles."

The captain, who was flying the airplane, conducted an approach briefing during the descent. The briefing included a discussion of the missed approach procedure. The flight engineer reviewed the first officer's instrument approach chart to familiarize himself with the procedure.

At 1958:21, approach control gave the flight further clearance: "Eastern 576, 5 miles northeast of Leesville, 3/ contact tower 119.3." The first officer acknowledged the transmission and contacted the Raleigh-Durham tower.

At 1958:35, the tower controller stated: "Eastern 576 is cleared to land runway 23. The wind is variable 180° at 4, and I have a Queen Air reported strong wind from the left about 20 kn at between 900 and 1,000 — correction, — and 2 —and 1,200 feet on final." At 1958:54, the first officer replied: "Okay, thank you sir. It looks like you have quite a storm coming your way."

The airplane intercepted the runway 23 localizer course about 7 miles from the final approach fix (FAF). The glide slope was intercepted about 1,800 feet m.s.l. 4/ and the airplane was flown with flaps at 30°. The landing reference speed for the approach was 140 KIAS. During the approach, airspeed indications were stabilized and the airspeed indicator needles did not "bounce." The highest airspeed indication observed by the flightcrew after the aircraft passed the FAF was 147 KIAS. The airplane averaged about 142 KIAS during the final 1 minute 20 seconds before impact. The average KIAS from the flight data recorder readout was consistent with the airspeed callout by the first officer of "bug plus six" at 2000:54.

At 2000:35, the tower controller reported: "Eastern 576, visibility at the airport now is a mile and three-quarters." At 2000:43, in answer to a request by the first officer, the tower controller stated: "The wind right now is 190° at 5; it's been holding pretty well at 5 kn."

At 2001:42, the local controller and the Raleigh-Durham approach controller assessed the airport visibility, and at 2002:07, the Raleigh-Durham approach controller said to the local controller, "—visibility three quarters now."

2/ ATIS-The continuous broadcast of recorded general information in selected high activity terminal areas. "Oscar" was the phonetic designation of information being broadcast when Flight 576 was on the approach.
3/ Leesville - A nondirectional beacon (NDB) which serves as the final approach fix.
4/ All altitudes are above field elevation unless otherwise indicated.

The flightcrew made altitude awareness calls and instrument crosschecks at 1,000 feet and at 500 feet. The instrument check indicated that all systems were operating normally. At 2001:37, with the airplane about 500 feet above the airport, the first officer repeated, "Five hundred feet ground contact." At 2001:46, as the airplane descended below the well-defined ceiling of 400 feet, the first officer stated, "There's the flashers just ahead." The captain said that, following this call, he looked out, saw the approach lights, shortly afterwards the runway threshold, and then the runway lights. He was satisfied that the airplane was aligned properly with the runway and was at the correct altitude to complete the approach and landing.

Flight 578 had been in light to moderate rain throughout the final approach, and the windshield wipers had been used at the low setting. The captain called for the wipers to be placed at the high setting at 2001:49, when the rainfall rate began to increase. The call for a high setting on the wipers came after the first officer reported that the flashers were in sight and after the captain confirmed that the approach lights were in sight. The captain stated that he continued to fly the airplane with reference to visual cues for the remainder of the flight. The rainfall intensity varied, but the first officer said that the visibility remained better than 1 mile.

At 2001:55, the first officer reported the runway in sight. The airplane was about 200 feet above the runway. The crew said that the approach lights, threshold lights, and runway lights were well defined and easily seen, without noticeable halo effect or backscatter.

The captain said he increased thrust when the airplane was at 200 feet above the runway, because he noticed that the airplane was slightly below the glide slope. This evaluation was made from the landing sight picture and by reference to the raw data from the glide slope. He said he planned to level the airplane and to reintercept the glide slope. He said he did not make a conscious effort to increase the airplane's angle of attack since he still had the threshold and runway lights in sight. Both pilots noticed that the VASI indication was a "pinkish" color, which indicated that the airplane was below the desired ILS glidepath.

The flight engineer, who had been looking at his panel, scanned the first officer's panel and observed the position of the airplane below the glide slope. While doing so, he heard the calls of the first officer that they were low and that the rate of descent was high. However, he saw the captain adding thrust to correct the glide slope deviation, so he did not call the low position of the airplane to the captain's attention. All flightcrew members said that although the rainfall was heavy, the runway lights remained visible. Shortly after the captain began to increase power to return to the glide slope, the first officer stated, at 2002:00, "Looks to be a little bit low." At this point, the airplane was just inside the middle marker, about 100 feet above the runway. At 2002:04, the first officer stated, "Rate of descent too high." He repeated the same call at 2002:05. This was the last cockpit comment before the initial impact at 2002:08.5.

The first officer said that he never saw a rate of descent during the approach which exceeded 1,000 feet per minute (fpm). The captain said that he did not hear the first officer's callouts concerning the rate of descent or the airplane's position on the glidepath.

The captain said that at 100 feet, the crosswind increased and he adjusted the airplane heading to the left to maintain runway alignment. The flight data recorder showed a 2° heading change to the left. Almost simultaneously with his course adjustment to correct the drift, the captain lost all forward visibility as the windshield became "opacue" and the external light glare became "brilliant." He described the situation as encountering "a wall of water" and, that the airplane developed an excessive sink rate; in his words, "the bottom dropped out." He stated that he started adding more thrust as these events developed. However, he was unable to recall the amount of added thrust. The captain stated that he had not considered a missed approach before encountering the heavy rainfall. The approach to runway 23 had been routine, and the airplane was almost to the runway threshold before any significant change occurred in the meteorological conditions.

The flight engineer said that his forward visibility "went to nil" and that he did not see any lights until the airplane passed over the green threshold lights. The first officer said that he lost forward visibility at the 1,000-foot approach light bar and that his visibility was limited to three or four approach light bars ahead of the airplane. He said that he did not have any sensation of a downdraft; however, at the time, he felt uncomfortable and thought a missed approach should be started.

The captain said that he was "caught totally unaware" by the sudden sinking of the airplane and the loss of visibility. As he added more thrust, he "pulled back on the yoke in an instinctive manner and almost simultaneously I felt the main gear catch." He further stated that he knew the airplane was over the runway and in line with the centerline. When the landing gear hit the ground, he thought he had caught the lip of the runway. As a result, he "had the thought that I did not want to try to go around." He then reduced power on the engines.

The first officer and flight engineer said that the airplane continued to descend after the captain added thrust. The captain said the intense rain, the loss of outside visibility, the increased thrust, and the airplane's contact with the ground occurred almost simultaneously. Contact was made 282 feet short of the threshold about 6 feet below the runway touchdown zone elevation, at an indicated airspeed of 147 kns.

The flightcrew believed that the airplane would land on the runway, or at most several feet short of the threshold. The first officer believed that the airplane had made a premature touchdown on the runway. The crew described the first ground contact as firm or "stiff," and the travel down the runway as "rough." They believed that a tire, or tires, had blown.

The captain said that after the airplane struck the ground, it continued forward and emerged from the "heavy rain" at the runway threshold. He could then see the entire length of the runway. He deployed the ground spoilers and placed the Nos. 1 and 2 engines into reverse thrust. The No. 3 engine thrust reverser had been deactivated before this flight. His concern at that time was stopping the airplane on the wet runway. He did not have wheel braking and ordered the antiskid system turned off. He stated that he did not have directional control problems; however, while the airplane's longitudinal axis remained aligned with the runway, the airplane drifted off the right side of the runway and stopped with a portion of the left wing extended over the runway, about 4,150 feet from the runway threshold. The captain pulled the fire-control/fluids shutoff handles and turned the emergency lighting switch on.

The flight engineer went into the passenger cabin area to assist with the evacuation of the passengers. He left the airplane from the forward left door and found the escape slide wet and very fast.

Shortly thereafter, the pilots left the cockpit and found that the passenger evacuation was almost complete. They verified that all the occupants had evacuated the airplane, then departed by the forward door slide.

An Eastern Air Lines Boeing 727 captain had landed on runway 23, 18 minutes before Flight 576. The visibility during the final approach was about 5 miles with light to moderate rainfall. The captain maintained a 10° to 13° drift correction to the left. At 300 feet, he saw the VASI lights change rapidly to red. He immediately applied thrust and pulled back on the control wheel. At the same moment, the Ground Proximity Warning System activated. The captain regained the proper glide slope and completed the landing. Neither pilot recalled a sudden "seat of the pants" sensation of an increasing rate of descent.

At the time of the accident, a commercial pilot was standing by a hangar 800 feet to 1,000 feet from the threshold of runway 23. He estimated the airport visibility as one-half to three-quarter miles with rainshowers. The rainshowers were initially light but rapidly increased to a moderate and then heavy rate. The winds were from the southwest at 10 to 15 knots with gusts to 20 knots. He first observed Flight 576 about one-quarter to one-half mile from the threshold. As he watched the airplane, he concluded that it would not be able to make the runway since it began to settle toward the ground. He heard a "large increase of power" and he observed the airplane at a high angle of attack. He then saw the airplane hit the ground. He stated that a few minutes after the accident the wind became calm. He noted about 1 inch of standing water on the runway.

A second witness, also a pilot, reported that the rainfall increased from light to a "hard downpour, accompanied by lightning and gusting winds." When he first observed the airplane, it appeared to be on a normal approach path to runway 23. He looked away for "only a few seconds." He looked back and saw the airplane had "become too low for a normal approach to this runway." He heard turbine engines spool up and saw the airplane level off, but the rate of descent did not slow appreciably, and he saw the airplane hit the ground.

A pilot in a light airplane was in the runup area near the threshold of runway 23 at the time of the accident. He said that just before Flight 576 hit the ground, the magnitude of the wind gusts made it difficult for him to hold the control wheel of his airplane. He had only a momentary glance at Flight 576 as it slid past his airplane. He said that the heavy rainfall obscured his vision.

The accident occurred at night, at an elevation of about 436 feet m.s.l., and at latitude 35° 52'N and longitude 78° 47'W.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	0	0	0
Nonfatal	0	8	0
None	8	123	0
Total	8	131	0

1.3 Damage to Aircraft

The airplane was damaged substantially.

1.4 Other Damage

The localizer antenna for the instrument landing system (ILS) of runway 05 was damaged substantially. The antenna is located about 400 feet before the approach end of runway 23 and is aligned with the runway centerline. Centerline monitors and width monitors for the ILS localizer, located 260 feet before the threshold, were destroyed.

Five approach lights, located 200 feet before the threshold, were destroyed. Two runway threshold lights and some blue taxiway lights on the right side of runway 23 were broken.

1.5 Crew Information

The three flight crewmembers were properly certificated for the flight. (See appendix B.)

1.6 Aircraft Information

The airplane was certificated, equipped, and maintained in accordance with Federal Aviation Administration (FAA) requirements. The airplane was configured for installation of a ground proximity warning system; however, because of a manufacturing delay, the hardware for this airplane had not been delivered to Eastern Air Lines.

The airplane was not equipped with an aural radio altimeter signal.

The gross weight and c.g. were within prescribed limits for both takeoff and landing. At the time of the accident, about 17,000 pounds of Jet A-1 fuel was on board. (See appendix C.)

1.7 Meteorological Information

The terminal forecast for Raleigh-Durham, issued by the National Weather Service (NWS) at Raleigh, on November 12, 1975, and valid for 24 hours beginning at 1700 was, in part:

> 1700 - 2200: 1,200 feet scattered, 2,000 feet overcast, wind -- 180° at 10 knots; occasionally, 800 feet overcast, visibility — 3 miles, light rain, fog; chance of visibility — 1/2 mile, thunderstorms and heavy rain showers.

The official NWS surface weather observations at Raleigh-Durham Airport near the time of the accident were as follows:

> 1955: 1,000 feet scattered, measured 2,000 feet overcast, visibility -- 4 miles, moderate rain, fog, temperature — 67°F, dewpoint — 66° F, wind 160° at 5 knots, altimeter setting 29.72 inHg.

> 2004 - Special: Partial obscuration, estimated 500 broken, 1,500 feet overcast, visibility — 3/4 mile, heavy rain, fog, wind — 160° at 6 knots, altimeter setting — 29.73 inHg, runway 05 RVR — 4,000 feet variable to 6,000 + feet, rain and fog obscuring 4/10 of the sky.

2009 - Local: Partial obscuration, estimated 500 broken, 1,500 feet overcast, visibility — 3/4 mile, heavy rain, fog, wind — 190 ° at 8 knots, altimeter setting — 29.73 inHg, runway 05 RVR — 4,000 feet variable to 6,000 + feet, rain and fog obscuring 4/10 of the sky, lightning in clouds and cloud-to-ground west. Aircraft mishap.

The rainfall rate measured at the airport between 1957 and 2000 was about 7 inches of rain per hour. This rate decreased to about 1.7 inches per hour between 2001:57 and 2003:00.

The Universal Rain Gauge was located 3,700 feet southwest of the threshold of runway 23, and 500 feet to the north of the runway centerline. Witnesses located about 800 feet to 1,000 feet from the runway 23 threshold reported that as Flight 576 was on final approach, the rainfall increased from a light, steady rain to a heavy downpour in a short period. Witnesses also estimated the winds at 10 to 15 knots with gusts to 20 knots.

A WRS-3 weather radar set is located at the NWS station at the Raleigh-Durham Airport. It is an obsolete system used only for local information. A line of convective activity was observed on this radar by the observer on duty at the time of the accident. The line extended from the northwest to the southwest of the airport; however, significant weather cells were not portrayed. No official reports are made or required using information observed on this weather radarscope. This information was not transmitted, nor was it required to be transmitted, to any other agency.

1.8 Aids to Navigation

The Raleigh-Durham Airport is equipped with an ILS for runway 23, with an inbound course of 229°. The Leesville NDB is located on the inbound course 4 nmi from the threshold of runway 23, and is the FAF for the approach.

The altitude at the FAF is 1,800 feet m.s.l. (1,365 feet above the touchdown zone) and the glide slope is intercepted just before crossing the Leesville NDB. The glide slope crosses the NDB at 1,785 feet m.s.l. (1,350 feet above the touchdown zone). Decision height for the approach is 200 feet.

There were no reported discrepancies in the navigational aids at the time of the accident. Postaccident flight checks of the ILS, the VASI, and the NDB showed no indications of malfunctions or misalignments.

1.9 Communications

No air-to-ground communication difficulties were reported.

1.10 Aerodrome and Ground Facilities

Runway 23 at the Raleigh-Durham Airport, an asphalt surfaced runway, is 7,500 feet long and 150 feet wide. The published elevation of the touchdown zone is 435 feet m.s.l. The runway is equipped with high intensity runway lights, medium intensity approach lights, runway alignment indicator lights, and a type-A VASI on the left side of the runway. All runway lights, approach lights, and the VASI were illuminated at the time of the accident.

1.11 Flight Recorders

The airplane was equipped with a Fairchild Model A-100 cockpit voice recorder (CVR), Serial No. 740. The CVR was not damaged, and the tape was read out without difficulties.

The airplane was also equipped with a Sundstrand Data Control, Model FA-542, flight data recorder (FDR), serial No. 1304. The recorder and foil medium were undamaged and all parameter traces had been recorded clearly and actively.

The FDR showed that the airspeed on the final approach varied from 140 knots to 145 knots until about 300 feet and had increased to about 147 knots at initial impact. The rate of descent remained fairly constant at between 650 fpm and 700 fpm until about 100 feet. During the 5 seconds before impact, the FDR showed that the average rate of descent was 1,260 fpm, with an airspeed of 145 knots. This airspeed and descent rate equalled a flight path angle of about 5°. Ground damage and marks on the ILS glide slope shack indicated a glidepath angle of about 2.5° at impact. This angle could be produced by a rate of descent of 640 fpm at 145 knots.

Both recorders were located in the aft section of the airplane fuselage. Data from the FDR and the CVR were correlated into a descent profile. (See appendix D.)

1.12 Wreckage

The airplane first struck the ILS localizer antenna screen for runway 05, which is located 400 feet before the threshold of runway 23. The top 2 feet of the parallel antenna screen wires were severed. The elevation of the top wire was about 430 feet m.s.l., about 1.5 feet below the runway threshold elevation, and about 5 feet below the touchdown zone elevation. An antenna dome was also damaged. (See appendix E.)

The main landing gear tires hit the ground first—about 282 feet short of the runway 23 threshold. The elevation of the ground marks was about 425 feet m.s.l. about 3.5 feet below the elevation of the runway threshold, and about 6 feet below the elevation of the touchdown zone. The airplane's angle of descent between the broken ILS localizer antenna domes and the ground marks was about 2.5°.

After it first contacted the ground, the airplane again became airborne; however, its second touchdown point could not be determined. Because of the first ground contact, both main landing gears and the No. 3 engine separated from the aircraft. These components continued down the runway and came to rest between 1,275 feet and 1,600 feet from the runway threshold.

After its second contact with the ground, the airplane slid down the runway and off the right side. It left the runway about 3,250 feet from the threshold. The airplane stopped about 4,150 feet beyond the threshold and about 33 feet off the right side of the runway.

The nose landing gear remained on the airplane; the tires were flat. Portions of both main landing gear support structures, the left inboard, mid-inboard, and the mid-trailing edge flaps; the airstair handrails; and airstair control access panel were found between the point of the first ground contact and the runway threshold.

There was no evidence of a failure of the airplane's systems, structures, or powerplants before impact. All of the high lift wing devices were found fully extended. The measurements of the outboard trailing edge flap jackscrew showed that the flaps were extended 27.5° on the left wind and 28° on the right wing. The airplane's fuel system remained intact.

1.13 Medical and Pathological Information

Eight persons were injured during the evacuation. One passenger sustained a fractured right ankle and was hospitalized; injuries to the remaining seven were minor.

1.14 Fire

There was no fire.

A witness said that when he saw the airplane strike an object short of the runway threshold, he also saw a burst of fire of very short duration near the No. 3 engine at the rear section of the aircraft fuselage.

According to a report of the crash/fire/rescue operation, the control tower initiated the crash alarm at 2006 and the first vehicle responded at 2007. At 2008, the control tower sent ambulances to the accident scene; three units responded.

1.15 Survival Aspects

This was a survivable accident. The cabin and crew compartment remained intact; the fuselage and cabin floor did not deform substantially.

Because the airplane came to rest in a level attitude, the occupants evacuated quickly and without difficulty. The evacuation was completed in 1.5 minutes; all four exit doors and the overwing exits were used. The four escape slides deployed properly; one slide lighting system malfunctioned. All airplane emergency lights operated normally, except for the unit located above the main cabin door.

1.16 Tests and Research

None.

1.17 Other Information

1.17.1 Eastern Air Lines, Inc., Flight 738

Eastern Air Lines Flight 738, another Boeing 727-225, landed at Raleigh-Durham Airport, about 14 minutes before Flight 576. The Safety Board obtained its FDR, read it out, and compared the traces with those obtained from the FDR readout for Flight 576.

Both FDR altitude traces disclosed similar flight profiles until about 100 feet above the runway surface. At that point, Flight 738's rate of descent decreased to near zero.

The captain of Flight 738 said that he was alerted to a descent below the glide slope by a change in color of the VASI and an aural warning from the Ground Proximity Warning System. He took control of the airplane from the first officer and completed the approach and landing.

1.17.2 14 CFR Part 91 — Instrument Flight Rules

With regard to descent below minimum descent altitude (MDA) or decision height (DH), 14 CFR 91.117(b) states:

> Descent Below MDA or DH No person may operate an aircraft below the prescribed minimum descent altitude or continue an approach below the decision height unless—
>
> (1) The aircraft is in a position from which a normal approach to the runway of intended landing can be made; and
>
> (2) The approach threshold of that runway, or approach lights or other markings identifiable with the approach end of that runway, are clearly visible to the pilot.
>
> If, upon arrival at the missed approach point or decision height, or at any time thereafter, any of the above requirements are not met, the pilot shall immediately execute the appropriate missed approach procedure.

1.17.3 FAA Advisory Circular No. 91-25A

FAA AC No. 91-25A, dated June 22, 1973, "Loss of Visual Cues During Low Visibility Landings—Discussion," reads as follows:

> Pilots conducting instrument approaches utilize visual cues as they become available during the approach. At the DH or MDA the pilot should, however, be aware that due to shallow fog, snow flurries, or heavy precipitation, these cues may be lost after descent below the DH or MDA. If visual cues are lost after DH or MDA, the pilot should execute the appropriate missed approach procedure as required by Federal Aviation Regulations. Missed approaches, when properly executed, involve little loss of altitude below the altitude at which the missed approach is "started."

