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At 1110 e.s.t., December 1, 1974, Trans World Airlines, Inc., Flight 514, a Boeing 727-231, N54328, crashed about 25 nautical miles northwest of Dulles International Airport, Washington, D. C. The accident occurred while the flight was descending for a VOR/DME approach to runway 12 at Dulles in instrument meteorological conditions. The 92 occupants -- 85 passengers and 7 crewmembers were killed, and the aircraft was destroyed.

The National Transportation Safety Board determines that the probable cause of the accident was the crew's decision to descend to 1,800 feet before the aircraft had reached the approach segment where that minimum altitude applied. The crew's decision to descend was a result of inadequacies and lack of clarity in the air traffic control procedures which led to a misunderstanding on the part of the pilots and of the controllers regarding each other's responsibilities during operations in terminal areas under instrument meteorological conditions. Nevertheless, the examination of the plan view of the approach chart should have disclosed to the captain that a minimum altitude of 1,800 feet was not a safe altitude.

Contributing factors were: (1) The failure of the FAA to take timely action to resolve the confusion and misinterpretation of air traffic terminology although the Agency had been aware of the problem for several years; (2) the issuance of the approach clearance when the flight was 44 miles from the airport on an unpublished route without clearly defined minimum altitudes; and (3) inadequate depiction of altitude restrictions on the profile view of the approach chart for the VOR/DME approach to runway 12 at Dulles International Airport.

As a result of the accident the Safety Board submitted 14 recommendations to the Administration.

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See also: Sound of Impact

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SA-446 File No. 1-0029

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: November 26, 1975

TRANS WORLD AIRLINES, INC.
BOEING 727-231, N54328
BERRYVILLE, VIRGINIA
DECEMBER 1, 1974

SYNOPSIS

At 1110 e. s. t., December 1, 1974, Trans World Airlines, Inc., Flight 514, a Boeing 727-231, N54328, crashed 25 nautical miles northwest of Dulles International Airport, Washington, D. C. The accident occurred while the flight was descending for a VOR/DME approach to runway 12 at Dulles during instrument meteorological conditions. The 92 occupants -- 85 passengers and 7 crewmembers -- were killed and the aircraft was destroyed.

The National Transportation Safety Board dete'rmines that the probable cause of the accident was the crew's decision to descend to 1,800 feet before the aircraft had reached the approach segment where that minimum altitude applied. The crew's decision to descend was a result of inadequacies and lack of clarity in the air traffic control procedures which led to a misunderstanding on the part of the pilots and of the controllers regarding each other's responsibilities during operations in terminal areas under instrument meteorological conditions. Nevertheless, the examination of the plan view of the approach chart disclosed to the captain that a minimum altitude of 1,800 feet was not a safe altitude.

Contributing factors were:

(1) The failure of the FAA to take timely action to resolve the confusion and misinterpretation of air traffic terminology although the Agency had been aware of the problem for several years:

(2) The issuance of the approach clearance when the flight was 44 miles from the airport on an unpublished route without clearly defined minimum altitudes; and

(3) Inadequate depiction of altitude restrictions on the profile view of the approach chart for the VOR/DME approach to runway 12 at Dulles International Airport.

1. INVESTIGATION

1.1 History of the Flight

Trans World Airlines, Inc., Flight 514 was a regularly scheduled flight from Indianapolis, Indiana, to Washington, D. C., with an intermediate stop at Columbus, Ohio. There were 85 passengers and 7 crewmembers aboard the aircraft when it departed Columbus.

The flight was dispatched by TWA's dispatch office in New York through the operations office in Indianapolis. The captain received a dispatch package which included en route and destination weather information. The flight operated under a computer-stored instrument flight rules (IFR) flight plan.

Flight 514 departed Indianapolis at 0853 e. s. t. 1/ and arrived in Columbus at 0932. The crew obtained weather and aircraft load information. The flight departed Columbus at 10-24, 11 minutes late.

At 1036, the Cleveland Air Route Traffic Control Center (ARTCC) informed the crew of Flight 514 that no landings were being made at Washington National Airport because of high crosswinds, and that flights destined for that Airport were either being held or being diverted to Dulles International Airport.

At 1038, the captain of Flight 514 communicated with the dispatcher in New York and advised him of the information he had received. The dispatcher, with the captain's concurrence, subsequently amended Flight 514's release to allow the flight to proceed to Dulles.

At 1042, Cleveland ARTCC cleared Flight 514 to Dulles Airport via the Front Royal VOR, and to maintain flight level (FL) 290. 2/ At 1043, the controller cleared the flight to descend to FL 230 and to cross

1/ All times are eastern standard times expressed on 24-hour clock.

2/ Altitude reference used above 18,000 feet m. s.l., using an altimeter setting of 29.92.

a point 40 miles west of Front Royal at that altitude. Control of the flight was then transferred to the Washington ARTCC and communications were established with that facility at 1048.

During the period between receipt of the amended flight release and the transfer of control to Washington ARTCC, the flightcrew discussed the instrument approach to runway 12, the navigational aids, and the runways at Dulles, and the captain turned the flight controls over to the first officer.

When radio communications were established with Washington ARTCC, the controller affirmed that he knew the flight was proceeding to Dulles. Following this contact, the cockpit voice recorder (CVR) indicated that the crew discussed the various routings they might receive to conduct a VOR/DME approach to runway 12 at Dulles. They considered the possibilities of proceeding via Front Royal VOR, via Martinsburg VOR, or proceeding on a "straight-in" clearance.

At 1051, the Washington ARTCC controller requested the flight's heading. After being told that the flight was on a heading of 100°, the controller cleared the crew to change to a heading of 090°, to intercept the 300° radial of the Armel VOR, to cross a point 25 miles northwest of Armel to maintain 8,000 feet, 3/ and "... the 300° radial will be for a VOR approach to runway 12 at Dulles." He gave the crew an altimeter setting of 29.74 for Dulles. The crew acknowledged this clearance. The CVR record indicated that the Armel VOR was then tuned on a navigational receiver. The pilots again discussed the VOR/DME approach to runway 12 at Dulles.

At 1055, the landing preliminary checklist was read by the flight engineer and the other crewmembers responded to the calls. A reference speed of 127 kn was calculated and set on the airspeed indicator reference pointers. The altimeters were set at 29.74.

At 1057, the crew again discussed items on the instrument approach chart including the Round Hill intersection, the final approach fix, the visual approach slope indicator and runway lights, and the airport diagram.

3/ All altitudes and elevations are expressed in feet above mean sea level unless otherwise noted.

At 1059, the captain commented that the flight was descending from 11,000 feet to 8,000 feet. He then asked the controller if there were any weather obstructions between the flight and We airport. The controller replied that he did not see any significant weather along the route. The captain replied that the crew also did not see any weather on the aircraft weather radar. The CVR recording indicated that the captain then turned on the anti-icing system.

At 1101, the controller cleared the flight to descend to and maintain 7,000 feet and to contact Dulles approach control. Twenty-six seconds later, the captain initiated a conversation with Dulles approach control and reported that the aircraft was descending from 10,000 feet to maintain 7.000 feet. He also reported having received the information "Charlie" transmitted—)on the ATIS broadcast. 4/

The controller replied with a clearance to proceed inbound to Armel and to expect a VOR/DME approach to runway 12. The controller then informed the crew that ATIS information Delta was current and read the data to them. The crew determined that the difference between information Charlie and Delta was the altimeter setting which was given in Delta as 29.70. There was no information on the CVR to indicate that the pilots reset their altimeters from 29.74.

At 1104, the flight reported it was level at 7,000 feet. Five seconds after receiving that report, the controller said, "TWA 514, you're cleared for a VOR/DME approach to runway 12." This clearance was acknowledged by the captain. The CVR recorded the sound of the landing gear warning horn followed by a comment from the captain that "Eighteen hundred is the bottom." The first officer then said, "Start down." The flight engineer said, "We're out here quite a ways. I better turn the heat down."

At 1105:06, the captain reviewed the field elevation, the minimum descent altitude, and the final approach fix and discussed the reason that no time to the missed approach point wag published. At 1106:15, the first,.," office'? commented that, "I hate the altitude jumping around." ~Theme commented that the instrument panel was bouncing around. At 1106:15, the captain said, "We have a discrepancy in our VOR's, a little but not much." He continued, "Fly yours, not mine." At 1106:27, the captain discussed the last reported ceiling and minimum descent altitude. He concluded, ". . . should break out."

4/ ATIS - Automatic Terminal Information Service.

At 1106:42, the first officer said, "Gives you a headache after a while, watching this jumping around like that." At 1107:27, he said, "... you can feel that wind down here now." A few seconds later, the captain said, "You know, according to this dumb sheet it says thirty-four hundred to Round Hill --- is our minimum altitude." The flight engineer then asked where the captain saw that and the captain replied, "Well, here. Round Hill is eleven and a half DME." The first officer said, "Well, but ---" and the captain replied, "When he clears you, that means you can go to your ---" An unidentified voice said, "Initial approach." and another unidentified voice said, "Yeah!" Then the captain said "Initial approach altitude." The flight engineer then said, "We're out a --- twenty-eight for eighteen." An unidentified voice said, "Right," and someone said, "One to go.

At 1108:14, the flight engineer said, "Dark in here," and the first officer stated, "And bumpy too." At 1108:25, the sound of an altitude alert horn was recorded. The captain said, "I had ground contact a minute ago," and the first officer replied, "Yeah, I did too." At 1108:29, the first officer said, "*power on this #." 5/ The captain said "Yeah --- you got a high sink rate." The first officer replied, "Yeah." An unidentified voice said, "We're going uphill," and the flight engineer replied, "We're right there, we're on course." Two voices responded, "Yeah!" The captain then said, "You ought to see ground outside in just a minute. -- Hang in there boy." The flight engineer said, "We're getting seasick."

At 1108:57, the altitude alert sounded. Then the first officer said, "Boy, it was --- wanted to go right down through there, man," to which an unidentified voice replied, "Yeah!" Then the first officer said, "Must have had a # of a downdraft."

At 1109:14, the radio altimeter warning horn sounded and stopped. The first officer said, "Boy!" At 1109:20, the captain said, "Get some power on." The radio altimeter warning horn sounded again and stopped. At 1109:22, the sound of impact was recorded.

At 1109:54, the approach controller called Flight 514 and said, "TWA 514, say your altitude." There was no response to this or subsequent calls.

5/ * Indicates unintelligible word(s); # indicates nonpertinent word(s).

The controller subsequently testified that he noticed on the radar-scope that the flight's altitude was about 2,000 feet just before he called them.

The flight data recorder (FDR) readout indicated that after the aircraft left 7,000 feet, the descent was continuous with little rate variation until the indicated altitude was about 1,750 feet. The altitude increased about 150 feet over a 15-second period and then decreased about 200 feet during a 20-second period. The recorded altitude remained about 1.750 feet until impact.

During that same portion of the flight, the indicated airspeed varied from 240 kn to 230 kn until the altitude trace leveled off about 1,750 feet after which the airspeed decreased and fluctuated between 222 kn to 248 kn. Some of the fluctuations occurred within short time spans while others were within longer spans.

The heading trace showed little variation during the latter portion of the flight. As the aircraft left 7,000 feet, the heading changed from an indication of 112° to about 120° in about 2.5 minutes. The heading did not vary more than 2° to 4° from that indication until impact.

As the aircraft left 7,000 feet, the vertical acceleration (g) trace was smooth with little fluctuation. After 40 seconds, the g trace activity increased to about ± 0.1 g. This continued for about 1 minute and then increased in amplitude to about ± 0.2 g for about 70 seconds. At this point there was a blank in the g trace. When the trace reappeared, it was still active, with variations in indicated g ranging from ± 0.2 to 0.5 g, until impact.

The accident occurred on the west slope of Mount Weather, Virginia, about 25 nmi from Dulles, at an elevation of about 1,670 feet. The latitude was 39° 04.6' N and the longitude was 77° 52.9' W.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	7	85	0
Nonfatal	0	0	0
None	0	0	

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

Power and communications lines were damaged.

1.5 Crew Information

The flightcrew was qualified and certificated in accordance with the existing FAA requirements. The captain was qualified to operate into Dulles under the provisions of 14 CFR 121.443. (See Appendix B.)

1.6 Aircraft Information

The aircraft was certificated and maintained in accordance with FAA-approved procedures. The aircraft weight and balance were calculated to be within limits at takeoff and at the time of the accident. The aircraft was serviced with Jet A fuel, and there were 29.700 pounds of fuel aboard when the flight departed Columbus. There were about 19,300 pounds of fuel aboard at impact. (See Appendix C.)

1.7 Meteorological Information

The weather in the area where the accident occurred was characterized by law clouds, rain mixed with occasional wet snow, and strong, gusty easterly winds. A complex low-pressure system extended from western Kentucky to southeastern Virginia and the eastern Carolinas with small low centers located in western Kentucky and south-central Virginia. An occluded front extended from the Kentucky low through North Carolina into the Virginia low. A warm front extended northeastward from the Virginia low into the Atlantic, while a cold front extended from the same low to the Virginia coast, then southward into the Atlantic. A large area of low cloudiness and precipitation extended from the mid-Atlantic states to the Great Lakes, and southward to Tennessee. High gusty winds existed from the Middle Atlantic States to the Great Lakes.

The aviation weather observations taken at Washington National Airport between 0853 and 1054 reported scattered clouds at 700 feet, overcast at 1,200 feet, and visibility of 5 or more miles with very light to light rain. The winds were blowing from 070°, and the velocity varied from 25 to 28 kn with gusts of 35 kn reported at 0853, 44 kn reported at 0953, and 49 kn reported at 1054.

The aviation weather observations taken at Dulles International Airport between 0858 and 1055 reported an overcast at 900 feet with visibility varying from 3 to 7 miles in light rain. The winds were from:

080° at 20 kn gusting to 32 kn reported at 0858; 090° at 26 kn, gusting to 40 kn reported at 0955; and, 080° at 25 kn, gusting to 36 kn, reported at 1055.

The 1131 radar weather observation from Patuxent, Maryland, showed a large area of weather echoes which included the accident area. One-tenth of the area was covered with thunderstroms which were producing moderate rain showers, and five-tenths of the area was covered with moderate rain. The thunderstorm cells were moving from 170° at 45 kn The maximum cloud tops were at 24,000 feet between Charlottesville, Virginia, and the accident site.

There were three SIGMETS [6/] in effect at the time of the accident. They recommended caution due to "... moderate to severe mixed icing in clouds and precipitation above the freezing level" and embedded thunderstroms with tops near 40,000 feet. The cells were moving northeastward at 25 to 30 kn.

Although there were numerous pilot reports of weather conditions in the area around Washington, none was received from pilots flying in the area where the accident occurred.

Ground witnesses in the accident area stated that, at about the time of the accident, the local weather was characterized by low ceilings with visibilities ranging from 50 to 100 feet at the crash site. The wind was estimated at 40 mph with stronger gusts. There was a steady drizzle in the accident area.

At the request of the Safety Board, the National Weather Service (NWS) studied the possibility of pressure changes in the accident area which could have contributed to the cause of the accident. Based on the observed wind direction and velocity at Dulles at 1025 (43 kn), the NWS calculated that a pressure drop of 0.4 millibars, equivalent to 0.012 in. Hg., could have occurred if the wind conditions in the accident area were the same as the winds at Dulles. This pressure change could result in an aircraft altimeter reading 13 feet higher than the actual altitude of the aircraft. They further calculated that if the wind velocity was 60 kn, the resulting pressure change could be 3.2 millibars (0.094 in. Hg.)

6/ SIGMETS are advisory warnings of weather severe enough to be potentially hazardous to all aircraft. They are broadcast on navigation aid voice frequencies and by flight service stations. They are also transmitted on the Service A weather teletype circuits.

causing an altimeter reading 95 feet higher than the actual altitude. A wind velocity of 80 kn could result in an altitude indication 218 feet higher than altitude.

The accident occurred in clouds and during the hours of daylight.

1.8 Aids to Navigation

The navigational aids in use for the VOR/DME approach to runway 12 at Dulles included the Martinsburg, Front Royal, Linden, and Armel VOR's. These navigational aids were flightchecked after the accident and were operating within the prescribed tolerances. The distance measuring function of Armel had been inoperative about 2 hours before the accident, but it was operating without reported malfunction shortly before and after the accident.

Automated radar terminal system equipment (ARTS III) was used by the approach controller to observe and control the traffic. The ARTS III is a system which automatically processes the transponder beacon return from all transponder-equipped aircraft. The computed data are selectively presented on a data block next to each aircraft's updated position on the air traffic controller's radar display. The information provided on the video display is aircraft identification, groundspeed in knots, and, when the transponder of the aircraft being tracked has Mode C capability, pressure altitude in 100-foot increments. The aircraft's transponder has this capability. The position accuracy of these data is limited to about $1/4^{\circ}$ in azimuth and 1/16 nmi in range. Altitude is presented with a tolerance of $\pm$ 100 feet.

The controller's radarscopes are equipped with video maps which depict various terrain features, the position of navigational aids, and other pertinent data. In this case, the video map did not display the Round Hill intersection which is the intermediate approach fix for this approach, nor did it display the high terrain northwest of that fix. The updated video maps depicting the Round Hill intersection had been ordered but had not been received at the time of the accident.

There was no current letter of agreement between Dulles Approach Control and the adjacent ARTCC's regarding the use of the Armel VOR/DME approach to runway 12 at Dulles. (See Appendix D.)

1.9 Communications

No air-to-ground radio communication difficulties were reported.

1.10 Aerodrome and Ground Facilities

Dulles International Airport is equipped with three primary runways: 12/30, 1L/19R, and 1R/19L. The north-south runways (1L/19R and 1R/19L) are 11.500 feet long and 12/30 (runway 12) is 10,000 feet long. There are provisions for ILS approaches to the north- south runways. Runway 12 is served by a VOR/DME approach. In addition, a surveillance radar approach is available to all runways. Runway 12 is equipped with high intensity runway lights but not with approach lights. There is a visual approach slope indicator (VASI) installed on the left side of the runway.

1.11 Flight Recorders

N54328 was equipped with Lockheed Aircraft Service Model 109-D flight data recorder, serial No. 117, and a Fairchild Model A-100 cockpit voice recorder, serial No. 1123. Both recorders were installed in a nonpressurized area aft of the pressure bulkhead.

The flight data recorder parameter traces were clearly recorded. There were no recorder malfunctions. A readout was made of the last 15 minutes 25 seconds of the flight. There was a small gap in the vertical acceleration trace shown on the data graph at time 13 minutes 30 seconds because of foil damage which obliterated the trace. (See Appendix E.)

The cockpit voice recorder remained intact and the recording was clear. A composite flight track was prepared by correlating the recorder data. (See Appendix F.)

1.12 Wreckage

The wreckage was contained within an area about 900 feet long and 200 feet wide. The evidence of first impact was trees whose tops were cut off about 70 feet above the ground. The elevation at the base of the trees was 1.605 feet. The wreckage path was oriented along a line 118° magnetic. Calculations indicated that the left wing went down about 6° as the aircraft passed through the trees and the aircraft was descending at an angle of about 1°. After about 500 feet of travel through the trees, the aircraft struck a rock outcropping at an elevation of about 1,675 feet. Numerous heavy components of the aircraft were thrown forward of the outcropping.

The wing flaps, wing leading edge devices, and the landing gears were retracted. The condition of the flight control system could not be determined because of impact and fire damage. No evidence was found of preimpact structural failure or control system malfunction.

All three engines separated from the aircraft and were damaged.

The major rotating compressor components were bent or broken in a direction opposite to normal rotation. There was no evidence found of preimpact engine fire or malfunction. (See Appendix G.)

Most of the instruments on the pilots' instrument panels were destroyed, as were most of the aircraft navigational and flight instrument systems' components. Among those that were recovered and from which useful information could be obtained were the first officer's DME indicator which read 12 miles; the first officer's course deviation indicator which showed a selected course of 123°; and the first officer's altimeter, set at 29.70 in. Hg., with an internal indication of 1.818 feet. The first officer's flight director indicator showed the altitude marker at "0" feet, and the pitch display showed 5° aircraft nose up. An airspeed indicator was recovered with the reference pointer set at 123 kn; and a radio altimeter was found which indicated 10 feet. One distance measuring equipment interrogator unit was recovered; it showed a mileage indication of 12 miles and was tuned to a channel paired with 115.3 MHz., the frequency of the Front Royal VOR.

1.13 Medical and Pathological Information

All of the occupants of the aircraft died of traumatic injuries. Post-mortem examinations and toxicological and histological analyses were conducted on all flight crewmembers. No evidence of disease was found and the analyses were negative. The medical histories of the flight crewmembers disclosed no evidence of abnormal conditions.

1.14 Fire

No evidence of in-flight fire was found. Scattered intense ground fires occurred throughout the wreckage area. Local fire departments were notified of the location of the wreckage about 1145 and about 150 fire and rescue personnel responded with six pumpers and several rescue vehicles.

1.15 Survival Aspects

This was not a survivable accident.

1.16 Tests and Research

None.

1. 17 Other Information

Testimony at the public hearing indicated that air traffic controllers may vector flights to proceed to various points within the approach area to position the aircraft for execution of the approach. Aircraft are often vectored off published routes toward points on the approach path and are often cleared to descend to altitudes below the published minimum altitudes on the approach charts. Controllers and pilots have available to them the same information regarding minimum sector altitudes within 25 miles of airports as well as minimum altitudes for various segments of an instrument approach. However, the controller also has available minimum vectoring altitudes which he may use to clear aircraft to altitudes in certain areas even when those altitudes are below the minimum altitudes depicted on the instrument approach charts in the pilot's possession. Pilots have no way of knowing the minimum vectoring altitudes except through experience. Pilots testified that they had become accustomed to this sort of service and frequently did not know exactly where they were in relation to the terrain and obstacles depicted on their charts.

The testimony indicated that the pilots have become so accustomed to receiving assistance from the controllers that, unless advised by the controller, they do not know what type of services they are or are not receiving. Witnesses from FAA testified that it is not necessary for pilots to know what services they are receiving and that the pilot still has the ultimate responsibility for maintaining terrain clearance. In their testimony, the FAA referred to the pilot's responsibilities as outlined in 14 CFR 91 7/ and 14 CFR 121. 8/

7/ 14 CFR 91.3(a), under "Responsibility and Authority of the Pilot in Command" states: "The pilot in command of an a'ircraft is directly responsible for, and is the final authority as to, the operation of that aircraft."

8/ 14 CFR 121.533 outlines the "Responsibility for Operational Control; Domestic Air Carriers." Paragraph (d) of 121. 533 states, "Each pilot in command of an aircraft is, during flight time, in command, of the aircraft and crew and is responsible for the safety of the passengers, crewmembers, cargo, and airplane."

1.17.1 Development of Instrument Approach Procedures

Instrument approach procedures are developed by the FAA according to prescribed, standardized methods contained in the United States Standard for Terminal Instrument Procedures, FAA Handbook 8260.3.

The official document is FAA Form 8260.5 which contains all the information required to depict and publish an instrument approach procedure. U. S. Government charts which depict the procedure are prepared and printed by the Department of Commerce, National Ocean Survey (NOS). The charts prepared by NOS are used by air traffic controllers while the Jeppesen charts are commonly used by air carrier flightcrews.

The Jeppesen chart depicting the approach used by the crew of Flight 514 was based on the data published by the FAA on the Form 8260.5. However, there was no formal program of review or approval by the FAA in comparing the Jeppesen chart with the basic data on FAA Form 8260.5. FAA requirements for instrument approach procedures 9/ and Certificate Holders' Manual Requirements 10/ are outlined in 14 CFR 121.

The Inter-Agency Air Cartographic Committee (IACC), composed of representatives from the Department of Defense, the Department of Commerce, and the FAA, has developed a manual containing U. S. specifications for use in the preparation of low-altitude instrument approach procedure charts. These specifications are used by cartographers in preparing NOS approach charts from the information on the FAA Form 8260.5. The third edition of this manual, dated July 1971, states, in part, that: "These specifications shall be complied with without deviation until such time as they are amended by formal IACC action."