1.17.4 Eastern Air Lines Procedures

The following is excerpted from the pertinent Eastern Air Lines, B-727, Flight Operations Manual, Enroute Operation Section (Altitude Awareness Call-outs) and B-727 Flight Manual, Normal Operations (Callouts as Required), Revision 147; dated October 21, 1975:

> During approach, the pilot flying* will call out:
>
> When IFR:
>
> Altitude crossing FAF (i.e., OM, VOR, etc.) above field level (AFL), 1,000 feet above field level.

Any significant deviation below 1,000 feet should be announced. Immediate corrective action will be taken, or the approach abandoned.

100 feet above DH or MDA.
Minimums (DH or MDA)

*The pilot not flying will verbally acknowledge all callouts. In addition, he will cancel the terrain warning system when necessary.

The second officer will serve as an additional backup. The pilot(s) not flying will challenge the absence of any callout.

The following company NOTAM (Notice to Airmen) issued October 22, 1975, was attached to flight papers for every flight between October 23, 1975, and November 27, 1975:

Important all flight crewmembers review new altitude awareness callout procs as described in Vol. one, rev. 174, Page 4-1-12 and in the latest revision to each airplane flight manual, all dated 10/21/75. Also note changes in pre-takeoff and approach briefings as described in normal operation and flight training sections of all AFM's.

Missed Approach

By definition, a missed approach and a rejected landing are two separate maneuvers. The procedures for execution of these two maneuvers are identical.

To initiate a Missed Approach or Rejected Landing:

Apply takeoff thrust.
Rotate to 8° nose up - stop descent.
Flaps 25°.
Positive rate of climb - "Gear Up."
Airspeed - V_2 to V_2 + 10K.
Clean up as in normal climb.
Follow published missed approach procedure.

The following item is excerpted from the Eastern Air Lines Company Training Manual:

Landings

B. The recommended approach and landing procedures consists primarily of the following:

1. Aim point or point of intended landing 1,000 feet beyond the runway threshold. Touchdown should occur at a point between 500 feet and 1,500 feet inside the runway threshold.

2. Stabilized approach from the outer marker or 1,000 feet depending upon the type of approach being made. Gear and flaps extended, stabilized on desired speed, rate of descent

between 500 and 700 FPM. A rate of descent in excess of 1,000 FPM is considered undesirable and must be corrected prior to 500 feet above the field or a missed approach executed.

1.18 **New Investigative Techniques**

None

2. ANALYSIS

2.1 **General**

The airplane was certificated, equipped, and maintained according to regulations. The gross weight and c.g. were within prescribed limits during the approach to Raleigh-Durham Airport.

The Safety Board concludes that the airplane's powerplants, airframe, electrical and pitot/static instruments, flight controls, and hydraulic and electrical systems functioned properly and were not factors in this accident.

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

2.2 **The Weather**

The weather in the Raleigh-Durham Airport area was substantially as stated in the NWS forecast which included thunderstorms and heavy rain showers. However, the actual conditions encountered by Flight 576 were far worse than the general weather reported to the flightcrew when it first contacted the ATC at the airport.

The weather over the approach end of runway 23 deteriorated rapidly as Flight 576 progressed down the approach path for landing. The rapid deterioration was corroborated by the flightcrew statements, the observations of witnesses, and significant differences between the weather observations taken at the airport at 1955, and those taken at 2004 and 2009 by NWS weather observers. Moreover, a measured rainfall rate of about 7 inches per hour between 1957 and 2000 at a point 3,700 feet southwest of the accident site supports the statements of the flightcrew and the ground witnesses that there was very heavy rain near the threshold of runway 23 just before the accident. Although the rainfall rate decreased to about 1.7 inches per hour between 2001:57 and 2003:00, at the measurement site the rainstorm was observed to move generally from west to east. Accordingly, the rainfall rate recorded between 1957 and 2000 at the measurement site was consistent with similar rain conditions having been encountered by Flight 576 near the threshold of runway 23 about 2002 hours. Consequently, the Safety Board concludes that Flight 576 encountered heavy rain, which probably included downdraft activity and a horizontal wind shear as it descended below decision height (DH) for landing. The intensity of the heavy rain, coupled with the suddenness with which the rainfall increased, caused the captain to rapidly lose visual contact with the runway just as the airplane approached the runway threshold, and he apparently did not regain forward visibility until after the airplane struck the ground, bounced, and touched down past the runway threshold lights.

2.3 The Approach

The correlation of the CVR and the FDR data indicate that the ILS approach to runway 23 was stable until the airplane neared DH. The airplane had been slightly below the glide slope just before the first officer reported the "flashers just ahead," at 2001:46, and the airplane was then slightly above the glide slope until 2001:55, when it returned to the centerline of the glide slope. About the time the first officer stated that the runway was in sight, the airplane was about 250 feet above the runway elevation. When the airplane passed through DH, it was about 5 feet below the glide slope. At 2002:00, when the first officer said "Looks to be a little bit low," the airplane was 10 to 15 feet below the glide slope, and its rate of descent began to increase rapidly. At 2002:04, when the airplane was less than 100 feet above the runway, the first officer called "rate of descent too high." He immediately repeated the call. According to the captain, he increased thrust at DH, and as the airplane started to correct to the glide slope, the airplane entered a "wall of water" and continued to descend. The captain continued to increase thrust but the airplane struck the ground. These actions and conditions were confirmed by the first officer and the flight engineer.

The evidence established that the flightcrew acquired sight of the flashers, the approach lights, and finally the runway lights as the airplane descended from about 380 feet to about 250 feet Further, the runway lights remained visible to the flightcrew until 4 to 6 seconds before impact, when, while at an altitude of less than 100 feet above the runway, the airplane entered the heavy portion of the rainstorm. Consequently, the Safety Board concluded that the heavy rain caused the flightcrew to lose sight of the runway immediately, while the downdrafts and horizontal wind shear associated with the heavy rain resulted in a significantly increased rate of descent.

The Safety Board concludes that the heavy rain was accompanied by downdrafts and horizontal wind shear, although it was not able to calculate their magnitude. Therefore, the Safety Board concludes that when Flight 576 suddenly entered the heavy rain area, it encountered changes in wind which hampered the effectiveness of the captain's efforts to maintain a proper descent profile during the very last portion of the approach. Consequently, the captain probably failed to perceive promptly the onset of the increased descent rate which resulted from the adverse winds because of the concurrent loss of visual references.

Once the airplane encountered the heavy rain, the captain had very few seconds to take corrective action. The airplane was less than 100 feet above the runway, and the captain had transitioned from instrument references to visual references to complete the landing. The FDR and CVR indicate that the captain had between 4 and 6 seconds to correct the airplane's flight path if he was to avoid a crash. In that time, he had to transition to the flight instruments, analyze the magnitude of the situation, make a decision with respect to landing or go-around, and initiate the appropriate control actions. Assuming that the captain could have reacted to the situation properly in 4 to 6 seconds, there was the further problem of the airplane's response time to the control actions initiated by the captain.

Studies of reaction time requirements for pilots in similar situations, by the Safety Board and by consultants who have examined this subject, indicate that between 2.5 seconds and 3.8 seconds are necessary from recognition of the event to movement of airplane controls. During this period, the flightpath of the airplane, however, would continue to respond to the adverse weather conditions until the captain initiated appropriate control actions to complete the landing or to begin a missed approach procedure.

The observations of the witnesses, the statements of the flightcrew, and the FDR recording of the airplane performance indicate that the captain began to react to the effects of the changing weather conditions on the airplane just before impact. The witnesses reported hearing an application of engine power and observed Flight 576 rotate to a nose-high attitude. The FDR trace showed that during the last 5 seconds of flight, the average flight path angle was about 5°. However, ground damage and markings showed an impact angle of about 2.5°. The difference between the average glidepath angle of about 5° and the impact angle of about 2.5° indicates that the captain had initiated action to rotate the airplane and that the airplane had begun to rotate. Additionally, this maneuver was verified by witnesses. However, the airplane struck the ground before the descent could be stopped. Consequently, the Safety Board concludes that once the airplane encountered an unexpected heavy rainstorm and downdrafts while less than 100 feet above the runway, insufficient time was available for the captain to react and the airplane to respond to avoid impact with the ground.

Another factor which might have affected the captain's perception of the airplane's altitude in relation to the runway was the refraction of light through the water on the windshield. The effect of a heavy film of water on the windshield is to cause a downward refraction of the pilot's line of sight to the runway. The FDR trace indicated that the airplane went below the glidepath after the captain transitioned to visual cues. This could have been the result of the approach and runway lights appearing to be higher than their actual elevation. Consequently, it is possible that the captain was misled as to the actual altitude of the airplane and that he thought he was higher, which resulted in his allowing the airplane to descend below the glidepath. Moreover, he was using the VASI as a visual reference and the limitations of the VASI would not have permitted immediate recognition of either the descent below the glidepath or the increasing descent rate.

The captain said that when he noted the position of the airplane below the glide slope by reference to the ILS display, he added power to level the airplane and regain the centerline of the glidepath. About the same time, the first officer made a call concerning the position of the airplane below the glide slope, followed by a call about the rate of descent. The captain stated that he did not hear the calls of the first officer, even though they were clearly noted on the CVR. However, since he was already aware of the position of the airplane and was concentrating on putting the airplane back on the glide slope, it is not likely that the calls, even if heard, would have stimulated the captain to take more aggressive action.

2.4 Adherence to Checklist Procedures

Eastern Air Lines procedures required that the pilot flying the airplane make specific altitude calls and that the nonflying pilot and the flight engineer monitor the altitude calls to further assure that proper altitude awareness is maintained in the cockpit. In this accident, the captain made the first altitude call of "2,000 feet" at 1959:43. At 2000:03, the captain stated "Eighteen hundred's our. . .—yep" The required call was the final approach fix (FAF) at 1,785 feet. It appears likely that the captain's altitude call at 2000:03 was the glide slope intercept altitude, while the first officer's call, at 2000:21, "glide slope cap both sides" was the actual crossing of the FAF. Although the captain, under Eastern Air Lines procedures, was required to make the FAF callout, he apparently anticipated the call and was conscious of the proper altitude before the airplane reached the FAF. Once the first officer noted the glide slope capture at the FAF, and then reported the passing of the FAF to the tower at 2000:28, the checklist requirement had been met, although it was done by the first officer rather than the captain.

According to the procedure, the captain was required to make another altitude awareness call at 1,000 feet above the airport. However, at 2000:49, the terrain warning system sounded, which indicated that the airplane was about 1,000 feet above the airport. Four seconds later, the first officer said "one thousand feet." This call was followed by the second officer's statement of "one thousand feet." This again was an altitude call by the first officer that should have been made by the captain. It was possible that the captain was too busy or too engrossed in the approach to make the prescribed altitude calls. However, it was also possible that the first officer made the calls as the airplane arrived at the appropriate altitude either because he was waiting to reach that point or because he wanted to relieve the captain's workload. In either case, although the captain did not initiate the required calls, the proper altitude checks were made.

At 2001:34, the first officer called, "five hundred feet, ground contact." Shortly afterwards, the captain said he had visual contact with the flashers, the approach lights, and the runway environment. He continued to fly the airplane with reference to visual references, and he did not make the required call of "100 feet above decision height" or "decision height." Moreover, the first officer and the flight engineer did not challenge the captain's failure to make either of these callouts. Although the first officer's calls concerning the airplane's position on the glide slope, and the rates of descent, as well as the captain's and the flight engineer's statements about observing the airplane go below the glide slope, indicate that the flightcrew did monitor the instruments, the calls of 100 feet above DH and at DH were checklist items and should have been observed by the flightcrew. The captain had begun to fly the airplane by visual references before he reached 100 feet above DH; however, the meteorological conditions were marginal, and the Safety Board believes that it would have been prudent to complete the required checklist calls, if for no other reason, in order to establish the airplane at a specific point and altitude in the final approach sequence. The fact that the approach was being conducted at night was further reason for the entire checklist to be followed. The checklist callouts were a backup to the flightcrew to confirm their observations of the position of the airplane at times during the instrument approach, and as a result, were not items which should have been arbitrarily discounted. Although the absence of the callouts does not appear to have had an influence on subsequent events, a reminder to the captain that the airplane was below DH might have influenced his subsequent decisionmaking process. Further, although the deviations from the approved checklist did not contribute to the accident, they indicate a lack of discipline which is not professional.

3. CONCLUSIONS

3.1 Findings

1. There was no evidence of preimpact structural failure, fire, or flight control or powerplant malfunction.

2. The flightcrew did not accomplish all checklist items which related to altitude awareness; however, members of the flightcrew did monitor the altitude of the airplane and the flight instruments during the final approach.

3. The deviations from the checklist did not contribute to the accident.

4. The instrument approach was stable and uneventful until the airplane passed decision height.

5. The general weather forecast was substantially correct; however, the localized weather encountered by Flight 576 while on final approach was much worse than was reported on the Airport Terminal Information Service.

6. Air traffic control (ATC) personnel at the Raleigh-Durham ATC facility were not aware of the rapidly deteriorating weather conditions in time to warn the flightcrew.

7. About 1957, heavy rain moved across the airport toward the approach course to runway 23.

8. The weather conditions changed rapidly after Flight 576 passed decision height.

9. The airplane encountered an unexpectedly heavy rain with associated downdrafts and horizontal wind shear about 100 feet above the ground.

10. The magnitude of the downdrafts and wind shear could not be determined from the available information.

11. The rainfall rate may have been as high as 7 inches per hour when Flight 576 encountered the heavy rain.

12. The captain observed the descent below glide slope caused by the initial encounter with the heavy rain and responded by adding thrust.

13. The flightcrew lost forward visibility rapidly when the airplane entered the heavy rain.

14. The captain was not aware of the magnitude of the downdrafts and horizontal wind shear, with the result that he initially applied the thrust he believed necessary to maintain the glide slope.

15. The rate of descent increased rapidly after the airplane encountered the heavy rain despite the addition of thrust and the upward rotation of the airplane by the captain.

16. The captain had less than 6 seconds to correct the airplane's flightpath if he was to avoid the airplane hitting the ground.

17. There was insufficient time for the captain to react and the airplane to respond to prevent the airplane from striking the ground after the encounter with the heavy rain when the airplane was less than 100 feet above the ground.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was an encounter with heavy rain and associated downdrafts and wind shear during the final stages of landing when the airplane was less than 100 feet above the ground. The sudden onset of the meteorological conditions did not allow sufficient time for the captain to perceive and react to the effect of the downdraft and wind shear on the airplane's performance to stop the airplane's increased rate of descent and for the airplane to respond before striking the ground short of the runway.

4. RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board has recommended that the Federal Aviation Administration:

> Issue an Airworthiness Directive to require that the seatbelt tiedown rings on all Boeing 727 forward jumpseats be relocated so that the seatbelt will be positioned across the occupant's pelvic girdle at the recommended angle with the seatpan of 45° to 55°. (A-76-80) (Class II - Priority Followup.)
>
> Inspect the flight attendant jumpseats on all other air carrier aircraft to insure that the seatbelt tiedowns are positioned properly; where improper installations are found, take immediate action to require that the tiedowns be relocated. (A-76-81) (Class II - Priority Followup.)

As recommended by the Safety Board in 1971, the FAA issued Air Carrier Operations Bulletin No. 71-9 to emphasize the common errors which are made by flightcrews during the execution of nonprecision approaches and has recommended practices to eliminate these errors. The Safety Board believes that the FAA's recommended practices should apply to precision approaches as well.

Approach and landing accidents continue to occur at an unacceptable rate; this accident, as have many others in the recent past, demonstrates either a disregard for, or a modification of, approved operating procedures and lax flightcrew discipline. The Safety Board has recommended to the Administrator, Federal Aviation Administration, several measures to reduce the number of approach and landing accidents. However, in view of their continued occurrence, the Safety Board reiterates its concern and reemphasizes the importance of flightcrews' adhering more meticulously to approved procedures and regulations.

REVISED REPORT ADOPTED
BY THE NATIONAL TRANSPORTATION SAFETY BOARD*

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

September 7, 1983

*The original report was adopted on May 19, 1976, by the following members of the National Transportation Safety Board: Webster B. Todd, Jr., Chairman; Francis H. McAdams, Philip A. Hogue, Isabel A. Burgess, and William R. Haley, Members.

APPENDICES

APPENDIX A

INVESTIGATION, HEARING, AND RECONSIDERATION OF PROBABLE CAUSE

1. Investigation

The Safety Board was notified of the accident about 2200 on November 12, 1975. The investigation team went immediately to the scene. Working groups were established for operations, air traffic control, witnesses, weather, human factors, structures, maintenance records, powerplants, systems, flight data recorder, and cockpit voice recorder.

Participants in the on-scene investigation included representatives of the Federal Aviation Administration, the Boeing Company, Eastern Air Lines, Inc., the Air Line Pilots Association, the Transport Workers Union, Pratt & Whitney Aircraft Division of United Aircraft Corporation, the National Weather Service, and the Professional Air Trafffic Controllers Organization.

2. Public Hearing

There was no public hearing in this case; however, deposition proceedings were held December 16 and 17, 1975. Parties represented at the deposition proceedings were: the Federal Aviation Administration, Eastern Air Lines, Inc., the Air Line Pilots Association, the National Weather Service, and the Professional Air Traffic Controllers Organization.

3. Reconsideration of Probable Cause

On October 3, 1978, the Air Line Pilots Association submitted to the Safety Board a petition for reconsideration of the probable cause in the subject accident. The petition offered new evidence concerning the accident investigation, and discussed errors and omissions in the original report. The original accident report was revised as a result of the Air Line Pilots Association's petition.

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APPENDIX B

CREW INFORMATION

Captain Edward A. Barchard

Captain Edward A. Barchard, 45, holds Airline Transport Pilot Certificate No. 1327749 with ratings in the Boeing 727 and the Douglas DC-9. He was upgraded to pilot-in-command of the Boeing 727 aircraft on November 15, 1972. His first class medical certificate was upgraded on May 20, 1975, and was issued with a limitation to wear corrective eyeglasses when exercising the privileges of the airman's certificate. He stated that he was wearing the eyeglasses at the time of the accident.

Captain Barchard's last proficiency check was satisfactorily in compliance with 14 CFR 121.441. His last en route competency report was completed satisfactorily in compliance with 14 CFR 440 on December [illegible], 1974. He had accumulated about 5,986 total flight hours, 1,724 hours of which were in B-727 aircraft. Captain Barchard had 14 hours 47 minutes of rest time before this flight sequence. At the time of the accident, he had been on duty for 10 hours 57 minutes of which 6 hours 22 minutes were flight time.

First Officer Robert F. Nicholson

First Officer Robert F. Nicholson, 42, holds Commercial Pilot Certificate No. 1484308 with ratings in airplane multiengine land B 727, and instruments. His first class medical certificate, issued with waivers for corrective eyeglasses, was upgraded on May 27, 1975. He stated that he was wearing the eyeglasses at the time of the accident.

First Officer Robert F. Nicholson's last proficiency check was completed satisfactorily on April 7, 1975. He had accumulated about 5,831 total flight hours, of which about 2,939 hours were in B-727 aircraft. First Officer Robert F. Nicholson's rest time, as well as his duty time and flight time on this trip, were the same as Captain Barchard's time.

Second Officer Jiles L. Robinson, Jr.

Second Officer Jiles L. Robinson, Jr., 35, holds Commercial Pilot Certificate No. 1641970, with ratings in aircraft single engine land and instruments. He also holds Flight Engineer Certificate No. 1808743. His first class medical certificate, issued with waivers for corrective eyeglasses, was updated on September 15, 1975. He stated that he was wearing the eyeglasses at the time of the accident.

Second Officer Jiles L. Robinson's last flight proficiency check as a flight engineer was completed satisfactorily on March 24, 1975. He had accumulated about 3,880 total flight hours, of which about 950 hours were in B-727 aircraft. Second Officer Jiles L. Robinson's rest time, as well as his duty time and flight time on this trip, were the same as the other two flightcrew members.