9/ 14 CFR 121.567 "Instrument Approach Procedures and IFR Landing Minimums" states: "No person may make an instrument approach at an airport except in accordance with IFR weather minimums and instrument approach procedures set forth in the certificate holder's operations specifications."

10/ 14 CFR 121.135 "Contents," states, in part, that each manual required under 121.133 must include: "Appropriate information from the airport operations specifications, including for each airport ... Instrument approach procedures. . . ."

Chapter III of the manual, Revision 9. c (35) and (36) dated January 1973, states under the heading "Profile" that: "A profile diagram of the instrument approach procedures shall be placed in the space provided below the plan view. All facilities, intersections, fixes, etc., used in, or pertinent to the approach procedure as portrayed in the plan view shall be shown."

The profile view of the VOR/DME approach to runway 12 at Dulles Airport, as published by NOS, depicted only the 6 DME fix and the final approach fix altitude of 1,800 feet. It did not depict the Round Hill intermediate approach fix altitude or the minimum altitudes associated with the routes inbound from the three initial approach fixes that were part of this procedure, although these data were displayed on the plan view. Form 8260.5 for this procedure did not list the requirement for the Round Hill intermediate fix to be included on the profile view.

1.17.2 FAA Air Traffic Control Manual

The FAA Terminal Air Traffic Control Manual 7110.8C, which was in effect on December 1, 1974, prescribed the air traffic control procedures and phraseology to be used by FAA personnel who provide terminal air traffic control services.

Controllers are required to be familiar with the provisions of this handbook which pertain to their operational responsibility and to exercise their best judgments if they encounter situations not covered by the manual. The manual is offered for sale to the public by the Superintendent of Documents, Government Printing Office, Washington, D. C., but is not routinely disseminated to flightcrews. Some portions of the manual are used in air carrier training programs and portions are used in some FAA publications to indoctrinate pilots regarding the air traffic control system. FAA witnesses testified that pilots do not need to know specifically the contents of the manual, including the application of radar services.

Chapter 5 of the manual deals with radar operations. Sections 2 through 6 and section 9 of this chapter defines various aspects of radar operation including vectoring, radar handoffs, radar separation, radar arrivals, and radar identification. Section 9, Radar Arrivals, paragraph 1360, Arrival Instructions, contains the following guides for controllers

regarding an aircraft before it reaches the approach gate, 11/ provided that the aircraft was not conducting a radar approach.

> "Issue . . . approach clearance, except when conducting a radar approach. If terrain or traffic does not permit unrestricted descent to lowest published altitude specified in approach procedure prior to final approach descent, controllers shall: (1) Defer issuance of approach clearance until there are no restrictions or, (2) Issue altitude restrictions with approach clearance specifying when or at what point unrestricted descent can be made . . . ."

The FAA witnesses testified that Flight 514 was inbound to Armel by means of the pilot's own navigation, thereby relieving the controller of responsibility under paragraph 1360 of the manual. The witnesses also testified that IFR arrivals are routinely handled as nonradar arrivals in a radar environment whenever the pilot is navigating without assistance from air traffic control. The witnesses testified that under these conditions, the pilot must provide his own terrain clearance. The air traffic control system provides only separation from other known IFR traffic. No official definitions were provided for the terms "radar arrival" and "nonradar arrival."

The Air Traffic Control Manual states that the FAA provides three kinds of radar service: (1) Radar separation, when radar spacing of aircraft is accomplished in accordance with established FAA minima; (2) radar navigational guidance, when vectoring aircraft to provide course guidance; and (3) radar monitoring, defined as radar flight-following of an aircraft whose primary navigation is being performed by its pilot, to observe and note deviations from its authorized flightpath, airway, or route. As applied to the monitoring of instrument approaches from the final approach fix to the runway, radar monitoring also includes provisions for advice on aircraft position relative to approach fixes and advisories whenever the aircraft proceeds outside the prescribed safety zones.

11/ Approach gate is that point on the final approach course which is 1 mile from the approach fix on the side away from the airport or 5 miles from the landing threshold, whichever is farther from the landing threshold.

1. 17. 3 Airman's Information Manual

The Airman's Information Manual (AIM) is designed to be a pilot's operational and information manual for use in the National Airspace System. It is divided into four basic parts, of which Part 1 is the basic flight manual and ATC procedures for flying in the National Airspace System. Included are air traffic control information affecting rules, regulations, and procedures; a glossary of aeronautical terms and definitions; designated mountainous areas; and emergency procedures. This document is for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. The manual is available at most FAA facilities and Air Carrier Operations offices.

The material in Part I of the manual originates in various parts of the FAA and is offered for publication by the various services. There is no single function within the FAA that controls and assures the technical accuracy of the data included in the manual.

The February 1970 issue of the ~~manual~~ AIM under the heading "Instrument Approach" states that upon receiving an approach clearance, the pilot should begin his descent to the "approach" altitude as soon as possible. This sentence was deleted in May 1970; however, the notation used to indicate a change was not published on that page. There is evidence to indicate that some pilots were not aware of this change.

A review of the November 1974 issue of the manual, which was in effect at the time of the accident and which describes radar approach control states in part, ". . . In the case of aircraft already inbound on the final approach course, approach clearance will be issued prior to the aircraft reaching the approach fix. When established inbound on the final course, radar separation will be maintained and the pilot will be expected to complete the approach utilizing the approach aid designated in the clearance. . . as the primary "

The manual also stated, under the heading Instrument Approach Procedures, that "Instrument approach procedures are designed so as to ensure a safe descent from the en route environment to a point where a safe landing can be made. A pilot adhering to the altitudes, flightpaths (headings), and weather minimums depicted on the Instrument Approach Procedure Chart is assured of obstruction clearance and runway/airport alignment. "

1.17.4 TWA Flightcrew Training

The TWA Flight Operations Policy Manual and Flight Operations Handbook prescribe the following procedures applicable to a VOR/DME approach.

1. The landing preliminary checklist will be read 10 to 15 minutes before the estimated time of arrival or when leaving FL 180.

2. The captain and the first officer will review the approach plate. The pilot not flying will call out the field elevation, the minimum descent altitude, and the time to missed approach, where applicable.

3. The navigational receivers are to be tuned to the appropriate navigational aids for the approach.

(In this case, the aids were Armel and either Front Royal or Martinsburg VOR's.)

The following instructions regarding the use of the altitude alert system and the radio altimeter during descent were excerpted from the same publication:

1. Set the altitude alert system for each altitude assigned by Air Traffic Control. If cleared for the approach prior to reaching the charted initial approach altitude, set the initial approach altitude into the system until further descent is initiated. When cleared to descend below the initial approach altitude, position the altitude alert control to cancel further warnings.

2. After the altitude alert system is set for the initial approach altitude, an amber light will come on 1,000 feet prior to reaching that altitude. At this time the pilot not flying will call, 1,000 feet to go. Five hundred feet above the initial approach altitude a beep will sound. The amber light will turn green two hundred and fifty feet above that altitude.

3. Set the radio altimeter at 100 feet. It will provide a 2-second tone when the aircraft is within 500 feet of the terrain and the radio altimeter indicator will begin to display the last 500 feet of altitude. When the aircraft is 50 feet above the radio altimeter "bug" setting, the tone will begin and increase in amplitude until the bug setting is reached. On passing the bug, the tone will shut off abruptly, to alert the pilots that minimums have been reached.

TWA Flight Operations Training Bulletin 74-8 directed pilots to use the radio altimeter as a ground proximity warning on all approaches.

TWA trained it4 pilots on the provisions of, among other regulations, 14 CFR 91.119 and 14 CFR 121.657. These regulations prohibited any person from operating an aircraft under IFR at an altitude less than 1,000 feet above the highest obstacle within a horizontal distance of 5 miles from the center of the intended course or, in designated mountainous areas, less than 2,000 feet above the highest obstacle within the same horizontal distance from the center of the intended course. Air carrier pilots are not required to have topographical charts in the cockpit and, therefore, must rely on low-altitude en .route charts and instrument approach charts to determine the height of this accident, the Jeppesen chart depicting the ap[redacted]wed an obstacle at an elevation of 1,764 feet near the impact point. The highest obstacle shown on the chart was an obstruction marked 1,930 feet, about 5 nmi south of the track of Flight 514. This obstruction was marked with a heavy black arrow.

1.17.5 Changes Requested to AIM and ATC Manual 7110.8C

In 1967, the United States Air Force (USAF) questioned the FAA's procedures for instrument approaches with regard to the responsibility for terrain clearance. FAA responded that they would change the Air Traffic Control Handbooks to require the controller to include altitude information when approach clearances were issued. The change made to the manual did not require altitude restrictions on all approach clearances. Correspondence between the USAF and the FAA regarding this subject continued intermittently until December 11, 1974. when the FAA advised the USAF that a pilot should understand that, regardless of whether he is or is not receiving radar navigational guidance (except for a surveillance or precision radar approach) and regardless of the pilot's position when cleared for an approach, he is expected to remain at the last assigned altitude or descent not below the minimum en route altitude,

transition altitude, or minimum obstruction clearance altitude and adhere to any remaining altitudes specified on the instrument approach plate while completing the instrument approach. Subsequently the USAF made an emergency change to AF Manual 51-37 which instructed military pilots that: "Once approach clearance has been received, maintain last assigned altitude until established on the published final approach course." The manual previously stated that a pilot under radar control, when cleared for a nonprecision approach, could descend to the final approach fix altitude.

Early in 1970, TWA personnel became concerned about proper interpretations of the AIM and ATC Manual 7110.8 regarding what a pilot's action should be when he was cleared for an approach under certain conditions. Their primary concern was with clearances which did not contain positive altitude assignments. On July 1, 1970, TWA wrote to the FAA regarding this matter and characterized the situation as potentially disasterous. They further stated that pilots, radar controllers, and air carrier inspectors must be in total and unqualified agreement as to what the pilot is expected and safely permitted to do after an approach clearance is issued without an altitude reference. The FAA response stated in part: "Because of inquiries by you and others we are undertaking a study of the problem to determine the clarification that may be required."

On December 21, 1970. the FAA issued a general notice (GENOT) for internal distribution that said in part: "There appears to be some pilot and controller misunderstanding as to the meaning of the 'lowest published altitude specified in approach procedure prior to final approach descent,' therefore, controllers are cautioned to use care when clearing radar vectored aircraft for approach. To guard against the possibility of misinterpretation controllers shall assure adherence to the requirements of 7110. 8A-674C (1) and (2) and 7110. 9A-539C (1) and (2) whenever terrain or traffic does not permit unrestricted descent to: (1) the glide slope interception altitude or (2) the lowest altitude depicted on the profile view of the approach plate for all other types of approaches, (or) (3) the minimum decision altitude (MDA) if no altitude is depicted. The provisions of this GENOT will be incorporated in future changes to handbooks 7110. 8A and 7110. 9A." The GENOT was cancelled by the FAA on June 1, 1971. (See Appendix H.)

17.6 Air Traffic Controller Training

Air traffic controller training is conducted in air traffic procedures, operational directives, and equipment familiarization. No flight training is required of or given to controllers.

The Dulles Air Traffic Controllers are divided into three teams for training purposes. The schedule is made up to provide one full day of training per week for each controller. Two types of training are provided -- developmental and proficiency. Developmental training is conducted to perfect the skills necessary to qualify a controller for a particular operating position. Proficiency training is divided into three areas: Refresher, remedial, and supplemental. Refresher training is conducted to review current facility operational procedures. Remedial training is conducted to correct a specific operational deficiency. Supplemental training is conducted to train controllers in new or revised procedures, regulations, equipment, etc. Supplemental training is intended to assure that each controller remains proficient in his assigned operating positions.

Proficiency training is conducted through a combination of classroom training, briefings, and self-study. The self-study is facilitated by use of "Facility Mandatory Read and Initial Binder." This book contains material required for proficiency training, and each item included in the book has an attached initial sheet. The controller initials this sheet to indicate that he has read, understands, and will comply with the contents of the book.

The controller who handled Flight 514 at the time of the accident was in a group that, according to witnesses, received training on the VOR/DME approach to runway 12 on July 17, 1974. Nineteen controllers, including this controller, assigned to the facility stated that they had not received formal training on this subject. However, the controller who cleared Flight 514 for the approach said that he understood the approach and knew how to use it. He did not refer to the approach chart while he was handling Flight 514 nor was he required to. He stated that he was familiar with the terrain west of Dulles by virtue of his 12 years of experience at Dulles.

Controllers were trained to provide "additional services" as specified in paragraph 1540 of 7110.8C, to aircraft when they could fit the service into the performance of higher priority duties and on the basis of the following:

a. Provision of a service is not mandatory because many factors (such as limitations of the radar, volume of traffic, communications frequency congestion and your workload) could prevent you from providing it.

b. You have complete discretion for determining if you are able to provide or continue to provide a service in a particular case.

c. Your decision not to provide or continue to provide a service in a particular case is not subject to question by the pilot and need not be made known to him.

Among the additional services that a controller could offer to a flight pursuant to 7110.8C were:

a. Paragraph 1545 - Safety Advisory. "Issue an advisory to radar identified aircraft whenever radar observation reveals a situation which, in your judgement, is likely to affect the safety of the aircraft.

b. Paragraph 1546 - Altitude Deviation Information. "If you observe an automatic altitude report showing continuous deviation of 300 feet or more from the assigned altitude of an aircraft, issue altitude readout information to the pilot. Except during climb or descent, apply this procedure to aircraft whose automatic readout has been verified.

The controller in this case stated that he saw the data block from Flight 514 show an indicated altitude of 2,000 [redacted] ted to contact the flight at 1109:54. Prior to tha[redacted] e, the controller stated that the data was in a precipitation return and was "difficult to see."

1.17.7 Handling of Other Flights at Dulles

The Safety Board reviewed the handling of other arriving IFR traffic at Dulles on December 1, 1974.

About 1/2 hour before the accident, an air carrier flight approached Dulles from the northwest and was cleared for a VOR/DME approach to runway 12. The pilot of that flight said that because he was a considerable distance from the airport and was not given an altitude restriction to use before arriving on a published approach segment, he requested information regarding the minimum vectoring altitude at the flight's position. The controller gave the pilot the minimum vectoring

altitude and offered the flight a surveillance radar approach. The captain accepted the surveillance approach and landed without further incident.

About 6 hours after TWA 514's accident, a second air carrier aircraft approached Dulles from the southwest and at a point about 21 miles from Dulles, and asked the controller for the flight's position relative to the Round Hill intersection. The controller replied that he did not have Round Hill depicted on his radar. The captain later testified that he was familiar with the terrain around Dulles and did not descend until after he was on the inbound heading to runway 12 and inside 17.6 miles as indicated on his DME indicator.

1. 17.8 Unsafe-Condition Reporting and Investigating

In January 1974, an air carrier in the United States initiated a Flight Safety Awareness Program. The purpose of the program was to encourage the carrier's pilots to report to the company any incident, or any suggestion, that could have safety implications, so that required remedial action could be taken.

Under this program, an individual could make a report without identifying himself or his fellow crewmembers. The pilots were assured that the carrier would not take any punitive action as a result of information procured through this program. The carrier would not voluntarily divulge information secured in this program to any outside agency which would permit identification of any individual involved. The carrier undertook to protect vigorously individual anonymity unless this protection was waived by the individual involved.

In October 1974, the carrier received a report under this program. A crew reported that they were approaching Dulles and after passing Front Royal at 6,500 feet, they were issued a clearance to descend to 4,000 feet and instructed to contact Dulles approach control. The crew anticipated an ILS approach to runway 1R, but they were cleared for a VOR approach to runway 12. After the captain reviewed the chart for the latter approach, he descended to 1,800 feet, intercepted the 300° radial (120° inbound) to the Dulles VOR, and landed without incident.

After landing, the crew reviewed the approach and decided that they had descended to 1,800 feet about 25 nmi from the VOR and were at that altitude before they reached the Round Hill intersection.

The captain reported that he believed at the time he made the approach, that a clearance for an approach authorized him to descend immediately to the final approach fix altitude. He had looked at the profile of the approach, saw the 1,800 feet at the 6 nmi DME fix, and overlooked the minimum altitude for the approach segment from the Front Royal VOR to Round Hill.

The carrier investigated this incident and contact was made with FAA at the Dulles tower. The carrier's representative making this contact understood that in the future, a clearance for this approach would be issued when the flight was about 30 nmi from the airport. He also understood that future flights would be radar monitored unless the controllers had other duties and activities which would preclude that action. The VOR/DME approach was reviewed with several company pilots and in each case, the chart was interpreted properly by the pilots. As a result of this investigation, the carrier believed it was not necessary to make any recommendations to the FAA or to change the carrier's procedures. However, they did publish a notice to all flightcrews:

> "The extensive use of radar vectoring, in terminal areas, had led to some misunderstanding on the part of flightcrews. Recent. . . events prompt these reminders:
>
> 1. The words 'cleared for approach' generally put the flightcrew on their own.
>
> 2. Don't start down to final approach fix altitude without reviewing other altitude minimums.
>
> 3. Inbound minimum altitudes to outer fixes are on the Jepp plates.
>
> 4. Flightcrews should thoroughly familiarize themselves with the altitude information shown on approach and/or area charts for the terminals into which they are operating. This includes minimum segment altitude (MSA) information."

Except for regulatory reporting requirements that aircrews notify the nearest ground station when an irregularity is noted in a navigational facility or ground facility, the FAA had no formal system for pilots or controllers to report unsafe conditions involving instrument flight procedures in the terminal area. Witnesses testified that

reports of unsafe conditions were not furnished to the FAA or to the carriers because the individuals were afraid of punitive action. These witnesses recommended that the FAA establish a system to enable pilots and controllers to report operational hazards with immunity provided for the person making the report. 12/

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

There was no evidence that any malfunction of the aircraft, aircraft systems, powerplants, or the flight control system contributed to the cause of the accident. The aircraft had been maintained in accordance with the FAA-approved procedures and was certificated properly.

The flightcrew and the involved air traffic controller were qualified to perform their assigned duties. There was no evidence that any medical factors played a part in this accident.

The flightcrew was provided with the necessary dispatch data and weather information before their departure from Indianapolis and these data were updated in Columbus. The flight was routine until the crew was advised by ATC that National Airport was not accepting landing traffic and that they would either have to hold until they could land at National or they could divert to Dulles. After consultation with the dispatcher, the captain elected to proceed to Dulles and the dispatch release was amended accordingly. During their conversations with ATC the crew was advised to expect an instrument approach to runway 12 at Dulles.

12/ The FAA issued Advisory Circular 0046, "Aviation Safety Reporting Program" on May 9, 1975. The Advisory Circular states that the program will serve as a basis for an evaluation study of the National Air Transportation System by providing reporting procedures and by inviting pilots, controllers and other users of the airspace system or any other person to report discrepancies or deficiencies noted in the system to the FAA. The program will initially apply to that part of the system involving the safety of aircraft operations, including departure, en route, approach and landing operations and procedures; air traffic control procedures, pilot/controller communications; the aircraft movement area of the airport and near midair collisions.

The crew reviewed the approach chart for the VOR/DME approach to runway 12 shortly after they confirmed their plan to divert. Their'next clearance was to " . . . Dulles via direct to Front Royal, direct Dulles. " At 1043, the captain's radio receiver was tuned to the Dulles ATIS and the ATIS information was recorded three times on the CVR. After a discussion of the weather, the control of the aircraft was given to the first officer. The flightcrew then discussed the different transition routes that they might use to get to Dulles. The crew referred to the approach chart and the area chart in planning their approach.

At 1051, ATC instructed the pilot to fly a heading of 090° to intercept the 300° radial of the Armel VOR and to cross 25 miles northwest of Armel at 8,000 feet and to maintain that altitude. This clearance was followed by a conversation between the pilots which again indicated that they were referring to the approach chart for a VOR/DME approach to runway 12 at Dulles.

At 1055, the landing preliminary checklist was initiated and completed at about 1056. About 1 minute later, the crew again reviewed the approach chart and referred to the Round Hill intersection and the 6 nmi DME fix. The altitude at the DME fix was announced properly as 1,800 feet. They then discussed the runway and the runway lighting including the VASI.

About 1101, Flight 514 was cleared to descend to and maintain 7,000 feet and to contact Dulles approach control. They were then advised by approach control to expect a VOR/DME approach to runway 12. They were also given the new altimeter setting of 29.70. The flight reported level at 7,000 feet at 1104 and 5 seconds later was cleared for a VOR/DME approach to runway 12. The captain announced that 1,800 (feet) was "the bottom" or, the altitude to which the flight was to descend. The first officer initiated an immediate descent. The crew again reviewed the approach chart.

At 1106, there was 'mention of a discrepancy between the two VOR indicators in the cockpit. The investigation indicated that the first officer's VOR receiver was tuned to the Front Royal VOR. The tuning of the captain's VOR receiver could not be determined, but the Board believes that it was tuned to the Armel VOR. Apparently the discrepancy was of no navigational significance since the aircraft was following the prescribed inbound track.

Shortly after 1107, the captain first expressed doubt concerning the action he should be taking and the minimum altitude to which he was descending. He noted that the minimum altitude to Round Hill (from Front Royal) was 3,400 feet. He discussed the chart with the crew and again decided that the flight was authorized to descend to 1,800 feet, the intermediate approach segment altitude. Seconds later the altitude alert system warning sounded indicating that the flight was approaching 1,800 feet and the captain stated that he had seen the ground "a minute ago." The first officer indicated that he had seen the ground also. Apparently they had only fleeting glimpses of the ground and did not derive any relative altitude information from what they saw. The first officer mentioned the power and the captain noted that they had a high sink rate. Then the captain said that the ground should be visible in just a minute. At 1108:57, the altitude alert sounded again. This sound may have been caused by a pilot positioning the altitude alert control to cancel further warnings. This is a normal TWA procedure once cleared to descend below the initial approach altitude. In this particular case the aircraft had arrived at the altitude the captain had determined to be the initial approach altitude, and clearance for the approach had been received. Subsequent altitude information was provided by the barometric altimeter and height-above-the-ground information was provided by the radio altimeter. There was some conversation regarding a downdraft and the radio altimeter warning horn sounded then stopped. The captain said at 1109:20, "Get some power on." The radio altimeter warning horn sounded again and at 1109:22, the sound of impact was recorded.

The first radio altimeter warning was activated by the aircraft coming within 500 feet of the terrain, the designated altitude where the radio altimeter will begin to indicate the altitude. The second radio altimeter warning sounded as the aircraft approached 100 feet above the terrain. TWA's procedure, when [illegible] approach, requires that the radio altimeter be set to provide a warning at 100 feet above the terrain. The first warning came 7 seconds before impact and the second warning about 1 second before impact, after the captain ordered the first officer to "get some power on." The crew should have realized that the aircraft should not have been that close to the ground at that point in the approach. However., their reaction to the warning probably could not have been faster than it was.

A review of the flight data recorder graph indicates that at the times when the recorded altitude can be cross-checked against other altitude data sources within the aircraft, the aircraft was near

the altitudes recorded. This indicates that the altimeter system was operating properly. The elevation at impact was about 1,675 feet. The altimeter was set at 29.70, the last altimeter setting given to the crew.

Two reasons why the aircraft might have been below its target altitude of 1,800 feet are evident. First, the aircraft was entering ground effect as it got closer to the ground and this may have caused an error in the pitot static system which caused the altimeter to indicate an altitude higher than the actual aircraft altitude. Second, it is possible that the high winds blowing over the rough terrain in the accident area may have caused a pressure change which affected the altimeter indication. However, the crew's evident concern about the altitude was indicated by the captain's order regarding the power and the first officer's comments about the downdraft when the aircraft went below the target altitude. Based on the evidence available, the Safety Board concludes that there was no significant error in the altitude information presented to the pilots by their instruments.

The crew's comments regarding the altitude and the power indicate that the first officer was not flying the aircraft at the target altitude of 1,800 feet. The Board examined the flight data recorder trace and found that while there was evidence of moderate turbulence, it was probably not of sufficient magnitude to prevent the first officer from maintaining the desired altitude. There was also no evidence that there was any problem within the aircraft that would have prevented the pilot from staying at 1,800 feet. Therefore, the Board concludes that the deviation below the target altitude was probably a result of the combination of the first officer's flying technique and the turbulence.

From the above, it is clear that this was an operational accident and that the crew knowingly descended to approximately 1.800 feet after being cleared for the approach. The basic questions requiring resolution are *(1)* why did the crew knowingly descend to 1,800 feet in an area where the terrain obstacles extended almost up to that altitude; and (2) why did the approach clearance not include an altitude restriction under the circumstances of this case.

Our review of the record supports the conclusion that the captain believed that when he approached the airport in a radar environment for a nonprecision approach he would not be "cleared for the approach" without an altitude restriction unless he could make

an unrestricted descent to the final approach fix altitude. In attempting to determine the reasons for the captain's belief in this regard, a brief description of the development of the usage of radar and its impact on pilot responsibilities is required.

Before the advent of radar, the pilot alone was responsible at all times for knowing the position of his aircraft with regard to the terrain. The pilot kept the controller informed of the aircraft's position and of the pilot's intentions. Typically, during an instrument approach, numerous radio calls were made as the pilot reported his position, altitude, and intentions.

With the advent of radar, the controller was able to observe the aircraft in two dimensions -- range and azimuth -- and was able to vector flights to arrive over geographical positions. By issuing headings the controller could prevent the tracks of known IFR traffic from converging if the danger of a collision existed. However, it was still necessary for the pilot to advise the controller of the flight's altitude. As experience was gained in the use of radar, a new language was introduced to pilots and controllers and new procedures were instituted to provide for the control of IFR traffic in the terminal area. The controller played a greater role in maneuvering the aircraft by providing headings and altitudes to pilots. As traffic became heavier and aircraft became faster, the controller played a greater role in the movement of the traffic in an effort to provide an uninterrupted flow of traffic to the runway. In an effort to improve his ability to move traffic, he was assigned blocks of airspace and minimum vector altitude information, which was not known to the pilot, to be used in moving traffic off the published approach routes.

The advent of the ARTS III radar system and similar systems now provides the controller with information on properly equipped aircraft in three dimensions -- aircraft altitude, range, and azimuth, as well as ground speed.

The volume of terminal air traffic has grown to the point that the FAA has frequently found it necessary to divert flights away from published instrument approach routes in order to improve the flow of traffic. In addition, it has become commonplace to clear pilots to descend below the altitudes published on the terminal area charts and instrument approach charts. Pilots in turn have tended to become more and more dependent on the air traffic controller to control their flight's altitudes, headings, and airspeeds. Concurrent with this

increasing dependency has been (1) a lessened ability to know the type of terrain over which the aircraft is flying, and (2) in some cases, limited information regarding the position of the aircraft relative to the airport and obstacles on the ground.

Controllers are trained in the air traffic control procedures and the terminology associated with IFR navigation. Pilots, on the other hand, are trained in the operation of the aircraft, air traffic control procedures, and terminology essential to safe operation of aircraft in the airspace system. However, as this case demonstrates, imprecise terminology, unresolved differences of opinion, and unnoticed changes in the definitions and procedures can result in an inadequate understanding on the part of one or both of the participants in the air traffic control situation.

At the Safety Board's public hearing, FAA witnesses testified that they were not aware that there was any potential misunderstanding on the part of pilots as to the meaning of the term "cleared for the approach," in a case where a nonprecision approach is made, particularly when the clearance was issued a long distance from the airport. The evidence, however, does not support this conclusion, since, for several years prior to this accident, various organizations had perceived a problem in the use of the term "cleared for the approach."

Ironically, approximately 6 weeks before the TWA accident an air carrier flight, after being "cleared for the approach," descended to 1,800 feet while outside of the Round Hill intersection during a VOR/DME approach to runway 12 at Dulles. The carrier involved had implemented an anonymous safety awareness program, was in fact made aware of the occurrence, and subsequently issued a notice to its flightcrews to preclude the recurrence of a near-fatal misinterpretation of an approach clearance. The Board is encouraged that such safety awareness programs have been initiated. It is through such conscientious safety management that the expected high level of safety in air carrier operations can be obtained. In retrospect, the Board finds it most unfortunate that an incident of this nature was not, at the time of its occurrence, subject to uninhibited reporting and subsequent investigation which might have resulted in broad and timely dissemination of the safety message issued by the carrier to its own flightcrews.

Both the USAF and TWA had pointed out to the FAA that the terminology "cleared for the approach" could be misinterpreted and

that pilots might understand that they could descend unrestricted unless a specific altitude restriction was included in the clearance. With respect to the crew of TWA 514, the conversation in the cockpit as reflected in the CVR transcript permits no other conclusions than that they assumed the clearance received permitted an unrestricted descent to 1,800 feet. Subquestions requiring discussion are whether other available information should have indicated to the crew the unsafe nature of such a descent and why the crew was not alerted at least to the point of making inquiry to ATC.

Considering the number of times the captain examined this chart after being informed that he was to divert to Dulles. he should have realized that the minimum altitude of 1,800 feet might not be a safe altitude. Although the captain did not know his exact position relative to the terrain when he received the approach clearance, the Board believes that with his VOR tuned to Armel'and with the information provided by that navigational aid, he should have been able to read his DME range from Armel. At the time he received the clearance, he was about 44 nmi from Armel on the 300° radial inbound to the station. By reference to the approach chart, he should also have been able to identify the high obstacles between that position and the Round Hill intersection. With that information, he should have been able to determine that 1,800 feet was not an adequate altitude to provide terrain clearance of 2,000 feet in this designated mountainous area. If he did not realize that he was over a designated mountainous area, he should have applied terrain clearance of 1,000 feet as prescribed for nonmountainous areas. He did notice the 3,400 feet associated with the course between Front Royal and Round Hill. That should have suggested that he should reexamine his decision regarding the descent to 1,800 feet. If he had questioned the controller regarding the minimum altitude in the area of his aircraft, he should. have received information that would have alerted him that he could not descend to 1,800 feet until after he passed Round Hill.

The information available to the pilot, including the approach chart, should have alerted the crew that an unrestricted descent would be unsafe. It does appear to the Board that there was a deficiency in the chart. This particular approach chart depicted the profile view from the final approach fix to the airport. It did not depict the intermediate fix, Round Hill, with its associated minimum altitudes. This information was available from the plan view of the chart, but it appears that the crew gave their primary attention to the profile. If this was the

case, it may have led the crew to discount the other information available on the chart and to continue their descent on the assumption that it was .permissible by reason of the clearance they received.

The second major question deserving consideration is the role of the ATC system in this accident, specifically why TWA 514 was not given an altitude restriction in its approach clearance. The testimony of all FAA witnesses, including the controller, was consistent in stating that Flight 514 was not a "radar arrival;" that because of this fact the controller was not required to implement the provisions of paragraph 1360 of the FAA Handbook 7110.8C; and that they considered TWA 514, after intercepting the 300° radial of Armel, as proceeding on its own navigation and as being responsible for its own obstacle clearance.

The FAA witnesses stated that Flight 514 was not a radar arrival because it had not been vectored to the final approach course. They did not consider the vector of Flight 514 by the Washington Center to intercept the 300° radial as being a vector to the final approach course, even though the VOR/DME approach procedure utilizes the 300° radial inbound from Round Hill. Particular emphasis was made by FAA that the vector to the 300° radial occurred when the flight was approximately 80 miles from the airport and that it was vectored by the center on to an en route course. Operational advantage'was indicated by the controllers as the reason for the vector to the 300° radial rather than to an initial approach fix on the approach procedure.

The counterposition is that Flight 514 was operating in a radar environment, was receiving at least one type of radar service, and was on a course which would lead directly to the Round Hill intermediate approach fix. Furthermore it had been advised that the reason for the vector to the 300° radial was for a VOR/DME approach for runway 12. Consequently, it should have received services, including altitude restrictions, as set forth in Paragraph 1360 of 7110.8C.

In evaluating these facts, the one issue present is whether the handling of Flight 514 required the provision of an altitude restriction. FAA witnesses agreed that, had Flight 514 been classified as a radar arrival within the meaning of the handbook, the flight would have been given an altitude restriction until it reached Round Hill. In resolving this issue, the Board has been troubled by the fact that ATC procedures are almost always dependent upon the usage of certain specified phrases and terms, many of which have no established definitions and mean different things to controllers and pilots.

The term "radar control" is an example. The pilot witnesses believed that, when they were operating in a traffic control radar environment, they were being controlled by radar. The controller group was aware that this was not always the case, but the **FAA** apparently did not perceive the difference of understanding, and the efforts made by the **FAA** to clarify when an aircraft was or was not radar controlled did not eliminate the confusion.

The Board concludes that based on the criteria in 7110.8C the system allowed for the classification and handling of Flight 514 as a nonradar arrival. The Board, however, believes that the flight should have been classified and handled as a "radar arrival."

This, however, does not dispose of the issue of whether the **ATC** system should have provided for a redundancy that would have prevented or consequently identified and corrected a deviation of an aircraft from a clearance which was not followed as the controller expected it to be.

The system should clearly require controllers to give the pilots specific information regarding their positions relative to the approach fix and a minimum altitude to which the flight could descend before arriving at that fix. Pilots should not be faced with the necessity of choosing from among several courses of action to comply with a clearance.

The Board believes that the clearance, under these circumstances, should have included an altitude restriction until the aircraft had reached a segment of the published approach procedure or the issuance of the approach clearance should have been deferred until the flight reached such segment. Therefore, the Safety Board concludes that the clearance was inadequate and its issuance and acceptance was the result of a misunderstanding between the pilot and the controller.

The Board believes that there is a general lack of understanding between pilots and controllers in their interpretations of air traffic control procedures. There is also a lack of understanding about the meaning of some words and phrases used by both the controller and pilot in the handling of IFR traffic in the terminal area.

In this case, there was no definition of the term "radar arrival" or "final approach course," nor, as indicated earlier, did

there seem to be common understanding between pilots and controllers as to the meaning of "radar control."

Therefore, the Safety Board concludes that it is essential that a lexicon of air traffic control words and phrases be developed and made available to all controllers and pilots who operate within the National Airspace System. Additionally, there should be one book of procedures for use by both pilots and controllers so that each will understand what to expect of the other in all air traffic control situations. This manual must be used in the training of all pilots and controllers.

The need for such a lexicon and procedures manual is evident from the circumstances of this accident. Flight 514 was vectored to intercept the 300° radial of Armel, the reciprocal course of which coincides with the course for the intermediate and final approach segments of the published instrument approach procedure. The vector was given when the flight was more than 80 miles from the airport and at a point where the 300° radial of Armel was not a part of the published instrument approach procedure. While proceeding inbound on the 300° radial of Armel, the flight would not have reached a segment of the published approach procedure until it arrived at Round Hill.

However, there was some testimony contending that Flight 514 was final approach course when the flight intercepted and was inbound on the 300° radial, and accordingly it was permissible for the pilot to descend to the minimum altitude of 1,800 feet prescribed for crossing the final approach fix of the VOR/DME instrument approach procedure. Qualified instrument pilots and air traffic controllers should know and understand beyond equivocation that the coincidence of the inbound course being an extension of the final instrument approach course does not permit descent to altitudes lower than those published for that air space segment unless specifically authorized by ATC.

A clear, precise definition of final approach course and final instrument approach course should preclude future misunderstandings. Neither of these terms was defined in the AIM at the time of this accident. However, the AIM glossary did contain a definition of "Final Approach - IFR" wherein the final instrument approach course is shown to be confined to the final approach segment of the instrument approach procedure and that it begins at the final approach fix.

The issue of when flights are or are not radar arrivals must also be resolved. It is difficult for a pilot who is operating in a radar environment and communicating with a radar controller to realize that, under some circumstances, his flight is, without formal notification, considered to be a nonradar arrival and subject to a different ATC procedure. Specifically, he may not realize that the responsibility for obstacle clearance shifts from the controller to the pilot under some circumstances without the pilot being specifically informed. While the Safety Board recognizes that the FAA is concerned about radio frequency congestion in busy terminal areas, any control procedure which effects a change in the responsibility for providing terrain clearance must be communicated and clearly understood by both pilots and controllers. If radar service is terminated, the crew should be so informed. Then they will be prepared to resume the responsibility for navigation which was vested in the controller while the flight was classified and handled as a radar arrival.

The ARTS III system provides, as previously noted, information capability not formerly available to controllers, The Safety Board has previously recommended that the altitude information capability of this equipment be used as an additional safety factor in the terminal area to help prevent controlled flight into the ground. In the case of Flight 514, the controller testified that he could not clearly see the target associated with the flight until he noted that the altitude was 2,000 feet. Immediately thereafter, he attempted to contact the flight to verify its altitude, but impact had already occurred. The FAA has taken action to install an altitude deviation warning in the ARTS III system which should be beneficial in alerting controllers to altitude deviations in the terminal area.

Although the record of this investigation shows that the weather was a factor in the occurrence of the accident, it was not of such nature as to have made the accident inevitable. The icing encountered by the aircraft in the descent was apparently eliminated by the anti-icing systems. The intensity of the turbulence may have been sufficient to make the control of the aircraft somewhat difficult. The excursions of the traces on the flight data recorder are indicative of light to moderate turbulence. The possible effect of the high winds on the indicated altitude has been discussed previously. While the evidence does not indicate whether the crew was aware of the SIGMETS issued for the Washington area, there is no evidence to indicate that knowledge of the SIGMETS would have caused the crew to operate any differently than they did.

The CVR indicates that the crew did encounter considerable turbulence during the descent. However, the record also indicates that they were able to read the altimeters well enough to know that they had descended below their target altitude of 1,800 feet. The Safety Board believes that the effect of turbulence was not critical but could not determine positively why the descent was not arrested at 1,800 feet.

In summary, this accident resulted from a combination of conditions which included a lack of understanding between the controller and the pilot as to which air traffic control criteria were being applied to the flight while it was operating in instrument meteorological conditions in the terminal area. Neither the pilot nor the controller understood what the other was thinking or planning when the approach clearance was issued. The captain did not react correctly to his own doubt about the line of action he had selected because he did not contact the controller for clarification. The action of the other air carrier pilot who questioned the clearance he received about 1/2 hour before the accident is the kind of reaction that should be expected of a pilot suddenly confronted with uncertainty about the altitude at which he should operate his aircraft.

The Board again stresses that it is incumbent upon air carrier management to assure the highest possible degree of safety through an assertive exercise of its operational control responsibility. This management function must assure that flightcrews are provided with all information essential to the safe conduct of flight operations. Furthermore, the air carrier must assure that its flightcrews are indoctrinated in the operational control precept and that during flight the final and absolute responsibility for the safe conduct of the flight rests solely with the captain as pilot-in-command regardless of mitigating influences which may appear to dilute or derogate this authority.

Whereas the air carriers and the pilots are expected to perform their services with the highest degree of care and safety, this same high level of performance must be expected from the management of the air traffic control system and the controller. The instant case provides a classic and tragic example of a pilot and controller who did not fully comprehend the seriousness of the issuance and acceptance of a clearance which was not precise or definitive. The pilot should question a clearance which leaves any doubt as to what

course of action should be followed. 13/ The Board also believes that it is incumbent upon the controller to ascertain beyond a doubt that the terminology of a clearance conveys the intent to the pilot, and to question the pilot if there is any doubt that he has understood it and is initiating actions compatible with the intent of the clearance.

Since, as FAA witnesses testified, the ATC system is a cooperative system, it is imperative that pilots and controllers fully understand the intent and execution of clearances to the extent that one is able to back up the other whenever there is doubt that the clearance or the execution of it may be unsafe or is likely to lead to an unsafe situation.

2.2 Conclusions

a, Findings

1. The flight operated without reported difficulty and in a routine manner until the diversion to Dulles Airport from Washington National Airport was approved.

2. The crew of Flight 514 reviewed the approach chart for the VOR/DME approach to runway 12 at Dulles several times before beginning the approach.

3. The Washington Air Route Traffic Control Center controller vectored the flight to intercept the 300° radial of the Armel VOR at a point about 80 nmi from the VOR. This portion of the radial was not part of the published instrument approach.

4. The crew of Flight 514 intercepted the radial and tracked inbound on it, and control of the flight was passed to the Dulles approach controller.

13/ Subsequent to the accident the FAA amended 14 CFR 91.75(a) to reemphasize that "If a pilot is uncertain of the meaning of an ATC clearance, he shall immediately request clarification from ATC."

5. The Dulles approach controller cleared the flight for a VOR/DME approach to runway 12 when the aircraft was about 44 nmi from the airport. The clearance contained no altitude restrictions.

6. The captain assumed that the flight could descend to 1,800 feet, immediately. The first officer, who was flying the aircraft, initiated an immediate descent to 1,800 feet.

7. The flight encountered icing and turbulence during the descent. Neither of these conditions should have appreciably endangered or restricted the control of the aircraft, but contributed in the apparent inability of the crew to arrest the descent at 1,800 feet,

8. The first officer allowed the aircraft to descend below the target altitude of 1,800 feet and did not take sufficient corrective action to regain and maintain that altitude.

9. The first officer's altimeter was set properly.

10. It is possible that wind velocity over the hilly terrain may have induced an altimeter error which could have caused the instrument to indicate that the aircraft was higher than its actual altitude. However, the crew's last comments regarding altitude indicated that they knew they were below 1,800 feet.

11. The altitude alerting system and the radio altimeter aural warnings sounded at appropriate altitudes to indicate to the pilots that the aircraft was below 1,800 feet and that the aircraft was within 500 feet and 100 feet of the ground. These latter warnings occurred 7 seconds and 1 second, respectively, before impact.

12. The flightcrew apparently did not have sufficient time to avoid the accident after these warnings.

13. The approach clearance was given to the flight without altitude restrictions because the flight was not being handled as a radar arrival and because the controller expected the crew to conduct the approach as it was depicted on the approach chart.

14. Procedures contained in FAA's Terminal Air Traffic Control Handbook were not clear and resulted in the classification and handling of TWA 514 as a "nonradar" arrival. The terms "radar arrival" and "nonradar arrival" were not defined.

15. In view of the available ATC facilities and services and since the flight was receiving radar service in the form of radar monitoring while under the jurisdiction of a radar approach control facility, the procedure should have provided for giving altitude restrictions in an approach clearance for an aircraft operating on an unpublished route prior to its entering a segment of the published approach procedure.

16. The ATC system was deficient in that the procedures were not clear as to the services the controllers were to provide under the circumstances of this flight.

17. The flightcrew believed that the controller would not clear them for an approach until they were clear of all obstructions.

18. The depiction on the profile view of the approach charts neither indicated the position of Round Hill intersection nor did it contain all minimum altitudes associated with the approach procedure. This information was available on the plan view of the approach chart.

19. The captain noticed the minimum altitude associated with the approach segment from Front Royal to Round Hill but he decided that the flight could descend to 1,800 feet without regard for the 3,400-foot minimum altitude depicted on the chart because he was not on that segment.

20. The captain of Flight 514 did not question the controller after receiving the approach clearance, regarding the action the flightcrew was expected to take. Another crew that questioned a similar clearance received further instructions and information which resulted in their accepting a radar surveillance approach to Dulles.

21. Both military and civil aviation officials for several years had indicated concern regarding a lack of understanding on their part of what the Air Traffic Control procedures and terminology were intended to convey to the pilots. They were also concerned about the possibility of misunderstandings which could result in pilots descending prematurely.

22. The FAA was not responsive to the long standing, expressed needs and concerns of the users of the Air Traffic Control System with regard to pilot/controller responsibilities pursuant to the issuance of an approach clearance for a nonprecision approach. Furthermore, the FAA did not provide users of the Air Traffic Control System with sufficient information regarding the services provided by the system under specific conditions.

23. The FAA did not utilize the capability of the ARTS III system to insure terrain clearance for descending aircraft conducting nonprecision instrument approaches in instrument meteorological conditions.

24. The flightcrew of Flight 514 was not familiar with the terrain west and northwest of Dulles. However, they did have information regarding the elevation of obstacles west of Round Hill intersection depicted on the plan view of the approach procedure.

b. Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the crew's decision to descend to 1,800 feet before the aircraft had reached the approach segment where that minimum altitude applied. The crew's decision to descend was a result

of inadequacies and lack of clarity in the air traffic control procedures which led to a misunderstanding on the part of the pilots and of the controllers regarding each other's responsibilities during operations in terminal areas under instrument meteorological conditions. Nevertheless, the examination of the plan view of the approach chart should have disclosed to the captain that a minimum altitude of 1,800 feet was not a safe altitude.

Contributing factors were:

(1) The failure of the FAA to take timely action to resolve the confusion and misinterpretation of air traffic terminology although the Agency had been aware of the problem for several years;

(2) The issuance of the approach clearance when the flight was 44 miles from the airport on an unpublished route without clearly defined minimum altitudes; and

(3) Inadequate depiction of altitude restrictions on the profile view of the approach chart for the VOR/DME approach to runway 12 at Dulles International Airport.

3. RECOMMENDATIONS

As a result of the accident, the Safety Board submitted 14 recommendations to the Administrator of the Federal Aviation Administration. (See Appendix I.)

Subsequent to the accident, the FAA has taken several actions in an effort to prevent recurrence of this type of accident.

1. The FAA has directed that all air carrier aircraft be equipped with a ground proximity warning system by December 1975.

2. The FAA has revised the provisions of 14 CFR 91 with regard to pilot responsibilities and actions after receiving a clearance for a nonprecision approach.

3. The FAA has established an incident reporting system which is intended to identify unsafe operating conditions in brder that they can be corrected before an accident occurs.

4. The FAA has changed its air traffic control procedures to provide for the issuance of altitude restrictions during nonprecision instrument approaches.

5. The FAA is installing a modification to the ARTS III system that will alert air traffic controllers when aircraft deviate from predetermined altitudes while operating in the terminal area.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

REED, Chairman, THAYER and BURGESS, Members, concurred in the adoption of this report. (BURGESS, Member, concurring statement on page 43.)

McADAMS and HALEY, Members, dissented. (See page 45.)

/s/ FRANCIS H. McADAMS
Member

/s/ WILLIAM R. HALEY
Member

November 26, 1975

Member Burgess Concurring:

While I fully concur with the majority, I wish to explain more fully my position regarding the primary difference of opinion as expressed by the dissenting members.

In my judgment the reason why **TWA** flight 514 was not a radar arrival is predicated on the following:

Generally, the "final approach course" is a straight-line extension of the centerline of the runway. Although it may "coincide" with a radial of a VOR located on the runway, a clear distinction must be macle between a vector to the final approach course and a vector to such a radial.

Although both the center approach controllers are vectoring aircraft to centerline extensions of the runway, they are doing so for different phases of the aircraft's operation, for different purposes, generally at different altitudes.

Once an aircraft is vectored to the "final approach course," (the controller must specifically use these words to describe the purpose of the vector) it becomes a radar arrival and remains such as long as it stays on the final approach course and until radar service **is** terminated. During this time paragraph 1350 of 7110.8C would be applicable. **If** the aircraft is taken off the final approach course (for such reasons as traffic or a go-around) the aircraft would cease being a radar arrival unless and until given another vector to the final approach course.

Flight 514 was cleared to the 300° radial even though 80 miles out, not the "final approach course." Tberzfore, by definition, Flight 514 was not a radar arrival.

The foregoing finding does not absolve the ATC system since by definition Flight 514 was not a radar arrival. During the course *of* the investigation it became clear that there was an omission in the ATC handbook concerning exactly when radar service is terminated. It was unfortunate that the handbook did not clearly

require the controller to provide altitude restrictions when ..an aircraft is operating over an unpublished route for which there is no minimum enroute altitude prescribed, while the flight was beiog handled as a non-radar arrival.

The FAA has since limited such clearances and some action is being taken to correct the deficiencies cited above.