APPENDIX C

AIRCRAFT INFORMATION

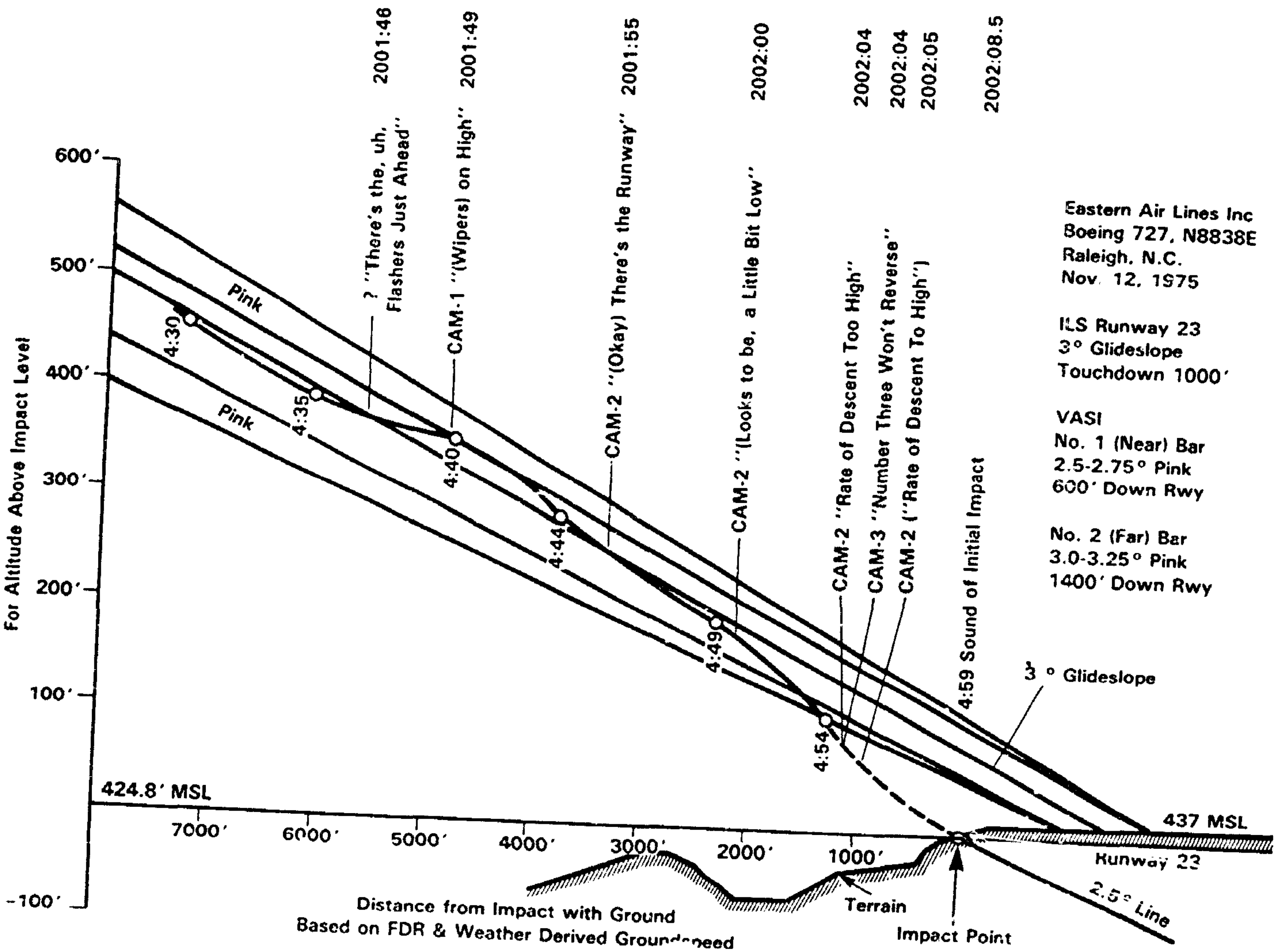
Boeing 727-225, Serial No. 20381, N8838E, was registered to Eastern Air Lines, Inc. It was certificated and maintained in accordance with procedures approved by the Federal Aviation Administration. At the time of the accident, the aircraft had flown 15, 969.57 flight hours; 571 hours had been flown since the last major phase check.

Engines: Three Pratt and Whitney JT-8D-7

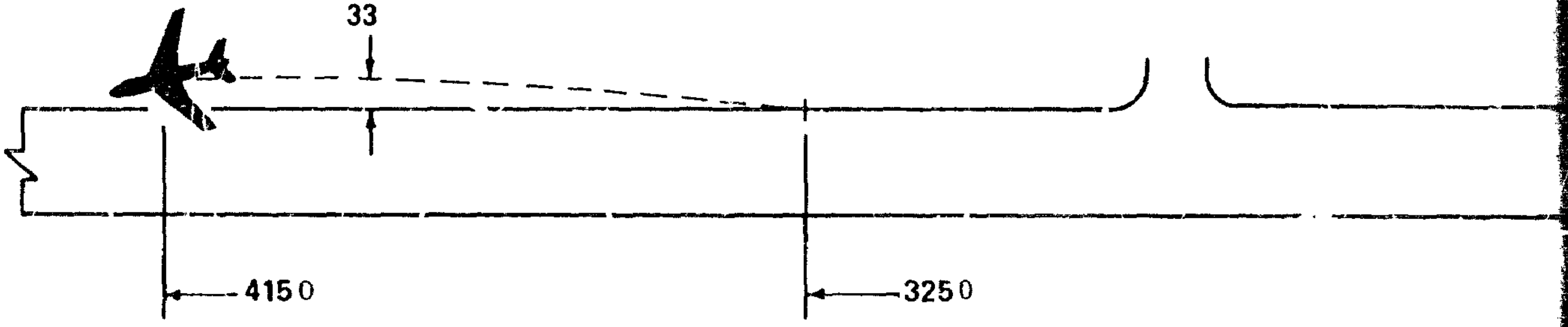
	Date of Manufacture	Serial No.	Total Time	Hours Since Last Overhaul
No. 1	9/10/68	655082	19,208	4,517
No. 2	3/25/66	653413	27,227	16,172
No. 3	3/13/64	648783	29,705	9,868

DESCENT PROFILE

FDR/CVR/Runway/ILS/VASI Correlation



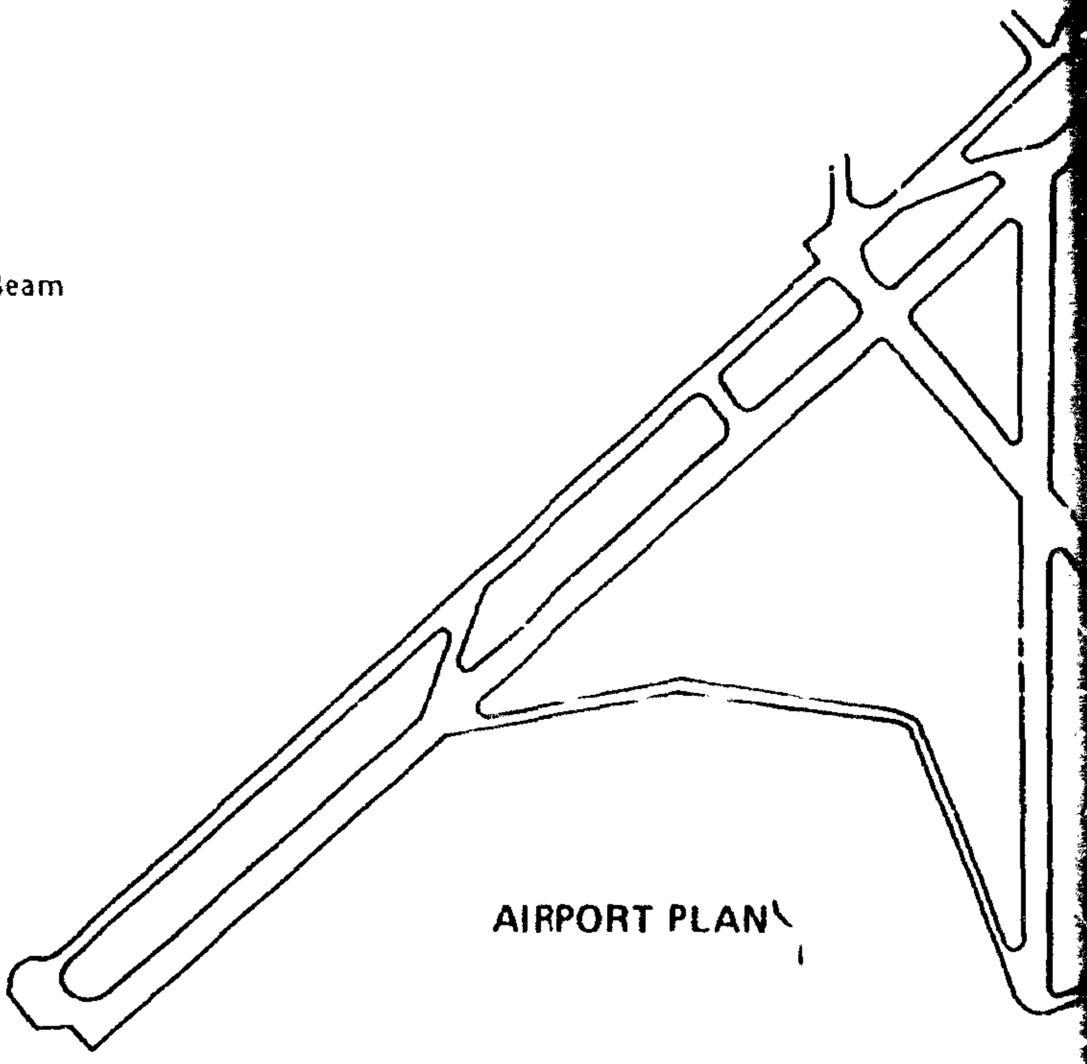
APPENDIX D



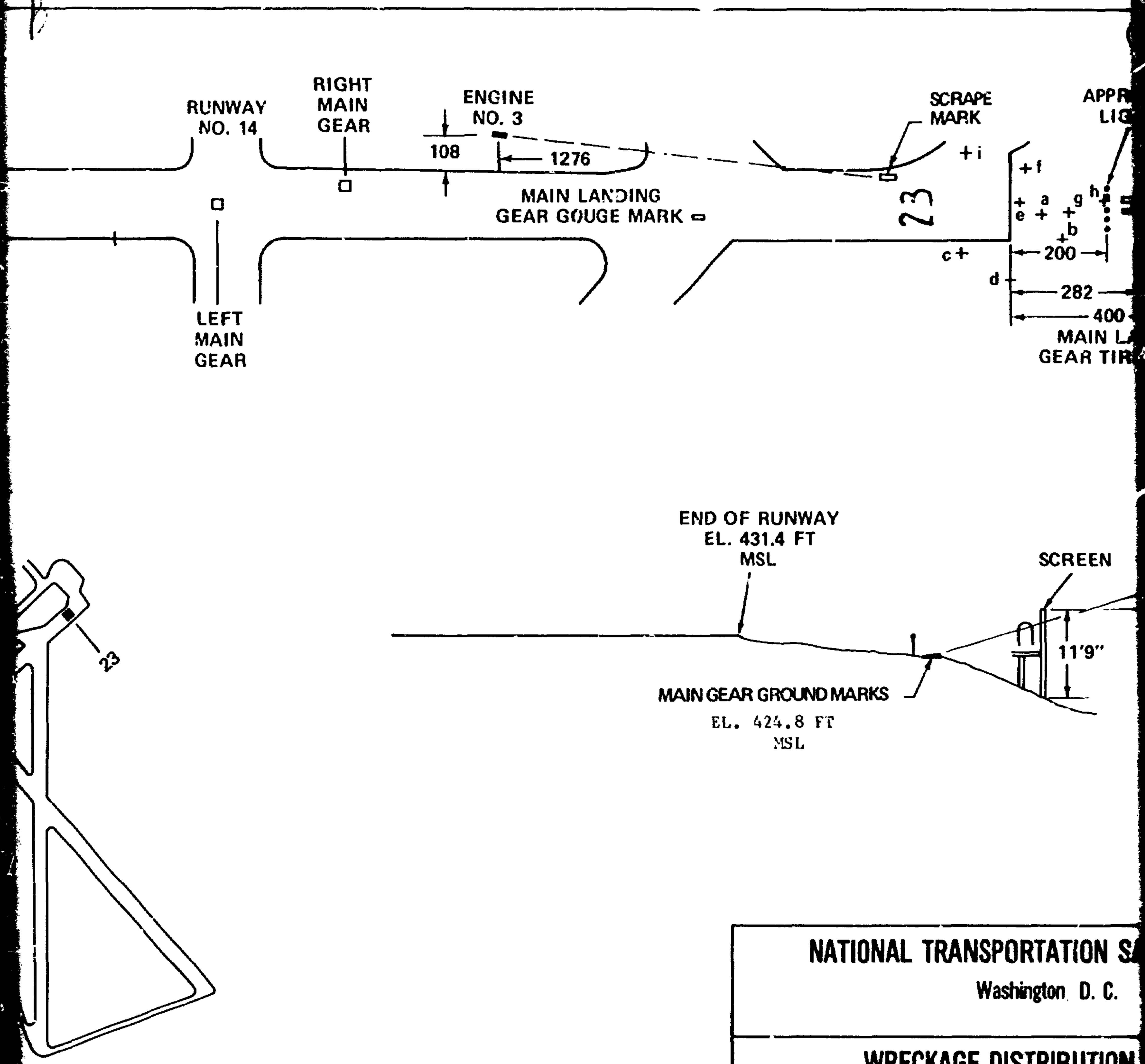
AIRCRAFT LEGEND

a Support - Main Landing Gear Door to Strut Attach.
b Left Inboard T.E Aft Flap (9.5 Ft. Inbd.)
c Mid Flap - Left T.E. Inbd.
d Left T.E. Inbd Mid Flap, Outbd Half
e Portion of Wing T.E. Structure Spoiler and Support Beam
f Lower Right Wing Access Door Near Main Gear
g Handrails (10 Ft. Apart) Airstairs
h Airstair Control Access Panel
i Right Main Landing Gear Extension Actuator

ALL DISTANCES IN FEET



AIRPORT PLAN



NATIONAL TRANSPORTATION S

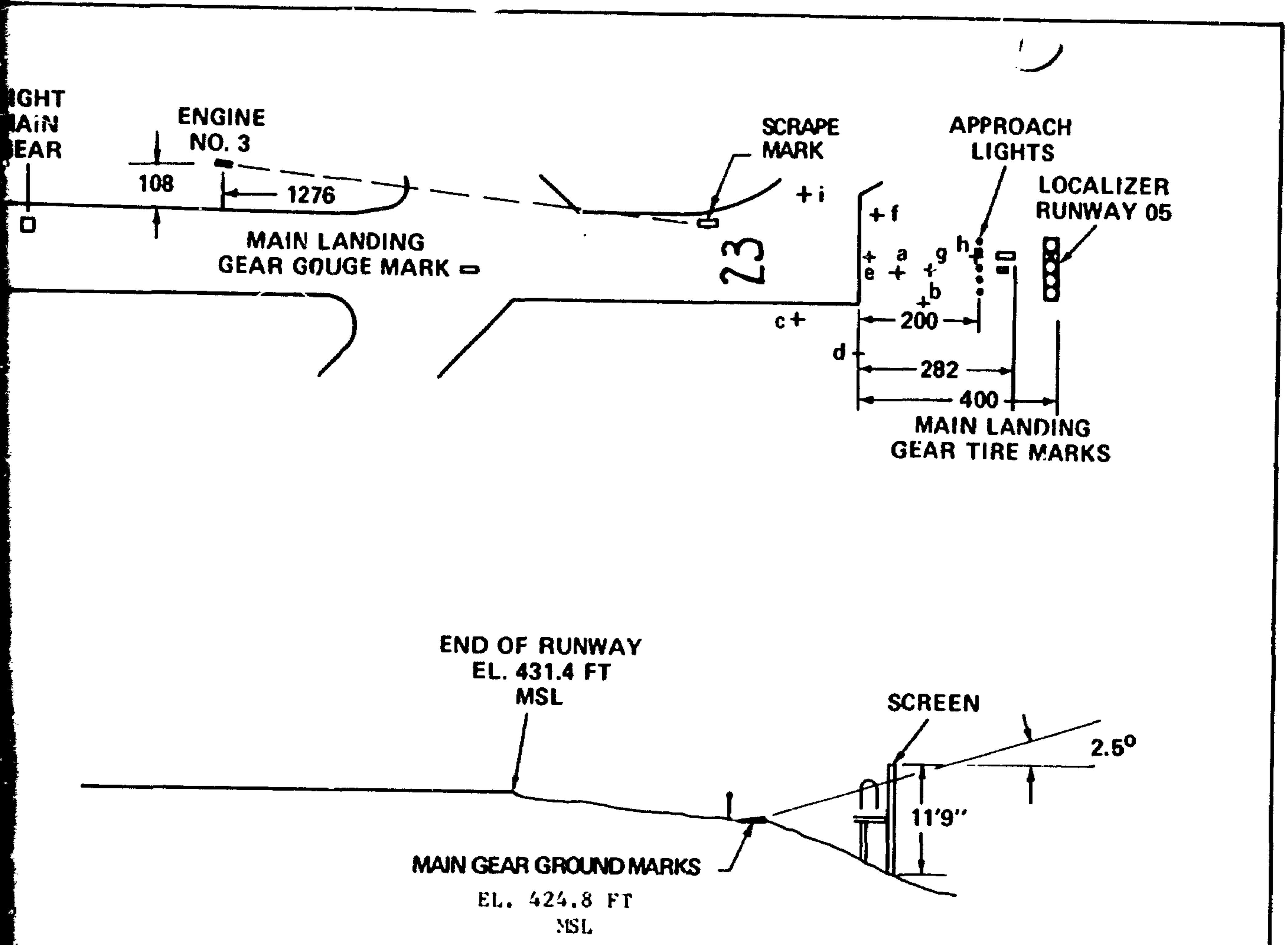
Washington D. C.

WRECKAGE DISTRIBUTION

EASTERN AIRLINES FLIG

Raleigh-Durham N.C.

12 November 1975



NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D. C.

WRECKAGE DISTRIBUTION CHART
EASTERN AIRLINES FLIGHT 576
Raleigh-Durham N.C.
12 November 1975

APPENDIX F

AIR LINE PILOTS ASSOCIATION'S PETITION FOR RECONSIDERATION OF PROBABLE CAUSE

AIR LINE PILOTS ASSOCIATION
1625 MASSACHUSETTS AVENUE, N.W. □ WASHINGTON, D.C. 20036 □ (202) 797-4000

October 3, 1978

Mr. James B. King, Chairman
National Transportation Safety Board
800 Independence Avenue, S.W.
Washington, D.C. 20594

Dear Mr. King:

In accordance with the Part 831.36 of the Board's rules, we are enclosing a petition for reconsideration of the probable cause involving an Eastern Airlines Boeing 727 accident which occurred at Raleigh, North Carolina.

This petition, prepared by ALPA representatives intimately involved with the accident investigation, has been reviewed by most of the ALPA technical committee members and therefore reflects a wide range of technical expertise. ALPA has expended considerable resources in going beyond the original investigation conducted by the NTSB in an effort to determine in a detailed manner just why the accident occurred. We trust the professional views contained in this petition will be given an equally thorough review and evaluation.

ALPA representatives would be pleased to provide any additional information required by the Board in their consideration of this petition.

Copies of this petition have been forwarded to all parties who participated in the investigation.

Sincerely,

J. J. O'Donnell, President

JJO'D/pas
Enclosure

cc: NTSB Board Members
F. Taylor, NTSB
M. Clark, NTSB
J. Kuehl, NTSB
C. Bruggink, NTSB
FAA
EAL
National Weather Service
PATCO

AIR LINE PILOTS ASSOCIATION
1625 MASSACHUSETTS AVENUE N.W. □ WASHINGTON, D.C. 20036 □ (202) 797-4000

March 7, 1979

Mr. James B. King, Chairman
National Transportation Safety Board
800 Independence Avenue, SW
Washington, DC 20594

Dear Mr. King:

Subsequent to submitting our petition for reconsideration of the Board's findings in the case of an Eastern Airlines Boeing 727 which experienced an accident at Raleigh, North Carolina on November 12, 1975, our representatives determined that a very simple calculation would show the error of the flight recorder readout as described in the petition. We recognize that the complexities of the readout procedures may not allow an easily understood explanation of the source of the error; however it should be readily apparent whether or not the FDR data is correct by merely taking the NTSB readout values of altitudes, indicated airspeeds, and elapsed times and calculating the distance traversed to impact with the ground (i.e., 282 feet short of the threshold). With the distance obtained using the velocity versus time calculation, the altitude profile can thus be determined.

We have done this for several of the NTSB FDR data points in the following tabulation. The results are then plotted on the enclosed layout of the VASI and ILS glide slope profiles. It can be easily seen that the NTSB points place the aircraft's flight path above not only the ILS glide slope but also at the very upper edge of the VASI glide path.

Needless to say there is no instrument which would have allowed the captain to fly an almost constant altitude above the glide slope throughout the final approach. Also it should be noted that when the first officer makes the comment "VASI looks a little bit low," the NTSB data has the aircraft at the upper (high) side of the VASI on-course signal.