Isabel A. Burgess

Isabel A. Burgess, Member

December 2, 1975

McADAMS and HALEY, Members, dissenting:

We do not agree with the probable cause as stated by the majority.

In our opinion, the probable cause was the failure of the controller to issue altitude restrictions in accordance with the Terminal Air Traffic paragraph 1360(c), and the failure of the pilot to adhere to the minimum sector altitude as depicted on the approach plate or to request clarification of the clearance. As a result, the pilot prematurely descended to 1,800 feet.

The flight was a radar arrival and, therefore, entitled to altitude protection and terrain clearance. If the controller, as required by the then-existing procedures for radar arrivals, had issued altitude restrictions with the approach clearance or had deferred the clearance, the accident probably would not have occurred. On the other hand, if the pilot had either maintained the minimum sector altitude of 3,300 feet as depicted on the approach plate, or requested clarification of the clearance, there would not have been an accident.

The majority states (p. 32):

> "The Board concludes that based on the criteria in 7110.8C the system allowed for the classification and handling of as a nonradar arrival. The Board, however, believes that the flight should have been classified and handled as a 'radar arrival.'"

This statement cannot be reconciled with the probable cause as stated by the majority. If the majority believes that under all the circumstances the flight should have been classified and handled as a radar arrival, then the flight was in fact a radar arrival and the probable cause should so state, It is not possible to determine from the majority opinion whether Flight 514 was a radar or a nonradar arrival.

The Board attributes the failure of the controller to handle the flight as a radar arrival to be a terminology difficulty between pilots and controllers, There was no terminology difficulty. The plain fact of the matter is that the controller simply did not treat the flight as a radar arrival as he should have. All the criteria of paragraph 1360 for a radar arrival were present. Neither the pilot nor the controller had terminology difficulties. The pilot assumed he was a radar arrival and would be given altitude restrictions if necessary. Not having received such restrictions, he initiated a descent to 1,800 feet.

Additionally, the Board concludes on the subject of radar arrival (p. 32):

> "...under these circumstances, [the clearance] should have included an altitude restriction until the aircraft had reached a segment of the published approach procedure or the issuance of the approach clearance should have been deferred until the flight reached such segment. Therefore, the Safety Board concludes that the clearance was inadequate and its issuance and acceptance was the result of a misunderstanding between the pilot and the controller."

Such a conclusion can again only mean that the flight was in fact a radar arrival since altitude restrictions are issued only in accordance with paragraph 1360(c), the provisions of which pertain solely to radar arrivals. Therefore, based upon the foregoing, it would appear the majority believes the flight was a radar arrival but refuses to make an unambiguous finding to that effect.

The Board further states (p. 32) that "there is a general lack of understanding between pilots and controllers in their interpretations of air traffic control procedures." We find that there was no misunderstanding in this instance on the part of the pilot. As previously stated, he undoubtedly descended to 1,800 feet after receiving an approach clearance because he was not issued an altitude restriction. If the controller was confused with regard to the application of paragraph 1360, he should have asked for clarification from his supervisor. But there should have been no reason for confusion insofar as terminology is concerned. One of the most important functions of an air traffic controller is to possess the highest degree of knowledge in procedures and terminology and to apply it with the greatest diligence and care.

In any event, we can only conclude that, in not handling the flight as a radar arrival, the Dulles controller did not properly apply the provisions of the controller's handbook. Furthermore, it appears from the testimony of other controllers at the hearing that they would have handled the flight in a similar manner, which may in turn indicate a lack of understanding or comprehension by controllers generally regarding the application of paragraph 1360.

The majority states (p. 33):

> "... there was some testimony contending that Flight 514 was on its final approach course when the flight intercepted and was inbound on the 300° radial, and accordingly it was permissible

for the pilot to descend to the minimum altitude of 1,800 feet prescribed for crossing the final approach fix of the VOR/DME instrument approach procedure."

There was not merely "some testimony"; indeed, as hereinafter pointed out, there was considerable testimony and evidence from controllers, as well as pilots, to support the conclusion that the flight was on the final approach course and was a radar arrival.

The majority states (p. 33):

"...Qualified instrument pilots and air traffic controllers should know and understand beyond equivocation that the coincidence of the inbound course being an extension of the final instrument approach course does not permit descent to altitudes lower than those published for that air space segment unless specifically authorized by ATC."

The foregoing seems to conclude that a final approach course is the same as a final instrument approach course. This is an invalid conclusion. The phrase "final instrument approach course" is included in the definition of "final approach-IFR" as set forth in the Airman's Information Manual. From this usage it can be inferred that the final instrument approach course is that segment of the approach which begins at the final approach fix and extends to the runway. A final approach course, on the other hand, is a straight line extension of the localizer or radial and has no geographical or mileage limitations. The only limitation is the usable capability of the facility. 1/

It is true that at the time of the accident there was no formal definition of final approach course; however, from the testimony of the ATC personnel it is clear that they understood the meaning of the term and were aware that there were no mileage or geographical limitations. When TWA 514 intercepted the 300° radial 84 miles from the facility, the radial

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1/ "Q. And when you say it was on there as a final approach course, what are the limits, as you understand it, tnat are depicted for that approach?

"A. [FAA witness, Dulles Supervisory ATC Specialist] Well, there's none depicted on the chart, but there are usable limits to any radial. The controller knows that he can use them under certain conditions.

"Q. And I understand from that that you're talking about the usable range of the VOR facility?

"A. Yes, sir." (Tr. 1153)

was the approved final approach course for runway 12, and the aircraft was then within the usable limits of the facility. 2/

In any event, at the time Flight 514 was cleared for the approach at 1104, it was 44 miles from the facility, and certainly at this point it was on the final approach course and as a radar arrival should have been given altitude restrictions by the controller.

The testimony with respect to the meaning of a final approach course is now supported by the new definition which has been issued since the accident. Final approach course has now been defined as "a straight line extension of a localizer, a final approach radial/bearing, or a runway centerline." 3/ This makes it crystal clear that the final approach course was at the time of the accident, as evidence shows, the 300° radial which was a straight line extension of the runway centerline. The controllers by their own testimony understood this, and it was the only reason the Washington center controller, with the coordinated approval of Dulles approach control, vectored the flight to the 300° radial so as to put the flight on the final approach course.

Notwithstanding the contrary conclusion reached by the FAA witnesses, in our opinion TWA 514 was a radar arrival for the following reasons:

1. Continuous radar services had been provided from the time of takeoff from Columbus, Ohio, until the accident.

2. A vector to the 300° radial was issued by the center for a VOR/DME approach to runway 12 at Dulles and the pilot was so advised.

2/ "Q. Are you aware of the distance from Armel that the 300° radial was intercepted by Trans World 514 on that heading?

"A. [FAA witness, Dulles Supervisory ATC Specialist] Yes, I am.

"Q. Was it within the service volume of the facility, sir?

"A. It was, considering that he was on a radar vector or being radar monitored, I mean." (Tr. 1228)

3/ Airman's Information Manual. Part I, November 1975, page 1-3; Terminal Air Traffic Control Handbook, 7110.8D, paragraph 23.

3. The vector was coordinated by the center controller at the request and with the approval of Dulles approach control. 4/ 5/

4/ "Q. Now, based upon those transcribed conversations between Dulles Approach Control and Washington Center, does it not appear that Dulles Approach Control was approving the vector for TWA 514 to intercept the 300 degree radial off of Armel and the altitude of 7,000 that he was to descend to?

"A. [FAA witness, Dulles Supervisory ATC Specialist] Yes, it does." (Tr. 1257)

5/ "Q. If a vector to the final approach course, using your definition of final approach course, was issued by a center controller would the approach controller have to apply Paragraph 1360?

"A. [FAA witness, Dulles Arrival Controller] I answered that before.

"Q. Could you refresh me with your answer?

"A. My answer was it depends on what conversation took place between the center controller and the terminal controller. The center controllers normally do not vector to the final approach course in terminal air space.

"Q. If they did and agreed to do that, the center controller would provide the vector to the final approach course within terminal air space, using your definition of final approach course, which is 40 miles in this case, would the approach controller have to apply 1360?

"A. If I told the center'controller to vector that aircraft to the final approach course and that is what he did, most certainly I would have to apply the other three items of 1360." (Tr. 1201)

4. The center controller was acting as the agent for the approach controller in that vector and the descent clearance. 6/ 7/ 8/

6/ "Q. So that, sir, the information being given to TWA-514 prior to 1600 with respect to descent to 7,000 is really your clearance and not the center's clearance, is that correct, sir?

"A. [FAA witness, Dulles Arrival Controller] In the sense that I approved it, if that is what you want to call it, the clearance, the actual word, was delivered by the center controller as I say, but I have control jurisdiction from eight to seven, and he has got to coordinate. He has to request from me what to do." (Tr. 1026)

7/ "Q. All right. Did the center initiate that clearance?

"A. [FAA witness, Dulles Arrival Controller] Yes: if I understand the word 'initiate,' yes.

"Q. With your approval?

"A. That is correct." (Tr. 1027)

8/ "Q. If the center assigns a heading or places an aircraft on a route to an airport from directions the center controller receives from the approach controller, is that a case where the center controller is then providing the vector?

"A. [FAA witness, Chief, ATC Operations Procedures Division] Well, let's see if I understand your question. Your proposition is that the approach controller has asked the center controller to vector the aircraft to a particular point or position, or what have you?

"Q. Yes, sir. Specifically, to vector the airplane to the final approach course.

"A. It is very conceivable that that could be done, and if that were the case, then I would view the center acting as an agent of the approach control facility." (Tr. 2375)

5. A coordinated radar handoff from the Washington center controller, to the Dulles arrival controller was accomplished.

6. Radar services were never terminated. 9/

7. The 300° radial is the approved final approach course for runway 12. 10/ 11/

9/ "Q. Was radar service to TWA 514 ever terminated while the aircraft was under your control?

"A. [FAA witness. Dulles Arrival Controller] No, sir. It was not.

"Q. Referring to 7110 8 C, sir, chapter 5, section 9, radar arrivals. We have explored that section pretty thoroughly.

The question I have now is to ask you: can a radar arrival, once he becomes a radar arrival in your area of control, can he ever later become a non-radar arrival assuming that your radar remains functioning?

"A. Yes. If you terminate radar." (Tr. 955)

10/ "Q. Okay. When you made the decision to use the VOR-DME approach to Runway 12 did you say that an aircraft coming from the west, they will be vectored to the 300 degree radial and then fly inbound, or did you just say, 'We'll use the VOR-DME approach to Runway 12'?

"A. [FAA witness, Dulles Supervisory ATC Specialist] I just said we'd be using the Runway 12 approach. I knew that the aircraft would be vectored to the 300 degree radial.

"Q. And how did you know that they would be vectored to the 300 degree radial?

"A. Well, that's the final approach course." (Tr. 1106-07)

11/ "Q. Well, prior to the implementation of the VOR-DME approach at Dulles, was there any training, or did you participate in any discussions concerning the conditions under which the 300 degree radial would be used?

"A. [FAA witness, Dulles Supervisory ATC Specialist] No, there was no training or discussion. There -- it was on the approach plate as the final approach course. And the people had the approach plates.

"Q. You're referring now to the NOS chart?

"A. Yes, sir." (Tr. 1153)

8. While there is no published definition of a final approach course, common usage over the years has extended that course outward with no mileage limitations as far as reasonable, depending on the usable reception of the facility. 12/

The majority, however, has taken an ambiguous position on the most critical issue in the case -- was TWA 514 a radar or a nonradar arrival?

Nevertheless, despite our conclusion that the flight was a radar arrival and therefore should have been provided altitude restrictions, the crew had at their disposal sufficient information which should have prompted them either to refrain from descending below the minimum sector altitude or, at the very least, to have requested clarification of the clearance. Although the profile on the approach plate did not fully and accurately depict the various minimum altitudes associated with the entire approach, it appears there was adequate information on the plan view of the plate to alert a prudent pilot of the hazards of descending to an altitude of 1,800 feet prior to reaching the Round Hill intersection.

The existing air traffic control system and today's aircraft are highly complex and sophisticated. Neither can operate independent of each other -- there must be a cooperative and coordinated effort on the part of both the pilots and the controllers if the system is to function efficiently and safely.

The real issue in this accident is not one of inadequacy of terminology or lack of understanding between controllers and pilots. Rather, it is a failure on the part of both the controllers and pilots to utilize the ATC system properly and to its maximum capability.

Member

Member

12/ "Q. . . . What is your definition of final approach course?

"A. [FAA witness, Chief, ATC Operations Procedures Division] Well, I suppose it would vary, depending on where the aircraft was told to intercept the final approach course. It would extend from that point in towards the runway.

"Q. Could the final approach course be 85 miles long?

"A. Conceivably. Surely." (Tr, 2379)

APPENDIX A

Investigation and Hearing

1. Investigation

At 1125 e.s.t. on December 1, 1974, the National Transportation Safety Board was notified of the accident by the FAA communications center in Washington, D. C.

An investigation team was dispatched immediately to the accident site near Berryville, Virginia. Working groups were established for operations, air traffic control, human factors, structures, systems, powerplants, weather, aircraft records, flight data and cockpit voice recorders.

The FAA, Trans World Airlines, Air Line Pilots Association, The Boeing Company, Professional Air Traffic Controllers Association, Pratt and Whitney, Federal Bureau of Investigation, Virginia State Police, Commonwealth of Virginia Medical Examiner's Office, and the Armed Forces Institute of Pathology participated in the investigation.

2. Hearing

A public hearing was held in Arlington, Virginia, from January 27, 1975, through February 21, 1975. Parties to the hearing included the FAA, Trans World Airlines, Air Line Pilots Association, Professional Air Traffic Controllers Association, Aircraft Owners and Filots Association, Aviation Consumer Action Project, and the National Weather Service. The United States Senate and the House of Representatives were represented.

Depositions were taken from an additional TWA/ALPA witness on March 22, 1975.

APPENDIX B

Airmen Information

Captain Richard I. Brock

Captain Richard I. Brock, 44, was hired by Trans World Airlines on December 5, 1955. He served as a flight engineer until March 1, 1967, when he qualified as first officer on the Convair 880. He qualified as first officer on the B-727 on June 19, 1969, and was upgraded to captain on the B-727 on June 23, 1971. He was also qualified as a rated first officer on the B-707.

Captain Brock had a total of 3,765 flight-hours as a captain or first officer and about 3,100 hours as a flight engineer on turbojet aircraft. He had flown about 1,557 hours as a B-727 captain and 1,342 hours as a B-727 first officer. He had flown about 372 hours since May 1974, all as a B-727 captain. He had been on vacation from November 1 until November 28.

Captain Brock completed B-727 requalification in February 1973. His last recurrent training was in March 1974, and his last line check was completed March 5, 1974. His latest proficiency check was completed on July 17, 1974. This check included two nonprecision approaches. Captain Brock's training contained no adverse comments or unsatisfactory checks. Captain Brock's most recent company physical examination was conducted October 10, 1974. His FAA first-class medical examination was completed September 13, 1974. The first-class certificate contained no limitations.

Captain Brock held Airline Transport Pilot Certificate No. 1595791 dated November 22, 1971. He had ratings for airplane multiengine land B-707/720/727. He had commercial privileges for airplane single engine land. Captain Brock also held Flight Engineer Certificate No. 1338598, dated March 2, 1966, with ratings for reciprocating engine powered and turbojet powered aircraft.

Captain Brock had viewed the Dulles Airport Qualification film in October 1973 and August 1974. He had flown into Washington National Airport twice in September, once in August, and once in July of 1974. He was observed by FAA Air Carrier Inspectors on March 9, 1973, and April 5, 1973. The first check included a VOR/DME approach. The comments made by the Inspectors stated that the crew coordination and proficiency were satisfactory.

APPENDIX B

First Officer Lenard W. Kresheck

First Officer (F/O) Lenard W. Kresheck, 40, was hired by Trans World Airlines on March 7, 1966. He had a total of 6,205 flight-hours of which 1,160 hours were flown in the B-727. He was qualified on the B-727 on March 30, 1973. Since May 1974, F/O Kresheck had flown 416 hours. This total included 104 hours as first officer in the B-707 and 311 hours in the B-727. F/O Kresheck had flown only the B-727 during October, November, and December.

F/O Kresheck completed an annual line check on January 31, 1974. His last proficiency check, completed March 22, 1974, included two nonprecision approaches. Recurrent training was accomplished in March 1974. This training also included two nonprecision approaches. F/O Kresheck's training records disclosed no adverse comments or unsatisfactory checks.

F/O Kresheck held Airline Transport Pilot Certificate No. 1451975 dated March 5, 1968. He had a type rating for airplane multiengine land B-707/720 and commercial privileges for airplane single engine land. First Officer Kresheck's most recent company physical examination was conducted on September 10, 1973. His FAA fir&-class medical examination was completed on June 13, 1974. The certificate contained no limitations. He also held Flight Engineer Certificate No. 1687052, dated March 20, 1966.

F/O Kresheck was observed during FAA en route inspections four times since 1971. There were no adverse comments on any report. He had flown into Dulles International Airport once in September. He also had flown into Washington National Airport three times in June and into Baltimore-Washington International Airport, Baltimore, Maryland, twice in May.

Flight Engineer Thomas C. Safranek

Flight Engineer (F/E) Thomas C. Safranek, 31, was hired by Trans World Airlines October 20, 1967. He was qualified as a flight engineer on the Convair 880 on March 19, 1968. He qualified on the B-707 August 6, 1968, and completed checkout on the B-727 on June 6, 1974. At the time of the accident he maintained current

APPENDIX B

qualification on the B-707 and the B-727. F/E Safranek had a total of 2,798 flight-hours, 128 hours of which were flown in the B-727. Since May 1974, F/E Safranek had flown a total of 242 hours. This total consisted of 128 hours in the B-727 and 113 hours in the B-707.

F/E Safranek completed recurrent training June 4, 1974, and a line check March 8, 1974. His last proficiency check in the B-727 was in June 1974. His most recent company physical examination was completed January 31, 1974. His FAA first-class medical examination was completed March 12, 1974, with no limitations. He held Commercial pilot Certificate No. 1606150, issued February 15, 1972, with airplane single engine land, and instrument ratings. He also held Flight Engineer Certificate No. 1822336, issued February 22, 1968, for turbojet powered aircraft. F/E Safranek's training record contains no adverse comments or record of unsatisfactory checks.

In the 24-hour period preceding TWA-514, each of the crew-members had flown 4 hours, 44 minutes and had 12 hours of crew rest.

Flight Attendants

Denise A. Stander, 22, was hired by TWA on October 9, 1974, and completed training on November 7, 1974.

Jen A. Van Fossen, 22, was hired by TWA on October 9, 1974, and completed training on November 7, 1974.

Elizabeth H. (Stout) Martin, 23, was hired by TWA on April 11, 1973, and completed training on May 11. 1973.

Joan E. Heady, 23, was hired by TWA on June 20, 1973, and completed training on July 20, 1973.

Ms. Heady and Mrs. Martin received recurrent training which was completed May 1974.

All the flight attendants were qualified on DC-9, B-707, B-727, B-747, and L-1011 aircraft. Ms. Heady and Mrs. Martin were also qualified in the CV-880.

APPENDIX B

Approach Controller

Mr. Merle W. Dameron, an Air Traffic Control Specialist, had been employed by the Civil Aeronautics Administration and the Federal Aviation Administration in that capacity for about 20 years. His initial employment was as a communications specialist in Alaska. He was trained and received an area rating at the Fairbanks, Alaska, Radar Approach Control. In 1958, he was assigned to a combined station/tower and received a senior rating at that facility located at Burlington, Vermont. He was assigned to Dulles in August 1962 and was assigned to that facility continuously until the time of the accident.

Mr. Dameron received a facility rating at Dulles on October 21, 1970, and a senior rating at Dulles on September 30, 1972.

In addition to his facility ratings, Mr. Dameron held current ratings and certificates as: Air Traffic Control Specialist, November 23, 1959; 1960; and, Commercial Pilot - Instrument Rating, January 2, 1953.

Mr. Dameron held a current Class II medical certificate issued without limitations on January 7, 1974.

On April 22, 1975, the National Transportation Safety Board requested a complete examination of Mr. Dameron's eyes to determine his ability to exercise the privileges of a second-class medical certificate without corrective lenses.

Mr. Merle Dameron was given a complete vision examination on May 23, 1975, by Dr. Edwin E. Westura, Assistant Regional Flight Surgeon, Washington Air Route Traffic Control Center, Leesburg, Virginia.

Dr. Westura found that Mr. Dameron's vision was "normal and within the limits established by Civil Service Commission standards for air traffic control specialists" without the use of corrective lenses.

APPENDIX C

Aircraft Information

The airplane, a Boeing 727-231, United States registry N54328, was manufactured on March 3, 1970. It was received by Trans World Airlines on the same date and subsequently placed into service. The airplane had accumulated a total of 11,997:10 flight hours.

The airplane was certificated and maintained in accordance with existing Government regulations and company procedures at the time of the accident.

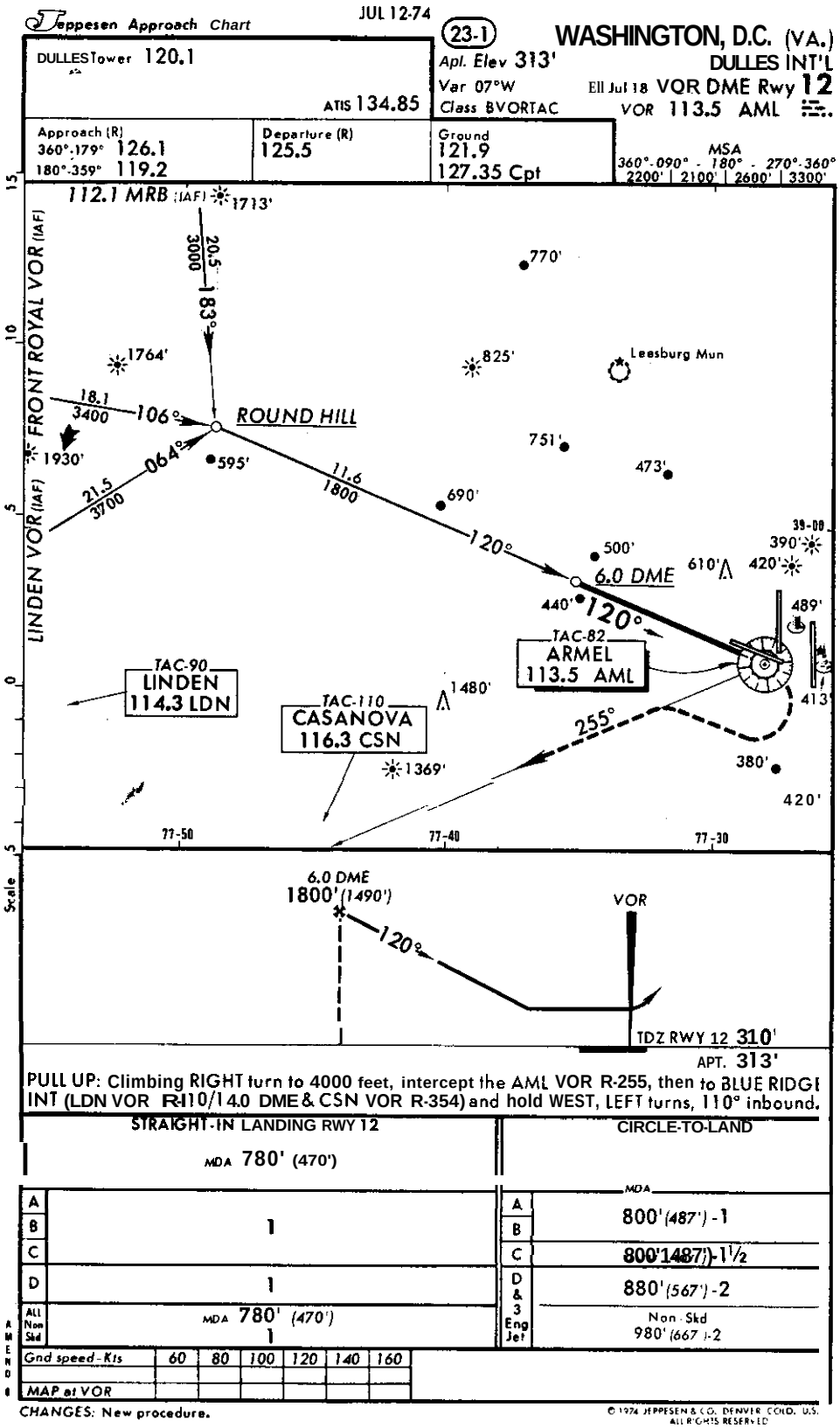
There were no open or uncorrected safety of flight items listed in the aircraft log when the aircraft departed Indianapolis, December 1, 1974.

The last "C" check was completed August 12, 1974, when the aircraft had a total flight time of 11,197 hours. A review of the maintenance records since that date revealed no evidence of any preexisting maintenance problems which could be associated with the accident.

The aircraft was equipped with three Pratt and Whitney JT8D-9A turbofan engines:

Engine Position	No. 1	No. 2	No. 3
Serial Number	P665329B	P666010B	P665336B
Total Time (hrs)	12801:36	768:40	13224:45
Time Since Overhaul	12801:36	768:40	5353:38
Date Installed	7/3/74	8/18/74 (new)	9/21/72

APPENDIX D



PULL UP: Climbing RIGHT turn to 4000 feet, intercept the AML VOR R-255, then to BLUE RIDGE INT (LDN VOR R-110/14.0 DME & CSN VOR R-354) and hold WEST, LEFT turns, 110° inbound.

STRAIGHT-IN LANDING RWY 12		CIRCLE-TO-LAND	
MDA 780' (470')		MDA	
A	1	A	800' (487') -1
B		B	
C		C	800' (487') -1½
D	1	D & 3 Eng Jet	880' (567') -2
All Non Std	MDA 780' (470') 1		Non-Std 980' (667') -2

Gnd speed-Kts	60	80	100	120	140	160
MAP at VOR						

AMEND 8

CHANGES: New procedure.

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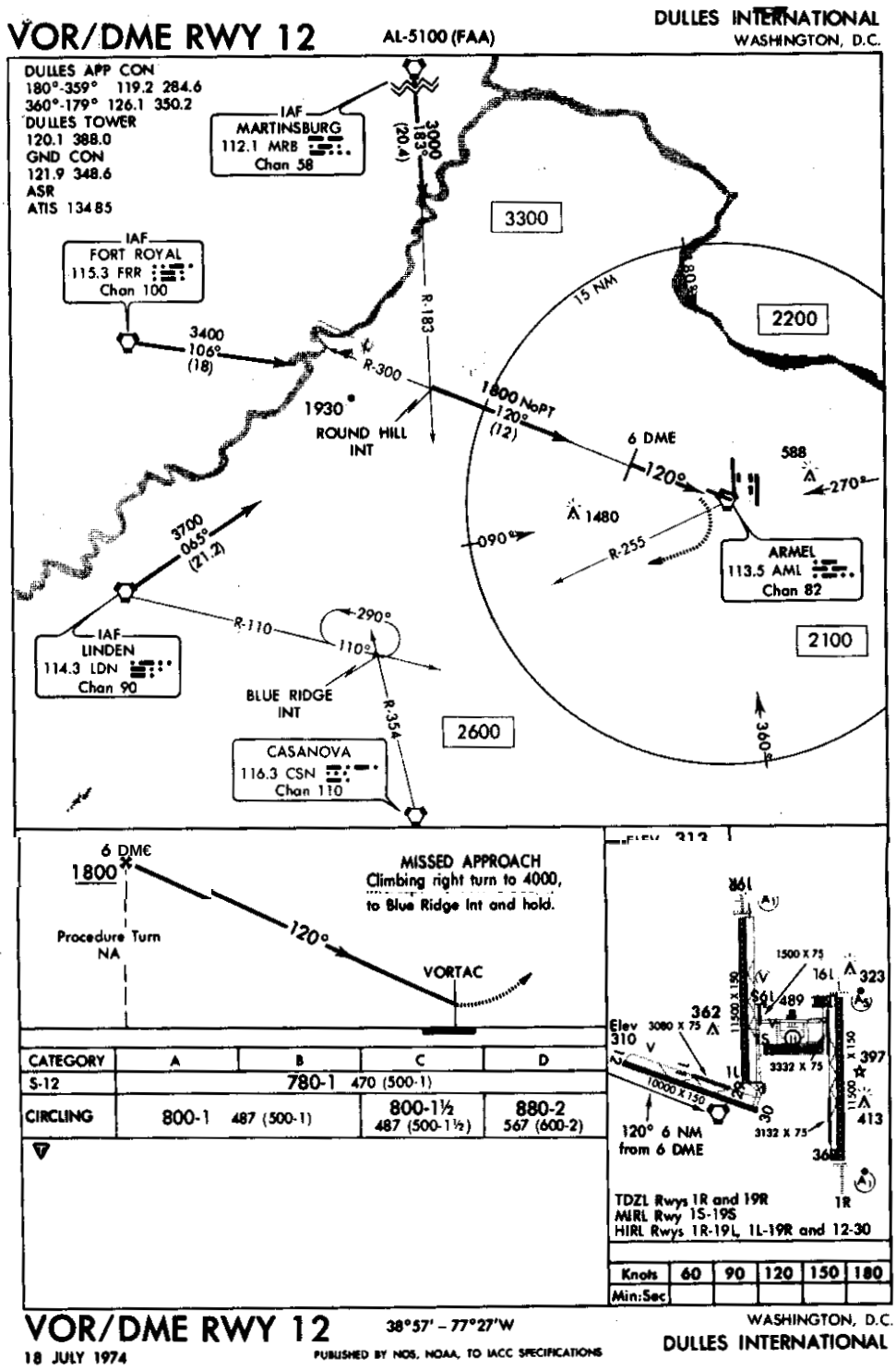
"ILLUSTRATION ONLY - NOT TO BE USED FOR NAVIGATIONAL PURPOSES"

APPENDIX D



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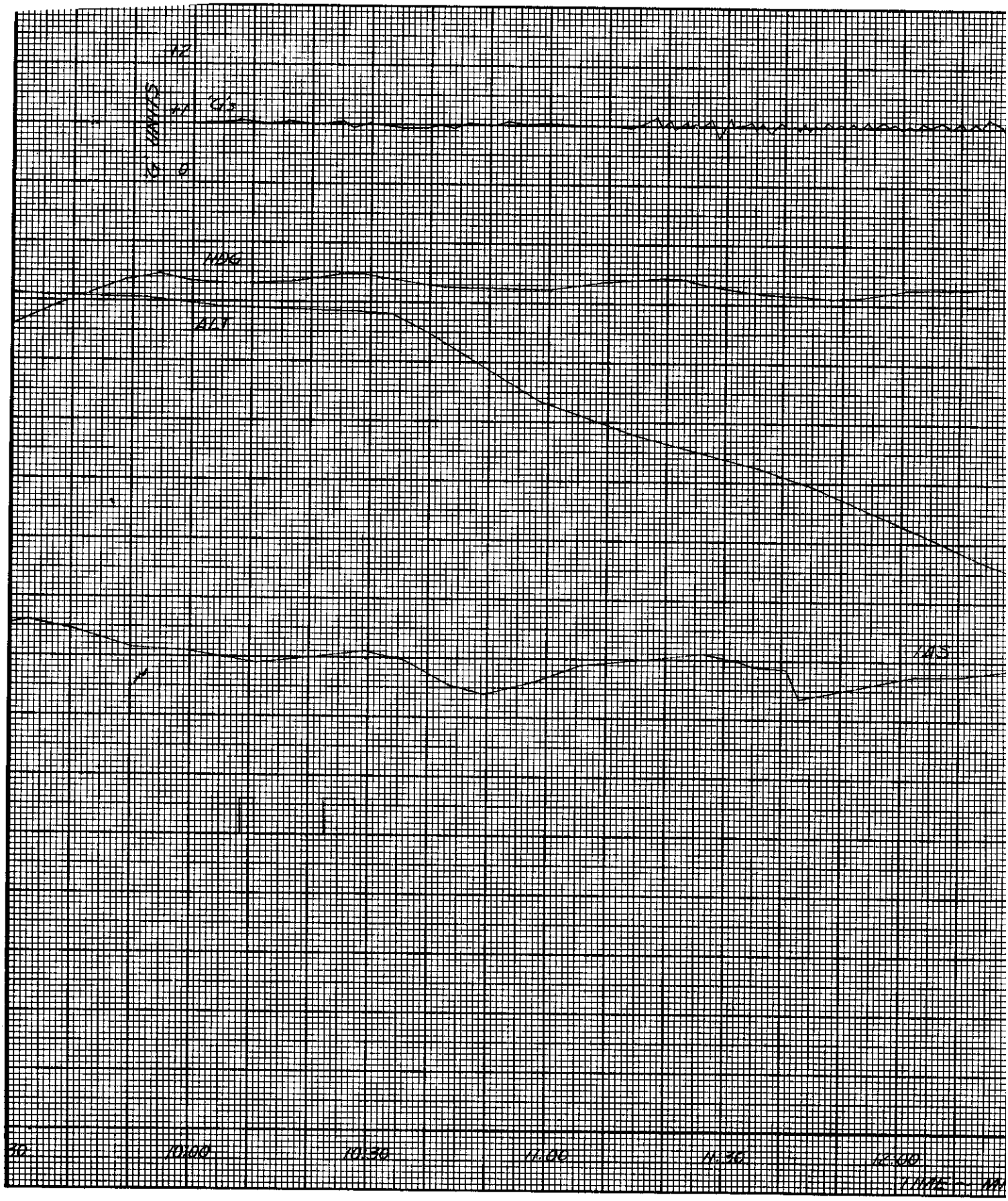
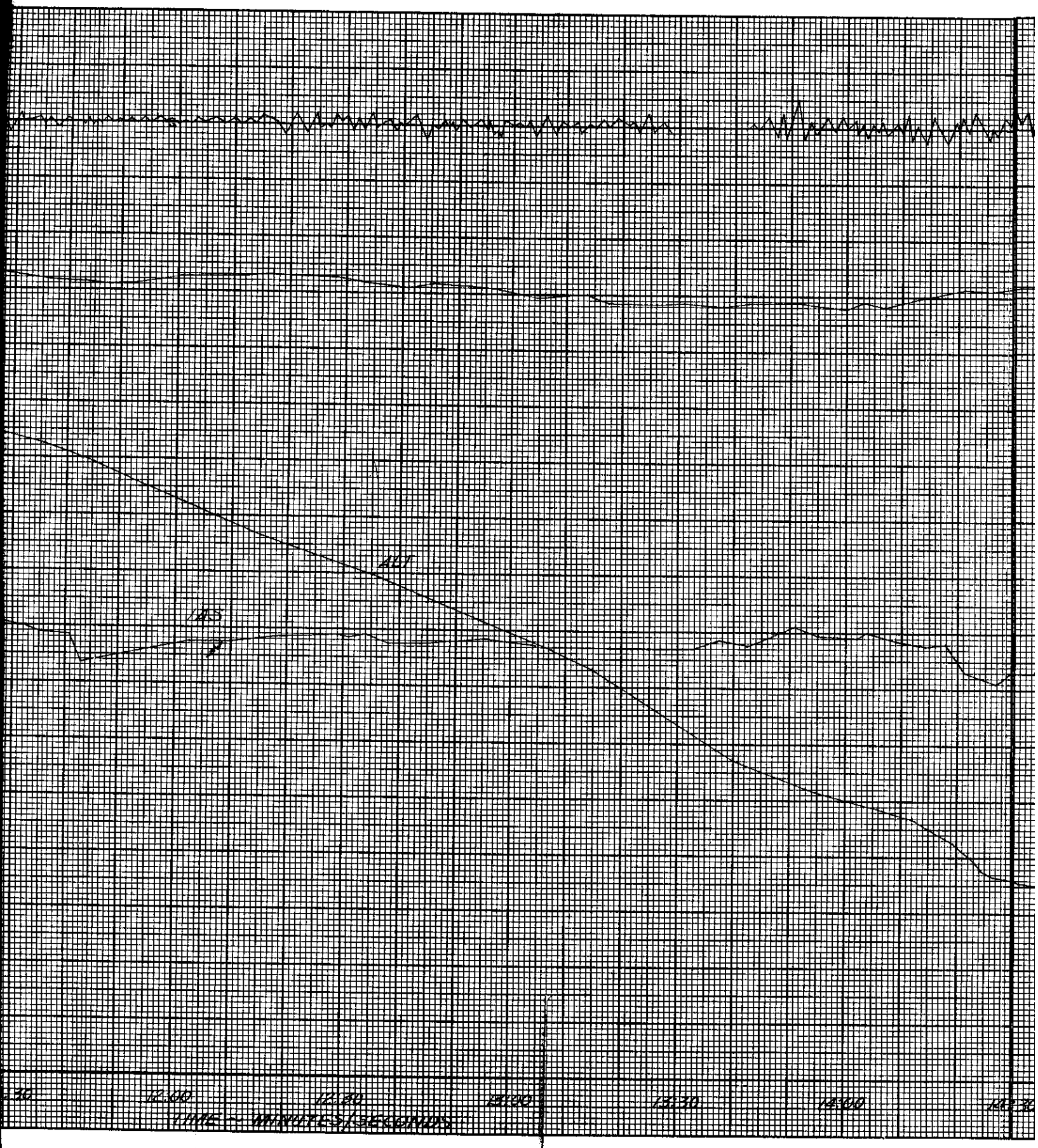
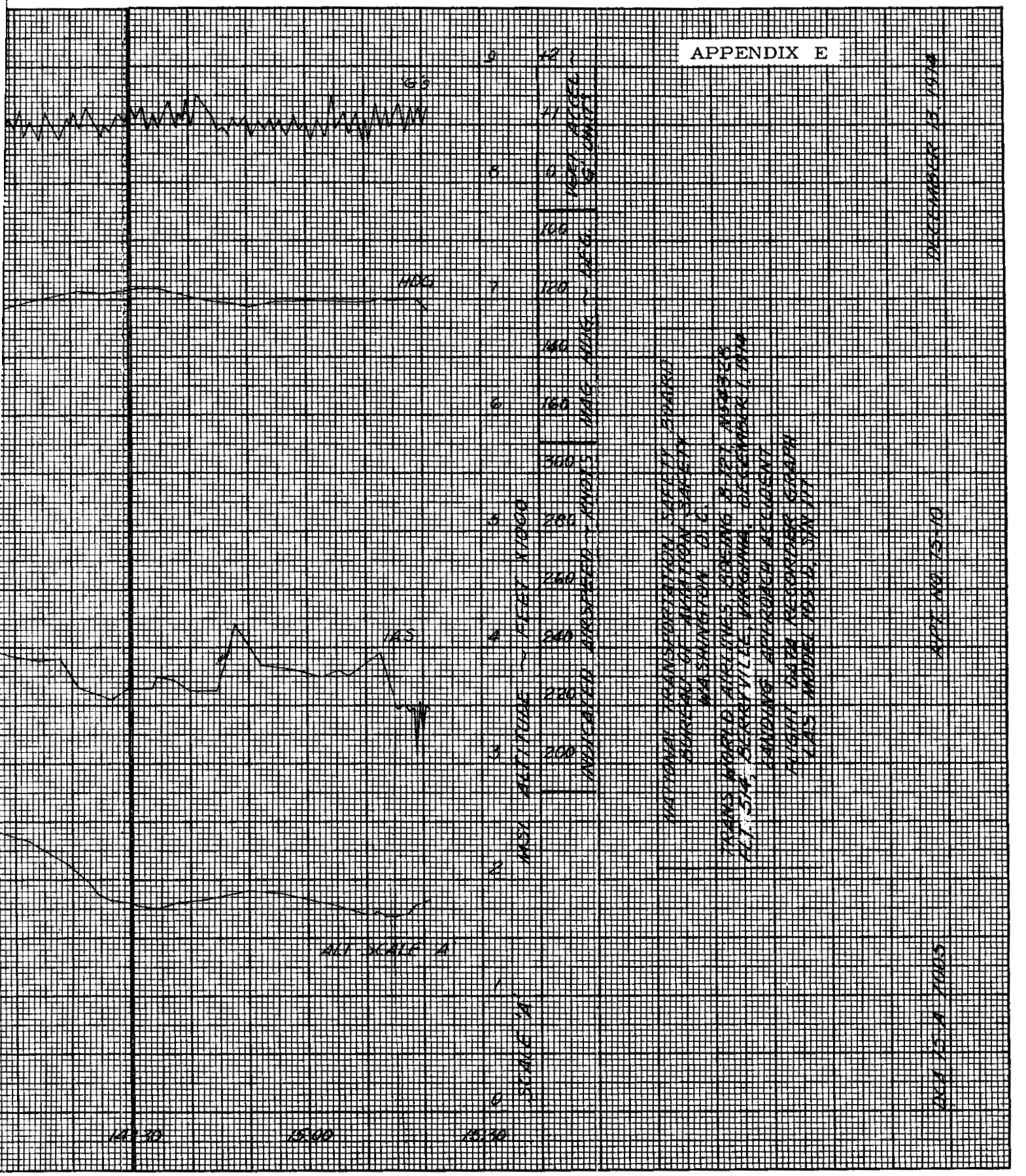


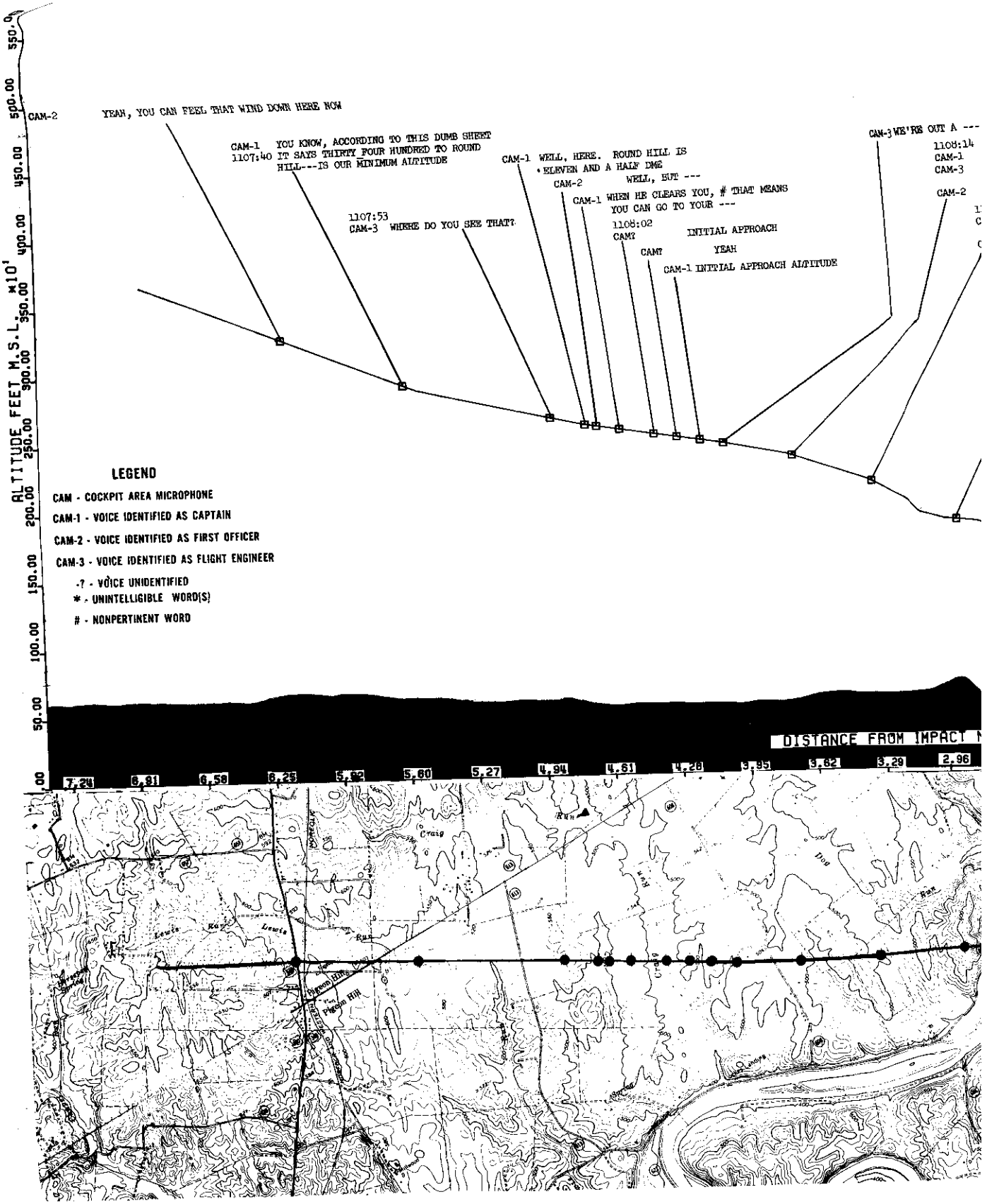
+2
+1
0
G UNITS
G's
HDG
ALT
IAS
30
10:00
10:30
11:00
11:30
12:00
TIME


ALT
IAS
12:00
12:30
13:00
13:30
14:00
TIME ~ MINUTES/SECONDS

APPENDIX E



G's
HDG
IAS
ALT SCALE 'A'
14:30
15:00
15:30
SCALE 'A'
MSL ALTITUDE ~ FEET X1000
INDICATED AIRSPEED ~ KNOTS
MAG. HDG. ~ DEG.
VERT. ACCEL. 'G' UNITS
NATIONAL TRANSPORTATION SAFETY BOARD
BUREAU OF AVIATION SAFETY
WASHINGTON D.C.
TRANS WORLD AIRLINES BOEING 8-727 N54328
FLT. 514, BERRYVILLE, VIRGINIA, DECEMBER 1, 1974
LANDING APPROACH ACCIDENT
FLIGHT DATA RECORDER GRAPH
LAS MODEL 105-D, S/N 117
DECEMBER 13, 1974
APT. NO. 75-10
DCA 75-A 7005



ALTITUDE FEET M.S.L. x10¹
550.00
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
CAM-2
YEAH, YOU CAN FEEL THAT WIND DOWN HERE NOW
CAM-1 YOU KNOW, ACCORDING TO THIS DUMB SHEET
1107:40 IT SAYS THIRTY FOUR HUNDRED TO ROUND HILL---IS OUR MINIMUM ALTITUDE
1107:53
CAM-3 WHERE DO YOU SEE THAT?
CAM-1 WELL, HERE. ROUND HILL IS ELEVEN AND A HALF DME
CAM-2 WELL, BUT ---
CAM-1 WHEN HE CLEARS YOU, # THAT MEANS YOU CAN GO TO YOUR ---
1108:02
CAM? INITIAL APPROACH
CAM? YEAH
CAM-1 INITIAL APPROACH ALTITUDE
CAM-3 WE'RE OUT A ---
1108:14
CAM-1
CAM-3
CAM-2
LEGEND
CAM - COCKPIT AREA MICROPHONE
CAM-1 - VOICE IDENTIFIED AS CAPTAIN
CAM-2 - VOICE IDENTIFIED AS FIRST OFFICER
CAM-3 - VOICE IDENTIFIED AS FLIGHT ENGINEER
-? - VOICE UNIDENTIFIED
* - UNINTELLIGIBLE WORD(S)
# - NONPERTINENT WORD
DISTANCE FROM IMPACT
7.24
6.91
6.58
6.25
5.92
5.60
5.27
4.94
4.61
4.28
3.95
3.62
3.29
2.96
Craig
Run
Dog
Lewis
Pigeon Hill

APPENDIX F

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON D.C.