/continued/

Mr. King
Page 2

Clearly the N7SE FDR readout contains an error as we pointed out previously. It is evident that the impact with the ground as recorded by the FDR occurred at 4:59 (FDR time) as illustrated by the start of the increase in the vertical acceleration. At this time point, however, the altitude is indicating 475 feet whereas the ground impact elevation is 424.8 feet. Obviously this is a significant altitude discrepancy.

We believe this error is associated with a shifted reference line of the FDR tape as briefly outlined in the petition. In any event, we trust the above clarification will show more clearly the nature of the error and how with the proper corrections applied the data conform to the known facts.

Sincerely,

J. J. O'Donnell, President

JJO'D:bh
Enclosures

FDR TIME	ALTITUDE	AVERAGE IAS	DISTANCE	
4:59	475'	-----	0	ground impact
4:54	58[illegible]'	148 kn	1249'	
[illegible]	670'	148 kn	2498'	
4:44	76[illegible]'	147 kn	3738'	
4:4[illegible]	810'	145 kn	4557'	
[illegible]	865'	145 kn	5941'	
4:3[illegible]	93[illegible]'	146 kn	7173'	

PETITION
TO THE NATIONAL TRANSPORTATION SAFETY BOARD
FOR RECONSIDERATION OF THE PROBABLE CAUSE
INVOLVING EAL B-727, N8838E,
RALEIGH, NORTH CAROLINA
NOVEMBER 12, 1975

TABLE OF CONTENTS

I. INTRODUCTION

A. Intent

The Air Line Pilots Association offers the following petition for modification of the National Transportation Safety Board Aircraft Accident Report 76-15: Eastern Air Lines, Inc., Boeing 727, N8838E, Raleigh, North Carolina, November 12, 1975. Based upon new evidence relevant to the report, as well as substantive errors and omissions on the part of the Board, the petitioner will establish a revised accident scenario that supports modification of the Board's findings and probable cause.

The petition details errors and omissions both in analysis of the Flight Data Recorder (FDR) tape and in the correlation of the Cockpit Voice Recorder readout with the approach path summary, then presents a revised analysis of the approach that accurately portrays the path of the aircraft relative to the actions of the flight crew and meteorological phenomena. The succeeding portion of the petition will address specific errors and omissions in the derivation of Board conclusions in the context of both the revised scenario and new evidence.

B. Errors and Omissions

The following errors and omissions in the Board's conclusions and analysis of the evidence will be discussed:

1. Errors in the FDR Readout and Analysis

   a. Altitude trace error.

   b. Impact time error.

   c. Airspeed trace error.

   d. Lack of correction for ground effect or rotation of the aircraft about its lateral axis.

   e. Failure to read out radio transmission time binary.

2. Errors in CVR transcript timing.

3. Misinterpretation of altitude at which crew lost forward visibility.

4. Failure to understand limitations in ability of crew/aircraft to execute missed approaches under adverse conditions.

5. Misinterpretation of required IFR callouts.

6. Misunderstanding of the term "approach speed" as opposed to the term "V_{ref}" (the speed required for the approach).

Lack of substantive analysis of the appropriate meteorological data.

8. Erroneous interpretation of rainfall rate.

9. Failure to analyze effect of heavy rain on aircraft performance.

10. Misunderstanding of use of flight instruments during landing.

C. New Evidence

The following new evidence will be presented in support of revision of AAR 76-15:

1. Air Traffic Control (ATC) failure to relay information pertinent to execution of the approach.

2. Inadequacies of the aircraft's windshield wiper system.

3. Deficiencies in the standard Visual Approach System Indicator (VASI) presentation.

4. Analysis of pilot event-related reaction times.

II. ERRORS IN FLIGHT RECORDER READOUT

We must emphasize how important a correct analysis of the final approach profile is to the understanding of the true factors leading to this accident.

ALPA's examination of both the calibration and recorder tapes revealed an average reference line error of .0075 inches. This is a significant error which, if unaccounted for, would result in an altitude trace 151 feet too high.

Another effect of the reference line error is to produce an airspeed trace which is too high by approximately 5 knots. As will be shown later, this error resulted in the Board's misinterpretation of the actual approach speed being flown and its relationship to V_{ref}.

The corrected altitude and airspeed traces were re-plotted over the Board's readout for easy comparison (Figure 3). Although the heading trace would have been similarly effected, no correction was made to it since it is not relevant to the analysis.

Another error in the Board's readout is the time of initial impact. The Board's analysis of the FDR concluded that the accident occurred at an FDR time of 5:00. However, the FDR readout shows the start of a sharp increase in the vertical acceleration trace beginning at 4:59. This represents the actual impact time rather than the peak "g" as assumed by the Board since the impact force which caused the accelerometer to rise to a peak value had to occur at some time prior to the peak value time.

The above corrections, plus two others, a 177-foot barometric correction and a 14-foot pilot's eye-to-static-port vertical separation were applied to ALPA's readout and resulted in the flight path profile shown in Figure 1. (According to Boeing, eye path and ILS antenna path are approximately the same; therefore, this flight path profile represents the path of the pilot's eyes and glide slope antenna.) The main wheel path lies 20 feet below the eye path.

It should be noted that the impact point of the altitude profile wheel [illegible] feet MSL, yet the impact elevation is 424.8 feet MSL. This discrepancy is due to ground effect and rotation errors. As an aircraft in ground effect is rotated about its lateral axis, the static pressure ports, which are located under the forward fuselage, are pressurized as the air flow angle changes. This pressurization produces a decrease in the indicated altitude which, if not corrected, could be interpreted as indicating an increased descent rate. (Figures 1 and 2 show the corrected altitude profiles.)

The Board's report stated that "At 3.6 seconds before touchdown, the descent rate increased to an average of 1400 fpm." The Board failed to understand that this was only an apparent, and not an actual, increase in the descent rate. At 140 knots ground speed, a 1400 fpm descent rate would produce a flight path angle of 5.6 degrees; yet, according to the Board's report, "the angle of descent between the broken ILS localizer antenna domes and the ground marks was about 2.5 degrees."

In summary, when all corrections are applied, the Board's pressure altitude trace is generally high by 81 feet, and the last few seconds of the trace were misinterpreted as an increasing descent rate when in fact a pullout was underway.

The possibility of additional error can be raised since the Board's readout of the FDR did not contain the radio transmission time binary which is used to obtain a real time conversion of the FDR data. ALPA's readout of this binary revealed erroneous transmission timing of the entire trace. While ALPA believes the lack of this information was not critical to the investigation, we do feel this malfunction should have been mentioned in the FDR Group Chairman's Factual Report. Because these radio transmission timing traces are often relied upon to accurately correlate ATC transmission times to events which occur on the FDR tape, it is important to know the history of the reliability of this particular part of the recorder. The opportunity to examine these traces occurs only during accident investigations. But in this case the cause of the erroneous timing will never be known since it was never investigated.

III. ERRORS IN CVR TRANSCRIPT TIMING

After careful examination of the FDR tape, ALPA concluded that accurate application of real time to the events leading to the accident could be effected only by careful synchronization of the Air Traffic Control (ATC) and Cockpit Voice Recorder (CVR) tapes.

ALPA reviewed the ATC transmissions beginning at 0051:27Z until 0100:49Z utilizing a digital readout playback device. With the aid of a variable speed tapedeck and stopwatch, the CVR tape speed was then adjusted to coincide with the 9-minute, 21-second period covered by the two ATC transmissions. Real time was then applied to the CVR When comparing ALPA's times with those of the Board, there is as much as a three-second discrepancy between ALPA's and the Board's transcripts.

As an example, the Board's transcript shows that the 500 feet callout made by the first officer occurred 31.5 seconds prior to impact. According to our examination, the callout actually occurred 34.5 seconds prior to impact, at a corrected altitude of 490 feet above the touchdown zone elevation.

IV. SUMMARY OF THE APPROACH BASED ON A CORRECTED PROFILE

The key to understanding this accident lies in careful scrutiny of the last 34.5 seconds of flight. In Figure 1, the later portion of the flight path profile has been expanded; and, in Figure 2, cockpit voice recorder (CVR) comments have been time correlated to the flight path profile. This profile confirms the crewmembers' statements and depositions regarding the events which occurred during the approach. Thirty-four and a half seconds prior to impact, the first officer [illegible] feet - ground contact." At this time the aircraft was positioned on the electronic glide slope and the captain was flying the aircraft solely by reference to the flight instruments.

Thirteen seconds later, 21.5 seconds prior to impact, the first officer said, "There's the ah flashers up ahead." At this time, the aircraft was still positioned on the electronic glide slope approximately 300 feet above the airport and being flown solely by reference to the flight instruments. According to the captain's deposition, "The first officer commented he had the approach lights in sight. I hesitated a few seconds after he made the comment before I came off the instruments to look out and when I came off the instruments., came in view pretty much in sequence; the lights, threshold and runway were pretty much in a row." (TR 114-6) In addition, the first officer's deposition, "I recall 400 feet; I'm sure that's what it was. We have a procedure to call in a hundred feet above designation light (decision height) and that's when I caught the approach." (TR 80-23) It should be pointed out that the decision height for this approach is 200 feet.

The CVR transcript shows that 18 seconds prior to impact the Captain requested that the windshield wipers be placed to high; this is 3 seconds after the "Flashers up ahead" callout by the F/O. It is obvious that the captain's request for a higher windshield wiper speed indicates that at about this time his vision was transferred outside the aircraft. The flight profile also shows that the aircraft began a deviation below the electronic glide slope 16.5 seconds prior to impact or 5 seconds after the "Flashers up ahead" callout.

The captain's deposition stated, "At approximately 200 feet or so again I was visual. I felt somewhat low and I checked back to the raw data on my glide slope and it showed that I was slightly below the glide slope and I added power and flattened the airplane out to fly back into the glide slope. I was also trying to compare it with the VASI and the runway as to how it felt to me at the same time."

"After that, I did not refer to the glide slope. I stayed more or less on the VASI. Everything was normal. The approach was flat." (TR 114-15)

The flight profile indeed shows that at 200 feet the pilot's eyes and glide slope antenna were approximately 12 to 15 feet below the electronic glide slope and the descent rate had increased to slightly over 1,000 feet/minute. However, the VASI was showing an on-glidepath indication (Figure 2).

The fact that the VASI was observed by the captain at this point (approximately 200 feet above the airport) indicates that the visibility was equal to or greater than the distance of 4,800 feet (.9 statute miles) to the upwind VASI bar.

When the captain requested the wipers be placed to high the first officer returned his vision from outside the aircraft to the overhead switch panel to locate and select the high position on the wiper switch and then returned his vision outside the aircraft.

[illegible] officer's vision had to shift from a more intensely lit outside scene to the dimly illuminated overhead switch panel. He then had to locate the windshield wiper selector switch, make the selection to high speed, and shift his attention back to the outside environment.

During this 6-1/2 seconds, the VASI would have provided an on-glide-path indication as depicted by the flight path profile (Figure 2). This on-glide-path indication would have been displayed to the flight crew for an additional 2 seconds after the first officer's callout of "and there's the runway." It is emphasized that all visual cues up to this point have indicated a normal approach.

From 10 to 8 seconds prior to impact, the aircraft would have been traversing the transition or pink zone of the VASI system. One-half second later, 7-1/2 seconds prior to impact, the first officer said, "VASI ah looks a little bit low." With a descent rate of slightly more than 1,000 feet/minute established after departure from the electronic glide slope, a period of 9 seconds elapsed before the flight crew received a positive low indication from the VASI; i.e., both upwind and downwind boxes red. The failure of the standard VASI system to provide rate guidance is a critical factor overlooked in the Board's investigation. This subject will be discussed further in the section on New Evidence.

The visibility up to this time, 7 seconds prior to impact, was at least 3,350 feet since the full VASI system was in view as evidenced by the first officer's ability to determine that the aircraft looked "a little bit low." At this time, the aircraft's wheels were 90 feet above the touchdown zone.

Five seconds prior to impact, the first officer said, "Rate of descent's too high;" the aircraft's wheels were 56 feet above the touchdown zone and the flight recorder shows a descent rate of 1020 feet/minute.

At this time the visibility was probably deteriorating; however, it was still at least 1480 feet, as the first officer testified that he could still see the runway shortly after he made the callout concerning the high rate of descent. (TR 84A-5)

Shortly thereafter, the aircraft encountered the torrential downpour described by all three crewmembers in their statements and depositions. The captain's description follows:

> "I straightened the airplane out and began to drop the left wing when -- I'm not certain as to the sequence -- but I felt a sinking feeling and lost visibility and at that point it was certainly strictly a reaction type of thing. I was caught totally unaware by it. It was so sudden, just a sudden happening and I added the power up and pulled back on the yoke in an instinct manner and almost simultaneously I felt the main gear catch. The thought that passed through my mind was I was pretty well over the runway and in line with the runway but possibly the main gear might have caught on the lip of the runway and with that I had the thought that I did not want to try to go around. So I went from power on to power off and had the thought in my mind that all I wanted to do is keep the airplane straight and level and try to keep it on the runway and about this time we broke out and I could see the full length of the runway and we were pretty well centerlined all the way down the runway for the greatest portion; had engines in reverse; had speed brake extended. Then we started a slight, gradual slide to the right which I tried to stop with nose wheel steering and with rudder, but it just continued on." (TR 115-14)

It is obvious from the crew statements, crew depositions, and ALPA's flight path profile, that power was applied, the nose of the aircraft was rotated after the encounter with the wall of water, and the aircraft began to respond to the captain's inputs. This is evidenced by the fact that, from the time the aircraft left the electronic glide slope (16 seconds prior to impact) until 3 seconds prior to impact, the flight path angle averaged approximately 4 degrees. Furthermore, as depicted in the Board's Report AAR-76-15, Appendix E, the flight path angle of the aircraft's wheels between impacting the localizer antenna and the ground was 2.5 degrees. It is obvious, therefore, that a marked decrease in the flight path angle took place during the last 3 seconds of flight.

It also becomes evident that the aircraft's encounter with this "wall of water" had to occur less than 5 seconds prior to impact. At this point, as additional corrobative evidence, ALPA suggests that the statement of ground witness Robert L. Crutchfield, a pilot, and the statement and deposition of ground witness Allan Hare, a pilot, and the witness statement summary prepared by the witness group be examined. These documents reiterate the following facts numerous times:

1. That at least takeoff thrust had been applied by the flight crew.

2. That the aircraft had a high angle of attack.

3. That the descent rate had been reduced.

4. That it was raining extremely hard.

5. That the wind was gusting.

6. That all of the above had occurred prior to the aircraft crossing the localizer antenna.

V. CORRECTIONS TO ERRONEOUS FINDINGS AND OMISSIONS

A. Misinterpretation of Altitude at which Crew Lost Forward Visibility

The Board's Report, AAR-76-15, Page 13, states,

> "Flight 576 encountered heavy rain which was probably associated with downdraft activity and a slight horizontal wind shear as it descended below 200 feet. Although visual contact with the runway environment was lost at this point, the captain regained forward visibility as the aircraft passed over the threshold lights."

As we have shown in the revised approach profile summary, the aircraft entered heavy rain shower activity approximately 4 seconds prior to impact, when the aircraft's wheels were 47 feet above the touchdown zone and not at or near the decision height of 200 feet, as the Board's report implies.

If the Board's implication were correct, the aircraft would have encountered the "wall of water" 13-1/2 to 14 seconds prior to impact. None of the evidence supports this. The CVR comment, "and there's the runway", occurs at 12.7 seconds prior to impact. Again, according to the CVR, the first officer was still able to see the VASI 8 seconds prior to impact. Furthermore, according to the first officer's deposition (TR 84A-5), he still had the runway in sight 5 seconds prior to impact when he called out the high descent rate:

"Q. And having made this callout of a thousand--sorry--you alerted the captain to a high rate of descent, then what did you do?

A. At the same moment as I called it out the captain was reacting to it. I doubt if he heard me. But he was reacting to a reduction, what appeared to me reduction, of descent and increase in power.

Q. Did you make any cross reference to anything else that would give you some feel of whether this rate of descent was going to get you in trouble or not?

A. Just visually out the window, out at the runway.

Q. Out at the runway?

A. Yes.

Q. So you had the runway in sight at this point?

A. Yes.

Q. Do you recall any time after calling out this high rate of descent looking at the VASI?

A. No. I don't believe we could see it."

Review of Figure 2 shows the rate of descent callout was made when the aircraft was 1,482 feet from the threshold.

It is evident therefore that the crew had visual contact with the runway as close as 1,482 feet from the threshold.

In conclusion, according to the crew depositions, crew statements, witness statements, and flight data graph, it becomes apparent that upon encountering the "wall of water":

1. Thrust was increased yet the airspeed stayed constant.

2. The aircraft's pitch attitude was increased yet the flight path angle remained nearly constant until 3 seconds prior to impact.

The only way these two actions and their results can physically take place is for the aircraft to encounter a downdraft associated with the heavy rainfall.

It should be pointed out that the flight recorder readout of an encounter with a downdraft will not necessarily show airspeed dropoffs as has been the case in several other previous accidents reviewed by the Board. In those other cases, the aircraft transited the downdraft and emerged into the tailwind of the outflow as the aircraft continued its descent. In the present case, however, the aircraft never exited the downdraft prior to impact with the localizer antenna.

The exact altitude at which downdraft action cannot exist due to the physical necessity of the flow to turn into horizontal winds as it approaches the earth's surface has not been determined. It is generally believed, however, that the downdraft effects can be experienced at 100 feet or perhaps even lower. It should be noted that the terrain prior to the threshold of Runway 23 at Raleigh drops off to almost 75 feet below the elevation of the runway. In this case, the effects of a downdraft could be experienced at very low altitudes relative to the runway threshold. Furthermore, this terrain characteristic would have allowed the aircraft to penetrate the downdraft without first encountering a headwind component. This is entirely consistent with the lack of appreciable airspeed increase on the FDR readout.

B. Failure to Understand Ability of Crew/Aircraft to Execute Missed Approaches under Adverse Conditions.

The NTSB concluded in its Findings 6 and 10 that, "That captain did not execute a missed approach when he lost forward visibility," and "The captain demonstrated poor judgment and did not exercise the prudence and care expected of an air carrier pilot when he failed to make a missed approach."

As ALPA has already pointed out, the visibility loss did not occur at or near decision height as the Board's report implied, but rather within seconds of the runway at an altitude too low to effect recovery. The suddenness with which the intense rain was encountered did not leave adequate time to make corrective actions to regain the glide slope, let alone transition from a visual environment to an instrument go-around. When examining flight path profile (Figure 2) and the crew statements and depositions, it is obvious that 5 seconds prior to impact and with a flight path angle of 4 degrees, the captain initiated a correction. Almost instantaneously (one second later and approximately 4 seconds prior to impact), the aircraft entered the "wall of water." Regardless of the acuity of an individual, there will be a time interval between encountering a phenomenon and the response of that individual to the encounter (i.e., recognition, decision, and reaction). In addition, there will be a time period for the aircraft to respond. This total time period is portrayed on the flight path profile. At 4 seconds prior to impact, at an altitude of 40 feet and a flight path angle of 4 degrees, the aircraft entered the "wall of water." By the time the main gear struck the localizer antenna, 3.75 seconds later, the aircraft's wheels were approximately 5 feet above the ground impact point and the flight path angle was 2.5 degrees (according to the Board's Report AAR-76-15, Appendix E). To accomplish this change in flight path angle, the captain had to provide the inputs of additional thrust and increased angle of attack. The problem which was encountered by the crew was that there just wasn't enough time for the pilot to recognize, decide, and react, and subsequently for the aircraft to react, before impact.

To assist the Board in recognizing the time required for a pilot to react to an unexpected encounter with dangerous phenomena, ALPA is including an outline of a study of this particular accident by Dr. A. O. Dick (Attachment A). Dr. Dick has conducted a number of studies looking at pilot reaction times and division of attention to flight instruments during low visibility approaches.

As the Board will recognize, this is new evidence relating to this accident. It now becomes most important to reiterate that the encounter with the "wall of water" occurred less than 5 seconds prior to impact. Dr. Dick concluded that a 3.8 second reaction time for the captain would be required prior to initiation of a control input. However, with 3.8 seconds for the crew to react and less than 5 seconds to impact, only 1.2 seconds remained for the control input to be applied by the captain and for the aircraft to react before impact with the ground. It is important to note that no reaction time for the aircraft response is incorporated into Dr. Dick's study. It is quite evident, however, that some aircraft reaction to the captain's inputs had occurred prior to impact. At 3-1/2 seconds before impact, the flight path of the aircraft was 4 degrees; however, during the last 1/2 second of flight (i.e., from the time the main landing gear struck the localizer antenna, until impact with the ground) the flight path angle was 2-1/2 degrees.

Contrary to the Board's opinion that the captain demonstrated "poor judgment," ALPA believes that when considering the factors encountered during the last 4 seconds of flight, the captain's decision not to execute a missed approach after ground contact undoubtedly saved the lives of all those on board the aircraft. This fact becomes obvious after examination of the damage to the aircraft; i.e. #3 engine missing, both main landing gear separated and extensive flap damage.

C. Misinterpretation of Required IFR Callouts

The Board's Finding 9 states: "The first officer did not make loud, distinct callouts when a hazardous situation was encountered."

ALPA has great difficulty in determining how the Board arrived at Finding 9. Careful scrutiny of the CVR, flight path profile and flight crew depositions shows that the first officer made the callout "VASI looks a little bit low" at 0102:01.5 (8 seconds prior to impact) and that this callout was plainly audible in spite of the noise of the windshield wipers at high speed and the ambient air noise from the nose wheel well. 5.4 seconds prior to impact, not 4 seconds as stated in the Board's report, the first officer said, "Rate of descent's too high." This callout was made with more inflection than the previous callout. It is noteworthy that this is the time, according to the first officer's and second officer's depositions, that the captain was already applying power and attempting to correct the aircraft's flight path relative to the VASI. Four seconds prior to impact the first officer again said, "Rate of descent's too high." This callout was almost certainly not heard by the captain because of the second officer's simultaneous advisory that "Number three will not reverse". It should be noted that ALPA's CVR readout picked out two callouts of "Rate of descent's too high."

There is no way that the Board can determine the clarity or the volume of callouts received by the captain. The CVR only records the clarity and volume of comments received by the CVR itself. As a matter of fact, when examining the CVR, and considering all the ambient noise in the cockpit, i.e., wipers, rain on the windshield, and air noise, it is obvious that the callouts were quite loud and distinct, as evidenced by the fact that these callouts could easily be heard on the CVR tape.

Nevertheless, it is simply not possible to say because the CVR picked up these comments that they were indeed heard by the captain. As a matter of fact, the captain in his deposition (TR

135-11) stated that he did not hear either of these callouts by the first officer. The Board's report (pages 4 and 15) erroneously implied that the captain heard these callouts but "did not understand" them. (ALPA emphasis)

However, as an explanation for the reason the captain did not hear either of the above callouts, ALPA suggests two possibilities: (1) that during this period, the captain was operating at a high level of concentration which tuned out cockpit comments; (2) that the noise level in the cockpit was such that he was unable to hear the callouts.

As we have attempted to point out to the Board in the past, callout procedures are not the panacea the Board apparently thinks they are. In our petition regarding the Pan Am Pago Pago accident, we informed the Board that "under high workload, pilots filter callouts, and may in fact not even be aware of them or may disregard them. Callouts under some situations may be distracting, harmful rather than helpful." The fact that callouts tend to go unheard in high stress situations was noted by the Air Force pilots who conducted the famous PIFAX program in 1967.

It is important that the Board recognize that the Pan Am, Pago Pago, Delta, Chattanooga and Raleigh accidents all occurred under similar circumstances. The presence of descent rate callouts during the Chattanooga and Raleigh approaches did not prevent those accidents.

It is interesting to note the Board's analysis of the Chattanooga accident:

> "In analyzing the evidence, the Safety Board believes that the captain's visual illusion caused him to ignore the two reports from his first officer that the rate of descent was increasing too rapidly. The fact that the approach had been correct in every aspect up to that point, reinforced the captain's belief that he was in the proper position to complete the landing. Since no additional means of vertical guidance was available during the visual segment of the approach, the seriousness of these combined factors increased. However, the procedures to alert the captain to the problem that was developing were used, and the information was conveyed to the captain in the prescribed manner."

The inconsistency in the analysis between the Chattanooga accident and the Raleigh accident, as evidenced by the above paragraph, is startling. How can similar accidents be analyzed so differently?

The Board further states in Finding 11 of the Raleigh report that, "The flightcrew failed to follow company procedures concerning required callouts on final approach."

Not only did the crew make all the prescribed callouts on final approach, but they made an additional three callouts not required: two of altitude and one of airspeed. In an effort to assist the Board, ALPA would like to provide the history of altitude callout procedures on EAL prior to 11/12/75. Prior to October 21, 1975, when IFR on approach the pilot not flying would call out: (1) the FAF altitude; (2) 1,000 ft. AGL, A/S, and descent rate; (3) 500 ft. AGL, A/S, and descent rate; (4) 100 ft. [illegible] MDA/DH; and (5) MDA/DH.

On October 21, 1975 (21 days prior to the accident) EAL changed the callout procedures substantially. The new procedures are as follows: The pilot flying will call out: (1) FAF; (2) 1000 ft. AGL; (3) 100 ft. above MDA/DH; and (4) MDA/DH.

The EAL Flight Operations Manual (Vol I, Page 4-1-12 dated 10/21/75) additionally states that if the pilot flying doesn't make the above callouts the other crewmembers will challenge the absence of these callouts.

In addition, it has never been a practice on EAL, or most other airlines, that the 100 feet above or the MDA/DH callout be required once the aircraft is in visual contact with the runway environment.

To summarize, on the date of the accident the required callouts for the ILS Runway 23 approach were as follows: Three callouts were to be made by the pilot flying the aircraft: 2,000 ft. MSL within 10 NM of the final approach fix, 1785 ft. MSL at final approach fix, and 1,000 ft. AGL. No descent rate or speed callouts were required unless they were out of limits. The 100 feet above DH and DH callouts were not required because the crew had visual contact with the runway environment at 770 feet MSL or 320 feet above the runway as determined by the CVR/FDR analysis.

Upon examination of the CVR, the Board will see that all the required callouts were made by the crew of EAL 576. It should also be clear that the crew was well aware of the aircraft's actual altitude throughout the approach.

Approximately 5-1/2 minutes prior to the accident, EAL 576 was cleared to descend and maintain 3000 feet. The aircraft maintained 3000 feet while being radar vectored for the ILS approach. At 0057:322 Raleigh Durham Approach Control cleared EAL 576 for the approach. Ten seconds later at 0057:43, the captain said, "Going down to 2000 feet — would ya like ta throw out the gear then we'll..." ALPA maintains the 0057:43 statement by the captain qualifies as the required altitude callout. This callout is required when descending the last 1000 feet from one assigned altitude to another.

At 0059:43, the captain said "two thousand," reiterating the aircraft's altitude. At 0100:03, the captain said, "Eighteen numerous our ah——— yep." This in effect constituted compliance with the requirement to call 1785 feet (the glide slope intercept altitude depicted on the ILS approach plate)

Eighteen seconds later at 0100:21, the first officer said, "Glide slope cap both sides." This meant that the flight directors had captured the ILS glide path.

Seven seconds later at 0100:28, the first officer reported to the Raleigh Durham tower that the aircraft had passed the Leesville Radio Beacon, the final approach fix.

At 0100:49, the terrain warning system sounded, indicating that the aircraft was approximately 1000 feet above the terrain.

Four seconds later at 0100:53, the first officer said, "One thousand feet." Almost simultaneously the second officer said, "One thousand feet." Then the first officer said, "Bug plus six." At this time, according to the FDR readout, the aircraft was 1439 feet MSL or 1003 feet above the airport. At this point the captain did not call out 1000 feet. However, the two altitude callouts, one by the first officer and one by the second officer, plus the airspeed callout by the first officer, plus the confirmation by the flight data recorder and TWS that the aircraft was 1,000 feet above the field, more than adequately satisfied the requirement for one altitude callout at 1,000 feet.

In summation, at 1,000 feet AGL, one additional callout was made by the second officer and an additional airspeed callout was made by the first officer.

At 0010:35 the first officer said, "Five hundred feet, ground contact." This was an additional non-required altitude callout and the aircraft was 468 feet above the airport. At 0101:48 the first officer said, "There's the flasher up ahead." And 1-1/2 seconds later, at 0101:49.5, the captain said, "Wipers on high." At this time the aircraft was at 770 feet MSL or approximately 320 feet above the airport. The "wipers on high" comment by the captain is indicative that he had visual contact with the runway environment.

As the captain stated in his deposition, (TR 114-6):

> "The first officer commented he had the approach lights in sight. I hesitated a few seconds after he made the comment before I came off the instruments to look out and when I came off the instruments, came in view pretty much in sequence; the lights, threshold, and runway were pretty much in a row."

Once the pilots are visual, there is no requirement for the 100 above DH (300 feet) and DH (200 feet) callouts by the crew. Additionally, the Board should realize that even if the 100 above DH and DH callouts had been required and made, they would have had no bearing on the accident. At 300 feet above the airport, the aircraft was positioned on the localizer and glide slope in a stabilized condition (according to the flight path profile). At 200 feet the aircraft was positioned on the localizer, on the VASI, 15 feet low on the glide slope and stabilized — according to the flight path profile and according to the captain's deposition (TR 144-15) which reads as follows:

> "At approximately 200 feet or so again I was visual; I felt somewhat low and I checked back to the raw data on my glideslope and it showed that I was slightly below the glideslope and I added power and flattened the airplane out to fly back into the glideslope."

In summary, a realistic analysis of the CVR reveals that the substance of the callout procedures had been more than complied with by the flight crew.

D. Misunderstanding of Approach Speed Versus V_{ref} and Speed Required for the Approach

Page 15 (second paragraph) of the Board's report erroneously states, "Company procedures require that the final approach be flown at target speed (in this case 135 knots) plus 1/2 headwind (in this case 2 knots) plus gust (in this case none). The target speed for this approach was 137 knots."

For the Board's information, the following is an excerpt from Eastern Airlines B-727 Training and Reference Manual (Page 2-8-37) dated June 17, 1975:

> "TYPICAL APPROACH PROFILE
>
> Always set Airspeed Bug on V_{ref} (or V_{ref} plus correction when required for abnormal flap config.). Never set wind and/or gusts considerations on the Bug. Carry 1/2 the wind and all the gust correction over and above Bug setting. Maximum correction - plus 20 Knots. Carry 5 Knots for all wind conditions from calm to 10 Knots."

		Airspeed	
Landing Flaps	Bug Setting	Maximum	Minimum
40°	V_{ref}	Bug + 20	Bug + 5
30°	V_{ref} + 5	"	"
15°	V_{ref} + 15	"	"
5°	V_{ref} + 30	"	"
0°	V_{ref} + 60	Bug + Gust	Bug

The above paragraph explains the procedure for determining the proper approach speed. For the landing weight of Flight 576, the V_{ref} for 40° flaps was 130 knots. Because the captain intended to land with 30° flaps as required by the company policy for the particular weight of the aircraft, the "Bug Setting" would have been V_{ref} + 5 or 135 knots.

But the minimum airspeed would have been Bug + 5 or 140 knots! As further explained in the above paragraph, the pad for "1/2 wind" applies only to headwinds above 10 knots. The reference speed for the approach (with 30 degrees flaps) was 135 knots. As we have previously pointed out, the airspeed trace of the NTSB readout is too high by approximately 5 knots. The NTSB's conclusion regarding an "airspeed margin" is therefore based on an erroneous FDR airspeed trace. When examining the corrected Flight Data Recorder readout for the last one minute and twenty seconds of flight, when the aircraft was stabilized on final approach with landing flaps extended, the average indicated airspeed was 142.5 knots. This is within 2.5 knots of the desired speed of 140 knots. Additionally, the first officer's airspeed callout of "bug plus six", has the aircraft flying at 141 knots or within 1 knot of recommended airspeed.

Because these speeds required by company procedures are for normal approaches, it is difficult to understand how the Board can believe there was an "airspeed margin" which could have "overcome" the forces exerted by the meteorological activities.

E. Lack of Substantive Meteorological Analysis

The Board also contends that the thrust available was sufficient to overcome the meteorological effects. Obviously, if the magnitude of the downdraft is unknown, then the amount of thrust necessary to overcome the effects cannot be determined. On the other hand, all crewmembers testified to the application of thrust by the captain as the aircraft encountered the heavy rain. While the exact amount of thrust applied is unknown, pilot witnesses at the end of the runway believed the engines were at takeoff thrust.

Additionally, the captain in his deposition said, (TR 115-14):

> "I straightened the airplane out and began to drop the left wing when -- I'm not certain as to the sequence -- but I

...felt a singing (sinking) feeling and lost visibility and at that point it was strictly a reaction type of thing. I was caught totally unaware of it. It was so sudden, just a happening and I added the power up and pulled back on the yoke in an instinct manner and almost simultaneously I felt the main gear catch."

The above facts substantiate the presence of downdraft activity. The flight path change from 4.0 degrees to 2.5 degrees without ... of airspeed is a positive indication of a substantial power application and pitch attitude change.

The Board acknowledged the existence of "downdraft and wind shear activity which adversely affected the captain's efforts to maintain a proper descent profile during the last portion of the final approach." Obviously, since no measurement of downdraft velocities was recorded at the time of the accident, the Board is merely speculating as to the severity of the downdraft. Yet it concludes that the crew could have overcome these effects! It bases this conclusion on the "airspeed margin and thrust available."

Obviously, downdrafts were present; however, their specific magnitude cannot be determined solely by use of the flight recorder. It is obvious that the Board merely hypothesized as to the magnitude of the downdraft. There was simply no detailed meteorological analysis conducted by the Board of the conditions which existed at the time of the accident.

F. Erroneous Interpretation of Rainfall Rate

The Board's report states that the rainfall rate was 2 inches/hour from 2005 - 2008. While it is true that rainfall rates have been historically measured over relatively long periods of time (i.e., minutes), these rainfall rates are often irrelevant in terms of what the pilot may encounter in very short time periods (i.e., seconds).

Analysis of the rain depth recorder shows that the heavy rain started at 1957 EST (see recording rain gauge chart, Figure 4). The instantaneous rainfall rate at this time approached 7 inches/hour, an intensity characteristic of the heaviest tropical downpours. From the recording it is clear that the rainfall rate increased to its maximum almost instantaneously. This is consistent with the crewmembers' testimony that the aircraft encountered a "wall of water."

Radar photos taken from the Wilmington radar weather station at the time of the accident showed an essentially southerly flow dominating the Raleigh area. As this cell which produced the downpour moved northward, it probably progressively obscured the runway creating a foreshortening effect to the pilots.

The accident occurred at 0102:09Z.

It is interesting to compare the rainfall rate at Raleigh-Durham from 0101:57Z to 0103:00Z (4.40 in/hr) to the average rainfall rate encountered by Pan Am Flight 806 at Pago Pago, 4.60 in/hr. Both rates were in excess of 4 inches per hour, which indicates a very high probability that downdrafts were present in sufficient strength to have an adverse effect on aircraft performance.

G. Failure to Analyze Effect of Heavy Rain on Aircraft Performance

The Board makes no mention of the effect of heavy rain on the aircraft's aerodynamic characteristics or thrust output. The available literature, although sparse, indicates that rain in sufficient quantities will produce a drag force on the aircraft. While it may be difficult to quantify the aerodynamic effects, the existence of this force cannot be denied. It is certainly a factor in this accident and should not have been ignored as it has been in past accidents; i.e., Pan Am, Pago Pago; Allegheny, Philadelphia; and Eastern, New York.

It is especially significant that the instantaneous rainfall rates in the Raleigh accident are essentially the same as they were at Pago Pago. It is also more than just a coincidence that the accident occurred within minutes of the large increase in rainfall rate as shown by the recording rain gauge.

Furthermore, consideration should have been given to the effect the heavy rain had on the thrust output of the engines. Even a momentary thrust loss as the aircraft progressed through the downdraft and the associated "wall of water" would have reduced the aircraft's ability to perform as the pilot intended and expected it to perform.

H. Misunderstanding of Use of Flight Instruments during Landing

The Board's Findings 7 and 8 stated that "The pilots failed to monitor their flight instruments until a safe landing was assured," and "The captain did not use all of the flight instruments available to him."

According to the captain's testimony, at 200 feet he felt low and checked his raw data glide slope. (TR 114-15) It is extremely important to remember that at this time everything about the approach had been normal. At 200 feet the VASI indicated on course, while the electronic glide slope indicated very slightly low. The captain made a small adjustment to maintain the glide slope and then returned his vision outside to follow the VASI. The captain at this time would be getting his vertical guidance from the VASI, his pitch information from the VASI and runway view, and would be monitoring his airspeed, while attempting to land the aircraft visually on the aiming point. It is likely that the captain did return inside the cockpit to monitor the airspeed because, from the time the aircraft passed 200 feet until impact, the airspeed variation was no greater than ± 1.5 knots.

It is also obvious that the first officer was observing his flight instruments. This is indicated by the two excessive descent rate callouts made by the first officer during the last few seconds of flight.

When an aircraft with presently available instruments is in visual conditions, the pilot manipulating the controls must [illegible] a majority of his attention to the runway and specifically the aiming point with occasional crosschecks of airspeed. Only the pilot not flying would be able to crosscheck instruments and, in fact, did so as evidenced by the two additional sink rate [illegible]. However, recent accidents have made it abundantly clear that callouts cannot be depended upon to transfer essential instrument information to the pilot flying. Several deficiencies in "callout" theory have been identified, including:

1. The information is inadequate. The Board itself recognized this in Special Study AAS-76-5 when it showed that a simple callout of either sink rate or glideslope position was insufficient in itself, but had to be correlated with other instrument information to be useful to the pilot flying.

2. Communication of the information is unreliable:

   a. The pilot making the call may not state it correctly.

   b. Cockpit noise may interfere.

   c. The pilot flying may not hear it, either because it is inaudible or because he is "tuned out" by his intense concentration, which is probably made necessary by the very situation which generated his urgent need for instrument information and prompted the callout.

   d. The pilot flying may hear but not understand the callout.

   e. The pilot flying may understand the callout, and try to respond, but find himself still short of needed instrument information. For example, in response to a callout of "low" he would pull the nose up; but how far up? Since the external visual cues were not adequate for the task of maintaining normal conditions, they are unlikely to be adequate for restoring normal conditions.

3. In any case, the information will be significantly delayed by the callout process.

In summary, compared with information received directly from an instrument display by the pilot flying, callout information is inadequate, unreliable, and significantly delayed.

Furthermore, even when the callouts are made, conditions may not always permit the recovery of the aircraft from a dangerous position.

It should be noted that there are no requirements that a flight crew on Eastern Airlines monitor a specific number or all of the flight instruments subsequent to passing the decision height as long as the runway or its environment is in sight. These approaches are conducted on a see-to-land concept from the breakout point or the decision height (whichever occurs first).

"The National Transportation Safety Board recognizes that at present there is no requirement for a pilot to continue to monitor the instruments down to decision height after the approach lights or other ground environment associated with the end of the runway is called in sight. In fact, in a see-to-land concept it is understandable that a pilot would wish to make a transition from instrument guidance to ground visual guidance as early as possible. However, in circumstances of low visibility, particularly as related to Category II minima, the approach lights may often be in sight before the decision height is reached, but they will not provide a visual guidance segment sufficient to furnish adequate vertical information to the pilot. The result can be a touchdown far short of the threshold as in this instance.

"Accordingly, the Safety Board recommends that the Federal Aviation Administration require that air carriers establish procedures in their operations manual that would require the pilot who flies an aircraft during approaches in low visibility conditions to monitor the instruments continuously until the runway threshold or runway lights are called in sight." (ALPA emphasis)

In support of the NTSB's philosophy is a statement made by Mr. J. R. Harrison, then Assistant Chief Counsel, Litigation Division, FAA, at a deposition hearing conducted by the NTSB in regard to an April 1976 air carrier accident at Ketchikan, Alaska.

"Mr. Kampschror, these questions are argumentative. I think I could make a statement that could be acceptable to most people here. The decision height in this particular case is established because of obstruction criteria and many, many factors. Whether or not it (i.e., the glide slope) is usable below a thousand feet (i.e., the decision height) is really a paradoxical question. It doesn't need to be, because of the decision height at a thousand feet; and if in fact it is usable another 300 feet or 500 feet is really quite irrelevant to the circumstances here. A pilot ought to be visual when he gets to a thousand feet (i.e., the decision height) and thereafter." (Note: parenthetical insertions and underlining by ALPA)

It is clear, therefore, that both the NTSB and FAA considered that a pilot would be visual during the later stages of the approach; i.e., after obtaining the required visual cues. It should also be clear that at the time the NTSB made this recommendation to the FAA it was not the intent of the NTSB that pilots monitor their flight instruments to touchdown.

At no time prior to this accident had the Board recommended that the instruments be monitored beyond the point where the runway threshold or runway lights are called in sight. And yet it wants to fault a crew for not going beyond what it had recommended. As far as the crew was concerned, a safe landing was assured when the visual cues associated with the runway became visible.

Subsequent to the Raleigh accident, the Board did make such a recommendation in Report AAS-76-5; but the FAA, underestimating the importance of this recommendation, failed to act upon it.