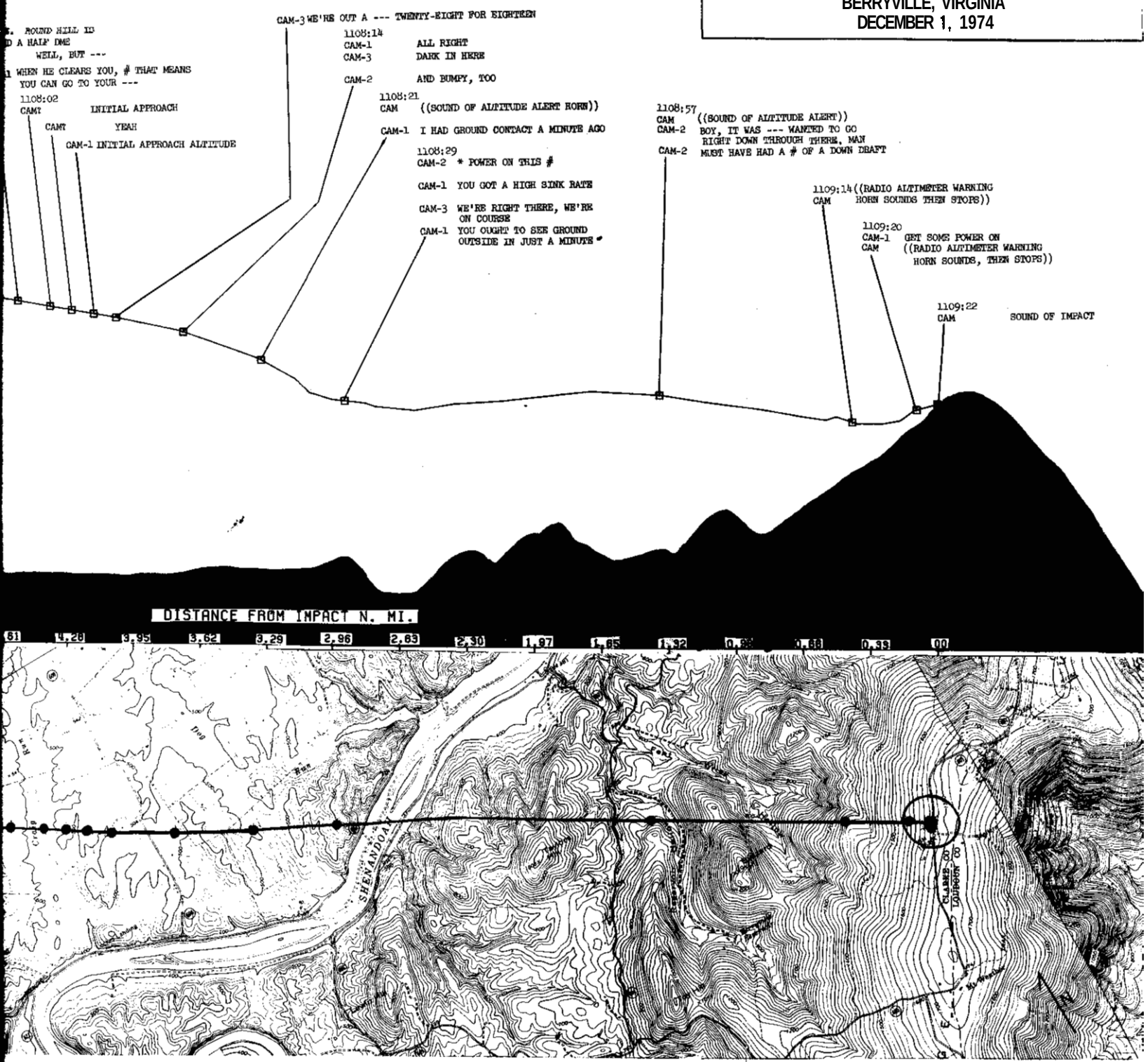
DESCENT PROFILE

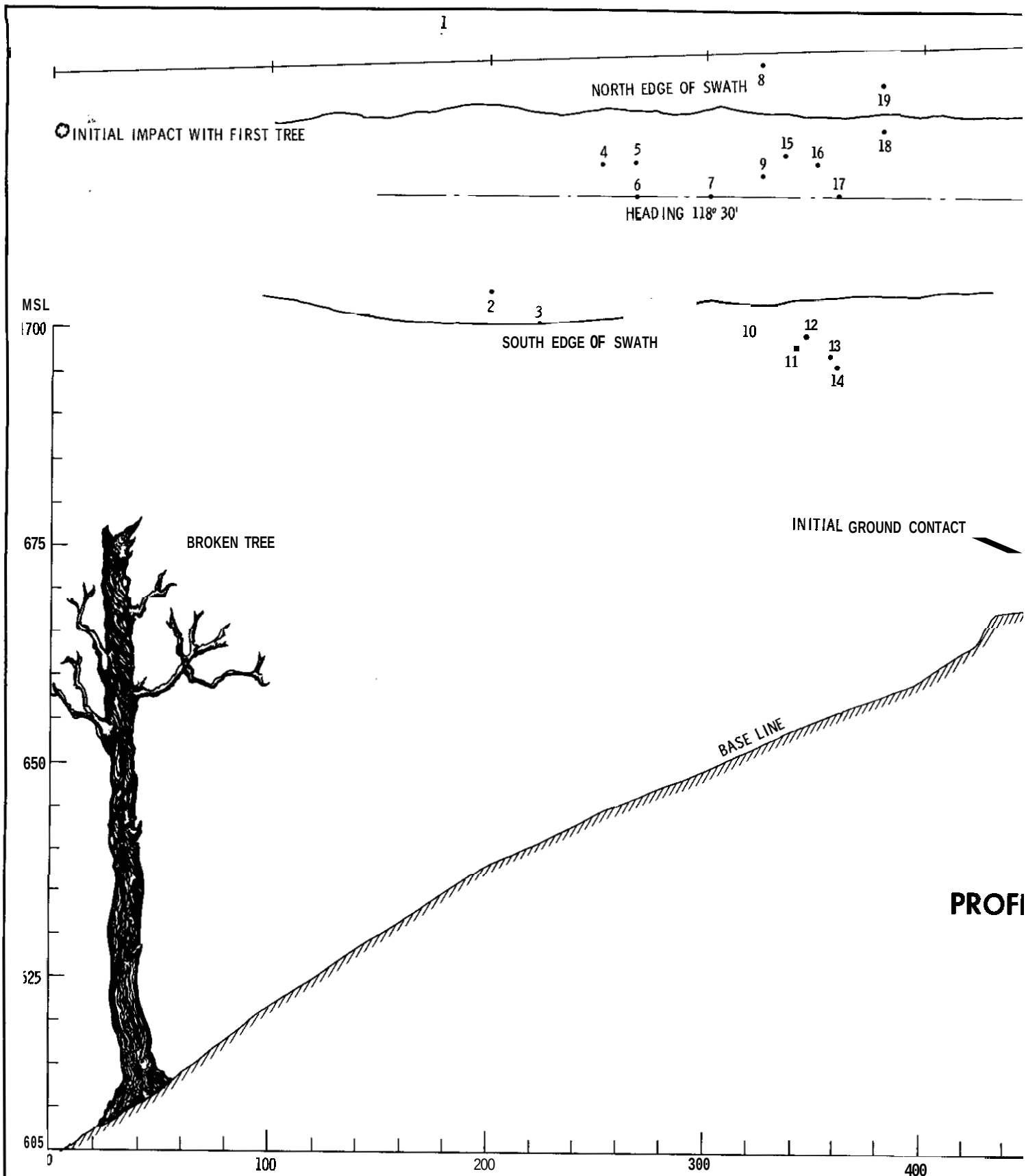
TRAMS WORLD AIRLINES

FLIGHT 514

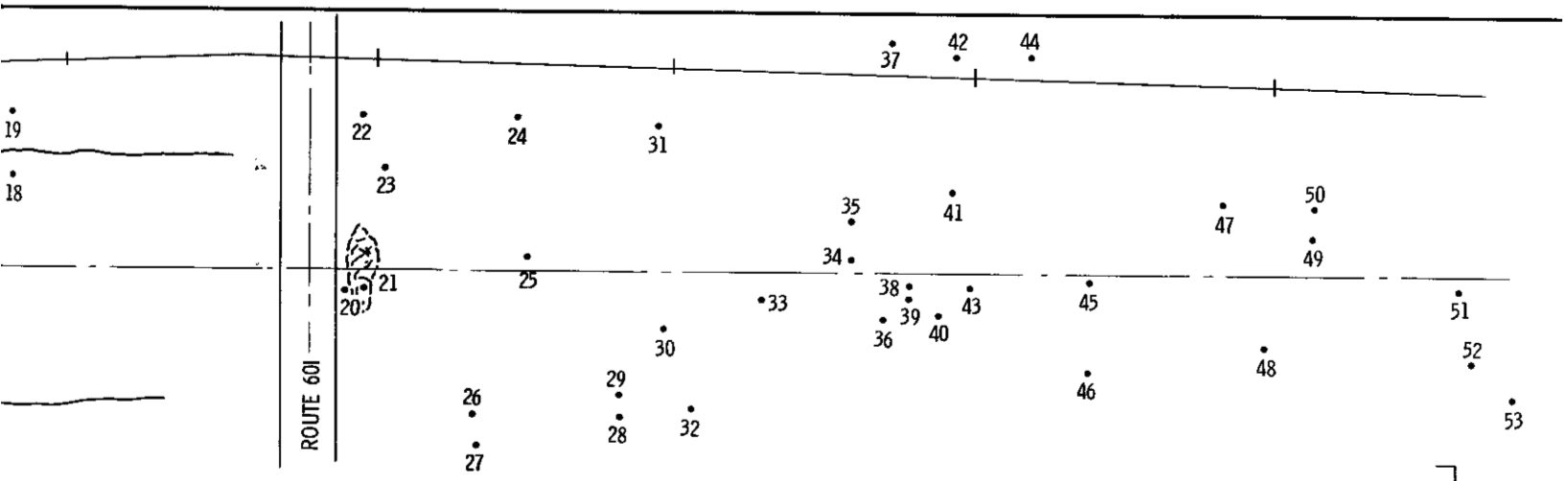
BERRYVILLE, VIRGINIA

DECEMBER 1, 1974

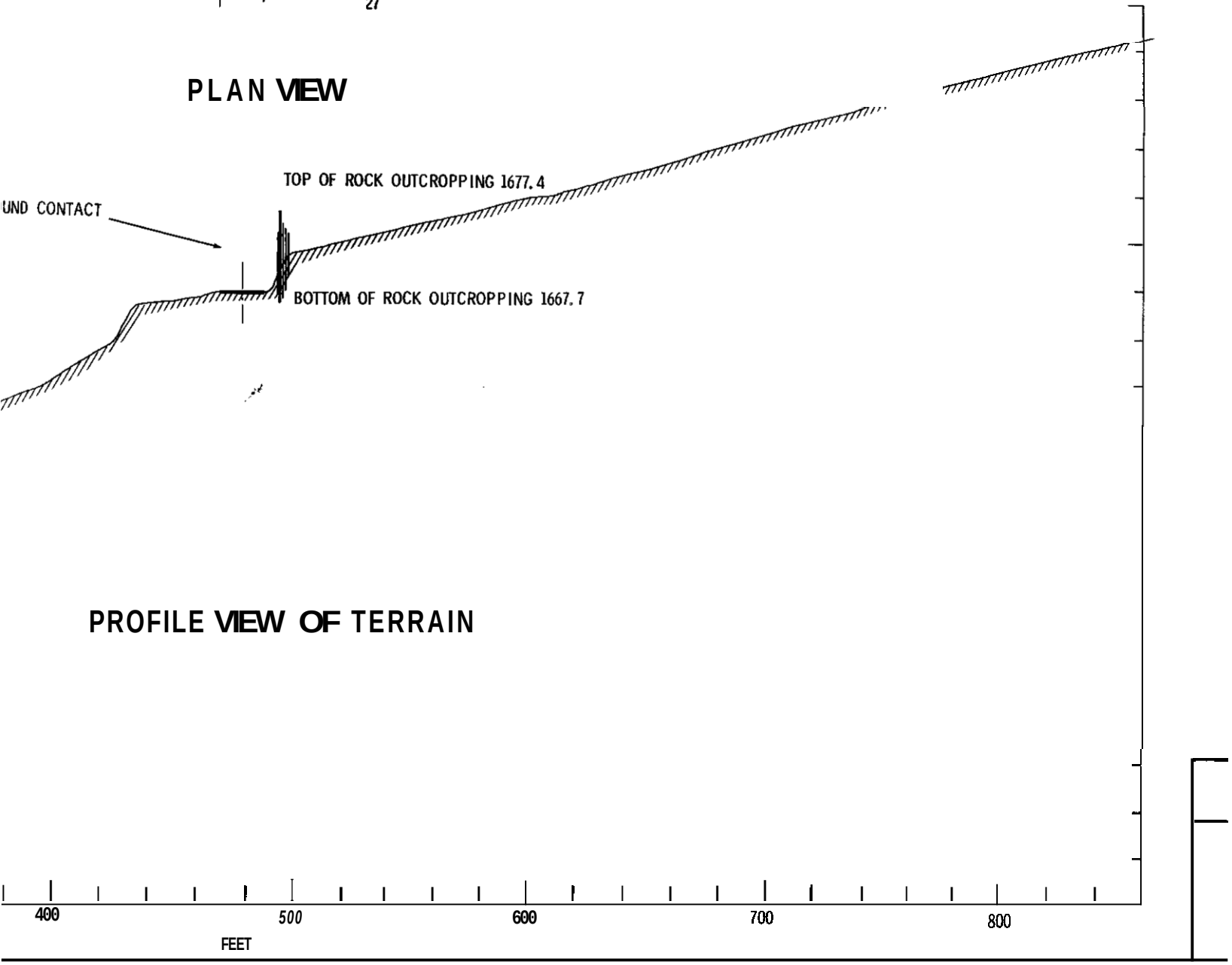



1
NORTH EDGE OF SWATH
8
19
INITIAL IMPACT WITH FIRST TREE
4
5
15
16
18
9
6
7
17
HEADING 118° 30'
MSL
2
3
SOUTH EDGE OF SWATH
10
12
11
13
14
1700
675
650
625
605
BROKEN TREE
INITIAL GROUND CONTACT
BASE LINE
0
100
200
300
400

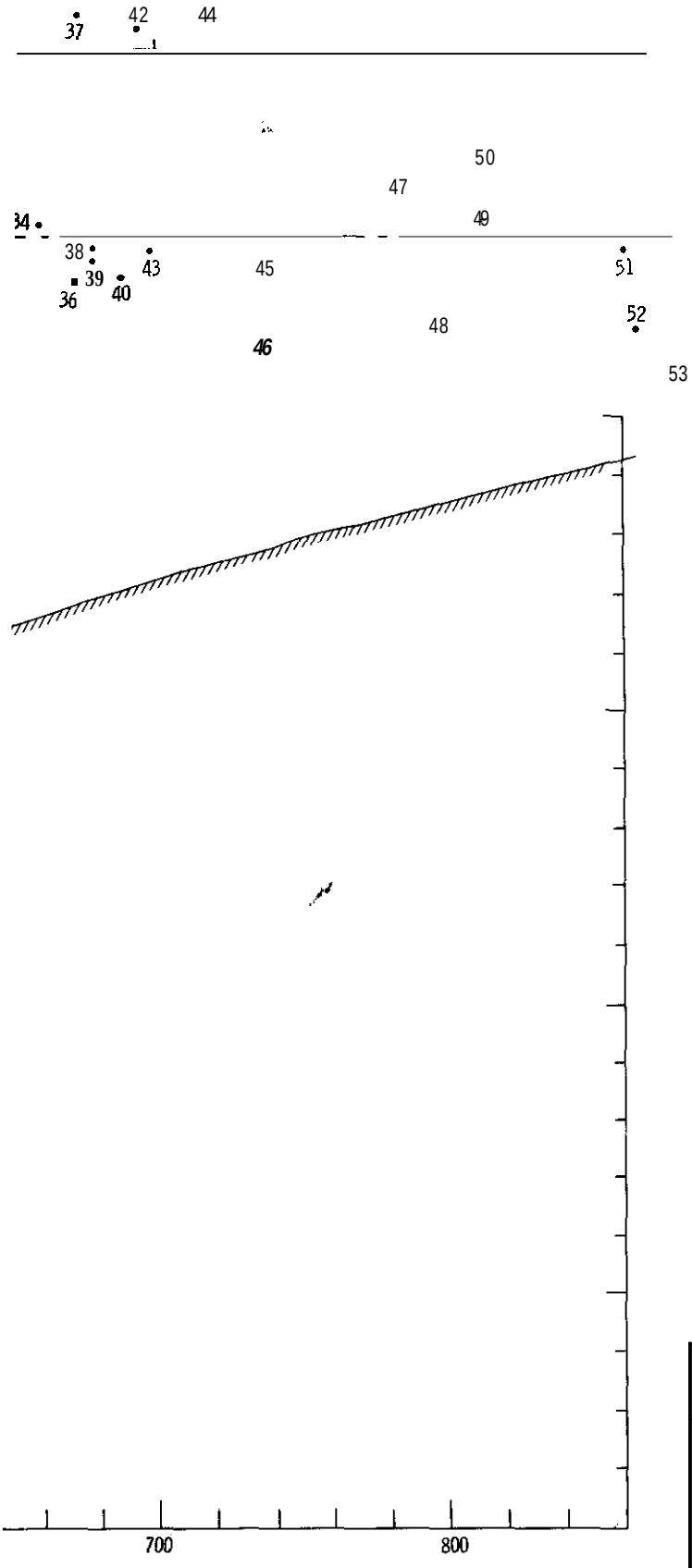
PROFI



PLAN VIEW



PROFILE VIEW OF TERRAIN



LEGEND

1. FIRST
2. OUTBOARD AILERON SECTION LEFT SIDE
3. AILERON SECTION RIGHT SIDE
4. SLAT SECTION LEFT SIDE
5. REAR SPAR SECTION LEFT SIDE
6. WING TIP SECTION LEFT SIDE
7. RADOME ROD ASSEMBLY
8. ANTI-ICE DUCT SECTION
9. WING TIP SECTION LEFT SIDE
10. WING TIP SECTION RIGHT SIDE
11. QUADRANT ASSEMBLY OUTBOARD AILERON RIGHT SIDE
12. OUTBOARD AILERON SECTION RIGHT SIDE
13. ROD ASSEMBLY AILERON/ SPOILER
14. ANTI-ICE FITTING
15. BALANCE PANEL SECTION
16. OUTBOARD TRAILING EDGE FLAP SECTION LEFT SIDE
17. ELEVATOR SECTION AND BALANCE PANEL LEFT SIDE
18. LEADING EDGE SLAT SECTION LEFT SIDE
19. QUADRANT ASSEMBLY OUTBOARD AILERON LEFT SIDE
20. KEEL BEAM
21. TRAILING EDGE FLAP SECTION
22. SECTION OF LEFT WING UPPER SKIN
23. PART OF LEFT WING REAR SPAR
24. TWO FLAP TRACKS
25. SECTION OF FLAP
26. RIGHT WING SECTION
27. FLAP JACK SCREW
28. UPPER EMPENNAGE SECTION
29. RIGHT MAIN LANDING GEAR
30. NO. 2 ENGINE
31. MAIN GEAR WALKING BEAM
32. TRAILING EDGE FLAP SECTION
33. NO. 2 ENGINE THRUST REVERSER
34. NO. 1 ENGINE FAN SECTION
35. NO. 2 ENGINE FAN DISK
36. FUSELAGE SECTION AT FORWARD GALLEY
37. UPPER LEFT SKIN SECTION
38. FUSELAGE SECTION AT FORWARD ENTRY
39. NOSE GEAR STRUT
40. NO. 3 ENGINE REVERSER
41. CENTER WING SECTION
42. CENTER WING SECTION
43. NO. 2 ENGINE COWL
44. THREE UPPER WING SKIN SECTION
45. FUSELAGE AND EMPENNAGE SECTION
46. NO.3 ENGINE
47. NO. 1 ENGINE
48. AFT LEFT FUSELAGE SECTION
49. FORWARD LEFT EMERGENCY EXIT
50. AFT LEFT SERVICE DOOR
51. FORWARD FUSELAGE SECTION
52. APU
53. LEFT MAIN LANDING GEAR

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON , O.C.

WRECKAGE DISTRIBUTION CHART
TRANS WORLD AIRLINE INC.
BOEING 727-231 , N54328
BERRYVILLE , VIRGINIA
DECEMBER 1, 1974

APPENDIX H

COPY

5 Jan 1971

AT-300

Altitude management when cleared for an approach
while under radar control

FS-1

We have had correspondence with Trans World Airlines representatives concerning altitude management after a radar vectored aircraft has been turned toward the final approach course and cleared for an approach. They have highlighted an area that we believe needs immediate clarification. At the present time pilots are apparently confused as to what altitude they should maintain after being cleared for an approach. Some of the possibilities are:

1. Maintain the last assigned altitude.

2. Maintain the procedure turn altitude.

3. Maintain the altitude prior to final approach descent.

4. Maintain the minimum sector altitude.

5. Maintain the minimum terminal route altitude.

Handbook 7110.0A-674 instructs controllers to specify the altitude to maintain unless the pilot can descend immediately to the altitude prior to final approach descent. This presents a problem as to the interpretation of the altitude prior to final approach descent. In the case of an ILS approach this is fairly straightforward as the glide slope intercept altitude but in other approaches, especially where there are stairstep descents or stepdown fixes, the altitude prior to final approach is not as obvious. Other factors effecting this area of confusion are the different terminology used by FAA in TERPS and that used by Jeppesen. Also the profile view as depicted on Jeppesen frequently indicates stairstep descent where government published plates illustrate a steady descent to the minimum decision height.

We have transmitted a GENOT instructing controllers that an altitude must be assigned to radar-controlled aircraft cleared for an approach unless the pilot can immediately descend to the glide slope intercept altitude or the minimum decision height for nonprecision approaches. This temporary fix will cover this ambiguous situation; however. a more permanent fix is required.

APPENDIX H

We request that you review this problem and establish standard operating practices for these situations. We will modify our handbook to conform to whatever standard you establish.

We will be happy to assist you in any way possible. If you have any questions or wish to discuss the matter, please contact Mr. Edward Harris, AT-324, extension 68532.

Original signed by
William M. Flener

William M. Flener
Director, Air Traffic Service, AT-1

APPENDIX H

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

Date: 12 February 1971

In Reply Refer To: FS-730

Subject: Altitude management when cleared for an approach while under radar control; AT-1 (AT-300) ltr of 5 Jan 71

To: AT-1

We have reviewed the subject letter and concur that some clarification is required with respect to altitude management when radar vectors are utilized in conjunction with instrument approach procedures.

We are presently exploring possible courses of action and will be in contact with your project office for assistance in preparing recommended operating practices.

/s/ James F. Rudolph

JAMES F. RUDOLPH
Director, Flight Standards Service, FS-1

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX I

ISSUED: May 26, 1975

Forwarded to:

Mr. James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-75-45 & 46

During its investigation of the accident involving TWA Flight 514 at Berryville, Virginia, on December 1, 1974, the Safety Board noted that the monitor for tne Armel, Virginia, distance measuring equipment (DME) is located at the Washington, D. C., Flight Service Station (FSS). Information regarding the operational status of the Armel DME must be relayed by Washington FSS personnel to the Dulles International Airport air traffic control tower, since there is no monitor for the Armel DME in the Dulles tower cab or in the associated approach control facility.

Although the remote location of the Armel DME monitor was not a causal factor in the accident, we believe that the monitor snould be located at tne Dulles facility. For safety considerations Dulles controllers should have direct access to indications regarding the operational status of the Armel DME, especially when VOR DME approaches to runway 12 are being conducted.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

1. Relocate the Armel, Virginia, distance measuring equipment monitor from the Wasnington, D.C., flight service station to the Dulles terminal air traffic control facility. (Class II)

2. Conduct a review of all terminal air traffic control facilities to assure that controllers at each facility serviced by a navigational aid will have direct access to tne associated monitor for tnat navigational aid. (Class III)

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By John H. Reed
Chairman

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF THE ADMINISTRATOR

May 30, 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Dear Mr. Chairman:

This will acknowledge receipt of your letter of May 20 which transmitted NTSB Safety Recommendations A-75-45 and 46.

We are evaluating the recommendations and will respond as soon as the evaluation is completed.

Sincerely,

J. W. Cochran
Acting Administrator

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

RECEIVED
JUL 17 1975
OFFICE OF THE ADMINISTRATOR

JUN 30 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D.C. 20594

Notation 1517A

Dear Mr. Chairman:

This is in response to *NTSB* Safety Recommendations A-75-45 and 46.

Recommendation No. 1. Relocate the Armel, Virginia, distance measuring equipment monitor from the Washington, D.C., flight service station to the Dulles terminal air traffic control facility. (Class II)

Recommendation No. 2 Conduct a review of all terminal air traffic control facilities to assure that controllers at each facility serviced by a navigatipnal aid will have direct access to the associated monitor for that navigational aid. (Class III)

Comment 1 and 2. We concur with the intent of these recommendations. We plan to review and determine the methods by which all terminal air traffic facilities may be made aware of the operational status *of* navaids. We have been looking into the feasibility of installing in all our tower facilities a "go, no go" (operational, non-operational) indicator for VOR/DME equipment upon which instrument approaches are predicated. This device would provide approach controllers the ability to detect outages of the VOR/DME but not require them to perform the monitoring function. It is our position that the actual monitoring of any VOR/DME should remain in a flight service station so that notification of maintenance personnel and issuance of a Notice to Airmen (NOTAM) can be accomplished in a timely manner.

Our review and plans for action in this matter are scheduled for completion by July 1, 1976.

Sincerely,

James E. Dow
Acting Administrator

APPENDIX I

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: June 12, 1975

Forwarded to:

Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-75-52

The National Transportation Safety Board's investigations of an accident involving Trans World Airlines Flight 514 on December 1, 1974, and an accident involving N57V, a Beech BE-90, on January 25, 1975, indicate that the controllers possessed safety advisory information which was not issued to the pilots. Both pilots were flying at excessively low altitudes. The issuance of such essential information is currently not mandatory since a safety advisory is an "additional service" and the controller has complete discretion for determining if this service is to be provided.

The categorization of a safety advisory as an additional service in paragraph 1545 of FAA Handbook 7110.9D is inconsistent with the apparent intent of paragraph 1800 of FAA Handbook 7110.8~ and paragraph 907 of FAA Handbook 7110.9D. There is a lack of definitive guidelines to enable controllers to distinguish between a situation which is "likely to affect the safety of an aircraft" and a situation involving an imminent emergency. We believe both situations should be treated as emergencies.

On the basis of the above conclusion, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Revise FAA Handbook 7110.8D and FAA Handbook 7110.9D to make the issuance of a safety advisory mandatory. (Class II) 3.

REED, Chairman, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation. McADAMS, Member, did not participate.

By: John H. Reed
John H. Reed
Chairman

1517B

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

RECEIVED
JUL 25 1975
OFFICE OF THE ADMINISTRATOR

July 18, 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Notation 1517B

Dear Mr. Chairman:

This is in response to your letter of June 5 which transmitted NTSB Safety Recommendation A-75-52.

The following are our comments on the recommendation:

On June 2, we issued a General Notice (GENOT) to all facilities making it clear that the provision of ATC additional services, which includes safety advisories, is a required duty to be accomplished to the extent permitted by higher priority duties and other circumstances. The GENOT explains that the provision of additional services is not optional on the part of the controller. In addition, we issued another GENOT on the same date requiring as a first priority duty, along with the separation of the aircraft, the immediate issuance of a "low altitude alert" to radar identified aircraft if an automatic altitude report is observed on radar showing the aircraft to be at an altitude, which in the controller's judgment places the aircraft in unsafe proximity to terrain/obstructions. It requires that the provision of such information, when observed, be considered the equivalent of furnishing timely air traffic control instructions, advisories or clearances necessary to assure the primary objective of separation. Handbooks 7110.8D and 7110.9D will be revised to clearly reflect this requirement.

Sincerely,

James E. Dow
James E. Dow
Acting Administrator

2 Enclosures
Air Traffic Service GENOT (N 7110.405) of 6/2/75
Air Traffic Service GENOT (N 7110.406) of 6/2/75

APPENDIX I

TELEGRAPHIC MESSAGE

NAME OF AGENCY	PRECEDENCE	SECURITY CLASSIFICATION
FEDERAL AVIATION ADMINISTRATION ATC OPERATIONS AND PROCEDURES DIVISION AIR TRAFFIC SERVICE	ACTION: ROUTINE INFO:	
ACCOUNTING CLASSIFICATION	DATE PREPARED May 30, 1975	TYPE OF MESSAGE ☐ SINGLE ☐ BOOK ☐ MULTIPLE-ADDRESS
FOR INFORMATION CALL		
NAME WCHamilton;AAT-322.1;ldg	PHONE NUMBER 426-8511	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED (Use double spacing and all capital letters)

TO:

NOUS2 KRWA

GENOT RWA 5/17 SVC B

JJ ALRGNS1/6/500 ALFSS ALIFSS/IATSC ALTWR ALARTC ALCS/T AAC/1

ANA/1 AREA OFFICES

NOTICE N 7110.405 SUBJECT/PRIORITY OF DUTIES

CNL NOVEMBER 1 1975

PART 1-CP-5. FACILITY CHIEFS SHALL ENSURE THAT ALL SUPERVISORS AND CONTROLLERS ARE BRIEFED ON THE PROVISIONS OF THIS NOTICE.

THE PUBLIC INTEREST CMA IN LIGHT OF RECENT CONTROLLED FLIGHTS INTO THE GROUND CMA DICTATES THAT WE AMEND OUR PRIORITY OF DUTIES TO ASSIST PILOTS IN EXECUTING THEIR REGULATORY RESPONSIBILITIES. THIS CHANGE REQUIRES CMA AS A FIRST PRIORITY DUTY CMA ALONG WITH THE SEPARATION OF AIRCRAFT CMA THE IMMEDIATE ISSUANCE OF A QOT LOW ALTITUDE ALERT UQOT TO RADAR IDENTIFIED AIRCRAFT IF AN AUTOMATIC ALTITUDE REPORT IS OBSERVED ON RADAR SHOWING THE AIRCRAFT TO BE AT AN ALTITUDE CMA WHICH IN THE CONTROLLER's JUDGMENT CMA PLACES THE AIRCRAFT IN UNSAFE PROXIMITY TO TERRAIN/OBSTRUCTIONS. THIS CHANGE REQUIRES THAT THE PROVISION OF SUCH INFORMATION CMA WHEN OBSERVED CMA BE CONSIDERED THE EQUIVALENT OF

SECURITY CLASSIFICATION

PAGE NO.	NO. OF PGS.
1	5

STANDARD FORM 14
REVISED AUGUST 1967
GSA FPMR (41 CFR) 101-35.306

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974-535-402

14-306

APPENDIX I

TELEGRAPHIC MESSAGE

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ACCOUNTING CLASSIFICATION	DATE PREPARED	TYPE OF MESSAGE ☐ SINGLE ☐ BOOK ☐ MULTIPLE-ADDRESS
FOR INFORMATION CALL		
NAME	PHONE NUMBER	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO:

NOUS2 KRWA _____

GENOT RWA _____ SVC B

JJ ALRCNS1/6/500 ALFSS ALIFSS/IATSC ALTWR ALARTC ALCS/T AAC/1

ANA/1 AREA OFFICES

PART 2 OF 5. FURNISHING TIMELY AIR TRAFFIC CONTROL INSTRUCTIONS CMA ADVISORIES OR CIEARANCES NECESSARY TO ASSURE THE PRIMARY OBJECTIVE OF SEPARATION.

THE RELATIVE ANALYSIS OF POSITION AND ALTITUDE CMA IN RELATION TO TERRAIN AND OBSTRUCTIONS CMA ALONG WITH CONTINUOUS MONITORING OF THE AIRCRAFT TARGET AND INFORMATION TAG CANNOT BE MANDATED. NONETHELESS CMA AN AWARENESS OF DEVIATION CAN CMA IN RESPECT TO TERRAIN AND OBSTRUCTIONS CMA BE EXPECTED ON A REASONABLE INTERMITTENT BASIS. IN EACH CASE CONDITIONS OF WORKLOAD CMA IMPACT OF THE VOLUME OF TRAFFIC CMA THE QUALITY/LIMITATIONS OF RADAR CMA ETC. CMA WILL BE THE BASIS CMA ALONG WITH THE TIME OR PERSISTENCE OF THE DEVIATION CMA FOR DETERMINING REASONABLENESS. THEREFORE CMA THE FOLLOWING STANDARD FOR THE PROVISION OF THE ISSUANCE OF LOW ALTITUDE ALERTS IS ADOPTED CMA PURSUANT TO THE CONCEPT THAT A NORMAL SCAN OF THE RADAR SCOPE

SECURITY CLASSIFICATION

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NAME OF AGENCY	PRECEDENCE ACTION: INFO:	SECURITY CLASSIFICATION
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FOR INFORMATION CALL		
NAME	PHONE NUMBER	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO:

NOUS2 KRWA _____

GENOT RWA _____ SVC B

JJ ALRGNS1/6/500 ALTWR

ANA/1 AREA OFFICES

PART 5 OF 5. MAY REVEAL SIGNIFICANT OR EXTREME DEVIATIONS WHICH MAY BE WRRECTIBLE BY COMMUNICATION WITH THE AIRCRAFT.

MAKE THE FOLLOWING REVISIONS TO HANDBOOKS 7110.8D-28 AND 7110.9D-55 CMA AND ADD A NEW PARAGRAPH 28A/55A.

28/55 DUTY PRIORITY

GIVE FIRST PRIORITY TO SEPARATION OF AIRCRAFT AS REQUIRED IN THIS HANDBOOK AND TO THE ISSUANCE OF LOW ALTITUDE ALERTS TO RADAR IDENTIFIED AIRCRAFT IF AN AUTOMATIC ALTITUDE REPORT IS OBSERVED ON RADAR SHOWING THE AIRCRAFT TO BE AT AN ALTITUDE CMA WHICH IN YOUR JUDGEMENT CMA PLACES THE AIRCRAFT IN UNSAFE PROXIMITY TO TERRAIN/OBSTRUCTIONS, GIVE SECOND PRIORITY To OTHER SERVICES THAT ARE REQUIRED BUT DO NOT INVOLVE SEPARATION OF AIRCRAFT. PRIORITY TO ADDITIONAL SERVICES To THE EXTENT POSSIBLE. PAREN N PAREN PAREN R PAREN

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FOR INFORMATION CALL		
NAME	PHONE NUMBER	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO:

NOUS2 KRWA ____

GENOT RWA _____ SVC B

JJ ALRGNS1/6/500 ALFSS ALIFSS/LATSC ALTWR

ANA/1 AREA OFFICES

PART 4 OF 5

28A/55A LOW ALTITUDE ALERT

IMMEDIATELY ISSUE A LOW ALTITUDE ALERT TO A RADAR IDENTIFIED AIRCRAFT

IF mu OBSERVE AN AUTOMATIC ALTITUDE REPORT ON RADAR SHOWING THE

AIRCRAFT TO BE AT AN ALTITUDE CMA WHICH IN YOUR JUDGMENT

THE AIRCRAFT IN UNSAFE PROXIMITY TO TERRAIN/OBSTRUCTIONS. PAREN N PARID

PHRASEOLOGY CLN

PAREN IDENT PAREN LOW ALTITUDE ALERT CMA ADVISE YOU

28A/55A MTE. THE PROVISION OF THIS SERVICE IS CONTINGENT UPON THE

CAPABILITY OF THE CONTROLLER m OBSERVE THE UNSAFE ALTITUDE CONDITION.

THE RELATIVE ANALYSIS OF POSITION AND ALTITUDE CMA IN RELATION TO

TERRAIN AND OBSTRUCTIONS CMA ALONG WITH CONTINUOUS NONITORING OF THE

AIRCRAFT TARGET AND INFORMATION TAG CANNOT DE UNDATED. NONETHELESS

CMA AN AWARENESS OF SIGNIFICANT OR EXTREME DEVIATIONS CAN CM

IN RESPECT TO TERRAIN AND OBSTRUCTIONS CMA

SECURITY CLASSIFICATION

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14-304

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APPENDIX I

TELEGRAPHIC MESSAGE

NAME OF AGENCY	PRECEDENCE ACTION: INFO:	SECURITY CLASSIFICATION
ACCOUNTING CLASSIFICATION	DATE PREPARED	TYPE OF MESSAGE ☐ SINGLE ☐ BOOK ☐ MULTIPLE-ADDRESS
FOR INFORMATION CALL		
NAME	PHONE NUMBER	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO:

NOUS2 KRWA _____

GENOT RWA _____ SVC B

JJ ALRGNS1/6/500 ALFSS ALIFSS/IATSC ALTWR AAC/1

ANA/1 AREA OFFICES

PARAGRAPH. BE EXPECTED ON A REASONABLE CMA THOUGH INTERMITTENT BASIS. IN EACH CASE CONDITIONS OF WORKLOAD CMA IMPACT OF THE VOLUME OF TRAFFIC CMA THE QUALITY/LIMITATIONS OF RADAR CMA ETC. CMA WILL BE THE BASIS ALONG WITH THE TIME OR PERSISTENCE OF THE DEVIATION CMA FOR DETERMINING REASONABLENESS. IN SUMMARY CMA BECAUSE OF THE MANY FACTORS AFFECTING THE ABILITY m OBSERVE CMA ON RADAR CMA A SITUATION IN WHICH UNSAFE PROXIMITY TO TERRAIN/OBSTRUCTIONS MAY BE DEVELOPING CMA THIS PARAGRAPH DOES NOT IMPOSE A DUTY TO SEE THE DEVELOPMENT OF SUCH SITUATIONS SCLN IT DOES REQUIRE CMA THAT WHEN SUCH A SITUATION IS OBSERVED CMA THE PILOT BE SO ADVISED.

Belanger

BELANGER AAT/1

SECURITY CLASSIFICATION

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APHIC MESSAGE

NAME OF AGENCY	PRECEDENCE	SECURITY CLASSIFICATION
FEDERAL AVIATION ADMINISTRATION AIR TRAFFIC SERVICE ATC OPERATIONS AND PROCEDURES DIVISION	ACTION: ROUTINE INFO:	
ACCOUNTING CLASSIFICATION	DATE PREPARED MAY 30, 1975	TYPE OF MESSAGE ☐ SINGLE ☐ BOOK ☐ MULTIPLE-ADDRESS
FOR INFORMATION CALL		
NAME WCHAMILTON:smd:AAT-322.1	PHONE NUMBER 426-8511	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO:

NOUS2 KRWA

GENOT RWA 5/9P SVC B JJ

ALRGNS1/8/500 ALFSS ALIFSS/IATSC ALTWR ALARTC ALCS/T

AREA OFFICES

NOTICE N 7110.406 SUBJECT/ADDITIONAL SWVICES

CNL NOV 1 75

PART 1 OF 4. FACILITY CHIEFS SHALL ENSURE ALL SUPERVISORS AND CONTROLLERS ARE BRIEFED ON THE IMPORTANCE OF PROVIDING ADDITIONAL SERVICES.

CONSISTENT WITH HANDBOOKS 7110.8D DASH 28 AND 7110.9D DASH 55 CMA DUTY PRIORITY CMA IT IS REQUIRED THAT ADDITIONAL SERVICES BE PROVIDED TO THE EXTENT PERMITTED BY HIGHER PRIORITY DUTIES AND OTHER CIRCUMSTANCES. WHILE THE PROVISION OF ADDITIONAL SERVICES IS A THIRD PRIORITY DUTY CMA THIS DOES NOT MEAN THAT ADDITIONAL SERVICES ARE NOT IMPORTANT SEMI CLN IT ONLY MEANS THAT HIGHER PRIORITY DUTIES MUST BE EXECUTED FIRST. OF COURSE THERE ARE CERTAIN FACTORS WHICH MIGHT PREVENT YOU FROM PROVIDING THE SERVICE FROM TIME TO TIME AND THAT IS THE REASON WE CAN NOT GUARANTEE THAT IT WILL ALWAYS BE PROVIDED. BUT CMA FRANKLY CMA YOU ARE DOING IT MUCH OF THE

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APPENDIX I

TELEGRAPHIC MESSAGE

NAME OF AGENCY	PRECEDENCE ACTION: INFO:	SECURITY CLASSIFICATION
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FOR INFORMATION CALL		
NAME	PHONE NUMBER	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

O:

PART 2 OF 4. TIME AND WE WANT YOU CMA NEED YOU TO KEEP IT UP SEMI CIN IT IS THAT EXTRA EFFORT THAT LENDS SO MUCH TO YOUR CONTRIBUTION TO THE FLYING PUBLIC.

WHEN YOU PROVIDE ADDITIONAL SERVICES CMA YOU MAKE A MAJOR CONTRIBUTION TO THE FLYING PUBLIC. WHAT YOU NEED TO DO NOW IS REVIEW YOUR FACILITY AND YOUR INDIVIDUAL PRACTICES. YOU NEED TO EXAMINE THE TECHNIQUES USED TO KEEP THAT AIRCRAFT IN YOUR SCAN AND AVAUABLE TO RECEIVE ADVISORY INFORMATION. YOU NEED TO MAKE SURE THAT CONTROL AND CONTROL CHANGEOVER POINTS ARE A MATTER OF NEED AND NOT CONVENIENCE. YOU NEED TO MAKE A PRACTICE OF SCANNING YOUR SCOPE CMA TAKING NOTE OF THE DIFFERENT CMA THE UNUSUAL SITUATION. YOU NEED TO STAY AHEAD OF THE GAME CMA ANTICIPATE THE SITUATICN CMA BUT NEVER ASSUME THE CCNDITION DASH PART OF YOUR JOB IS HELPING THE PILOT STAY AHEAD OF THE GAME TOO.

MAKE THE FOLLOWING REVISIONS TO HANDBOOKS 7110.80 DASH 600/1540 AND 7110.90 DASH 560/805 CIN 600/1540/560/805 APPLICATICN

PROVIDE ADDITIONAL SERVICES TO THE EXTENT POSSIBLE CONTINGENT YOUR CAPABILITY TO FIT IT INTO THE PERFORMANCE OF HIGHER PRIORITY DUTIES AND ON THE BASIS OF THE FOLLOWING.

PAREN R PAREN PAREN N PAREN

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ACCOUNTING CLASSIFICATION	DATE PREPARED	TYPE OF MESSAGE
FOR INFORMATION CALL		☐ SINGLE ☐ BOOK ☐ MULTIPLE-ADDRESS
NAME	PHONE NUMBER	

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO:

PART 3 OF 4. A, FACTORS SUCH AS LIMITATIDNS OF THE RADAR CMA VOLUME OF TRAFFIC CMA FREQUENCY CONGESTION AND WORKLOAD.

NO CHANCE TO PARAGRAPHS B AND C.

560/805/600/1540 REFERENCE DUTY PRIORITY DASH 28/55

NOTE. THE PRIMARY PURPOSE OF THE ATC SYSTEM IS TO PREVENT A COLLISION BETWEEN AIRCRAFT OPERATING IN THE SYSTEM AND TO ORGANIZE AND EXPEDITE THE FLOW OF TRAFFIC. IN ADDITION TO ITS PRIMARY FUNCTIM CMA THE ATC SYSTEM HAS THE CAPABILITY TO PROVIDE PAREN WITH CERTAIN LIMITATIMS PAREN ADDITIONAL SERVICES. PROVIDE ADDITIONAL SERVICES IS LIMITED BY MANY FACTORS SUCH AS THE VOLUME OF TRAFFIC CMA FREQUENCY CONGESTION CMA QUALITY OF RADAR CMA CONTROLLER WORKLOAD CMA HIGHER PRIORITY DUTIES AND THE PURE PHYSICAL NABILITY TO SCAN AND DETECT THOSE SITUATIONS THAT FALL IN THIS CATEGORY. IT IS RECOGNIZED THAT THESE SERVICES CANNOT BE PROVIDED IN CASES IN WHICH THE PROVISION OF THE SERVICES IS PRECLUDED BY THE ABOVE FACTORS. CONSISTENT WITH THE AFOREMENTIONED CONDITIONS CMA CONTROLLERS SHOULD PROVIDE ADDITIONAL SERVICE PROCEDURES TO PERMITTED BY HIGHER PRIORITY DUTIES AND THE PROVISION OF

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STANDARD FORM 1.
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NAME OF AGENCY	PRECEDENCE ACTION: INFO:	SECURITY CLASSIFICATION
ACCOUNTING CLASSIFICATION	DATE PREPARED	TYPE OF MESSAGE ☐ SINGLE ☐ BOOK ☐ MULTIPLE-ADDRESS
FOR INFORMATION CALL		
NAME	PHONE NUMBER	
THIS SPACE FOR USE OF COMMUNICATION UNIT		

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO:

PART 4 OF 4. ADDITIONAL SERVICES IS NOT OPTIONAL ON THE PART OF THE CONTROLLER CMA BUT CMA RATHER IS REQUIRED CMA WHEN THE WORK SITUATION PERMITS.

Belanger

BELANGER AAT/1

SECURITY CLASSIFICATION	PAGE NO.	NO. OF PGS.
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APPENDIX I

August 6, 1915

612 Miccosukee Road
Tallahassee, Fla. 32303

Honorable John H. Reed
Chairman
National Transportation Safety Board
Washington, D. C. 20594

Dear Chairman Reed:

I have just reviewed safety recommendations A-75-52 pertaining to safety advisory information passed to pilots by controllers. However, the Board didn't go quite far enough. Since the controllers are very much a part of safety and share traffic separation responsibilities with the pilot in controlled airspace, a harmonious working relationship with the pilot in managing the air transportation system is essential. It seems that identity with the system that is being managed would increase harmony and enhance safety.

There seems to be no better way to identify with the system that is being controlled than for controllers to have pilot experience. True, many controllers are also pilots. However, the public interest and public safety would be better served if all new controllers were required to have at least a private pilot's certificate as a condition of employment.

This would accomplish at least two things:

1. Clearly establish the motivation of the applicant, and

2. enable controllers to better understand and visualize the airport airways system as it exists in the operational world which, in turn, would equip them to manage traffic in a safe efficfent manner.

There seems to be no better way to insure an awareness of the value of time with associated trade-offs than when you are paying $25 to $50/hr. for flight training and it doesn't take long for one to start searching for ways to reduce trip times if the cost of that trip runs 1 to 3 dollars a minute.

APPENDIX I

Honorable John H. Reed

August 6, 1975

A natural reaction to such a proposal would be "fine, and let's make all pilots aircontrolmen." This is understandable, however, pilots are now required to demonstrate a satisfactory working knowledge of air traffic control procedures at least once every two years and must have experience in a controlled environment prior to licensing, A complete part of the AIM is even entitled "... ATC Procedures".

I urge you and the FAA to seriously consider this particular action as having a positive influence in aviation safety.

Sincerely,

/s/ Bob Babis

Robert E. Babis, Aviation Specialist
Safety & Inspection Section
Bureau of Aviation Safety

REB:jl

cc: **AOPA**
James Dow

APPENDIX I

National Transportation Safety Board
Washington, D.C. 20594

Office of Chairman

September 3, 1975

Mr. Robert E. Babis
Aviation Specialist
Safety & Inspection Section
Bureau of Aviation
672 Miccosukee Road
Tallahassee, Florida 32303

Dear Mr. Babis:

Thank you for your proposal as presented in your letter of August 6, 1975. The supporting rationale is thought-provoking, and we believe your views merit consideration.

As you know, the basic responsibility of the National Transportation Safety Board is to investigate accidents for the purpose of accident prevention. However, our investigative experience does not provide us with an adequate basis to support a recommendation on the actions set forth in your letter.