The Board should have followed up on that recommendation, but to date has not done so. The Board should clearly state that the pilot flying needs instrument information throughout the approach and landing, and that callouts are an inadequate way to supply it.

Considering the widespread military (and growing civilian) use of existing technology which can deliver both instrument and visual information simultaneously to the pilot flying, ALPA calls upon NTSB to support priority development of Head Up Display for use in air carrier aircraft. The Board's most recent statement on HUD:

> "The Safety Board could reach no conclusions regarding the advantages or disadvantages of HUD in the low-visibility environment."

is insufficient to the point that it is sometimes interpreted as "damning with faint praise". We ask the Board to make a strong direct statement in favor of HUD development.

VI. DISCUSSION OF NEW EVIDENCE

In addition to the new evidence regarding pilot reaction time previously discussed, ALPA would like to address three additional subjects: ATC involvement, the windshield wiper system presently installed on the EAL B-727, and the deficiencies in the present United States VASI System.

ATC

ALPA strongly believes that one of the main omissions committed by the Board in this, as in many other accident investigations, is the determination of ATC involvement. This omission usually results from a cursory examination of ATC procedures, actions by controllers and the resultant effect on the accident aircraft.

After careful examination of the ATC tapes, ATC Group's factual report, and Terminal Air Traffic Controllers Handbook 7110.8D, ALPA believes that a number of factors involving ATC were not addressed by the Board and that these factors certainly had a bearing on the safe conduct of EAL 576.

ALPA examined in detail the Local Control (LC) ATC tape during the time period 0030Z - 0125Z, (time of accident 0102:09Z). During the 32-minute period prior to the accident, there was an almost continuous (hot mike) dialogue carried on by the local controller with a second inaudible partner. Starting at approximately 0031Z and continuing almost nonstop until 0100:28 when EAL 576 called passing the Leesville Radio Beacon, for some 29 minutes, the local controller was talking about becoming involved as a referee in a recreational soccer league and then moving up to referee high school and college games. (Selected portions of this transcript from approximately 0030Z until after the accident are included for the Board's examination.) Again ALPA would like to reiterate that this extraneous non-operational dialogue was continued for a 29-minute period prior to the accident. During this 29-minute period, there were two important transmissions made by aircraft. An Army Guard Helicopter called the LC and requested permission to proceed to the East side of the field and do some hover work until the thunderstorm passed. Additionally, at 0058:54, the first officer on EAL 576 said, "OK, thank you, sir, yeah look like you have ah quite a storm coming your way." Almost immediately following the 0058:54 transmission, the LC went back to the extraneous conversation regarding the soccer referee business. It now becomes interesting to note that at 0055Z the record weather at RDU was as follows: 100M200 four miles vis., rain and fog. At 0100:35 the LC advised EAL 576 that the airport visibility was 1-3/4 miles (the controller did not say what phenomenon was restricting the visibility). By 0101:55 (at the latest), the visibility had dropped from 4 miles to 3/4 mile. This is a drastic change in the weather over a relatively short period of time.

The Terminal Air Traffic Controllers Manual 7110.8D in effect at the time of the accident specifies some of the things the local controller should have done during this period of rapidly changing weather. Paragraph 1002 Airport Conditions states:

> "a. On first contact or as soon as possible thereafter and subsequently, as changes occur, inform an aircraft of any abnormal operation of approach and landing aids and of airport conditions which might affect an approach or landing. Omit information currently contained in the ATIS broadcast if the pilot states the appropriate ATIS code or says he has received it from another source." (Underlining supplied)

Obviously rapidly deteriorating visibility could and did affect the approach and landing of EAL 576.

Paragraph 468 of the Controllers Manual states "operate HIRL which control the associated MALS/RAIL in accordance with the accompanying intensity setting table, except (T) (N)

a. as requested by the pilot

b. as you deem necessary, if not contrary to the pilot's request.

Visibility

Step	Day	Night
5	Less than 1 mile	when requested
4	1 to but not including 2 miles	less than one mile
3	2 to but not including 3 miles	1 to but not including 3 miles
2	when requested	3 to 5 miles inclusive
1	when requested	more than 5 miles

In addition the Federal Meteorological Handbook No. 1, Surface Observations, Chapter A6-7, Paragraph 3.11 (WS, FAA) Control Tower Observations and Actions states:

"Unless otherwise exempted, certificated tower personnel shall report prevailing visibility when the prevailing visibility at the usual point of observation or at the tower is less than 4 miles. The Control Tower visibility observations may be used immediately for aircraft operations, but they shall be recorded and forwarded to the weather station as soon as practicable. During this condition, Control Tower personnel shall notify the weather station as soon as possible when they observe the prevailing visibility at the tower level to decrease to less than 4 miles, and change by one or more the reportable values (Table A3-4). When the tower visibility is reported as variable, subsequent actual observed values within the limits of the reported variability need not be transmitted to the weather station." (Underline Supplied)

Table A3-4. Reportable Visibility Values (Miles)

Increments of Separation (Miles)							
1/16	1/8		1/4	1/2	1		5
0	3/8	1 1/4	2	2 1/2	3	10	15
1/16	1/2	1 3/8	2 1/4	3	4	11	20
1/8	5/8	1 1/2	2 1/2		5	12	25
3/16	3/4	1 5/8			6	13	30
1/4	7/8	1 3/4			7	14	35
5/16	1	1 7/8			8	15	40
3/8	1 1/8	2			9		etc.

1. Enter in statute miles at land stations, nautical miles on Navy ships and ocean-station vessels. When the visibility is halfway between consecutive tabular values, select the lower value.

2. When the prevailing visibility is more than 7 miles and is also estimated to be more than twice the distance to the most distant marker visible, encode the visibility as twice the distance to that marker, rounded to the nearest reportable value, or 7 miles, whichever is the greater, and if the visibility is estimated to be greater than the coded value, add a +; e.g., 7+, 12+, 30+, etc.

3. Suffix the average of all observed values with a V (for variable) whenever the prevailing visibility:

   (a) Is less than 3 miles, and

   (b) Rapidly increases and decreases by one or more tabular values during the period of the observation.

At 0100:35Z the local controller advised EAL 576 of the visibility reduction to 1-3/4 miles in accordance with Paragraph 1002 (7110.8D). Also, according to his statement he put the HIRL (High Intensity Runway Lights) up to Step 3, in compliance with paragraph 468 (7110.8D).

However, beginning at 0101:08, approximately 1 minute and 1 second prior to the accident, the local controller starts the first of several statements. The first three statements, covering a 10-second period, are statements made either in bewilderment or a state of surprise. The four remaining statements concern the assessment of the tower visibility. This visibility assessment was obviously completed at 0101:55Z, at the latest 14 seconds prior to impact, when the aircraft was 210 feet above the airport. His realization that the visibility had dropped from 1-3/4 mile to 3/4 mile should have caused the controller to do two things: (1) advise EAL 576 of the visibility and (2) turn the HIRL up to Step 4. Neither of these procedures was accomplished. However the LC, for whatever reason, felt compelled to notify approach control at 0102:07, 2 seconds before impact, of the visibility reduction. ALPA also realizes that the controller may have felt that under Paragraph 468 (b), "as you deem necessary," would negate any responsibility to elevate the HIRL from Step 3 to Step 4. However, ALPA would emphatically point out that, at 0100:35Z per the local controller's statement (1 minute and 34 seconds prior to impact), the local controller set the HIRL up to Step 3 as a result of the visibility reduction from 4 miles to 1-3/4 miles as outlined in Paragraph 468.

ALPA would assume that if the controller deemed it necessary to raise the intensity for this visibility change, he should also have deemed it necessary to raise the lights to Step 4 when the visibility dropped to 3/4 mile.

Additional analysis of the transcript leads to the conclusion that the local controller was not paying sufficient attention to his duties. The Board's factual report says the local controller stated he monitored the BRITE display in the tower continuously while EAL 576 approached the airport. However, at 0102:42Z, 33 seconds after the accident, the Local Controller asks the approach controller, "Who's that last jet that landed?" ALPA has to conclude that after three communications, one of which is a landing clearance, and a continual monitoring of the BRITE display with ALPHA numeric data, the local controller should at least have been aware of the flight number and airline name of the #1 landing aircraft. Obviously, he was not.

Subsequent to the accident, there is more hot mike conversation by the local controller. "Did I whay — yeah, I told him a mile and a half. I didn't give him the three quarters cause he was on final*----- Eastern Five Seventy-Six is what they told me downstairs."

ALPA is sure that a lengthy description of the omissions of pertinent local weather information to EAL 66 at Kennedy Airport, to Allegheny 121 at Philadelphia Airport and EAL 576 at Raleigh-Durham is not required. The only person in a position to collect such information is the local controller. ALPA believes it is incumbent upon the local controller to inform the pilot of weather information which may affect his flight.

WINDSHIELD WIPERS

Enclosed for the Board's information are two internal letters and a selected portion of the B-727 Newsletter to EAL pilots regarding the efficiency of the B-727 windshield wipers (Attachment B).

The fourth paragraph of this letter dated March 2, 1976 shows that in the conditions encountered by EAL 576 the wipers could be expected either to stall or to remove the rain improperly. In this case the wipers moved, so it is very likely that the rain was not properly removed.

The Board should have considered the possible effects of improper rain removal on the ability of the pilots to make use of external visual cues in conducting the approach, in detecting any deviation from the correct approach path, and in making required corrections. On the theory that the EAL letter of March 2, 1976 was not available to the Board in its deliberations, we ask that it and the whole subject of windshield wiper performance be addressed at this time.

VASI

ALPA has become extremely concerned about a new discovery regarding the design efficiency of the present U.S. VASI System. Prior to this accident the aviation community was generally aware of only one minor problem associated with a U.S. VASI installation, that being color discrimination during periods of poor visibility. Now it becomes alarmingly apparent when examining Figure 2 that an aircraft can depart the centerline of the VASI on-course area at a descent rate of over one thousand feet per minute and fly for a period of six seconds and still receive an on-course indication. The aircraft can fly for an additional three seconds, or a total of nine seconds, before a positive (red over red) low indication from the VASI is received by the crew. During this nine-second period the aircraft would have covered a horizontal distance of 3/8 of a nautical mile.

When examining the design of the VASI System with the above deficiencies in mind, it becomes all too apparent that an aircraft, close to the runway threshold, (i.e., 1/2-1/4 NM), could fly in the on-course area with descent rates above 1000 ft./min., for an extended period of time while receiving a safe VASI indication, even though the aircraft's safety had been compromised. Furthermore, the on-course area can be even wider than that of the Raleigh-Durham VASI due to the range of installation tolerances allowed in the FAA's criteria.

The above information should be given full attention in a reconsideration of Finding 2 which states that, "The VASI lights alerted the first officer that the aircraft had descended below the glide slope." While that finding is in a limited sense true, it reflects a misunderstanding of the point where the off-course indication from VASI first became available to this crew.

ALPA's flight path profile adequately demonstrates that an aircraft can deviate from the VASI glide slope centerline for an extended period of time and attain an excessive rate of descent before the VASI will alert a crew that they are too low. The accident aircraft had a 9-second period of flight from the time when deviation from the VASI glide slope centerline began, until a low indication was provided to the crew. The VASI actually provided incorrect information to the captain at or near the decision height and from then on until several seconds prior to impact. At 200 feet, the captain said he felt low and the electronic glide slope showed him slightly low. However, the VASI showed safe; i.e., red over white. For the next two and one-half seconds it continued to show a safe red-over-white indication. The aircraft then flew for an additional two and one-half seconds through the VASI transition zone; i.e., red over pink.

Enclosed for the Board's information is a detailed letter to the New Zealand Pilots Association outlining the dangerous deficiency in our present red/white VASI System (Attachment C).

VII. COMMENTS ON BOARD'S RECOMMENDATIONS CONTAINED IN REPORT

ALPA fails to understand the basis for the last two paragraphs on page 17 of the Board Report AAR-76-15. When the main body of a report contains numerous errors and results from an incomplete investigation, the recommendations could only be based upon incomplete or erroneous findings.

While ALPA supports having FAA OPS Bulletin 71-9 (Attachment D) applied to precision approaches, and agrees that accidents occur at unacceptable rates (in that any accident is one too many), we most emphatically disagree that this accident illustrates either a disregard for approved operating procedures or lax crew discipline.

The new and corrected evidence offered here by ALPA makes it very clear that not only did the crew of EAL 576 not fall victim to any of the 21 shortcomings listed in FAA Buletin 71-9, but that they actually used many of the recommendations listed in that bulletin. Specifically, the crew used the following recommendations from 71-9: 2 a,b,c,d,f & 9 (as it applies to a precision approach.)

The Board and the FAA bulletin refer to "professionalism". If there was any lack of professionalism involved in this accident, it was not on the part of the crew of EAL 576.

LEGEND FOR ATC TRANSCRIPT

HM/LC = Hot Mike Local Controller

EA-576 = Radio transmission from Eastern Airlines Flight 576.

RDO-L/C = Radio Transmission from Raleigh Durham Local Controller

IF/AC = Interphone transmission by Raleigh Durham Approach Controller

IF/LC = Interphone transmission by Raleigh Durham Local Controller

IF/? = Interphone transmission not assignable to any particular position

EA-393 = Radio transmission from Eastern Airlines Flight 393

74E = Radio transmission from Beechcraft 74E

Guard = Radio transmission from unidentifiable Guard aircraft

784 = Radio transmission from Forecast 784.

ATC TRANSCRIPT

0031:00Z	HM/LC	You start off in City Recreation *** you go from there to high school and then to college.
0031:11Z	HM/LC	But ah I'm a I'm gonna read the book on everything he says that a lot of rules to know * but it's the easiest game to officiate.
0031:15Z	HM/LC	I guess because you know it's basically kicking--you can't trip em, but I'm gonna get the book on P.E.--read it--they play what (eight) halves, don't they--and no what and don't think they have any substitutes either (additional conversation).
0031:20Z	HM/LC	But I don't ** and hell I don't know how much they--and ah---
0031:35Z	HM/LC	Guard 59784 __*__ __* *__ ____ TRW moves through lightning noticed lightning.
0058:31Z	EA-576	Raleigh Eastern five seventy six with you ah we're three from Leesville.
	RDO-L/C	Eastern five seventy six is cleared to land runway two three and wind ah variable one ah eight zero degrees at four and I had a Queenair reported ah strong winds from the left about twenty knots at ah between nine hundred and one thousand ah correction and two ah one thousand two hundred feet on final.

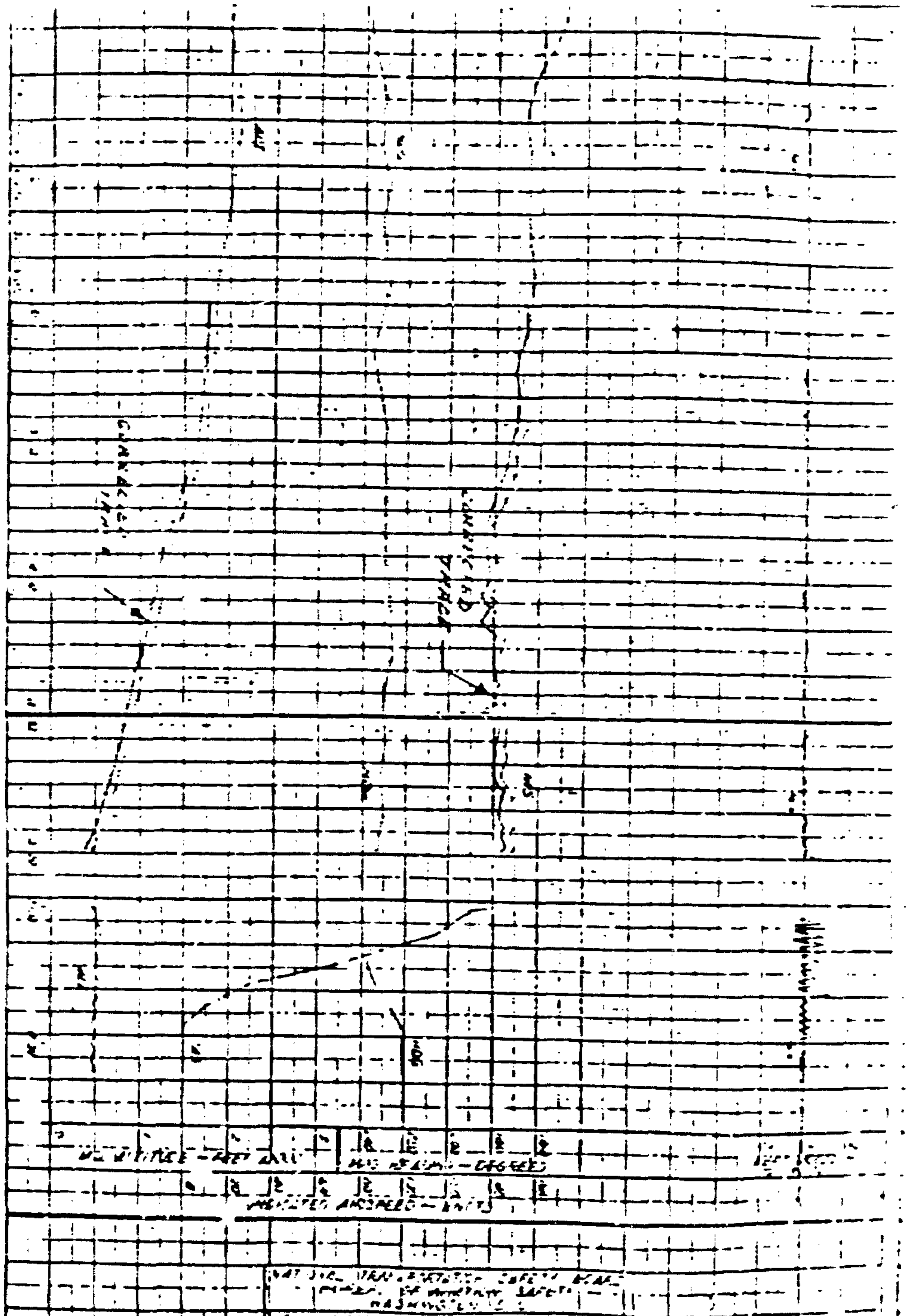
0058:54Z EA-576	OK, thank you, sir, yeah look like you have ah quite a storm coming your way.
RDO-L/C	Kay
HM/LC	But I don't know how much; I assume they pay about the same thing they pay you -- well ah recreation or high school or -- but see, you start off with recreation with a player on -- on the team this might pose a little problem but I'm sure could do ______ would ah ya know take a couple of hours leave ah cause I think they play around two thirty.
HM/LC	How much do you get paid? Ah how much have you made if you don't mind me asking? -- (I bet you) enjoyed it! Did you? Yeah -- I like it because ya know Chucky's going to a school where I think soccer's gonna be real big--and more so than football and ah -- that's right (and who knows) on ah open field basis -- he said (that he's ah) -- he's got forty-three high schools and colleges.
0100:28Z EA-576	Five seven six is Leesville.
0100:30Z RDO-L/C	Eastern five seven six roger
HM/LC	Yeah you ain't got ah we got ah
0100:35Z RDO-L/C	Eastern five seventy six, visibility at ah airport now is ah mile and three quarters.
0100:41Z EA-576	OK, thank you, sir, say your wind please.
0100:43Z RDO-L/C	The wind right now is ah one nine zero degrees at five. It's been holding pretty well at five knots.
EA-576:	OK
IF/AC	Hay Ja Poco
IF/LC	Go ahead
IF/AC	Turn your runway lights up on three two
IF/LC	(Simultaneous with "on" above) I did
IF/AC	Wheeler's requesting a contact approach
IF/LC	(Simultaneous with "approach" above) on three two
IF/AC	Aw right --- hey John
HM/LC	* _____
0101:08Z HM/LC	Hey ah --- (sound of mike or speaker movement) ---