The Federal Aviation Administration is the agency responsible for setting up ATC requirements and they have conducted a number of special studies and evaluation programs to determine qualifications of an applicant for an ATCS position. We are advised that they are interested in your proposal and will respond to your letter.

The Safety Board appreciates your interests in the advancement of aviation safety.

Sincerely yours,

/s/ John H. Reed

John H. Reed
Chairman

cc: Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

Date September 5, 1975

The enclosed correspondence is referred to your office for such action as may be necessary.

The writer has been notified of this referral.

/ Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

/

Remarks:

Mr. Babis will be expecting further response from FAA.

Enclosure

National Transportation Safety Board

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20591

RECEIVED
OCT 22 1975

OCT 15 1975

Mr. Robert E. Babis
Aviation Specialist
Safety and Inspection Section
Bureau of Aviation
Tallahassee, Florida 32303

Notation 1517B

Dear Mr. Babis:

We received a copy of your August 6, 1975, letter to Honorable John H. Reed, Chairman of the National Transportation Safety Board, regarding safety recommendations A-75-52 pertaining to safety advisory information passed to pilots by air traffic controllers.

For many years one of the qualifying experiencesfor eligibility for ATC appointment is to have or have held a pilot rating with 350 hours flight time. Another qualifier is to have or have held an instrument flight rating. A random sampling conducted in 1970 revealed that approximately 29 percent of controllers checked had pilot experience and approximately 40 percent had pre-FAA air traffic control experience.

Research on aptitude testing of applicants has evolved to the point that the aptitude test is a better predictor of successful training completion than aviation related background, except work directly related to air traffic control. Based upon our experience with aptitude testing. background in aviation related fields is no longer a mandatory requirement for eligibility, although pilot and air traffic control experiences continue to be weighted in the selection process. After the aptitude test has identified those applicants most likely to succeed, the screening process incorporated into our training program further assures that only the most competent will complete the course. The training program is lengthy and thorough so when the employee reaches the full performance controller level, he should have a more extensive knowledge of the entire National Airspace System than most pilots.

Others have suggested that controllers be offered pilot training but our research has shown that pilot experience is not a necessary part of air traffic control training so the cost of extending the training program plus federal funding for pilot training cannot be justified. We do have an air carrier flight familiarization training program which allows a controller a maximum of eight flights per year in the cockpit. This gives the controller and the pilot an excellent opportunity to discuss air traffic control procedures and how they may affect aircraft routings, delays, etc. Furthermore, the controller can view a cockpit that is much more complex than any he would encounter in small aircraft

flight training. We think it is a very beneficial program and satisfies a part of the controller's need to know how the system operates from a pilot's viewpoint. We agree that a controller is better prepared to perform his air traffic control duties when he understands the effect that his control instructions have upon the pilots.

As you have stated, pilots are required to periodically demonstrate a satisfactory working knowledge of air traffic control procedures. The controller is subjected to a proficiency check semiannually and demonstrates a satisfactory working knowledge of the air traffic control system every working day.

Thank you for your interest in this subject.

Sincerely,

ORIGINAL SIGNED BY
GLEN D. TIGNER

Acting Director, Air Traffic Service, AT-1

APPENDIX I

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: July 3, 1975

Forwarded to:

Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-75-54 and 55

During the National Transportation Safety Board's public hearing concerning the TWA 514 crash which occurred on December 1, 1974, near Berryville, Virginia, several pilots from a number of large U. S. air carriers testified that they had seldom, if ever, received SIGMET messages via navigational aid voice frequency. They indicated that there was neither a radio reception problem nor a difficulty in transmission of the data. The problem was that the SIGMETS were not being broadcast over the navigational aids in accordance with current procedures. As you know, current procedures are for the SIGMETS to be broadcast upon receipt and at 15-minute intervals at H+00, H+15, H+30 and H+45 for the first hour after issuance. Indications are that communicator workload may be the reason that SIGMETS are not always broadcast on schedule.

The Safety Board is concerned that warnings of weather severe enough to be potentially hazardous to aircraft in flight may not always be available or may not be available in a timely manner.

The Board recognizes that air carrier pilots do have another source of SIGMETS in flight and that is the company dispatcher. In accordance with 14 CFR 121.601(b), the dispatcher is required to furnish the pilot in flight with "....any additional available information of meteorological conditions ....that may affect the safety of the flight." In the case of TWA 514, the dispatcher testified that he used SIGMETS to make operational decisions and treats them as, "....just another piece of forecasting information we take into consideration." He also testified that it was not standard procedure to transmit or relay SIGMETS or AIRMETS to flightcrews. When asked what procedure is expected of TWA flightcrews in regard to securing SIGMETS in flight, the dispatcher replied that, "....they generally pick it up en route, I would suspect, from ARTC or tuning in one of the weather broadcasts on the way."

APPENDIX I

Honorable James E. Dow

In view of the requirement to disseminate the large number of SIGMETS and AIRMETS issued by the National Weather Service, and to reduce substantially the manpower necessary to make the live broadcast of these In-flight Advisories, it would appear more practical to tape the advisories upon receipt for subsequent broadcast.

In view of the testimony at the TWA 514 public hearing, it would also seem necessary to conduct a survey of air carrier dispatch departments to assure that there are standard procedures in use to provide pilots in flight with SIGMET and other meteorological information.

On the basis of the foregoing, the National Transportation Safety Board recommends that the Federal Aviation Administration:

4. 1. Require that In-flight Advisories (SIGMETS and AIRMETS) be taped on receipt, for subsequent broadcast via navigational aid voice frequency and assure that they are, and continue to be, broadcast in accordance with current procedures. ~~(Class II)~~

5. 2. Require that Principal Air Carrier Operations Inspectors survey all air carrier dispatch departments to assure that adequate standard procedures are in use to provide pilots in flight with SIGMET and other meteorological information in accordance with ~~14 CFR 121.601(b). (Class II)~~

REED, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: John H. Reed
Chairman

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

RECEIVED
AUG 12 1975
AUG 12 1975

JUL 28 1975

OFFICE OF THE ADMINISTRATOR

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Notation 1517D

Dear Mr. Chairman:

This is in response to NTSB Safety Recommendations A-75-54 and 55.

Recommendation No. 1.

Require that In-flight Advisories (SIGMETS and AIRMETS) be taped on receipt, for subsequent broadcast via navigational aid voice frequency and assure that they are, and continue to be, broadcast in accordance with current procedures. (Class 11)

Comment.

We concur in principle with this recommendation and will change existing procedures. Facilities now are required to broadcast SIGMET/AIRMET information pertinent to their areas of responsibility. However, this only identifies the currency of a particular advisory and does not address the conditions nor the area affected. Changes will be made so that broadcasts of this type will highlight the nature of the advisory and specify where the SIGMET/AIRMET weather can be anticipated. Amplifying data will be available from flight service stations on request.

Flight service stations which do not originate transcribed weather broadcast recordings will continue to furnish these advisories in accordance with existing procedures; i.e., at WOO, H+15, W30 and H+45 for the first hour after issuance. These announcements will also be modified to conform with the transcribed weather broadcast procedures.

Additionally, we plan to include an article in our next air traffic service bulletin to field personnel reminding them of their responsibility to broadcast this information as required.

APPENDIX I

Recommendation No. 2.

Require that Principal Air Carrier Operations Inspectors survey all air carrier dispatch departments to assure that adequate standard procedures are in use to provide pilots in flight with SIGMET and other meteorological information in accordance with 14 CFR 121.601(b). (Class II)

Comment.

We plan to issue an air caxrier operations bulletin within the next 30 days to implement the action recommended.

sincerely,

James E. Dow

James E. Dow
Acting Administrator

APPENDIX I

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: July 3, 1975

Forwarded to:
Honorable James E. D o ~
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOWMENDATION(S)

A-75-56

The National Transportation Safety Board has noted the amendments to 14 CFR 91.75(a) and 91.116(f), effective March 6, 1975, regarding pilot responsibility under IFR after an ATC clearance has been received. However, the Board believes that further action should be taken to reduce the probability of misunderstanding by pilots and controllers of the meaning of ATC terms.

The aviation profession has its own unique language which tends to become ambiguous sometimes, as evidenced by our investigation of the accident involving TWA 514 at Berryville, Virginia, on December 1, 1974. Such ambiguity will be eliminated if everyone in the aviation community utilizes a standardized language in which the terms have a precise meaning. To accomplish this, a U. S. lexicon of air traffic control words and phrases should be published for the use of all pilots and ATC specialists. Words and phrases unique to air traffic control used in any document whatever, such as the Code of Federal Regulations, ATC handbooks, the TERPS Manual, the Airman's Information Manual, and military ATC publications should be included in this lexicon. Terms in common usage which are not now published (e.g., "cleared for the approach," "final approach course," "intermediate approach fix") should be included. The definitions in this lexicon should, to the maximum extent possible, be exactly those set forth in Volume II of the International Civil Aviation Organization (ICAO) Lexicon.

On the basis of the above, the National Transportation Safety Board recommends that the Federal Aviation Administration:

6. Publish a comprehensive lexicon of ATC terms and provide for its use by all pilots and ATC specialists. (Class II)

APPENDIX I

Honorable James E. Dow

REED, Chairman, THAYER, BURGESS, and HALEY, Members, concurred in recommendation. McADAMS, Member, did not participate.

John H. Reed

John H. Reed
Chairman

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

Notation 1517C

RECEIVED
JUL 11 1975

JUL 3 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Dear Mr. Chairman:

This will acknowledge receipt of your letter of June 26 which transmitted NTSB Safety Recommendation A-75-56.

the recommendation and will respond as soon as the evaluation is completed.

Sincerely,

J. W. Cochran

J. W. Cochran
Acting Administrator

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON. D.C. 20590

AUG 12 1875

OFFICE OF THE ADMINISTRATOR

JUL 28 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Indepmdmce Avenue, S. W.
Washington, D. C. 20594

Notation 1517C

Dear Mr Chairman:

This is in response to NTSB Safety

Recommendation.

Publish a comprehensive lexicon of ATC terms and provide for its use by all pilots and ATC specialists. (Class II)

Comment.

We concur in this recommendation and are developing a lexicon of this type. Examples of terms to be used in the lexicon are: "approach clearance," "cleared for approach," "final approach course," "intermediate approach fix," "radar route" and "low altitude alert."

We expect to transmit a completed lexicon to the printers by December 1.

Sincerely,

for James E. Dow
Acting Administrator

APPENDIX I

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: July 24, 1975

Forwarded to:

Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-75-58 & 59

The National Transportation Safety Board's investigation of the crash of Trans World Airlines (TWA) Flight 514 at Berryville, Virginia, on December 1, 1974, revealed that air traffic control (ATC) established radar contact with TWA 514 immediately after the airplane departed from Columbus, Ohio. TWA 514 progressed through the control jurisdictions of Columbus departure control, Indianapolis Air Route Traffic Control Center (ARTCC), Cleveland ARTCC, Washington ARTCC, and Dulles International Airport arrival control. The flightcrew was never advised of termination of radar control up to the time of the crash.

During the public hearing following the accident, the Dulles arrival controller testified that TWA 514 was classified as a nonradar arrival even though he was monitoring the progress of the flight by radar. The controller's testimony was corroborated by FAA management personnel from Air Traffic Service and from Flight Standards Service, who maintained that TWA 514 was a nonradar arrival since the pilot was performing his own navigation during the instrument approach.

The Board notes in Chapter 1 of FAA Handbook 7110.8D, dated January 1, 1975, that the term "radar service" encompasses radar separation, radar navigational guidance, and radar monitoring.

While we have been unable to locate an official FAA definition for the term "radar arrival," we believe that it is patently inconsistent and confusing to pilots for the FAA to categorize as "radar arrivals" flights receiving either radar separation or radar navigational guidance, and to categorize as "nonradar arrivals" flights receiving radar monitoring service.

APPENDIX I

Honorable James E. Dow

Therefore, we believe that a significant contribution would be made to the safety and efficiency of the National Airspace System by discontinuing the automatic termination of radar service in accordance with paragraph 1212c of ATC Handbook 7110.8D, dated January 1, 1975, and paragraph 662b of ATC Handbook 7110.9D, dated January 1, 1975, except after the aircraft has been visually sighted by a local controller.

Whenever a need arises for radar service termination after the aircraft is vectored to the final approach course, the pilot should be so advised. In any event, such termination should not be automatic as it is described on page 1-67 of the Airman's Information Manual.

On the basis of the above, the National Transportation Safety Board recommends that the Federal Aviation Administration:

7. 1. Define the term "radar arrival" and assign an equal weight of controller responsibility to all arrivals receiving radar service, regardless of the kind of radar service. (Class II)

8. 2. Discontinue automatic termination of radar service in accordance with paragraph 1212c of Handbook 7110.8D, ~~dated January 1, 1975, and paragraph 662b of Handbook 7110.9D, dated January 1, 1975,~~ except after the aircraft has been visually sighted by a local controller.

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: John H. Reed
Chairman

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

RECEIVED
AUG 12 1975

OFFICE OF
THE ADMINISTRATOR

July 24, 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Mependence Avenue, S. W.
Washington, D. C. 20594

Dear Mr Chairman:

This will acknowledge receipt of your letter of July 17 which transmitted NTSB Safety Recommendations A-7558 and 59.

We are evaluating the recommendations and [redacted]spond as soon as the evaluation is completed.

Sincerely,

J. W. Cochran
Acting Administrator

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

RECEIVED
AUG 28 1975
Notation 1517F

OFFICE OF THE ADMINISTRATOR

August 18, 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Dear Mr Chairman:

This is in response to NTSB Safety Recommendations A-75-58 and 59.

Recommendation No. 1. Define the term "radar arrival" and assign an equal weight of controller responsibility to all arrivals receiving radar service, regardless of the kind of radar service.

Recommendation No. 2. Discontinue automatic termination of radar service in accordance with paragraph 1212c of Handbook 7110.8D, dated January 1, 1975, and paragraph 662b of Handbook 7110.9D, dated January 1, 1975, except after the aircraft has been sighted by a local controller.

Comment 1 and 2. Basically, we concur with the recommendations. Prior to receipt of the recommendations, we established a task force to review and study the definitions, terms and phrases used in the ATC system to determine what terms and phrases should be defined; also what definitions should be made available to the pilot community. Recommendations A-75-58 and 59 are part of this study and we will take whatever action is necessary to clarify these issues.

We expect to complete the study by December 1 and will advise you of our proposed action.

Sincerely,

James E. Dow

James E. Dow
Acting Administrator

APPENDIX I

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: August 5, 1975

Forwarded to:

Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)
A-75-62

Testimony introduced at the public hearing concerning the accident involving Trans World Airlines (TWA) Flight 514 at Berryville, Virginia, on December 1, 1974, indicated that diversified data included in Part 1 of the Airman's Information Manual originate from various services of the Federal Aviation Administration, such as Flight Standards Service and Air Traffic Service. However, there is no single control function within the agency to assure the technical accuracy of data included in the manual.

Since the Airman's Information Manual is a primary source of aeronautical information concerning the National Airspace System, we believe that final editorial review and authority for the publication of the Airman's Information Manual should rest in a specified jurisdiction within the FAA. The designated authority should assure that the contents of the manual are and remain consistent with relevant regulatory and procedural documents.

On the basis of the above, the National Transportation Safety Board recommends that the Federal Aviation Administration:

10. Designate a specific authority to have final responsibility, both editorially and technically, for the content of the Airman's Information Manual. (Class III).

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.

By: John H. Reed
Chairman

1517E

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF THE ADMINISTRATOR

RECEIVED
AUG 15 1975

August 8, 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Dear Mr. Chairman:

This will acknowledge receipt of your letter of July 29 which transmitted NTSB Safety Recommendation A-75-62.

We currently have a designated point for coordinating and publishing the AIM. Action with regard to your recommendation is underway and we will respond immediately upon its completion.

Sincerely.

J. W. Cochran
J. W. Cochran
Acting Administrator

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON. D.C. 20590

September 5, 1975

OFFICE OF THE ADMINISTRATOR
RECEIVED
SEP 6 1975
Notation 1517E

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Dear Mr. Chairman:

This is in response to NTSB Safety Recommendation A-75-62.

Recommendation. Designate a specific authority to have final responsibility, both editorially and technically, for the content of the Airman's Information Manual.

Comment. We concur with the intent of the recommendation. However, responsibility for the technical accuracy of information contained in Part 1 of the Airman's Information Manual (AIM) is assigned to the contributing Services. This assures attention by specialists in each of the many technical areas in the AIM.

We have made the Air Traffic Service, Flight Services Division, responsible for editing and correlating all future data requested to be put in the AIM. The Flight Services Division will be required to edit the composition, assure the proper coordination, and retain copies of all backup material pertinent to all future items placed in the AIM. We believe this alternate action satisfies the intent of the recommendation.

Sincerely,

James E. Dow

James E. Dow
Acting Administrator

APPENDIX I

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: September 4, 1975

Forwarded to:
Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-75-74 thru -77

On December 1, 1974, Trans World Airlines Flight 514, a B-727-231, crashed at Berryville, Virginia. During the National Transportation Safety Board's public hearing into the accident, testimony was heard regarding cartographic specifications and procedures used by the Jeppesen Company and the National Ocean Survey (NOS) to prepare instrument approach charts.

The Safety Board determined that the Jeppesen approach chart used by the crew of TWA 514 and the NOS approach chart used by the FAA controllers handling the flight were properly constructed; both met the requirements outlined in FAA Form 8260.5.

However, differences do exist between the Jeppesen charts and the NOS charts. The two charts vary considerably in areas where FAA Form 8260.5 does not specify exact format. The specific areas in which the Jeppesen charts and the NOS charts differ are (1) depiction of the minimum sector altitudes, (2) size and structure of the profile view, (3) criteria for the depiction of obstacles on the plan view, (4) color of inks, (5) size of type, and (6) portrayal of navigational facilities.

The Jeppesen Company produces most of the instrument approach charts used by the civil aviation community. The company receives a wide range of comments and suggested changes in these charts from pilots, carriers, and other segments of the industry, and is constantly revising its published charts to respond to the needs and requirements of its users.

The official United States Government specifications for cartographic presentation are contained in the Interagency Air Cartographic Committee (IACC) Manual No. 4, Flight Information Publication, Low-Altitude, Instrument Approach Procedures. The National Ocean Survey is governed by the cartographic specifications of the IACC Manual. This interagency committee is made up of representatives of the Federal Aviation Administration, the Department of Commerce, and the Department of Defense.

APPENDIX I

Honorable James E. Dow

The Safety Board believes that the latitude allowed in preparation of the two published charts creates an undesirable degree of dissimilarity. While these variations do not necessarily create a hazard, the application of uniform criteria and uniform cartographic depictions would eliminate any areas of possible misinterpretation. In order to insure that the best cartographic techniques are identified and employed, we believe that both types of charts should be analyzed to determine the most effective specifications for instrument approach charts. Once identified, these specifications should provide a basis for revision of IACC Manual. No. 4.

In order to insure consistency between the preparation of FAA Form 8260.5 and the revised IACC specifications, the Safety Board further believes that reference to these revised specifications should be required of FAA personnel engaged in the preparation of FAA Form 8260.5.

Accordingly, the National Transportation Safety Board recommends that the Federal Aviation Administration:

10 1. In concert with the two other IACC Members (Department of Commerce and Department of Defense) and the Jeppesen Company, conduct a study of the cartographic techniques used and specifications used throughout the aviation industry ~~for approach charts for the purpose of identifying those~~ techniques and specifications that best lend themselves to uniformity and standardization for approach charts in the aviation industry.

11 2. Based on the above study, initiate steps to revise the IACC manual. ~~to include those techniques and specifications that best lend themselves to uniformity and standardization and to which there~~ is unamimous agreement by the ~~parties engaged in the study.~~

12 3. Require that the IACC manual be used as the minimum standards for cartographic presentation, ~~of specified data on all instrument approach charts used in U. S.~~ for civil + military aviation civil and military ~~aviation.~~

13 4. Require that the revised IACC manual be used as a mandatory reference by FAA. ~~personnel whenever a new instrument approach procedure is developed or whenever an existing procedure is modified.~~

APPENDIX I

Honorable James E. Dow

McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation. REED, Chairman, did not participate.

By: John H. Reed
Chairman

APPENDIX I

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: September 9, 1975

Forwarded to:

Honorable James E. Dow
Acting Administrator
Federal Aviation Administration
Washington, D.. C. 20594

SAFETY RECOMMENDATION(S)

At the National Transportation Safety Board's public hearing into the crash of Trans World Airlines Flight 514 at Berryville, Virginia, on December 1, 1974, the Federal Aviation Administration's (FAA) guidelines, which govern the construction of the profile view of an instrument approach chart, were discussed.

The VOR/DME 12 instrument approach procedure plan view in effect at the time of the accident provided guidance from a point 38 miles from the VORTAC and as high as a highest initial approach altitude of 3,700 feet. However, the profile was depicted only from the final approach fix of 6 miles from the VORTAC and from an altitude of 1,800 feet.

At the public hearing, pilots testified that, after they are cleared for approach, they immediately use the profile view as a primary source of altitude information. Without considering the merits of this technique, the Safety Board believes that, if the profile view represented a consistent altitude transition from the initial approach fix to the final approach fix, any tendency to overlook the altitude restrictions between these points would be avoided. In an approach procedure where neither a procedure turn nor a 1-minute holding pattern is authorized, and where the profile starts at the final approach fix, pilots can become confused about the applicable minimum altitudes before the final approach fix.

A consistent altitude transition throughout the approach procedure is even more logical in view of changes made by the FAA to the VOR/DME 12 procedure (now a VORTAC 12 approach) at Dulles International Airport. An important revision to this procedure is the extension of the profile to 4,000 feet m.s.l., which exceeds the minimum sector altitude for this quadrant.

APPENDIX I

Honorable James E. Dow

FAA Handbook 8260.19 contains guidelines used by the procedure specialist for the construction of the profile view. However, the handbook does not specify exactly where the profile should start if the procedure does not include a procedure turn or a 1-minute holding pattern, Rather, the handbook is concerned with obstruction clearances, and it merely assumes that the transition from the plan view to the profile view will be made properly. However, as illustrated by Flight 514 and the United Air Lines aircraft which narrowly missed the same mountain, existing approach procedure guidelines must be revised.to eliminate any misunderstanding concerning applicable minimum altitudes.

An approach chart must not be subject to misinterpretation or misunderstanding. Accordingly, we believe that FAA Handbook 8260.19 should be revised regarding requirements for the profile of an approach which does not have an authorized procedure turn or a 1-minute holding pattern. The profile for this procedure should start at the intermediate approach fix or at an altitude equal to the minimum sector altitude for the quadrant. This extension of the profile, as demonstrated by the new VORTAC 12 chart, would provide a consistent altitude transition throughout the approach and would improve the effectiveness of the chart, since the profile and plan view would reflect identical altitude information for a greater portion of the approach.

Accordingly, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> ~~Revise paragraph 1011 of FAA Handbook~~ 8260.19. ~~dated~~ ~~, to~~ require that on approach procedures, for which neither a procedure turn nor a 1-minute holding pattern is authorized, the profile must start either at the intermediate fix or at an altitude equal to the minimum sector altitude for the quadrant in which the procedure begins. (Class II)

By: John H. Reed
Chairman

REED, Chairman, THAYER and BURGESS, Members, concurred in the recommendation. McADAMS and HALEY, Members, did not participate.

APPENDIX I

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF THE ADMINISTRATOR

September 9, 1975

RECEIVED SEP 6 1975

Honorable John H. Reed
Chairman, National Transportation Safety Board
800 Independence Avenue, S. W.
Washington, D. C. 20594

Dear Mr. Chairman:

This will acknowledge receipt of your letter of September 2 which transmitted NTSB Safety Recommendation A-75-78.

We are evaluating the recommendation and will respond as soon as the evaluation is completed.

Sincerely,

James E. Dow

James E. Dow
Acting Administrator

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