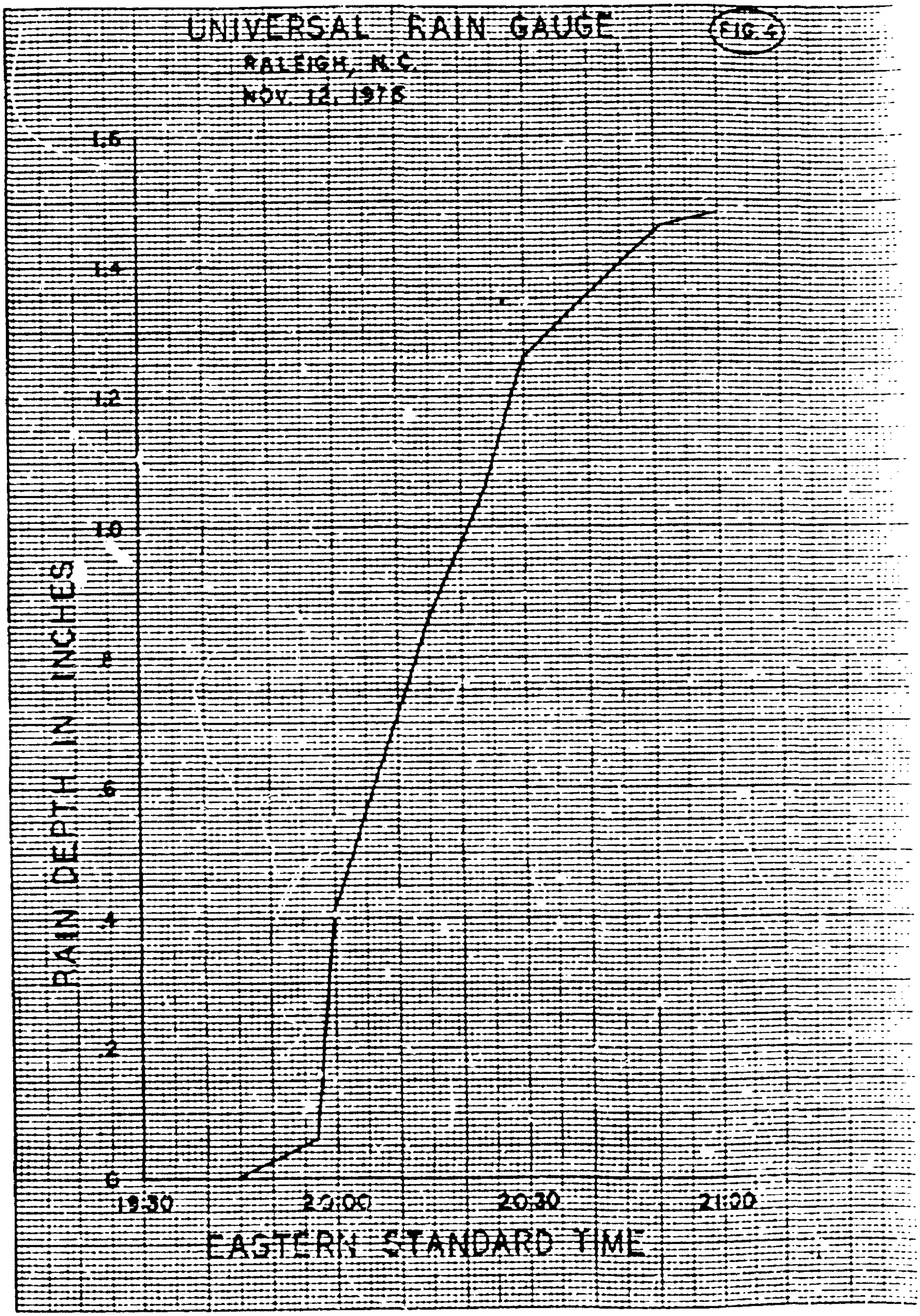
0101:14Z EM/LC	Let's see ---
0101:18Z EM/LC	What we got ah mile and three quarters with what ---
0101:22Z EM/LC	See em red lights
0101:28Z EM/LC	* strobes at night --- only see the miles eastward * -- - ***
0101:42Z EM/LC	(but) what ah ______ go ahead and give em the weather it's ________ on down ---
0101:45Z EM/LC	Hell, I can't see the white house --- ah
0101:48Z EM/LC	I can't see the Angus Barn ____ * give em ah give em ah quarter there
0102:07Z IF/LC	Howard --- visibility three quarters now
0102:11Z IF/?	Hey John
IF/?	Hey Charlie --- is it raining hard or is it fog moving in?
IF/?	Hey Chuck
IF/?	(Simultaneous with above) wait ah minute for an ILS.
0102:23Z IF/LC	Wait ah minute!
IF/AC	** three ninety three when I got that three quarters how about give it to him
EA-393	Raleigh tower Eastern three ninety three
RDO-L/C	Eastern three ninety -- Eastern three ninety three ah stand by
IF/AC	You're talking to us, Chuck.
0102:44Z IF/LC	Who's that last jet that landed?
IF/AC	Five seventy six
IF/LC	Five seventy six, ah what's your problem, sir?
IF/AC	Chuck, you're talkin' to us -- get off the override
RDO-L/C	Five seventy six, what's your problem, sir?
RDO-L/C	Hit that alarm *** runway ___ ** on the way out *
RDO-L/C	Eastern
EA-393	Eastern three ninety three

RDO-L/C	Eastern three ninety three ah roger -- ah I be right there ah momentarily we ah Eastern three ninety three just proceed to the VOR, maintain three thousand.
EA-393	You say proceed to the VOR, maintain three thousand.
RDO-L/C	Yes, sir, we got ah disabled aircraft on the runway.
EA-393	Roger
RDO-L/C	Eastern five seventy six ah tower (background with above) OK, all emergency vehicles * on the runway. The runway is closed at this time.
IF/LC	Hey, I'm sending Eastern 393 ah cleared to the VOR at three thousand, putting him on ah one twenty five three
IF/LC	OK, Charlie, let him come on.
RDO-L/C	Eastern three ninety three contact Raleigh approach one two five point three
EA-393	One twenty five three
RDO-L/C	Eastern five seventy six ah tower (background with above) turn three ninety three over -- he's talkin' to approach control -- aw right you all talkin' to three ninety three.
RDO-L/C	Eastern five seventy six Raleigh tower (background with above) the airport's closed ** -- hey Tom
74E	Raleigh this is Beech ah seven four echo
RDO-L/C	Seven four echo Raleigh
74E	Ah it looked like he had an engine on fire when he went by me.
RDO-L/C	Ah say again sir:
74E	That ah jet looked like he had an engine on fire when he went by here at the end.
RDO-L/C	OK, thank you sir, appreciate it. I just saw what ah looked like ah flame out there.
74E	I can smell kerosene all over the place down here. I don't know where; it's everywhere.
RDO-L/C	OK, thank you sir.
HM/LC	74 echo said looks like an engine on fire to him. He smells kerosene all over the place down there.
RDO-L/C	Eastern five seventy six tower

HM/LC	I smell it -- and it looked like an engine was on fire, that's what that Beech D-eighteen just said.
HM/LC	Did I what -- yeah I told him a mile and I told him ah mile and ah half, I didn't give him the three quarters, 'cause he was on final * -- Eastern five seventy six it's what they told me downstairs.
HM/LC	I can't ah -- I can't talk to him -- call the South Ramp, tell 'em they need additional fire trucks -- I don't think he's off the runway.
74E	Raleigh this is Beech ah seven four echo, look like the runway's tied up now.
RDO-L/C	Yes, sir, Beech seven four echo, the run at airport is closed at the present time sir.
74E	OK, ah how about me taxiing back in?
RDO-L/C	Aw right, sir, ah taxi ah stand by, sir.
HM/LC	Number four somebody's callin' -- ah looks like he is off the runway, I can't see ah *-in' thing.
RDO-L/C	Eastern five seventy six tower
HM/LC	I *** right here -- sent him the VOR at three thousand ah and ah put him on ah --* see if you can taxi this guy back to the South Ramp -- I knew it, see if he wants to taxi, just see if you can send him back -- call these guys, see if you can taxi somebody to the South Ramp -- that one at the approach end, he wants to taxi back to the South Ramp -- South Ramp.
RDO-L/C	Ah Beech seven four echo, taxi to the South Ramp.
74E	Seven four echo, roger, he ran off the end.
RDO-L/C	Ah negative, sir, ah I can't see where he is, sir, it's ah raining up here so hard I just I can't see anything.
Guard?	Tower, he's right at the center of the refueling area for helicopters.
784	Hello, tower, Forecast 784
RDO-L/C	Forecast seven eight four, go ahead.
784	Roger, sir, he appears to be right in front of ah where we helicopters
RDO-L/C	OK, thank you, sir, appreciate it -- can you tell me if he's in the grass or what, sir?

784	Roger sir, stand by ---
HM/LC	OK.




UNIVERSAL RAIN GAUGE
FIG 4
RALEIGH, N.C.
NOV. 12, 1978
RAIN DEPTH IN INCHES
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
19:30
20:00
20:30
21:00
EASTERN STANDARD TIME

APPENDIX F

BEHAVIORAL RESEARCH APPLICATIONS GROUP INC.

822 HARVARD STREET • ROCHESTER, NEW YORK 14607 • (716) 442-5861

October 26, 1977

Mr. Donald McClure
Safety and Engineering Section
Air Line Pilots Association
1625 Massachusetts Avenue, N. W.
Washington, D. C. 20036

Dear Don:

Enclosed you will find an outline indicating the physiological and psychological activities of the pilot beginning with the time the rain hit the wind screen. You will note that the total time from the time the rain hit the wind screen until the time of completing any kind of control input is approximately 3.8 seconds. Much of this time was consumed in involuntary activities.

Sincerely,

A. O. Dick, Ph.D.

AOD/cal

Rain hiss/approach light glare

A. Startle reaction - reflexive (involuntary) .500

B.
1. Physiological changes/central changes
   a. Heart rate increase
   b. GSR
   c. Muscles tighten

   (Both increased heart rate and muscle tightening have been associated with slowed RT)
2. Reduced sensitivity to information
3. Glare - flash blinding

C. Orienting reflex
1. Physiology
2. GSR (3000)
3. Pupil changes (5000)
4. Heightened sensitivity
5. Brain wave changes
6. Heart rate high

D. Behavior
1. What is it? .500
2. Resume activity .500
   e.g. monitor VASI
3. Realize rain (.200)
4. Check instruments
   a. FD - CB 1.100
   b. Crosscheck .250
5. Accommodation and convergence
   a. reduced sensitivity
6. Decision to go around .300
7. Reaction time .250
8. Movement time .400

E. Aircraft reaction time

Extenuating circumstances

A. Expectancy
B. Noise in cockpit (complex decisions)
C. Fatigue (complex decisions)
D. Higher altitude (complex decisions)
E. Memory load/processing capacity
   1. Wet runway
   2. Fully loaded - heavy airplane
   3. Downhill runway

[illegible]

Captain E. D. Meador — DCAFO

R. F. Forbes — MIACK

B-727 Windshield Wipers — March 2, 1976

Ed, as I indicated to you several days ago, Homer has assigned the B-727 windshield wiper problem to me for resolution.

I talked to Whitey John today, to cut him in on the problem, and to find out if he had received complaints in the nature of yours--he has not. The complaints he has received relate to noise and the "park" mode.

I then went to Terry Timmons in Engineering and asked for his help. He is going to begin an immediate check of past records to determine if, on the phase check, blades are showing up bad, or if arm tension regularly needs adjustment. We are also proposing an E.O. to check the next five or ten aircraft coming into phase check.

One interesting item keeps recurring in my conversations on this matter. That is: The wiper motor appears to be underpowered, and in developing the specs for blade arm tension, there was a trade-off between what would be optimum tension on the blade arm for best water removing action, and what the motor can generate in the way of torque. Too much tension causes the blade to stall. The cure is to reduce tension, and this may cause unsatisfactory performance.

As you can see, this may turn out to be a design problem, and therefore, a Boeing problem.

We intend to pursue all aspects of this problem, and I will keep you posted.

R. F. Forbes

RFF:do
cc: Captain W. L. Colsh

interoffice correspondence

EASTERN

TO Captain W. R. Brady — ADDRESS MIAFV

FROM L. Homer Mouden — ADDRESS MIACK

SUBJECT: B-727 Windshield Wipers — DATE March 24, 1976

Walt, I received several complaints from pilots concerning the inadequate wiping action of the B-727 windshield wipers. These were presented to me as safety items. Since some of our recent landing incidents occurred when the wiper system was in use (the IAH incident wherein there was a wiper malfunction, and the RDU incident of 11-12-75, to mention a few), I thought the complaints merited investigation.

Accordingly, Dick Forbes, and Terry Timmons of Engineering, have been working together in an attempt to run this problem down. Their tentative assessment was that the tension on the wiper blade arm was inadequate. To test this, a random check of the blade arm tension was made on 10 aircraft. A significant number of these showed improper blade arm tension.

To correct this problem Engineering plans to change their work program to add this function to those of the mechanic. His work card will specify the use of the scale to check tension, and will specify the required value and tolerances. This is to be done on the phase check and, if accomplished as proposed, it will be approximately six months before the entire B-727 fleet is checked.

Since we are coming up on the rainy season, and in view of the possible correlation of windshield wiper inadequacy with recent landing incidents, you may want to consider asking for a one shot immediate check of the entire B-727 fleet to be followed by the routine phase check, as a continuing program.

Homer

L. Homer Mouden

LHM:F:a
cc: Mr. Don Crosby

All B-727 Flight Officers -3- June 1, 1976

From my own experience, I keep a how goes it on the fuel burn-off as the trip progresses. If the TOGW is within 1,000 lbs. of the RGW on the CFP, the burn-off is usually pretty close--except after the descent begins. That's where vectoring or whatever happens in a terminal area takes its toll. That also is where the judgment factor comes in as to what additional fuel, if any, is required by the Captain.

We suspect the QCs are burning a little more fuel than the computer is programmed for. Any feedback from you would be appreciated. If an adjustment is needed, we'll get it done. All we need is good valid data from you to justify a change.

Windshield Wipers
As we had put in "Items," write up any wiper if the blade "floats" at cruise speed. We usually don't get the opportunity to test them before they are needed (because of a dry windshield) this is one way to get a potential problem area fixed rather than get caught by surprise on that next rainy approach.

Reverse Thrust vs. Rudder Directional Control Capability
With the thunderstorm season upon us, a little discussion on the above subject may be appropriate since we do a lot of landing under various combinations of adverse runway and wind conditions.

As a result of some tests done several years ago with the rudder pedal nose wheel steering linkage deactivated, the following results were observed:

1. Reverse thrust from the center (#2) engine had negligible effect on rudder effectiveness.

2. Reverse thrust from the pod (#1 and #3) engines generally reduced rudder effectiveness. At 60-80 knots IAS, approximately 65% N_1 in reverse thrust rendered the rudder completely ineffective. At 85-100 knots IAS, approximately 80% N_1 in reverse thrust rendered the rudder completely ineffective.

The report on the same series of tests stated that asymetric reverse thrust is of little help in maintaining directional control.

DEPARTMENT OF TRANSPORT

Attachment C

Telephone: 62 0111 (Area Code 03)
Telegraphic Address: 'AVIAT, MELBOURNE.'
Postal Address: BOX 1839 Q, G.P.O., MELBOURNE, 3001.

AVIATION HOUSE,
[illegible] QUEEN STREET,
MELBOURNE, 3001.

23 Feb 1971

In Reply Quote ....

Captain N.B. Crosbie,
1A Yattendon Road,
St. Heliers,
Auckland 5,
NEW ZEALAND.

Dear Sir,

I was interested in receiving your query regarding the replacing of the red-white VASIS with a T-VASIS at Pago Pago. The proponents of the red-white system do not generally realise that it is an unsafe system in that a pilot can receive an "on slope" indication for a mile or so not realising that he is descending too rapidly and he may receive a double red signal too late to check his descent.

One big advantage of the T-VASIS is that when it is installed for regular aircraft, it does not have to be re-sited for long bodied aircraft. The pilot of a long bodied aircraft can fly 'on-slope' in the early part of the approach and check the rate of descent so that he sees a 1 dot signal in the later stages as described on page 12 of Publication 56. If a pilot decides to exercise a little caution in his approach, he could make sure he sees a 2 dot fly down signal immediately before the threshold.

The current Australian Standard installation is designed for 15 m (50 ft) above the threshold and an approach slope of 3°. I have enclosed a diagram showing the height over threshold for the standard 3° system as well as those designed for 2.75° and 3.25° all with a height of 50 ft over threshold. You will note that while there is considerable variation in the distance from threshold at which each light unit is placed, there is very little difference in height over threshold due to the varying approach slopes. When compared with an ILS, these heights must be corrected by the vertical difference between the pilot's eye and the glide path aerial on the aircraft.

I understand that in New Zealand the authorities alter the setting of the whole light unit to provide a variation in the approach slope, this means that the red undershoot signal is always the same distance below the approach slope.

Here in Australia, we prefer any non-standard installation to have the light control blades specially manufactured for the selected approach slope therefore retaining the red undershoot signal at a standard angle of 1.9°. Only in one of the 100 installations in Australia and Papua New Guinea have we varied the red undershoot signal and that was at Canberra where we also raised the approach slope.

... been used are as follows:

	Approach Slope	Red Undershoot Signal	Interval between Approach Slope & Red Undershoot Signal
Non Standard	2.50°	1.9°	.60°
Non Standard	2.75°	1.9°	.85°
Old Standard	2.86°	1.9°	.96°
New Standard	3°	1.9°	1.10°
Canberra	3.05°	2.10°	.95°

If the difference quoted in the last column of this table is reduced below 1° there is a corresponding reduction in the amount of light emitted by the light units in the fly up leg, therefore, I always recommend the approach slope should be at least 1° above the undershoot signal.

A perusal of Pago Pago landing chart shows that a T-VASIS with an approach slope of 3.25° would be required to match the ILS and that a red undershoot signal at approximately 2.5° would be required to clear the obstructions in the approach. The difference is .75° which, while it is approaching the minimum, would be acceptable.

We have no snow problems in this country therefore, we did not develop the original design for any form of snow protection. After discussion with the manufacturer regarding the possibility of supplying the equipment to countries with snow problems, a snow lid was designed and a mould constructed but none have been manufactured and the design has yet to be evaluated in practice. On page 15 of the enclosed copy of Publication 15, Fig 16 has been modified to show this lid.

If requested by FAA, or the equivalent authority in any other country, I would expect that my Department would be only too happy to promote the T-VASIS by making available on loan a set of field equipment for evaluation purposes.

If I can be of any further assistance in providing information, please do not hesitate to write to me again.

Yours faithfully,

(J.H. Loevero)
Principal Airport Lighting Engineer

Encl.

AIR CARRIER OPERATIONS BULLETIN NO. 71-9

SUBJECT: Training Emphasis on Non-Precision Approach Procedures and Interpretation of Low Visibility Weather Reports.

Recent air carrier accidents which occurred during non-precision approaches pin point the need for action to improve this type of operation. A study was initiated sometime back with a goal to examine existing criteria and make recommendations for changes to criteria. The study group must determine if improvements can be made which will aid the pilot in making a decision to descend below MDA during a non-precision approach. Meanwhile, there is a need to reemphasize training in non-precision approaches as well as improving the knowledge and understanding of the implications of reported low visibility weather.

Accident investigators from the NTSB and inspectors from the Washington Office have questioned air carrier pilots about the meaning and implication of reported obscuration in weather sequences. The pilot response reflected inadequate knowledge of the subject. Of particular interest is the fact that partial obscuration is described in the remark section and can be anything from 1/10 to 9/10 coverage and still be considered partial. The implication of a 7/10 or 8/10 obscuration is that a pilot could reasonably expect to encounter restrictions to visibility as he descends from a position below cloud level toward the runway environment. However, pilots questioned were not aware of this because they did not relate the remarks information to the obscuration.

In view of the lack of knowledge on the part of the pilots interviewed, operations inspectors should assure that training programs adequately cover weather sequences and interpretations that may be made from the low visibility data supplied on the weather sequence.

The FAA Academy has prepared a paper on non-precision approaches which contains excellent material to assist in upgrading the professionalism required during a non-precision approach. The material is reproduced in part as follows:

THE NON-PRECISION INSTRUMENT APPROACH
—— MORE PRECISION IS NEEDED ——

The ability to conduct the non-precision approach in a professional manner has given way in large part to the computed and automated approaches; i.e., flight director and autocoupled approaches. The instrument pilot of today is being trained in a manner which emphasizes the philosophy of the precision

ILS approach to Category I, II and III procedures and weather minima, but de-emphasizes the basic non-precision instrument approach procedures. His training no longer stresses the need for precise timing, closely controlled rates of descent, thorough knowledge of the procedure, and the basic skills and techniques of using the raw data information displayed in the cockpit. As a result, he has become in far too many cases, something less than a professional in conducting the non-precision approach.

What can be done to reverse this trend? One way would be to re-emphasize the need to know and practice the basic skills and techniques associated with the non-precision approach. Another could be to recognize the need for more precision during the so-called non-precision approach. Even a name change for this type procedure(s) may be in order. Perhaps we should stop using the philosophy of non-precision and face up to the need for standards that all phases of flight should be based upon precision and professionalism. Still another area in the conduct of non-precision approach has to do with the attitude, cockpit discipline and crew coordination of the flight crew. Recent events strongly indicate a widespread lack of appreciation for the importance of these factors. Substandard attitude, discipline and coordination are apparent to the degree that many approaches are being flown in a hit-or-miss fashion rather than in a disciplined by-the-book procedure. The results in far too many instances have been making newspaper headlines. This area in particular is in great need of added emphasis.

In addition to the preceding points, more operational knowledge of the construction of the non-precision approach as spelled out in the TERPS Handbook 8260.3A, is needed. Such things as obstruction clearances, descent gradients, final course alignment criteria, and the primary boundaries of the approach segments are need-to-know factors for the professional airman.

What are some of the shortcomings and common faults frequently noted in the execution of non-precision approaches?

1. Failure to conduct comprehensive briefing on the approach procedure and techniques to be used.

2. Failure to execute the procedures as published; i.e., cutting the procedure short, especially when the initial phase is on top of the restriction to visibility. This corner cutting carries over into the final approach phase where all at once everything piles up and the crew is not always equal to the task.

3. Failure to cross-check altimeters and other flight instruments during the initial and final approaches.

4. Using procedures and techniques which give the pilot too much to do at the start of the final approach segment; i.e., checking the final approach fix passage; calling for gear down and before landing

checklist; calling for approach or landing flaps as appropriate; commencement of timing if required; commencement of the required descent rate; establishment of correct airspeed; etc., at least six things which must be accomplished in short order. Experience has shown that one or more of these items are often unintentionally delayed or forgotten, usually to the degradation of the overall quality of the approach.

5. Failure to tune and properly identify the approach facility(s).

6. Failure to precisely note FAF passage.

7. Failure to commence timing at the FAF.

8. Failure to promptly commence a properly controlled and correct rate of descent so as to arrive at MDA in a position to sight the runway environment and continue a normal approach to a landing so as to avoid excessively high rates of descent at any point during the final approach segment.

9. Inattention to the details of the task at hand; e.g., conversation and actions concerning unrelated and irrelevant things.

10. Opposite corrections to tail ADF bearings.

11. Poor quality of ADF maintenance and upkeep; e.g., the oft-heard remark that, "the ADF is no good in the modern jets," when all it likely needs is to be written up and carefully repaired.

12. Lack of appreciation or knowledge for the different scale values of the localizer and VOR as displayed on the Course Indicator.

13. Failure to carry out proper crew coordination procedures. Especially, when the copilot is flying the Captain often fails to execute the normal copilot functions and duties.

14. Not staying on instruments; i.e., both pilots looking out for the runway threshold rather than one staying on instruments and the other cross-checking and looking out for the runway environment.

15. Inattention to precise course interception, and cross-checking on secondary instruments.

16. Failure to level off at or slightly above MDA.

17. Persistence in continuing a substandard approach rather than promptly executing the missed approach. There seems to be a strong-feeling false pride against executing a missed approach.

18. Not using a stabilized approach concept.

19. Not preplanning how to conduct the approach so as to fly the airplane through the window (key point) at MDA approximately one mile from the runway threshold.

20. Not striving for a high degree of accuracy and precision in the conduct of the non-precision approach.

21. Not giving due consideration to the possible adverse effect of remote-source weather and altimeter setting information.

RECOMMENDATIONS.

1. Emphasize the need for more discipline, crew coordination and precision in the various non-precision approaches.

2. Develop new and more specific crew-concept procedures for all non-precision approaches similar to the procedures being used on the full ILS approaches. Following are some examples which apparently are appropriate.

   a. Complete in-range checklists and comprehensive instrument approach briefing prior to initiating the approach. Careful calculation of final approach ground speed.

   b. Extend landing gear and approach flaps and complete before-landing checklist after intercepting inbound course and prior to FAF passage. Establish altitude at the minimum recommended value so as to avoid subsequent high rates of descent.

   c. Use established altimeter, flight instrument and warning flag cross-check procedures just prior to the FAF.

   d. Note FAF passage, start timing and promptly commence predetermined rate of descent. Set landing flaps if appropriate.

   e. Make altitude and course deviation callouts during final descent.

   f. Carefully monitor timing and descent so as to arrive at or slightly above MDA prior to the KEY POINT (Normally one mile from the runway threshold). The KEY POINT may be determined by timing (usually 30 seconds prior to MAP), by DME, by cross bearing, or other type fix.

   g. POSITIVELY monitor MDA limits and do not descend below until the runway environment is in sight and the airplane is in position for a NORMAL approach to a landing. Assuming a HAT of 300' to 400', this should occur at the KEY POINT and approximately one mile from the threshold.

Abandon the approach and execute the missed approach procedure if the approach is substandard or if g. above is not possible. It is NOT necessary to carry out the timing to the final MAP.

3. Consider revising the instrument procedures and approach plate display by establishing a KEY POINT FIX (KPF), approximately one mile from the threshold or farther out where MDA and visibility minima are above standard. The fix may be determined by DME, MM, NDB, intersection, or by timing.

4. Calculate and display on approach plates the timing from FAF to the Key Point Fix (KPF).

5. Calculate and display on approach plates the recommended rate of descent required on final approach to reach MDA at or before the KPF.

APPENDIX G

RESPONSE TO PETITION FOR RECONSIDERATION OF PROBABLE CAUSE

Air Line Pilots Association
Petition for Reconsideration of
Probable Cause
Aircraft Accident—Eastern Air Lines, Inc.,
Boeing 727-225, N883E,
Raleigh, North Carolina, November 12, 1975
(NTSB-AAR-76-15)

RESPONSE TO PETITION FOR RECONSIDERATION

In accordance with the Safety Board's rules (49 CFR Part 845), the National Transportation Safety Board has entertained a Petition for Reconsideration of its findings, analysis, and probable cause in the aviation accident involving Eastern Air Lines, Inc., Boeing 727-225, N883E, Raleigh, North Carolina, on November 12, 1975. As a result of its review of the Petition for Reconsideration, the Safety Board has granted the Petition in substantial part. The aviation accident report has been extensively revised to reflect the relief granted and to revise the probable cause of the accident.

On May 19, 1976, the Safety Board determined that during the landing at Raleigh-Durham Airport in instrument meteorological conditions the instrument landing system (ILS) approach was uneventful until the airplane was about 100 feet above the ground. The flightcrew had the approach lights, the runway threshold lights, and the runway lights in sight. At that point, heavy rain moved across the approach path, and the captain, who was flying the airplane, lost all outside visibility. The rate of descent increased, despite the application of increased thrust, and the airplane struck the ground 282 feet short of the runway. The airplane bounced onto the runway and slid to a stop 4,150 feet past the runway threshold. There were eight persons injured; one was injured seriously.

When the report was adopted, the Safety Board determined that the probable cause of the accident was the pilot's failure to execute a missed approach when he lost sight of the runway environment in heavy rain below decision height.

In its petition, the Air Line Pilots Association addressed 10 issues relating to alleged errors and omissions in the Board's conclusions and analysis of the evidence. These issues are addressed as follows:

1. Errors in the flight data recorder (FDR) readout and analysis.

The original flight data recorder group was reconvened to address the errors in the FDR readout and analysis alleged in the petition. The petitioner contends there was an error of 0.0075 inches in the reference line measurement on the FDR foil. The reference line stylus assembly is bolted to the recorder frame. To examine the possibility of the error asserted in the petition, the zero airspeed trace was measured relative to the reference line for the three previous takeoffs and landings. The reference line values were all between 0.0005 and 0.0001 inch, which is not unusual for a bellows-operated stylus.

Although the relative distance between the reference line and the zero airspeed line remained essentially constant, a weave was detected in the foil. Measurements were taken at different locations from the reference line to the bottom edge of the sprocket holes on the foil to establish the effect of the weave. The values of the traces on the foil, however, are relative to the reference line and not to the edge of the foil. Thus the second examination of the foil recorded the same values as the original examination of the foil. With regard to issue No. 1, the Safety Board's analysis shows that there were no errors in the Board's original readout. As a result, the Safety Board concludes that there was no error in the reference line measurement on the foil.

The Safety Board agrees that the radio transmission binary information from the foil should have been read, and that this information was not essential to the investigation.

The Safety Board does not agree that there is a lack of correction for pilot's eye to static port vertical separation in the FDR readout. It is a common misconception that the air pressure sensed by one side of the bellows in a barometric altimeter is the pressure at the static port end of the tube which is connected to the bellows. In fact, the static pressure is sensed at the bellows. The accident airplane had a separate bellows in the FDR for sensing altitude and there was only a slight difference between the height of this bellows and the cockpit bellows during normal flight operations. The FDR altitude error tolerance, on the other hand, far exceeds this difference.

The Safety Board does not agree that the readout of the altitude trace was in error. However, the Safety Board's extrapolation of the altitude information on the FDR in the original report exceeded the actual capability of the FDR to represent airplane altitude. The FDR altitude information has been reexamined and those sections of the report where altitude data inappropriately were used factually or analytically have been revised. The Safety Board agrees that the original report's FDR altitude information relating to the last 15 seconds before impact was not accurate. Accordingly, the discussion in the text has been revised.

2. Errors in the cockpit voice recorder (CVR) transcript timing.

The final 4 minutes 37 seconds of the CVR tape were reexamined keyed to the FAA transcript times. There were two errors noted in the CVR transcript, wherein the times differed by more than 1 second. There was a 3-second error in the timing of the "Five hundred feet ground contact" comment. The correct time is 2001:34, rather than 2001:37. The other error relates to when "okay" was said by the first officer. The correct time is 2001:27 not 2001:29. All other times are correct within 1 second.

The petitioner included in the section on CVR errors six conclusions relating to the approach profile.

(a) "That at least takeoff thrust had been applied by the flightcrew."

While the evidence establishes that some thrust was applied, neither the petition nor the Safety Board's examination of the evidence allowed a determination of the exact level of thrust that was applied.

(b) "That the airplane had a high angle of attack."

The Safety Board agrees that there was an increase in angle of attack during the last few seconds of flight based on the Safety Board's analysis of the FDR and of the physical evidence at the point of initial impact but cannot conclusively state that it was a "high angle of attack."

(c) "That the descent rate had been reduced."

The Safety Board agrees, based on the Safety Board's analysis of the FDR and of the physical evidence at the point of initial impact, that the descent rate was reduced.

(d) "That it was raining extremely hard."

The Safety Board agrees that the rainfall was heavy in the vicinity of the accident.

(e) "That the wind was gusting."

Witness statements and meteorological conditions support a conclusion that there were gusting winds. However, the wind values cannot be quantified.

(f) "That all the above had occurred before the aircraft crossed the localizer antenna."

The Safety Board believes that the precise point of the events cannot be established on the basis of the existing evidence.

3. <u>Misinterpretation of altitude at which flightcrew lost forward visibility.</u>

The report has been revised to indicate that the flightcrew lost forward visibility when the airplane was 100 feet or less above the ground. Although the petition asserts that the wheels of the airplane were 47 feet above the touchdown zone when this occurred, the Safety Board's view is that the limitations of the FDR data preclude such a definitive statement.

The section of the petition which referred to this subject also contained a discussion of downdrafts and the body angle of the airplane. Both of these issues have been addressed in the revised report in a manner closely paralleling the discussion in the petition.

4. <u>Failure to understand limitations in ability of crew/aircraft to execute missed approaches under adverse conditions.</u>

In the reexamination of the evidence, the Safety Board determined that it is likely there was insufficient time for the captain to perceive the situation and react to the effects of downdrafts and wind shear on the airplane's performance and for the airplane to respond and to arrest the airplane's descent. The analysis appears in the revised report.

5. Misinterpretation of required IFR callouts.

The Safety Board agrees that the original report was incorrect with respect to finding 9 that the first officer did not make loud distinct callouts when a hazardous situation was encountered. The report has been revised to correct this point.

The second part of this issue addresses Eastern Air Lines' required IFR callouts and the manner in which the flightcrew of Flight 576 made such callouts.

Eastern Air Lines requires the pilot flying to call out the final approach fix (FAF), 1,000 feet above the airport, 100 feet above decision height (DH), and DH. The flightcrew did maintain altitude awareness by making the calls at the FAF and at 1,000 feet above the airport. However, the captain was required by Eastern Air Lines procedures to make the altitude calls. Instead, the first officer made the callouts. While the Safety Board does not believe that this lapse in carrying out the checklist contributed to the accident, nevertheless the actions of the flightcrew were contrary to Eastern Air Lines procedures.

No member of the flightcrew made the required 100-foot above DH or the DH callout. Despite the contention of the petition that these callouts were not required because the captain was flying the airplane with reference to visual cues, the Safety Board believes that they should have been observed. However, the Safety Board agrees that the omission of these callouts did not contribute to the accident. The weather conditions were poor and the approach was conducted at night. The purpose of the callouts is to provide backup to the flightcrew's observations of its position at specific times during an approach. The revised report discusses this issue at length.

6. Misunderstandings of approach speed versus Vref and speed required for the approach.

The Safety Board agrees that the term target speed cited in the original report was incorrect.

7. Lack of substantial meteorological analysis.

The magnitude of the wind shear and downdrafts, and the effect of heavy rain on the airplane were not determinable. Therefore, the Safety Board's original report was incorrect in stating that sufficient speed margin and thrust were available to overcome the effect of these meteorological conditions because the thrust demands needed to arrest the descent are not known. The report has been revised accordingly.

8. Erroneous interpretation of rainfall rate.

The Safety Board agrees that the rainfall recording at the airport indicates a heavy rain within a few minutes before the accident and that it is likely that the heavy rain, which was recorded at a rate of about 7 inches per hour between 1957 and 2000, had moved to the vicinity of the accident site by 2002. The revised report examines the rainfall rate at the time of the accident more thoroughly.

9. Failure to analyze effect of heavy rain on aircraft performance.

The petition acknowledges that it is difficult to quantify the aerodynamic effect of heavy rain. However, the petition states that the existence of the aerodynamic effect of heavy rain cannot be denied, and that it was a factor in the accident. This is true to the extent that no substantive research has been completed which allows the quantification of the effect of heavy rain on airplane performance or thrust generation. The aerodynamic effects of heavy rain are currently being studied by the National Aerospace and Space Administration. However, it may be some time before meaningful data will be developed for the purposes of accident investigation. A recent research paper entitled "The Effect of Heavy Rain on Windshear Attributed Accidents" by James K. Luers addresses the issue. However, Luers states that the paper was based totally on a theoretical analysis of the data and that there is no experimental wind tunnel or flight test data to support the results. The Safety Board recognizes that heavy rain has an effect on the thrust generation of turbojet engines, and that the meteorological conditions associated with heavy rain can affect airplane performance. However, it was not possible in this accident to quantify the effect of rain on the aerodynamic performance of Flight 576. Upon completion of the current research on this phenomenon, the Safety Board would hope to be able to begin to apply the research findings in its analysis of accidents where heavy rain is involved.

10. <u>Misunderstanding of use of flight instruments during landing.</u>

The Safety Board's review of the accident report and the supporting factual information has indicated that the flightcrew did monitor the flight instruments during the instrument approach in a manner consistent with accepted procedures. The report has been revised to reflect this conclusion, and a number of findings in the original report to the contrary have been deleted.

The Air Line Pilots Association introduced four items as "new" evidence in its petition. These items are addressed as follows.

1. <u>Air traffic control (ATC) failure to relay new information pertinent to execution of the approach.</u>

The portion of the petition dealing with ATC involvement contains nothing which can be considered new evidence under the Safety Board's rules. However, the Safety Board has reviewed this issue as a claim of an erroneous finding based on existing evidence.

The local controller did engage in considerable extraneous conversation before Flight 576 passed the Leesville radio beacon at 2000:28. However, all conversation from that time until the time of the accident related to ATC duties. The two transmissions received by the local controller described in the petition before Flight 576 passed the Leesville radio beacon came from Flight 576 and from an Army helicopter. The Army helicopter did not relate new weather information to the controller, while Flight 576 did comment on a storm in the area. The Safety Board does not agree that the controller failed to comply with paragraph 1002 of ATC Handbook 7110.80, or that the extraneous conversation before 2000:28 had an effect on the safety of Flight 576. There was no information available to the controller to relate to Flight 576 which was not already known to the flightcrew.

The local controller provided the flightcrew with the revised airport visibility of 1 3/4 miles at 2000:35, and subsequently raised the intensity of the runway lights to step 3. There was a discussion between the tower controllers of the visibility between 2001:18 and 2002:07. At 2002:07, the visibility was stated as three-quarters of a mile.

Two seconds later the accident occurred. The Safety Board does not agree that in the 2 seconds before the accident the local controller could have been expected to advise Flight 576 and turn up the runway lights to step 4. However, he knew the airplane was within one-half mile of the airport, with the runway in sight.

The final ATC issue raised in this section was the contention that the controller was not paying sufficient attention to his duties. This conclusion of the petitioner is based on the 2002:23 question of the controller, "Who's that last jet that landed?" The Safety Board disagrees with this assertion. The local controller stated that he saw Flight 576 at the approach end of runway 23 and then saw a "flash," after which he activated the crash alarm. The 2002:23 question was more logically the result of confusion and surprise caused by the accident than a lack of attention to his duties. His previous communications with Flight 576 were correct, and there was no indication of confusion about Flight 576's identity.

Accordingly, the Safety Board does not agree with the petitioner's interpretation of the ATC transcript and declines to revise its report to find ATC involvement in the accident.

2. Inadequacies of the aircraft windshield wiper system.

The petition states that the fourth paragraph of a letter dated March 2, 1976, "shows that in the conditions encountered by EAL [Flight] 576 the wipers could be expected either to stall or remove the rain improperly. In this case the wipers moved, so it is very likely that the rain was not properly removed." No other evidence is offered to support the assertion of improper removal of rain from the windshield of Flight 576.

The cited paragraph 4 of the letter merely offers a hypothesis without any factual support. Although not mentioned in the petition, the tests mentioned in a second letter (dated March 24, 1976) apparently are to be considered the factual support to prove the hypothesis. However, those tests do not indicate the number of airplanes that had improper wiper blade tension, the degree of improper tension, or whether the airplanes tested had been modified with appropriate Boeing Service Bulletins. Therefore, these tests do not support any conclusion about either a deficiency in the wiper system of Flight 576 or a design deficiency on the B-727 wiper system.

A statement in the last paragraph of the March 2, 1976, letter is significant: It reads, "We intend to pursue all aspects of this problem, and I will keep you posted." Since there was no other information provided by the author to Captain Meador, or further pursuit of the problem, we assume that there was nothing more to report. If there was a deficiency or a design problem as alleged in paragraph 5 of the letter, the Boeing Company has never heard of it from either Eastern Air Lines or from R.F. Forbes, the author of the March 2, 1976, letter. Further, Boeing has no records of complaints from other operators in the form of service reports on windshield wiper deficiencies.

Although it is true that insufficient tension of the wiper will provide less than optimum wiper blade performance, there was no evidence to indicate that before the airplane crashed wiper arm tension on the accident airplane was less than specified. The only recent reported preaccident difficulty with the wiper system on the accident airplane was on October 9, 1975, when the captain's wiper was recorded as ineffective. The wiper motor was changed on October 13, 1975, and no further complaints were recorded. Therefore, the presumption of proper wiper performance on Flight 576 must stand.

As a result, the Safety Board believes that the new evidence provided relating to the Boeing 727 windshield wiper system does not permit any valid conclusions to be drawn about the condition of Flight 576's wiper system.

3. Deficiencies in the standard visual approach system indicator (VASI) presentation.

The Safety Board disagrees with the submission of this issue as new evidence. The VASI was never intended for use as a precision instrument, and should not be used as a precision landing instrument. Furthermore, the Safety Board believes that most professional pilots are very much aware of the limitations of the VASI glide slope presentation, and of the inaccuracies which may result from viewing a VASI through heavy rain or other obstructions to vision.

4. Analysis of pilot event-related reaction times.

The report has been revised to address this issue.

As a result of the Safety Board's reexamination of the accident investigation, the accident report has been revised extensively. The Safety Board also has revised the findings, conclusions, and the probable cause.

ACCORDINGLY,

The National Transportation Safety Board determines that the probable cause of the accident was an encounter with heavy rain and associated downdrafts and wind shear during the final stages of landing when the airplane was less than 100 feet above the ground. The sudden onset of the meteorological conditions did not allow sufficient time for the captain to perceive and react to the effect of the downdraft and wind shear on the airplane's performance to stop the airplane's increased rate of descent and for the airplane to respond before striking the ground short of the runway.

The Safety Board commends the Air Line Pilots Association for its thorough petition and for its interest in aviation safety.

JIM BURNETT, Chairman, PATRICIA A. GOLDMAN, Vice Chairman, FRANCIS H. McADAMS, G. H. PATRICK BURSLEY, and DONALD D. ENGEN, Members, concurred in the disposition of this Petition for Reconsideration.